PRODUCTION OF EDIBLE OIL IN WEST BENGAL : STUDY OF POSSIBILITIES IN ATTAINING SELF SUFFICIENCY

THESIS SUBMITTED FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY IN GEOGRAPHY (Arts)
NORTH BENGAL UNIVERSITY

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This is to certify that Shri Harsha Kumar Das Gupta, Lecturer, Selection Grade of Union Christian Training College, Berhampore, has completed his work on 'Production of Edible Oil in West Bengal: Study of Possibilities in attaining self sufficiency', under my direct supervision and guidance for his Ph.D.(Arts) degree in Geography in North Bengal University. His analyses for production of edible oil and possibilities of its self sufficiency have opened up a new horison in relation to economic restructuring in the State of West Bengal.

He has fulfilled the requirements of the regulations in relation to the nature and period of research work. This work is the first of its kind done by Shri Das Gupta and so far as I am aware, no research in this format has been done in any Indian and Foreign Universities. The candidate himself has done this work through his field collection of both primary and secondary data and computer processing. He has not published this thesis or part thereof anywhere.

I hope his work will receive proper recognition from the academicians in the field and analyses and suggestions will help bring self sufficiency, eliminating the constraints and exploring the new sources in the way to accelerate production and ameliorating the consumption rate of edible oil in West Bengal.

Anindya Pal

(Anindya Pal) 24.6.93

PROFESSOR,
Department of Geography and Applied Geography
University of North Bengal.

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June, 1993

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C O N T E N T S

ABBREVIATIONS

AICORPO - All India Co-ordinated Research Project.

A.I.S and L.U.S. - All India Soil and Land use Survey.

A.P - Andhra Pradesh.

BARC - Bhaba Atomic Research Centre.

B : C - Benefit : Cost Ratio.

B.C.K.V. - Bidhan Chandra Krishi Viswavidyalay.

BIH - Bihar.

B.M. - Bench Mark.

BNV - Bud hecrosis virus.

B.S.R. - Bran Stabilisation route.

C.E.C. - Cotion Exchange Capacity.

CFTRI - Central Food and Technology Research Institute.

COI - Census of India.

CPCRI - Central Plantation Crop Research Institute.

DAS - Days after Showing.

DAV - Directorate of Agriculture Aviation.

D.A.W.B. - Director of Agriculture , West Bengal.

DFA - Desolventised falley acid.

DPAP - Drought Prone Area Programme.

DPPQS - Directorate of plant protection Quarantive and Storage.

D.S.R. - Disteillative satabilization route.

ESP - Exchangable-sodium percentage.

FAO - Food and Agriculture Organisation.

FFA - Free and Fatty Acid.

FP - Farmers Practice.

FYM - Farm yard manure.

GBPUTA - Govindaya Ballav Panth University on Technology of Agriculture.

G.S.I. - Geological Survey of India.

GUJAR - Gujrat.

HARYA - Haryana.

H.A.U. - Hissar Agriculture University.

HLFR - Hindustan Leaver Research Foundation.

I - Irrigated.

IARI - Indian Agricultural Research Institute.

IB: C - Incremental Benefit : Cost Ratio.

ICAR - Indian Council of Agricultural Research.

ICOC - Indian central oilseed commission.

ICRAI - Indian Council of Research on agro Forestry.

ICRISAT - International Crop research Institute for Sami Arid Tropic.

IMD - Indian Meteorological Department.

IRDP - Integrated Rural Developement programme.

IT - Improved Technology.

K - Kharif.

KARNA - Karnatak.

KVIC - Khadi and Village Industries Commission.

LAO - Lipose activated oil.

LI - Limited Irrigation.

LUP - Land use planning.

MAHAR - Maharastra.

M.G.D. - Mysore Geological Department.

MOR - Mourakshi River.

M.P. - Madhya Pradesh.

M.S.L. - Mean Sea Leavel.

NBSS - National Board of Soil Survey.

NCA - National Commission on Agriculture.

NET - National Evaluation Trials.

NODP - National oilseed development project.

NOVODB - National oil and Vegetable oil Development Board.

N.S.C. - National Seed Corporation.

O.J.G.S.- Quarterly Journal of the Geological Society of London.

ORI - Orissa.

OPTP - Oilseed production thrust project.

P.F.A. - Palm Fattey acid.

PUN - Punjab.

RAJAS - Rajasthan.

RBO - Rice Bror Oil.

RF - Rain Feed.

R/S - Rabi / Summer.

R.W.C. - Relative water content.

S.A.O. - Subdivisional Agricultural Officer.

SAR - Sodium - adsorption-ratio $\dfrac{Na^{+}}{\sqrt{(Ca^{++} + Mg^{++})/2}}$

SFCI - State Farns corporation of India.

T.N. - Tamilnadu.

TG - Trombay Groundnut.

TSWV - Tomato spolted wilt virus.

U.P. - Utter Pradesh.

U.S.D.A. - United States Department of Agriculture.

VMAI - Vanaspati Manufactors' Association of India.

LIST OF TABLES

LIST OF CARTOGRAMS

LIST OF MAPS

CHAPTER - I

INTRODUCTION

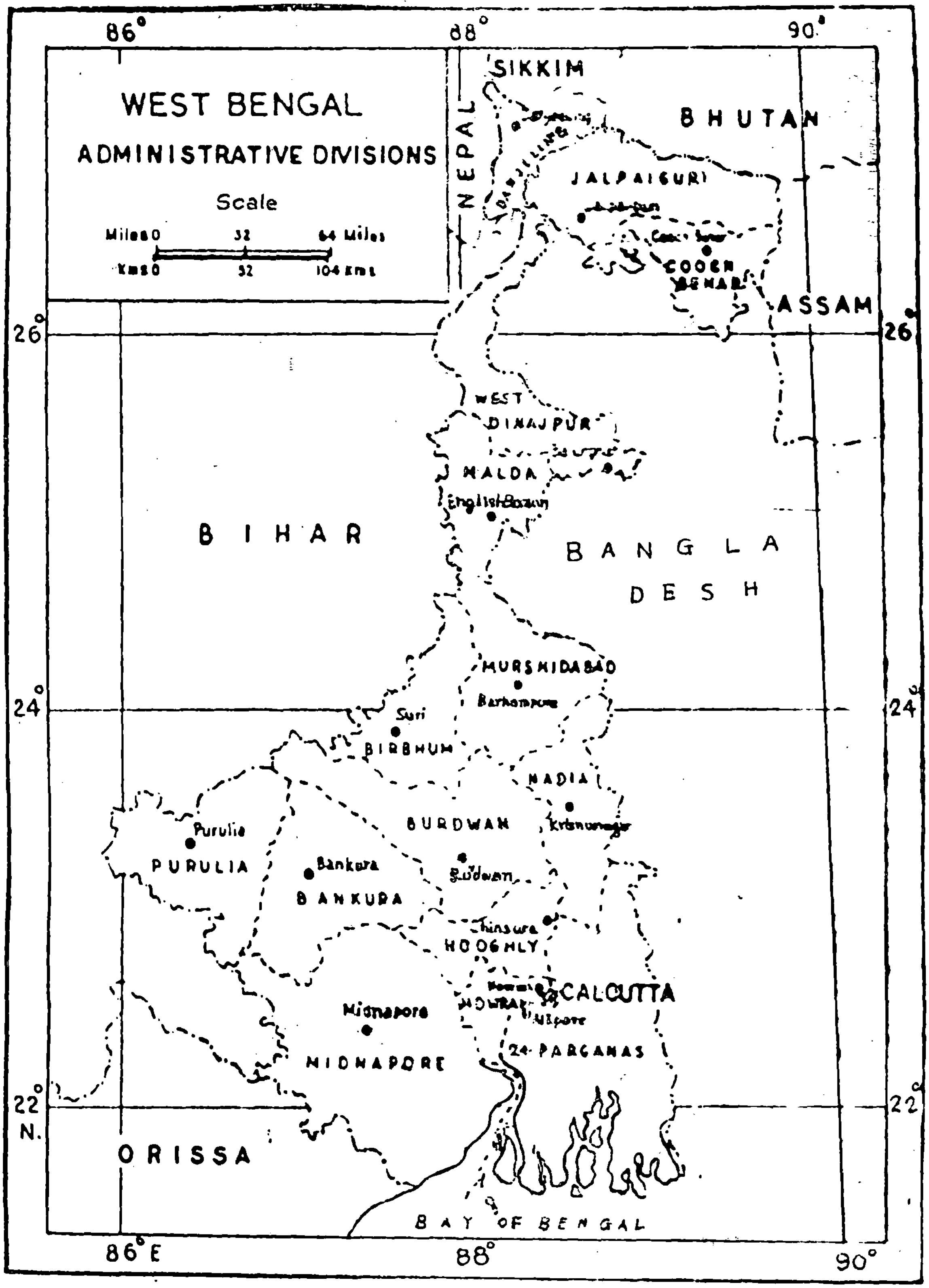
India is one of the major producers of oilseeds in the world. Yet our vegetable oil economy is to be set with the problems of shortage. The demand-supply gap in vegetable oils, once developed to a fightening level necessitating massive imports of edible oils. During 1986-87 and 1987-88, the country imported edible oils to the extent of 15 lakh tonnes and 18 lakh tonnes respectively, while in 1988-89 and 1989-90 it came donw to 3.70 lakh tonnes and 6.90 lakh tonnes respectively.

During the current oil year 1990-91, the availability of edible oils in India has been estimated at 49 lakh tonnes, which is higher than the estimate of 47.45 lakh tonnes in 1989-90. If the per-capita consumption is assumed at 6.5 kgs, (including 5.3 kgs. of liquid oils and 1.2 kgs of vanaspati) the total requirement of edible oils would be around 54.60 lakh tonnes in 1990-91 to feed about 850 millions of people. The per-capita consumption if however, taken at 7 kgs, the total requirement of edible oils would be of the order of 58.80 lakh tonnes.

A recent exercise conducted at Krishi Bhavan reveals that the agregate production of oilseeds during 1989-90 crop year would be in the neighbourhood of 186.6 lakh tonnes (88.6 lakh tonnes kharif and 80 lakh tonnes rabi) which indicates that the deficit in edible oils would be an anything between 6 and 9 lakh, tonnes in the current oil year.

The importance of oilseeds in our national economy can hardly be over emphasised. Oilseeds crops are the principal source of edible oils, forming and integral part of human diet. Besides, it constitutes important raw materials for a number of manufactured goods including soap, paint, lubricants and so on

Next to foodgrains, oilseeds contribute significantly to the agricultural economy of the country. In India, Oilseeds crops are cultivated


WEST BENGAL
ADMINISTRATIVE DIVISIONS
Scale
Miles 0
32
64 Miles
Kms 0
32
104 Kms
86°
88°
90°
26°
24°
22° N.
86° E
SIKKIM
NEPAL
BHUTAN
JALPAIGURI
COOCH BEHAR
ASSAM
WEST DINAJPUR
MALDA
English Bazar
BIHAR
BANGLA DESH
MURSHIDABAD
Barhampore
Suri
BIRBHUM
NADIA
Krishnanagar
BURDWAN
Burdwan
Purulia
PURULIA
Bankura
BANKURA
Chinsura
HOOGHLY
CALCUTTA
HOWRAH
24-PARGANAS
Midnapore
MIDNAPORE
ORISSA
BAY OF BENGAL

Map No. 1

in an area of 18 million hectarea, accounting for about 12% of the total land under cultivation. Oilseeds crops like groundnut, mustard/rapeseed, safflower, niger and sunflower are largely used for edible purposes while linseed and castor are pre-dominantly growth for industrial purposes. The production of cultivated oilseeds taken together touched a new peak of 179 lakh tonnes by the end of the Seventh plan as against the target of 180 lakh tonnes.

Among the major oilseeds crops, groundnut and mustard/rapeseed account for about 80% of the total production of oilseeds in the country. Gujarat contributes about 30% of the area and output of groundnut while U.P. accounts for about 60% of the area and production of Mustard/rapeseed in the country.

It is well-known that land is a limiting factor in West Bengal. The availability of cultivable land in the oilseeds sowing seasons is a problem of wide dimension as the farmers have a definite cropping pattern of their own. Extension of acreage for raising the production of oilseeds crop is almost ruled out, and as such, greater emphasis has to be laid on raising the productivity of oil seeds and also the introduction of new oilseeds crop and also explanation of non-conventional seeds of tree origine and other sources like rice bran etc. to make the state self-reliant in respect of edible oils as it is well known that West Bengal has a wide demand-supply gap in edible oils.

CHAPTER - II

HISTORICAL BACKGROUND

Turning to the history of oilseed research in our country, up to 1947, oilseed research in India was conducted independently by the states and there was very little coordination among them. From 1947 to 1966 oilseed research was supported by Commoditiy committees and research commenced in an organised way. Only in 1967 in ICAR took over the research on oilseeds and coordinates, like in the case of wheat and rice, the oilseed programme would not pick up any momentum. That was the reason ICAR took over the All India Coordinated Programme in 1967. In the Third Plan, there were 32 centres working on oilseeds with a budget of Rs.10 million; in the Fourth Plan 40 centres with a budget of Rs.15 million; in the Fifth Plan we had 62 centres with an outlay of Rs.40 million and in the Sixth Plan we had 77 centres with Rs.60 million. Considerable emphasis has been given by the ICAR to intensify the work on oilseed research. The Project Directorate on oilseed was started in 1976 and the regular Project Director joined in 1973. In addition to that we appointed a series of Project Coordinators for each of the individual crops to give impetus to oilseed research. All India Coordinators for groundnut, sesame, rapeseed-mustard, and other oilseed crops and their job is to see that research of that particular crop is coordinated properly. In addition, the National Training Centre and organised some training programmes for groundnut, castor, etc., and now, within a few days, a training programme is being organised for rapeseed-mustard at Haryana Agriculture University, Hissar. The National Centre for Groundnut Research at Junagarh started in 1979 exclusively to work of groundnut. In addition to that there are a number of ad hoc schemes of the ICAR, dozens of them to do research in different agricultural universities. The international collaboration from International Development Research Centre of Canada. The work on sesame, safflower, and repeseed-mustard. There is also a Swedish Development Agency, on repeseed-mustard. In addition to that, ICRISAT, which is located in Hyderabad, is also doing extensive work on groundnut. We have a separate All India Coordinate Research Project on soybean with 18 centres. The coconut programme going on at a number of centres. In Bangalore last year a decision wastaken that we should initiate and intensify work on the African oil palm. This is one of the potential areas of research. The elite seed production programme for sunflower. A hybrid of sunflower has been developed and given to the National Seed Corporation and other seed agencies.

The Department of Agriculture is more concerned then us because they are answerable for the total production of oilseed in the country. Since 1980-81 they have intensive projects for increasing the production of groundnut with a budget of Rs.35 crores. Soybean project in Madhya Pradesh is operating since 1981-82 with an outlay of Rs.10.56 crores. There is intensive oilseed Development Programme, extension of oilseeds to new areas, irrigated areas, development of soybean and sunflower, with an outlay of Rs.19.35 crores. Then we have the NDDB Project in Gujarat on augmenting production and marketing of edible oils and oilseed. They have 1268 cooperatives in the country and the number of cooperative is increasing. The Oil Palm India Limited has plated about 3,110 hectares under oil palm in Kerala and about 640 in the Andaman Nicobar Islands. The National Oilseeds Development Project, a huge project to increase production by 3 million tonnes with a budget of Rs.70 crores. we have a very extensive minikit programme: in 1982-83, 3.97 lakh of minikits have been supplied, as compared to 72,000 in 1981-82 and 32,000 in 1980-81 - all of which shows the importance being given to improve oilseed production in the country. In addition to that a centrally sponsored and World Bank-aided Kerala Agricultural Development Project is operating, which is involved in the improvement of the coconut production in the country.

The area under rabi groundnut has increased from 2,000 hectares to 1.1 m hectares in Gujarat, and yields are about 1530 kg per hectare as compared to 610 kg of the kharif groundnut. This is a hopeful sign area under sunflower and soybean is increasing in a big way. Inter-cropping of sunflower is going up in Gujarat because they keep 90 cm distance between two rows of groundnut and this trend is catching up in Gujarat.

The national scientists have developed new varieties of different crops - e.g., 30 varieties in the case of rapeseed mustard alone. It is possible to produce 25 to 35 quintals of seed of this crop per hectare with proper management and plant protection. The production and protection technologies have been standardised in a number of crops. They have produced early maturing varieties to fit into the cropping systems and also for the intercropping systems. Two sunflower hybrids from the University of Agriculture Sciences, Bangalore, BSH I and II and Surya from the Punjabrao krishi Vidyapeeth, Akola are vary promising, and variety Morden is picking up very well in Gujarat for intercropping.

The work on oil content should be intensified. It is not enough if only the oilseed production is increased but it is also very important to increase the yield of oil per kg oilseed or per unit area. In case of safflower, our scientists have improved the oil content by about 4-5 per cent as compared to the commercial varieties we are growing. Our present emphasis is to improve the oil content per se. The collection, evaluation and cataloguing of the germplasm is going on in a big way. We have 7,000 varieties of groundnut, about 3,000 varieties of sesame, and about 4,000 varieties of rapeseed-mustard. We have reasonably assembled the world germplasm of all the major oilseed crops. We are cataloguing them and also developing facilities for long-term storage.

The production technology for higher yields is being perfected and as I said, 25-35 quintals per hectare is possible with the new technologies and new varieties. Our scientists will have to work on improving the yield per hectare. Another important aspect is the oil content in various crops. In the case of cottonseed oil, rice bran oil and African oil palm there are tremendous potentialities; in fact there are several non-conventional oilseed plants. The U.S. Department of Agriculture lists about 2,000 varieties round the world, capable of producing edible oils, out of which we have about 100 in our country.

In view of the importance of the development of minor and non-edible oilseeds in the country, the President, Indian Central Oilseeds Committee vide Government of India. Ministry of Food and Agriculture, letter No. 11-37/58- Com. II dated the 17th June 1959, constituted a "Special Committee for development of minor and non-edible oils".

A number of plants like mahua, neem, sal, kusum, karanja and even rubber seed and tea seed can be use for extraction of edible oils. It was planned to produce 1.38 lakh tonnes of oil from the non-conventional sources by 1981-82 and an outlay of about two crores has been earmarked. The World Bank Project on cotton has been a very good success. Similarly, if some blocks can be taken up where oilseeds are grown intensively, it will go a long way to increasing the production of oilseeds in the country. One of the problems in oilseeds is the risk factor involved. As to say the vagaries of monsoon influence oilseed production tremendously. Some type of crop insurance on a limited scale in selected districts will create a lot of confidence in our farmers. Another area is, to improve Processing technologies to extract more oil. With some of our current technologies we are not able to extract all the oil and considerable amount is left in the oil cake - this requires special attention. Breeders have to pay more attention to increasing the yield of the crops per se. Quality seed production should be taken up on a massive scale and seed should not become a limiting factor. We need to develop dry farming technology because over 90 per cent of the oilseeds are under dry farming situations. Some kind of mechanisation is necessary but nobody is coming forward to manufacture the implements for dry farming situations.

Vegetable oilseeds and oils have assumed an importance of their own in the economy of the country. The demand of vegetable oils, both for edible and non-edible purposes, has increased in recent years with the increase in population and standard of living. It is in this context that increasing production of oilseeds has been given a high priority under the new 20-point programme.

The first three years of the Seventh Plan have seen a remarkable change in the agricultural scenario of West Bengal. There has been a major break-through in production of foodgrains, especially rice. It has also been noticed that there is a perceptible trend towards change in the cropping pattern specially in commercial crop production. However, the State continues to face substantial deficit in oilseed production. Being a major consumer of mustard oil in the country West Bengal has to depend on supply from other States.

To fill up the gap, imported edible oil like Rapeseed oil is distributed through public distribution system. During 1986-87 this State produced 0.58 lakh tonnes of mustard oil from its internal production of Rapeseed - mustard and about 2.16 lakh tonnes of mustard oil was imported from other States in addition to substantial quantity of Rapeseed oil from imported edible oil pool. If fact only 28% of the requirement of edible oil was met from internal production. However, due to introduction of various scheme like NODP, OPTP, NOVODB, the situation has changed during 1987-88 and this State has produced 3.34 lakh tonnes of rape-mustard seed which has yielded 1.11 lakh tonnes of mustard oil. Now this State is in a position to meed about 50% of the overall requirements of various oil seeds. This could be achieved due to the integrated extension support vis-a-vis transfer of technology at the field level under the technology mission. There is also a growing awareness amongst the farmers about need for adoption of improved package of practices in the cultivation of oilseeds crops, which is giving them a high return. As a result the production of soilseeds is expected to increase from 2.36 lakh tonnes in 1984-85 to 5.44 lakh tonnes by 1989-90.

The major constraint in the state are that most of the area under oilseed crops is rainfed comprising largely of marginal and sub-marginal lands resulting in year to year fluctuations in production. Considerable production losses occur due to pests and diseases, inadequacy of arrangements for timely supply of quality seed of improved varieties, other inputs and credit, etc. These coupled with the small size of holdings have made the oilseeds to be grown under conditions of poor crop management resulting in low yields. Finally, marketing support is practically non-existent. No body can expect the farmer to use fertile and irrigated lands for crops like oilseeds because wheat, paddy, sugarcane, cotton and various other crops prove to be much more profitable, in spite of the fact that oilseeds fetch very good prices in the market. This is only because of the shortage of edible oils. They have been fixing the support prices for oilseeds only to give a boost and incentive more as a satisfaction to the farmer, but this is more or less irrelevant because the market prices are much higher than those announced by the Government.

CHAPTER - III

GEOLOGY AND GEOMORPHOLOGY OF THE STUDY AREA

3.1 BOUNDARY

West Bengal is bounded on the north by Sikkim and Bhutan on the east by Goalpara district of Assam and Bangaladesh, on the south by the Bay of Bengal, and on the West by Balasore and Mayurbhanj district of Orissa, Singhbhum, Ranchi, Hazaribagh, Santal Paraganas and Purnea district of Bihar and the kingdom of Nepal. Thus the state has land frontiers on its three sides and the southern frontier is limited by the Bay of Bengal.

3.2 AREA

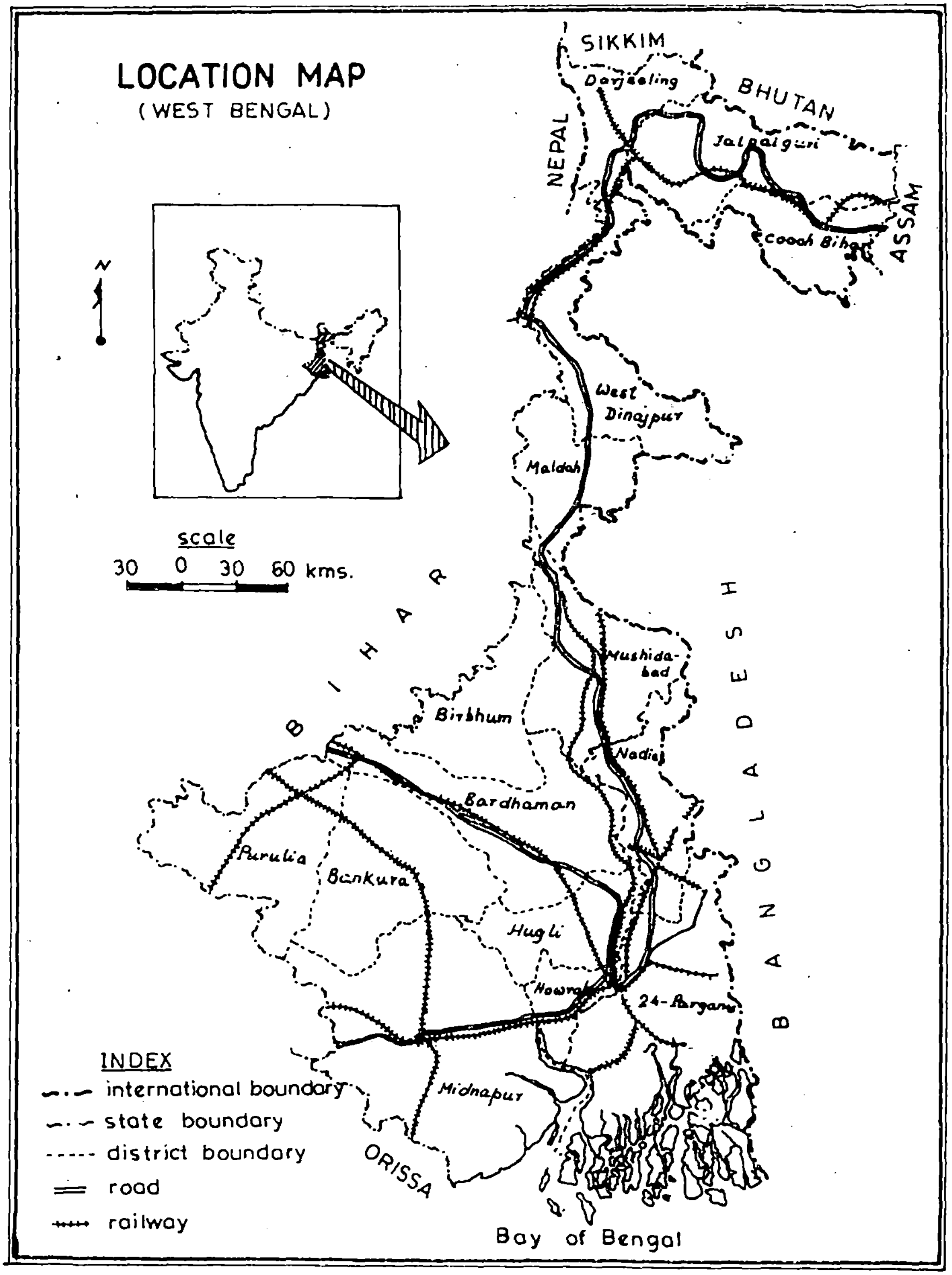
The State of West Bengal stretches from the Himalayas on the north to the Bay of Bengal in the south situated between latitude 21°25' 24" N and 27°13'15" N and longitude 85°49'20" E and 89°53'04"E. The present state covers an area of 87, 616 Sq Kms which is about three percent of the total land surface of India

3.3 GEOLOGICAL BACKGROUND

(i) Tracts of the Himalays in the north

Since the Dalings practically always underlie the Darjeelings and show a different grade of metamorphism. The two were formerly considered to be distrinct series separated by a hypothetical thrust zone. J.B. Auden regards the presence of a thrust zone improbable (Rec G.S.I. LXIX, P. 123-167, 1935).

The Darjeeling seem to be merely the granite - injected and highly metamorphosed upper part of the Dalings. The granitic constituent of the Darjeelings, and that a similar granite has given rise, by disintegration to the felspathic sandstone of the middle siwaliks of the Darjeeling Nepal foot hills


LOCATION MAP
(WEST BENGAL)
N
scale
30 0 30 60 kms.
SIKKIM
Darjeeling
BHUTAN
NEPAL
Jalpaiguri
ASSAM
Cooch Bihar
West
Dinajpur
Maldah
BIHAR
BANGLADESH
Murshidabad
Birbhum
Nadia
Bardhaman
Purulia
Bankura
Hugli
Howrah
24-Parganas
Midnapur
ORISSA
Bay of Bengal
INDEX
international boundary
state boundary
district boundary
road
railway

Map No. 2

The Daling and Darjeeling series have been thrust over the gondowana with which they are sometimes intercalated as thrust slices. They form a large recumbent fold thrust to south In the core of the fold are the Kanchanjunga, Parnri and some other massifs, while Mount Everest is in its upper limb.

The Darjeeling and Daling series continue into the sub Himalayan area of Bhutan and also farther east. Argillaceous schists and gneisses are predominent. The gnesisses are very finely foliated of heterogeneous composition, the different schistose planes being characterised by material of different composition. The gneiss is often closely associated with schists of various composition.

The gneiss is often dioritic, owing to the larger proportion of the plagioclase present Numerous intercalated beds of limestones, dolomites, hornblends rock, epidote-rock, corundumrock etc. occur among the gneiss. There is an abundance of accessory minerals, contained both in the rock itself and in the accessory beds associated with it, such as magnetite, ilmenite, schorl, garnet, Calcite, lepidolite, beryle, apatite, epidote, corundum, micas and sphens. In all the above characters the rocks commonly designated Bengal gneiss-differ strikingly from those commonly named Bundelkhand gneiss.

The Weathering of some parts of the gneiss of North Bengal is very peculiar, it gives rise to semi-circular, dome like hills, or ellipsoidal masses, by the exfoliating of the rock in regularly circular scale. From this peculiarity the gneiss has received the name of Dome gneiss.

A strip of gondwana adpressed against the siwalik foot hills in the Darjeeling sector of West Sikkim. There is an interesting occurrence of a lower gondwana coal field with thick coal seams, underlying the dolomite and phyllites of the Daling series. In the Ranjit Valley north of Darjeeling, the coal field is exposed from underneath the eroded cover as a window. Intercalated in the fillites and boulder beds of Talchir affinities and underlying the coarse sandstones and shales containing glossopteris, vertebraria and schizoneura are marine hands with fossil spirifer productus, Uridesma, conularia and chonetes.

Regional scheme

The regions has been divided into two second order regions (a) Darjeeling Sikkim (b) Bhutan, Darjeeling-Sikkim Himalaya is further divided into sub-regions. (1) Singalila range (ii) Donkhya range (iii) Darjeeling region (iv) Kalimpong region.

Among the four divisions a conciderable parts of the regions are within the administrative area of West Bengal.

Tista Valley

Directly opposit the Ganga Delta, the Tista Valley, like the Kosi reproduces on a vast scale de Martonne's schema of a mountain torrent. The upper basin is 50 miles wide and occupies easily eroded slates, phyllites and schists along the axis of an overfalded anticline, at the core of which lies Kanchenjunga". The river cuts through the Darjeeling ridge (2,135-2,440 m) in a narrow gorge to spill on to the plain in a vast fan or para delta seamed with old course.

Western Undulating Plateau

The western plateau and the undulating topography of West Bengal is very much closely intercalated with the different rock structures of the various characters. Purulia is holding the main system the chatonagpur plateau. Purulia becomes a part of the Singhbhum region of the plateau and may be considered as purulia upland. This area includes the Bagmundi plateau which is an extension of the Ranchi plateau. The land slopes gradually towards the east until it merges with West Bengal plain.

The Rarh plain of West Bengal consists of Birbhum, Bankura, Western part of Burdwan and Midnapur district holds major experiences of gondwanas, which form generally low undulating terrian. The Midnapur area of Bengal is continous with Dhalbhum (Eastern Singhbhum and Contains gnesisses and schists known as Bengal gneisses).

Bengal Gneisses

Highly foliated, heterogeneous, schistose gneisses and schists, of Bengal, Bihar, Orissa, Carnatic and large tracts of the Peninsula.

Types of Bengal Gneiss

Besides the foregoing varieties stated earlier some other petrological types are distinguished in the Bengal gneiss, the most noted being the Sillimanite-gneiss and Sillimaniteschist of Orissa, known as Khondalites (from the Khond inhabitants of Orissa). These give clear evidence of being metamorphosed sediments (para schists) and are discussed in the next chapter. A large part of the schistose and granetiferous gneiss of south India, commonly designated "Fundamental gneiss" or "Peninsular gneiss" belongs appropriately to this division. The Bengal gneiss facies is revealed in the gneisses of Bihar, Manbhum and Rewah, and some other parts of the Peninsula also. The Carnatic and Salem gneisses are examples, Carnatic gneiss is schistose, including micaceous, talcose, and hornblendic schists. The wellknown micabearing schists of Nellore, which support the mica mines of the district, belong to the facies of the Bengal gneisses. The schistose type of Bengal gneiss is regarded as probably the oldest member of the Archaean Complex. The Peninsular gneiss of Karnataka, covering 64,750 square Km, is now believed to be a granitic gneiss intrusive into an older Dharwar complex. What have been called the Closepet and Champion gneisses are also later granites intruded in the same basement complex. Recent work in the Archaean Complex of South India has shown that many of the fine-grained gneissic rocks are actually granitoid phases of recrystallised pre-existing formations and do not represent the crushed of foliated phases of true cruptive granites (Records M.G.D., Vol. 42, 1944).

Damuda Series

The Talchir series is succeeded by the second division of the lower gondwana, the Damuda series, the most important portion of the gondwana system. Where fully developed as in the Domuda area of Bengal, the series is divided into three stages, in the descending order.

Raniganj - 1,500 m.

Ironstone Shales (Barren measures) 400 m.

Baraker - 600 m.

The Barakar Stage along the Damodar rivers rests upon the Talcher Series, and consists of coarse, saft usually with white massive sandstone and shole with thick variable coal seams.

The stage is met with the Jharia and Karanpura coalfields but when followed west wards it marges into the overlying Raniganj series. The group is of a most inconstant thickness and appears only at a localities in the Domuda area, being altogether missing from the rest of the gondwana area. This is succeeded by the Raniganj stage of the Domuda series, named from the important mining town of the West Bengal. The Raniganj stage is composed of massive, false bedded, coarse and fine sandstones and red brown and black shales with numerous interbadded coal seams. The sandstones are felspathic, but the felspar in them is all decomposed i.e. Kaolinised. The Kaolinised ore is also extended in the Birbhum district of West Bengal a few km. of the district Headquater Suri - the name of the location is Patelnagar.

The Damuda fossils are nearly all plants. The flora is chiefly cryptogamic, associated with only a few spermaphytes. It is exceedingly rich in peteridosperm leaves of the netveined type.

The Damuda Flora

The Damuda fossils are nearly all plants. The flora is chiefly cryptogamic, associated with only a few spermaphytes. It is exceedingly rich in Pteridosperm leaves of the netveined type, the genus Glossopteries here attaining its maximum development, while Gangamopteris is on the decline. The following are the most important genera :

(Pteridosperms) - Glossopteris with Vertebraria, at least nine species, several of them confined to the Raniganj stage, Gangamopteris, Belemnopteris, Merianopteris, Sphenopteris, Pecopteris, Palaeovittaria.

(Ginkgoales) - Rbipidopsis.

(Cordaitales) - Noeggeratbiopsis, Dadoxylon.

(Cycadophyta) - Taeniopteris, Pseudoctenis.

(Filicales) - Cladophlebis.

(Equisetales) - Scbizoneura, Phyllotheca.

(Sphenophyllales) - Sphenophyllum.

(Lycopodiales) - Bothrodendron.

(Incertae) - Barakaria, Dictyopteridium, scales, seeds including Samaropsis and Cordaicarpus.

Raniganj Series

The Raniganj series is represented by the Bijori stage in the satpura by Kamithi beds of Nagpur and wardha valley in chanda, the Pali beds of south Rewa; the Himgir beds in the Mahanadi and Brahmari valleys; the almod beds occuring just south of the Panchmari scarp; and the chintalpudi sandstone of the godavari valley.

From the geological point of view the Raniganj coal field is the easternmost field in the Damodar valley and is situated around Asansal about - 210 km. North of Calcutta. It covers about 1550 sq.km. of proved coal bearing area. It is surrounded on three sides by Archacan rocks but on the east it passes beneath alluviam and laterite where its extension is a matter of speculation to be proved by driking. The table below shows the succession of the formation exposed in the field.

Formation	Description	Maximum thickness Mtrs.
Supra panchets	Red and gravy sand stones and shales	300
Panchet	Micaceous yellow and grey sandstones, red and greenish shales	600
Raniganj	Gray and greenish soft feldspathic sandstones shales and coal seams	1,050
Ironstone shales	Dark carbonaceous shales	

Formation	Description	Maximum thickness Mtrs.
Barakar	Coarse and medium grey and white sandstones, shales and coal seams	630
Talchir with boulder bed at the base	Coarse sandstones above and greenish shales and sandy shales below	300

The Raniganj Coalfield is faulted down on the south and west, the southern boundary being a series of fault, indicating a throw of 2,700 m near the panchet hill. Over the greater part of the northern side. The goundwana boundry is one of original deposition, modified of course by later erosion. The oldest beds are found in the north, and are overlapped by younger beds in a southward direction, the general dip being also south wards, Besides the boundary faults, there are also oblique and cross faults in the field. The main dislocation probable took place in the Jurasic. The field is traversed by many dolerite and micaperidotite dykes, the latter having produced much damage to coal as stated earlier. The intrusives are later than the faults and may be of Raniganj or Deccan trap age.

Coal

Coal seams, most of which have two or more local names, occur both in Barakar and Raniganj stages.

This coalfield has been worked since about 1800, the total amount raised to 1980 450 million tones from the secondary statistics.

It is only the Raniganj and Jharia fields which have been mapped satisfactorily. There are now some data for reserves at depths of more than 600 m. Our knowledge of the other coalfields in still unsatisfactory. It is however certain that the present estimates of reserves will be appreciably increased as a result of detailed investigations.

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Barakar Series

The name is derived from the Barakar river which cuts across this stage in the Raniganj coalfield. It consists of a thickness of 750 m of white to fawn coloured sandstones and grits with occasional conglomerates and beds of shale in the Jharia coalfield. The sandstones often contain more or less decomposed feldspars. Because of their uneven hardness, the sandstones weather with a rough surface and produce potholes in stream beds. This stage contains much carbonaceous matter in the form of streaks, lenticles and seams of coal. In the Jharia coalfield, the Barakars include at least 24 seams of coal, each more than 1.2 m in thickness, and it has been calculated that over 75 m of coal are present in the total thickness of some 660 m of strata.

This is the chief coal bearing stage in practically all the Lower Gondwana areas of India, including Darjeeling, Buka Duars and Abor Hills. In the last mentioned place the base of Barakars shows intercalations of marine beds containing anthracolithic fauna. The Barakars consist of sandstones with false bedding shales and coal seams which appear in this order and are repeated over and over again. The sandstones sometimes contain trunks of trees but generally they lie flat. The Barakar seems are best developed in the Jharia coalfield, where the ratio of the thickness of coal to the of the strata is as high as I: 8. Occasionally very thick seams occur, such as the Kargali seam of Bokaro and the Korba seam of Hasdo valley each of which is about 100 feet thick. In several cases the coal seams are associated with beds of fire-clay.

The Barakars seem to have been laid down in a series of large shallow lakes probably connected by streams. The coal appears to be due to the accumulation of large amounts of debris of terrestrial plants accumulated under quiescent and stagnant conditions. Though coal is no abundant in the Barakar strata, plant fossils are found only in some localities and animal fossils seem to be rare.

Among the more important fossil plants in the Barakars are :

Equisetales

Sphenophyllales, Pteridospermae

Cycadophyta

Cordaitales

Ginkgoales

Incertae

In the Darjeeling area the Barakars are found, with occasional coal seams, at Pankabari and other places. A glacial boulder bed has been noted at Tindharia at the base of the Gondwanas.

The Barrakars in the Himalayan foot-hills are generally thrust over the Siwaliks or other Upper Tertiary (e.g. Tipam) sediments, and are in turn overridden by more ancient rocks such as a the Buxa and Daling Series.

Barren Measures (Ironstone Shales)

The Barren Measures, which intervene between the Barakar and Raniganj series in the Jharia coalfield, are about 600 mthick being entirely barren of coal seams, but containing streaks of carbonaceous matter. They consit mostly of sandstones, which are somewhat less coarse than the Barakar type. They are represented in the Raniganj coalfield by the Ironstone Shales whose thickness is about 420 m. Their representatives are thinner still in the Karanapura fields and farther west. They consist generally of carbonaceous shales with clay-ironstone nodules which are sideritic at depth, but when oxidised at and near the surface become limonitic. These are, in places, rich enough to form workable iron ore which was used in the blast furnaces of the Bengal Iron Co. (since amalgamated with the Indian Iron and Steel Co.) situated at Kulti. But the use now have been obsolidated. The ironstone contains about 35-40 percent iron. The Barren Measures are seen in the Jharia and Karanpura fields but when followed in the coal fields farther west, they merge into the overlying Raniganj Series which are also barren of coal seams.

The fossils plants found in the Barren Measures are :

Lycopodiales

Pteridospermea

Cordaitales

Rajmahal Series

The type area is the Rajmahal hills at the head of the Ganges delta near the border of Bihar and Bengal. This series consist of 450 to 600 m of basaltic lava flows with intercalated carbonaceous shales and clays, some of these being silicified a and porcellanoid. Two of the flows near Taljhari are of pitchstone. The total thickness of these intercalated sedimentary beds is only 30 m, each bed being 1.5 to 6 m thick. The intertrappean sediments between the lower four or five flows contain plant remains, fossil wood and unionids. The more important plant fossils found in the chert beds near Nipania (24°36' : 86°33') Amajhola, Kalajhor, etc. are :

Equisetales

Lycopodiales

Filicales

Pteridospermae ?

Cycadophyta

Coniferales

Caytoniales

Gymnospermous steams and cones

Incertac

The Rajmohal Traps, resembling to the Deccan Traps in composition extend to the east and southeast but have been faulted down and covered by Cretaceous and Tertiary strata in the Ganges delta. The thickness of the sedimentary cover increases castwards to over 3,600 m, probably as a result of step faulting.

A radiating columnar structure due to "prismatic" jointing is produced in the finegrained traps at many places. It is probable that these superficial basalt-flows through the step faults of the Rajmahal series are connected internally with the dykes and sills that have no copiously permeated the Raniganj and other coal fields of the Damuda region, as their underground roots. The latter are hence the hypabyssal representative of the subaerial Rajmahal eruptions. Among these dykes mica-peridotites, lamprophyre, minette and kersantite types have been found.

The low lying plains and the deltaic regions of the ganga in the east :

Underneath the alluvium of Bengal and the gangetic delta, borings for petrolium deposite have revealed a thick series of Eocene strata over 1000 m thick, resting over a SE shelving platform of Rajmahal trap and some cretaceous beds and underlying a thick succession of esturarine and marine oligocene to pliocene formations, aggregating 1,700 m. This Tertiary series becomes thicker in southerly direction, reaching over 4,600 m near port canning.

The types of alluvium is concerned may be condidered as :

The Bhangar or order alluvium of Bengal and of Uttar Predesh, corresponds in age with the middle pleistocene, while the khadar gradually phasses into the recent. The former generally occupies the higher ground forming small plateaus which are too elevated to be flooded by rivers during their rise. As compared to Bhangar, the khadar, though to hewer in age, occupies a lower level than the former. This, of course, happens in comformity with the principle that as a river becomes older in time. Its deposits become progressively younger, and if the bed of the river is continually sinking lower, the later deposits occupy a lower position along its basin than the earlier ones. Such is the case with all old river deposits (e.g. river terraces and flood plains). Remnants of the Bhangar land are being eroded by every change in the direction of the river channels, and are being planed down by their meandering tendencies.

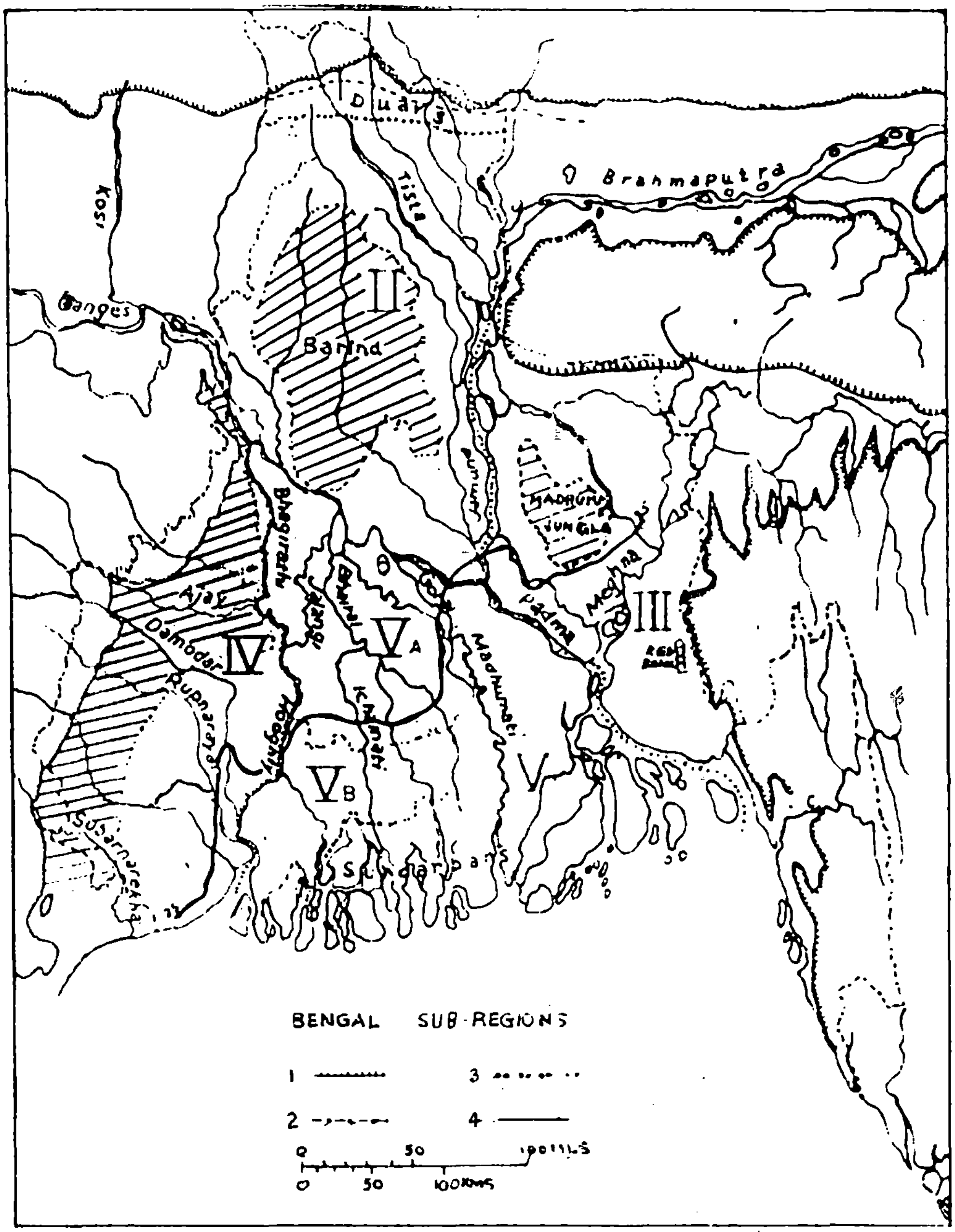
The khadar, the Ganga delta - The Khadar deposits are, as a rule, confined to the vicinity of the present channels.

The clays have less kankar, and the organic remains entombed in them all belong to still living species of elephants, horses, oxen, dear, buffaloes, crocodiles, fishes etc. The khadar imperceptibly merges into the deltaie and other accumulations of prehistronic times. The delta of the Ganga is merely the sea ward prolongation of the khader deposits of the respective river valleys. It covers an area of hearly 70,000 sqr. km. composed of repeated alternation of clays, sands, and marls with recurring layers of peat, lignite and some forest beds.

Southern Bengal has been reclaimed from the sea at a late data in the history of India by the rapid southward advance of the ganga and Bramhaputra delta through the deposition of enormous load of Silt. J. Fergusson has stated that only 5,000 years ago the sea washed the Rajmahal hills and the country round shylhet was a lagoon of the sea, as was also a part of the province of Bengal at a later date. The cities of lower Bengal become established as the ground become desiccated enough to be habituable, only about 1,000 years ago. The diverssion of the Bramhaputra to the east of Madhupur some centuries ago and its later deflection again to the west in the middle of the nineteenth century are well recorded events. This diverted portion which broke away from its course to join the ganga was named Jumuna. The eastern sea face of the delta is changing at a rapid rate by the formulation of new ground and new islands, while the western portion of the deltaic coast-line has remained practically unchanged since rennels surveys of the 1770's.

Bengal Delta

The main bulk of the region is taken up by the true Delta and the great mass of alluvial fans - strickland's paradelta to the north. There have been many attempts at defining the Delta, most of which appear decidedly old to a geographer. No purpose would be served by reviewing them here; this has been done by Bagchi, and on the whole his delimitation and sub-division appear valid, and in fair conformity with stricklands distinction between the area of transcendent deposition, the delta, and that of corrasion, the paradelta we have then :



Duars
Brahmaputra
Tista
Kosi
Ganges
II
Barind
Jamuna
MADHUPUR
JUNGLA
Padma
Meghna
III
Bhagirathi
Ajay
Damodar
IV
Rupnarayan
Bhairab
VA
Kabadak
Madhumati
Hooghly
VB
Subarnarekha
Sundarbans
BENGAL SUB-REGIONS
1
2
3
4
0
50
100MILES
0
50
100KMS

Map No. 3

I. The sub-montane terai, here known as Duars.

II. The northern paradelta, or Ganga-Bramhaputra Doab and the Barind.

III. The eastern margin, the surma valley the plains along the Meghna and along Chittagong coast.

IV. The western margins (i) The largely lateritic piedmond plain between the Hooghly and the peninsular Block (ii) Contai Coastal plain.

V. The ganga Delta proper (hereafter the Delta) between Hooghly Bhagarathi, Padma-Meghna and the Sea, further sub-division into (A) Moribund (B) Mature (C) Active sections. Of these all of III, all of II except Jalpaiguri and Cooch Behar in the north and the Malda are in west, and all of V except the western margine of V (A) and V (B) are in Bangaladesh. For convenience, the non-deltaic country of the Chittagong Hill Tracts is treated in the Bangaladesh portion.

Bengal and Ganges Delta

Western and Eastern Bengal formed the shelf area of a marine basin which stretched from the eastern coast of Orissa to Upper Assam and the geosynclinal facies lay to the southeast of the southeast of the shelf. The succession of strata in West Bengal is now known from information provided by boreholes put down in connection with exploration for petroleum by the Indo-Stanvac project in the early fifties (B. Biswas, 1959, 1962). The strata dip gently in a S.S.E. direction (Map No. 3). It is found that the Rajmahal Traps which are exposed in the Rajmahal hills have been stepfaulted and are encountered in boreholes at increasing depths to more than 3,500 m in the south. The Dauki fault more or less terminates the continuity of the beds into the Assam plateau, while in the surma valley and Upper Assam the older strate are thrust over the younger in a series of thrusts directed northwest ward. In table 68 the maximum thickness of the formations is given

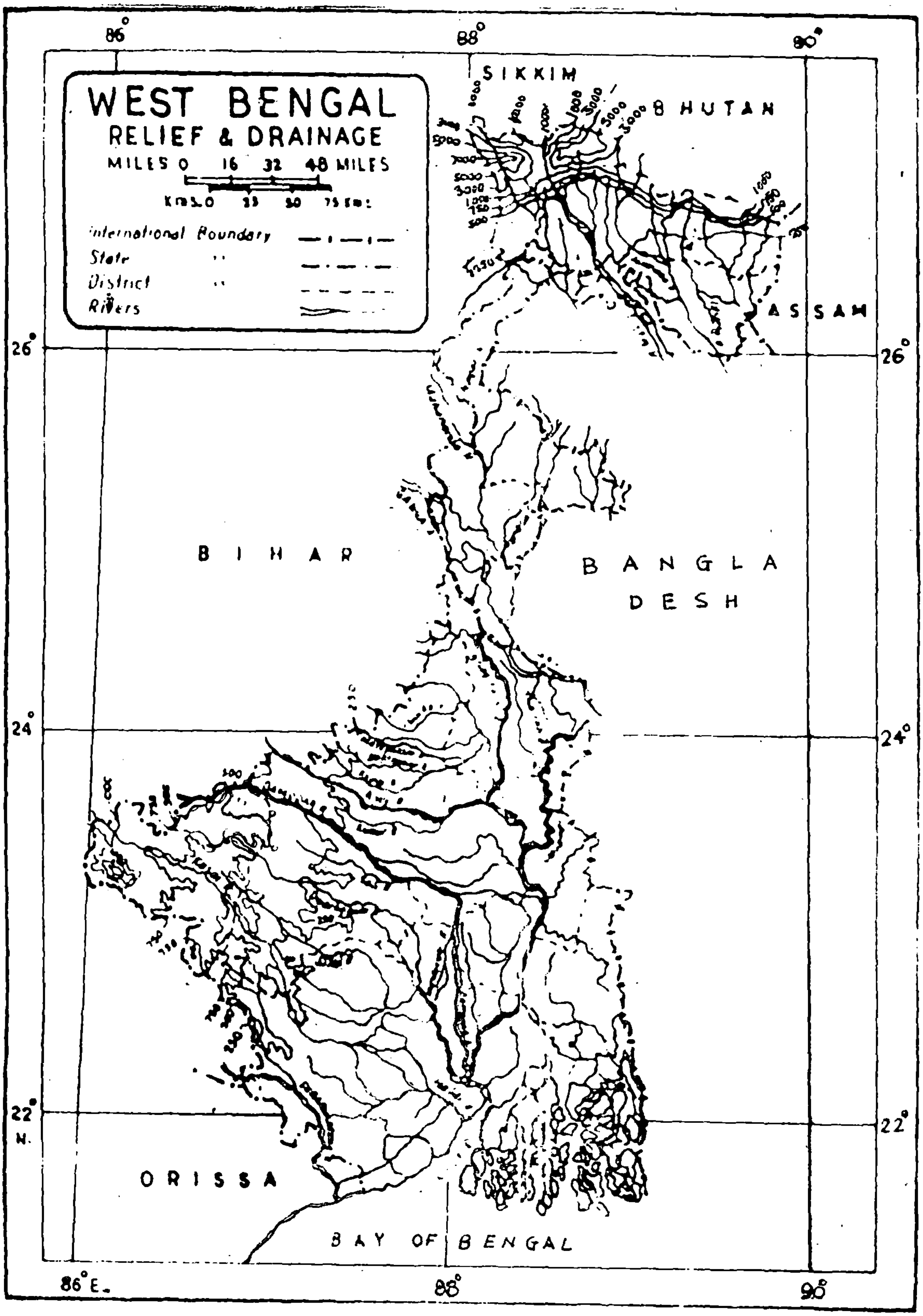
Tertiary Succession in Bengal Basin

Shelf Facies	Geosynclinal Facies	
Debagram (900 m) Clays and silits showing lateral variation, shallow marin	RANAGHAT (2,530 m) below 200 m. of alluvium Esturine to marine	Plio-pleistocene
PANDUA (700 m) Open shelf deposits of sands, silts and shales similar to Durgapur Beds	MATLA (1,200 m) Alternating marine and deltaic	Mico-pliocene
BURDWAN (160 m) Fresh to brackish weather sandstones and lignitic shales. Rich in fossils including brachyhaine forms and and spores pollen. Uncon-formable at bottom but passup conformably into the Memari formation.	Oligocane	
KOPILI (20-25 m) Brackish water grey shales and calcareous shales. Resemble the Kopili Alternations of Assam.	Upper Eocene	
SYLHET (320 m) Marine clastics with limestone bands. Rich in formaminifera.	Mid to Upper Eocene	
JALANGI (700 m) Mainly estuarine sands and shales with lignitic matter basal portion marine in the south	L. Eocene to Upper Cretaceous	
GHATAL (120 m) Estuarine to fresh water; mainly Trap wash some white sandstone	Lower cretaceous upper Jurassic?	
	Erosional Unconformity	

RAJMAHAL TRAPS (Over 600 m) One borehole penetrated 287 m. of the Traps.

The present deltas of the Ganges and Brahmaputra and also the Shillong plateau appear to have been under the Sea in the Upper Cretaceous and to have formed a shelf area trending in anortheast direction. The geosynclinal part of the basin lay to the southeast, covering the southeastern part of East Bengal and Eastern and Southeastern Assam. As revealed in borcholos put down in this basin by the Indo-Stanvac project for petroleium, the sedimentary deposition gere commence from the Lower Cretaccous and consist of the estuarine to fresh water BOLPUR FORMATION and lagoonal black shales and pink shaly limestone with calcareous sandstone intercalations of forming the GHATAL FORMATION. The Eocene comprises the JALANGI, SYLHET and KOPILI FORMATIONS. The JALANGI, about 700 m thick, consits of estuarine carbonaceous shales containing pyrites, lignite and resin, the strata become marine in the dip direction and enclose Lower Eocene formanifera. It is possible that the lowermost beds of this formation are of late Creatceous age. The SYLHET FORMATION overlying the Jalangi can easily be correlated with the SYLHET LIMESTONE which is exposed on the southern side of the Assam plateau. In the boreholes this formation is marine, and 320 m thick. It consists of three limestone bands separated by clastic beds, which have yielded a rich fauna including Assilina daviesi, A. papillata, Nummulites obtusus, Alveolina Elliptica, Discocyclina javana, etc. the age being Middle to Upper Eoocene. The KOPILI FORMMATION which is of Upper Eocene age, is only 20-25 m thick and consists of brackish grey shales and calcareous shales poor in fossils. They are easily correlated with the Kopili Alternations on the Assam plateau. There is an unconformity above this formation.

The area between Bhagirathi-Hooghly and the surface outcrop of the solid rocks of the Peninsula; like the estern margines it falls into a northern and a litoral section; but here the resemblance ends. The west is a shelf of lateritic old alluvium (the Rarh), flanked by the coalesced fans of rivers draining the Peninsular plateaus - Ajai, Damodar, Rupnarayan, Kasai - which in turn fall to a dead delta zone below the higher land along the Hooghly banks. In the south lowland Midnapore is only deltaic, with a prograding coastal plain marked by lines of old beach ridges, which give rise to linear settlement patterns around Contai.



WEST BENGAL
RELIEF & DRAINAGE
MILES 0 16 32 48 MILES
International Boundary
State
District
Rivers
SIKKIM
BHUTAN
ASSAM
BIHAR
BANGLA DESH
ORISSA
BAY OF BENGAL
86°
88°
90°
26°
24°
22° N.
86° E.

Map. 4

The lateric areas (Khoai) are very poor, with a decidedly xerophytic aspect. The firm shelf has been from early times an avenue of settlement, between the dense jungle of the plateau and the marsh of the delta; the forest destruction has brought the usual nemesis of erosion. On the lateritc interfluves poor short grass thorny bushes, scattered wild dates and the rust red lateritic in roadside cuttings combine to present a landscape of drought and deslation, relieved only by the countersunk paddy-floored valleys. Father east the area within the great bend of the Damodar is especially liable to floods, breaching levees and embankments, and between the Damaodar elbow and the Hooghly is a most typical dead delta zone. Here the small streams, some formely spill channels of the Damodar, have lost their headwaters by siliting or shifts of that river, while the Hooghly has probably been pushed to the east by the detritus of the plateau streams.

3.4 RELIEF

West Bengal, apparently a homogenous geographical entity exhibits significant variations in geographical phenomena, both physical and cultural, which render feasible the delineations of somewhat more uniform lower order units depending on different attributes. Within this region of alluvial morphology throughout its spread from the foot of the Himalaya in the north to the Sundarbans and the Kanthi Littoral in the north to the south, remarkable variations in the physical settings exist, which have their imprints on the total cultural landscape of the region. The northern districts (north of the ganga) have the turbulent tributaries of the Ganga and the Brahmaputra, which while dissecting this tract of olderalluvium have rather contributed to the development of distinct cultural patterns including human occupaance units as also the patterns of transportation. Likewise, the region bordering the Chotanagpur Highlands has relatively more stable configuration with greater diversity of physical resources and consequent differentiations in the cultural landscape. In constract, the Delta proper is characterised by the old mud, new mud and marshes, being a play ground for the dynamics of the streams leading to accordant changes in the physical as well cultural landscape (Map No. 4). Thus, the Lower Ganga Plain can be divided into three first order region :

Relief Setting

1. Himalayan Tract

The Himalayan tract of West Bengal comprises mainly of Darjeeling district. Therefore, it is knwn Darjeeling Himalaya.

The hills of Darjeeling Himalaya are divided into two parts by the deep gorge of the Tista. To the east of the gorge are the Kalimpong hills rising to a peak 3,200 metres high. Rivers radiate in all directions from it, ultimately draining into the Tista. To the west of the Tista gorge, the highest peak is the well-known Tiger Hill (2,576 m). From it also spurs radiate in many directions. The Darjeeling spur to the north, the Takadah spur to the east, the Dow Hill ridge to the south ending in the plains of Siliguri and the Ghoom ridge to the West anchoring in the Singalila range near Manebhanjang and Sukia Pokhri. South of the Ghoom ridge the Balason river fed by rain water, flows southwards into the Mahanadi, which is also of a similar nature and which rises from the Dow Hill. The two combined rivers join the Mechi and are thereafter called the Mahananda.

2. North Bengal Plain

A. Duars - which can be subdivided into three :

i) Western
ii) Central
iii) Eastern

B. Barind Tract : Which can again be subdivided into the following heads.

i) Kosi-Mahananda corridor
ii) Mahananda Tista Interfluve
iii) Cooch Behar Plain
iv) Southern W. Dinajpur plain
v) Malda Plain.

Unassorted materials and older alluvium (lateritc) constitute the surface of the North Bengal plain. The swiftly flowing. Himalayan streams, the Mahananda, the Tista, the Jaldhaka, the Sankosh drain the area with frequent shifts in their channels, the Tista and the Mahananda being more motorious. The sub-montane Tarai containing the foothills and the Tarai (Darjeeling, Jalpaiguri and Cooch-Behar districts). The Duars in the north and (b) the Barind tract of the Tista Flood plain in the south become second order regions of the North Bengal Plain. The former comprising Jalpaiguri and Siliguri is the zone of coarser alluvium (Tarai type), forested tracts and confined water channels; small scale mining distinguishes the eastern section from the otherparts. Thus the three third order units are (i) the WesternDuar or Siliguri Duar, (ii) the Central or Jalpaiguri Duar and (iii) the Eastern of Alipur Duar. The Barind tract comprises Kishanganj, Cooch Beher, West Dinajpur and Malda and continues eastward into East Pakistan. It is conterminus with the former Rajmahal Garo alignment. Vigorous river action has imparted somewhat undulating character to this region. Intensity of bils increases southward, being maximum in Maldha five order units may be distinguished in this sector (i) Kosi-Mahananda corridor or Kishanganj plain (ii) Mahananda Tista Interfluve, (iii) Cooch Behar Plain (iv) Southern Dinajpur Plain and (v) Malda Plain.

3. Delta Regions

A. Delta Proper

i) Murshidabad Plain

ii) Nadia Plain

It is known as moribund Delta. This lies mainly in Nadia, Jessore, and Murshidabad Districts, the northeastern quadrilateral bounded by Bhagirathi, Padma and Madhumati, and on the south by aline roughly along the northern boundaries of 24-Parganas and Khulna. Here the off takens of the old distributaries in the north have been silted up and the rivers themselves flow on old levees. Even in flood the country in general is not inundated; on the other hand the interfluves are ill-drained and locally saline owing to their saucer section.

B. Mature Delta

i) Burdwan Plain

ii) Howrah-Hooghly Plain

iii) Midnapur Plain

The Mature Delta is an area of choked rivers lying to the west of the Bhagirathi Hooghly. Between the moriband Delta and the Sundarban is a belt, roughly the northern half of 24 Parganas and Khulna, where the rivers are more live and some silting occurs along the larger ones. They still carry a good deal of water from the local rain, but in general they are detriorating, and are becoming more and more brackish or saline in the dry weather. Along the western and eastern confines Hooghly and Madhumati - the land is still being built up to some extent. In the Burdwan Plain the Hooghly side industrial and urbanised belt leads to the delineation of 2 fourth order regions, Burdwan Plain East and Burdwan Plain West. (iii) The Midnapur Plain is the least developed region in the Mature Delta with moderate degree of development. In this region Midnapur-Kharagpur area is emerging as the pocket in the Lower Ganga Plain with a distinct form the dune-infested coastal tract.

C. Active Delta

i) Northern

ii) Southern

The Active Delta occupying the S.E. corner is the land of marshes, levees, saline water lakes and the coastal forests. Sub-regional disparity is not so high anywhere else in the Lower Ganga Plain. (i) The Upper Delta (Northern in the west; the Bidyadharya Peali tract is emerging as a unit. (ii) The Lower Delta (Southern) has the zone of tidal forests of Sundarbans in the south as also a zone of patchy cultivation by reclamation in its northern section.

4. Rarh Plain

A. Birbhum - Assansol Rarh

i) Birbhum Plain

ii) Ajai-Damadar Interfluve

B. <u>Bankura Rarh</u>

i) Damodar Dwarkeswar Doab.

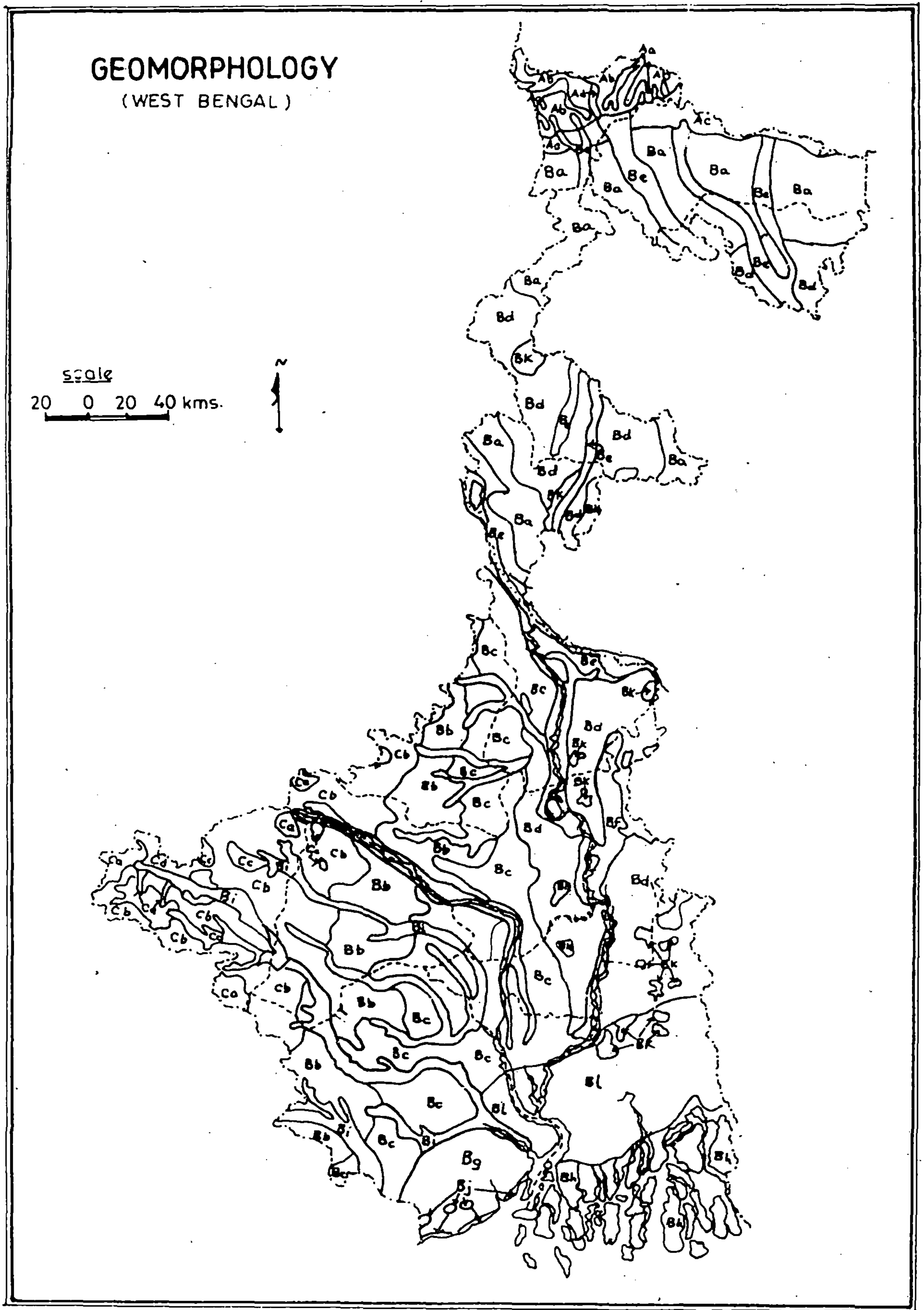
ii) Dwarkeshwar Kasai Tract

C) <u>Midinapur Rarh</u>

i) Eastern

ii) Western

The tract to the West of the Bhagirathi was known as Rarh. The Rarh Plain consists of Birbhum, Bankura and Western part of Burdwan and Midnapur districts. This lateritc region with exposures of the Gondwanas experiences different climatic conditions from the rest of the Lower Ganga Plain. The region is characterised by semicompact and sprinkled settlements with occasional riverside lineations. Lower population density with predominant agrarian economy, except in the Ajai-Damodar interfluve is remarkable. On the basis of variations in surface configuration and the type of economy and level of economic development, three second order regions may be distinguished. The Birbhum Asansol Raha, where the northern tract (i) the Birbhum Plain predominantly rural (93% with Aman culture and moderate degree of development, stands in contrast to (ii) the Ajai Damodar interfluve which has developed as an important industrial and urban concentration towns and has high degree of development, the Bankura Rarh is distinguished by its lower urbanisation, preponderance of primary sector employment of transport arteries. Here again (i) the Damodar Dwarkeswar Doab differs from (ii) the Dwarkeswar Kasai Tract due to some mining activity. The Midnapur Rarh is divided into two third order regions (i) Eastern and (ii) Western, the former is more developed than the latter due to the influence of Kharagpur.



index overleaf

Map No. 5

L E G E N D

GEOMORPHIC UNIT

SYMBOL	
A	<u>Highly dissected, folded and faulted mountainous region</u>
Aa	Folded ridge
Ab	Highly dissected hill slopes
Ac	Piedmont fan plain
Ad	Inter montane valley
B	<u>Available and deltaic plain</u>
Ba	Old alluvial plain
Bb	Undulating upper alluvial plain
Bc	lower alluvial plain
Bd	meander flood plain
Be	Active flood plain
Bf	Natural levee
Bg	Coastal plain
Bh	Active delta (mangrove swamp)
Bi	Valley bottom
Bj	Coastal sand dune
Bk	Marshy area
Bl	Deltaic flood plain
C	<u>Low dissected plateau interspersed with hills, hillocks, mounds and valleys</u>
Ca	Residual hills, hillocks and mounds with pediments
Cb	Pediplain
Cc	Highly gullied land
Cd	Inter hill valley
*	Residual hillocks and mounds

Geomorphology of West Bengal

The State of West Bengal is highly significant geographically, historically and strategically since times immemorial. It is situated within north latitudes 21°30' to 27°13' and east longitudes 85°51' to 89°52' covering a total area of 87,85,300 hectares. The State is endowed with remarkable variations in physiographic resources from sea to snow having an elevation ranging from five metres in the south to 3,658 metres above mean sea level in the north. The histogenesis of the land form is a function of the tectonics changing river channels and sea level changes. The present land forms of West Bengal have arisen through the gradual infilling of the basin and the resultant land forms varied accordingly to the local circumstances and the geomorphic processes.(Map No. 5)

The state exhibits three broad well-marked physiographic regions on the basis of their surface forms, origin and stage of their development, viz.

a) The Himalayan mountainous tract in the north;

b) The alluvial and deltaic plain; and

c) The undulating rocky plateau in the West.

a) The highly regged mountainous terrian is intricately designed by numerous perennial and nonperennial rivers and streams and covers most of the northern part of the Darjeeling district except the Siliguri subdivision. The two ranges named Singalila and Darjeeling trending north-south are dissected into a series of escarpments and are separated by narrow longitudinal tectonic valleys called 'dun'. The rocks comprising the region consist of Siwaliks, Gondwana, Deling and Darjeeling formations. The alluvium of piedmont fan deposit is of late quaternary period The Siwaliks consist of sandstones, conglomerates, silt stones and the sandstones with thin coal seams of Gondwana rocks which override the Siwaliks along the main boundary fault. The Slate, phyllites and quartzites of Daling formation and granite gneiss of Darjeeling formations were subjected to intensive folding, faulting and thrusting. Intensive rainfall and steep slopes have aggravated the severe erosion along with landslides which make the rivers meander and sometimes change their courses.

The southern part of the Darjeeling district and northern part of the Jalpaiguri district comprise the submontane tract of piedmont area locally known as Duars composed mainly of hill wash consisting of gravel and coarse sand. Geomorphologically, the mountainous terrian can be subdivided into the following as per their morphological characteristics, (i) folded ridge, (ii) highly dissected hill slopes, (iii) piedmont fan plain and (iv) intermontane valley.

(b) The alluvial plain covers approximately three fifths of the area of the state concealing the older rocks under variable thicknesses of sediments. The alluvial formations are grouped into bhanger or old alluvium of pleistocene age occupying comparatively higher grounds and generally of course, reddish colour having calcareous and limotic concretions and 'Khadar' or newer alluvium of sub-recent to recent age consisting of alternate beds of clay, silt, snad, marl, peat bed and some forest beds and merges into deltaic flood plain. There is also a coastal plain at the south western part of Midnapur district.

The river action has imparted undulating character to the Tista flood plain comprising Cooch Behar, West Dinajpur, Malda and Part of Jalpaiguri districts. The closely spaced streams from the mountain discharge the load and make the piedmont alluvial fan made up of boulder beds, gravels, sand, silt and clays.

c) The plains lying to the west of the Bhagirathi river exhibits anatured topography covering parts of Birbhum, Burdwan, Midnapur and entire district of Hooghly and Howrah having uneven ground due to remnants of abandoned channels, bill, swamps, marshes and levees. Numerous streams have criss-crossed the area with valley fills, while the areas east of Hooghly river possess the characteristics of younger flood plains and are studied by a number of depressions, meander scars, loops, ox-bow lakes, point bars, cut-offs etc. The easterly shift of the river Ganga has rendered the area a land of almost dead and decaying rivers.

The active delta or deltaic flood plain comprises the whole of Sundarban area where the depositional activity of the streams is prominent and formations of new lands or islands over continental shelf are still active. The intricate network of tidal creeks divide the area into large number of islands with mangrove forest and other vegetation.

The tide wate form sea through the rivers Matla, Ichhamati, Piali, Vidyadhari, Gosaba, Saptamukhi carry saline water and overflow inside creating some saline marshy tract.

CHAPTER - IV

C L I M A T E

4.1 CLIMATIC CHARACTERISTICS OF THE STUDY AREA

West Bengal's climate is influenced largely by its relative position to the eastern Himalayas and the Bay of Bengal. The State enjoys a typical tropical monsoonal climate. Agriculture in the State largely depends on the timely arrival of the monsoon inasmuch as irrigated area forms hardly a quarter of the total cultivated area in the State.

Temperature Condition

The average maximum temperature in the plains is attained in April and the highest maximum in May. The summer temperature iin the plain varies from 80°F (26.7°C) to over 110°F (43.3°C). The proximity of the sea has a moderating effect on the temperature conditions particularly in the southern part of the State. The maximum mean temperature is 47°F (8.3°C) in Darjeeling and 74°F (23.3°C) in Jalpaiguri while the minimum mean temperature is 35°F (1.7°C) and 50°F (10°C) respectively. The average maximum temperature over the plains is attained in April and the highest maximum in May Over the Darjeeling Hills the maximum temperature is attained during the month of June. During the month of January. West Bengal experiences the lowest temperature throughout the state. April is the hottest month of the year. The evening thunderstorms known as Kalbaisakhi or Norwestes (as they come from the north West) bring relief from the heat of the summer.

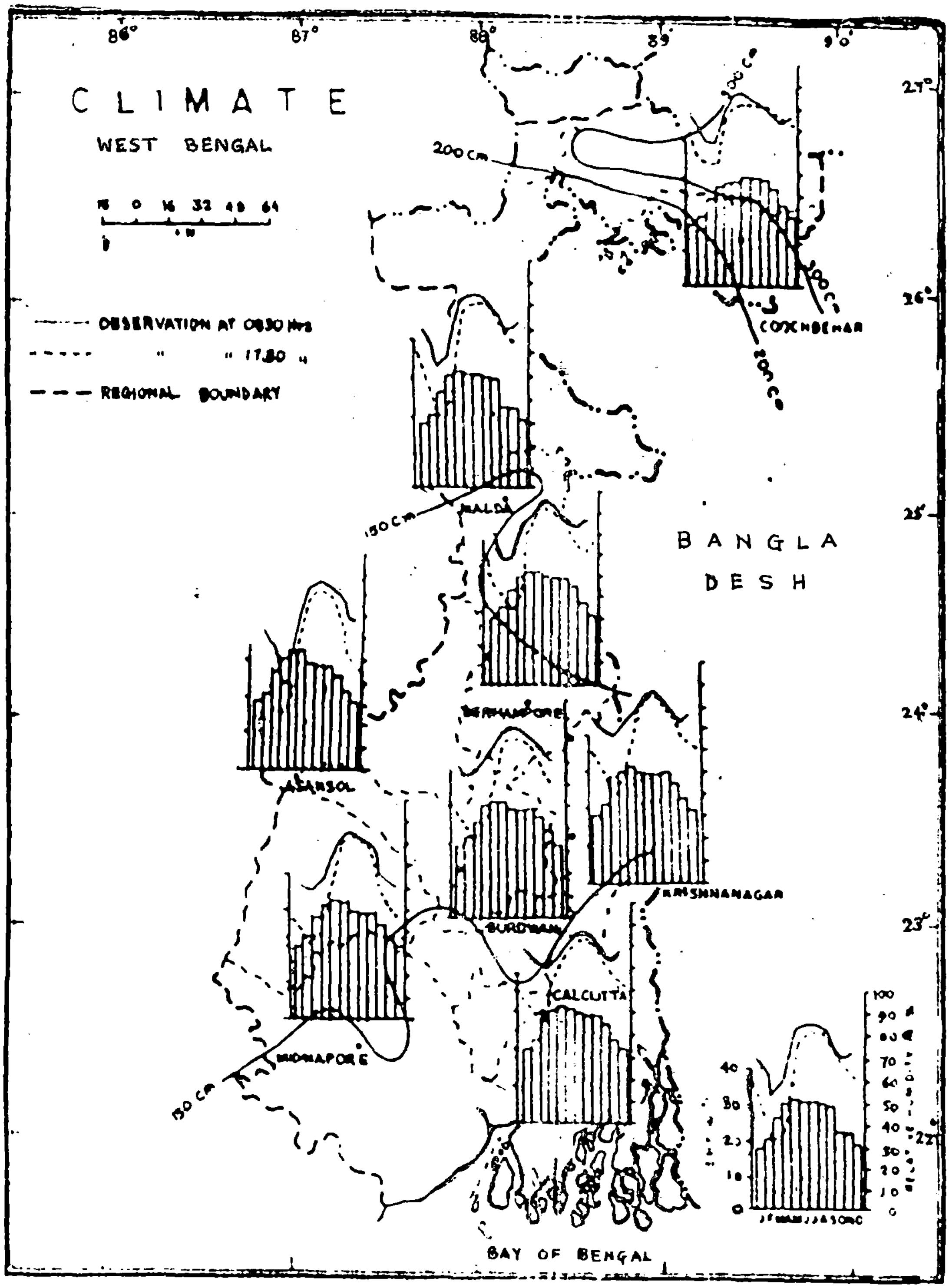
Rainfall

The State experiences an average annual rainfall of about 70" (175 cms.) about 80 to 85 per cent of the annual rainfall and rainy days occur during the south west monsoon season of June to October. Another 10 to 15 per cent of the annual rainfall and rainy days occur due to thunderstorm in the hot months of March to May. Rainfall in the hills and sub-mountain districts of West Bengal is much higher than in other parts of the State. Rainfall in the Himalayan region ranges from 100" (250 cms) to over 200" (500 cms) while the plai n districts receive on an average 45" (125 cms to 75") (187.7 cms). The district of Bankura records the lowest rainfall (47" or 117.5 cms) and Jalpaiguri experiences the highest rainfall (156" or 390 cms).

4.2 DISTRIBUTION OF TEMPERATURE AND RAINFALL

The region experiences a hot and humid monsoonal climate. The proximity to the Bay of Bengal on the south, the alignment of the Himalaya in the north and that of the Meghalaya Plateau in the north east determine largely the climatic character, i.e., the distribution of the weather elements with respect to time and space. Irrespective of the general vegaries and mechanism of the monsoon, the spatial and seasonal distributions of the elements such as temperature, rainfall and relative humidity are too uneven.(Map No. 6).

January invariably appears as the coldest month, the temperature ranging between 17 and 21°C and increasing southward (Sagar Islands 20.4°C). The regional variation is considerably low but becomes significant when analysed with respect to the occasional cold spells accompanied with the western disturbances. The lowest temperature has been recorded in the north (2.2°C at Jalpaiguri) but in the south it is as high as 7.2°C (Sagar Islands). The temperature starts rising gradually throughout the region from February but the rise is well marked (4° to 6°C) in March (Table 1) and it containues till the end of May; the rise like other monsoon regions is checked by the outburst of the monsoon which in this region becomes active by the first week of June. Except the northern part, i.e., the Barind tract and the Duars in the whole of the region, May records the maximum average temperature (29-33°C). The central part (Asansol and Krishnagar) indicates relatively lesser impact of the proximity to either the Bay or the Himalaya even in this region of near uniformity. Conspicuously enough, the average monthly temperature shows a range seldom exceeding 5°C over a span of seven months : April to October (Jalpaiguri 25.7°-27.85°, Krishnanagar 27.8°-31.1°, Sagar Island 27.55°-29.7°). The only exception to this generality


CLIMATE
WEST BENGAL
OBSERVATION AT 0830 Hrs
" " 1730 "
REGIONAL BOUNDARY
200 cm
150 cm
MALDA
BERHAMPORE
ASANSOL
BURDWAN
KRISHNANAGAR
CALCUTTA
MIDNAPORE
COOCHBEHAR
BANGLA DESH
BAY OF BENGAL
86°
87°
88°
89°
90°
27°
26°
25°
24°
23°
22°

Map No. 6

is presented by the western margin (Asansol) of the region where the bare rock exposure contribute to a little higher May average (32.7°C). In spite of this uniformity which partly owes to the premonsoon showers (nor'Westers), there are evidences of occasional high temperature rising sometimes to over 45°C (Table 1). Even these exceptional temperatures are lower in the Duars (Jalpaiguri 40°C) and the coastal regions (Sagar Island 40°C). Notably the range of temperature also corresponds with the general distribution. March and April are the months when the range is at the maximum though rately exceeding 16°C (Jalpaiguri, 13.2°C, Malda 15.2°C, Berhampur 15.7°C and Krishnanagar 16.2°C all in March) excep the coastal areas where January and December record the maximum range (Sagar Island 9.2°C and 8.9°C respectively). The temperature range is at its minimum during July and or August when atmospheric moisture imposes the moderating influences. The range for these months remains around 5°C and seldom exceeds 10°C during the five rainy months (June to October),

The gradual decline inaverage monthly temperature commencing often from June (September in case of Jalpaiguri becomes well marked when in falls by 3° to 5°C between October and November. This marks the start of the winter season.

The average relative humidity is generally high (over 50%) throughout the region except in the western fringes where for about two months, March and April, it is less than 40%. This is also the period of lowest RH all over the region except the Sundarbans. December and January however, show the minimum in the coastal tract (Sagar Island 68.5 and 69.5% respectively). It can well be observed that during July, August and September the average RH remains over 80% which spatially decreases westward (Krishnagar 84.2% and Asansol 82.7%). The relative inland belt away from the Himalaya and the Bay is again quite well defined. From the monthly RH pattern the occeanic influence is also distinct (range at Sagar Island 17%; Asansol 47.5%). Mornings are invariably damper with usual regional variations. The diurnal range is maximum in the month of February (30%) and minimum in August (7% when the monsoon is at its climax.

The rainfall (120 to more than 400 cm) is fairly widespread in the region though with uneven seasonal and spatial distribution characteristic of the monsoonal condition. Out of the four sources of rainfall, i.e., westerly disturbances of winter, convectional overturning of air resulting in local depression (Kal Baisakbi) during March May causing pre-monsoon showers, cyclonic disturbances of the monsoon and post monsoon periods and the monsoon currents occurring along the convergence lines of the sea level monsoonal troughs, the last two account for the major precipitation received in the region (Sagar Island about 85% Krishnanagar about 80%, Asansol about 85% and Jalpaiguri about 85%). But for the southern beld, i.e., the active delta, where August is the wettest month (41.0 cm.), July emerges as the wettest month of the region with rain varying between 28 cm in the Bhagirath-Padma fork to 77.6 cm in the Duars. December undoubtedly is driest though with relatively damper atmosphere (RH more than 55%).

Spatially the northern and southern parts, owing to the proximity of the Himalaya and the Bay respectively, experience relatively more annual rains (Jalpaiguri 335 cm and Sagar Islands 190 cm) than the central part. It is the area bordering the Chotanagpur Highlands that experiences minimum rainfall (Asansol 139.22 cm).

The erratic nature of precipitation is evident by the fact that even the wattest months receive sometimes rain below 20 cm, e.g., Asansol 5.71 cm in July, 1918; Jalpaiguri 11.43 cm, in August, 1896 Krishnanagar 8.59 cm in August, 1992 and Sagar Islands 11.45 cm in July, 1919; while their averages for the respective months are 34.44, 66.28, 27.11 and 40.94 cm. Similarly the heavy downpours of 64.92, 151.76, 71.43 and 96.42 cm have also been recorded for stations in the respective months in the years 1943, 1958, 1909 and 1913. Even the drier months sometimes record exceptionally heavey downpours (Jalpaiguri 57.0 cm in December, 1932). Heaviest downpours within 24 hours ever recorded are at Calcutta 369.1 cm on September 20,1900; Sagar Islands 359.2 cm on June 5,1927 and Jalpaiguri 390.4 cm on July 8,1892.

The overall impact of the climatic elements can be interpreted interms of water surplus and defict in the region which have direct correlations with the agricultural economy. The seasonal surplus period, often between mid July and end of October, is a common feature all over the area except in the Duars where due to the early commencement of the monsoon it starts from May end. Depending on the amount of rainfall the Duars show maximum surplus equivalent to about 60 cm of rain in July/August which aggrevates the work of running water resulting in floods, shifting of river channels, etc. Elsewhere, it is below 20 cm rian equivalent being the lowest in central part (Krishnanagar about 10 cm). It is also evident that there is a general water deficiency period from January to mid June, being shortest in the Duarsa (January-April). The soil moisture in the Active Delta is sufficient for about three months to get evaporated while in the remaining parts it can stand only for two months.

The position though relatively better than the other parts of the country, calls for irrigation measures to be developed to ensure more intensive land utilisation and better yield in the region.

The dry summer is characterised by three air streams, i.e., the northwesterly current from the west, a shallow southerly stream from the Bay of Bengal and a feeble easterly to north-easterly current through the Assam valley resulting in a marked instability in the atmosphere accompanied by thunder storms, dust storms, squalls, etc. Out of the 74 instances of squalls at Alipur during 1948-52 as many as 57 were recorded during March-May. Rainfall is associated with afternoon or evening thunder showers and squalls. Hailstorms (upto 3) during the season occur in the SW part. High temperature (23-33°C) and low humidity (up to 40%) are the characteristic features. The temperature range is also the highest (16°C).

The Bay depressions bring in the monsoon by the first week of June. Series of such depressions sweep over the region during June-October and Cause heavy to moderate rainfall with July-August emerging as the rainiest months. The withdrawal of the monsoon by mid-October is followed by a short transition between the rainy and the cold season (post-monsoon season). The commencement (June) and the end of the rainy season (September/October) are associated with more thunderstorms than the rainy months of July and August. High relative humidity (70% and above) alongwith high and almost uniform temperature (26-31°C) and heavy downpours are the characteristics of the season. The climate is often sultry during rainy season.

The winter season is characterised by the sweep of northerly or north westerly winds. The weather changes are associated with the occasional western disturbances causing some rainfall, but cold waves are rare. Low average temperature (17-24°C) increasing southward and moderate relative humidity (50%) mark the characteristic of the season.

Agro-Climate of West Bengal

The Indian sub-continent of which West Bengal is a state belongs to the northm-hemisphere of the earth. The sun crosses the equator twice in a year (i.e. 21st March and 23rd September) during its journey from south to north and north to south. The sun reaches tropic of cancer and tropic of capricon on 21st. June and 22nd December respectively. The periodic shifting of the position of the sun with reference to the earth mainly controls the seasons and whether conditions. However, other major factors viz. monsoon wind, western disturbances, presence of the Himalayas in the north and Bay of Bengal in the south influences the periodic weather conditions substaintailly.

During the period from 21st. March to 23rd. September, the northern hemisphere not only receives more amount of sun rays but a also the length of the day becomes 12 hours or more. Whereas the same hemisphere not only receives less amount of sun rays from 24th September to 20th March, but also the length of the day becomes less than 12 hours. However, the shifting of vertical rays to oblique rays and again back to vertical rays and increase or decrease of day length occures very slowly. Due to all these factors, we generally experiences three major seasons viz., winter from November to February, summer from March to May and monsoon from June to October. However we have also other three minor seasons of short duriation viz. Basanta (Spring) in between winter and summer, Sarat and Hemanta (autuma) in between rains and winter, and they have mixed characteristics of major seasons.

The topic of cancer runs almost across the the middle of southern part of West Bengal. The areas lying north of this line fall within the north temperate zone and the southern portion within the equatorial zone. Though the lower position lies within the equatorial zone. The presence of Bay of Bengal, innumerable river systems, canals, tanks forest cover, orchard around homestead areas etc. do not allow extreme climatic conditions to prevail upon at any time of the year in this area.

The climate of West Bengal ranges from subhumid (moist and dry) and humid to per humid. Crop production in the state is influenced significantly by the highly varying weather conditions during monsoon and post monsoon period. The normal on set of southwest monsoon in the state is from 7th June. After the monsoon sets in it gradually extends northward and north west ward by the end of June. The monsoon begins to retreat by the fourth week to September and the withdrawal is completed by the middle of October. In the monsoon period (Kharif season) the state receives 78 to 90 percent rain of annual rainfall which not only varies from year to year but also from place to place. During monsoon period again one cannot expect continuous rain in any part of the state. Hence breaks of longer or shorter duration prevail during the monsoon period. These 'breaks' of longer duration are known as periods of drought. Studies conducted to quantity drought in the form of an index taking into account of rainfall, evapo-transpiration and soil moisture show that on an average, droughts occur in 20-25 per cent of the period of the kharif season. The state experienced drought in the past and during the recent years, viz. 1966, 1972, 1976 and 1981 when the winter rice (aman) production fell much below the normal production.

The state also suffers from flood due to heavy rainfall in the monsoon period (kharif season). Occurences of flood cannot be fully controlled in the basin areas of larger river systems. Due to the occurence of flood, life, property and field crops and damaged severely, since very often in it is accompanied by cyclonic storm. In coastal areas, severe damages are caused by cyclonic storm accompained by high tide. Not very long ago some great floods occured in North Bengal (in the year 1968) in south Bengal (in the year 1978) and in coastal areas (in the year 1981).

Generally, before or after the monsoon season, the thunder and hail storms are the predominant weather phenomena. Thunder storm with associated squalls (locally known as Kal--Baisakhi) are of short duration but some are very violent and destructive. One of such storms occurred over Calcutta in May 1945 when the wind speed was as high as 128 km per hour. Post monsoon storms occur when the S-W moonsoon receeds and N-E winds comes forward. A great storms occurred in the month of October, 1942 and we faced a grave famine afterwards. In West Bengal, heat wave, cold wave and frost hazards generally do not occur excepting in some smaller specific areas.

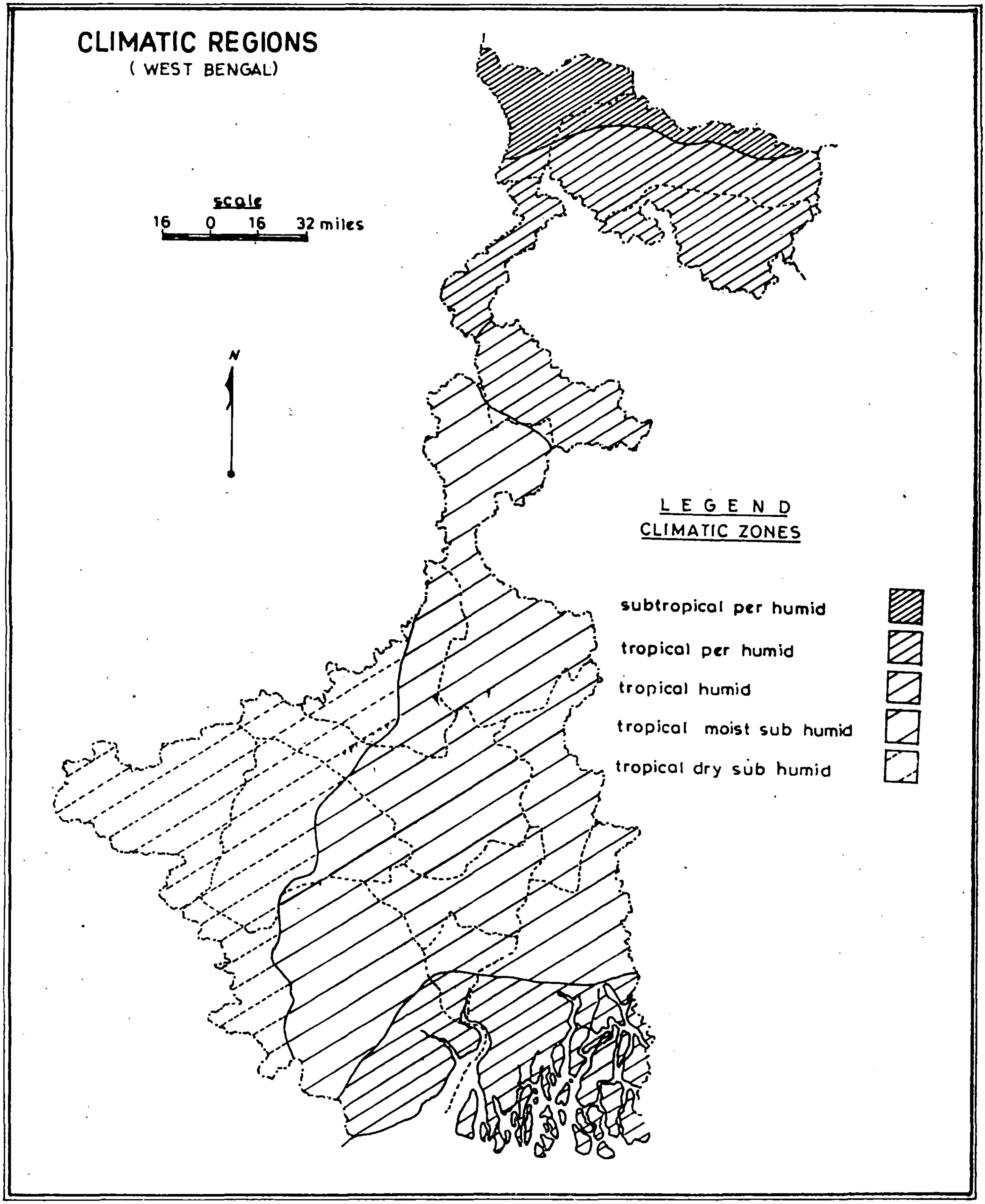
Geographically, the state of West Bengal can be divided into five broad regions, viz., north hilly, North Bengal Plain, Central Plain and western undulating. Approximate locations of these regions have been given in the following Table. Moreover, in respect of latitude and longitude the boundary line of each region is not sharp but gradual in nature. Each of these regions has its own independent seasonal weather characters (viz. summer, rainy and winter) as shown by its rainfall, air temperature humidity and dew fall. These seasonal weather characters are clearly depicted in the following table as far as practicable. The weather characters of one region very slowly change towards another region in a season and hence the said character are shown on a mean annual basis.

If the weather of each of the above geographical region is studied in respect of moisture and temperature indices values it is found that the three regions of South Bengal and one region of North Bengal tally well with the climatic zones. Only the North Bengal plain region has a different climatic zonal picture in respect of moisture and temperature indices values. Hence, the North Bengal plain is again divided into three zones, viz., tropical per humid, tropical humid and tropical moist sub-humid. These climatic zones are shown in the accompanying map along with the other climatic zones. So, the state of West Bengal has been divided into five broad agro-climatic zones. viz. sub-tropical per humid, tropical per humid, tropical humid, tropical moist sub--humid and tropical dry sub-humid. (Map No 7)

Agro-climate (All figures are mean of annual normals)

Sl. No.	Geographical regions with approximate latitude and longitude	Wheather Factor	Weather Character (Major seasons)		
			Summer March to May	Rainy June to October	Winter November to February
1.	North Hilly	Rainfall (mm)	398.5	2,637.5	68.5
		Max	17.0	19.5	12.0
		Air temp.°C Min	10.5	14.3	4.8
	26°50' to 27°14'N	R.H. (%)	74.0	88.0	77.0
	88°00' to 88°55'E	Dew fall	S	N.S.	V.S.
2.	North Bengal Plain	Rainfall (mm)	371.6	2,134.0	42.6
		Max	32.3	31.3	26.0
	24°40' to 26°50'N	Air temp.°C Min	20.5	24.5	12.8
	87°48' to 89°53'E	R.H. (%)	60.0	81.0	70.0
		Dew fall	L.S.	N.S.	V.S.
3.	Central Plain	Rainfall (mm)	233.8	1,206.0	67.8
		Max	35.0	32.2	27.4
	22°40' to 24°40'N	Air temp.°C Min	23.4	25.6	15.6
	87°45' to 89°06'E	R.H. (%)	58.0	80.0	65.0
		Dew fall	N.S.	N.S.	S.
4.	Coastal plain	Rainfall (mm)	195.0	1,475.2	82.8
		Max	34.0	32.0	28.2
	21°32' to 22°40'N	Air temp.°C Min	24.8	26.0	16.0
	87°30' to 89°06'E	R.H. (%)	72.0	82.0	68.0
		Dew fall	N.S.	N.S.	S.
5.	Western undulating	Rainfall (mm)	137.0	1,224.4	66.0
		Max	37.0	32.4	27.2
	22°40' to 24°40'N	Air temp.°C Min	23.7	25.0	14.8
	85°51' to 87°45'E	R.H. (%)	44.0	78.0	55.0
		Dew fall	N.S.	N.S.	S.

N.B.: V.S. - Very significant; S - Significant; L.S. - Less Significant; N.S. - Not Significant; R.H. - Relative Humidity



Map No. 7 (Legend Overleaf)

LEGEND

Climatic Zone	Temperature Index T° Max- T° Min	Moisture Index $\frac{PPT-PET}{PPT} \times 100$
Sub Tropical Per Humid	4.0 to 8.0	50
Tropical Per Humid	5.5 to 15.0	50
Tropical Humid	5.5 to 13.0	20 to 50
Tropical Moist Sub Humid	3.5 to 17.0	1 to 20
Tropical Dry Sub Humid	6.0 to 15.0	1

MEAN OF ANNUAL NORMALS

P.P.T - Precipitation

P.E.T - Potential Evapotranspiration

T - Summation of Temperatures

Agro-climatic zones of West Bengal

The year is divided into three distinct crop seasons viz.

1.	Kharif (Rainy Season)	June to October
2.	Rabi (Cold and dry season)	October to February and
3.	Summer (Hot and dry season)	March to June

The seasonal variations due to different climatic conditions depending upon rainfall, temperature humidity and altitude accompanied by various complex soil groups and its physiography and types have great influence on farming systems in West Bengal. Depending upon the soils and climatic variation, the State is broadly divided into following six agro-climatic regions (Map No. 7).

1. Hill Region

Darjeeling district excluding Siliguri sub-division and northern fringe of Jalpaiguri district.

Climate

		March to May	June to October	Novbember to February
Rainfall (mm)		398.5	2,637.5	68.5
Air temp. °C	Max	17.0	19.5	12.0
	Min	10.5	14.3	4.8
R.H. (%)		74.0	88.0	77.0
Dew-fall		Significant	Not Significant	Very Significant

Soil

Soil in general is shallow, coarse textured, high in organic matter content, low in bases and phosphate, acidic in nature. Due to high run-off rate and scope for vertical and lateral seepage, moisture stress frequently occurs. Area is mostly bench terraced on high slope.

2. North Bengal Plain

Plains of Jalpaiguri and Coochbehar, Siliguri sub-division of Darjeeling district and Islampur sub-division of West Dinajpur district.

Climate

		March to May	June to October	November to February
Rainfall (mm)		371.6	2,134.0	42.6
Air temp. °C	Max	32.3	31.3	26.0
	Min	20.5	24.5	12.8
R.H. (%)		60.0	81.0	70.0
Dew-fall		Low Significant	Not Significant	Very Significant

Soil

Deep, light texture, high permeable porus soil with water regime fluctuating within 1 metre depth relative to river flow level; moderate level of organic matter content with appreciable mineralisation highly acidic low in bases, phosphate, potash and micro nutrient. Area is mostly flat with 0-1% slope having low height field bund.

3. Western Undulating Region

Part of Birbhum, Burdwan, Bankura, Midnapore and Purulia disdtricts with pockets of Malda and West Dinajpur districts.

Climate

		March to May	June to October	November to February
Rainfall (mm)		137.0	1,224.4	66.0
Air temp. °C	Max	37.0	32.4	27.2
	Min	23.7	25.0	14.8
R.H. (%)		44.0	78.0	55.0
Dewfall		Not Significant	Not Significant	Significant

Soil

Shallow to deep soil with light texture surface with heavy sub--surface, somewhat well drained due to deep placement of water table and scope of lateral seepage. Acidic in soil reaction, low in base status, low in organic content, phosphate, moisture stress frequently occurs. Area is mostly bunded and bench terraced on moderate slope.

4. Central Plain

Nadia district, part of Malda, West Dinajpur, Murshidabad, Burdwan, Hooghly and 24 Parganas district.

Climate

		March to May	June to October	November to February
Rainfall (mm)		233.8	1,206.0	67.8
Air temp. °C	Max	35.0	32.2	27.4
	Min	23.4	25.6	15.6
R.H. %		58.0	80.0	65.0
Dew-fall		Not Significant	Not Significant	Significant

Soil

Deep, moderately well drained light texture soil, having neutral to alkali soil reaction, moderately high in base saturation NPK status is medium to medium low. Area is mostly flat having close net work of irrigation system of different types.

Average Monthly Temperature in °C

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Jalpaiguri	17.1	18.95	23.0	26.0	26.9	27.45	27.8	27.85	27.55	25.7	21.95	18.55
Asansol	18.95	21.5	26.9	31.15	32.7	31.25	28.8	28.55	28.6	26.8	22.55	19.3
Krishnanagar	18.95	21.65	26.9	30.65	31.1	30.15	28.95	29.05	29.2	27.8	23.45	19.75
Sagar Island	20.4	22.85	26.95	28.9	29.7	29.55	28.5	28.45	28.55	27.55	24.1	20.85

CHAPTER - V

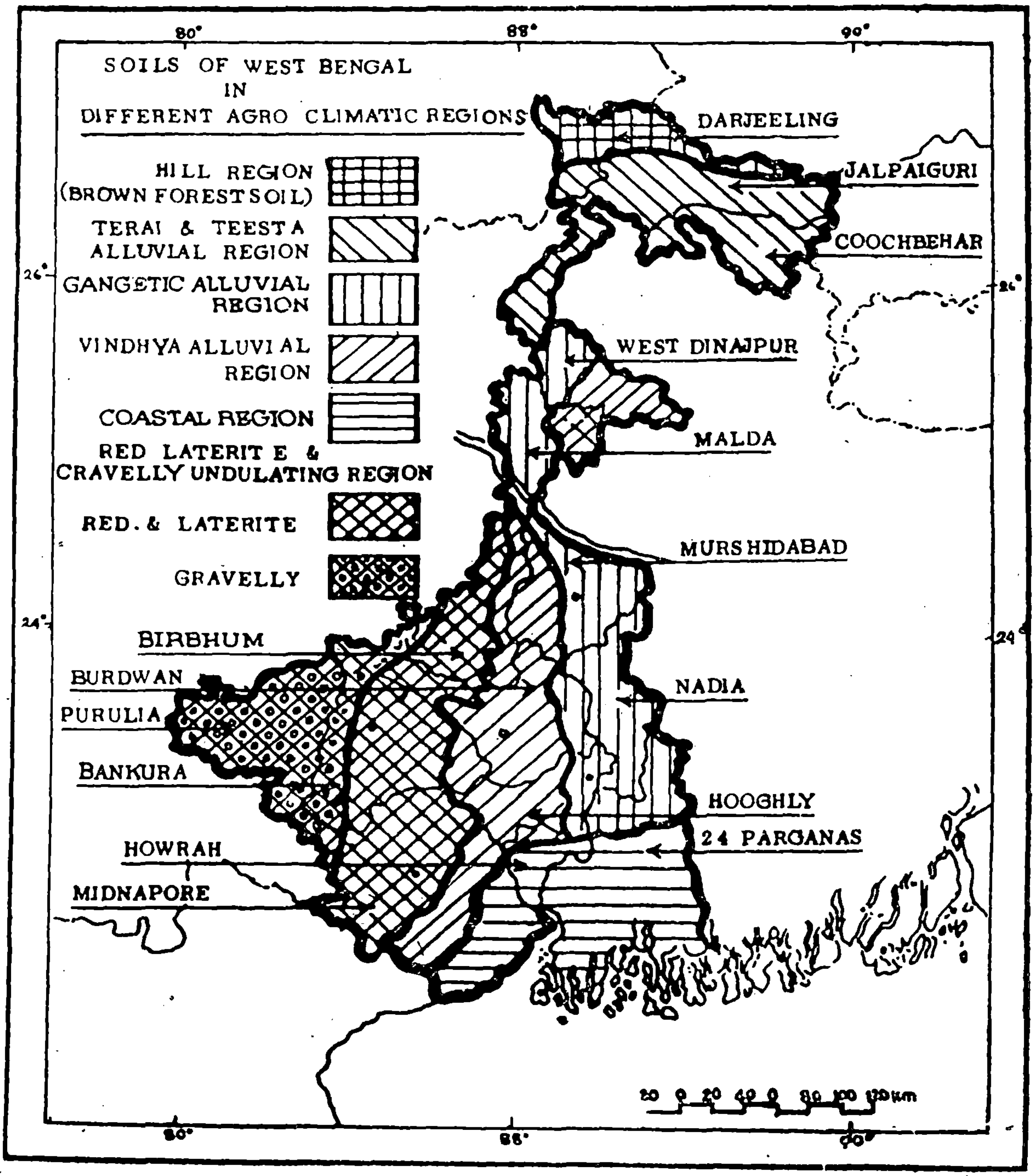
SOILS OF WEST BENGAL

5.1 INTRODUCTION

The soils of Bengal have been studied widely by different scholars. The studies carried out so far lead to the convenient grouping of soils as (i) Laterites, (ii) Red Earths, (iii) Tarai soils, (iv) Alluvial soils and (v) the Coastal soils, developed under their usual respective processes.(Map No. 8).

The lateritic soils (5,888 km^2) are found in the undulating well--drained tract along the Chotanagpur highlands covering the western part of the region At places honeycombstructures of the rocks are exposed. Acidic in character (pH 5.5-6.5) and dificient in organic matter these are poorly aggregated and possess low water holding capacity; usually Sal forests thrive.

The transported laterites deposited on the castern flanks of the lateritic stretch are known as the Red soil (lateritic alluvium) and are found in the eastern margins of the Rarb Plain and the Barind tract of Malda and West Dinajpur covering about 4,963.6 km^2 area. Morum and feldspar and sometimes lime concretions are also observed in the bed. The shallow and coarse-textured soils are acidic in character (pH 6-6.6) and are poor in organic matters and plant nutrients (N) Mostly they have been brought under cultivation after deforestation which has accelerated the process of erosion. The unassorted materials deposited at the foot of the Darjeeling Himalaya are responsible for typical Tarai(Duar) soils in Jalpaiguri and Silivuri tahsil with an areal coverage of about 6,600 km^2. The deficiency of plant food and organic matter and acidity (pH 5.8-6.7) are common. By far the most important, arcally (28,921.3 km^2) as well as agriculturally, are the alluvial soils. The minor differences in the parent materials distinguish the alluvial soils which, though at places inter digirated, have distinct spatial



SOILS OF WEST BENGAL
IN
DIFFERENT AGRO CLIMATIC REGIONS
HILL REGION
(BROWN FOREST SOIL)
TERAI & TEESTA
ALLUVIAL REGION
GANGETIC ALLUVIAL
REGION
VINDHYA ALLUVIAL
REGION
COASTAL REGION
RED LATERITE &
GRAVELLY UNDULATING REGION
RED. & LATERITE
GRAVELLY
DARJEELING
JALPAIGURI
COOCHBEHAR
WEST DINAJPUR
MALDA
MURSHIDABAD
BIRBHUM
BURDWAN
PURULIA
BANKURA
NADIA
HOOGHLY
24 PARGANAS
HOWRAH
MIDNAPORE

Map. No. 8

locations. The narrow alluvial strip along the lateritic and red soils in parts of the districts of Murshidabad. Bankura, Burdwan, Hooghly and Midnapur are different from the Ganga alluvium which covers parts of the North Bengal Plain and the whole of the remaining West Bengal Delta excluding the coastal strips in 24 Parganas and Midnapur. In the former alluvial group the riverine tracts of the Damodar and the Kasai have alternating sands beds and immature and irregular stratification and hence ill-developed profiles. The soils are neutral (pH 6.5-7.2) and relatively poor in plant nutrients and organic matter. Relatively greated leaching of clay mottling, etc. characterise the flat land soils of the tract. These are mildly acidic in reaction (pH 5.8-6.8). Relatively mature profile and higher leaching have affected the uplands of the tract, leading thereby to acidity (pH 5.8-6.9) and deficiency of organic matter.

The Ganga alluvium is however, rich in plant nutrients and organic matter and is alkaline in reaction (pH 7.0-8.2), though the uplands i.e., the older alluvium is somewhat neutral in reaction. The riverine tracts are prone to frequent siltation which mars the proper development of profiles. The greyish colour owes to the existence of fine sands. The interfluvial zones are covered by soils, clavey to sandy in texture, depending on the location. With the altitude of the distance from the flood plain, the process of concretion accelerates, and profile developments are also fair.

The coastal soils are the outcome of the interaction of rivers and tides and have developed in the districts of 24 Parganas and Midnapur. The soils are saline and alkaline and contain deposits rich in Ca, Mg, and half decomposed organic matter.

5.2 SOIL CLASS OF WEST BENGAL

It is seen from the review of the past work on soil survey by P. Chakravorty and S. Digar that studies of soil in the field were taken up under the following schemes. This objective and findings are given below.

1. Mor irrigation (Birbhum): Soils of only small areas in the sistrict of Birbhum were studied for irrigation purposes covering a total area of 312 sq. miles.

2. Howrah-Hooghly flush irrigation scheme: Under the scheme, soils were studied for texture, pH and salt content of different soil profiles in certain areas of Howrah and Hooghly districts covering 900 sq miles.

3. Reconnaissance soil survey of Burdwan (excluding Asansol sub--division) and Hooghly districts. This survey was carried out under Stewart scheme by the department of agriculture. West Bengal in collaboration with ICAR from 1952-56 and soil map classifying the soils into series, association and number of types was prepared covering an area of 3,000 sq miles.

Simultaneously, a rapid reconnaissance soil survey scheme for the other districts of West Bengal was also taken up following the similar soil survey procedures as under stewart scheme, as there was no authentic soil map of the state at that time.

Under this system of survey, representative soil profiles were studied at six miles (i.e. nine and half kilometers) grid intersection points and up to a depth of 4 ft. (i.e. 120 cm). More than 900 soil profiles were studied in the field all over West Bengal by the trained officers about the important morphological properties of soil and other information around profile sites as detailed below. Laboratory analysis of the collected soil samples were done also for the required physical and chemical constituents. All such information were compiled and published in a printed book form. entitled classification, composition and description of soil profiles of West Bengal (Tech. Bulletin No. 6) in the year 1965. In addition to this four printed books about soil survey work in the districts, viz. Murshidabad, Nadia, 24 Parganas. Hooghly and Burdwan (excluding Asansol sub-division) and were published during the period from 1956 to 1966.

Morphological characteristics of soil profiles and other items of field study: (Items from 1 to 10 are related to each soil layer of horizon and others are related to the area around profile site).

1. Depth in inches from surface; 2 Degree of soil moisture; 3. Root penetration and its abundance; 4. Presence of insect holes; 5. Texture; 6. Presence of concretions and their nature; 7. Colour according to Mansell colour chart; 8. Hardness of soil; 9. Effervescence with dilute hydrochloric acid; 10. pH with pH paper; 11. Natural vegetation; 12. Relief of the area; 13. Agricultural practices in the area; 14. Any other special problem of the area; 15. Depth of water table in summer and rains; 16. Altitude of the area for Darjeeling district only).

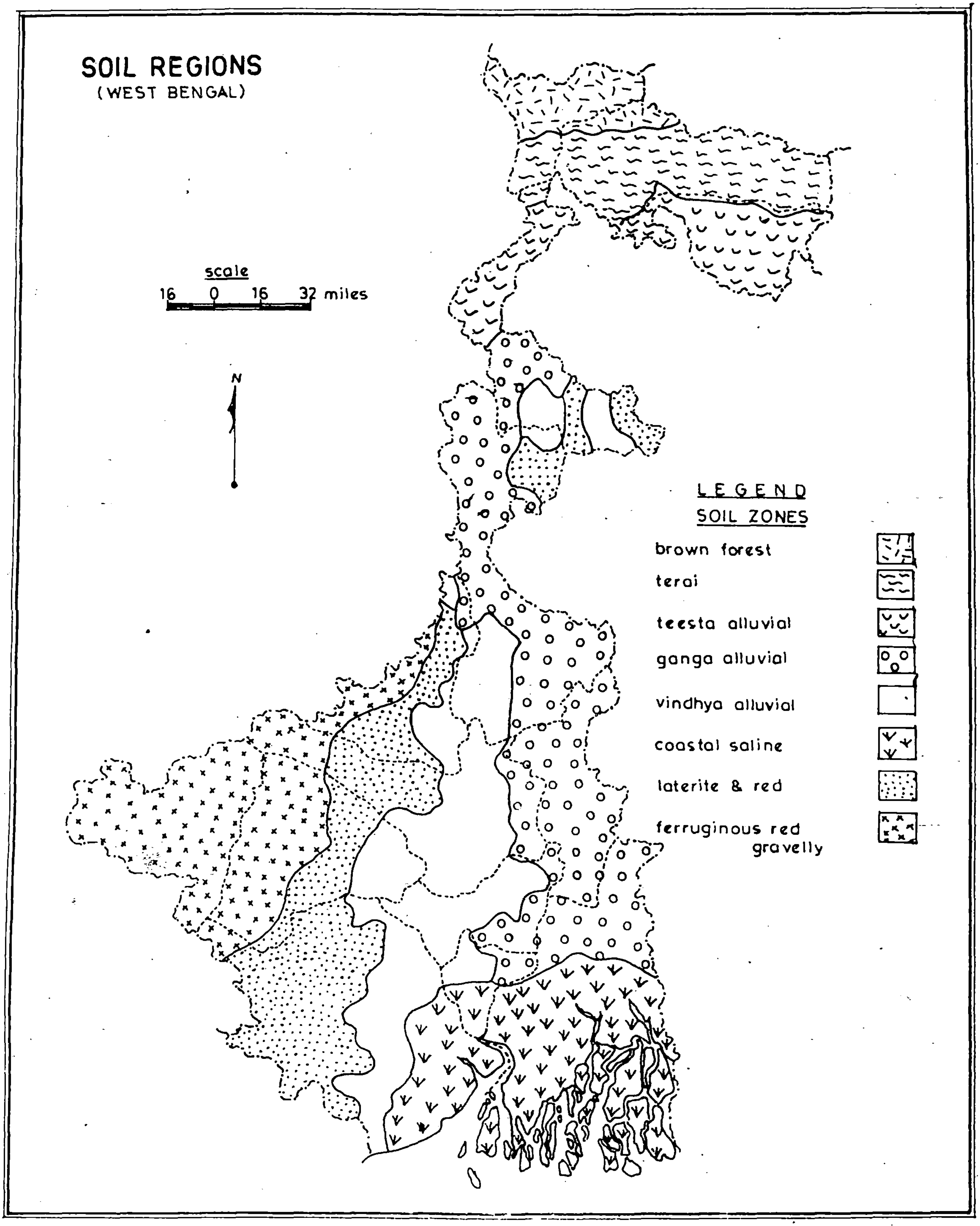
Chemical Study: Hydraochloric acid soluble Fe_2O_3, $R_2)_3$, Cao, K_2O and P_2O_5. Dilute acetic acid soluble bases and CaO. Carbon, nitrogen, soil reaction water soluble salts, coarse and fine sands silt and clay.

Based on the above information, the soils of West Bengal were classified according to old concept of soil classification as was prevailed at that time (Map No. 9). Soils were broadly divided into seven broadly divided into seven broad classes and some of these divisions were further sub-divided in the following manner into broad groups or families and again into small groups of soil association (i.e. predominant soil profile in a mapping unit). Naming of various classes of soils has been made a follows:

a) Alluvial soils

The alluvial soils of the state occupy the major area which is being drained by innumerable rivers rivulets, kandors (natural drainage way), etc.

The soils of the alluvial tract are divided into three families depending upon the nature of the parent material i.e. alluvium carried down and deposited by the principal river or rivers and its or their tributaries.


SOIL REGIONS
(WEST BENGAL)
scale
16 0 16 32 miles
N
LEGEND
SOIL ZONES
brown forest
terai
teesta alluvial
ganga alluvial
vindhya alluvial
coastal saline
laterite & red
ferruginous red gravelly

Map No. 9

Table V-1. Soils of West Bengal

Laterite and Lateritic Soil	Red Soil (5.6)	Alluvial Soil (39.4)	Coastal Soil (13.0)	Terai Soil (3.2)	Colluvial or Skeletal Soil (12.7)	Brown Forest Soil (2.2)

Surface Laterite	Buried Laterite

Saline Soil	Non-saline Alkali Soil	Saline Alkali Saline	Degraded Alkali Soil

Soils of transition seroes	Bengal Gondwana Soil	Bengal gnessis soil

Soils of Tista Family (6.5)	Soils of Vindhya Family (14.7)	Soil of Ganga Family (18.2)

Vindhya sub-families viz., Rajmahal (Ra), Damodar (Da) and Cossaye (Co)

Ga riverine Soil	Ga flat land Soil	Ga up land Soil	Ga low land Soil

Ra, Da, Co Riverine soil	Ra, Da, Co flat land soil	Ra, Da, Co high land soil

NB.: Figures in parenthesis show percentage of area occupied by the broad soil classes and some families against total geographical area of 87,85,300 ha. Rest of the geographical area is barren and unavailable for cultivation. Areas of braod classes of soils under different districts are mentioned in Table 1.

The total area of this alluvial tract is about 34.57 lakh ha only. Out of this area Ganga alluvium, Vindhya alluvium and Tista alluvium, occupy 15,97,110 ha, 12,92,217 ha and 5,67,657 ha respectively. Accordingly, the soils are divided under Ganga. Vindhya and Tista families. Then, according to physiographic situation of the land the soils of each family are again subdivided into various groups of soil association viz, high land or upland, flat land, riverine land and low land. According to genetical character, high or uplands accur on old flood plains, flat lands occur on newly formed flood plains, riverine lands occur on very recently formed flood plains and low lands occur at depressions of abandoned river courses and marshy lands.

Ganga is the principal river of the middle and eastern part of the state. Hence the soils formed by the river and its tributaries are called as Ganga alluvium. Similarly, the principal river of North Bengal is Tista and hence the soils formed by it or its tributaries are called as Tista alluvium. In the case of western tract, the soils are formed by many principal rivers and their tributaries viz., Damoder Kangsabati, Silabati, Ajoy, Mayurakshi etc. and hence to put them under a common name, they are called as Vindhya alluvium since the catchment areas of all these rivers lie in Rajmahal hills and Chhotanagpur plateau, which may have some physiographic similarity or continuity of the Vindhya range (lying further west).

b) Colluvial and Skeletal soils

Next to the alluvial area is the area occupied by colluvial and skeletal soils of the western part of the state. The total area covered by these soils is about 11.14 lakh ha only. This area is physiographycally linked with the Rajmahal and Chhotanagpur plateau. In this area we wtill have hills of low altitude, domes and escarpments and rock outcrops etc. These various features of land withstand the weathering cycles of the world for a long long times and may remain as such for another million years from now. The area is undulating in nature and hence the upper convex slope has poor soil depth and are skeletal in nature, whereas the lower part of the valley has good soil depth and is colluvial in nature. This region is again sub-divided into various subgroups of families according to main geological character and soil depth or both in the area under each broad group of family.

c) Coastal soils

Next to the colluvial and skeletal soils is the area occupied by coastal soils, which occur near the bay. The total area covered by this soil is about 11.42 lakh ha only. This area is influenced by the saline tidal water of the bay region, which comes into this area twice in a day. Since the land situation is below the high tidal level, the reclaimed agricultural area is protected by the earthern embankments. In spite of this, sometimestrom upsurge damages the embankment and allows the saline water to flood the field. This region is again subdivided into various broad groups or families, according to levels of salinity, alkalinity and acidity of the area, coming under each braod group of family.

d) Laterite and lateritic soils

Next to the coastal soils is the area occupied by laterite and lateritic soils, which occur at the western part of the state. This area is undulating in nature and is the catchment area of many small and big rivulets of the principal rivers. The total area occupied by the soils is about 5.89 lakh ha only. Laterite soils occur either at valley floor margine or at upper piedmont regions sometimes below a rock outcrop. The underlying laterite may be massive nodular or soft and sometimes establishment of their relationship with the overlying soil creates difficulty during field survey. This type of soil is light textured, porrous and acidic in nature regarding plant nutrients they are poor in organic matter, available phosphorous, available potassium and bases. Small nodules of iron concretion are found in the surface layer and its number increases with depth. This class is again subdivided into two broad groups, viz. surface laterite and buried laterite on the basis of occurrence of laterite layer within the depth of normal profile study or below this zone. This type of soil is well responsive to fertiliser application with or without organic manure. Natural vegetation, e.g. Sal, Palas and Mahua trees, grow well in these soils.

e) Red soils

Next to the laterite and lateritic soils is the area occupied by the red soils, which not only occur in the western part but also in the northern part of the state. This area is also mildly undulating in nature and is the catchment area of many tiny rivulets nala or village drains. The total area occupied by this class of soils is about 4.96 lakh hactores only.

The soils are low in organic matter and medium to medium low in available phosphorous and potassium. In these soils, bath nodular iron concretions and calcium carbonte ghootings are found. The amount of clay progressively increases as we study the soul profile from surface to down-wards. The percentage of base saturation of red soil is more than the laterite and lateritic type of soil, because of higher base saturation and lamy texture the red soil becomes more responsive to fertiliser application than the laterite and latritic soil. Natural vegetation e.g. Sal and Palas trees grow well in this region.

f) Terai soils

Next to the red soils is the area occupied by Terai soils of the North Bengal districts. These soils are found only in the districts of Darjeeling and Jalpaiguri. The total area covered by this soil group is about 2.80 lakh hectares only. These occupy the foothill area of the mountain region of the Himalayas. These soils are found very close to the mountain region and over the deposit of the hilly rivers like Tista, Mahananda, Torsa, Jaldaka and their numerous tributaries. These rivers bring varieous types of soil and rock materials from heights of above 3,000 metres and deposit them at first in the area, which is now about 60 to 90 metres above mean sea level. The area is moderately undulating and during rains the rate of infiltration and surface flow is lower than the rate of precipitation and for this reason the are suffers from temporary water logging at places. These types of soils are mostly lighter in texture with lower base status and contains a good amount of a mixture of partially and fully decomposed organic matter. For this reason the colour of the soil varies from deep black to grey black. Due to the above factors, the soil is acidic in nature and is poor in base status and available plant nutrients. It has been found that the soil is also deficient in micro-nutrients. There is a good prospect of suitable rabi crop with residual moisture after rainy season with proper application of soil conditioners and fertiliseers.

g) Brown forest soils

Next to the Terai soil is the area occupied by Brown Forests soils. These soils are found only in Darjeeling district which is the northern most part of West Bengal. The total area covered by this soil is about 2 lakh hectares.

This soil class is formed over Himalayan and sub-Himalayan ranges at altitudes of 500 m to about 2,500 m above mean sea level. The soil depth of this type of soil is variable and may be shallow or deep. Slope percentage of this area also ranges from 10% to 50%. The underlying rock structure is not very stable and due to steep slope, landslide and land slip often occur during rainy season. Most of the area is either covered by forest of tea plantation. The soil is acidic in nature and mostly lighter in texture. Due to low temperature and high rainfall, only some selected field and horticultural crops can be cultivated in this region. Plant nutrient status is low to medium. Fertiliser practices can only be sone under favourable weather condition.

5.3 SOIL MORPHOLOGY

Soil plays a vital role in the very existence of mankind. Study of soil system depicts highly organised physical, chemical and biological complex on which man depend for his basic needs of food clothing and welfare.

While investigation on soils were initiated in Russia during the later part of the nineteenth century, pedological study was taken up in the India and West Bengal, in particular during the middle of twentith century by launching Stewart scheme by the department of agriculture, West Bengal in collaboration with Indian Council of Agricultural Research from 1952-56 and a soil map was brought out on the basis of rapid of rapid reconnaissance survey based on 9.6 km grid system and broadly classified into eight units viz. Gangetic alluvium, Vindhya alluvium. Terai and Teesta alluvium, coastal, laterite, red, gravelly and brown forest (S.K. Mukherjee, 1965).

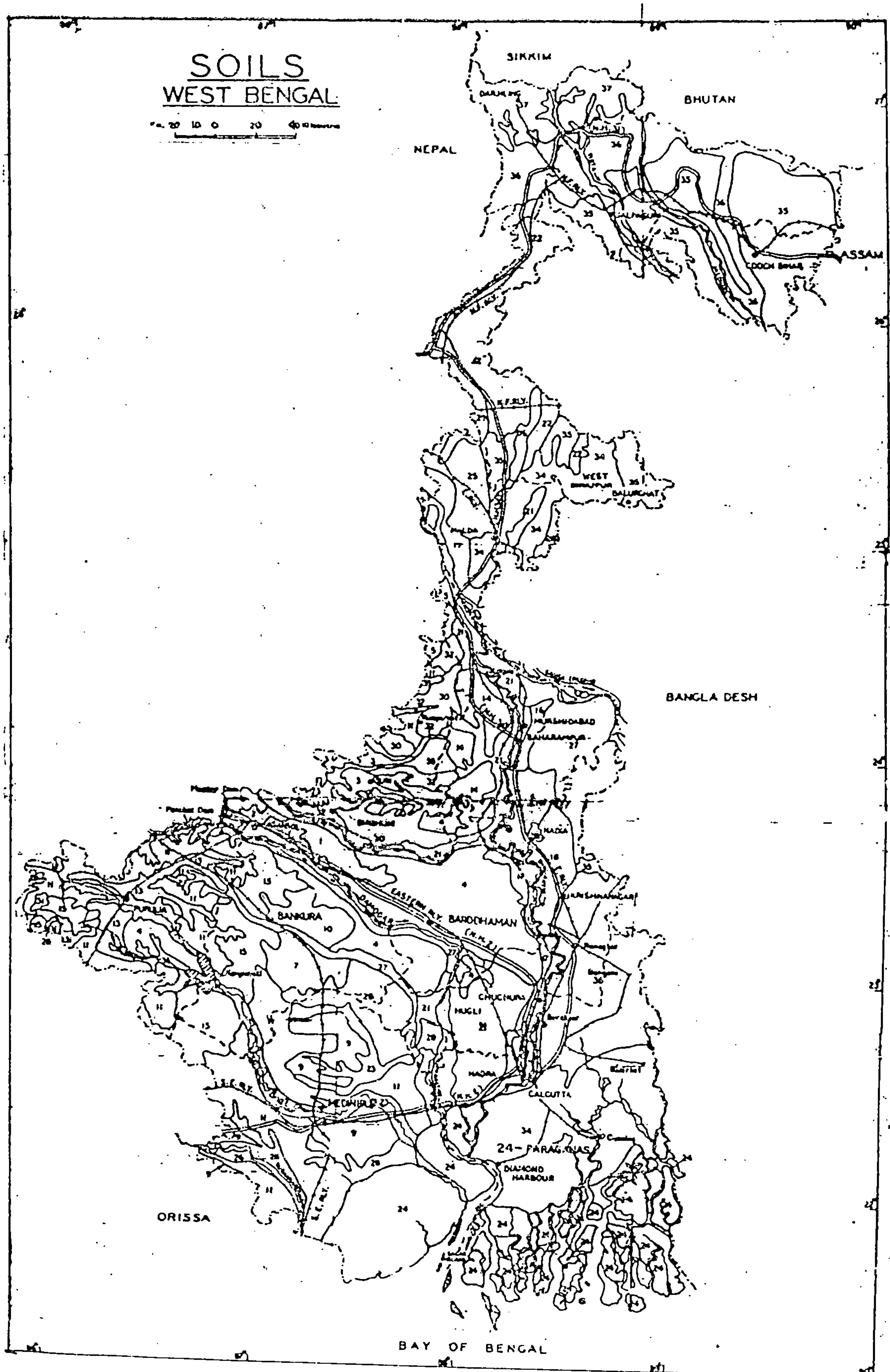
By the advancement of research and availability of more information it has been found that a correct presentation of different soils could not be made in a grid system because in nature they form of continuous, dominantly with geomorphic pattern of landscape. To make it more scientific. Raychaudhury and Mathur (1954) have prepared a soil map of India into 16 major soil regions and 108 minor basic soil regions by integrating the effects of climate, vegetation an topography on soil formation. Raychaudhury et al. (1963) have divided India into 27 major soil groups

They were more or less similiar to earlier classification Govindarajan (1973) further revised the soil map of India (1:7 million) and distinguished 25 broad soil units together with equivalent USDA 7th Approximation classification systems. By the increase in the generation of more data on soil survey, National Bureau of soil Survey and Land Use Planning updated the soil map of India in 1983 (R.S. Murthy et al., 1983) based on soil variation related to relief or physiography in different climatic zones. 101 suborder associations were recognised according to soil taxonomy (1975) in the soil map of 1:6.3 million scale 16 suborder associations are identified in West Bengal wherein dominant suborders recognised are Aqualfs, Aquepts, Aquents, Ochrepts, Fluvents, Ustalfs and Orthents. The present soil map of West Bengal is based on the soil map of 1983 which was largely on the data base generated by the bureau through reconnaissance and rapid reconnaissance soil survey and updated by incorporating up to date data generated by

Table V-2. Area of Broad Classes/Associations of Soils in Different Districts (Area in .000 ha)

District	Name of soil classes (or association)								
	Lateritic/ lateritic	Red	Vindhya alluvium	Ganga alluvium	Terai and Teesta	Coastal	Colluvial and skeletal	Brown forest	Total
Hooghly	-	6.80	184.95	58.57	-	-	-	-	250.32
Howrah	-	-	62.53	26.33	-	34.71	-	-	123.57
Burdwan	62.72	21.05	333.55	75.54	-	-	92.23	-	585.09
Birbhum	85.48	59.75	96.36	19.28	-	-	134.81	-	395.68
Midnapore	306.66	234.16	282.40	-	-	298.82	31.11	-	1,153.15
Bankura	133.96	39.92	90.62	-	-	-	345.32	-	609.82
Purulia	-	-	-	-	-	-	510.15	-	510.15
24 Parganas	-	-	-	365.67	-	808.17	-	-	1,173.84
Nadia	-	-	-	339.25	-	-	-	-	339.25
Murshidabad	-	-	147.80	301.27	-	-	-	-	449.07
Malda	-	77.77	17.13	243.54	-	-	-	-	338.44
West Dinajpur	-	56.90	76.88	167.66	134.12	-	-	-	435.56
Jalpaiguri	-	-	-	-	453.37	-	-	29.07	482.44
Cooch Behar	-	-	-	-	204.56	-	-	-	204.56
Darjeeling	-	-	-	-	55.73	-	-	165.26	220.99
Total	588.82	496.35	1,292.22	1,597.11	847.78	1,141.70	1,113.62	194.33	7,271.93

(i.e. 72.72 Lakh ha)



Legend Overleaf

Map. No. 10

Legend

1. Ochraqualfa-Paleustalfs
2. Ochraqualfs-Haplustalfs
3. Ochraqualfs-Ustifluvents
4. Ochraqualfs-Haplaquepts-Eutrochrepts
5. Ochraqualfs-Ustochrepts-Ustorthents
6. Ochraqualfs-Eutrochrepts-Fluvaquents
7. Paleustalfs-Plinthustalfs-Ochraqualfs
8. Paleustalfs-Plinthustalfs-Ustochrepts
9. Paleustalfs-Haplustalfs-Ustochrepts
10. Paleustalfs-Haplustalfs
11. Haplustalfs-Ochraqualfa-Ustochrepts
12. Haplustalfs-Paleustalfs-Ustochrepts
13. Heplustalfs-Ustochrepts
14. Haplustalfs-Ustochrepts-Haplaquepts
15. Haplustalfs-Ustochrepts-Ustorthents
16. Fluvaquents-Ochraqualfs-Haplaquepts
17. Ustifluvents-Fluvaquents-Ochraqualfs
18. Ustifluvents-Haplaquents
19. Ustifluvents-Ustorthents-Haplaquepts
20. Ustifluvents-Ustochrepts-Haplaquepts
21. Ustifluvents-Haplaquepts-Ochraqualfs
22. Ustorthents-Haplaquepts-Dystrochrepts
23. Ustorthents-Ochraqualfs
24. Haplaquepts-Fluvaquents
25. Haplaquepts-Ustochrepts
26. Haplaquepts-Haplaquents-Ustorthents
27. Haplaquepts-Ustifluvents-Ochraqualfs
28. Haplaquepts-Ochraqualfs
29. Haplaquepts-Ustorthents
30. Haplaquepts-Ustochrepts-Ustorthents
31. Ustochrepts-Haplaquepts-Haplustalfs
32. Ustochrepts-Haplaquents-Ustifluvents
33. Ustochrepts-Ustorthents-Haplaquents
34. Eutrochrepts-Dystrochrepts-Haplaquepts
35. Dystrochepts-Haplaquepts
36. Dystrochrepts-Udifluvents
37. Dystrochrepts-Udorthents

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National Bureau of Soil Survey and Land use Planning, All India Soil and Land Use Survey, and Soil Survey Organisation, Govt. of West Bengal. As can be seen from the map and decriptions, there are altogether 14 great groups based on USDA taxonomy constituting 37 mapping units each consisting of great group soil association. The description of the representative soil series belonging to the different great groups are given mapping unitwise in the following pages. Traditional popular nomenclature followed earlier is also indicated for easy understanding.

The detailed morphological descriptions of the representative typing pedone (soil profiles) of these soil series along with the soil analysis data are furnished (Map No. 10)

Ochraqualfa-Paleustalfs (mapping unit-1)

This unit consists of two important soil groups with inclusions of some other soil groups Jagadishpur and Mrigindighi soil series represent said two soil groups.

Jagadishpur soils (B.M. soils of India 1982) have developed in granite alluvium on nearly level to very gently slopping old flood plains of the Dwaraka river in Birbhum district at an elevation of 30 to 50 m above MSL. They are very deep clayey, imperfectly drained soils and have light brownish gray to pale olive strongly acid to slightly acid silt loam to silty clay a horixon and gray medium acid silty clay loam to silty clay Bt horizon is more than 100 cm. The climate of the area is tropical moist subhumid with mean annual air temperature of 26.5°C and mean annual rainfall of 1,422 mm. The CEC ranges from 18 to 28 meq per 100 gm of soil. The moisture retention capacity is high. The lands are usually terraced, but susceptible to erosion if the terraces are not properly maintained. This soil is cultivated for rice in the kharif season and crops like wheat, pulses and oilseeds with irrigation in the rabi season. Their productivity potential is medium.

Mrigindihi soils (B.M. Soils of India, 1982) have developed in old alluvium in the undulating interfluve plains of western part of West Bengal at an elevation of 50-100 m above MSL Slope of land is up to five per cent. They are very deep, fine loamy somewhat excessively drained and have yellowish red, very strongly to very strongly acid, sandy loam. horizons, and yellowish red to red, strongly to very strongly acid, sandy clay loam Bt horizons. The thickness of A horizon ranges from 25 to 35 cm and that of Bt horizon is more than 100 cm. The climate of the area is tropical moist sub-humid with mean annual air temperature of 27°C and mean annual rainfall of 1,550 mm. The CEC ranges from 6 to 10 meq per 100 gm of soil. The moisture retention capacity is medium to low. The lands are cultivated to rainfed rice and vegetables, wheat potato and winter vegetables are raised under irrigation. Their productivity potential is low to medium depending on the availability of irrigation. In modern USDA classification system, Jagadishpur group soil was placed under ochraqualfs abd Mrigindihi group soils were placed under Paleustalfs at great group level. In earlier classification Jagadishpur group soils belong to Ganga upland and Mrigindihi group soil belong to belong to laterite (DA,WB* 1965).

Ochraqualfs-Haplustalfs (mapping unit-2)

This unit consists of two important soil groups, Jagadishpur group and Hensla group, with inclusions of some other soil group. Jagadishpur group soils have been discussed in mapping unit 1. Hensla series (NBSS-1982) a representative of Hensla group have developed on weathered granite geneiss in gently slopping peneplained plateau in Purulia district at an elevation of 200 to 260 m above MSL. Slope of the land is up to five per cent. They are moderately deep, fine loamy, well drained and have yellowish brown to reddish yellow, slightly acid, loamy sand to sandy loam A horizon, reddish yellow to strong brown sandy clay from loam to caly loam B horizonz over massive laterite Cir horizon. The thickness of A horizon ranges from 20 to 25 cm and that of Bt horizon between 20 to 25 cm. The climate is tropical dry sub-humid with mean air temperature of 26°C and mean annual rainfall of 1,307 mm. The CEC ranges from 8 to 13 meq per 100 gm soil. The moisture retention capacity is medium to low. Lands are cultivated to dry land crops and their productivity potential is low to medium depending on the availability of irrigation. Hensla group soils have been tentatively classified as Haplustalf at great group level as per USDA soil texanomy. The same soil group was classified earlier as Gandwana colluvial.

Ochraqualfs-Ustifluvents (mapping unit-3)

This unit consists of two important group of soils with inclusion of some other group of soils. One group is represented by Jagadishpur soil series which have been described under mapping unit-1. Another group is represented by Ghoshat soil series.

Ghoshat soils (NBSS-1984) have developed in recent alluvial materials on nearly level river terraces or on low lying lands along river bank of Ajoy in Birbhum district at an elevation of 20 to 25 m above MSL. They are very deep, well drained and have dark yellowish brown moderately fine textured neutral A horizon underlaing by layer of sandy deposit constituting C horizon. Abundant mica particles are present throughout the soil profile.

The climate is tropical moist subhumid with mean annual air temperature 26.6°C and mean annual rainfall 1.422 mm. The moisture retention capacity is medium to low. The soils are susceptible to river bank erosion and flood damage. These soils are culvated for paddy and other rabi crops if irrigation facilities are available and the productivity potential of the soils is medium. In modern USDA soil classification system Ghoshat group soils have been placed under Ustifluvent at great group level. In earlier classification (DA,WB-1965) the same soil group was under Gneissic colluvial.

Ochraqualfs-Haplaquepts-Eutrochrepts (mapping unit-4)

This unit consists of three important group of soils. Jagadishpur, Banpara and hanrgram group with inclusion of other soil groups. Jagadishpur soil group has been described under mapping unit-1.

Banpara series (NBSS-1984) which represents Banpara soil group have developed on old alluvium on nearly level to very gently sloping lower alluvial plain at an elevation of 40 to 50 m above MSL in Burdwan district. They are very deep, imperfectly drained and have light brownish gray to olive gray, slight acid, sandy loam to loam A horizon, light gray to olive gray neutral sandy clay loam to clay loam B horizon and gray neutral clay loam to clay C horizon. The soils have aquic moisture regime and so have the inherent problem of poor aeration. The climate is tropical moist sub-humid with mean annual air temperature 26.6°C and mean annual rainfall 1,529 mm. The CEC ranges from 8.0 to 16.0 meq per 100 gm soil. The soils are suited only for paddy kharif season. They can support climatically adapted crops, pulses, etc. on conserved soil moisture. The productivity potential of the soils is high. Banpara group soils have been classified as Haplaquepts as per USDA soil taxonomy in great group level. The same Banpara group soil was classified earlier as Vindhya flat lands (DA,WB-1965). Totpara soil series also belongs to this soil group and is intensively cultivated for rice crop.

Hanrgram series (B.M. soils of India - 1982) a representative of Hanrgram soil group was originally established in Burdwan district. These soils have developed in alluvium on old flood plain of river Damodar on nearly level to level lands at an elevation of 20 to 30 m above MSL. The soils are deep, imperfectly drained and have high gray to olive brown, strongly to slightly acid, clay loam to clay A horizon and gray to grayish brown, slightly acid, clay loam to clay B horizon which are distinctly mottled with strong brown to olive brown in colour. The climate is tropical moist sub-humid with mean annual air temperature of 26.6°C and mean annual rainfall of 1,400 mm. The soil cracks one cm wide up to about 30 cm depth. CEC ranges from 18 to 28 meq per 100 gm soil, Hanrgram soils are subjected to flooding and water stagnation during rainy season. Hence, they are suitable only for growing rice. However, lentil and gram may be grown in winter on conserved moisture and wheat with supplementary irrigation. Productivity potential of this type of soil is medium, Hanrgram soil group have been classified as Eutrochrepts as per USDA soil taxonomy at great group level. In earlier time Hangram group soil has been classified as Damodar flat lands.

Ochraqualfs-Ustochrepts-Ustorthents (mapping unit-5)

This mapping unit consists of three important soil groups Jagadishpur. Hatikheda and Amra groups. The characteristics of Jagadishpur soil group has already been discussed earlier in unit-1.

Hatikheda series (NBSS-unpublished) representative of Hatikheda group soils were originally established in Bankura district. These soils have developed on colluvial deposits on very gently sloping valleys of low developed plateau at an elevation of 120 to 140 m above MSL. They are very deep, imperfectly drained and have yellowish brown slight acid loam A horizon, yellowish brown neutral clay loam B horizon, underlain by massive clayey soil as C horizon with lithological discontinuity. The climate of the area is tropical dray sub-humid with annual air temperature of 2.7°C and mean annual rainfall of 1,422 mm. The CEC ranges from 15 to 21 meq per 100 gm soil. Hatikheda soils are moderately productive and crops respond to better management. In some soils poor drainage may give rise to some problems. Productivity potential of these soils is low. Hatikheda group soils have been placed under Ustochrept at great group level as per USDA soil classification. Earlier this soil group was placed under Gondwana colluvial (1965).

Amra series (AIS and LUS) which represents Amra soil group was originally identified in Purulia district. The soils have developed on granite gneiss on moderately steep to very steep hill slopes escarpment. They are shallow to very shallow well drained and have brown and dark brown slight acid gravelly clay loam A horizon over stones and pebbles as C horizon. The climate is tropical dry sub-humid with mean annual air temperature of 26°C and mean annual rainfall of 1,307 mm. The soils are highly erosive in nature and under proper soil conservation measures only forest species can grow. The productivity potential of soil is poor. Amra soil group has been placed under Ustorthent at great group level as per USDA taxonomy. The same soil group has been classified earlier (1965) as transition soils.

Ochraqualfs-Eutrochrepts-Fluvaquents (mapping unit-6)

This mapping unit consists of three major soil group - Jagadishpur, Madhupur and Kanagar groups with inclusion of other minor soil groups. The characteristics of Jagadishpur soils group has already been discussed earlier in unit-1.

Madhupur series (B.M. Soils of India-1982) representative of Madhupur soil group was originally established in Murshidabad district. These soils are formed in mixed alluvium and occur on the Bhagiriathi flood plain with usually less than one per cent slope at an elevation of 50 m above MSL. They are deep moderately well-drained and have brownish gray moderately alkaline silt loam horizons and dark grayish brown to dark brown moderately alkaline silt loam to silty clay loam B horizons and brown, moderately alkaline, silt loam C horizons underlain and lithologically discontinuous, moderately alkaline, silty clay loam LIC horizon. The soils are calcareous throughout. The climate of the area is tropical moist sub-humid with mean annual air temperature of 20.9°C and mean annual rainfall of 1,417 mm. The CEC ranges from 9 to 29 meq per 100 gm soil. Madhupur soil have good air-water relationship and response to management is expected to be favourable. Under irrigation, they are suitable for wheat, oilseeds, vegetable and orchards. Productivity protential of this type of soil is medium to high. In modern classification system Madhupur group soils have been placed under Eutrochrepts at great group level. This soil group was placed under Ganga flat land in earlier classification.

Kanagar soil series (B.M. soils of India 1982) a representative of kanagar soil group originally occur in Hooghly district. They have developed on the old flood plain of the river Hooghly on nearly level to very gently sloping lands at an elevation of 5 to 10 m above MSL. Kanagar soils are very deep, imperfectly drained and have dark gray to dark grayish brown mottled, mildly alkaline, silty clay loam A horizons over dark gray to grayish brown mildly alkaline silty clay loam C horizons. The soils are glayed below one metre. The climate is tropical moist sub-humid with mean annual air temperature of 27.5°C and mean annual rainfall of 1,503 mm. The CEC ranges from 10 to 21.6

meq per 100 gm soil. Kanagar soils are fine silty and situated in low lying area. They are heavier in texture and subjected to hydromorphic moistures. As a result they are suited only to rice during kharif. Their productivity potential is medium. At gret group level kanagar soil group has been placed under fluvaquent as per USDA soil taxonomy. The same soil group was classified earlier as Ganga low land.

Paleustalfs-Plinthustalfs-Ochraqualfs (mapping unit-7)

This unit consists of three important soil groups with inclusion of some other soil groups. The major soil groups are Mrigindihi, Sankarpur and Jagadishpur. The principal soil characteristics of Mrigindihi and Jagadishpur soil groups have been described earlier in unit-1.

Sankarpur series (NBSS-1948) which represents Sankarpur soil group have developed on weathered granite gneiss on strongly sloping dissected plateau in Asansol sub-division of Burdwan district at an elevation of 110 to 120 m above MSL. Sankarpur soils are deep well-drained and have reddish yellow, strong acid, sandy loam A horizon yellowish red to dark red medium to light acid, sandy loam to gravelly loam B horizon underlain by massive conglomerate of nodular ferruginous, beads, quartzgravels and small pieces of stones C horizon. The climate is sub-humid tropical with mean annual temperautre 26°C and mean annual rainfall of 1,393 mm. The CEC ranges from 9.0 to 15.5 meq per 100 gm of soil. The available moisture capacity is 8 cm at 60 profile depth. Sankarpur soils have good air-water relationship but they are highly erosive in nature and strong slope causes run off during rains. With proper conservation measures the soils support forest vegetation. The productivity potential of soils is poor. In modern soil classification system Sankarpur group soils have been classified as plinthustalf at great group level. This soil group was placed under laterite in earlier classification.

Paleustalfs-Plinthustalfs-Ustochrepts (mapping unit-8)

This unit consists of three principal soil groups - Mrigindihi, Sankarpur and Hatikheda. The characteristic features of these three soil groups have already been discussed earlier under soil units-1, 7 and 5 respectively.

Paleustalfs-Haplustalfs-Ustochrepts (mapping unit-9)

This unit consists of three principal soil groups Mrigindihi, Hensla and Hatikheda. The characteristics of these soil groups with occurrence have been described in earlier units-1, 2 and 5 respectively. Soils of this unit mostly occur in Midnapur district.

Paleustalfs-Haplustalfs (mapping unit-10)

This unit consists of two important soil groups with inclusion of some minor soil groups. The major soil groups are Mrigindihi and Hensla, which are described under units 1 and 2.

Haplustalfs-Ochraqualfa-Ustochrepts (mapping unit-11)

This unit consists of three principal soil groups with few minor soil groups as inclusion. The three major groups are Hensla, Jagadishpur and Hatikheda - the characterisation feature of which are described earlier under mapping units 1, 2 and 5 respectively. Soils of this unit mostly occur in Birbhum, Bankura, Purulia and Midnapur districts.

Haplustalfs-Paleustalfs-Ustochrepts (mapping unit-12)

This unit consists of three important soil groups - Hensla, Mrigindihi and Hatikheda. The characteristics features of these soil groups are elaborately discussed under mapping units 2, 1 and 5 respectively. Soils of this unit mostly occur in Purulia district.

Heplustalfs-Ustochrepts (mapping unit-13)

This unit consists of two principal soil groups. Hensla and Hatikheda, with one or two minor soil groups as inclusion. The principal characteristics of soil groups Hensla and hatikheda are presented earlier under units 2 and 5 respectively. The soils of this unit also mostly occur in Purulia district.

Haplustalfs-Ustochrepts-Haplaquepts (mapping unit-14)

This unit consists of three principal soil groups - Hensal, Hatikheda and Banpara soil groups, with inclusion of few other minor soil groups. The principal characteristics of above three major soil groups are discussed earlier in this chapter under mapping unit 2, 5 and 4 respectively. Soils of this unit occur mostly in Murshidabad district.

Haplustalfs-Ustochrepts-Ustorthents (mapping unit-15)

This unit consists of three principal soil groups with some minor soil groups. The important groups are Hensla, Hatikheda and Amra. The soil characteristic of Hensla, Amra and Hatikheda are discussed earlier under units 2 and 5.

Fluvaquents-Ochraqualfs-Haplaquepts (mapping unit-16)

This unit consists of three important soil groups Kanagar, Jagadishpur and Banpara, with few other soil groups as inclusion. The characteristics of these soil groups are vividly discussed under mapping units 6, 1 and 4 respectively. Soils of this unit occur mostly in Purulia district.

Ustifluvents-Fluvaquents-Ochraqualfs (mapping unit-17)

This unit consists of three important soil group Ghoshat, Kanagar and Jagadishpur soil groups. The principal soil characteristics of these soil groups are discussed earlier under mapping units 3.6 and 1 respectively.

Ustifluvents-Haplaquents (mapping unit-18)

This unit consists of two important soil groups with some other groups. The major soil groups are Ghoshat and Charcha. The characteristics feature of Ghoshat soil group is described earlier in this chapter under unit 3.

Charcha series (NBSS and LUS) which represents Charcha soil groups was originally established at Mohammad bazar Police Station in Birbhum district. Charcha soils are developed on local colluvial wash and occur in low laying areas. Charcha soils are deep, imperfectly to poorly drained and have gray medium to slightly acid, sandy loam to sandy clay loam A horizon over grayish brown neutral loamy and C horizon. The climate is tropical subhumid with mean annual air temperature of 26.5°C and mean annual rainfall of 1,422 mm, CEC ranges from 6.0 to 12.0 meq per 100 gm soil. These soils are best suited to rise in kharif season with improvement of drainage condition. Jute can also be grown well under recommended dose of fertilizer application. Productivity protential of these soils is medium. Characha soil group have been placed under Haplaquent at great group level as per soil taxonomy. The same Charcha group soil was classified as Vindhya riverine in earlier classification.

Ustifluvents-Ustorthents-Haplaquepts (mapping unit-19)

This unit consists of three important soil groups with few other soil groups as inclusion. The major soil groups are Ghoshat, Amra and Jotghasi. The characteristic features of Ghoshat and Amra soil groups are presented under mapping units 3 and 5 respectively.

Jatghasi series (DA, WB-1984) which represents Jotghasi soil group originally occur at Gajol police station in Malda district. Jotghasi soils have developed from alluvium brought down by river Tanga. Jotghasi soils are deep, poorly drained and have brown neutral silty clay loam A horizon, light gray to dark gray, neutral to mild alkaline, silty clay loam B horizon. The soils occur on nearly level land at an elevation of about 20 to 30 m above MSL. The climate is tropical moist sub-humid with mean annual air temperature of 25.4°C and mean annual rainfall of 1,814 nm. CEC ranges from 7.0 to 14.0 meq per 100 gm soil. Jotghasi soils are poorly drained and situated in low lying area and subjected to hydromorphic condition under improved drainage. The soils, have medium potentiality for agricultural production. They are best suited to rice in kharif season. Jotghasi soil group has been placed under Haplaquept at great group level as per USDA soil taxonomy. The same soil group has been clasfified as Tista riverine in older system (1958).

Ustifluvents-Ustochrepts-Haplaquepts (mapping unit-20)

This unit consist of three important soil groups - Ghoshat, Hatikheda and Banpara. The principal soil characteristics of these soil groups are elaborately discussed earlier under units 3, 5 and 4 respectively. Soils of this group generally occur in Hooghly and Howrah district.

Ustifluvents-Haplaquepts-Ochraqualfs (mapping unit-21)

This unit also consists of three important soil groups - Ghoshat, Banpara and Jagadishpur. The characteristic features of soils of these groups are discussed under mapping units 3, 3 and 1 respectively. The soils of this unit occur mostly in Hooghly, Howrah, Burdwan, Murshidabad and Malda districts.

Ustorthents-Haplaquepts-Dystrochrepts (mapping unit-22)

This unit consists of three important soil groups with one or two other soil groups. The major soil groups are Amra, Banpara and Gitaldaha. The characteristic behaviour of Benpara soil group has been discussed under mapping unit-4.

Gitaldaha series (NBSS, 1983) which represents Gitaldaha soil groups was established at Dinhata Police Station of Coochbehar district. Gitaldaha soils have developed on mixed alluvium on flat land at an elevation of 40 to 45 m above MSL. Soils are deep, moderately well drained and have brown very strongly acid fine texture. A horizon gray to pale brown, medium to slightly acid sandy loam B horizon over sandy C horizon. The climate of the area is tropical per humid with mean annual air temperature of 24.4°C and mean annual rainfall of 3,628 mm. Gitaldaha soils are agriculturally important. They have fairly good air-water relationship. They are productive and crops respond to management. Gitaldaha group soils have been placed under Dystrochrept at great group level as per modern USDA system of soil classification. The same soil group has been classified earlier as Tista riveine soils of Amra series have already been discussed in mapping unit-5.

Ustorthents-Ochraqualfs (mapping unit-23)

This unit consists of two important soil groups Amra and Jagadishpur, with some of the soil groups. This unit occurs mostly in Midnapur district. The soil character of Amra and Jagadishpur soul groups have been discussed under mapping units 5 and 1 respectively.

Haplaquepts-Fluvaquents (mapping unit-24)

This unit consists of two principal soil groups with one or two other soil groups. The major two soil groups are Sagar and Kanagar, the characteristic features of kanagar series was discussed under mapping unit-6.

Sagar series (NBSS, 1984) a representative of Sagar soil group soil group originally occur in Sagar Island of 24 Parganas district. Canning soil series is another important soil of this soil group and is used for rise cultivation. The soils have developed in alluvium on deltaic plain of river Ganga having 1-2 per cent slope.

The soils are deep, imperfectly drained and have light gray, strong acid, silty clay loam A horizon, dark gray mild alkaline silty clay distinctly mottled B horizon. The climate is subtropical moist subhumid with mean annual air temperature of 26.4°C and mean annual rainfall of 1,908 mm. CEC ranges from 21.9 to 26.1 meq per 100 gm soil. Electrical conductivity in 1:2.5 water extract ranges between 1.2 and 2.0 mmhos. In absence of sufficient rainfall, the crop yield suffer due to moisture and salinity. The productive potential of Sagar soils is medium to high according to annual rainfall. Sagar soil group has been placed under Haplaquept (salinephase) at great group level in recent adopted USDA soil classification system. The same soil group has been classified as saline, saline-alkali soils. Soils of this unit generally occur in Midnapur, Howrah and 24 Parganas districts.

Haplaquepts-Ustochrepts (mapping unit-25)

This unit also consists of two principal groups with few other soil groups as inclusion. The major soil groups are Jotghasi and Hatikheda. The soil characteristics of these soil groups are described earlier in this chapter under mapping units 19 and 5 respectively. Soils of this unit mostly occur in Malda district.

Haplaquepts-Haplaquents-Ustorthents (mapping unit-26)

This unit consists of three important soil groups Banpara, Charcha and Amra. The characteristic features of above soil groups are broadly discussed under mapping units 4, 18 and 5 respectively. Soils of this unit mostly occur in Midnapur district.

Haplaquepts-Ustifluvents-Ochraqualfs (mapping unit-27)

This unit also consists of three principal soil groups with some other soil groups as inclusion. The major soil groups are Banpara, Ghoshat and Jagadishpur. The principal soil characteristics of above soil groups have been discussed earlier in this chapter under mapping units 4,3 and 1 respectively. Soils of this unit occur in Murshidabad Nadia, Purulia and Hooghly and districts.

Haplaquepts-Ochraqualfs (mapping unit-28)

This unit consists of two principal soil groups-Banapara and Jagadishpur. The characteristic features of Banpara and Jagadishpur soil groups have already been discussed in this chapter under mapping units 4 and 1 respectively. Soils of this unit occur in Hooghly, Purulia, Malda, Bankura, and Midnapur districts.

Haplaquepts-Ustorthents (mapping unit-29)

This unit also consists of two important soil groups - Banpara and Amra. The soil characteristics and behaviour of the above soil group have already been discussed earlier under mapping units 5 and 5 respectively. Soils of this unit mostly occur in West Dinajpur district.

Haplaquepts-Ustochrepts-Ustorthents (mapping unit-30)

This unit consists of three principal soil groups with some other soil groups as inclusion. The major soil groups and Banpara, Hatikheda and Amra. The characteristic features of the above soil groups have been discussed earlier under mapping units 4 and 5 respectively. Soils of this unit mostly occur in Birbhum and Burdwan districts.

Ustochrepts-Haplaquepts-Haplustalfs (mapping unit-31)

This unit consists of three principal soil groups with inclusion of some other soil groups. The major soil groups are Hatikheda, Banpara and Sirkabad. The characteristic features of Hatikheda and Banpara soil groups have already been discussed earlier in this chapter under mapping units-5 and 4 respectively.

Sirkabad series (AIS and LUS, 1978) which represents Sirkabad soil group originally established at Area police station in Purulia district. Sirkabad soils have developed on recent erosion deposits on very gently sloping valley plain and river terraces. The soils are deep, well-drained and have grayish brown to dark brown acid loamy sand to sandy loam A horizon, dark yellowish brown to dark brown and reddish brown acid sandy clay loam to clay B horizon. The climate is sub-humid (dry) tropical with mean annual air temperature 26°C and mean annual rainfall of 1,307 mm. CEC ranges between 7.0 and 12.0 meq per 100 gm soil.

Sirkabad soils are agriculturally important. They have good air--water relationship. Measures to check run off and conserve moisture are needed. Under irrigation, soil responds to intensive input use with crops like jute, vegetables, etc. Productivity potential of this soil group is medium under ordinary level of management. Sirkabad soil group has been placed under haplustalfs at great group level as per USDA soil taxonomy. The soil group has been classified earlier (1958) as gneissic colluvial.

Ustochrepts-Haplaquents-Ustifluvents (mapping unit-32)

This unit consists of three principal soil groups - Hatikheda, Charcha and Ghoshat. The principal characteristics of the above soil groups have vividly been discussed under mapping units 5, 18 and 3 respectively. Soils of this unit generally occur in Birbhum, Murshidabad and Purulia districts.

Ustochrepts-Ustorthents-Haplaquents (mapping unit-33)

This unit consists of three principal soil groups - Hatikheda, Amra and Characha. The characteristic features of above soil groups have been discussed earlier in this chapter under mapping units 5 and 18 respectively. Soils of this unit mostly occur in Birbhum, district.

Eutrochrepts-Dystrochrepts-Haplaquepts (mapping unit-34)

This unit consists of three principal soil groups - Madhupur, Gitaldaha and Banpara. The principal soil characteristics and behaviour of these soils have been discussed earlier under mapping units 6, 22 and 4 respectively. Soils of this unit occur in West Dinajpur and Malda districts.

Dystrochepts-Haplaquepts (mapping unit-35)

This unit consists of two important soil groups-Gitaldaha and Banpara. The characteristic features of above soil groups have been discussed earlier under mapping units 22 and 4 respectively. Soils of this unit generally occur in Jalpaiguri, Darjeeling, Coochbehar, Nadia and 24 Parganas districts.

Dystrochrepts-Udifluvents (mapping unit 36)

This unit consists of two important soil groups Gitaldaha and Balarampur. The characteristic features of Gitaldaha soil group have been discussed earlier in this chapter under mapping unit 22.

Balarampur series (NBSS, 1980) which represents Balarampur soil group is originally established at Tufanganj police station of Cooch Behar district. Balarampur soils have developed on recent alluvium and occur on nearly level lands at an elevation of 40 to 45 m above MSL Climate of the area is tropical per humid with mean annual air temperature of 24.4°C and mean annual rainfall of 3,628 mm Balarampur group soils are moderately deep to deep, moderately well-drained and have dark grayish brown to light gray mild to medium alkaline silt loam to loam A horizon over lithological discontinuous coarse loamy C horizon.

Balarampur soils are medium textured. They occur in low-lying situation on nearly level land; and moderately slow in premeability and subjected to water stagnation during rains. The productivity potential of this soil is medium to high. Soils of this unit occur in Darjeeling, Cooch Behar, West Dinajpur, 24 Parganas and Nadia districts.

Sasanga series of Burdwan district also belongs to this soil group and extensively cultivated for rice crop. At great group level, Balarampur soil groups have been placed under Udifluvents as per soil taxonomy 1975. The same soil group has been classified as Tista soils in older classification 1965.

Dystrochrepts-Udorthents (mapping unit-37)

This unit consists of two principal soil groups-Gitaldaha and Darjeeling. The characteristic feature of Gitaldaha soil group has been discussed earlier in this chapter under mapping unit 22.

Darjeeling series (NBSS unpublished) which represents Darjeeling soil group originally occur in Ghum Police Station in Darjeeling district. Darjeeling soils have developed on mica schists and gneisses on moderately steep to steep hill slope at an elevation of about 2,100 m above MSL. The soil are moderately deep to deep and have yellowish brown medium acid loamy sand to sandy loam A horizon over brown to yellowish brown medium to slightly acid sandy loam C horizon. The climate of the area is sub-tropical per humid with mean annual air temperature of 12.3°C and mean annual rainfall of 3,106 mm. Darjeeling soils are coarse loamy soil with low moisture retention capacity. They occur on very steep hill slope and are highly erodible. Run off loss further aggravates the moisture deficit. Productivity potential is low to medium. Darjeeling group soils have been classified as Udorthent at group level under USDA classification. The same soil group was placed under brown forest soil in order classification 1965.

5.4 INTERPRETATIVE GROUPING OF SOILS

Vide R.R. Biswas, C.J. Thampi, P. Chakraborty and S. Digar. There are eight land capability classes as designed by Roman numericals from 1 to VIII grouped according to the progressively greater limitations and narrower choice for practical use. The classes 1 to IV implay arable lands, whereas classes V to VII are for uncultivable lands and class VIII lands are restricted for use of wild life habitat, recreation and water supply, etc.

The definitions of land capability classes are as follows:

(a) Land suited for cultivation

Class I land: This is very good land that may be cultivated safely with oridinary good farming methods. It is nearly level land (slope less than one per cent) and has deep, productive, easily worked soils and is subject to only slight erosion. It is well-drained and is suited for a wide variety of crops. For continued good production, these lands require the use of fertilisers, green manure crops and crop rotation.

Class II land: This is good land that may be cultivated with easily available practices. Some of the limitations of this class of land are gentle slope, moderate susceptibility to erosion, moderate soil depth, moderate overflow and moderate wetness. Each of these limitations requires special methods for correction, such as contour bunding, strip cropping, contour tillage, crop rotations that include grasses or legumes, drainage improvement and the application of fertilisers and manures.

Class III land: This class of land has restricted use for cultivation. The land is moderately good and may be used for croppin provided intensive management measures are taken. This kind of land is characterised by one or more of the following limitations:

(a) moderate steep slope, (b) high susceptibility to erosion, (c) moderate overflow, (d) slow sub-soil permeability, (e) excessive wetness, (f) shallow soil depth, (g) hard pan or clay pan (h) sandy or gravelly with low moisture capacity, and (i) low inherent fertility.

Class IV land: This class of land has very restricted use for cultivation and needs special care in handling and management. The variety or crops that may be grown is limited. Its croping croppin use is restricted by slope, erosion, unfavourable soil characteristics and adverse climate.

(b) Land unsuited for cultivation

Class V land: This land is not suited for cultivation but is suited for pasture and grassland. Cultivation may not be feasible because of one or more factors, such as, wetness, stoniness of some other limitations. Land is nearly level and not subject to more than slight wind or water erosion. It occurs in many swampy or high water table areas that cannot be drained easily.

Class VI land: This land is subject to moderate limitations under grazing or forestry use. It is too steep subject to erosion shallow, Wet or dry but with careful management may be made suitable either for grazing or forestry. Gullies in such areas should be controlled by diversion of water, provision of contour furrows or ridges.

Class VII land: This land is very steep, eroded, stony, rough shallow, dry or swampy and is recommended particularly in humid regions only for forestry and woodland and not pasture.

Class VIII land: This land includes such areas as marshes, deserts deep gullies, rocky eserpments and very steep, rough stony, barren land. It is suited only for wild life, recreation or watershed protection uses.

A land capability class can be further subdivided into different land capability subclasses. Capability subclasses are soil groups, each of which is recognised by the same kind of dominant limitations. These are designated by adding small letters' to the class numericals. The following limitations are recognised at subclass level.

e : where the erosion susceptibility and erosion hazards are the major limiting factors for their use.

W : where excess water is the dominant factor to limit their use; poor drainage, wetness, high water-table and overflow are the criteria for determining the soils belonging to this subclass.

S : where the major limitations are due to shallow depth, extreme textures such as clay or sand, low moisture holding capacity, low fertility, salinity or alkalinity, stoniness, etc.

C : where the limitations are due to climatic hazards like snowfall, hailstorm, dust storm, fog, prolonged dryness or coldness etc.

Where the soils have two kinds of limitations both can be indicated, if needed for better understanding, but dominant one is shown first.

Land capability subclasses can further be subdivided into land capability units. But since the mapping units of the updated soil map of West Bengal are very broad-based being association of great groups, no attempt has been made to indicate the land capability units. Attempt has also not been made to indicate the land capability class and subclass in each of the mapping units. However since the mapping unit is based on properties of soil series in a particular association of great group, it is found to be more justified to classify these soil series only up to land capability classes and subclasses. Again, it must be remembered that each great group of soil may have other types of land capability classes and subclasses than what has been stated here, on the basis of variation of properties of soil series coming under the soil great group. However, in this chapter, an attempt has been made only to place each of 18 soil series under a particular land capability class and subclass on the basis of soil properties studied in the field as well as in the laboratory.

Class I: The soils under this category have very few negligible limitations that may restrict their use and this type of land is not normally found to occur in West Bengal.

Class IIs: Soils of this category have moderate soil limitations that refuce their choice of plants or require minimum conservation practices, or both. Only four soil series come under this land capability class and subclass. These soil series are Hatikheda, Madhupur, Balarampur and Gitaldaha. These soils are best suited for paddy cultivation under normal rainfall during kharif season. These have been brought under minimum soil and wather water conservation practices by construction of bunds for growing paddy which is the staple food of the people of the state. The yield of paddy can be increased by susing improved verieties of paddy, improved agronomic practice, recommended doses of fertilizers and supplementary irrigation etc.

Class IIw: Soils of this category have moderate wetness limitation. Only two soil series come under this land capability class and subclass. These soil series are Banpara and Jotghasi. These soils occur in depressional situation and are very suitable for growing paddy during kharif season. These are also suitable for growing a leguminous crop after harvest of kharif paddy and the second crop will grow well as moisture retentively of the soils are good.

Class IIes: Soils of this category have both erosion and soil limitation at moderate level. Only two soil series come under this land capability class and subclass. These soil series are Mrigindihi and Ghoshat. These soils occur on high land with sufficient slope to cause erosion. Though in these types of soils, paddy and vegetables are cultivated, but crop failure occurs due to occasional drought condition during kharif season Irrigation and fertiliser use will improve the crop production of these soils.

Class IIsw: Soils of this category have both soil and wetness problems at moderate level. Only one soil series, viz. Sagar, comes under this class of land capability class and subclass. These soils occur on deltaic clood plain and are subjected to frequent innundation by brackish water from creeks. These soils are protected from natural calamity like flood by embankments. Suitable salt-tolerent paddy varieties and vegetables can be grown successfully during kharif and rabi season. But crops of rabi season requre irrigation with sweet water.

Class IIw: Soils of this category have serve wetness limitation. Only four soil series comes under this land capability class and subclass. These soil series are Jagadishpur, Hanrgram, Kanagarh, and Charcha. These soils occur on low lying alluvial flood plain or backswamp area of a river and suffer from overground drainage problem for most part of the year. The internal drainage problem of the soil series is also equally bad due to fine texture of the soil. These soils have been found to be suitable for both kharif and boro paddy only.

Class IIIs: Soils of this category have serve soil limitation. Only one soil series, viz. Sirkabad, comes under this land capability class and subclass. The soils are developed on erosional surface of river terraces, which brought down and deposit the alluvial material from nearby hills and mountains. The soils have coarse texture, low organic matter and low natural fertility. The soils are cultivated with paddy during kharif season, which suffers from moisture stress during drought period. In rabi season, a second suitable crop can be grown, with fertiliser, provided irrigation facility is available.

Class IIIce: Soils of this category have severe climatic and erosional problems. Only one soil series, viz. Darjeeling, comes under this land capability class and subclass. The soils of this series have moderate soil depth and steep slopes of sub-Himalayan mountain. Due to altitude factor and presence of clouds, the climate is always cool and the influence of sun-rays becomes less on crop growth. During monsoon period, due to heavy preciptation land slides and land slips often occur. In spite of all these adverse factors, in these soils very good quality tea and orange are grown under suitable management practices.

Class IVe: Soils of these category have very severe erosional problems. Only two soil series, viz. Hensla and Sankarpur, with slope 5 to 10 per cent come under this land capability class and subclass. Due to prevailing erosional character of soil, the natural fertility of the soil becomes so low, that no agricultural crops can be grown successfully on these soils. Hence, wherever these soils occur, they are recommended for pasture, orchard or forestry. But due to pressure of population, these soils of marginal land are sometimes cultivated for dry land crops and it has been found that only the antierosional crops can protect these soils from further deterioration.

Class Vs: The soils of this class are not likely to erode out cultivation is not possible due to severe rockiness. These uncultivable rocky patches are scattered mainly in western parts of this state which could not be shown in such small scale map due to their scattered and less extent of occurance. These lands have thin cover of coarse and medium textured soils, which can never be economically cultivated. As such these areas may be put under permanent vegetative cover of suitable and useful grasses or trees.

Class Vw: These areas cannot be made use of due to their waterlogged ormarshy conditions for agricultural crops, but can be used for fishery or for meadows and pastures after some reclamation like drainage improvement, etc. The patches of these lands are scattered mainly in eastern and southern parts of the state which could not be shown in such small scale maps.

Class VIe: One soil series, viz. Sankarpur, with slope 10 to 15 per cent, come under this land capability class and subclass. The soils under this class of land come under steep slope and occurs in the western undulating tract of this state. This is a shallow depth loamy skeletal soil previously used for grazing purpose, but due to excessive grazing at present soil erosion and land degradation occur very extensively.

However, this type of land under forestry is fafe, wherever illegal felling of trees are not done.

Class VIIes: Only one soil series, viz., Amra, with slope gradient ranging from 15 to 50 per cent having very shallow to shallow soil depth come under this land capability class and subclass. The soils of this series are loamy skeletal and occur on moderately steep hill slopes and escarpment having different degrees of stoniness and rockiness. These lands are neither suitable for agriculture nor for pasture and orchard. Hence, these lands are placed under forest. But due to illegal felling of trees, the density and quality of forest growth is too poor to protect soil from erosion.

Class VIII: Lands of this type are rarely seen in West Bengal excepting in a very few patches, which could not be shown in such small scale map. These have very severe soil erosion or Wetness limitation that preclude their use for plant production and restrict their use to wild life habitat, recreation or water supply.

CHAPTER - VI

NATURAL VEGITATION OF THE STUDY AREA

Forest conservancy in Bengal dates back to 1864 when Mr. T. Anderson, M.D., was appointed temporary Conservator of Forecasts, in addition to his duty as Superintendent of the Botanical Gardens in Calcutta and Mr. Mann (who was in charge of Cinchona Cultivation in Darjeeling) as Assistant Conservator of Forests. The first Division to be formed was the Sikkim Division which comprised the area surrounding the station of Darjeeling. During 1864-65 the first nursery was established near Darjeeling with the aid of British tropps and local labour, and the first plantations were formed in 1968 a teak plantation at Damanpokhri in the Terai, and a plantation of hill species near Darjeeling. The earliest reservation was that notified in January 1866 in the Bengal Gazette constituting certain lands Reserved Forests and framing certain Forest Rules.

Composition and Distribution of Vegetation

Since 1879 most of the forest blocks in the districts of Darjeeling and Jalpaiguri in the north and in the tidal flates of the 24 Parganas in the south were declared as Reserved or Protected Forests, only minor additions having been made after that date.

The present position of the forests of the State is as follows :

The forest areas of the State are

		Sq. miles
Reserved Forest		2,673.00
Protected Forests		1.27
Private Forests		1,508.00
Unclassed State		15.00
	Total	4,197.27

This is 13.63 per cent of the total area of West Bengal (30,775 sq. miles). In view of (a) the northern mountainous region, cut up bya number of rivers and streams which swell enormously in the monsoon, and (b) the undulating lateritic tracts of the south-western districts where the soil is subject to severe erosion, this forest cover is hopelessly inadequate even as a protection against natural foreces. Compared to the population (24,810,308) the area of forest is only about a ninth of an acre per capita.

The unsatisfactory position will be more clearly apparent when the distribution of the forests is considered. 1,630 square miles of reserved forest in the south occur on the tidal flats of the Ganges-Brahmaputra delta. Both the growth and the density of stocking of this mangrove vegetation are very poor, especially in the more saline areas in the west that have been allotted to the Indian Union. Of the remaining 1,041.6 square miles (in the northern region), 27 per cent (284 square miles) is either inaccessible or has to be retained for protective purposes. Much of the 1,400 odd square miles of private forests are on poor lateritic soils and are far from being in a good state of preservation because of unrestricted fellings in the past, though there has been a definite improvement in their condition since the exercise of control on their working after the promulgation of the Private Forests Act in 1945.

The improvidence with which the more accessible forests have been destroyed has given rise to a situation where the majority of agriculturists are unable to obtain their requirements of firewood, timber and other forest produce within reasonable reach. Timber for industrian purposes has also to be transported over uneconomical distances.

Natural vegetation of the West Bengal Plain can be grouped into several classes according to distribution, growth and expanse (about 9,00,000 hectares).

The regional distribution of forests in the State is extremely uneven. Six districts of West Bengal do not have any forest cover. The following forest belts in the State may be distinguished: (i) Coniferous forests in the districts of Darjeeling and Jalpaiguri in the Himalayan region, at different elevations. (ii) West ever-green forests in the sub--montane and comparatively plain tracts of Jalpaiguri, Darjeeling and Cooch Behar where rainfall exceeds 80" annually. (iii) Wet deciduous forests in the southern parts of Jalpaiguri, Cooch Behar and Dinajpur and the western districts of the State. (iv) Mangrove forests in the district of 24 Parganas

The mangrove and tidal forests in the Sundarbans and humid tropical forests in the extreme north of the region are the only preserves of natural vegetation while the western fringe is covered by tropical deciduous forests mostly in the induced form.

At different altitudes in the Darjeeling Himalayas different types of vegetation occur which have been studied by J.D. Hooker[1] and other authorities. The principal trees found according to them at different elevations in the Darjeeling district include the following: (i) Firs (abies Wabbiana), different varieties of rhododendron, juniper, polly, red-current bushes, cherry, pear or paper tree, creeping raspberry, Hypericum, balsam, lichens, etc. They are found at elevations between 12,000 to 10,000 feet above sea level. (ii) Oak, chestnut, magnolia, arboreous rhododen dron, michelia or champa. Olive, fig. laurel, maple, lily, white rose, etc., occur at a height of from 10,000 to 9,000 feet. (iii) Magnolia, maple, rhododendron, oak, laurel, simplocus, vivernum and vaccinium among others are found at a height of 9,000 to 8,000 feet. (iv) Peach, oak, chestnut, maple, alder, olive, walnut, birch, magnolia, respberry, strawberry and hypericum among others are seen at elevations of 8,000 to 6,500 feet. (v) Alder, oak, maple birch, acacia, terminalia, cryptomaria japonica, cherry, olive, alder, pear, pepper, etc., are found at altitudes of 6,500 to 4,000 feet. (vi) Sal, tun, bombax or cotton tree., banian, fig, orange, peach, pine, banana, lemon, wormwood, etc. occur at elevations of 4,000 to 1,000 feet. (vii) Different kinds of figs, dates, bamboos, wild mulberry, orchids, fern, ginger and many types of grasses are found from 1,000feet down to the plains. Sal, sisu, and chilauni are found in the plains of Siliguri.

In the districts of Jalpaiguri and Cooch Behar as well the vegetation changes according to altitude. On sandy and gravelly soils to the west of the Bhagirathi, occurs sal (Shorea robusta). Teak or segun is not found in abundance. The tropical evergreen forests (167,000 hectares) are concentrated in Duar regions. Deciduous and scrub vegetation covers greater part (299,000 hectares) of the western regions of the Lower Ganga Plain in Midnapore, Bankura, Burdwan and Birbhum. Scattered and isolated patches are also visible in Howrah and Hooghly districts of the Delta Proper. In the tropical evergreen forest the natural vegetation comprises of gurjun; the tropical moist deciduous forests comprise of sal, and tropical dry deciduous forests, teak, shisham, bamboo, etc.

In the south the two most important types are the tidal forests of the Ganges-Brahmaputra delta (Type 3b/1S-1) and the dry sal forests of Midnapore, Bankura, Birbhum, etc. (Type 4b-C2). The importance of these forests lies in their extensiveness rather than in the value of individual trees and in their relative proximity to well developed regions of the State. The tidal forests are made up of goran (Ceriops roxburghiana), gewa (Excoecaria agallocha), stunted sundri (heritiera minor), baen (Avicennia officinalis), dhundal (Carapa obovata), etc. The privately owned dry sal forests have been mostly kept as coppiced fuel jungle in which also occur fire-resisting species like peasal (Pterocarpus marsupium), kendu (Diospyros melanoxylon), mahua (Bassia latifolia), Terminalia tomentosa, T. Belerica, Butea frondosa, etc.

A curious forest type is the Barringtonia swamp (3b/1S-4 of Champion) which occurs on large areas in the Malda district.

Forests and Economic Life of the People

In relation to the population, the forests resources are indeed modest. At least 25 per cent of the total geographical area of the State has to be brought under forests in order that forests may help in the economic rehabilitation of the State. The State and heavily wooded areas even at the end of the nineteenth century in Darjeeling, Jalpaiguri, Duars, Cooch Behar, Dinajpur, Malda, Birbhum, Burdwan, Midnapore and 24 Parganas.

The only low-level pine in the eastern Himalayas (where the climate is very much moister than in the western Himalayas) is Pinua longifolia which occurs in one small forest at Badamtam (Darjeeling district) in mixture with sal, being an intrusion from Sikkim where this mixture is to be found on dry southern slopes from 1,000 feet to 3,000 feet elevation.

Extension of ten plantations in Darjeeling and Jalpaiguri necessitated the denudation of forests. Destruction of forests accelerated soil erosion, and silting of rivers. Deforestation is considered as one of the contributory causes of floods in North Bengal rivers. Extension of frontiers of cultivation in wide areas in Dinajpur, Malda, Murshidabad, Hooghly, Howrah, Birbhum, Burdwan, Bankura and Midnapore also necessitated the destruction of forests. Deforestation resulted in the loss of sub-soil water and lowering of the water table. Water supply for drinking and irrigation has thus been affected adversely. Besides, pasture facilities have been denied to very large areas due to deforestation.

Forest Products

Timber: Among the important types of timber are the Acacia arabica (babul), Anthocephalus cadamba (Kadam), Artocarpus chaplasha (Chaplash), Betula alnoides (Indian birch), Bombax malabaricum (Semul), Castanopsis hystrix (Indian chestnut), Cedrela tonna (Tun), Cedrus deodar), Canarium strictum (dhup), Dalbergia sissoo (Sissoo), Gmelina arborea (Gamari), Heriliera fomes (Sundry), Lagerstroemia flos-regina (Jarul), Picea morinda (Spruce), Shorea robusta (Sal), Tectonia grandis (Teak), for railway sleepers, household furniture, constructional, and agricultural purposes timber is obtained, though not in good abundance, from the forests of West Bengal. Various types of timber available in the Sundarbans deserve special mention. They include the Balai, Bhalia, Bhara Bonjam, Chaila Dabur, Damal, Jhau, Khalsi, Pancheoli, Singra, etc., for firewood, Dal Karamcha for charcoal and Garan, Geoa, Hental, Kankra, Karai, Keora, Kirpa, Loha Kaera, etc., are used for building purposes. Sundri and Pasur are used for planks and house-posta. The cocoanut plam, the Indian palm and the areca palm are highly useful for house building and bridge-making. The sundari trees (Sundarbans) provide base for the indigenous woodworks as well as large scale forest-based industries including paper mills.

The fruit trees, mainly mang, jack and the jam (Blackberry), occur over wide areas and particularly in the district of Dinajpur Malda, Murshidabad, 24 Parganas, and Hooghly.

The forests of West Bengal are well-managed. New forest areas have to be developed in the State for its economic rehabilitation. A deliberate policy has to pursued for afforestation in the State. The eroding and marginal lands in the Darjeeling Himalayas, the reclaimed lands in the tidal forests should be kept fore afforestation. Sal, teak and other commercially valuable trees may be grown alongside the roadways in the plains and foothills in the state. It may sometimes be more economic to exchange the industrial products of the State for food crops from other States instead of augementing areas under food crops. A systematic land utilisation survey of the State has yet to be made for selection of lands to the profitable uses to which they can be put.

Another 10 per cent of the area of the State has to be brought under forests for soil conservation, increasing agricultural productivity and sustaining the forest-based industries both large and small-scale.

CHAPTER - VII

OIL SEEDS OF VARIOUS ORIGIN IN INDIA

Classification of Oil Seeds on various basis

From the stand point of the origin the oil seeds are divided into three types.

(a) Crop origin (b) Tree origin (c) others (which are derived from processing of main products like cotton seed, rice bran).

Oil seeds are the raw material of the vegetable oil, Oil is available in most of the seeds available in the earth, but all the oils are not edible and some of the oils are used for industrial needs and some for medical science. Production of the oil from the seeds, depends on the low coast raw input and also on the oil content in the seeds. Exploitation of the full potencials is the main factor for the use of seeds as a raw material for the production of vegetable oil. For the above reasons all the seeds available are not been used for the production of edible oil.

Crop origin

(1) Ground nut (2) Rape seeds and Mustards (3) Sesame (4) Linseed (5) Castor (6) Sunflower (7) Soyabean (8) Safflower (9) Niger seeds.

Tree origin

(1) Mahua (2) Neem (3) Kusum (4) Karany (5) Sal (6) Rubber seed (7) Mango Karnal (8) Kakum (9) Dhupa (10) Vindi (11) Marotti (12) Pisa (13) Nahor (14) Khakan (15) Palash (16) Pilu (17) Plam (18) Olive (19) Coconut (20) Macuba

Other origin

(1) Cotton seeds (2) Corn Oil (3) Rice bran The following are the varities released in various oil seeds crops with salient features are as follows :

Table VII-1. G R O U N D N U T

Sl. No.	Name of the variety	Area of adaptability	Year of release	Average yield kg/ha	Shelling %	Oil %	Remarks
1.	2	3	4	5	6	7	8
1.	Sp. Impd. region	Bombay, Karnataka	1,905	2,400	67.0	44.0	Spanish bunch
2.	Kopergaon 1	Sangli and Kolhapur districts of Maharashtra	1,933	1,250	72.0	47.0	Virginia (semi-spreading)
3.	Kopergaon 3	Western Maharashtra	1,933	1,900	69.0	47.0	Valencia bunch
4.	TMV-1	Tamil Nadu	1,940	1,450	73.5	50.0	Virginia spreading
5.	TMV-2	Tamil Nadu, Andhra Pradesh and Karnataka	1,940	1,025	76.7	49.0	Spanish bunch
6.	AK.12-24	Vidarbha region of Maharashtra, also grown in Orissa, M.P. and Rajasthan	1,940	1,250	75.0	48.5	Spanish group
7.	TMV-3	Tamil Nadu	1,943	1,450	76.7	49.7	Virginia spreading
8.	TMV-4	Tamil Nadu	1,947	1,450	75.0	50.0	Virginia spreading
9.	PG-1	Punjab, Gujarat and Rajasthan	1,953	1,900	69.0	49.0	Virginia spreading
10.	RS-1	Rajasthan	1,953	1,300	71.0	45.0	Virginia spreading

1.	2	3	4	5	6	7	8
11.	Karad 4-11	Satara, Sangli, Sholapur and Pune district of Maharashtra	1957	1,000	72.0	48.0	Virginia spreading
12.	T-28	Uttar Pradesh	1960	1,900	74.0	47.5	Virginia (Semi-spreading)
13.	C-501	Punjab	1961	1,750	68.0	48.0	Virginia (semi-spreading)
14.	ESB-87	Kota region of Rajasthan	1961	1,750	66.0	50.0	Virginia (semi-spreading)
15.	TMV-6	Tamil Nadu	1961	950	73.0	48.0	Virginia (semi-spreading)
16.	J-11	Gujarat, Andhra Pradesh	1964	1,300	75.0	49.0	Spanish bunch
17.	SB XI	Maharashtra	1965	1,300	75.0	48.5	Spanis bunch
18.	T-64	Uttar Pradesh	1966	2,100	70.0	49.0	Virginia (semi-spreading)
19.	M-145	Punjab	1968	2,200	76.0	50.5	Virginia (semi-spreading)
20.	TMV-7	Tamil Nadu	1967	1,400	75.2	50.0	Spanish group, bold poded
21.	POL-1	Tamil Nadu	1968	1,270	76.6	48.2	Spanish group, Pollachi tract of Tamil Nadu
22.	TMV-8	Tamil Nadu	1968	1,700	74.4	50.1	Spanish group, more of 3-seeded pods
23.	S-206	Karnataka (Northern)	1969	1,900	73.0	49.5	Spanish group

1	2	3	4	5	6	7	8
24.	S-230	Karnataka (Norther)	1969	1,280	70.0	50.0	Virginia Spreading
25.	TMV-9	Tamil Nadu	1970	1,150(R) 2,000(I)	75.0	71.4	Spanish group
26.	TMV-10	Tamil Nadu and Maharashtra	1971	1,700	77.0	54.4	Virginia bunch, pods medium bold, testa variegated, high oil content (54.1%)
27.	Kadiri 71-1	Rayalaseema of A.P.	1971	1,390	74.0	47.0	Virginia spreading, drought tolerant
28.	Jyoti	Madhya Pradesh	1971	1,600	77.8	53.3	Spanish group
29.	M-13	Entire country	1972	2,750	68.0	49.0	Virginia spreading pods large
30.	POL-2	Coimbatore, Salem and Trichi Dist. of T.N.	1973	1,500(R) 2,700(I)	78.6	48.6	Spanish group, high shelling (78.6%)
31.	GAUG-1	Gujarat	1973	1,500	76.0	50.0	Spanish group, pods 2-seeded with less prominent reticulation but prominent beak
32.	GAUG-10	Gujarat	1973	1,800	74.0	50.0	Virginia spreading, stems thin pods with distinct reticulation and prominent beak
33.	TG-1 (Vikram)	Entire country	1973	2,659	68.0	46.5	Virginia (semi-spreading)

1	2	3	4	5	6	7	8
34.	MR-1	Haryana	1975	2,000	70.0	50.0	Spanish group, Responsive to irrigation
35.	Dh.3-30	Northern Karnataka	1975	2,800	77.6	46.5	Spanish group, pods medium blood, drought tolerant
36.	Chandra	Uttar Pradesh	1977	2,500	70.0	47.7	Virginia spreading, pods bold
37.	TMV-II	Tamil Nadu	1977	1,200	70.0	49.0	Spanish group
38.	Kadiri-2	Srikakulam, Vishakapatnam and Chittor dist. of A.P.	1978	1,800	78.0	47.0	Virginia bunch, high shelling percent
39.	Kadiri-3	Andhra Pradesh, but adapted to entire country	1978	2,100	75.0	49.0	Virginia bunch, clustered pod bearing, pods smooth, rose testa
40.	TMV-12	Tamil Nadu	1978	1,250(R) 2,100(I)	72.0	51.1	Spanish group
41.	MH-2	Haryana	1978	3,000	72.0	49.0	Valencia group, very dwarf, pods 1-4 seeded, red testa recommended spacing 15x15 cm
42.	BG-1	Bihar	1979	2,000	70.0	48.0	Virginia bunch, bold pods
43.	BG-2	Bihar	1979	2,200	69.0	49.3	Virginia bunch, bold pods

1	2	3	4	5	6	7	8
44.	Phule Pragati	Maharashtra, Gujarat and Tamil Nadu	1979	1,800	75.0	50.7	Spanish group, early (90 days)
45.	Co-1	Tamil Nadu	1979	1,300(R) 2,200(I)	74.0	50.4	Spanish group, high
46.	M-37	Punjab	1980	1,650	69.0	50.5	Virginia spreading, pods medium 2-seeded; suitable for groundnut wheat rotation
47.	Kisan	Orissa	1980	1,600	70.8	49.9	Spanish group, pods medium bold
48.	KRG-1	Raichur, Bellary and Gulbarga dist. of Karnataka for Rabi summer season	1981	1,200(R) 2,230(I)	73.0	49.0	Spanish group
49.	M-197	Loamy soils of Punjab	1982	1,800	67.4	51.2	Virginia semi-spreading Leaves dark-green, pods with slightly smooth venation
50.	TG-17	Maharashtra for Rabi summer season	1982	2,000	73.5	49.0	Spanish bunch, pods bold, pinkish kernels.

TABLE VII-2. RAPESEED - MUSTARD

Sl. No.	Name of the variety	Area of adaptability	Average yield kg/ha	Oil %	Maturity in days	Remarks
1	2	3	4	5	6	7
			Toria			
1.	M-27	Assam and Orrissa	1,200(R)	44.6	90	-
2.	TS-29	Assam and Orissa	1,200(R)	44.0	85	-
3.	Agrani(B-54)	West Bengal and Assam	800-1,200(R)	45.0	80	Dwarf plant, moderately susceptible to Alternaria downey mildew and aphids
4.	BR-23	West Bengal and Assam	900-1,000(R)	43.0	100	-
5.	T-9	Uttar Pradesh, Madhya Pradesh and Rajasthan	1,200-1,500(R+1)	44.3	100	-
6.	T-36	Uttar Pradesh, Madhya Pradesh	1,200-1,500(I)	43.0	100	-
7.	Sangam	Haryana	1,500(I)	44.2	105	Profusely branched, small brown coloured seeds, resistant to phyllody
8.	ITSA	Punjab	800-1,000(I)	44.0	-	Smooth leaves, yellow petals
8a.	TL-15	Punjab	1,000(I)	44.0	85	Profuse primary and secondary branching, seeds brown
9.	DK-1	Himachal Pradesh	800-1,000(I)	44.0	75	-

1	2	3	4	5	6	8
			Mustard			
10.	Seets (B-85)	West Bengal	1,200-1,400(R+1)	38.0	90	Plants Spreading, stem pigmented
11.	BR-40	Bihar	1,200-1,400(R+1)	40.0	115	-
12.	Laha-101	Uttar Pradesh	1,500(I)	41.0	150	-
13.	Varuna	Uttar Pradesh	2,000(R+1)	39.8	130	-
14.	Shekhar	Uttar Pradesh	1,800(R+1)	40.0	135	-
15.	Kranti(PR-15)	Uttar Pradesh	1,500-1,800(I)	40.0	135	-
16.	Patan-67	Gujarat	1,900(I)	38.0	119	-
17.	Durgamani	Rajasthan	1,000-1,200(R+I)	39.0	135	Resistant to orobanche
18.	RL-18	Punjab	1,250(R)	37.5	150	Tall plants, black-brown seeds
19.	Pusa Bold	Delhi	1,800(I)	40.0	140	-
20.	Prakash	Haryana	1,500-2,000(R+I)	39.0	150	Profuse branching, leaves hairy, escapes frost, moderately resistant to diseases and aphids
21.	RH-30	Haryana	1,600(R+I)	40.0	-	Profuse branching, leaves rough with deep serration. non-shatteringand very bold seeds

1	2	3	4	5	6	8
22.	RLM	Pubjab	1,700-1,800(I)	38.0	152	Tolerant to aphids, Alternaria blight and cold spell, leaves broad
23.	RLM-514	Punjab	1,500-2,000(R+1)	40.0	152	Seeds dark-black
24.	RLM-619	Punjab	1,500((R)	43.0	140	Short plants, tolerant to Alternaria blight, white rust and downey middle
			Brown Sarson			
25.	BS-2	Uttar Pradesh	1,200-1,500(R)	44.5	115	-
26.	BS-70	Uttar Pradesh	1,200-1,500(I)	45.0	130	-
27.	Pusa Kalyani	Uttar Pradesh	1,300-1,500(1)	45.0	135	-
28.	BSH-I	Haryana	1,200-1,500(I)	45.0	135	Leave hairy with large obtuse terminal lobe, petals deep yellow
29.	KOS-I	Kashmir	1,000(R)	44.0	230	-
			Yellow Sarson			
30.	Benoy(B-9)	West Bengal	1,200-1,400(R)	46.0	90	Plants tall erect, fruit two chambered moderately susceptible to aphids

1	2	3	4	5	6	8
31.	66-197-3	Bihar	1,400-1,600(1)	42.0	120	-
32.	T-151	Uttar Pradesh	1,400-1,500(1)	46.0	120	-
33.	K-88	Uttar Pradesh	1,400-1,800(1)	43.0	130	-
34.	Patna Sarson-66	Gujrat	1,200(1)	42.0	110	-
35.	Ys pb 24	Gujarat	1,400(1)	46.0	145	Plants tall, seeds yellow
			Taramira			
36.	T-27	Haryana	650(R)	36.0	150	Hairy, Profuse branching, late in maturity, yellow--green seed colour
37.	ITSA	Punjab	560(R)	35.0	150	Plants hairy, greyish brown seed

TABLE VII-3. SESAME

Sl. No.	Name of the variety	Area of adaptability	Year of release	Average yield kg/hg	Oil	Maturity in days	Remarks
1	2	3	4	5	6	7	8
1.	TMV-1	Tamil Nadu	1946	560	50.0	85	Fairly bushy, with moderate branching, red brown to black seed
2.	TMV-2	Tamil Nadu	1947	425	52.0	80	Plants open with moderate branching, dirty-white seeds
3.	TMV-3	Tamil Nadu	1948	560	52.0	80	Profuse branching, plants bushy
4.	T-12	Uttar Pradesh	1960	500	53.0	85	4-6 branches, white seed
5.	T-4	Uttar Pradesh	1961	600	52.0	100	Moderate branching white seed
6.	T-85	Maharashtra	1962	550	50.0	90	Bold white seed
7.	Punjab Til-1	Punjab	1966	500	50.0	80	Bold white seed
8.	Mrug-1	Gujarat	1967	500	53.0	85	More branches, monocapsular white seed
9.	KRR-1	Tamil Nadu	1967	400	51.7	120	Plants bushy, white seed
10.	Purva-1	Gujarat	1968	400	50.0	120	Multicapsular, reddish seed

1	2	3	4	5	6	7	8
11.	T-13	Uttar Pradesh	1968	600	50.0	90	4-5 branches, white seed
12.	Pratap(C-50)	Rajasthan	1968	500	50.0	100	Unbranched, capsules 6-8, white seed
13.	KRR-2	Tamil Nadu	1970	400	52.0	118	Profuse branching, seeds dull white
14.	N-32	Madhya Pradesh	1970	770	53.0	95	Single stem, multicapsular seeds shining white
15.	Vinayak	Orissa	1972	500	-	-	Tolerant to leaf spot
16.	Gauri	Andhra Pradesh	1974	800	37.0	95	Brown seeds.
17.	B-67	West Bengal	1974	-	40.0	-	-
18.	T-13	Rajasthan	1975	600	-	-	-
19.	TMV-4	Tamil Nadu	1977	650	52.0	85	Busy, profuse branching brown seed
20.	TMV-5	Tamil Nadu	1978	400	54.0	75	Moderate branching, seeds brown plumpy
21.	Phule Til-1	Maharashtra	1978	650	51.0	95	Seeds light-brown and bold
22.	TC-25	Rajasthan	1978	500	48.4	80	Branched (4-5), white seed
23.	Madhavi	Andhra Pradesh	1978	850	44.0	70	Light-brown seeds

1	2	3	4	5	6	7	8
24.	Haryana Til-1	Hryana	1979	500	50.0	85	Tall medium branched, seeds bold white, field resistance to phyllody
25.	JT-7	Madhya Pradesh	1980	800	37.0	85	Branched, white bold seeds
26.	Kalika	Orissa	1979	600	48.7	82	-
27.	Gujarat Til-1	Gujarat	1979	630	49.2	85	Light brown seed
28.	TMV-6	Tamil Nadu	1979	700	54.0	85	Tall growing, moderate branching seeds brown
29.	Kanak	Orissa	1979	600	47.0	78	-
30.	Kayamkulam-1	Kerala	1980	500	-	95	Branching type
31.	Thilethama (Kayamkulam-2)	Kerala	1982	600	-	-	-
32.	Co-1	Tamil Nadu	1983	730	50.1	90	Branched, seeds white
33.	Patan-64	Gujarat	-	746	52.5	-	Seeds white
34.	N-128	Maharashtra	-	450	49.0	120	Monocapsular habit, brown seeds
35.	N-8	Maharashtra	-	375	51.0	125	Monocapsular habit, brown seeds with whitish tinge

TABLE VII-4. LINSEED

Sl. No.	Name of the variety	Area of adaptability	Year of release	Average yield kg/ha	Oil %	Days to Maturity	Remarks
1	2	3	4	5	6	7	8
1.	K-2	Pubjab, Haryana, Himachal Pradesh	1952	1,100	46	175	Brown, bold seeded, tolerant to rust and wilt but susceptible to powdery mildew
2.	C-492	Maharashtra	1955	1,000	44	125	Moderately susceptible to powdery mildew, moderately tolerant to wilt and rust
3.	T-379	Bundelkhand of Uttar Pradesh, Bihar, Assam, Madhya Pradesh Rajasthan	1960	1,100	44	125	Brown, small seeded, spreading type, tolerant to rust wilt and drought, suitable for rainfed crop
4.	Hira	Bundelkhand of Uttar Pradesh	1964	1,200	43	135	Brown, bold seeded, spreading type tolerant to rust, will and drought, suitable for rainfed crop.
5.	Mukta	Eastern Uttar Pradesh	1964	1,200	45	130	Brown, medium bold seeded, compact growing, tolerant to rust and wilt
6.	S-36	Maharashtra	1966	500	44	-	Dwarf green stem, susceptible to capitulam borer

1	2	3	4	5	6	7	8
7.	LC-185	Punjab, Himachal	1970	500	46	170	Yellow, medium seeded, resistant to wilt and rust and tolerant to frost, suitable for paira or utera sowing
8.	Himalini	Punjab, Haryana, Himachal Pradesh Rajasthan	1973	1,310	42	165	Brown, medium seeded, fairly resistant to wilt, rust and powdery mildew
9.	Jawahar-18	Madhya Pradesh	1975	800(R) 1,300(1)	43	120	Brown, bold seeded, resistant to rust, moderately susceptible to wild and powder mildew
10.	Jawahar-7	Madhya Pradesh	1977	300(U)	43	118	Dull-brown, bold seeded, resistant to rust, moderately susceptible to wilt, highly suitable for utera (U) conditions.
11.	LC-54	Punjab, Harayana	1979	1,320	42	165	Brown, medium seeded, fairly resistant to wilt, rust and powdery mildew
12.	Neela (B67)	West Bengal	1980	850(R)	41	130	Brown, medium-bold seeded, moderately tolerant to rust, susceptible to powdery mildew
13.	Neelum	Central and Western	1980	1,500(1)	43	145	Medium tall, erect, brown, very-bold seeded, tolerant to wilt and rust, highly suitable for irrigation and high-fertility conditions
14.	Jawahar-552	Madhya Pradesh	1981	900(R)	44	120	Brown, medium bold seeded resistant to wilt, moderately resistant to rust and powdery mildew

1	2	3	4	5	6	7	8
15.	JLS (J) 1	Madhya Pradesh	1981	900	44	120	Escapes linseed gall-gly attack resistant to rust, moderately resistant to wilt and powdery mildew
16.	SPS 77/23-10	Bundelkhand of Uttar Pradesh, Orissa, Madhya Pradesh, Kanartaka and parts of Rajasthan	1983	700(R)	-	105	Brown medium-bold seeded field resistant to powdery mildew, resistant to rust and wilt but susceptible to Alternaria blight

TABLE VII-5. C A S T O R

Sl. No.	Name of the variety	Area of adaptability	Year of release	Average yield kg/ha	Oil %	Remarks
1	2	3	4	5	6	7
1.	S-20	Gujarat	1961	955	45.6	Tall, semi-compact spike, double blooming
2.	Pb No. 1	Punjab	1965	1,200	52.0	Seeds medium-bold, dark-chocolate in colour
3.	J-1	Gujarat	1968	1,202	47.8	Semi-compact spike, profuse branching, triple blooming
4.	GCH-(Hybrid)	Gujarat	1968	1,358	48.1	Heavy branches, double blooming and mahogany colour syste,
5.	Aruna	Andhra Pradesh, Karnataka, Orissa and Rajasthan	1970	2,000-2,500	52.0	Suitable for double cropping high female tendency in the spikes
6.	SA-1	Tamil Nadu	1970	1,000-1,100	54.0	Non-dehiscent capsule, rose coloured stem, single bloom, small seeds
7.	SA-2	Tamil Nadu	1970	1,000-1,200	52.5	Stem rose coloured, single blooming, non-dehiscent, medium sized seeds
8.	GAUCH-1(Hybrid)	Rujarat	1973	1,518	49.5	Medium tall 100-100 cm.
9.	Gauce-1	Gujarat	1973	1,442	47.1	Non-shattering fairly well branched

1	2	3	4	5	6	12
10.	Bhagya	Andhra Pradesh	1974	2,000-2,500	54.0	Tolerant to jassids and white flies
11.	Sowbhagya	Andhra Pradesh	1974	2,000-2,500	51.0	Dark-green leaves, short petioles, converging lateral shoots
12.	VI-9	Maharashtra	1980	1,100-1,500	47.7	100-110 days for first picking
13.	TMV-4	Tamil Nadu	1982	1,000-1,100	50.1	Stem rose coloured, single bloom, small seeded, 9-10 nodes to primary raceme
14.	TMV-5	Tamil Nadu	1984	1,100	50.8	Stem rose coloured, triple bloom, spiny capsules non-dehicent, small seeded 12-14 nodes to primary raceme
15.	RC-8	Karnataka	-	1,800	-	Tall, induced mutant of RC-1188 of T.N.
16.	Girija	Maharashtra	-	1,000	49.2	-
17.	T-3	Uttar Pradesh	-	1,100-1,400	55.7	Heads long and compact, seeds bold, brown with streaks
18.	Tarai-4	Uttar Pradesh	-	1,100-1,400	52.0	Non-shattering, seeds medium-bold
19.	Kalpi-6	Uttar Pradesh	-	1,200-1,400	51.0	Stem reddish with triple bloom, large, compact and conical spike
20.	CH-1	Haryana	-	1,800	49.0	Very-dwarf, early, uniform maturity of spikes, short inter-nodes and pinkred coloured stem

1	2	3	4	5	6	7
21.	TMV-1	Tamil Nadu	-	930	51.0	Stem rose coloured, double bloom, compact spike, small seeded
22.	TMV-2	Tamil Nadu	-	960	50.0	Stem rose colourd, double bloom, non-dehiscent, seeds medium sized
23.	TMV-3	Tamil Nadu	-	930	55.0	Stem green coloured, double bloom, seeds medium sized

TABLE VII-6. NIGER

Sl. No.	Name of the Variety	Area of adaptability	Year of release kg/ha	Average yield	Oil %	Days to maturity	Remarks
1.	Ootacamund	Madhya Pradesh, Orissa, Maharashtra	Before 1955	500	42	110	Sensitive to thermo and photo-periods
2.	N-5	Bihar	Before 1955	450	40	105	Photo and thermo-sensitive, seeds small and black
3.	IGP-76 (Sahyadri)	Maharashtra and Orissa	-	475	40	105	Photo and thermo-sensitive, small seeded
4.	N 12-3	Maharashtra	1970	450	40	110	-
5.	N-71	Karnataka	-	475	42	95	Seeds are bold and black
6.	Gaudaguda local	Andhra Pradesh	-	570	39	95	-
7.	Phulbani local	Orissa	-	400	40	100	Suitable for crop rotation with ragi or cowpea or French bean

TABLE VII-7. S A F F L O W E R

Sl. No.	Name of the variety	Area of adaptability	Year of release	Average yield kg/ha	Oil %
1.	A-300	Karnataka (drought-prone area)	-	800-1,000(R)	-
2.	N 62-8	Ahmednagar, Pune, Sholapur and Nasik district	1959	900-1,000(R)	30.3
3.	Manjira	Andhra Pradesh (assured Krishna area)	1976	800-1,000(R)	32.5
4.	S-144	Karnataka (assured moisture area)	1976	900-1,000(R)	32.0
5.	A-1	Entire country	1976	800-900(R)	31.0
6.	Tara	Entire Maharashtra	1976	1,000-1,200(R)	32.2
7.	K-1	Tamil Nadu	1976	600-800(R)	-
8.	CO-1	Tamil Nadu	1979	700-800(R)	-
9.	Bhima (S-4)	Maharashtra (both in moisture and drought-prone areas)	1982	1,200-1,400(R)	32.5
10.	JSF-1	Madhya Pradesh and Rajasthan	1982	1,000-1,500(R)	30.0
11.	T-65	Uttar Pradesh	-	1,200(R)	-

TABLE VII-8. SUNFLOWER

Sl. No.	Name of the variety	Area of adaptability	Year of release	Average yield kg/ha	Oil %	Days to maturity	Remarks
1.	EC-68414 (Peredavik	Tamil Nadu Maharashtra West Bengal A.P., U.P.	1972	800-1,000	42-46	110	Drought tolerant, suited for late planting, susceptible to rust and Alternaria.
2.	EC-68415 (Armaviriski 3497)	Karnataka Tamil Nadu	1972	800-1,000	42-45	110	Drought tolerant, suitable for marginal and sub-marginal lands, susceptible to rust and Alternarla
3.	Romson record	Punjab	1978	700	41.2	108	Dark seeded, broad leaves
4.	BSH-1 (CMS 34X RHA, 274	Karnataka	1980	1,000-1,500	42-45	95	Hybrid, uniform maturity suited for assured rainfall and irrigated tracts, resistant to rust and fairly tolerant to Alternaria leaf spots
5.	Morden (Cernianka-66)	Whole of India	1980	600-800(R) 1,500-1,700(I)	42-46	80	Very early maturing dwarf More self fertile
6.	Surya (PKV-SUF-72-37)	Maharashtra	1982	1,000-1,200	-	95	Better seed filling, increased seed weight and increased oil yield/ha over EC-68414, seeds black with white stripes, recommended for Vidharbha region, It has wide adaptability.
7.	Co-1 (SUF-2)	Tamil Nadu	1983	1,100	-	85	Dwarf 67-70 cm, suitable for growing as a eatch crop in garden lands.

CHAPTER - VIII

WORLD SCENARIO OF OIL SEED PRODUCTION IN COMPARISON WITH INDIA

World vegetable oil production

As a matter of interest, the world production figures for vegetable oils are presented in Table 1 so that our own production in India (Table 2) can be seen in relation to total production elsewhere. While we need 5.49 m. tonnes of oils and fats,after allowance is made for invisible fat consumption through other foods, our total production is only of the order of 2.89 m tonnes (Table 2), giving a deficit of 2.6 m tonnes when the requirements are considered from the dietetic point of view, and at least of the order of 1.3 m tonnes to meet the barest nutritional needs. Meeting this gap is the burning problem in India today (Fig. 8.1).

The availability of 6.4 lakh tonnes of industrial oils against the requirement of 5.7 lakh tonnes, may give a mistaken impression that as far as industrial are concerned we are in a happy position. However, large quantities of castor and sal are exported, some quantities of RBO is used for edible purposes, and these, along with the present ban on important of tallow, would increase pressure on the exploitation of minor oils to meet the increasing demands from soap and paint industries (Fig. 8.2).

Yield potential of oilseeds

An examination of the average yield of various oilseed crops in India, in comparison with dat a on their inherent yield potentials and highest yields obtained elsewhere in the world (Table 3), should infuse some confidence that technologies and management systems are available to increase the yield of most of these crops by at least two to three--fold. Oilseed crops have not received their due share of increase in area under irrigation and it is evident that irrigation alone is capable of doubling the yields. The institution of better management practices including attention to pest control and large-scale use of improved variety

Table VIII-1. World vegetable oil production

Edible vegetable oils	Major production	1982/83 Production (m tonnes)
Soybean	U.S.A., China, Brazil, Argentina	14.74
Cotton Seed	U.S.S.R., China, U.S.A., India, Pakistan	3.31
Groundnut	India, China, U.S.A., Senegal, Sudan	2.94
Sunflower	U.S.A., U.S.S.R., Argentina, Eastern Europe	5.81
Rape/mustard	India, China, Canada, France, U.K., West Germany	4.65
Sesame	India, Egypt, Isreal	0.66
Safflower	Mexico, India, U.S.A.	0.23
Olive	Spain	1.99
Corn	U.S.A., Brazil	0.60
Coconut	Philippines, Indonesia, India, Sri Lanka	3.19
Palm kernel Palm oil	Malaysia, Indonesia, Nigeria, Ivory Coast, Zaire	5.40

Table VIII-2. A vailability and requirements of vegetable oils in India

Availability		Requirements
EDIBLE VEGETABLE OILS - lakh tonnes		
Groundnut	14.83	Edible oils 5.49 m. tonnes
Rape/mustard	5.56	Industrial oils 5.7 lakh tonnes
Sesame	1.45	
Safflower	0.50	
Sunflower	0.54	
Soybean	0.50	
Niger	0.30	
Coconut	1.80	
Cottonseed	2.40	
Total	28.88	Deficit in edible oils: 2.61 m tonnes
NON-EDIBLE OILS		
RBO and minor oils	3.50	
Castor	1.20	
Linseed	1.10	
Solvent extracted oils	0.60	
Total	6.40	

seeds along with irrigation would enable us to get higher productivity if not the highest achieved by other countries (Fig. 8.3).

Rapeseed-Mustard Oilseeds

Among the major annual oilseed crops of the world, rapeseed and mustard rank fifth after soybean, sunflower, groundnut and cottonseed. More than two-thirds of the world's acreage is limited to Asian countries, principal among these include India, China, Pakistan and Bangladesh (Table 1). Within India, the rapeseed-mustard oilseeds occupy second place to groundnut both in area and production. From the total annual acreage (17.55 m ha) and production (9.3 m tonnes) of the oilseeds in India, these crops contribute 4.8 m ha producing 2.4 m tonnes of oilseed. These crops require relatively cooler temperatures within our agro-climatic conditions and are, therefore, grown extensively in the north-eastern and central parts with Uttar Pradesh, Rajasthan, Madhya Pradesh, Haryana, Punjab, Assam, West Bengal and Bihar accounting for the bulk of the area under commercial cultivation. The oil produced from these crops in consumed as food oil and the meal cake left after the extraction of oil form an important cattle feed or is utilised as fertiliser for various grain crops (Fig. 8.4).

Safflower production

India occupies premier position in the world in terms of total acreage, and Mexico, the U.S.A. and Ethiopia are the other principal countries where safflower is grown on a large scale (Table 1). Even though the country accounts for about 54 per cent of the world's safflower acreage it contributes less than 40 per cent of the total safflower pool in the world. Mexico with just half the area, ranks first in the world and produces 3.72 lakh tonnes as against 3.4 lakh tonnes of India. This should cause no surprise since for centuries the crop has been grown in Indiaunder conditions of energy starvation, precarious moisture (-100 per cent rainfed) and intense competition with traditional rabi crops (99 per cent of the country's area is from mixed stands) with little or no management. Notwithstanding rapid strides India has made since 1970-71 in safflower production and productivity levels; the per

Table VIII-3. Yield potential of oilseeds

Crop	No. of varieties	Yield potential Range in kg/ha		Average yield in India kg/ha	Highest yield in the world kg/ha
		D R Y	Irrigated		
Groundnut	30	800-1800	2000-2500	756	5784 (Isreal)
Rape/ mustard	28	800-1400	1500-2000	589	2826 (West Germany)
Sesame	17	400-800	-	181	2000 (Yugoslavia)
Sunflower	5	800-1000	Up to 2000	522	2209 (Italy)
Safflower	5	800-1500	Up to 2000	493	-
Soybean	2	800-1000	1500-2000	863	4500 (U.S.A.)
Niger	8	300-350	-	236	-

Table VIII-4. Area, production and yield of major rapeseed-mustard production areas

Production area	Area ('000 ha)	Production ('000 metric tonnes)	Yield kg/ha
World**	11,712	12,147	1,037
Asia**	8,311	6,466	778
India	4,063	2,247	553
China	3,603 F	3,803 F	1,055
Pakistan	415	252	607
Bangladesh	201	122	607
N. America**	1,451	1,797	1,239
Canada	1,448	1,794	1,239
W. Europe**	1,176	2,611	2,221
Germany (FRG)	126 F	330 F	2,627
France	456	1,023	2,243
Sweden	172	353	2,053
E. Europe**	1,748	3,746	2,142
Poland	277	486	1,751
Germany (GRD)	155	363	2,350

Table VIII-5. Major safflower producing countries in the world*

Sl. No.	Country	Area in ('000 ha)		Production in ('000 metric tonnes)		Yield (kg/ha)	
		1980	1981	1980	1981	1980	1981
1.	India	708	726	279	340	394	468
2.	Mexico	392	391	446	372	1,136	952
3.	U.S.A.	100	100	105	92	1,050	920
4.	Ethiopia	65	65	31	31	477	477
5.	Spain	20	30	20	25	995	833
6.	Australia	18	28	9	21	495	750
7.	Others	12	11	7	8	808	809
World Total		1,315	1,351	897	889	682	658

hectare yields of the crop continue to be far lower that a number of its recently adopted countries like the U.S.A., Mexico, Spain and Australia (Fig. 8.5).

Soybean production as oilseed in the world

Soybean (Glycine max. L.) has become the miracle crop of the twenticth century. It is a triple beneficiary crop, which contains about 2) per cent of oil and 38 to 42 per cent high quality protein possessing high level of essential amino acids except matheonine and cystine. The biological value of the soybean-protein is as good as meat-and fish--protein. Besides oils and high quality protein, being a leguminous crop, soybean fixes atmospheric nitrogen in the soil at the rate of 65 to 100 kg/ha depending upon the soil and climatic conditions through symbiosis with the help of Rhizobium bacteria.

Soybean was considered only as a food and fodder crop till World War II when its potential as an oilseed crop was realised. Due to its multifaceted advantages, soybean has since progressed by leaps and bounds as an oilseed crop. So much so that on the global scale it has come to the top of the list of oilseed crops and contributes over one-third of the total supply of the world vegetable oil pool.

Soybean is cultivated all over the world according to FAO production year book, 1980. Its total area is exceeding 53 m ha and production over 83 m tonnes during 1980. Among all the edible oil crops all over the world at present, soybean surpasses in terms of seed and oil production as mentioned in Table 1. As seen from Table 1, soybean has emerged as the most potential source of vegetable oil all over the world. China which is supposed to be the native country of soybean, share 75 per cent of the world production unitil middle of 1950s. After this the United States dominated in its production. Brazil emerged as a major soybean producing country from 1979 after U.S.A., pushing China to the third position (Fig. 8.7).

Presently, the United States, Brazil and the China are three major countries in soybean production. Other countries considered to be of potential for its production are USSR, Bulgaria, Romania, Yugoslavia in

Table VIII-6. World soybean production (in '000 tonnes) in selected countries in selected years during 1939-79

Year	World	United States	China	Brazil	Other countries	World Yield (kg/ha)
1939	13,167	2,453	9,495	-	1,219	1,064
1944	13,773	5,213	7,630	-	930	1,050
1949	14,169	6,374	6,673	25	1,097	1,100
1954	19,914	9,296	8,700	177	1,798	1,150
1959	25,845	14,511	9,525	147	1,662	1,212
1964	28,188	19,103	6,940	305	1,840	1,177
1969	40,516	30,839	6,200	1,057	2,420	1,425
1974	54,366	33,062	9,500	7,876	3,927	1,387
1979	34,373	61,715	8,300	15,200	9,160	1,857

Table VIII-7. Increase or decrease in total hectarage, mean yield, and total production of soybean in Asia in 1983 (base year 1974-76)

Country	Area ('000 ha)	Average yield (kg/ha)	Production ('000 metric tonnes)
Burma	6	144	8
China	900	153	2,133
India	610	235	623
Indonesia	-25	64	24
Iran	-2	564	26
Japan	55	68	87
Kampuchea	-3	0	-3
Korea DPR	19	227	90
Korea Rep.	-64	-7	-75
Laos	2	-206	1
Malaysia	-	171	-
Philippines	4	347	7
Sri Lanka	1	12	1
Taiwan	-39	12	-48
Thailand	22	-76	13
Turkey	25	497	52
Vietnam	65	526	88
Asia	1,617	141	3,080
U.S.A.	4,334	-40	6,659
Brazil	2,342	125	4,927
World	11,272	49	19,741

Table VIII-8. Area of coconut in the major countries of world in '000 ha

Country	1,979	1,980	1,981	1,982
Indonesis	1,748	1,803	1,844	1,959
India	1,076	1,083	1,088	1,113
Malayasia	334	327	330	327
Philippines	2,995	3,126	1,162	1,160
Sri Lakna	452	454	451	451
World	8,013	8,212	8,386	8,437

Table VIII-9. Production of coconut in the major coconut growing countries of the world in '000 tonnes

Country	1979	1980	1981	1982
Indonesia	10,700	10,900	10,800	11,700
India	4,181	4,250	4,175	4,209
Malayasia	1,237	1,219	1,207	1,196
Philippines	7,973	8,552	9,544	9,668
Sri Lanka	1,819	1,540	1,716	1,916
World	33,117	33,709	34,878	35,957

eastern Europe; Indonesia, Japan, Korea, Thailand and India in Asia; Egypt in north Africa; Mexico, Argentina, Paraguay, Colombia, Uruguay, Equador in Latin America (Fig. 8.6).

Coconut

The coconut palm is one of the major sources of edible oil. Next only to oilpalm it yields more oil per unit area of land. India occupies only the third position in the world acreage and production, with 1.1 m ha in area, having annual production of 5,618 m nuts (Tables 1 and 2). Regarding the productivity of the coconuts per hectare India is in the seconi place among the major coconut growing countries of the world (Table 3). Among the various States in our country, Kerala has the major has the major share in area as well as production. A perusal of the data on the area under production and productivity of the crop reveals certain interesting features (Fig. 8.8).

Recent developments of oils and fats

It is well to remember in this context certain basic factors regarding current edible oil crops. The world's oil production in 1984-85 was 41 million M.T. Soyabean is the largest source of edible oil (33%) of the total followed by oil palm (17%), sunflower (15%), Rape seed (14%) and Cotton Seed (10%). Eight countries are responsible for 86% of the total world edible oil production viz., U.S.A. (28%). China (20%), India (9%) Brazil (8%), U.S.S.R. (7%), Argentina (6.6%), Malaysia (5%) and Canada (3%). U.S.S.R. and India are the world's leading importer of fats and oils in 1984-85 with 1.6 and 1-5 mts. respectively. The two most populous countries-China and India showed consumption increases by 11.4% and 4.3% respectively form 1983-84 to 1984-85 season. Seeing from another angle, the Western hemisphere accounts for a little more than half (53%) of world oilseed production and a little less than half (47%) of world production of major protein meals but only about 29% of the vegetable and marine oil output. As a consuming area the Western hemisphere represents about 29% of the world meal use and 24% of world oil use. In Africa, the Middle East, the USSR and Eastern Europe the world oil seed production has shown no significant growth during the last 10 years

Table VIII-10. Producitivity of coconut (nuts/ha) in major coconut growing countries

Country	1978	1979	1980	1981	1982
Indonesia	6,284	6,121	6,045	5,702	6,153
India	4,035	4,041	3,913	3,913	3,913
Malayasia	3,577	3,703	3,727	3,657	3,657
Philippines	3,159	2,662	2,735	3,018	3,059
Sri Lanka	3,714	4,029	3,411	3,800	3,876

Table VIII-11. Seed and oil production of major oilseed crops in the world, 1980

	Group	Production (million tonnes)	Oil production (million tonnes)
I	Soybean	83.50	14.02
II	Groundnut	18.90	5.29
III	Sunflower	13.17	5.26
IV	Rapeseed and Mustard	10.57	4.23
V	Sesame	1.53	0.77
VI	Safflower	1.02	0.31

Table VIII-12. Relative position of India among the world's large producers of oilseed during 1979-81 ('000 tonnes/annum)

Crop	Rank in Production				
	I	II	III	IV	V
Groundnut	India	China	U.S.A.	Sudan	Senegal
	5,596	3,369	1,546	830	688
Rapeseed-mastard	China	Canada	India	France	Japan
	2,864	2,563	1,845	871	61
Sesame	India	China	Sudan	Burma	Mexico
	428	360	202	159	145
Linseed	Argentina	Canada	India	U.S.A.	U.S.S.R
	642	586	411	234	217
Castor	Brazil	India	China	U.S.S.R.	Thailand
	295	222	116	44	29
Safflower	Medico	India	U.S.A.	Ethiopia	Spain
	469	276	127	31	20
Cotton seed	U.S.S.R.	China	U.S.A.	India	Pakistan
	6,251	5,276	4,990	2,646	1,461
Coconut	Indonesia	Philippines	India	Srilanka	Malaysia
	10,800	8,689	4,444	1,692	1,221

(1975-1985). On the other hand, in the Western Europe the world oil seed production increased at an average annual rate of 22%. On the other hand, the Pacific region which consists of 15 countries including China, India, Indonesia, Japan, Pakistan, Philippines, South Korea, Malayasia, Australia, Hong Kong Papua Newguinea, Singapore, New Zeland and Fiji Produce 20.3 Million M.T. and between 1980 and 1984 Pacific region increased world oil production by 28%. In 1984 in India we have been forced to import 2.2 kg of oil per capita out of our average per capita consumption of 7.4 kg per capita.

CHAPTER - IX

NATIONAL SCENARIO OF OIL SEED PRODUCTION

India is one of the major producers of oilseeds in the world. Yet our vegetable oil economy is beset with the problems of shortage. The demand-supply gap in vegetable oils, once developed to fightening level necessitating massive imports of edible oils. During 1986-87 and 1987-88, the country imported edible oils to the extent of 15 lakh tonnes and 18 lakh tonnes respectively, while in 1988-89 and 1989-90 it came down to 3.70 lakh tonnes and 6.90 lakh tonnes respectively.

During the current oil years 1990-91, the availability of edible oils in India has been estimated at 49 lakh tonnes, which is higher than the estimate of 47.45 lakh tonnes in 1989-90. If the per-capita consumption is assumed at 6.5 kgs (including 5.3 kgs of liquid oils and 1.2 kgs of vanaspati) the total requirement of edible oils would be around 54.60 lakh tonnes in 1990-91 to feed about 850 millions of people. The per-capita consumption if however, taken at 7 kgs the total requirement of edible oils would be of the order of 58.80 lakh tonnes.

A recent exercise conducted at Krishi Bhavan reveals that the aggregate production of oilseeds during 1989-90 crop year would be in the neighbourhood of 186.6 lakh tonnes (88.6 lakh tonnes kharif and 80 lakh tonnes rabi) which indicates that the deficit in edible oils would be anything between 6 and 9 lakh tonnes in the current oils year.

9.1. OILSEEDS - NATIONAL SCENARIO

The importance of oilseeds in our national economy can hardly be over emphasized. Oilseeds crops are the principal sources of edible oils, forming an integral part of human diet. Besides, it constitutes important raw materials for a number of manufactured goods including soap, paint, lubricants and so on.

Next to foodgrains, oilseeds contribute significantly to the agricultural economy of the country. In India, oilseeds crops are cultivated in an area of 18 million hectares, accounting for about 12% of the total land under cultivation.

Oilseeds crops like groundnut, mustard/rapeseed, safflower, niger and sunflower were largely used for edible purposes while linseed and castor are pre-dominantly grown for industrial purposes. The production of cultivated oilseeds taken together touched a new peak of 179 lakh tonnes by the end of the seventh plan as against the target of 180 lakh tonnes.

Among the major oilseeds crops, groundnut and mustard/rapeseed account for about 80% of the total production of oilseeds in the country. Gujarat contributes about 30% of the area and outpur of groundnut while U.P. accounts for about 60% of the area and production of mustard/rapeseed in the country.

India is the third largest producer of oilseeds in the world. It ranks first in the production of groundnut and sesame and second in rapeseed and mustard. India's share in the world production of these oilseeds is as under :

TYPES	Per cent
Groundnut (Shelled)	37
Rapeseed and Mustard	19
Sesame	24
Linseed	20

The other two important oilseeds, i.e., soybean and sunflower are still to make a dent in the country. In spite of a large share in the world production, the per capita consumption of oil in India is very low about 5 kg as against the world average of 11 kg and the consumption of about 28 kg in the affluent countries.

According to the area and production, the oilseeds of the country are broadly divided into three catagories (Table IX-1). Area, production

Table IX -1. Area, production and productivity of different oilseed crops in the states

State		Groundnut	Rapeseed mustard	Sesame	Lineseed	Castor	Niger	Saflower	Sunflower
1		2	3	4	5	6	7	8	9
Andhra	A	1,433.9	0.6	165.5	11.0	271.5	10.3	35.8	5.5
Pradesh	P	1,407.3	0.1	26.6	2.0	54.1	3.6	7.3	2.9
	Y	981	167	161	182	199	350	204	527
	% Area	74.1	0	8.6	0.6	14.0	0.5	1.8	0.3
	% Prod.	93.6	0	1.8	0.1	3.6	0.2	0.5	0.2
Assam	A	-	224.0	12.6	5.5	2.0	-	-	-
	P	-	102.7	6.1	2.4	0.8	-	-	-
	Y	-	458	484	436	400	-	-	-
	% Area	-	91.8	5.2	2.3	0.7	-	-	-
	% Prod.	-	91.7	5.4	2.1	0.7	-	-	-
Bihar	A	5.4	75.3	18.3	97.2	2.1	45.8	0.3	1.0
	P	3.6	46.3	5.3	41.0	1.6	16.9	0.1	0.3
	Y	667	615	290	422	762	369	333	333
	% Area	2.2	30.7	7.5	39.6	0.9	18.7	0.1	0.4
	% Prod.	3.1	40.2	4.6	35.6	1.4	14.7	0.1	0.3

Table IX-1. (Contd.)

1		2	3	4	5	6	7	8	9
Gujarat	A	2,191.5	169.7	105.2	-	175.2	-	-	-
	P	2,145.3	78.3	40.2	-	196.9	-	-	-
	Y	976	461	382	-	1,124	-	-	-
	% Area	83.0	6.4	4.0	-	6.6	-	-	-
	% Prod.	87.2	3.2	1.6	-	8.0	-	-	-
Haryana	A	7.9	202.0	4.5	0.2	-	-	-	-
	P	7.4	141.0	1.9	0.2	-	-	-	-
	Y	937	698	422	1,000	-	-	-	-
	% Area	3.7	94.1	2.1	0.1	-	-	-	-
	% Prod.	4.9	93.7	1.3	0.1	-	-	-	-
Himachal Pradesh	A	1.5	6.5	8.2	5.3	-	-	-	-
	P	0.9	1.9	2.3	0.9	-	-	-	-
	Y	600	292	280	170	-	-	-	-
	% Area	7.0	30.2	38.1	24.7	-	-	-	-
	% Prod.	15.0	31.6	38.4	15.0	-	-	-	-

Table IX-1. (Contd.)

1		2	3	4	5	6	7	8	9
Jammu &	A	0.1	42.3	7.1	2.9	-	-	-	-
Kashmir	P	0.1	59.8	2.6	2.5	-	-	-	-
	Y	1,000	1,414	366	862	-	-	-	-
	% Area	0.2	80.7	13.6	5.5	-	-	-	-
	% Prod.	0.2	92.0	4.0	3.8	-	-	-	-
Karnataka	A	779.2	3.1	120.1	65.3	29.5	53.7	175.4	37.7
	P	618.0	0.9	38.4	14.3	17.0	9.3	89.0	19.7
	Y	793	290	320	219	576	173	507	523
	% Area	61.6	0.3	9.5	5.2	2.3	4.2	13.9	3.0
	% Prod.	76.6	0.1	4.8	1.8	2.1	1.2	11.0	2.4
Kerala	A	13.0	-	17.0	-	-	-	-	-
	P	11.2	-	4.4	-	-	-	-	-
	Y	862	-	259	-	-	-	-	-
	% Area	43.3	-	56.7	-	-	-	-	-
	% Prod.	71.8	-	28.2	-	-	-	-	-
Madhya	A	299.9	243.6	248.0	528.6	4.1	224.9	0.9	-
Pradesh	P	221.6	145.7	40.0	110.5	1.4	40.8	0.2	-
	Y	739	598	161	209	341	181	222	-

Table IX-1. (Contd.)

1		2	3	4	5	6	7	8	9
	% Area	19.3	15.7	16.0	34.1	0.3	14.5	0.1	-
	% Prod.	39.6	26.0	7.1	19.7	0.3	7.3	0	-
Maharashtra	A	823.8	4.6	178.2	251.6	4.2	101.0	542.2	142.7
	P	694.4	1.6	31.8	57.7	1.0	24.1	324.4	92.1
	Y	843	348	178	229	238	239	598	645
	% Area	40.2	0.2	8.7	12.3	0.2	4.9	26.5	7.0
	% Prod	56.0	0.1	2.6	4.7	0.1	2.0	26.4	7.4
Orissa	A	218.3	162.1	185.0	38.5	43.2	137.2	6.0	1.1
	P	297.8	72.4	79.3	16.6	22.5	57.6	2.8	0.4
	Y	1,364	447	429	431	520	420	467	364
	% Area	27.6	20.5	23.4	4.9	5.5	17.3	0.7	0.1
	% Prod	54.2	13.2	14.4	3.0	4.1	10.5	0.5	0.1
Punjab	A	92.0	108.0	19.4	1.3	-	-	-	-
	P	90.0	72.0	6.7	0.5	-	-	-	-
	Y	978	667	345	385	-	-	-	-
	% Area	41.7	48.9	8.8	0.6	-	-	-	-
	% Prod.	53.2	42.6	3.9	0.3	-	-	-	-

Table IX-1. (Contd.)

1		2	3	4	5	6	7	8	9
Rajasthan	A	160.7	651.3	429.1	84.7	5.6	-	-	0.6
	P	107.4	458.4	49.9	28.4	1.2	-	-	0.4
	Y	669	704	116	335	214	-	-	667
	% Area	12.1	48.9	32.2	6.4	0.4	-	-	0
	% Prod.	16.6	71.0	7.7	4.4	0.2	-	-	0.1
Tamil Nadu	A	1,44.6	1.0	137.0	20.1	-	-	30.6	
	P	1,368.6	0.3	40.7	-	5.8	-	-	9.6
	Y	1,196	300	297	-	289	-	-	314
	% Area	85.5	0.1	10.3	-	1.5	-	-	2.3
	%Prod.	96.0	0	2.9	-	0.4	-	-	0.7
Uttar Pradesh	A	270.7	2,258.0	748.3	636.3	0.3	-	-	6.3
	P	259.4	1,073	96.0	183.2	0.1	-	-	4.4
	Y	958	475	128	288	333	-	-	698
	% Area	6.9	57.6	19.1	16.2	0	-	-	0.2
	% Prod.	16.0	66.4	5.9	11.4	0	-	-	0.3
West Bengal	A	1.2	163.3	109.9	55.1	-	-	-	2.2
	P	1.1	94.7	48.8	13.6	-	-	-	1.1
	Y	917	580	444	247	-	-	-	500

Table IX-1. (Contd.)

1	2	3	4	5	6	7	8	9
% Area	0.4	49.2	33.1	16.6	-	-	-	0.7
% Prod.	0.7	59.5	30.6	8.5	-	-	-	0.7

A = Area ('000 ha.); P = Production ('000 tonnes); Y = Average yield (kg/ha) and productivity of different oilseed crops statewise (IX-1). That the cultivation of each oilseed is concentrated in different States of the country as given as follows :

1. Groundnut	:	Gujrat, Andhra Pradesh, Tamil Nadu, Maharashtra and Karnataka.
2. Rapeseed-Mustard	:	Uttar Pradesh, Rajasthan, Madhya Pradesh, Assam and Haryana.
3. Sesame	:	Uttar Pradesh, Rajasthan, Himachal Pradesh, Orissa, Maharashtra and Andhra Pradesh.
4. Linseed	:	Uttar Pradesh, Madhya Pradesh, Maharashtra, Bihar and Karnataka.
5. Castor	:	Andhra Pradesh, Gujarat, orissa and Karnataka.
6. Safflower	:	Maharashtra, Karnataka and Andhra Pradesh.
7. Sunflower	:	Maharashtra, Karnataka, Tamil Nadu and Uttar Pradesh.
8. Niger	:	Madhya Pradesh, Orissa and Maharashtra.

Even in these states the areas can be easily defined which are concentrated in specific zones.

Information on the average production of various oilseed crops in the country and scope of improvement per unit production is given in Table 9.2.

This table indicates that there is gap between the productivity in India as compared to the highest yields obtained in the world and thereby indicates the ample scope for further improvement.

The growth, production and yield per hectare of the oilseeds in the country over the years are given in Table 9.3.

One can see a large increase in the area sown under oilseeds, mostly of groundnut and rapeseed and mustard during the period from 1951-52 to 1982-83 reflecting the general increase in the area and production. This table also indicates that the country has made progress, although at a slower pace than expected.

Table IX-2. Productivity levels of Different of Oilseeds in India and abroad

Sl. No.	Crop	Average Yield of India (kg/ha)	Highest Yield in the world (kg/ha)
	MAJOR		
1.	Groundnut	756	5,784 (Israel)
2.	Rapeseed and Mustard	589	2,826 (FR Germany)
3.	Sesame	181	2,000 (Yugoslavia)
4.	Linseed	271	2,000 (New Zealand)
5.	Castor	605	384 (Philippines)
	MINOR		
6.	Safflower	493	-
7.	Sunflower	522	2,209 (Italy)
8.	Niger	236	-

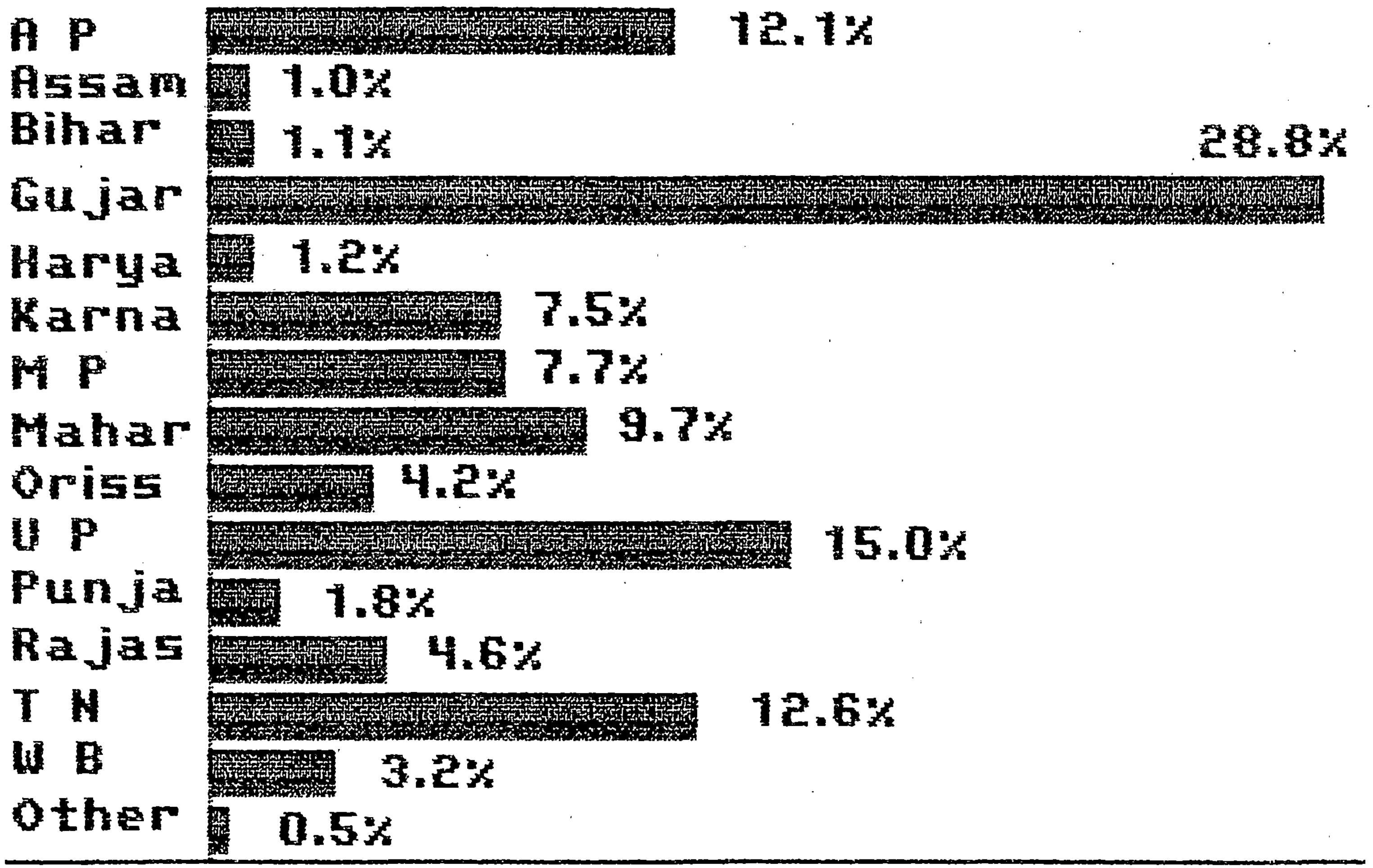
Table IX-3. Area, Production and Yield per hectare of Oilseeds
Area : '000 ha; Production : '000 tonnes; Yield : Kg/ha

Crop		1951-52	1982-83	Increase
Groundnut	Area	4,917	7,345	2,428
	Production	3,192	5,553	2,361
	Yield	649	756	107
Rapeseed	Area	2,401	4,194	1,793
Mustard	Production	943	2,472	1,529
	Yield	393	589	196
Sesame	Area	2,405	2,780	375
	Production	452	502	50
	Yield	188	181	-7
Linseed	Area	1,380	1,758	378
	Production	333	476	143
	Yield	241	271	30
Castor	Area	582	570	-12
	Production	108	345	237
	Yield	186	605	419
		1965-66		
Safflower	Area	462	755	293
	Production	69	371	302
	Yield	149	492	343
Niger	Area	522	501	-21
	Production	91	118	27
	Yield	173	236	63

(Data on Safflower and Niger available only from 1965-66)

Table IX-4. Share of States in the All India Area under Oilseed Crops and Production thereof in 1988-89

States	Area Under Oilseeds Crop (in %)	Share in the All India Production of Oilseeds (in %)
Andhra Pradesh	10.00	12.1
Assam	1.3	1.0
Bihar	1.5	1.1
Gujarat	13.8	28.8
Haryana	1.1	1.2
Karnataka	7.4	7.5
Madhya Pradesh	11.3	7.7
Maharashtra	11.1	9.7
Orissa	3.9	4.2
Uttar Pradesh	20.0	15.0
Punjab	1.3	1.8
Rajasthan	6.5	4.6
Tamil Nadu	6.6	12.6
West Bengal	1.5	3.2
Others	2.6	0.5
	100	100



Share of State in the All India production of oilseeds (IN %)

9.2. G R O U N D N U T

In West Bengal, groundnut is largely consumed as nut. In recent years refined groundnut oil has, however, entered into the kitchens of some afluent families of West Bengal but still then the quantity is negligible. The annual consumption of groundnut in terms of "nuts" in West Bengal is estimated at 50,000 tonnes which are largely imported from Western and Southern States. There is a not outflow of about Rs.35 crores from West Bengal to other States for meeting the consumption-demand for groundnut in the State. It is, however, encouraging that the cultivation of groundnut has been catching the imagination of the farmers of West Bengal. Generally groundnut is cultivated as a second crop after long duration Aman paddy in the mono-cropped area in the coastal areas and also in the high lands in the summer season. Since last two years the cultivation of groundnut in the districts of Hooghly, Midnapore, Purulia, Nadia, 24 Parganas, Cooch Behar and West Dinajpur has gathered momentum. The crushing of groundnut in West Bengal has, however, come to a grinding halt on account of various factors including high incidence of local taxes which has made the end-products quite uncompetitive.

India is the 3rd largest producer of oil seeds in the world it ranks first in the production of groundnut. In spite of countries share in the world production of groundnut (Shelled) - 37% -
- India is now passing through a critical phase of edible oil shortage.

In West Bengal Repeseed - Mastard and Sesame are the two major oilseed crops grown in most of the districts and recently groundnut area is also increasing. The total area in the field out groundnut production in thousand hectare in only 19.00. Production 24.00 thousand tonnes. Yield kg/ha 1320.

Considering the localization of areas under major irrigation projects have been weighted in favour of rice, which is the main competition of oil seeds and specially groundnut during the rabi summer season. Even many light soil areas, which are eminently suitable for groundnut, were being used for rice cultivation, Localization of areas between wet crops and light-irrigated crops would now be done on the basis of soil types, desirable cropping patterns and optimum utilization of water. All light soils areas may be reserved for groundnut. Detailed surveys for minor irrigations or pipelines should be conducted to identify the areas for groundnut.

As far as possible, water supply during the rabi-summer season should be restricted to light-irrigated crops like groundnut.

Localization once done may be made effective for at least four to five years. This would help not only in long-term planning of cropping patterns and removing uncertainties but also in proper soil and water management.

Delays in the announcement of localization of areas, which are very common, are not conductive to planning of appropriate cropping patterns. Sometimes, the localization for rabi-summer is being announced as late as November-December. Consequently, farmers are not able to do advance planning of cropping patterns. It is therefore important that the announcement regarding localization of areas as between wet and dry crops both for the kharif and rabisummer seasons should be make well before the kharif season, i.e., by April-May. This would enable the farmers to make an appropriate choice of the rice variety in kharif, which would enable timely planting of groundnut in the rabi-summer season. This in turn would enable the farmer to get good yields from groundnut.

As far as possible localization may be done according to the distributary, as this would prevent groundnut being taken up by the side of rice, leading to problems of seepage and low yields of groundnut owing to excess moisture. The localization pattern announced should be enforced strictly.

The present system of field to field irrigation should be expeditiously replaced by individual field irrigation wherever not done, to facilitate proper water-management for the light-irrigation crops like groundnut and also improve water availability for these crops. Arrangements should also be made for the construction of proper drainage channels.

The schedules for running of distributary channels should be worked out to synchronizo with the crucial stages of the growth period of groundnut crop when irrigation is most required and beneficial.

Introduction of rotational supply of water will be useful with periodic closure of the channels to discourage rice cultivation and its replacement with groundnut during the rabi-summer season.

Arrangement of early release of water in the first week of June, which would permit early sowing and planting of rice during kharif and subsequently of during the rabi-summer season is another step.

Introduction of warabandi on a priority basis in the areas localized for groundnut would ensure timely and equitable distribution of irrigation water.

The extension workers must be goven through training, particularly in water management practices for light irrigated crops like groundnut as also in the use of fertilizers to enable them to effectively transfer this technology to the farmars. Programmes for the mass training of farmers should also be taken up.

Special awards and incentives may be introduced in the Command Areas for the farmers who give a lead in increasing the areas and productivity of ground-nut during the rabi-summer season.

9.2.1. Agronomic considerations

a) <u>Plant Stand</u>

Achievement and maintenance of optimum plant population is a prime requirement for obtaining good yields. Low plant population in the initial stages results from a number of factors like poor soil preparation, non-selection of seeds, no pre-sowing treatment of seeds with fungicides, defective sowing techniques and lack of adequate soil moisture. It is therefore very important that the extension staff should conduct vigorous campaigns to educate the farmers in all these aspects to achieve a good plant stand. It sufficient attention is given to these simple aspects, many farmers would be able to even reduce the seed rate and yet achieve an optimum plant stand.

b) Optimum Sowing Tiem

The optimum sowing time should be determined for those regions of the southern District for which specific data are not available, and conditions should be created wereby the farmers can take up timely sowing of the crop.

c) Method of Sowing

The most common method of sowing the crop is by dibbling behind the country plough. The use of seed drills or gorrue needs to be popularized on a much larger scale than hitherto so that the sowing is done at the recommended spacing and depth in the interest of better crop management. Farmers have yet to be educated in proper sowing techniques. Criss-cross sowing, whereever practised, should be discouraged and the farmers advised to raise an optimum plant stand with the use of selected seed, pre-sowing treatment of seeds and use of seed drills rather than use of a high seed rate and criss-cross sowing. The State Department of Agriculture may substantially intensify their programmes for supply of efficient bullock-drawn seed drills, at subsidised rates, if the situation so required.

d) Fertilizers

The importance of application of balanced doses of fèrtilizers in obtaining high yields cannot be over-emphasized. The states should carry cut detailed surveys of the areas identified for raising groundnut during the rabi-summer season, wherever not done, so as to identify the nutrient deficiencies and recommend appropriate fertilizer schedules for specific areas. Adequate attention should also be paid to micronutrients like zinc, magnesium, boron and molybdenum.

There is great scope for educating the farmers in the judicious use of fertilizers. While many do not use any fertilizer at all or apply only in low doses in some areas as in Midnapore district, many farmers use much higher doses of nitrogenous fertilizers and farmyard manure than required but not enough phosphatic fertilizers, which results in excessive vegetative growth.

Phosphorus application, which is very important in groundnut, has not yet caught up sufficiently. Same is position of gypsum and potassic fertilizers as also micronutrients like zinc, magnesium, boron and molybdenum, the use of which in identified areas needs to be popularized.

e) Interculture and Weeding

These aspects assume an added importance in Command Areas, particularly in those where field-to-field irrigation is practised. Farmers should be advised to take up timely interculture and weeding operations. Insufficient intercultiure and weeding are not conspicuously noticed in new areas. Studies have shown that the critical period for weed competition in bounch groundnut is 45 days from planting, and if the crop is kept free from weeds during this period the weeds that come up later to not reduce the yield. For proper interculture and weeding, the crop should have been sown in rows and criss-cross sowing should be done as earlier.

f) Pests and Diseases

The most important pest of rabi-summer groundnut is leaf miner or leaf webber, which has become a severe menace in areas where sowings are continued over a long period both during the kharif and rabi-summer seasons. The control measures are well known. What is required is what the sprayings should be taken up well in time and on an area and community basis without which it would not be possible to control the pest. The facilities of financial assistance available under different centrally sponsored and State Sector Schemes should be fully utilized.

Among diseases, mention may be made of tikka, bud necrosis and rust. Tikka assumes serious proportions even in the rabi-summer season wherever water management is not proper and the crop is over-irrigated.

Attention to these aspects is therefore very important apart from adoption of the recommended control measures. Bud necrosis is now becoming more prevalent in parts of Andhra Pradesh and Karnataka. Researches conducted at the ICRISAT Centre, Patancheru, district Medak, Andhra Pradesh, have shown that the disease is caused by the Tomato Spotted Wilt Virus and is transmitted by a thrip species. Two or three sprayings against thrips in the early stages of crop growth should help in checking the severity of the disease. Resistant varieties are not yet available.

Groundnut rust (Puccinia arachidis) has during the last few years spread at an alarming rate in Tamil Nadu, Karnataka and Andhra Pradesh.

Several rust-resistant lines have been identified at the ICRISAT and by the National Oilseeds Research Project of the ICAR, which are being used in their breeding programmes. The rust problem would be solved only when rust-resistant materials become available for commercial cultivation. Pending that, some of the recommendations for chemical control of groundnut rust may be mentioned here. In Karnataka, the recommendation is to spray the crop with Dithane M-45 (40 g mixed with 18 litres of water; 625 litres of the mixture being used per hectare) or dusting with sulphur @20.5 kg/ha, once every 15 days. According to Seshadri (1976) nickel chloride at 0.15% concentration (3 sprays at 10 days intervals commencing from 60 days after sowing) was significantly superior to other chemicals. Pre-sowing treatment with Thiram or capitan (0.3%) followed by 2-3 sprays with Dithane Z-78 or Dithane M-45 (0.3%) at interval of 10-15 days when the disease appears, have also been recommended. Durairaj and Mohan (1978) reported that application of Dithane M-45 (0.2%) was most effective followed by sulphur dust (25 kg/ha) and Kocide (0.1%) significantly increased the yield. Raomackers and Preston (1977) reported from Zambia that fungicides tested for cercospora arachidicola were also effective when both rust and leaf-post occurred and yield increased up to 120%; the most effective chemicals were Chlorothalonil, Mancozeb + Bonomyl, and a mixture of Mancozeb, Benomyl and Fentin.

g) Seed Production

Good-quality seed is a basic input required for high yields. The programmes for production and multiplication of breeder's foundation and certified seeds must be strengthened and the certified seed made available to thefarmers in sufficiently large quantities at subsidized rates to encourage them to replace the seed at least once in five years.

Since the states hesitate to enter into large scale production and distribution of groundnut seeds because of the large amount of funds involved and fear of losses resulting from drying and price fluctuations, there is an urgent need for seeting up a risk fund or price-stabilization fund to absorb any losses in procurement and distribution of quality seeds of groundnut.

In coastal districts where rabi groundnut sowings start from the first week of October, there is a problem of arranging timely supply of seeds. Kharif crop is not grown in these rice-growing districts. Even the produce from the kharifcrop grown in other districts of the state becomes available only in November and December. The farmers in the coastal districts have therefore to depend largely on the seed procured from other states.

Another problem is that due to the high atmospheric humidity, it is very difficult to keep the seed from the rabi crop viable till the next rabi season. The state should therefore explore all possibilities of raising an early kharif crop in any available uplands of the coastal districts for meeting the seed requirements of the rabi crop. At the same time, research efforts should be intensified to work out appropriate seed-storage technology for the rabi produce.

The greater part of the area in these states is under rainfed conditions where groundnut is cultivated. Due to this reason the yields are comparatively low. Facrors responsible for low yields are discussed below.

Groundnut breeders have been making efforts to evolve bunch varieties having high yield, high oil content, dormancy and short duration, ignoring the requirements of various industries like baby food, confectionary and exportable H.P.S. varieties. Except 'TG 17' evolved by the BARC, there is no other bunch variety with dormancy of 20-30 days. There are no large-scale seed multiplication programmes in the country to cover even with these improved seeds. The total area under improved seeds, though claimed to be high, does not touch the frings of the problem. Instead of insisting upon very short-duration varieties, efforts should be made to screen Virginia types which have inherent dormancy. Instead of making a general approach to induce dormancy into Spanish bunch tyoe, we may take advantage of a chemical approach to break the dormancy in the Virginia types and fit them into the cropping pattern.

Owing to the completion of the various irrigation projects, lack of proper drainage is resulting in the extensive areas becoming saline--alkaline. With this rapid progress in saline-alkalinity of the soils, choice of selection of crops and varieties thus becames limited. We may have to re-orient our breeding programme with varieties whose calcium requirements pre relatively low by using suitable physiological indices.

Next to seed, management plays a very vital role, since there is no break-through in the production of high-yielding varieties. Recent surveys conducted in Andhra Pradesh on the causes of declining yields indicated that many packages of practices recommended are either not followed, or followed only partially by an insignificant minority.

Seed treatment with effective chemicals coupled with optimum seed rate not only ensures disease-free seedlings but also optimum plant population.

Use of Rhizobium culture is not in vogue in a majority of the areas where groundnut is cultivated. It is not used extensively even in the newly brought areas under groundnut and under irrigated lands. The effectiveness of the cultures supplied at present is not known both to the supplier and to the farmer and there are no agencies to varify the efficacy of the cultures supplied. Work in this direction is to be organized and accelerated.

Similarly, the full complement of the recommended fertilizer does not reach the soil, thereby yields decline greatly. Groundnut being a leguminous crop, responds to application of single superphosphate compared with complex fertilizers, as single superphosphate supplies sulphur and calcium also as nutrients. Continuous cropping of groundnut years after year depletes the micro-nutrients notably zinc, molybdenum and boron. This type of imbalance is leading to reduction in quality and quantity of the pods. It is suggested that a preparation incorporating many micronutrients should be made readily available to the groundnut growers.

Weeds have become a major menace and with accent on food crops the quantum of investment on inputs given to the groundnut crop is relatively very low, and cultivators are unable to apply weedicides which have been found to be quite effective in controlling weeds. Not only their cost has become prohibitive for the groundnut grower but also their ready availability is a problem to reckon with.

Irrigation plays a vital role in boosting up the productivity of the crop. The water requirement of groundnut though relatively low, is quite exacting. A single protective irrigation at the critical stages, either at the flowering or pod-filling stage, increases the yield by 50-60%. Hence all efforts should be made to educate the farmer to put in maximum efforts to irrigate the crop by any available cource instead of diverting the entire water source to the food crops alone.

Rust on groundnut caused by Puccinia arachidis Speg. is being recorded in a virulent form. Cheap and effective prophylactic and control measures are to be evolved and farmers are to be educated in these operations. Similarly, bud necrosis virus (BNV) caused by the tomato spotted wilt virus (TSWV) results in reduction of yield even up to 80% (Gibbone, 1979). We may have to develop an integrated system of controll, including tolerance to the virus, resistance to the vector and biological and insecticidal control of the vector.

Large-scale multiplication of the presently available potential yielders should be taken up to cover significant areas under improved seeds. This could be achieved by taking up multiplication for seed purpose under irrigated conditions in the project areas and under tube wells. The entire produce should be procured, processed and redistributed for the kharif season as a short-term measure on a large scale.

9.2.ii. Possibilities of groundnut in different agro-climatic zone (W.B.)

a) Red Laterite and Gravelly Undulating Region

* Extension of Kharif groundnut as substitute to low yielding direct seeded paddy.
* Extension of groundnut as intercrop in Arahar

b) Gangetic Alluvial Region

* Extension of area under summer groundnut.

c) Vindya Alluvium

* Extension of groundnut with bunch type varieties as summer irrigated crop.

9.2.iii. Scenario of Groundnut

Area	-	0.121 lakh hectare
Production	-	0.143 lakh tonnes
Imported groundnut oil	-	0.3 lakh tonnes

Figure refer to 1986-87.
(These figures refer to figure supplied by AE).

The following are the varieties of groundnut seeds used in the state for common aggricultural practices in different districts.

B-30 - Derived from A.K. - 10 (M.P.)
B.31
M.H-2
A.K.-12-24 (Bunch type)
J.L.-24 [Derived from E.C. 94943 (Bunch type)]

Junagarh - 11 (Bunch type)

J-11

Polachy - 1

9.3. S U N F L O W E R

There are several favourable points for sunflower cultivation in the state. Short maturity duration and its photo-insensitivity make the crop suitable for being fitted into existing cropping systems. Its relative resistance to drought and saline conditions would encourage its cultivation in the problem areas. Comparatively high oil content (45-50%) in the seed, relatively high amount (60%) of poly-unsaturated fatty acids and ease of oils extraction by country method make this crop suitable for adoption by the Indian peasant farmer. However, the reaction of farmers has not been as enthusiastic as was expected because of several reasons, chief amongst which are its susceptibility to bird attack (specially parrots), non-uniform grain-filling specially in the centre of the capitulum and lack of availability of good-quality seed.

9.3.1. Agronomic - considerations

a) Seed Treatment

Poor germination is one of the problems of sunflower cultivation. Apart from improperly filled seed, fungal attack during the seed germination impairs the germinability of the seed. Experiments cunducted at Vellayani in Kerala have shown that fungicides like Captan, Thairam or Brassicol (Quintozene) increased the germination of the seed (Abraham et al., 1976). The untreated seed lot showed germination of 73% while the germinability of the treated seed was 88%. Soaking the seed in water for 24 hr followed by treatment with Brassicol (2 g/kg seed) yielded 4 q more than the untreated seed. In the soaking process most of the unfilled seeds float to the surface and can be easily removed. Sowing depth of 5 cm is optimum for this corp.

b) Seeding Time

Sunflower as a photo-insensitive crop can be shown throughout the year. Under rainfed conditions, however, best results are obtained by sowing the crop with the onset of monsoon rains.

When the crop is raised under irrigated condition the best time for sowing the north-west parts of the country is the middle of October. Delay in sowing beyond the end of October progressively reduced the yield. Lowest yields were recorded (Chandra, 1974) when the crop was sown in February (Table 9.5).

For Berniput conditions of West Bengal, highest seed and oil yields were obtained by sowing the crop in the last week of November or mid-December (Bhattacharya et al., 1975). In the cropping sequence this crop can therefore follow mid and long-duration aman rice. A delay in sowing beyond the middle of December decreased the yield of the crop substantially. For the tarai belt of Himalayan foothills (as represented by Pantnagar conditions), optimum time for spring-summer crop was reported by Yadav and Singh (1974) to be the second week of March. A progressive reduction in grain yield occurred as the sowing was delayed. Very low yield was obtained when sown in April-July. Yield again improved by sowing in the middle of September (Table 9.6).

c) Planting Geometry and Plant Population

Under dryland conditions of plateau region of the country, as represented by Hyderabad conditions, a yield of approximately 900 to 1,300 kg seed/ha was obtained over a population range of 18,000 to 32,000 plants/ha and 56,000 to 98,000 plants/ha respectively. For dryland conditions a population of 60 to 75 thousand plants/ha at a row spacing of 35 to 60 cm is recommended (Vijailakshmi et al., 1975).

For the irrigated crop a row spacing of 45 to 50 cm and intra-row spacing of 20 to 25 cm is recommended. The irrigated conditions at a plant population of 50,000 plants/ha gave maximum yield (Hukker and Sharma, 1975).

d) Fertilizer Use

Experiments conducted on black cotton soil have shown that 25 kg N/ha was the optimum for this crop (Table 9.7). There was no response to P application on these soils (Girase et al., 1975).

Table IX-5. Yield (tonnes/ha) of Sunflower Varieties as Influenced by Seeding dates at IARI under Irrigated Condition

Seeding date	Sunflower Variety			
	'Sunrise'	'EC 69874'	'EC 68413'	Mean
October	2.80	2.11	2.77	2.56
November	2.35	1.85	2.31	2.17
December	2.31	1.54	2.47	2.07
January	2.25	1.60	2.40	2.08
February	1.71	1.71	1.96	1.79
Mean	2.29	1.72	2.34	
CD (P=0.05)				
Varieties	0.09			
Dates of	0.20			
V X D	0.28			

Table IX-6. Effect of Seeding Dates on the Seed Yield of Sunflower under Tarai Conditions

Date of Seeding	Seed Yield (tonnes/ha)
March	3.19
April	2.80
May	1.45
June	0.21
July	0.15
September	2.74
CD (P=0.05)	0.25

At Pantnagar a recommendation of 40 kg N and 13 kg P/ha was found optimum for a rainy season sunflower crop (Singh et al., 1973). For the spring season crop a fertilizer application of 60 kg N/ha is recommended (Table 9.8). No significant response to P was noted in the spring season. For Delhi conditions, Hukkeri and Sharma (1975) have recommended 50 kg N/ha as optimum for this crop.

e) Irrigation Requirement

Singh et al. (1973) conducted experiments on the effect of irrigation at different times, and noted that saturating the soil profile with 7 to 9 cm of water is sufficient to sustain the crop till maturity during the winter season. For the spring season crop one pre-sowing irrigation followed by 2 to 3 irrigations - the first one 3 weeks, the second one 10 weeks and the third one 14 weeks after sowing gave good yields (Table 9.9). Hukkeri and Sharma (1975) have reported for Delhi conditions that irrigation at flowering stage is more critical than at the seed-development stage.

9.3.ii. The current situation of sunflower crop

The development of high oil sunflower varieties in Soviet Union has stimulated worldwide interest in the commercial exploitation of this crop. Sunflower crop which was once ranked very low in the world, now occupies second place after soybean as a source of edible oil.

The commercial cultivation of sunflower crop was started in India during 1972-73 with few imported varieties from USSR and Canada. Among all the sunflower varieties tried, EC-68414, EC-68415 and Morden were found adaptable to various agro-climatic conditions and different croping systems. Varietal Renovation Programme initiated in 1977 helped in stablisation of yield and oil content in these varieties. Due to the intensive Research and Development Programme, the crop has now assumed importance as an oil seed crop in Indian agriculture. Rapid expansion of production and wide interest shown by farmers suggest that sunflower may become a major crop in India. At present, the crop

Table IX-7. Response of Sunflower to N and P fertilization at Jalgaon (Maharashtra)

Level of N (kg/ha)	Seed Yield(tonnes/ha)		Level of P_2O_5 (kg/ha)	Seed Yield(tonnes/ha)	
	1973	1974		1973	1974
0	0.81	1.04	0	0.96	1.27
25	0.96	1.34	25	0.99	1.23
50	1.01	1.30	50	0.91	1.26
75	1.00	1.35	75	0.92	1.27
CD(P=0.05)	0.08	0.13		NS	NS

Table IX-8. Sunflower Seed Yield as Affected by N and P Fertilization at Pantnagar

Level of N(kg/ha)	Monsoon season	Spring season	Level of P_2O_5	Monsoon season	Spring season
0	1.46	3.01	0	1.61	2.57
20	1.75	2.69	13	1.98	2.68
40	2.06	2.79	26	2.06	2.80
60	2.26	3.18	-	-	-
CD (P=0.05)	0.23	0.34		0.17	NS

Table IX-9. Irrigation requirement of Spring-Sunflower

Treatment	Seed Yield (tonnes/ha)
No Irrigation	1.42
One Irrigation (4-6 leaf stage)	1.88
Two Irrigations (4-6 leaf and flowering)	2.14
Three Irrigations (4-6 leaf, flower Bud initiation and flowering)	2.05

is being cultivated in 7 to 7.5 lakh ha in the country either as entire or mixed and inter-crop. The early duration variety Morden maturing within 70 to 75 days is found to be more suitable for mixed and inter--cropping. A high yielding and early maturing hybrid BSH-1 was developed. It has greater degree of self-compatibility, more stability in yield, uniformity in stand and resistance to rust. Hence, seed production in BSH-1 sunflower hybrid was initiated.

The sunflower crop can be grown during all the seasons kharif, rabi and summer.

However, higher yields are obtained during summer. It is observed that sunflower crop has more potential for the farmers and it is replacing some of the crops like kharif groundnut, rabi jowar and durum wheats which are less remunerative to the farmers. Hence, the area under sunflower is on the increase and it is gaining importance as one of the potential oilseed crops. At present, as the crop is newly introduced, it is not having major pests and disease. However, in certain localities, it is affected by the diseases - Alternaria, Rust and selerotania. During 1983, the Heliothis insect damage was also observed. It is found that the crop is comming up well in saline soils also. So, it is contemplated to introduce this crop in saline-affected areas like Bhal area in Gujarat and Sundarbans in West Bengal. In Uttar Pradesh, the crop can be successfully cultivated, after the havest of potato crop. The crop may also be cultivated with available residual moisture in paddy fallows after the harvest of paddy, crop.

9.3.iii. The achievements and progress made by the Sunflower research centres in the country

1) In the year 1980, a sunflower hybrid BSH-1 was released for commercial cultivation. A few open pollinated varieties like Surya and CO-1 have been developed and released for commercial cultivation in Maharashtra and Tamil Nadu State, respectively. S-55, an early maturing variety with a duration of 60 to 65 days has been developed at Akola. The work on developing new hybrids

and open pollinated varieties is in progress. The work on incorporation of male sterility and restoration characters into new promissing inbred lines is under way.

2) Some of the defects such as instability in yield, low oil content and low seed filling ability, the crop had in the initial stage, have been minimised. The seed filling ability, which was to the extent of 60 to 65 per cent only in the mid-seventies has been raised to 80 per cent by Varietal Renovation Method. The oil content in the commercial varieties has been raised by 4 per cent.

3) Due to the intensive Research and Development Programme, the crop has now assumed importance as an importance as an important oilseed crop in the Indian agriculture. Rapid expansion in production and wide interest shown by farmers suggest that sunflower may become one of the major oilseed crops in India.

4) The package of practices for cultivation of the crop has been developed and supplied to the farmers.

5) The critical stages of the crop have been identified. During these critical stages, i.e., bud, flowering and seed filling, irrigating the crop is necessary depending upon the soil moisture status to obtain higher yields.

6) Dithane M-45 and Zeneb fungicides have been indentified for control of leaf spot and rust diseases. Endosulphen (0.05 per cent) helped in controlling Jassids and Heliothis.

7) In the absence of bees during flowering, hand pollination in the morning hours (10 to 12 A.M.) on alternate days for five to six times during flowering, results in increased yield to the extent of 15 to 20 per cent. Growing niger crop along with sunflower, as a mixed crop, helps in attracting honey - bees and thereby, obtaining higher seed yield.

8) Split application of nitrogen was found to be better than single basal application.

9) Mixed cropping of sunflower with groundnut, ragi and blackgram in 2:6 proportion was found to be remunerative to the farmers.

10) In the maximisation trials, it was observed that a fertilizer does of 40:60:40 kg/ha gave 22 per cent higher yield with that of half the recommended dose.

11) Keeping plots weed-free up to 45 days helped in getting 35 per cent more yield over unweeded plots.

12) The sunflower seeds were found to have the dormancy period of 45 days. Ethrel (25 ppm) was found to be the effective chemical to break the dormancy.

13) Seed viability studies indicated that seed stored in tin containers were found to retain viability for more than nine months. Short term seed hardening treatment using water on six months old seeds revealed that treated seeds showed viability even ten months after the treatment.

14) It was observed that growing one crop of sunflower after another reduces the yield ability of the crop. Hence, crop rotation should be followed. Among the rotations tried, sunflower was found to come up well after groundnut, rabi jowar and avena crops.

15) It is important that the sowing date should be adjusted in such a way that flowering period should not synchronise with continuous rains.

16) The seed production centres initiated in 1977 have produced nearly 14 tonnes of breeders and 400 tonnes of foundation seeds. These quality seeds were supplied to the State Departments of Agriculture, N.S.C. and other agencies.

9.3.iv. Deficiencies/constraints in research and development of sunflower crop

1) The crop is developing fast in the country. Hence, to cater to the needs of research under varied agroclimatic conditions, it is better to have more number of research centres.

2) At present, the research and seed production centres do not have sufficient lands with irrigation facilities. It is necessary to have these to advance the generations of the breeding material quickly and hasten research programmes.

3) As area under this crop is on the increase, the demand for quality seeds is also increasing. So, to cater to the needs of farmers for quality seeds, it is essential to have more number of seed production centres.

4) To screen the germplasm collections against disease and pests under laboratory conditions, there should be green-house facilities.

5) Sunflower crop is mostly cultivated under rainfed conditions. Hence, there should be inter-projects. This may help in reducing the number of years of trials and understanding the crop cultivation aspects.

6) There should be closer liaison between research and extension agencies. This would help in imparting the research results to the farmers effectively. This interaction is particularly necessary in the development of a newly introduced crop like sunflower.

9.3.v. Prospects of sunflower crop in India

1) At present 8 to 10 a/ha sunflower seed yields are being obtained. This is not at per with the yields obtained in other countries like Romania, U.S.A. and U.S.S.R. Hence, there is a scope for further improvement in the yields. However, this crop can make important contribution to the income of dryland farmers and at

the same time help to reduce the edible oil shortage in the country. Since it is having a low seed rate (10 kg/ha) and high seed multiplication ratio (1 to 100), rapid spread of the crop is possible.

2) Taking sunflower as an inter-crop is groundnut or in ragi in 2:6 proportion was found to bring higher returns. Under unfavourable weather conditions, groundnut may fail but sunflower gives at least some return, while under favourable conditions, sunflower and groundnut in 2:6 proportion gives higher returns as compared to a single crop. The short duration variety Modern was found to be most suitable for inter-cropping in groundnut and also for double or multiple cropping.

3) Introduction of sunflower crop in new areas like Ladakh in Srinagar valley. Koraput district in Orissa, Sundarbans in West Bengal and Bhal regions in Gujarat will help in increasing seed production in the country.

4) In Saurashtra region in Gujarat state, wide spacing in groundnut crop is adopted. If early variety like Modern is taken as an inter-crop in widely spaced groundnut crop, it would help in increasing the production of oilseed crop.

5) In southern State like Karnataka and Maharashtra, herbacium, arborium cottons, durum wheats and bajra crops are very low yielders. The farmers are already replaceing the low yielding crops with sunflower in Gulbarga, Bidar, Bijapur, Raichur and Bellary districts in Karnataka State and Solapur, Osmanadbad and Parbhani districts in Maharashtra State.

6) The crop is fairly tolerant to salinity. Hence, it can be introduced in saline-affected areas and increase the production of sunflower crop in the country.

7) Growing of early duration varieties like Morden in paddy follows would help to a great extent in increasing the production of the crop.

8) If sowings of groundnut crop are delayed due to late receipt of rains (i.e., beyond second fortnight of July), as a mid-season correction, cultivation of sunflower crop in such areas would be economical.

9) It is observed that under dryland agriculture, cultivation of sunflower is more economical than cultivation of groundnut and sesame crop during kharif season.

9.3.vi. Major thrust required indeveloping sunflower crop in the country

1) Collection, evaluation and utilisation of germplasm material from major sunflower growing countries, especially collection of wild species for imparting disease and pest resistance in the commercial varieties is necessary.

2) More emphasis should be placed on the development of high yielding sunflower hybrids, populations and composites suited to different agroclimatic conditions.

3) Effective and quick disseminetion of research findings is necessary to reduce the gap between the yields obtained in the experimental stations and in the farmers' fields

4) Production of early maturing and high yielding verieties for use in different cropping system.

5) Studies on viability of sunflower seeds.

6) Some of the non-monetary inputs like soaking of seeds, use of renovated seeds, optimum time of sowing and time of harvesting would enhance the productivity and production of the crop.

9.4. Factors limiting safflower production in India

Safflower (Karad, Kusum) is a traditional crop of India, Safflower cultivation in India has been primarily for edible oil extraction or for the preparation of vegetable dyes from the petals. Bulk of the crop is grown under drylands as border rows or as a mixture with other crops. It also thrives well when irrigated.

Although safflower is a traditional crop of India and accounts for 49% of the world area, its yield per unit area is one of the lowest (Table 9.10).

The main causes of low yields are: (i) lack of genetically improved cultivars with high oil content and resistance to rusts and aphids, (ii) lack of spineless cultivators for adoption in not-traditional areas, (iii) lack of awarences of quality of oil, and (iv) lack of proper marketing facilities and price structure to enthuse farmers to grow the crop in solid stands.

Some efforts have recently bean made to improve the genetic base of safflower, and as a result the following varieties (Rajan, 1974) have been recommended for the different climatic zones of the country.

State	Improved varieties
Tamil Nadu	'K1' or 86503'
Karnataka	'17-3-3'
Andhra Pradesh	'7-13-3'
Maharashtra	'N 62-8' or '116-42'
Gujarat	'N 62-8'
Madhya Pradesh	'N 62-8'
Rajasthan, Haryana	'A 300', 'N 62-8'
West Bengal	'N 62-8'
	'6503'

It is now established that by adopting suitable agronomic technology like seedbed preparation for proper moisture conservation, appropriate seeding time and fertilizer practices, yield of the crop can be

Table IX-10. Area, Production and Yield of Safflower in Different Countries of the World

Continent/Country	Area ('000/ha)	Yield (kh/ha)	Production ('000 tonnes)
Africa	64	391	25
North-Central America	499	1,433	715
South America	8	789	6
Europe	56	404	23
Oceania	44	637	28
USSR	11	467	5
India	668	325	217
World	1,356	754	1,023

Table IX-11. Effect of planting methods on performance of Safflower

Methods of Planting	Plant height (cm)	Seeds/ fruit	Branches/ plant	1,000-seed weight (g)	Seed yield (tonnes/ha)
Broadcast	119	25.9	7.4	35.9	1.09
Row sowing	126	28.6	8.0	77.4	1.12

increased several folds under dryland conditions. When irrigated at appropriate stages of growth, yields of almost 5 tonnes/ha have been realized. Some of the production practices are discussed below.

9.4.i. Production practices

Depth of Seeding and Treatment of Seed :

Under dryland conditions, where the crop is sown in the post--monsoon season, depth of seeding plays an important role. Daulay et al. (1974) have shown that seeding at a depth of 3 to 5 cm depth. They have recommended soaking the seed before sowing.

Since the moisture is found below the 5 cm depth under dryland conditions, the seed should be sown deep (8 to 9 cm), keeping the furrows open forrapid germination.

Planting Method :

Line sowing has been found better than broadcast sowing for this crop (Eunus et al., 1975). The crops grown in row produced higher seed yields, plant height, seeds per capitulum and thousand-seed weight than the broadcast sowing of the crop at the same seed rate (Table 9.11).

a) Seeding Time and Planting Geometry

Safflower is primarily a crop of the drylands. The seeding time and population pressures play important role in the yielding ability of the crop. Because of climatic (mostly temperature) variations, the optimum time of seeding is different under north and peninsular Indian conditions. It should be sown in the middle of October when the mean daily temperatures are around 26°C (Table 9.12). Because of high diurnal temperatures, earlier sowings make the seedlings weak. When sown after mid-October, flowering process is adversely affected. For peninsular India, Girase et al. (1975a) have recommended first week of October as the optimum time for sowing under Jalgaon conditions (Table 9.13).

Table IX-12. Seed Yield of Safflower as Influenced by Seeding Dates and Planting Density in Drylands of North-Western India

Seeding data	Seed Yield (tonnes/ha) 1975-76	Seed Yield (tonnes/ha) 1976-77	Planting density ('000 plants/ha)	seed yield (tonnes/ha) 1975-76	seed yield (tonnes/ha) 76-77
III week of Sep.	1.44	0.56	1.66(30x20cm)	1.64	1.29
II week of Oct.	1.92	1.85	1.11(45x20cm)	1.41	1.30
I week of Nov.	1.59	1.70	0.86(60x20cm)	1.18	1.02
III week of Nov.	0.69	0.70			
CD (P = 0.05)	0.32	0.14			

Table IX-13. Effect of seeding dates of the seed yield of safflower in the drylands of peninsular India

Seeding date	Seed Yield (tonnes/ha)	Seeding date	Seed Yield (tonnes/ha)
Early Sept.	1.28	Early Nov.	1.09
Middle Sept.	1.34	Middle Nov.	0.56
Early Oct.	1.47	Early Dec.	0.14
Middle Oct.	1.12	Middle Dec.	0.05
CD (P=0.05)			

A population of 111,000 plants/ha at a rectangular planting geometry of 45 cm x 20 cm was found optimum for dryland conditions, while Sounda (1975) recommended a population of 1,28,000 plants/ha for partially irrigated conditions.

For an irrigated crop 75,000 to 80,000 plants/ha were found optimum (Sharma and Hukkeri, 1973). Apparently the indeterminate flowering habit of the safflower plant enable it to adjust the population variations under adequate soil-moisture regimes by adjustment in the secondary and tertiary flower nodes (Table IX-14).

b) Fertilizer Use :

Rajan (1974) reported the recommendations on the quantity of fertilisers to be used in safflower for different states (Table IX-15).

For the irrigated conditions of north India, Sharma and Hukkeri (1973) have recommended 50 kg N/ha as optimu, while Sounda (1975) have found 80 kg N/ha to be optimum for the crop (Table IX-16).

c) Irrigation Use

Though safflower crop is primarily grown under dryland conditions, experiments conducted by Dastane et al. (1971) have shown that safflower and sunflower were the most remunerative crops when grown either with or without irrigation (Table IX-17). The monetary returns from safflower were highest amongst the crops tested by them, which included wheat, Bengal gram, linseed, sunflower and rapeseed.

According to these workers the irrigation given at 4-6 leaf stage, branching, flowering and capsule formation recorded seed yield of 4.8 tonnes/ha. Of these growth stages, 4-6 leaf stage and initation of branching phase appeared to be the most critical (Table 9.18).

9.4.ii. Safflower in the Plateau Region

The plateau region of Bihar comprising the districts of Palamau, Gumla, Lohardaga, Ranchi, Singhbhum, Hazaribagh, Giridih, Dhanbad, Deoghar, Godda, Dhamuka and Sahebganj accounts for nearly 46 per cent

Table IX-14. Effect of Plant Population on Yield of Irrigated Safflower

Plant Population ('000 plants/ha)	Seed Yield (tonnes/ha)
50	1.89
75	2.03
150	2.12

Table IX-15. State wise Recommendation for Fertilizer Use

State	N	:	P_2O_5	:	K_2O
Andhra Pradesh	50	:	25	:	25
Gujarat	40	:	30	:	20
Karnataka	30	:	15		
Maharashtra	40	:	30	:	20
Madhya Pradesh	20	:	10	:	0

Table IX-16. Response of Safflower to N Fertilization under limited Irrigation conditions

Rate of N (kg/ha)	Seed yield (tonnes/ha)
0	1.50
50	2.20
100	2.34
CD (P=0.05)	0.26

Table IX-17. Comparison of Rabi Crops to Irrigation levels

No. of Irrigations	Gross Income (Rs./ha)				
	Wheat	Bengal-gram	Sunflower	Mustard	Safflower
0	-	3,030	3,210	2,700	3,190
1	2,520	2,490	4,155	3,980	4,290
2	3,340	3,960	5,210	3,720	4,800
3	3,460	3,880	5,460	4,370	4,800
4	3,740	3,750	4,380	4,420	5,580

Table IX-18. Response of Safflower to Irrigation

Stages of Plant Growth for Irrigation				No. of Irrigation	Seed Yield (tonnes/ha)
4-6 leaf	Branching	Flowering	Capsule formulation		
-	-	-	-	0	2.75
-	X	-	-	1	3.22
X	-	X	-	2	4.14
X	X	-	X	3	4.14
X	X	X	X	4	4.81
CD (P=0.05)					

X = Irrigation applied, - = Irrigation not applied

Table IX-19. All India Index Number of Area Production and Yield, 1959-60 to 1980-81
(Base Year: Trinnium ending 1969-70 = 100)

	1959-60	1962-63	1964-65	1967-68	1970-71	1973-74	1976-77	1979-80	1980-81
Area	87.2	87.2	87.2	92.1	105.6	110.2	121.8	130.8	129.5
Production	71.0	71.0	71.0	74.3	147.1	182.6	208.2	265.0	322.5
Yield	82.1	82.1	82.1	82.3	140.4	167.0	170.9	202.6	249.0

Table IX-20. Average Yields of Safflower, Linseed and Rapeseed-Mustard in the Varietal Evaluation Trials at Ranchi

Crop/Varieties	Average Yield (q/ha)	Range of Yield (q/ha)
1. Safflower		
Annigeri-1	9.65	6.75 to 12.22
APRH -1	8.85	6.01 to 12.68
A. 300	8.77	6.58 to 12.70
2. Linseed		
T. 397	6.04	4.17 to 8.15
S.S. 2	6.02	3.78 to 9.08
3. Rai		
Varuna	2.62	1.67 to 3.05
4. Torai		
BR 23	2.10	0.78 to 4.04

of the land area of Bihar State. It is characterised by undulating topography and non-flow-perennial river systems. Although the mean annual rainfall is high (1,210-1,480 mm in different districts), the distribution is highly lopsided. About 82 per cent of the rainfall is received between the months of June and October. Year to year variation is also high and there are long and short gaps during the monsoon months making the crop vulnerable even during the Kharif season. Assured irrigational facilities are available to less than 5 per cent of the cultivated area. All these factors lead to a low cropping intensity.

The undulating topography results in definite toposequences with hills and hillocks at the top, gravelly, skeletal, light textured soils at the higher levels of topography (upland), followed by loamy sands to sandy loams at intermediate level (medium land) and sandy clays as the lowest element (lowland). Out of approximately 3 m ha under cultivation, uplands and medium lands account for nearly 60 per cent of the area. These are the land situations which are suitable for cultivation of oilseeds in general.

Life behalf in West Bengal Safflower per cultivation may be introduced in the State. As this crop is suitable in any type of soil.

As the horizontal extention is limited in the State due to the lack of agricultural line Safflower may be introduced in the saline shown of Sundarban or in the red latrite or in the gravelly soils of Purulia and Bankura. But though it has draught resistance capability still it is a neglected crop in the state.

The uplands soils are light textured, highly permeable, acidic, low in nitrogen and available phosphate and have low moisture holding capacity. In absence of irrigation, only Kharif crop is grown. Apart from a number of cereals and pulse crops, Kharif oilseeds like groundnut, sesame and niger (late Kharif) are currently being grown; these soils are also eminently suitable for soybean.

The medium lands are relatively heavier in texture, slightly acidic to neutral in reaction, and have better moisture holding capacity. These lands are mostly sown with rice in the Kharif season. The medium lands though able to support a good Rabi crop are mostly kept fallow, except for some portions of the medium upland which came under rapeseed-mustard, linseed, barley and bengalgram. These crops together cover hardly 30 per cent of the medium lands which have distinct potential for swquence cropping with suitable crop and varietal adjustment during the preceeding Kharif season. Sunder such a land situation, safflower is a potential crop.

Despite a pronounced drought resistance capability safflower has been a neglected crop until recently. As evident from All India Index Number for crops, it is only in the seventies that this crop started showing a rising tendency in area, production as well as productivity (Table 9.19), and by 1980-81 this rise in area was matched only by rapeseed-mustard, while in production and in yield the magnitude was unmatched by any other oilseed crop.

a) <u>Prospects of safflower in the plateau region</u>

Safflower is not a traditional crop of this region. With the inception of AICRP for dryland agriculture, work was started on this crop in 1971-72. Regular varietal varietal evaluation work commenced from 1972-73 and studies on its agronomic requirements were initiated in 1974-75.

Safflower was found eminently suitable for the plateau region. It is evident from the average yield over five years give in Table 9.20 along with those of linseed, toria and rai (B. juncea) grown under similar experimental conditions. Safflower varieties gave average yields of 8.77 q/ha (A-300) to 9.65 a/ha (Annigeri-1), linseed varieties gave an average of 6.04 q/ha (T.397) and 6.02 q/ha (L.S.2) while toria (BR 23) and B. juncea (Varuna) averaged 2.1 q/ha and 2.62 q/ha, respectively. On an average safflower varieties gave more yield by 151 per cent over linseed, 347 per cent over rai (B. Juncea) and 433 per cent over toria. This clearly establishes the suitability of safflower for the plateau region.

The markedly superior performance of safflower as compared to other Rabi oilseeds crops in this region is because of the fact that the safflower is in complete consonance with the climatic rhythm of the area. The Rabi seeding starts just after the cessation of monsoon rains around 10th of October, with usually a full moisture profile unless there is a failure of late monsoon rains. There are some rains in November too, while in December it is less than 5 mm. The rainfall again picks up around middle of January, February receives the highest amount of Rabi rainfall which continues in March as well. An early maturing crop like toria is not able to take any advantage at all of winter rains, mustard and linseed are able to take partial advantage, while safflower capitalises fully. Unlike other crops, safflower passes the major part of the period in the rosette stage when the crop has to depend on stored soil moisture and grows under an under a receding soil moisture regime. However, during this period it develops a rood system which is able to tap moisture from the deeper layers wee it is not deficient. Soon after its entry in the elongation phase, the regular winter rains arrive and are available in small quantities until the maturity of the cro. Its long duration of 160-170 days is thus turned to distinct advantage.

The diseases and pests are also not much of a problem in this region. Alternaria leaf spots mostly occur in very low intensity to cause any serious damage, rusts count be a problem in some of the years, but them resistant varieties like APRR-1 and APRR-2 are available. Black aphids do infest the crop, the hardly cause any palpable damage.

The comparison made here between the safflower and other Rabi oil-seed is only meant to establish the credentials of this crop, for there is enough land available not only for oilseeds, but for other Rabi crops as well. Out of a total of around 0.8 m ha of medium land, less than 20 per cent is being cropped at the moment. There is enough land to go round.

9.4.iii. Constraints/problems

a) Lack of systems approach in corp planning

The medium land is predominantly cropped with either direct seeded or transplanted rice. Most of the rice varieties under cultivation are of comparatively longer duration and consequently land does not become available in the early part of October. Hence planning for a Rabi crop in the medium land has to start in Kharif itself with sowing/ transplanting of rice varieties maturing in 110 to 120 days. A good number if such rice varieties are available. Lands which become available towards the end of September can go to rapeseed-mustard, those becoming available in October to safflower, linseed bengalgram and lentil and those available in early part of November can becropped with linsed, bengalgram, lentil and barley.

Since the crop has to grow on a receding soil moisture regime supplemented with meagre later October and November rains it has to be sown within four to five days of the harvest of the Kharif crop to enable it to make full use of available moisture. This is usually not followed and moisture depletion from top layer makes the germination of Rabi crop patchy.

b) <u>Lack of technical know-how among the farmers</u>

Since safflower is a now crop for the region, not only the farmers, but many of the extension functionaries particularly at the lower level, are not aware of the proper technology for raining the crop. An intensive training programme for the various levels of extension functionaries and farmers, coupled with an extensive programme of demonstrations is required for introducing the crop in a big way.

As a corollary, it follows that this programme must be back up with adequate arrangements for supplying seeds of proper varieties (A. 300, Annigen-1, APRR-1).

c) <u>Lack of adoption of proper seeding methods/devices</u>

Proper stand establishment of Rabi crops is a general problem in this area, but it is much more so incase of safflower which has a hard and thick seed coat. It takes seven to ten days for emergence. Hence the seed bed is required to maintain adequate moisture level during this period. If the sowing is shallow, the depletion of moisture from the seed zone levels the seed high and dry. This problem is accentuated, if proper precautions for moisture conservation are not taken after the harvest of the Kharif crop and during land preparation. If the sowing is done too deep, the soil overburden impedes germination. Hence the sowing needs to be done deep (8-10 cm) with less of soil overburden (4-5 cm). This can be achieved with indigenous seed tubes (Pora or Chonga) or seed drills developed at Birsa Agricultural University to suit the low draught power of the local bullocks. By the large, even the use of indigenous seed tubes is limited to only a part of Palamau district, the seed drills are yet to reach the general farmers.

d) Problem of stray cattle grazing

Since practically very little crop is grown during the Rabi season in this region, the cattle are let loose for free grazing after the harvest of the Kharif crop. Even the spiny varieties of safflower are valnerable to cattle grazing during this period since they do not develop spines for about two months. During the prolonged rosette stage, the field does not give a "cropped look" to the farmers who are not used to safflower and leads to a sort of psychological apathy which does not induce them to make extra efforts for warding off the stary cattle. Thus the social problem of stray cattle grazing gets compounded with a psychological attitude of apathy. Once the spines develop, it is largely left alone by the cattle but not by the goats.

e) Difficulties imposed by spiny leaves

While the spines, once they develop, act as a deterrent to cattle grazing they make inter-culturing, harvesting and threshing operations bothersome. But this is largely a problem of adaptation.

f) Problem of oil extraction

Inefficient oil extraction by village "ghanis" (expellers) because of hard seed coat makes the crop less attractive. Power expellers are generally not available in the interiors. Thn hulled varieties with higher oil content would be preferred in this context. Efforts need to be intensified in this direction.

g) Lack of marketing facilities and remunerative prices

Since efficient expellers are not available in the villages and also since safflower oil is not preferred largely due to unfamiliarity, marketing facilities assume an added importance. Proper marketing facilities should go a long way towards popularising the crop and exploitation of the vast potential both in terms of area and yield/unit areas.

Practically most of the common type of soil arrives as classified in soil chapter are suitable for safflower cultivation. From the plotau resions of West Bengal to the full fill of Himalaya and in the postal salayin soil of the state. In any aggroclimatic condition safflower may be cultivation with a best afficient approach. So far experiment done on seed varities C.T.S. 7803, N62-8, A-1 and A.P.R.R-1 are the most suitable seeds in the state yielding variety.

As the horizontal areas in the gangetive alluviun of the state are mainly covered by paddy pulses and other crops it is difficult to convince the farmers introduce safflower. As due to the lack of market and scarcity of Ghanies and other source of extracting oils from the safflower seeds turned the situation difficult. Other chemical technology for processing the same oil is not very much popular even among the industrials who are involve in the same field. As mustard oil is the most common and popular cooking midium in the state. It is very difficult the introduce safflower oil in the state of West Bengal. For the above reason with vast opportunity of producing safflower in the state it become difficult for the specilist in this field to make the farmers aware are necessary were market thus not prevail. Thus we loose a great protentiality for producing safflower in the state of West Bengal.

Cyanogen compounds, Bitter and cathartic factors are the main toxic constituents in safflower oilseeds though there is the present of amono acid content are not negligible but the chemical processing methr-

9.5. Soybeans

The soybean area in the world rapidly increased to 49 m.ha. in 1983, of which 21% was in Asia contributing about 16% of the world's total soybean production of nearly 78 m tonnes. This amounts to a conspicus increase by 11.3 m ha and 20 m tonnes of world areas and production of soybean, in less than a decade (1974-76 to 1983). Approximately 14 and 15% of increased production and area respectively, was in Asia. From the view point of global oil production, soybean ranked at the top, both in area and edible oil production in the world.

9.5.1. Soybean in India

Although soybean is not new to India, commercial cultivation of yellow seeded soybean is comparatively recent origin. Earlier, low yielding black seeded shattering type of soybean were conventionally grown under different names in hills and scattered pockets in plains. Initiation of efforts to popularies yellow soybean in early sixties faced considerable controversies about its usefulness in India which undoubtedly retarded the progress of commercial exploitation of this maracle gift of nature. While usefulness of soybean to mankind was recognised and its commercial exploitation in developed world resulted a record increase in the area to 43.39 m ha in 1977 to 78; at the same time the apathy and detraction in yester-years for utilisation of soybean in India was ironical particularly when the country was faced with acute shortage of edible oil, high protein food and feed. However, with time various apprehensions against the crop have been proved to be unfounded and soybean cultivation has taken a modest start in the country.

The area under soybean in India rose from 0.0003 mha in 1968 to 1 m ha in 1983. This feat had been possible due to ingenuity of Indian farmer and outcome of soybean research and development efforts in the country. Although, presently Madhya Pradesh and Uttar Pradesh with about 0.8 and 0.1 m ha, respectively, are the major soybean producers in the country, other States like Rajasthan, Himachal Pradesh, Bihar, Maharashtra and Karnataka also provide bright prospects for soybean production Table 9.21. The targets of 1.8 m ha are aimed for 1984-85.

Table IX-21. Identified/released varieties of soybean for different agro-climate zones

Agro-climatic zone	Variety	Day to maturity	Yield q/ha
Northern Hill Zone	Bragg	120	20-25
	Punjab-1	110	20-25
	Shilajeet	105	20-25
	DS-74-20-2	110	25-30
Northern Plain Zone	Bragg	120	20-25
	Ankur	130	25-30
	Alankar	120	25-30
	Shilajeet	105	20-25
	PK-327	110	25-30
	PK-262	125	30-35
	PK-308	115	25-30
	DS-73-16	120	30-35
	DS-75-22-4	120	30-35
Central Zone	Bragg	115	20-25
	Ankur	120	25-30
	JS-2	105	20-25
	Gaurav	110	25-30
	MACS-13	110	25-30
	Durga	110	25-30
Southern Zone	Hardee	110	15-20
	KHSb-2	115	20-25
	DS-74-40	110	20-25
	Improved Pelicon	110	15-20
Davis	Davis	110	15-20
	PK-74-292	110	20-25
	CO-1	115	20-25

9.5.ii. Possibilities of Soyabean Cultivation

The prospect of soyabean cultivation in West Bengal is indeed very great. Soyabean is essentially a Kharif crop maturing within 90 to 105 days. It is, however, distressing that the vultivation of soyabean in West Bengal has not received adequate attention it deserves. Presently, the cropped area of soyabean is only 300 hectares, producing about 200 tonnes of soyabean. The yield per hectare is around 670 kgs. It is stated that a farmer can make a net profit of Rs.3000 to Rs.4000 per acre of soyabean cultivation. There are quite a number of solvent extraction units in and around. Burdwan where soyabean can be cultivated by the farmers profitably. This year the association has taken a programme to grow soyabean in a small plot of land on an experimental basis in the district of Burdwan for which necessary foundation seed has already been procured. The cultivation of soyabean in the districts of Burdwan, Murshidabad, Midnapore and Purulia deserves special attention of the Department of Agriculture, West Bengal.

Although soyabean contains 18 to 22% oil and 38 to 42% protein, its importance could be realised more during the World War-II as a source of edible oil and also as a compact form of nutritious food for armed forces. Since then, area has grown over ten times and now soybean stands first in the world in contribution of edible oils. According to FAO estimate for 1986-87, 198 million tonnes of oilseeds including cotton seed was produced in the world. Of this, crop-wise production (million tonnes in parenthesis) of major oilseeds were: soyabean (98), cotton seed (29), groundnut (22), rapeseed and mustard (20) and sunflower (19) etc.

Therefore, analyses certain constraints, which need to be overcome in order to boost soybean production. Before this, a brief highlight on the prospect of area expansion in coming years under soybean have been discussed.

9.5.iii. Prospects of Area Expansion

Soyabean has shown tremendous growth during the last fifteen years particularly in the black-soils of the central India. Besides, area is also increasing in the eastern region of the country. Also, soybean researchers have shown the possiblities of soybean cultivation during rabi and summer seasons particularly in the southern India. It is, therefore, important to figure out, atleast roughtly, the area that might come under soyabean in the coming years. The potential area for soyabean in various part of country has been given briefly below:

a) <u>Use of fallow-lands</u>

The experience of area expansion in the black-soils in Madhya Pradesh, which earlier remained fallow, indicated that success story of Madhya Pradesh can be reported in the black-soils of other states as well which mostly remains fallow in kharif season. There are no data available as to how much kharif fallow-land is available in the black--soils. The senior author made some approximation for the year 1983-84 (a very good rainfall years) of the suitable soybean districts having black-soils. He estimated that about 7.11 million hectare of kharif fallow-land in the various states (fallow area in lakh ha in parenthesis) are; Andhra Pradesh (8), Gujarat (3), Karnataka (16), Madhya Pradesh (34), Maharashtra (29), Rajasthan (3), Tamil Nadu (5), Uttar Pradesh (10), etc. Besides, approximately 8-12 lakh ha of up-land kharif-fallow suitable for soybean are available in Bihar and north-eastern states.

The major soybean producing countries in the world in 1985-86 (with their percentage share of world production) were: USA (58), Brazil (18.3), China (9.2), Argentina (6.5), India (0.9) and rest (7). According to an ad-hoc estimation in 1958, about 17,200 ha was under soybean in India which produced about 6000 tonnes of soybean. The area under soybean started moving up after the introduction of yellow-seeded varieties from USA, establishment of All-India Co-ordinated Research Project (AICRP) on Soybean and Intensive Soybean Development Programme during seventies. The area which was about 32.3 thousand hectares in 1970-71 rose to 1392 thousand hectares in 1986-87. The corresponding production values were 13.1 and 835.3 thousand tonnes, respectively with the maximum production of 1024 thousand tonnes in 1985-86. Though, it is grown in many states of the country, Madhya Pradesh alone is producting amount 80% of total production of the country, which is followed by Uttar Pradesh (about 15%), Rajasthan (about 2.5%) and remaining 2.5% of production is made by other states.

Although, it showed tremendous expansion in area, the yield level is still very low in India as compared to many other countries of the world. The average yield (Q/ha) in 1985-86 was 23 for USA, 181 for Brazil, 7.6 for India, 12.7 for Asia and 19 for world. The policies have to be changed and constraints removed so that yield level is increased as this crop has great potential in India. It is because that this crop known as "gold of the soil" has many advantages such as easy cultivation, higher cost-benefit ratio, less requirement of nitrogenous fertilisers and labour, beneficial effect on following crop, soil conservation, relatively better suitability for black-soils etc.

Since the black-soils are suitable for soybean, much of fallow lands in this category can be deviated to to soybean. In the high rainfall areas of eastern regions, soyabean in upland fallow is among the crop giving profitable return, where as upland-paddy gives very poor yield. With allocation of 30% of such fallow land for soybean, an additional 30 lakha area can be added to the present area under soyabean.

The soyabean can also be grown in rabi/summer seasons. Some data indicate that it can be grown in rabi/summer in the southern India, eastern parts of India and even during spring in north India. The cultivation in rabi/summer, however, depends on the availability of water for irrigation. The vast fallow-lands after the harvest of kharif paddy are available in southern and eastern parts of country. The area that could be diverted to soybean is difficult to assess at this stage, when cultivation of soybean during rabi/summer is at the initial stage and, perhaps, it may not exceed 10 lakh ha. This also includes area in north India, where soybean, groundnut and sunflower can be grown in spring season in the land vacated by toria, potato, sugarcane etc.

b) Replacement of low-yield/remunarative crops

Various crops in rainfed as well as inadequately irrigated areas show poor yield or are less profitable. Soyabean, as compared to some crops in one or another zone appears to be promissing under above suitations. In the low-to-medium rainfall regions the rainfed crops such as paddy in Madhya Pradesh, Gujarat, Uttpar Pradesh, Maharashtra and Rajasthan: cotton in Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu and Gujarat and some pulses in Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh and Rajasthan can be replaced by soybean as it is applicable to in West Bengal.

In the high rainfall zones, the low-yielding rainfed crops such as paddy, small millets, pluses etc. in the parts of Orissa, West Bengal, Bihar, north-eastern states can be replaced by Soybean. Areas with water stagnation for some days, where Soybean has relatively more tolerance than maize, sorghum etc. or areas with inadequate water supply for water-intensive crops like paddy, sugarcane etc. can be switched over to soybean.

c) Area expansion through inter-cropping

Intercropping, in general, has been proved more beneficial than raising pure crop against erratic rainfall conditions. According to the reports of AICRP on Soybean, it can be inter-cropped with many crops with a increased return.

9.5.iv. Constraints

The productivity of soybean in India is very low, which could be due to various reasons including poor plantstand, low input application to erratic rainfall. The failure to expend the area under soybean in some regions of the country could be mainly due to lack of marketing facilities. Such constraints are required to be analysed and removed through research and developmental efforts so that not only area under soybean can be enhanced rapidly, but also to generate good income to the growers through increased productivity. Some of the constraints faced presently area presented below :

1. High seed cost

Unlike other oilseed except groundnut, seed-rate in soybean is high due to large seed size, low vability etc. The seed rate of 75 to 100 kg per hectare is a heavy initial input for the farmers particularly when yield per hectare is low. Consequently farmers are either using low seed-rate or are reluctant to buy expensive quality seeds. This is one of the important factors for poor plant stand in the field which leads to low yield.

The following lines of work may be useful in this regard :

a) Reducing seed-size.
b) Increasing seed-viability.
c) Changing the plant-type in order to increase spacing.
d) Developing storage techniques and facilities so that viability can be maintained during storage.
e) Multiplying soybean for seed purpose during rabi season in Southern India and during kharif in the hills of Northern India.

2. Varieties

a) Number of varieties

About 23 varieties have been released during the last two decades i.e. on an average one variety has been released every year. Many are old, absolute and have become susceptible to diseases. Thus, there are very few good varieties available for varying climatic regions of India. Though, there is always need of high-yielding varieties with resistance to diseases drought etc. the state Governments have great responsibilities for the popularisation and adequate supply of seeds of improved varities.

It has been noticed that some states are given indent for breeder seeds of varieties which are either low yielders of have become highly susceptible to one or another pathogen. In this context, it is important that information on diseases and pests, pre-planned seed production programme of improved varieties in right quantities, use of specific variety in the specific climate must be followed scrupulously in order to increase yield, reduced cost on disease/pest control, slow-down the spread of disease/pests etc.

b) Disease and pests

There is considerable damage in some years or zones by diseases, mainly mosaic, leaf blights, bacterial pustule, etc. and pests like girdle beetle, stem fly, Bihar-hairy catter-pillar, leaf miner etc. For many diseases, seeds are carrier, which cause seedling mortality. It has been observed that mostly farmers do not control disease and pests and seldom practice seed treatment. There reasons could be many including lack of purchasing power of farmers to buy pesticides. In the long-term basis, the breeding of varieties resistant to diseases and pests appears to be the best choice. The present day varieties are often susceptible to one or other disease. Gram-plasm collection, careful use of diverse and many genes for resistance, proper deployment of genes or their combination in different regions etc. are needed in order to slow-down disease development and its spread.

The losses by disease and pests can be reduced by concerted efforts under developmental programmes through increased awareness for seed treatment, quick diagnosis of diseases/pests and their control at the very begining, timely and adequate supply of quality chemicals etc.

(c) Germination and plant stand

Soybean is mostly grown under rainfed conditions in the uncertain rainfall areas of the country. The fluctuation in yield level over years and wide gap between yields under rainfed and irrigated conditions may indicate that the level of drought resistance is low in the present varieties and needs to be incorporated. Soybean shows poor emergence wherever there is heavy rainfall immediately after sowing particularly in black soils. Also under such soils, it is difficult to sow following heavy rainfall. The requirement that seeds should be 3-5 cm deep in the soil, poses a problem i.e., sowing after light rain is again risky as the soil moisture during hot days of June/July at upper 3-5 cm may dry up before seed germinates and result in poor plant stand.

d) Early maturity

Many of the present-day varities mature between 100-130 days. In major soybean growing areas of the country. 80-90% of annual rainfall occurs before the end of August and the long duration varieties usually face moisture-stress during the seed-filling stage (very sensitive stage to moisture-stress). Though, few early maturing varieties are available for some zones, more concerted efforts are needed for the breeding of early maturing but high yielding varieties to fit in as a pure crop, inter-crop and sequence crop.

Such varieties are also required in the farming situation where after taking soybean, farmers would like to conserve residual moisture for the sowing of rabi crop. Thus, the development of varieties with the maturity of 80-90 days will accelerate the area expansion.

3. Inter-cropping

Soybean has been advocated for intercropping with other crops particularly in low-to-medium rainfall areas. Besides additional returns, soybean adds nitrogen to soil (i.e., to companion and following crops), checks soils crosions supresses weed growth etc. Inspite of various advantages, inter-cropping is not popular and reasons for its slow or negligible adoption needs to be studied and analysed.

4. Date of sowing

Generally soybean is sown between 15th June to 15th July. In the West Bengal there is heavy rain in July and the farmer may like to sow in June or towards end of May. Also, the onset of monsoon in some regions or years may not be in time, as happened during the last three years in one or other part of country. Farmers are not sure as to which variety is recommended for such situations. Thus, it is suggested that besides complete package of practices for the sown conditions for each zone, will be of great help for realising maximum benefit from the varieties.

5. <u>Increase in the number of soybean zones</u>

At present the area under soybean cultivation has been divided into 4 agro-climatic zones viz. Northern Hills, Northern plains, Central and Southern. Looking at varying climatical conditions under which soybean is grown in India, the above four zones may not be sufficient for the realisation of optimum yield. It is known that soybean varieties show high environment - varietal interaction. A review on this aspect is need. A tentative soybean zones could be as below :

a) Northern Hills

The Hills of Himachal Pradesh, Uttar Pradesh and Jammu & Kashmir

b) The North Eastern State

The states of Assam, Sikkim, hills of West Bengal, Meghalaya, Arunachal Pradesh, Manipur, Nagaland, Mizoram and Tripura.

c) Nothern Plains

Pubjab, Haryana, parts of Jammu & Kashmir, Uttar Pradesh (except hills and Bundelkhand area), Northern Rajasthan.

d) Eastern Plains

Bihar, West Bengal (except hills), Orissa, Eastern Madhya Pradesh.

e) Central

Bundelkhand area of Uttar Pradesh, Madhya Pradesh (except Eastern area), Eastern Rajasthan Vidharba, and Marthwada region of Maharashtra.

f) Western

Rajashthan (except northern and eastern area) and Gujarat.

g) Southern

Andhra Pradesh, Karnataka, Tamil Nadu, Kerala, Kolapur region of Maharashtra.

6. Technology for home-utilisation

Though recipies are available for the preparation of multitude of soybean products, the awareness among people about the utility of soybean and the methods for its consumption at home etc. are lacking. Lately, about 5-7 lakh tonnes of soya meal is exported, which though is the highest foreign-exchange earner among oilseed meals, is a big drain of valuable protein. It could have been used for crores of people with mal-nutrition, particularly when prices of pulses are going up. The creation of such indigenous demand of soybean and its products, will accerlerate its development.

7. Technology adoption by the farmers

Some studies in the M.P. (Anonymous, 1987) for example showed that most of the farmers do not control diseases. Very few are applying fertilisers or rhizobium culture and many do not apply the required seed rate. This kind of district of zone-wise studies to know the real problems faced by the farmers in the adoption of new technology are important in order to make suitable strategies for the faster development of soybean in the country.

8. Marketing

Soybean is not consumed locally except by few people in the hills. Thus, most produce has to be marketted. Though, marketing facilities through the establishement of processing plants have been the one among main factors for the development in some states, but the lack of such infrastructure in other potential area have been hinderance for its growth. The processing plants are needed, for instance, in north-eastern, northern Karnataka regions of the country.

9. Extension and input service

Agrigultural extension is an important medium in transfering technology to the farmers. Though it is good in some states, adequate in others while very poor in remaining. This needs strengthening so that maximum yield can be obtained from the crop. Some years or places, production suffers due to inadequate and or poor quality of seed, pesticides, fertilisers, rhizobium etc. The improvement in these services including credit supply will increase area and yield of soybean.

9.5.v. Effect of sowing datas and fertility levels on the grain yield of soybean

Soybean (Glycine max L.) is an important legume crop rich in protein (42%) and oil (22%). Since it is a new introduction, the production technology for optimum yield of soybean under agroclimatic conditions is not perfectly available. Hence, the present investigation was taken upto find out the optimum time of sowing and fertilizer requirement for the newly released soybean varieties.

A field experiment was conducted during kharif seasons of 1983 and 1984 at Jawaharlal Nehru Agricultural University, Campus CSR Project, Indore. The climate of the area is substropical having temperature range 23°C to 41°C in summer and 7°C to 29°C in winter season. The amount of rainfall during the cropping period was 987.51 mm in 1983-84 and 863.24 mm in 1984-85. The soil of the experimental site was medium black cotton soil, having 246.0, 14.0 and 1036 kg/ha of available N, P_2O_5 and K_2O respectively. The experiment was laid out in the split plot design with four replications having sowing dates in main plots, four fertility levels in sub plots whereas varieties were assigned to sub-sub plots. Nitrogen, phosphorus and potas were applied through urea, single superphosphate and muriate of potash respectively. Full dose of N, P_2O_5, and K_2O was applied basally.

The results reveal that sowing of soybean in the first week of July in both the years of experimentation. The yield increase in the first date of sowing of soybean was 37.09% end 128.80% higher than the second data of sowing during both the years.

Application of fertilizers @ 10:20 of $N:P_2O_5:K_2O$ kh/ha has produced significantly higher yield over control in the year 1983-84. However, the optimum dose was found to be 20:40:20 N, P_2O_5 and K_2O kg/ha. Agrawal and Narang (1975) reported that application of 20 kg N

Table IX-22. The Salient Production Technology of Soybean for Different Agro-climatic Zones in India

Iteam	Northern Hill Zone	Northern Plain Zone	Central Zone	Southern Zone
Variety	Bragg, Lee, Shilajeet, Pb-1	Bragg, Ankur, Shilajeet, PK-327 PK-262	Bragg, Ankur, JS-2 Grurav, Durga	Davis, KHSb-2, Haridee, Co-1, Improved, Pelican
Planting time	Beginning of June to middle of July	Last week of June to middle of July	Middle of June to middle of July	Middle of June to middle of July (Kharif crop) 1st week of Oct. to November (Rabi crop)
Planting distance	Row to row 45 cm, seed to seed 5 cm	45-60x5 cm	30-45x cm5	
Depth of seedling	3-5 cm	3-5 cm	3-5 cm	3-5 cm
Fertiliser	20:40:40 NPK + Bacterial culture	20:40:40 NPK	20:40:40 NPK + Bacterial culture	20:40:40 NPK Bacterial culture
Seed rate (kg/ha)	75	75	75	75
Seed treatment and Irrigation	Thiram 3 gm/kg seed during flowering and pod filling stage, if drought			
Plant Protection	2-3 sprays of 0.1% thiodan + 0.1% met asystox if needed			

Table IX-22. (Contd.)

Iteam	Northern Hill Zone	Northern Plain Zone	Central Zone	Southern Zone
Harvesting	When leaves day and fall, approx. 14% moisture			
Threshing	By wheat or any other modified thresher with reduced cylinder speed			
Seed drying and storage	12% moisture, stores in moisture proof bags			
Weedicide	Basalin 2 litre/800 litre water/ha. Pre-sowing incorporation in soil.			
Mixed cropping	Maize	Cotton		

Table IX-23. Performance of some Promising Advanced Breeding Lines as Soybean Developed in India

Breeding line	Pedigree	Developed at	Suitable Zone	Days to maturity	100-seed wt.(g)	Yield potential (q/ha)	Reaction to diseases		
							Yellow mosaic	Bacterial pustules	
PK-374	M-534XPK-71-39	Pantnagar	Hill Zone	120	15.3	25-28	HT	R	MR
Himso-107	Sel. from PK-74-260	Palampur	Hill Zone	125	13.2	28-30	MR	MR	NA
N-23A	-	Ranchi	Northern	121	13.5	20.24	-	T	-
Himso-352	Bienvile	Palampur	Hill Zone	124	15.8	24-29	-	M	-
PK-429	(M-534XS-38) Bragg X Bragg	Pantnagar	Hill Zone	120	12.8	26-30	T	R	MR
PK-416	(M-534XS-38)	Pantnagar	Plain Zone	115	12.5	30-35	R	R	S
PK-486	(GFXBragg)XBragg	Pantnagar	Plain Zone	115	11.2	28-30	R	R	S
DS-76-1-37-1	BraggXJawa-16	Delhi	Plain Zone	120	11.3	28-32	S	R	MR
DS-76-1-29	BraggXJawa-16	Delhi	Plain Zone	116	10.6	21-27	S	S	-
PK-308	T-31XHardee	Pantnagar	Plain Zone	115	12.5	25.28	T	R	MR
JS-76-259	-	Jabalpur	Central Zone	108	14.3	22-28.	-	T	-
PK-472	HardeeXB-1	Pantnagar	Central Zone	105	14.9	25-30	R	R	NA
N-19	-	Ranchi	Central Zone	101	14.1	24-28	-	-	-
DS-74-62	SemmesX8-3	Delhi	South Zone	95	13.6	25-30	MR	R	NA
JS-72-185	-	Jabalpur	Southern Zone	94	14.3	26-33	-	T	-

Table IX-24. Targetted and Actual Cultivation (ha) as well as Production (tonnes) in India under the Centrally Sponsored Scheme for Soybean Development

State	1978-79		1979-80		1980-81		1981-82		1982-83		1983-84	
	Acreage	Production	Acreage	Production	Acreage	Production	Acreage	Production	Acreage	Production	Acreage	Production
Madhya Pradesh	2,32,562	2,32,000	4,14,341	N.R.	4,47,600*	3,50,000	6,47,711	5,00,000	5,84,000	3,58,600	8,09,000	6,00,000
	(2,00,000)	(2,11,400)	(4,00,000)	(51,400)	(4,80,000)	(3,74,000)	(6,00,000)	-	-	-	(11,00,000)	(9,50,000)
Uttar Pradesh	68,689	60,326	75,866	36,121**	1,31,747	84,200	1,41,196	1,00,000	1,57,200	1,17,400	1,02,000	1,05,500
	(1,30,000)	(76,400)	(1,37,000)	(70,400)	(1,75,000)	(1,06,400)	(2,13,000)	-	-	-	(2,75,000)	(1,50,000)
Karnataka	1,181	588	1,296	N.R	-	-	-	-	-	-	-	-
	(3,000)	(2,400)	(3,000)	(2,400)	-	-	-	-	-	-	-	-
Bihar	665	500	N.R.	N.R.	157	77	111	N.R.	-	-	6,000	5,000
	(3,000)	(2,400)	(3,000)	(2,400)	(5,000)	(4,000)	(6,000)	-	-	-	(8,000)	(5,000)
Himachal Pradesh	4,000	N.R.	244	N.R.	4,000	6,000	N.R.	N.R.	400	Neg.	N.R.	5,000
	(3,000)	(2,400)	(3,000)	(2,400)	(6,000)	(4,800)	(8,000)	-	-	-	(12,000)	(5,000)
Rajasthan	-	-	-	-	12,500	6,250	13,000	11,950	9,800	6,500	3,000	10,000
	-	-	-	-	(2,000)	-	(10,000)	-	-	-	(15,000)	(5,000)
Gujarat	-	-	-	-	-	-	-	-	11,000	4,500	N.R.	5,000
	-	-	-	-	-	-	-	-	-	-	(6,000)	(5,000)
Total	3,07,087	2,93,414	4,91,747	36,121	5,96,008	4,46,329	8,02,018	6,11,975	7,67,900	4,90,000	10,00,000	73,00,000
	(3,39,000)	(3,95,000)	(5,56,500)	(1,39,000)	(6,68,000)	(4,90,000)	(8,37,000)	-	-	-	(14,19,000)	(11,20,000)

Figures in parentheses indicate targetted acreage and production

*However, the State has taken up a coverage of 6,000 ha during 1980-81.

**Due to drought the yield and total production have gone donw. The production figures are communicated by the Director of Agriculture and the concerned State.

N.R. - Not received

Source: Directorate of oilseeds Development, Ministry of Agriculture, Govt. of India.

with 80 kg p 205/ha gave maximum average seed yield of soybean. Rehman _et al_. (1978) observed that maximum seed yield of soybean was recorded from N40+P_2O_5 40+K_2O 40 kg/ha. In the year 1983 the varieties JS 72-44 and Punjab-1 were comparable in grain yield, but in 1984 the variety JS 71-05 which was not tested in the previous year gave the highest grain yield of 16.9 q/ha, thus showing its superior performance over the rest.

9.6 COCONUT PLANTATION/COPRA

Coconut ranks first among the perennial oilseeds. Coconut/copra is one of the most important sources of vegetable oils, yielding upto 55% of oil. Coconut is grown widely in the country but the plantation has come to stay in the Coastal areas. The production of coconut, milling copra and coconut oil in the country can be gleaned from the following table (N. 9.25).

Table IX-25. Estimated production of Coconuts, Milling Copra and Coconut Oil

Year	Area under Coconuts in 000 ha.	Production of Coconuts (Million Nuts)	Production of Milling Copra (in lakh tonnes)	Production of Coconut Oil (in lakh tonnes)
1983-84	1,165.6	5,807.9	2.72	1.72
1984-85	1,183.3	6,912.8	3.56	2.24
1985-86	1,225.6	6,770.3	3.48	2.19
1986-87	1,231.2	6,376.8	3.18	2.00
1987-88	1,428.7	7,562.3	3.82	2.41

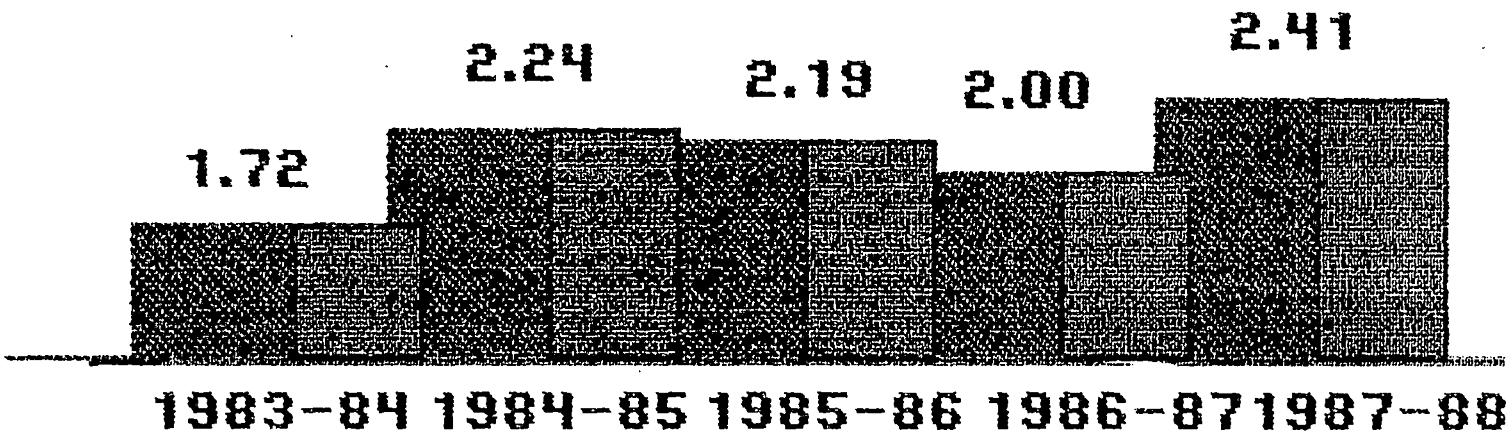
Though India is one of the biggest producers of coconut in the world, the per capita availability of coconut is 11 nuts per annum as against 220 nuts in Philippines and 230 nuts in Sri Lanka. The State wise production of coconut can be gleaned from the following table :

All India final estimate of coconut 1988-89

State/U.T.	Area (thousand hactares) 1987-88 (Revised)	Area (thousand hactares) 1988-89	Production (million nuts) 1987-88 (Revised)	Production (million nuts) 1988-89
Andhra Pradesh	48.8	52.0	480.3	511.2
Assam	9.1	9.3	79.9	65.9
Goa	23.2	23.2	106.9	107.2
Karnataka	213.1	219.5	1,096.5	1,129.4
Kerala	775.4	866.5	3,346.0	8,841.0
Maharashtra	7.8	7.8	88.9	103.0
Orissa	27.1	27.1	113.7	113.7

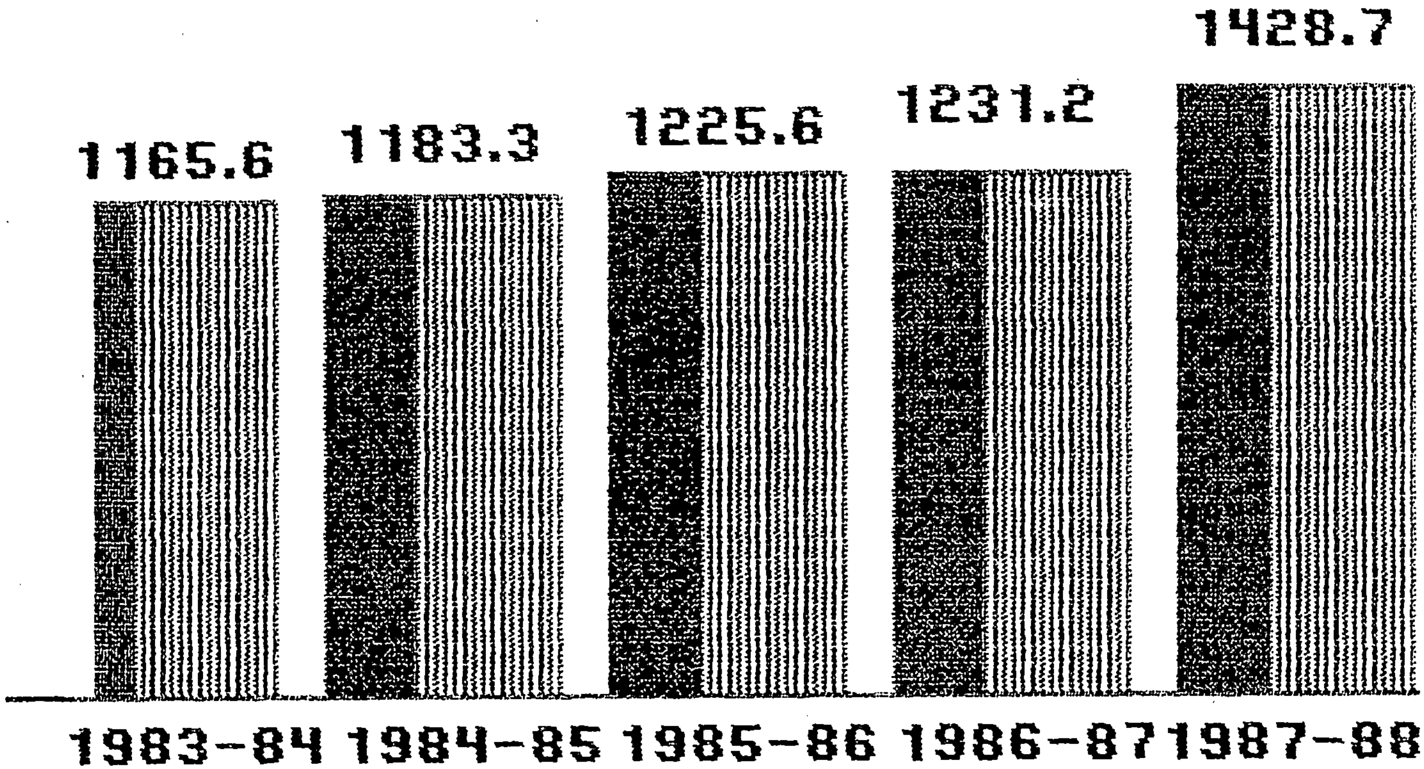
Production of Coconut Oil

(In lakh tonnes)



Estimated production of coconuts milling Copra and Coconut Oil

(Area under Coconuts in 000 Ha)



Estimated production of coconuts
milling Copra and Coconut Oil

State/U.T.	Area (thousand hactares) 1987-88 (Revised)	1988-89	Production (million nuts) 1987-88 (Revised)	1988-89
Tamil Nadu	189.5	214.2	1,578.3	1,917.8
Tripura	5.6	5.6	3.3	3.3
West Bengal	19.1	19.8	248.5	238.5
Andaman & Nicobar Islands	22.8	23.3	80.0	81.4
Lakshadweep	2.8	2.8	24.8	25.2
Pondicherry	1.7	1.7	22.8	23.2
	1,346.0	4,272.8	7,269.9	8,160.8

9.7 L I N S E E D

India, due to reasons of regional preferences and history, grows largest varieties of commercial oilseeds, unlike other countries which produce only few varieties of oils and fats. India enjoys a premier position in the world, being the largest producer of groundnut, rapeseed-mastard and sesame. It is second in respect of castor seed production, third in coconut production, fourth in cotton seed and fifth in linseed. India grows linseed on an area of about 20 lakh ha, which is about 10.8 per cent of the total area under lilseeds, producing around 5 lakh tonnes of seed, contributing about 4.3 per cent of the total oilseed production in the country. Madhya Pradesh, Uttar Pradesh and Maharashtra are the important linseed growing States of India, contributing about 75 per cent of the area and production of linseed seed in the country. Statewise area, production and productivity are presented in Table IX-26.

The most flagrant features of linseed is a high degree of instability in production from year to year as evident from Table IX-26. This is primarily because most of the linseed area is unirrigated. Adding to instability in linseed production is the fact that entire linseed area comprises marginal lands. Main cause for the low productivity of linseed and inadequate growth rates are that linseed, like any other oilseed crop is energy rich crop but it is cultivated under conditions of energy starvation. Hardly any area receives fertiliser. Further, diseases, pests and weeds cause heavy losses both in the early stages of plant growth and also at the stage of maturity.

Linseed is an important oilseed crop of India and has a wide range of uses. The seed has been a supplementary food in the ancient times and is still being so used in certain parts of the country. It yields a valuable drying oil used largely in the manufacture of paints and varnishes, oilcloth, etc. The by-product in the extraction of linseed oil is the linseed meal or cake which is a rich source of protein for cattle feeding.

Table IX-26. State-wise distribution of area, production and average yield per hectare of linseed

State		1976-77	1977-78	1978-79	1979-80	1980-81
Andhra Pradesh	A	6.5	8.9	14.2	12.1	10.9
	P	1.5	1.7	2.5	3.4	2.2
	Y	231	191	176	281	202
Assam	A	4.7	4.5	5.1	5.9	6.1
	P	2.0	1.9	2.2	2.5	2.6
	Y	-	-	-	-	-
Bihar	A	94.3	106.7	99.5	88.3	97.2
	P	39.9	40.1	37.9	37.7	41.0
	Y	423	376	381	427	422
Himachal Pradesh	A	6.3	6.2	5.6	5.8	5.8
	P	0.3	0.3	0.3	2.1	2.1
	Y	-	-	-	-	-
Jammu & Kashmir	A	3.4	3.9	3.1	2.4	2.4
	P	2.7	2.7	1.1	1.4	1.4
	Y	-	-	-	-	-
Karnataka	A	80.4	72.0	73.1	68.3	56.4
	P	17.6	12.5	21.3	15.4	11.0
	Y	218	174	291	225	195
Madhya Pradesh	A	652.5	741.2	770.6	444.0	555.9
	P	102.5	179.4	173.4	49.8	122.3
	Y	157	242	225	112	220
Maharastra	A	269.6	282.9	281.0	261.2	248.5
	P	55.5	67.6	60.2	58.2	52.2
	Y	206	239	214	223	210
Orissa	A	17.7	27.6	32.8	34.4	36.3
	P	16.5	11.3	14.2	13.6	16.0
	Y	367	409	433	395	441
Punjab	A	1.0	1.0	1.9	1.5	1.6
	P	0.5	0.5	1.0	1.0	1.0
	Y	-	-	-	-	-
Rajasthan	A	78.4	86.7	101.2	79.7	42.7
	P	24.6	31.1	38.1	16.7	14.4
	Y	314	359	376	210	337
Uttar Pradesh	A	630.2	607.6	634.6	557.0	578.4
	P	153.2	158.0	164.4	53.5	141.7
	Y	243	260	259	96	245

Table IX-26 (Contd.)

State		1976-77	1977-78	1978-79	1979-80	1980-81
West Bengal	A	43.1	60.2	68.3	52.6	67.8
	P	11.8	19.4	18.3	13.8	19.4
	Y	274	322	268	262	286
All India	A	1,999.4	2,009.9	2,091.5	1,613.6	1,710.4
	P	418.8	526.8	535.1	269.3	427.5
	Y	222	262	256	167	250

A, area in '000 ha; P, production in '000 tonnes and Y, yield in kg/ha.

The stem of flax gives one of the most important textile fibre from which linen is made. Linseed straw, which usually goes waste in this country can also yield fibre of utility and efforts are being made to tuilise the fibre economically for a variety of purposes. Attempts are also being made by Indian Scientists to improve the linseed fibre by hybridising linseed with flax and to evolve dual purpose cultivars.

The available classification of linseed, L usitatissimum (Tammes, 1916; Howard and Khan, 1924; Jeswani, 1953; Jeswani and Guglani, 1963) are based mainly on morphological characters without an indication of the type of their variability. The varied ecological conditions in which the genus Linum is distributed, augmented by human selection for widely different purposes namely, for fibre and oil, appear to have contributed to the enormous divergence between populations. With a view to supplement morphological classification with quantitative assessment of the degree of the diversification between individual populations and groups of populations, Jeswani, Murty and Mehra (1970) implied multivariate analysis to measure divergence between biological populations in a world collection of Linum. Jeswani et al. (1970) reported marked phenotypic diversity in Linum usitatissimum, unlike other crops under cultivation, due to prolonged selection in different directions, namely for fibre and for oil. Although the centre of origin of Linum is considered to be south-west Asia (Vavilov, 1935), its cultivation has extended to diverse agro-ecological conditions, such as tropical and sub-tropical regions of India, Argentina, Afghanistan and Asiatic parts of Russia, where it is grown for oil and temperature regions, including Germany, France, Sweden, Greece, U.S.A., Canada, European region of Soviet Russia and Australia, where it is grown for fibre. Within India itself, two distinct ecological types have been recognised: (1) Small to medium seeded Indi-Gangetic alluvial types with shallow and abundant root system, and (2) the blold seeded, deep-rooted peninsular types. Both these types are apparently the result of adaptation over long periods to the physical environment in the regions of their distribution. Even among the peninsular types, there is substantial diversity for several character. This could be due to wide soil and climatic differences in this region. Thus, the linseed crop in India has been subjected to selection pressures in several directions.

9.8 OIL PALM

Recent experience of imported palm oil has shown that it is readily acceptable in the Indian market. Being a perennial tree crop, oil palm can stabilise the production of oil for serval decades to come.

For the successful cultivation of oil plam the climatic conditions should be favourable for its growth and development. A mean maximum temperature of 28-30°C, mean minimum temperature of 22-24°C, a minimum of five hours sunshine a day and well distributed rainfall of about 2000 mm per annum and the absence of marked dry seasons are essential. It can also withstand higher rainfall as well as three to four months of drought with out drastic reduction in yield. The oil palm has been reported to the growing well up to 900 m, but an altitude below 450 m is considered the best. It can grow on a variety of soils but moist deep loamy soils rich in humus with good water permeability suit the palm best. These conditions are prevalent in Andaman Nicobar Islands and some parts of southern Kerala where the crop is grown as a rainfed crop. In other states like Karnataka, Tamil Nadu, Andhra Pradesh, Goa, Maharashtra, Orissa, West Bengal and Assam this crop can be grown under irrigated conditions since the other climatic conditions except adequate rainfall are available.

At present the only large-scale plantation available is at Anchal (Kerala) managed by Oil Palm India Ltd. planted over an area of 3000 ha. Another 500 ha is in Andamans (Central Forest Dev. Corporation), 20 ha at Palode and 25 ha at Thodupuza (Kerala). Except these there are few palms planted in Orissa, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu.

9.8.i) Technical Knowhow

One of the serious handicaps in successful oilpalm plantation as of now is the lack of reach information under Indian conditions. This has been partially overcome since the ICAR intiated research work on oil palm from 1975. Tenera seed required for commercial planting in this country was being imported till recently. We have now the know-how to produce up to 2 lakhs of seeds per year using indigenous dura and pisifera parents which is sufficient to cover about 1000 ha/year. Trials are underway to maximise the yield potential of the indigenously produced teneras. An oil yield of one tonne per hectare was obtead by the seventh year from tenera hybrids grown under rainfed conditions in Kerala which is expected to increase to two to three tonnes of oil per hectare when the palms stabilise in yield by the twelfth year. Fertiliser recommendations have been made based on nutritional studies made at the CPCRI research centre and it is now known that NPK at 800, 400, 1800 g respectively per palm per year are required for maximum production of fresh fruit banches. There is clear evidence from the few palms grown in a valley at the Palode research centre that an oil yield of five tonnes/ha/year of oil is possible. The favourable location particularly from the point of view of moisture availability appeared to be responsible for this high yield.

9.8.ii) Constraints

There are two oil palm mills now in operation one in Oil Palm India at Bharathipuram and the other in the Department of Agriculture, Kerala at Thodupuzha. A plantation of 200 ha will be required to produce sufficient raw material for these mills.

The main problem in the cultivation and development of oil palm is its requirement of a larger area for an economically viable unit for extracting the oil. Though small-scale extraction units are possible with hand-operated hydraulic press, maximum efficiency is obtained only through mechanically operated mills, for which a steady supply of fresh fruit bunches is to be ensured. The fruits should be processed as soon as they are harvested (preferably within three to four hrs) because of the low keeping quality of the oil palm fruits. Processing involves streilisation, stripping of fruits, fruit digestion, pressing of the pulp and clarification of oil. It therefore appears that developing a small-scale mill for processing requires priority attention as this would enable extension of oil palm cultivation to small holders.

Another alternative is to set up cooperative agencies to collect fresh fruit bunches from small holders and deliver to the nearest factory. Till such time technology for small-scale processing on arrangements for extraction on cooperative basis in large factories are developed, oil palm cultivation has to be restricted to large-scale plantations and to small holders in and around estates with processing facilities.

9.8.iii) Future Research and Development Strategy

Considering the scope of the crop in initiating the vegetable oil deficit, ICAR has given added emphasis in gathering research information which will be essential to maximise its yield and resultant economy.

The first and foremost aspect is the improvement of the tenera hybrids by testing a large number of dura X piscrosses and indentifying the best among them.

Tissue culture techniques are available outside the country for multiplication of high yielding palms. Work in progress at BARC and CPCRI on the vegetative propagation of oil palm through tissue culture technique, has given encouraging results.

Though there are a number of serious pests and diseases affecting the crop elsewhere certain maladies like bunch failure and leaf yellowing are now know to reduce the yield under Indian conditions.

In Malaysia, cultivation of oil palm under irrigation has given a yield of 8.5 tonnes per ha/year. Since the importance of irrigation is recognised, ICAR is planning research work on this aspect in Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu. Oil palm research work is proposed to be intensified under an All India Coordinated Programme of ICAR during the Seventh Plan.

As mentioned earlier, lack of technology for small-scale processing of the oil palm fruits is the main handicap in popularising the crop. Efforts have to be made to devise low cost mini mills. Oil palm is virtually a new crop in India, but if adequate efforts are made in the proper direction, India should be able to produce a large quantity of palm oil in addition to the traditional coconut and other oils. If some area having irrigation facilities in the mainland could be brought under oil palm with good management practices it should be possible to produce 2 lakh tonnes of palm oil annually.

There are only two major avenues for attaining self-sufficiency in oil seeds sector.

(a) Improvement in yield/hectare of present oil bearing crops.

(b) Introduction of new sources of oil bearing crops giving high oil yield per hectare.

The prospects of improving oil yield in the traditional crops are not bright due to the fact that oil seed crops are cultivated under rainfed conditions. Large scale investment and long term planning are required to provide irrigation wherever oil seed crops are cultivation has very high prospects.

Oil palm is the highest oil yielding crop with about 3-6 tonnes of oil per ha per year depending on the climatic and other environmental factors. Other oil seed crops grown in India are annuals except Coconut. In fact, the two perennial oil seed crops cultivated in the tropics are Coconut and Oil Palm. A comparative statement of the yield of oil crops is given below:-

	Average oil yield per ha
1. Oil Palm	3 to 6 M.T.
2. Coconut	1 Tonne
3. Ground-nut	376 kg/ha
4. Rape/Mustard	200 kg/ha
5. Sesame	225 kg/ha
6. Sunflower	208 kg/ha
7. Soyabean	134 kg/ha

The commercial variety of oil palm Elaeis Guineensis Jacq is grown in Africa. Equitorial America, South East Asia and the South Pacific. Though the ancestral home is doubted either as Africa or America, there are sufficient fossil, historical and linguistic evidences that the ancestral home of Oil Palm is West Africa. The American Oil Palm is called Elaeis Oleifera. There are short palms mainly used for breeding purposes at present.

The Oil Palm is a monoecious plant and the female flower gives fruits commonly referred to as fresh fruit bunches (FFB). The trees grow to a height of 15 m. It has an unbranched habit and produces a single trunk which bears a crown of fronds, having 25 to 40 large pinnate fronds. The root system is fibrous. Thousands of primary roots arise from the bole and spread horizontally or descend into the soil. Secondary roots descend or ascend from the primary roots. Tertiary and quaternary roots form a dense mat in the upper 30 cm of soil. The roots spread horizontally upto 19 m. Each tree is capable of bearning about 10 to 12 bunches per year. The number of fruits per bunch varies from 1000-3000 in mature palms and the everage weight of each bunch can vary between 20-30 kg. The economic life of the palm is around 20-30 years. The Oil Palm is quite unique in producing Kernel Oil from the seed and Palm Oil from the mesocarp.

The palm fruit is a drupe and consists of leathery exocarp, fleshy mesocarp from which palm oil is extracted and a stony endocarp (shell) which encloses the kernel. There are three fruit types :

(1) Nigrescens : (Black when unripe-red when ripe with part of the top half black in colour).

(2) Virescene : (Green when unripe, light reddish orange when ripe with a greenish tip).

(3) Albescens : (White when unripe, pale yellow when ripe)
Three fruit forms exist, based on sheel thickness.

(1) Dura - having thick shell, most common in wild groves.

(2) Pisifera - having little or no shell.

(3) Tenera - a hybrid between Dura and Pisifera having a thin shell with a larger fleshy pericarp containing 20% Palm Oil (of FFB). Kernel gives 40% Kernel Oil or 2% Kernel Oil (of FFB). This variety is commercially cultivated the world over.

9.8.iv) How Oil Palms are Raised?

150 seedlings are required for planting a ha. Germinated seeds are raised in poly bags of size 37.5 x 50 cm. and 10-11 months old seedlings are planted in the field in pits of size 80 x 80 x 80 cms. The planting distance is 8.7 m in a trangular pattern. The palms will start bearing 32 months after planting.

9.8.v) Insect Pollination

Assisted Pollination of female flowers is done to ensure fertilization of a majority of flowers. Now-a-days pollination is done by insects called Elaidubious Kamerunicus. Insects ensure 100% pollination which has resulted in a green revolution in Oil Palm production.

Harvesting of fruits is done at intervals of 7 to 10 days. During the 1st 5 years of harvesting, ripe bunches are harvested by means of a wide chisel and as the palms grow taller a sickle attached to a long bamboo or aluminium pole is used.

Oil Palm fruits have to be processed within 24 hours of harvesting failing which the quality of oil will be deteriorated due to increase in free fatty acid content.

9.8.vi) What is Palm Oil/Palmolein?

Palm Oil is a semi-solid edible oil extracted from the pulpy portion (mesocarp) of the fruit wall of the Oil Palm. Palolein is the fractionated liquid portion of Palm Oil after removing the hard fat stearin.

9.8.vii) Where are Oil Palms Grown Successfully?

Oil Palm is now grown in several parts of the tropics, generally within 10° of the Equator. Besides the West African Countries, Oil Palm is grown in Malaysia, Indonesia, Papua New Guinea and other countries in Far East and to a lesser extent in Brazil, Columbia, Ecuador, Panama and Costa Rica. Better yields (5 to 6 Tonnes oil per ha) are obtained in areas of evenly distributed rainfall throughout the year with a mean minimum and maximum temperatures of 22°C-24°C and 29°C-30°C.

If the distribution of rainfall is good throughout the year as in Malaysia and soil conditions are highly favourable, some estates give even upto 5-6 tonnes of oil per ha. But all factors should be favourable to get such a good yield. The soil must be physically fit, chemically balanced and biologically active. Flat or gently undulating land is preferable.

9.8.viii) Rainfall and Yield in Selected Countries

The answer is Yes. Kerala and Andaman Nicobar Islands are having favourable climates. If areas with good soil are selected 3 to 4 Tonnes of oil per ha could easily be achieved. But in Kerala, due to high density of population and intensive cropping the prospects are limited unless the diseased coconut trees are replanted with Oil Palm. In Andaman-Nicobar, though the climate is ideas, the forests cannot be cleared due to fear of enclogical imbalance.

<u>Which are the other areas?</u>

Large tracts of irrigated lands now cultivated with paddy and sugar cane in Karnataka, Andhra Pradesh and Maharashtra might be suitable provided irrigation water is made available for 10-11 months in an year. But in some of these areas day temperatures go upto 41°C and the photosynthetic efficiency will be very much reduced due to closure of stomata in the leaf, limiting production. However, 3 tonnes of oil per hectare are easily achievable. It is estimated that 2.5 to 3 lakh hectares are available for oil palm cultivation in the above States which can produce about 1.2 million tonnes of edible oil.

In Kerala, Oil Palm India Ltd. a Joint Venture Undertaking of kerala Government and Government of India has raised about 3705 ha of oil Palm plantations whereas in Andaman Nicobar Islands, Forest and Plantation Development Corporation has raised 1595 he till now. There are also two Oil Palm Research Stations in Kerala - one at Thodupuzha - a 40 ha station under the control of Department of Agriculture and the other at Palode near Trivandrum under the control of Central Plantation Crops Research Institute. The Research Station at Thodupuzha is a seed producing centre producing 4 lakh Tenera hybrid seeds per year. A few palms were raised in Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu both as ornamental and for experimental purpose in the past. Results are encouraging.

9.8.ix) Constraints and Prospects

The constraints could be summarised as given below :

1. Though not ideal, suitable climatic zones are limited to Kerala and Andaman Nicobar Islands, where availability of suitable land is a constraint for oil palm development.
2. Large tracts of irrigated land are available in karnataka and Andhra Pradesh where either paddy or sugarcane are grown. A change in cropping pattern is required and the farmers are to be convinced of the economic gains.
3. Minimum economic size for setting up of a modern palm oil factory of 100 M.Ts of FFB per day is 2000 ha and minimum size of a planatation for setting up a small scale factory is 200 ha.
4. There is a need for processing the fruits within 24 hours to avoid spoilage of the oil.

5. The forest Conservancy Act of 1980 preventing further release of land for oil palm cultivation is yet another constraint.

Prospects

1. The estimated shortage of edible oil in 2000 A.D. is 2.3 million tonnes. Oil Palm, being the highest oil producer per ha, has a big role to play. It is proposed that oil palm should be grown in 3 to 4 lakh ha in the regions mentioned above which can produce a minimum of 1.2 million tonnes of edible oil. The deficit of 1.1 million tonnes should be made up by improving the productivity per ha of various existing oil seed crops by the improved package of practices.
2. It should be seriously considered to plant 20% of some of the island in Andaman Nicobar islands with Oil Palm which will not have any adverse impact on ecology. Millions of ha of forests are being cleared in Indonesia and Columbia for planting oil palms as a National Policy.
3. Planting Oil Palms in about 2½-3 lakh ha in Andhra Pradesh, Kernataka and wherever irrigation facilities are available, (except of course climatic zones where there is serious temperature variation) should be systematically programmed.
4. Oil Palm should be exampted from land ceiling and should be considered as a Plantation Crop.
5. The rich experience of Oil Palm India Ltd. should be utilized in organising plantations elsewhere in the country.
6. India has professional experties in Oil Palm Plantation Management and Processing Technology. The most modern Palm Oil factory is being established by Oil Palm India Limited.
7. The farmers should be organised on a co-operative system of management and should be given all incentives.

9.8.x) Economics of Oil Palm Cultivation

The economics of oil palm cultivation are indeed very promising for the farmer. If we assume 3 tonnes of oil per ha about Rs.13,000/- per tonne of Crude Oil, the gross income per ha is about Rs.39,000/- per annum. The cost of harvesting, transport and processing will be about Rs.8,000/- per ha. The net income from one ha plantation is thus estimated at Rs.31,000/-. The estimated cost estimates for raising one ha of plantation till maturity (5 years) is approximately Rs.21,628/-. Thereafter the annual maintenance expenditure including cost of weeding, mulching, manuring, harvesting and processing is about Rs.8,000/-.

Under irrigated conditions and proper cultural operations 5 tonnes of oil could be obtained and the revenue per ha will be correspondingly high. In the case of rubber, the net income per ha will be only Rs.10,000/- while net income from coconut cultivation is about Rs.20,000/- Paddy cultivation is much less profitable with about Rs.4,000/- per ha for two crops.

From the above informations, it is clear that Oil Palm cultivation is much more profitable than any other crop in the proposed areas for Oil Palm Cultivation.

Table IX-27. Rainfall and Yield in selected Countries

	Total rainfall mm	Dry Months with less than 100 per month	Yield of oil per ha (tonnes)
AFRICA			
1. Nigeria	2409	4	2.0 - 2.5
2. Ivory Coast	1920	5	1.8 - 2.7
3. Camernoon	2641	3	1.6 - 2.0
4. Sierra Leone	2762	3	2.5
5. India (Kerala)	2178	5	2.5 - 3.0
AMERICA (South and Central)			
6. Columbia	2786	2	3.0
7. Honduras	2860	2	3.0 - 4.4
SOUTH EAST ASIA			
8. Malaysia	2393	0	3.6 - 4.4
9. Indonesia	1939	1	3.4

9.9 RICEBRAN OIL - INCREASING AVAILABILITY AND IMPROVING QUALITY

9.9.i) Introduction

In recent years the shortage of edible oils in our country has reached alarming levels. The expenditure in foreign exchange is estimated to be over Rs.1,000 crores in the current year only on account of imports of edible oil to meet the demand gap. In a span of just two decades our country has turned around from being a net exporter to an importer of oils. The grave situation is being approached on a priority level by the government as well as several research institutions in the country. Due credit must be given to the industrial users of natural oils. The Industrial users have gradually switched over to non-edible oils for applications such as soaps, paints, lubricants, etc. This has resulted in reducing the burden on edible oils to a considerable extent. An all round effect is being concentrated on increasing the productivity and acreage for cultivation of oil seeds and significant results have been obtained through sustained efforts. In this paper the emphasis is given on ricebran oil which is already existing in the country but is not available for use due to the lack of technology and infrastructure.

9.9.ii) Increasing Availability of Ricebran Oil

India produces nearly 800 lakh tonnes of paddy per annum. On an average basis of one per cent oil content, the total potential availability of ricebran oil (RBO) is 80 lakh tonnes. However, production of RBO in the country is only around 1.5 lakh tonnes of which only 10-15 per cent is of edible grade. The main reason for the significantly lower production than the potential is the status of milling operations in the country.

It is estimated that nearly 10-15 per cent paddy produced in the country is processed through hand pounding. Out of the rest, the major protion goes for milling through the huller mills. The relative distribution of the three different kinds of mechanical milling units is shown in Table IX-28. It is observed that the huller mills outnumber the sheller and modern rice mills by nearly an order of magnitude. It is estimated that huller bran containing nearly 4.5 lakh tonnes of oil

Oilseed Production

Table IX-28. Rice Milling Statistics

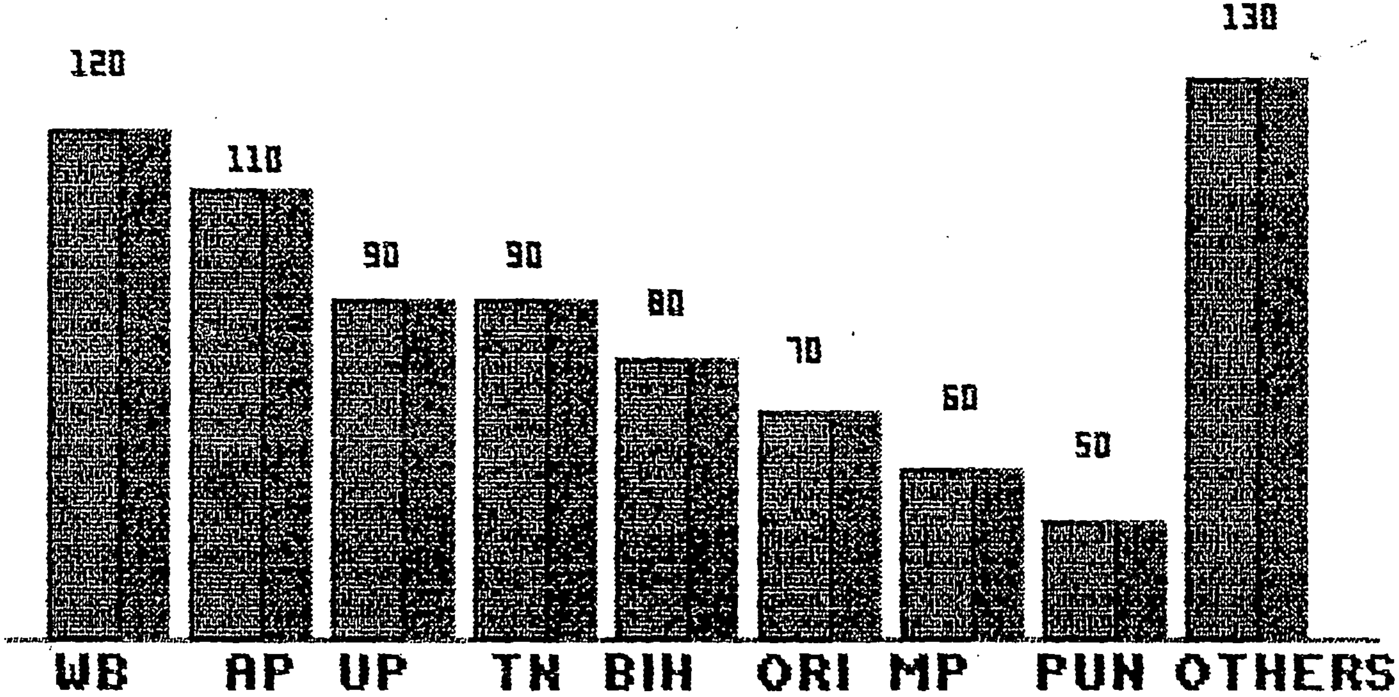
Sl. No.	State	Paddy produced, lakh tonnes	No or rice mills		
			Huller	Sheller	Modern
1.	West Bengal	120	1,200	200	160
2.	Andhra Pradesh	110	6,000	5,300	4,840
3.	Uttar Pradesh	90	5,700	700	1,220
4.	Tamil Nadu	90	5,800	650	1,130
5.	Bihar	80	4,800	100	50
6.	Orissa	70	3,000	250	670
7.	Madhya Pradesh	60	3,100	450	100
8.	Punjab	50	4,400	1,000	170
9.	Others	130	36,000	6,350	4,660
	Total	800	80,000	15,000	13,000

is being produced in the country. Since the bran is of poor quality in terms of oil content, and it is uneconomical to conduct solvent extraction on this bran, currently it is being consumed after incorporation in home made animal feed. In the past, major efforts have been put in to convert the huller mills to sheller mills through Government legislation and through improvements in the existing machines, but the progress has been extremely slow.

In order to expedite the recovery of oil from huller bran, a project has been undertaken at Hindustan Lever Research Centre to ascertain the status and problems of huller mill operators with an objective to develop a simple and practical technology for its ready acceptance.

Paddy production,

Lakh tonnes



9.9.iii) Status and Infrastructure of Huller Mill Operations

The huller mill is an inexpensive unit which costs around Rs.10,000 to Rs.15,000 to install for a capacity of 500-1000 kg/hr. The operations are simple and can be handled by one operator. The huller mill owners belong to the relatively lower income group bracket and operations are usually confined to the backyard of the residential premises. Paddy is passed through the huller mill in two passes two passes and the bran and busk are removed simultaneously. Due to the presence of husk, silica and crude fibre content of the bran are high and the oil content is of the order of 4-5 per cent. The analysis of bran is shown in Table IX-29 as compared to the desired specifications. In comparison, the bran from sheller and modern mills where the husk and bran are removed separately, in different operations, the oil content is around 14-18 per cent with silica and fibre in extracted bran matching the specifications. With the quality of huller bran currently available it is not feasible to extract the oil economically.

Table IX-29. Quality of Ricebran Extractions

	% Silica	% Fibre
<u>ISI Specification</u>		
Grade I	6	14
Grade II	10	16
<u>Exports</u>		
Grade I	8	16
Grade II	9	16
Grade III	8-12	-
Huller bran	15-25	20-35

An estimation of the oil price with respect to the bran cost and extractions price is shown in Table IX-30.

Table IX-30. Cost of Oil on Direct Extraction of Huller Bran

Bran Rs./tonne	Extractions, Rs./tonne					
	200	300	400	500	600	700
200	11,300					
300	13,800	11,450				
400	16,300	13,950	11,600			
500	18,800	16,450	14,000	11,750		
600	21,300	18,950	16,600	14,250	11,900	
700	23,800	21,450	19,100	16,750	14,400	12,050

The conversion of huller machines to sheller or modern mills has been extremely slow, primarily due to two reasons, Firstly, the cost of a sheller mill is nearly ten times as compared to the huller mill of the same capacity. Secondly, the huller mills serve a very important function in the village community. They provide a service to the farm labour and other households in processing small quantity of paddy ranging from 20 to 100 kg. If all the huller mill are converted to sheller operations, these consumers will be forced to move towards hand pounding which will result in total loss of bran. Thus it is imperative that the huller mills will continue to operate in out country for a considerable future. Hence the utmost urgency is to improve the quality of huller bran through modifications which are feasible and acceptable to the operator, at the same time no disturbance should be caused in the existing functionality to the village community.

9.9.iv) Objectives and Targets For Huller Bran Upgrading

The infrastructural constraints were considered while setting objectives for the huller bran improvement programme. The objectives were formulated in order to develop a scheme which could be implemented immediately at village level. The targets set were as below:

(a) The oil content in the huller bran must be increased to a minimum value of 12 per cent and silica and crude fibre content on oil--free basis should limited to less than 8 per cent and 16 per cent respectively. This will result in economical extraction of oil simultaneously producing extracted bran of export quality.

(b) Any modification suggested to the huller mill should involve minimum expenditure to the owner, at the same time avoiding complicated or labour intensive operation.

(c) The huller mill owner must benefit substantially in terms of revenue to compensate adequately for any expenditure and to give him incentive to change over to the new operation method.

(d) The main product for the huller mill operator is rice. The modified operation should at least maintain if not improve the quality and yield of rice.

(e) The modifications in operation must be viable for both parboiled or raw paddy so as not to limit the application area of huller mill.

(f) Since a significant proportion of consumers use the huller bran as an important ingredient in their home-made animal feeds, this availability should not be reduced. Hence a target of achieving 50 per cent oil in bran of upgraded quality was aimed at. The rest of the bran will be available for other applications.

9.9.v) Modification in the Huller Mill Operation

The huller mill consists of a rotating cylinder contained in a casing. The cylinder is grooved and a blade is positioned attached to the casing to provide the attrition power for removing of husk and bran. The power input is nearly 30 k WH/tonne of paddy processed. The processing is carried out in two passes with or without removal of husk from the partially polished rice obtained in the first pass. The bran from both the passes is mixed and sold after sieving through a 10 mesh screen to separate the broken rice and larger husk particles.

As compared to the huller mill power usage, the rubber roll sheller unit which removes the husk only, consumes only 2-3 k WH of power per tonne of paddy processed. Hence in our approach the first step was to reduce power input in the huller mill in the first pass.

This has been achieved simply by withdrawing the blade totally the dehusked paddy produced in this operation contains nearly 10-15 per cent of whole paddy, partially polished rise and broken husk. The bran containing mostly husk and small quantities of bran is removed and stored separately. In the second pass the paddy is fed again after removing the broken husk and blades totally inserted to increase the power input. The product now obtained is polished rice and improved quality bran. This bran is sieved through a 30 mesh screen and the bran obtained passing through the sieve is of desired quality containing greater than 12 per cent oil, less than 8 per cent silica and less than 16 per cent crude fibre on oil free basis. The various steps of the modified operation are shown in Fig. I along with an average material balance.

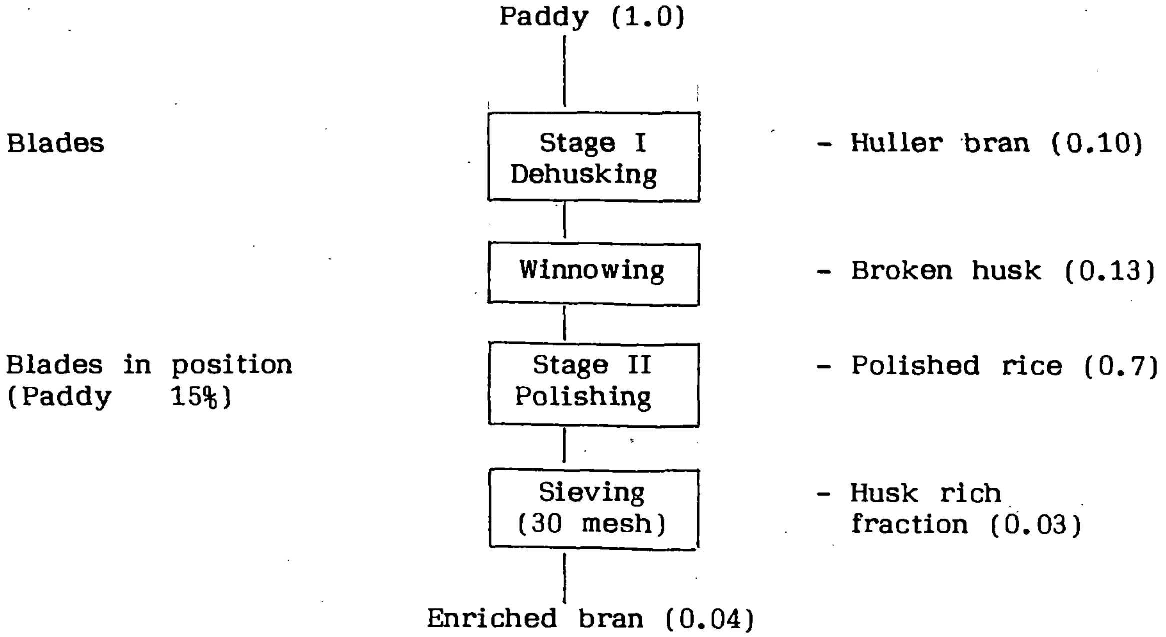


Fig. 1. Steps in modified operation.

The modified operation as described above has been carried out in several huller milling units in the different villages of Tamil Nadu. Nearly 100 tonnes of upgraded bran has been produced and the oil extracted has been found to be of acceptable quality. The analysis of bran obtained in these trials is shown in Table IX-31 which meets the

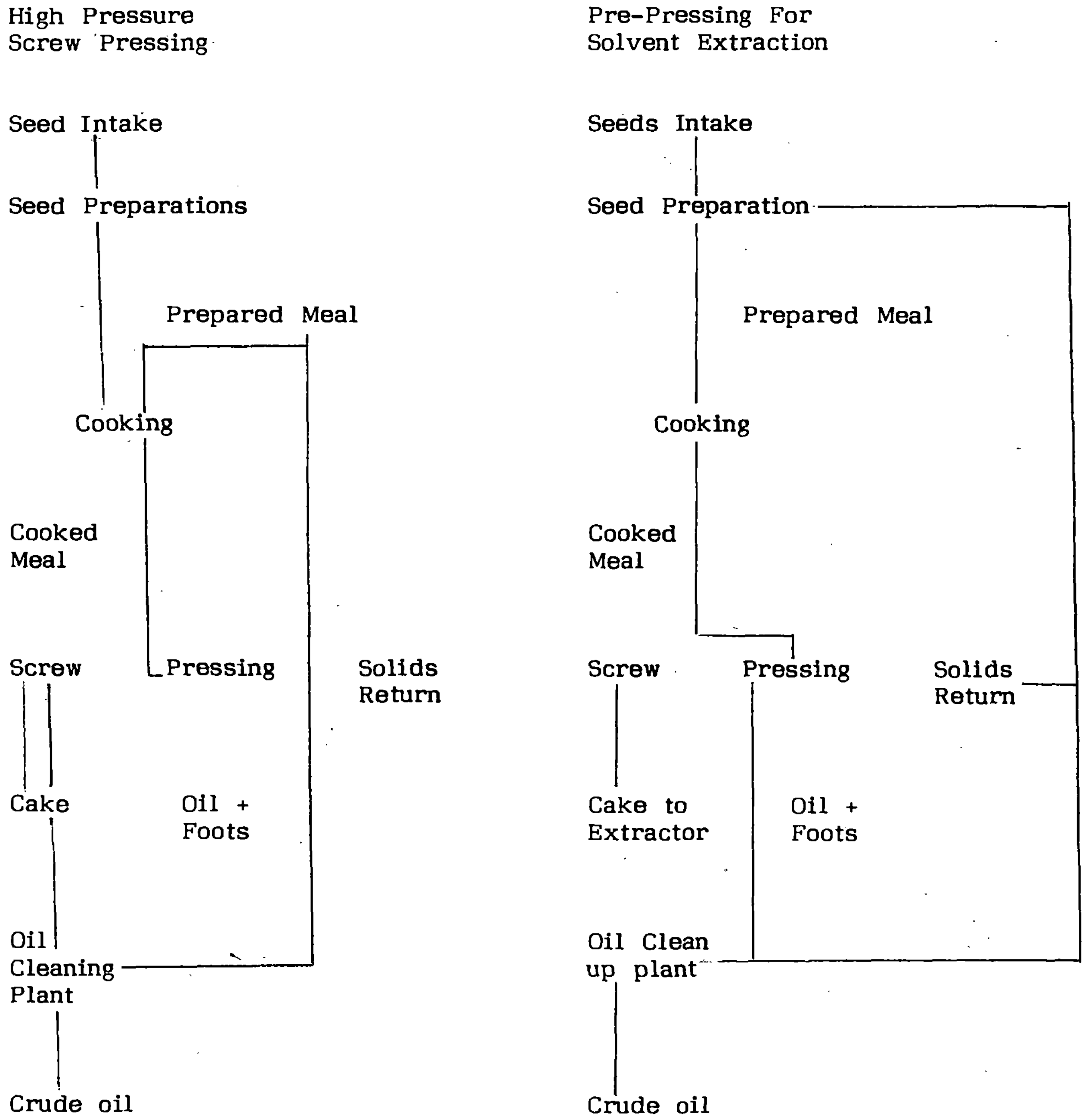

High Pressure
Screw Pressing
Seed Intake
Seed Preparations
Prepared Meal
Cooking
Cooked
Meal
Screw
Pressing
Solids
Return
Cake
Oil +
Foots
Oil
Cleaning
Plant
Crude oil
Pre-Pressing For
Solvent Extraction
Seeds Intake
Seed Preparation
Prepared Meal
Cooking
Cooked
Meal
Screw
Pressing
Solids
Return
Cake to
Extractor
Oil +
Foots
Oil Clean
up plant
Crude oil

Figure - 1

desired specifications. Additional expenditure to the huller mill owner is of the order of Rs.1,000-5,000 depending upon the facilities already existing.

Table IX-31. Quality of bran from modified operation

Paddy	Karinguzhi	Kanchipuram	Arni
	Parboiled	Raw	Parboiled
Oil - %	13.5	15.9	17.7
Fibre - %	10.7	-	10.2
Silica - %	5.5	5.1	4.2

9.9.vi) Economic evaluation of modified operation

The economic advantages of the modified operation to the huller mill owner are shown in Table IX-32. The comparison has been done

Table IX-32. Economics of modified huller mill operation (Basis:1 tone paddy)

	Qty.(tonne)	Price(Rs./tonne)	Revenue(Rs.)
Current Operation Huller bran	0.30	500	150
Modified Operation Upgraded bran	0.04	1,500	60
Huller bran	0.25	500	130
			190

Increase in revenue : Rs.40/tonne.

taking the maximum possible price for the current huller bran. It is clear that at lower bran prices the revenue increase will be even more significant. In the modified operation it has been assumed that nearly 40 per cent of the oil is recovered in the upgraded bran. The upgraded bran produced is nearly 15 per cent of the total, containing around 12 per cent oil content. A higher price for the upgraded bran should be relisable, however, since the bran collecting agents will have to put in extra effort for collection of smaller amounts from distributed locations, a price of Rs.1,500/ tonne has been assumed. The net increase in revenue to the huller mill operator is Rs.40/- tonne of paddy processed. On an average around 5 tonnes of paddy is processed per day by a huller mill, hence the additional income is Rs.200/day which results in a pay-back period of around one month for the additional investment in using the modified operation.

The economics of using the upgraded bran for oil extraction purpose is shown in Table IX-33. The evaluation is done on the basis of extracted meal containing 1 per cent residual oil. Therefore, 9 tonnes of upgraded bran containing 12 per cent oil will need to be processed for producing 1 tonne of the oil. Taking into account the extraction cost of Rs.350/tonne which includes the solvent losses and fixed costs, etc., the cost of oil comes to Rs.9,450/tonne. As compared to the current market price of around Rs.11,000/tonne the upgraded huller bran solvent extraction is fairly competitive.

Table IX-33. Economics of RBO extraction (Basis-oil content 12%)

	Qty.(tonne)	Price(Rs.tonne)	Cost(Rs./tonne) Oil
Bran	9	1,500	13,500
Extraction cost	-	350	3,150
Meal credit	8	900	(7,000)
			9,450

9.9.vii).

The factors presented earlier have considered the total scenario of the huller mill operation in our country and a technically viable modification has been detailed which is advantageous to the huller mill operator, the bran collector and the solvent extraction units. The major advantage, in addition, is the increase in the overall availability of oil in the country. The experience grained by conducting the operation in a few villages of Tamil Nadu has shown that the huller mill operators are interested in following the modified approach since there is a substantial increase in revenue with no adverse effect on the quality of rice produced by them.

In order to extend this operation throughout the country, significant efforts will be required from various agencies to popularise the modifications. It is suggested that local institutions and other agencies are involved in demonstrating the operations to the huller mill operator and explain the national relevance as well as the economic benefits. Our experience has shown that the village level operator graspe the advantages in no time and in certain cases even applied has own initiative in developing an operation method best suited to his machine. Another area where efforts will be required is the organisation of agents for picking up the upgraded material from the individual operators. This organisation is anticipated to be less of a problem, as once the huller mill operators at village level adopt the technology, the collection scheme will develop because of the economic advantages. Initially during the changeover period efforts will be required.

9.9.viii).

Ricebran oil (RBO) has a high content of poly-unsaturated fatty acids making it an excellent quality edible oil. In our country the edible RBO usage is limited mainly because of the high FFA content present in the oil. The high FFA presence is due to the lipase activity in bran which gets activated after separation of bran from rice. Due to our milling infrastructure, explained earlier the bran is stored for several weeks before it is taken for solvent extraction. Considerable emphasis has been put in our country to develop methods for upgradation of RBO and the inherent problems have been identified in individual steps. A review of the different processess available based on commercial viability shows that the double solvent refining route is the most actractive for upgrading of high FFA ricebran oil to edible grade.

Technically the most attractive propostion for upgrading RBO is through the bran stabilisation route. CFTRI has done pioneering work in this area and low cost thermal stabilisers have been designed. The recent developments reported using chemical spray for stabilisation will be of immense potential usage considering the milling operations in our country. However, in the foreseeable future it will be necessary to have technology for upgradation of high FFA ricebran oil. The three methods commonly employed for removal of fatty acids from RBO are: (a) distillative deacidification; (b) fatty acid extraction, and (c) double solvent refining.

In the case of distillative deacidification the operations involved are distillation of fatty acid under high vacuum and post refined for getting edible grade oil. A major problem faced in this approach is the fixation of colours which makes the bleaching of the deacidified oil extremely difficult. Also since high temperatures are involved the oil gets degraded in quality. The second approach on fatty acid extraction involves alcohol water counter current extraction. Since the selectivity is low, a large number of stages are involved which result in very high capital costs.

Considering the various advantages and disadvantages, the double solvent refining route is the most commercially viable operation. The process involves neutralisation of fatty acid in the degummed and dewaxed oil using two immiscible phases namely hexane and aqueous alcohol under mild conditions. The soap stock is extracted into the aqueous phase which is decanted, hydrolysed and distilled to recover the fatty acid. The organic layer containing neutral oil is desolventised and bleached to get the edible grade ricebran oil. In terms of bleaching, a column bleaching technology has been developed by us which can economically bleach the oil to a final colour aceptable for edible grade refined oil. The technology can be applied to produce different grades of oils in terms of colour based on specification for its ultimate usage. An economic evaluation of the variable costs for this process along with the by-product credits has been shown in Table IX-34. It is observed that the costs are firly attractive as compared to the current price of edible oil in India.

Table IX-34. Economics of DSR upgrading (Basis : 30% FFA RBO)

	Qty.(tonne)	Price(Rs.tonne)	Cost(Rs./tonne)
Raw RBO	1.71	10,000	17,100
Processing Cost		1,709	3,067
Credits			
D F A	0.45	14,500	(6,540)
L A O	0.156	10,000	(1,560)
W A X	0.041	10,000	(410)
Sod, sulphate	0.073	3,000	(218)
Post-refining			284
		Variable Cost	11,723

9.9.ix) Conclusion

An all around effort is essential for increasing the availability of natural oils in India. A scheme has been proposed here through a simple technological breakthrough in improving the huller bran quality for economical recovery of ricebran oil through this source. The potential is larg and additional 2-3 lakh tonnes of ricebran oil can be generated by spreading this modified operation throughout the country. It is recommended that various agencies in the country work in unison to popularise the improved operation through demonstration and discussions at the village level operators. The upgrading feasibility of ricebran oil to edible grade has been discussed and it has been shown that producing edible grade oil from RBO with up to 30 per cent FFA is commercially viable.

Rice Bran Oil

The paddy production in Indian is at present of the order of 800 lakh tonnes. On an average of one per cent oil content, the potential availability of rice bran oil (RBO) would be about 80 lakh tonnes. However, the actual availability is 1,50,000 tonnes (Chhatrapati, 1983). Although the total potentials not realisable as about 35 per cent of the paddy is hand pounded, there is still a great gap between the actual availability and realisable potential. Bridging this gap would require decreasing the production of non-economical huller bran with low oil content. This could be achieved by conversion of the huller mills to sheller mills or modern mills or modifying the huller mills to enable production of huller bran with a higher oil content to make the extract economical. Conversion of huller mills to sheller mills or suitable modifications of huller mills to give higher oil bran will almost double availability of oil

Rice Bran Oil

Potential	:	8.0 lakh tonnes
Actual	:	1.5 lakh tonnes

The total production of RBO can be divided into edible grade (26,000 tonnes) industrial grade (1,24,000 tonnes) (Seth, 1983). The primary difference between the two grades is the higher free fatty acid content (25-70%) in the latter. This increase in free fatty acid occurs as a result of the action of the endogenous lipase on oil in the bran during storage. The industrial grade oil is used for soap making. The edible grade oil obtained from fresh rice bran has low free fatty acid (5-6%) and is used for making refined oil or vanaspati

Rice Bran Oil

Total Oil 1,50,000 tonnes	
Edible 26,000 tonnes From better quality bran Usage:Vanaspati, refined oil	Industrial 1,24,000 tonnes From poor quality bran Usage:Soaps

Upgrading the industrial grade oil to edible grade oil will boost the edible oil availability and restrict imports. The first process (A) consists of dewaxing the hexane miscella followed by double solvent

Upgrading Industrial RBO to edible RBO

	FFA	Colour	Odour
Industrial	30-45%	Dark	Brany
Edible RBO	0.25%	Light	Acceptable

Upgrading Technology

A : RBO-Miscella Dewaxing Double Solvent Refining

B : RBO-Miscella Dewaxing Desolventising

Oil : Bleaching Thin Fil Distillation (FFA 2-3%) caustic Neutralisation.

C : RBO-Dewaxing (Lipofrac Process) 90% Ethanol Extraftion Caustic Neutralisation

refining (hexane and isopropanol) containing alkali 1 to 25% excess over theoretical requirementto neu-tralise free fatty acids (Goenka, 1983). The second method (B) involves de-acidification of the dewaxed, bleached oil by distillation of the fatty acids under high vacuum (3.4 mm/hg) and at 250-260 c. The low FFA (2-3%) oil obtained is then caustic refined to get refined grade RBO (Rao, 1983). In the process (C) dewaxing is carried out by the Lipofrac profess using surface active agents to facilitate wetting of the wax crystals which is followed by centrifuging. The dewaxed oil is extracted with 90% ethanol to bring down the FFA so that it could be caustic refined (Bhattacharyya and Bhattacharyya, 1983). Generally for all the above processes, a satisfactory refined RBO could be made, provided the starting oil has reasonable colour and its FFA content is preferably not more than 30%

9.10 RAPESEED-MUSTARD PRODUCTION IN INDIA

Among nine annual oilseed crops grown in the country rapeseed--mustard assumes significance in the national economy by occupying second position in area and production next to groundnut. It is one of the most important edible oilseed crops of the Indo-gangetic Plain. In spite of being an important oilseed crop, not much attention was paid to this crop till late seventies. It was only after the establishment of the All India Co-ordinated Research Project on Oilseeds in 1967 that the research work on rapeseed-mustard got a fillip. Technical problems limiting the productivity were indentified and priorities fixed for their solution at regional/state/national level. The research work carried out at different research centres has brought forth valuable information on various aspects of crop improvement and production technology which are briefly highlighted as under.

1) High Yielding varieties

Development of high yielding varieties of rapeseed-mustard has been one of the major objectives of the project. In this process, a large number of promising varities have been developed. Out of these, more than 50 varieties have been recommended for general release at national, state or zonal level. The diversified breeding methodology employed for increasing the productivity of rapeseed-mustard demonstrates a very high degree of genetic plasticity in the recently developed material (Kumar, 1984). In the last three years, 19 varieties of mustard, two of toria and one of yellow sarson have been recommended at All India level for release/pre-release testing (Table IX-35). A perusal of yield levels indicates that the newly recommended varieties of mustard under irrigated conditions give an increased yield ranging from 9.0 to 32 per cent over the standard varieties. Under rainfed conditions, the increased yield ranges from 8.92 to 20 per cent. In toria and yellow sarson, 9.0 and 31.3 per cent increased ased seed yield have been obtained (Anonymous, 1984). The development of such as high yielding yellow sarson variety, YSP-6 for eastern India particular for rainfed situation is of significance since its oil is very much liked by the people due to its high pungency.

Table IX-35. Recently recommended varieties of rapeseed-mustard for release/pre-release multiplication

Variety	Suitable for rainfed/ irrigated areas	Year of recommendation	Av. yield (kg/ha)	Per cent increase over the standard variety
		All-India Level		
Mustard				
Kranti	Irrigated	1981*	1,478	18.43
RLM-198	Irrigated	1981	1,425	9.00
Krishna	Irrigated	1982	1,372	12.70
RLM-514	Rainfed	1982	931	11.56
Toria				
Pant Toria-30	Irrigated	1982	995	9.82
Pant Toria-303	Irrigated	1982	991	9.32
		North-Western Zone (Jammu & Kashmir, H.P., Punjab, Haryana, Delhi, Rajasthan and Gujarat).		
Mustard				
RH-7859	Irrigated	1984	1,918	22.71
RH-7361	Rainfed	1983	1,576	8.92
RH-30	Rainfed	1984	1,615	16.86
		Central Zone (U.P. and M.P.)		
Mustard				
RLM-185	Irrigated	1983	1,285	11.00
RK-1467	Irrigated	1983	1,327	14.00
KRV-24	Irrigated	1984	1,431	20.66
KRV-47	Irrigated	1984	1,566	32.04
KRV-74	Irrigated	1984	1,402	18.21
RK-1418	Irrigated	1983	1,303	12.00
RK-1418	Rainfed	1984	1,499	20.02
RK-9	Rainfed	1984	1,480	18.57

Table IX-35 (Contd.)

Variety	Suitable for rainfed/ irrigated areas	Year of recommendation	Av. yield (kg/ha)	Per cent increase over the standard variety
	Eastern Zone (Bihar, West Bengal, Orissa and Assam)			
Mustard				
Pusa Bold	Irrigated	1982	1,322	17.00
RW-351	Irrigated	1983	1,401	25.04
RW-85-59	Irrigated	1983	1,449	29.38
RH-30	Irrigated	1983	1,401	25.09
RH-781	Irrigated	1983	1,394	24.46
RH-785	Irrigated	1983	1,238	10.50
Yellow Sarson				
YSP-6	Rainfed	1984	928	31.26

*Recommended by the Central Variety Release Committee in 1983.

2) Production Technology

A) AGRONOMIC STUDIES

The main objective of this study is to find out the maximum potential of recommended varieties. Studies carried out on important agronomic aspects, have generated data which are of immende value in increasing the productivity of rapeseed mustard in the country. For example, planting mustard in narrow-rows (30 cm) has given more yield (2,140 kg/ha) than at 45 cm (1,880 kg/ha). Further, planting of variety Varuna in north-south direction under Kanpur conditions gives 2,100 kg/ha than east-west planting. Studies on response of mustard show that the application of 20 kg sulphur and 1 kg boron per hectare increase the yield of mustard significantly (Anonymous, 1981). Border method of planting, wherein every fourth row is left as such or planted with a very slow growing crop like sugar cane and potato has not only increased the seed yield over the standard practice, but also helped in saving 25 per cent seed and fertiliser. Such a type of planting facilitates plant protection operation.

B) ROLE OF EACH TECHNOLOGICAL PACKAGE ON SEED YIELD

The contribution of each technological package on seed yield has been worked out for important agro-climatic zones. The results of studies on toria crop at Pantnagar and mustard at Hissar demonstrtes 77.2 and 201 per cent increase in productivity when full technological package is adopted (Table IX-36). When the contribution of individual recommended technological package for toria at Pantnagar and mastard at Hissar is considered, the use of standard variety alone is found to give 42.4 and 20.2 per cent increase in yield of toria and mustard, respectively. The application of fertiliser with standard variety has increased the productivity level by 56.5 and 88.6 per cent toris and mustard, respectively. Likewise, the practice of irrigation with standard variety has increased yield of toris and mustard by 34.4 and 36.6 per cent, respectively. The plant protection practice with standard variety, however, does not show any increase in yield of toria (Table IX-37).

Table IX-36. Effect of package of practices on yield of toria and mustard.

Treatment	Toria		Indian Mustard	
	Seed Yield (kg/ha)	Per cent Increase/ decrease over local variety with local practices	Seed Yield (kg/ha)	Per cent Increase/ decrease over local variety with local practices
<u>Local variety with local</u>				
Practices	1,006	-	590	-
<u>Standard variety with local</u>				
Practices	1,435	42.6	709	20.2
Standard variety + fertilisers (F)	1,574	56.5	1,113	88.6
Standard variety + irrigation (I)	1,352	34.4	806	36.6
Standard variety + plant protection (PP)	806	19.9	1,053	78.5
Standard variety + I + F	1,717	70.7	1,177	99.5
Standard variety + I + PP	1,514	50.5	810	37.3
Standard variety + F + PP	1,470	46.1	1,364	131.2
Standard variety + full package and practice	1,783	77.2	1,778	201.3

Table IX-37. Effect of package of practices on yield of toria under rainfed conditions in West Bengal

Treatment	Seed Yield (kg/ha)	% Increase/decrease over local variety with local practices
Local variety	409.98	-
Improved variety	549.98	83.54
Improved variety + Fertiliser	752.47	83.54
Improved variety + Pest control	619.14	51.02
Improved variety + Disease control	543.31	32.52
Improved variety + Pest + Disease Control	631.64	54.07
Local variety + Full package	639.97	56.10
Improved variety + Full package	874.97	113.42

Studies on the contribution of different technological package under rainfed conditions on toria in West Bengal demonstrate 113.42 per cent increase in yield over the local variety when the full technological package is adopted (Table IX-37). Improved variety when fertilised gives 83.54 per cent increased yield. The contribution of improved variety alone was 34.15 per cent.

3) Maximisation Trial on Mustard

Having looked into the performance of high yielding varieties in different agro-climatic zones of the country, maximisation trial with released/improved varieties of mustard was laid in 1983-84 at the experimental area of the co-ordinating Unit at Hissar. It was possible to realise the yield of improved varieties of mustard ranging from 1,852 to 2,815 kg/ha by adopting the full technological package (Table IX-38).

4) On-farm Testing

The newly developed varieties of rapeseed-mustard recommended for pre-release testings, were grown at the farmers fields in 10 States during 1982-83 and 1983-84 crop season. It was observed that the farmers of Uttar Pradesh, Delhi, Bihar and Gujarat were able to realise the seed yield of rapeseed-mustard beyond 2,400 kg/ha by adopting the important technological package (Table IX-39). In fact some of the farmers of Gujarat State harvested the seed yield of mustard to the extent of 3,334 kg/ha by adopting important technological package (Kumar, 1983).

5. Impact of New Technology

The impact of the newly developed technical knowhow coupled with transfer of technology, in recent years, have resulted in overall boosting of the production and productivity of rapeseed-mustard in the country. The area, production and productivity which was 3.0 m ha., 1.23 m tonnes and 408 kg/ha in 1966-67, has increased to 4.19 m ha, 2.47 m tonnes and per cent respectively of rapeseed-mustard in the last 16 years.

Table IX-38. Maximisation trial showing the performance of improved varieties of mustard in India

Variety	Seed Yield (kg/ha)
Prakash	2,815
VH-30	2,667
Patan-67	2,667
RLM-198	2,370
Kranti	2,370
Krishna	2,370
Shekhar	2,370
NR-40	2,222
Seeta	2,222
Pusa Bold	2,222
RW-175	2,000
RLM-514	1,926
T-6342	1,926
Varuna	1,852

Table IX-39. Performance of improved varieties of rapeseed-mustard at farmers' fields

State	Variety	No. of demonstrations	Seed Yield (kg/ha)
	Mustard		
West Bengal	RW-351	6	1,612
	Pusa Bold	1	1,557
	RW-85-59	5	1,695
Orissa	Kranti	3	1,069
	Pusa Bold	5	902
Bihar	Varuna	1	2,100
	Raur-1	1	2,000
U.P.	Kranti	3	1,810
	Pusa Barani	1	2,650
M.P.	Kranti	2	1,620
	Krishna	1	1,560
	Pusa Bold	1	1,400
Gujarat	Varuna	8	2,457
Delhi	Pusa Barani	1	2,800
Punjab	RLM-619	4	1,900
	Gobhi Sarson	2	1,550
Haryana	Prakash	20	1,418
	RH-30	69	1,770
	Toria		
Assam	M-27	10	913
U.P.	T-9	1	1,651
Bihar	T-9	2	1,000
Haryana	Sangam	14	1,128
	Yellow Sarson		
Bihar	Rauys	1	2,800

6. Challenges

The progress made in terms of increasing the production and productivity of rapeseed-mustard in the country is very satisfactory. However, much needs to be done to produce 24 m tonnes of edible oilseed to meet the domestic requirements of fats and oils by the turn of this century. Considering the minimum 20 per cent contribution of rapeseed-mustard in the oilseeds economy of the country, 4.80 m tonnes of rapeseed-mustard would be required to be produced by 2000 A.D.

7. Production Strategies

In order to produce such a huge quantity of rapeseed mustard in a period of 16 years, a multi-pronged approach is suggested.

A) VARIETAL REPLACEMENT

It has been observed that the farmers often prefer to grow their old and traditional varieties without looking into the merits of the new varieties. This is one of the major constraints affecting the production of rapeseed-mustard in the country. More than 50 improved varieties have been recommended or released at national or state or zonal level. Even though these varieties are higher yielders, their speread is rather too slow because of unawareness on the part of the farmers about the yield potential of these improved varieties. To overcome this problem, an organised time-bound programme is required to replace the old varieties. Unless this is done expeditiously, the advantage of new varieties cannot be exploited.

B) SEED PRODUCTION

Although there are a number of high yielding varieties of rape-seed mustard recommended for different agro-climatic conditions of the country, there is no suitable and adequate mechanism to produce and supply the quality seeds of improved varieties. The seed production and distribution system, therefore, needs to be strengthened to ensure timely availability of adequate quantity of quality seeds of improved varieties.

C) LOCATION SPECIFIC TECHNOLOGICAL PACKAGE

Based upon the diverse agro-climatic conditions and constraints that have been limiting the production and productivity of rapeseed--mustard, technological package having 18 steps has been suggested (Kumar, 1982). This is based upon the assumption that bulk of the area under this crop is rainfed and that both water and fertilisers and likely to be limited in availability, The package steps need to be well demonstrated/explained to the farmers.

D) TRANSFER OF TECHNOLOGY

The production technology developed for rapeseed-mustard demonstrates that the present available technology is capable of giving a quartum jump to the productivity and production of rapeseed-mastard in the country. But when an average yield (5.89 q/ha) at national level is observed and the yields of 8.8 and 5.8 q/ha obtained under irrigated and rainfed conditions in different size group of soldings in Bihar, Uttar Pradesh, Rajasthan, Punjab and Haryana States (Anonymous, 1980) a different picture is obtained. These findings obviously suggest that there is a wide gap between the production potential and actual realisation. In order to narrow the gap, production strategy needs to be geared up to facilitate the speedy diffusion of technological inputs and services at the field level with an aim to optimising crop output productivity of rapeseed-mustard. One of the ways for the speedy transfer of technology is to organise demonstrations at block level to highlight the effect of different technological package over the traditional practices.

E) EXPANSION OF AREA

Another way to achieve the target is to identify potential areas for cultivations of rapeseed-mustard, to the under irrigated and rainfed conditions as a pure of intercropped with potato or sugar cane or wheat. The irrigated area under rapeseed-mustard needs to be considerably expanded not only in command areas of Hirakud and Delta Irrigation Projects of Orissa; Rajasthan Canal Project. Bhakra Canal Command

and Tubewell Commands of Punjab; Western Yamuna canal and Lift Canals of Haryane; Chambal and Tawa Commands of Madhya Pradesh; Mangsmati and Mayurakshi Commands of West Bengal and Ramganga, Sards Sahayak and Gandak Commands of Uttar Pradesh, but also in Gujarat, West Bengal and Assam as a possible replacement for wheat. Besides, there are a number of potential areas in north-eastern hill States, Bihar, Himachal Pradesh and Jammu and Kashmir where the cultivation of rapeseed-mustard need to be popularised. Attempt should be made to encourage the cultivation of early maturing rapeseed-mustard as a summer crop particularly in Lahaul-Spiti, Kinnaur and Chamba district of Himachal Pradesh and in Anantnag and Pulwama districts of Kashmir.

9.11 AGRONOMIC CONSIDERATION FOR MUSTARD UNDER IRRIGATED CONDITIONS

a) Improved Seed

Experimental evidence suggests that simply by replacing the seed of old variety with the improved one, the yield of mustard (raya) increased by 14 to 26% at Ludhiana and Hissar respectively. Already a number of new desirable improved varieties of mustard like 'Varuna', 'Parkash', 'KLM 198' and some other have been developed and released.

b) Timely Sowing

Sowing of mustard at the right time is essential to harvest good yield. The optimum time has also to be determined in view of vagaries of low temperature or frost and occurrence of pests and diseases in a locality. Late planting generally tends to give lower yield, which may primarily be due to shorter duration of reproductive phase and thus allowing less time for the formation os siliquate and development of seed. The experiments conducted in some northern states where raya is mostly grown have revealed that first fortnight of October is the optimum sowing period for this crop. At Ludhiana each fortnight delay in sowing beyond 1 October resulted in 11.7, 33.5, 51.3 and 66% decrease in yield compared with 1 october sowing. A similar experiment conducted at Pantnagar revealed that planting of mustard (variety 'Varuna') on 1 October resulted in the highest yield of 25.3 q/ha. At each successive fortnight delay in planting after 1 October, the reductions in yield were 24.9, 46.9, 54.6 and 59.2%. At Gurgaon, 10 October sowing recorded the highest yield, which was 11.4, 53.3 and 122.3% higher than the crop sown on 25 October, 10 November and 25 November respectively.

c) Plant Density

The stand of crop in farmers' fields is generally low and uneven. To ensure good yield, the optimum number of plants per unit area and the geometry of crop is important. The optimum spacing between rows and within the row may, however, vary with the variety, soil type and its nutrient status and the availability of soil moisture. Experiments conducted at Ludhiana, Hissar and Kanpur have revealed that a spacing of 30 cm x 10 cm for 'RLM 198', 30 cm x 15 cm for 'Parkash' and 45 cm x 15 cm for 'Varuna' was best at the respective place, under irrigated conditions. Even direction of sowing (north-south) and skip-row technique have been found to yield better under many situations.

d) Adequate Fertilization

Mustard respónds to nitrogen application almost inveriable and to phosphorus, sulphur and some mocronutrients under certain specific situations. Fertilizers should therefore be applied preferably on soil--test basis.

These results show that raya is very responsive to N application and gives linear response even up to 125 kg N dose. However, a dose of 80 kg N/ha for Haryana and 100 kg N/ha for Punjab is recommended under irrigated conditions.

Table IX-40. Response of raya to nitrogen application (annual reports of Oilseed Crops, Hissar and Ludhiana)

Hisser			Ludhiana		
Dose of N (kg/ha)	Yield (kg/ha)*	Increase (%)	Dose of N (kg/ha)	Yield (kg/ha)**	Increase (%)
0	1,694	-	0	964	-
40	2,103	24	50	1,421	47
80	2,346	38	75	1,524	58
120	2,381	41	100	1,691	75
			125	1,842	91

*Mean data of 5 years, **Mean data of 3 years.

Shekhawat et al. (1972) in Rajasthan concluded that application of 30 kg N/ha resulted in an increase of 56 to 65% in yield and with 60 kg N/ha the increase was 66 to 121% over no nitrogen. The response with 30 and 60 kg P_2O_5/ha was much less than that with N.

At Behrampur (West Bengal), 5 levels of N from 0 to 300 kg/ha were tried on raya 'Varuna' for 3 years under irrigated conditions. It was concluded that 120 kg N/ha may be optimum and economic dose. Regarding split application, the yield differences were not significant in any year.

Table IX-41. Response of raya to micronutrients at different locations

Treatment	Yield (kg/ha)				Mean
	Ludhiana	Hissar	Kanpur	Berhampur	
Control	391	2,148	1,580	664	1,196
S 10 kg/ha	833	1,880	1,962	694	1,342
S 20	918	1,983	1,889	716	1,376
S 30	876	1,981	1,872	680	1,352
S 40	935	1,971	1,976	657	1,385
Zn 10	942	1,983	1,676	695	1,300
B 1	893	2,143	1,847	641	1,381
S 20 + Zn 10	1,003	1,843	1,753	731	1,332
S 20 + B 1	952	1,924	1,763	734	1,318
S 20 + Zn 10 + B1	1,049	2,019	1,790	768	1,406
Zn 10 + B 1	884	1,941	1,728	667	1,305
CD at 5%	163	NS	140	NS	

All the micronutrient treatments produced significantly higher yield over control at Ludhiana and Kanpur (except that the control yield did not differ from that of 10 kg Zn at Kanpur). The increase in yield at Ludhiana ranged from 442 kg (113%) to 658 kg (168%) and at Kanpur from 6 to 25%, over control. There were no significant differences in yield over control at Hissar and Berhampur. The mean values of four locations showed some superiority in favour at all treatments over control but not among various treatments.

Table IX-42. Fertility Status of Soil

	Initial Fertility Status of Soil				ppm						pH
	Organic C%	N (kg/ha)	P (kg/ha)	K (kg/ha)	S	Zn	Cu	Fe	Mn	B	
Ludhiana	-	L	H	M	11	0.72	0.40	6.15	4.95	-	8.7
Hissar	-	M	M	H	11	0.67				0.68	8.7
Kanpur	0.45		13.5	210							6.8
Berhampur	0.024		28	328							7.8

e) Timely Irrigation

Results eveal that one irrigation applied at flowering increased the yield by 26% compared with only 9% at pod-formation stage, over no irrigation. Two irrigations i.e. 1 at flowering and 1 at pod formation, were at part with only irrigation at flowering.

The results of some irrigation experiments on raya conducted at Ludhiana revealed that it should preferably be sown after applying heavy pre-sowing irrigation (i.e. 10-12 cm). One irrigation should be applied after 3-4 weeks of sowing. Irrigation given at this stage promotes deep rooting, which helps in the use of water stored in the lower soil layers. Another irrigation should be applied at flowering stage. If the crop is threated by frost damage, crop should be given an irrigation at that time.

Table No. IX-43. Irrigation effect on raya yield at Hissar

Treatment	Grain yield (kg/ha)		
	1970-71	1972-73	Mean
No irrigation	967	1,710	1,338
One irrigation at flowering	1,549	1,831	1,338
One irrigation at pod formation	1,235	1,656	1,495
One irrigation at flowering + One at pod formation	1,813	1,534	1,673
CD at 5%	471	143	

The response to a given level of irrigation is also determined by the fertility status or the dose of fertilizer applied. On soils of low fertility on where the crop has not been supplied any fertilizer, the response to increasing levels of irrigations is usually very low, but under adequate fertilization, 3 irrigations resulted in 4-fold increase in yield of mustard (33.23 q/ha) compared with 8.32 q of control at Kanpur (Singh, 1974).

f) Package Approach

The experimental evidence suggests that effective implementation of improved practices in package form increases the yield tremendously per unit area. The improved variety recorded an increase of 14% in yield over local variety. Over the improved variety, the contribution of fertilizer was 35%, of irrigation 67%, of plantprotection measures 111%, of irrigation + fertilizer 85%, of irrigation + plant protection 167%, and of combination of irrigation + fertilizer + plant protection (package) 263%. The adoption of package recommendations resulted in an increased profit of Rs.3,152/ha over improved variety.

In a similar study at Hissar conducted for 2 years, the improved variety alone contributed 26% increase in yield over local variety. Over improved variety, the contribution of fertilizer was 71%, of irrigation 19%, of plant protection 43%, of irrigation + fertilizer 120%, of irrigation + plant protection 68%, of fertilizer + plant protection 111%, and of irrigation + fertilizer + plant protection (package) 238%. The data also indicated that maximum return per rupee (1:69) was with the change of variety only. By spending Rs.595/ha in the form of package recommendations, an additional net income of Rs.3,476/ha was obtained.

9.12 High-yield varieties of toria [Brassica campestris (Linn.) var. toria)

Among the rapeseed and mustard group of oil crops, toria is the earliest maturing one. It usually matures in 85-110 days. Because of its early maturity characteristic, it usually escapes frost and aphid infestation, which are the major field hazards in production of Brassica oil crops in India. In frost-prone areas therefore farmers prefer to grow it as a short-duration crop, supporting mixed crop with sugarcane, gram, lentil, pea, or as a catch crop in intensive crop rotations with cereal crops. Usually the farmers raise this crop with the local varieties which often have poor yielding potentials and generally do not respond much to the improved agro-technology. Therefore, there is considerable need for developing high-yielding varieties in this crop.

Table IX-44. Impact of production factors on raya yield at Ludhiana in 1978-79 (Initial fertility status : NPK : low, high, medium; pH 8.5; treatment : 80 kg/ha; 2 irrigations; 2 sprayas)

Treatment	Seed Yield (kg/ha)	Increase in Yield		Gross Income (Rs/ha)	Cost of factor (Rs/ha)	Net profit	
		Actual (kg/ha)	Per cent			Actual	Over variety (Rs/ha)
Local Variety	407			1,221	15	1,206	
Improved variety (V)	465	58	14	1,395	20	1,375	
V+Fertilizer (F)	629	164	35	1,887	320	1,567	192
V + Irrigation (I)	765	300	67	2,295	70	2,225	850
V + Plant protection (PP)	980	515	111	2,940	150	2,790	1,415
V + I + F	859	394	85	2,577	390	2,187	812
V + I + PP	1,227	762	167	3,681	220	3,461	2,086
V + I + F + PP	1,689	1,224	263	5,067	540	4,527	3,152

a) Breeding System of Toria

Originating from lotni brown sarson, toria is basically a self-incompatible crosspollinated crop plant. The mechanism of cross-pollination is primarily because of presence of self-compatibility mechanism, entomophily, very high content of sucrose in nectaries (40 to 61%) to attract honey bees and extrores another arrangement. Generation after generation self-incompatibility mechanism maintains panmixis and a high degree of heterozygosity. Eventually, it also frustrates any effort of inbreding and fixation of genotypes. Hence, in such an outbreeding population, the breeding strategy for stepping up the yield would be the adoption of a breeding procedure which maintains the balanced heterozygosity for optimum plant productivity.

In crosspollinated crops like toria, this could be accomplished throuch the selection (mass-selection, recurrent selection etc.), breeding of synthetic and composite varieties and utimately breeding of the superior performing commercial hybrids. Presently a number of mass--selection populations have been pressed in for commercial cultivation. However, they have not made much impact on the overall rapeseed production in the country. It is now generally viewed that the breeding of composites and synthetic varieties would be a logical way to break the present yield plateau in this crop.

b) Evaluation of Genatic Divergence in Toria Germplasm

Genetic diversity in elite Indian rapeseed germ-plasm has been studied, utilizing Mahalanobis D^2 statistics in a collection of 27 indigempis amd exptoc (canadian) germplasm (Agarwal, 1976). In this analysis, days to maturity contributed the highest (46%) towards the expression of genetic divergence, a number of parents were picket from within and between the 11 gene constellations observed. Crosses were made between them. These parents were also classified based on their geographical distribution and plant-type diversity and the average extent of heterosis was estimated (Table 8.45).

The D^2 statistics is meaningful and adequate for selecting genetically divergent parents from the Indian toria germplasm (Table 1). However, if D^2 is not feasible to follow, it would be better to make crosses between the parents of east Indian (West Bengal and Assam) and Canadian Brassica campestris types. The detailed analysis indicated 'B54' of West Bengal and 'Span' of Canadian sarson germplasm to be genetically the most divergent.

The toria x toria crosses expressed comparatively less heterosis than toria x sarson crosses (Agarwal, 1976; Doloi, 1977). Therefore it appears that in toria composite breeding programmes, some introgression of sarson germplasm would be useful to enhance the yielding ability of toria varieties.

Table IX-45. Extent of heterosis with respect to seed yield in crosses of the parents chosen on the basis of D^2 statistics, geographical distribution and phenotypic diversity.

Type of cross	No. of crosses	Average yield heterosis (%)
Based on D^2 statistics		
Within-gene constellations	13	20.6
Between-gene constellations	18	60.5
West India x West India	7	3.5
West Indian x East India	9	38.0
West Indian x Canadian	9	25.4
East Indian x East Indian	4	42.0
East Indian x Canadian	3	54.4
Canadian x Canadian	2	18.7
Based on phenotypic diversity		
Toria x toria	22	27.7
Toria x sarson	32	59.3
Sarson x sarson	10	78.4

9.13 SESAME

As stated earlier sesame seed has been a very promising oilseed crop for West Bengal. Since early seventies, the production of sesame seed in West Bengal has increased by nearly 10 folds. The production of sesame seed in West Bengal rose from 0.2 lakh tonnes in 1975-76 to 1.40 lakh tonnes in 1988-89, accounting for about 30% of all India production. The production target of 5 lakh tonnes of sesame seed in West Bengal by the end of Eight Plan.

a) Effect of Climate on Growth and Production of Sesamum

Sesamum (Sesamum indicum) grows round the year in some part of the State or other and flourishes on a wide range of soils from light to heavy, sandy loam to black soils. It does not talerate waterlogging or acidic soils. In northern India it is mostly cultivated in kharif as a rainfed crop. In peninsular region it is cultivated in more than one season. The kharif varieties do not fair well in rabi season (November sowing) and vice versa. The varieties grown during rabi are typically short-day plants and hence do not flower under long-day conditions of 12 or more hours. The kharif varieties are however day-neutral.

In West Bengal Sesamum is basically a crop of the warmer climate, though its cultivation extends also to cooler climate as available in the Himalayas up to 1,500 m altitude. The plants grow luxuriantly and give best yields in temperature range of 24-32°C. Higher temperature than this at the time of flowering and fruit setting brings about premature shedding of flowers and reduction in capsule number and seed yield. Lower temperature (below 12°C) at flowering results in production of sterile pollen or premature flower fall. Invariably the winter-grown sesamum plants are shorter in height and put up less vegetative growth compared with the kharif-grown crop.

Sesamum is basically a short day plant, and with a 10 hour day will normally flower in 40 to 45 days, but many varieties have become locally adapted to various light periods. The local varieties which are bred and grown over years in a particular tract under a set of climatic conditions show considerable variation in growth and yield when shifted from their original home. The differences in growth and production observed in the short and long season types in India emphasize the need for selecting the most suitable variety for seasonal planting. The time of sowing of sesamum acts as a predisposing factor for incidence of certain diseases and pests in the crop. Premonsoon sowing of sesamum with summer showers in May helps the crop to escape phyllody. Incidence of heavy rains during the grand period of growth makes the plants more susceptible to phyllody.

Sesamum a fairly drought-restistant crop is highly susceptible to moisture stress at the seedling stage. Once established, it comes up wel with the available soil moisture. In 1979, when the drought conditions prevailed in the western districts of Orissa, sesamum was next to arhar, which stood drought better than rice and gave some yield to the growers. Excess of moisture at seedling stage also bring about loss of plants due to damping-off.

Tolerance of any crop to salt concentration in soils (saline soils) is an asset for the region. There is report that several sesamum varieties tested at 10,000 ppm showed variation in their degree of tolerance to salinity, suggesting that there is scope for breeding for salt tolerance.

b) Incidence of Pests and Diseases

Foliar pests are of major importance in India. Antigastra catalaunalis, known as sesamum left-roller, is a major pest of sesamum, and in acute infestation it completely destroys the crop.

Phyllody (vector Bemisia tabaci (Gen.) is caused by virus. Attempts were made to breed for phyllody resistance by corssing Sesamum indicum x S. Prostratum, but so far there is no single strain reported to be completely resistant to phyllody.

c) Sesamum Species and Varieties

Sesamum today is a vailable in a multitude of forms recognizable on the basis of maturing (early and late), season of cultivation (Kharif, rabi and summer), number of capsules per axil, number of carpels per fruit and seed colour. On the basis of chromosome number, sesamum is divided into three groups.

Group	Chromosome number	Species
Group I	2n = 26	S. indicum
	2n = 32	S. alatum
	2n = 32	S. prostratum
		S. augustifolium
		S. angloense
Group II	2n = 64	S. radiatum
		S. occidentalis

Sesame is a self polyneted so far yield performance is concern there are best protene varieties are found all over in there. These varieties may be introduce in West Bengal considering the agro climatic zone of the state to improve the space of production of sesame oil in the state. Varieties are as follows :

Amount the above varieties a few of them already introduce in the state but the out come of the same not yet received in detailed. Considering the agroclimatic zones of the state. The higheldinq varieties already suggested by the TMO West Bengal that in Tista and Alluvial region Extension of Sesame acreage as jute substitute to be introduction. In gangetic Alluvial Region.

Extension of sesame as jute substitute and pre-kharif crop after harvest of potato/winter vegetable by increase the horizontal expension of sesame.

Table IX-46. Performance of the best fourteen crosses (mean yield/plant)

Sl.No.	Crosses	Mean yield per plant
1.	HD 31 x Co 1	5.60 g
2.	HD 47 x Co 1	4.90 g
3.	HD 68 x Co 1	4.85 g
4.	HD 31 x TMV 3	5.50 g
5.	HD 47 x TMV 3	5.05 g
6.	HD 68 x TMV 3	4.40 g
7.	HD 16 x TMV 3	4.40 g
8.	HD 16 x TMV 6	6.06 g
9.	HD 62 x TMV 3	8.60 g
10.	HD 62 x TMV 6	8.40 g
11.	HD 24 x TMV 6	3.70 g
12.	HD 24 x Co 1	4.25 g
13.	HD 45 x TMV 6	5.05 g
14.	HD 45 x Co 1	8.75 g

In Vindya Alluvium Extension of sesame as a rainfed 2nd crop in field should be popularise among the farmars. In the West Bengal use of low quality seed is the major constraint to uniform stand establishment of the crop. The usual practice of the farmer to dry the seeds even upto eight days after threshing. The present experiment was taken up in 1985 to find out the optimum dryin requirement of seasum for ensuring the maximum viability of seeds.

Seven kilograms each of sesamum seeds of the improved varieties Kayamkulam I and Thilothama were dried for one day and their moisture content noted at the end of drying. One kilogram from the major lot was stored separately in an air tight tin container which constituted the first treatment.

The remaining six kilograms of seeds were dried on the second day and their moisture content recorded at the end. One kilogram from this lot was stored again separately in an air tight container and this constituted the second treatment. The remaining five kilograms of seed stored. The procedure was repeated upto the seventh day. The seven samples thus stored in seven containers fromed the treatments.

Drying was done for six hours in direct sun light from 10 am to 4 pm spreading the seeds uniformly and stirring occasionally.

As stated earlier sesame seed as been a very promissing oil seed crop for West Bengal the production of the same increased very nearly 10 folds in 1988-89 it reached to 1.40 lakhs tonnes the production target of 5 lacks tonnes for sesame seed in the West Bengal by the end of eighth plan but we should have to adopt fiellinding varieties of sesame seed and have to popularised the same among the farmers. With a knowledge of modern technology so far introduced in the oil seed production from of the state financial and technical guidance is the foremost requirement for the development of sesame production in the state is necessary.

It is found from the market research that til oil of West Bengal, Assam, Tripura origin can not be sold for direct human consumption without agmark lebel. But there is no provision in agmark for greading Til Oil of West Bengal Assam and Tripura. Origin as far standards let down in PFA rules this problems reacts amount the mill honours and also extented in its normal force among the farmars as the marketing facilities for the Til oil is restricted by the Govt. policy or may be consider as an administrative laps reduced the production front of Til oilin the state.

It evidend from the Govt. statistic in different Oil years within the last two plans some times Til Oil production towards greater than that of the rapeseed mastered oil production in the state.

9.14 SOME MINOR INDIAN OILSEEDS

1. Ambadi (Hibiscus cannabinus)
2. Dhupa (Vateria indica)
3. Dukudu (Celastrus paniculatus)
4. Indian almond (Terminalia catappa)
5. Indian kapok (Bombax malabaricum)
6. Kamala (Mallotus philippinensis)
7. Karanja (Pongamia glabra)
8. Kokum (Garcinia indica)
9. Kusum (Scheleichera trijuga)
10. Mahua (Madhuca iatifolio)
11. Mangoseed (Mangifera indica)
12. Maroti (Hydnocarpus wightiana)
13. Nahor (Mesua ferrea)
14. Neem (Azadirachta indica)
15. Niger (Guizotia abyssinica)
16. Pilu-Khakhan (Salvadora oleoides)
17. Pisa (Actinodaphne hookeri)
18. Rubber seed (Hevea brasiliensis)
19. Sal (Shorea robusta)
20. Sunnhemp (Crotolaria juncea)
21. Tea seed (Camellia sinensis)
22. Tobacco seed (Nicotiana tabacum)
23. Undi (Calophyllum inophyllum)
24. Watermelon seed (Citrullus valgaris)

Minor oilseeds of three origin are another important renewable resource. There are about 100 species of tree borne oilseeds having oil content and characteristics conforming to any commercial interest. Of these, over a dozen oilseeds for producing vegetable oils viz., sal, mohua, neem, karanja, kusum, kokum, undi, mango-stone, rubberseed, nehor, dhupa, pisa and khakan, etc., are already recognised as of commercial significance and are being processed. Complete and aughentic estimates of production of these minor oilseeds are not available, however, gaoss potential of oils of tress origin is estimated at around 15.1 lakh tonnes and 20 lakh tonnes according to the estimates of Khadi and Village Industries Commission (KVIC) and Minor Oilseeds Association of Calcutta, respectively. Out of the total potential available, a very low percentage only is being utilised. There are also fluctuations in the production of oils from these sources. The main problem with the minor oilseeds is the collection of oilseeds within the limited period. Infrastructure for collection, and pretreatment of the seed to avoid deterioration of the seed and development of free fatty acids, there storage and extraction has to be created to exploit this valuable potential.

Most of the oil obtained from minor oil seeds are dark, and possess disagreeable smell and contain non-lipid constituents with a variety of structural features and characteristics. It has been observed that some of these non-lipids are toxic and make the oil unsuitable for edible purposes. These problems are aggravated by the hostile conditions during collection from the forest areas, storage, and subsequent processing.

The oil, because of these limitations has limited applications which in most cases contain antinutritional factors as investigated by animal/poultry nutritionists and toxicalogists. Significant work has been done on processing of these economically important oil seeds and oils but very few have been successfully processed to produce good quality oil. No successful attempts to upgrade the quality of oil cake for better utilisation have been done. It has been observed that conventional processes of refining, bleaching and deodorisation are not very effective to upgrade the quality of oil. Recent advances on modified approach of pretreatment of these oilseeds prior to solvent extraction with hexane have goven encouraging results to produced a good quality oil and meal. Economic considerations for commercial scale production by modified processing technology have yet to assessed.

Looking at the oil scenario of the available potential and gap in demand and supply of the vegetable oils, there is a good scope to minimise the gap to about 90% if the total potential of the oils from unconventional oil bearing mate-rials if fully tapped. About 24 lakh tonnes of oil could be added to the vegetable oil wealth of the country, from unconventional resources, viz., 4 lakh tonnes from rice bran, 15-18 lakh tonnes from minor oilseed and 5 lakh tonnes from expeller pressed cakes.

Attempts to develop a modified approach to the technology for processing of minor oilseeds to obtain better quality oil efforts for recovery of oil from expeller pressed cakes have to be made.

Expeller pressed cake provides another significaet source of oil. Out of 87 lakh tonnes of cake porential available, only 12.3 lakh tonnes were processed by solvent extraction giving about 1 lakh tonne of oil (1984-85 estimate). On the basis of 7% recovery of oil from the cake by solvent extraction, about 6.1 lakh tonnes of oil could have been made available, instead of only 1 lakh tonne of oil presently being extracted from the cake. The rest of the cake containing about 5 lakh tonnes of oil is left unextracted and directly fed to the cattle or used as fertilizer. About 5 lakh tonnes of additional oil could be available if the total potential of oil-cake is utilised for solvent axtraction.

Research and developmental work should be intensified for solving the problems of technological gap in processing of oilseeds and oils as projected under the status of oil processing technologies of various oilseeds.

a) Tree-Origin

Among the 24 minor Indian Oil seed stated earlier in this Chapter 11 important tree origin oil seeds are found whide spread throught the country. The distribution general characteristic and fatty acid compotions are as follows :

1. Mahua (Madhuca latifolia syn. Bassia latifolia)

Mahua is largely found in the Sub-Himalayan tracts and is particularly concentrated in the State of Uttar Pradesh, Madras, Maharashtra, Gujarat Bihar, Orissa, Madhya Pradesh, Mysore and West Bengal. The flowers are used for extracting liquor and also valued as cattle feed. Madhuca latifolia is replaced in South Indian by M. longifolia, the oil of which is also used for the same purposes. Both the species are frequently cultivated in and around villages, as avenue trees, etc.

The seeds (1 to 4) are contained inside fleshy fruits. The kernels weigh about 75 per cent of the whole seed and contain about 50 per cent of the fat.

Mahua oil is a pale-yellow, semi-solid fat with the following characteristics:

Specific gravity (15/15°C)	0.920
Refractive index (40°C	1.460
Saponification value	187-194
Iodine value (Wijs.)	58-63
Acid value	5.40
Unsaponifiable matter (%)	1.5 to 3.0
Setting point (°C)	18-25
Melting point of fatty acid (°C)	39-45
Melting point (°C)	23-31
Titre (°C)	38-40

The fatty acid composition of the oil is reported to be under :

	Acid	Percentage
1.	Palmitic	23.7
2.	Stearic	19.3
3.	Lignoceric	1
4.	Oleic	43.3
5.	Linoleic	13.7

The fat is obtained by hot expression in screw presses and hydraulic presses, ghanis, and sometimes in oil expellers.

The total production of mahua seeds in the state is given below:

States	No. of trees	Yield Per tree	Total estimated production (tonns)	Actual Collection (tonns)
West Bengal	1,61,700	20-80 lbs	2,941	1,000

Estimates by Khadi and Village Industries Commission. Directorate of Economics and Statistics, Ministry of Food and Agriculture.

2. **Neem** (Azadirachta indica)

The neem tree is found all over India occurring wild or planted as a shady tree in villages and cities, on roadsides, on canal banks, etc. It thrives best in drier climates shere the rainfall ranges between 18 to 45 inches and occurs largely in the States of Uttar Pradesh, Madras, Maharashtra, Gujarat, Mysore, West Bengal, Rajasthan, Madhya Pradesh and Delhi. The time when the fruit matures and falls from the tree, varies from State to State.

The seed is contained in a fruit which is more or less oval in shape and about 3/8 to 1/2 inch in length and 1/4 inch in thickness.

It consists of a soft pulp covered with a thin skin and a seed inside the pulp. The oil content of the kernal is about 50 per cent.

The oil is contained in the kernal and can be obtained by expression either in improved bullock of power-driven ghanis, hand screw presses or hydraulic cage presses. Pressing in expellers is not satisfactory. There are two methods of processing neem fruit. One method consists of depulping the fruit and subsequent decortication of dried depulped fruit and the other consists of drying of whole fruit and decortication of dried whole fruit. Pressing of kernel yields comparatively better quality oil than pressing of whole fruit or undecorticated neem seed.

Neem oil is a brownish-yellow, non-drying oil with an acrid and bitter taste and unpleasant odour. The quality of the oil differs according to the quality of seed and the method of processing it.

The characteristics of the oil processed at Harcourt Butler Technological Institute, Kanpur are given below :

Specific gravity (30/30°C)	0.9189
Saponification value	193.0
Iodine value	75.0
Hehner value	88.7
Acid value	4.0-16.0
Unsaponifiable matter (%)	2.0
Colour (Lovibond)	40 Y in 1" 6 R cell

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Palmitic	13.6 - 14.9
2.	Stearic	14.4 - 19.1
3.	Arachidic	1.3 - 2.4
4.	Oleic	49.1 - 61.9
5.	Linoleic	7.5 - 15.8

The oil finds use in the manufacture of soap. Some methods have been suggested in the literature for removing the unpleasant odour of the oil. A method for refining of neem oil by alcoholic extraction and the recovery of bitter principles having medicinal and insecticidal properties, has been developed at the National Chemical Laboratory, Poona. The oil is also used in medicine. It can also be used for the production of industrial oleic acid, stearic acid, etc.

Neem cake finds ready use for manurial purposes. It is particularly valued for its strong insecticidal properties and as a white and destroyer in fields and gardens.

In a country like ours with the majority of its population suffering from fat deficient diat it is important that the use of edible oils like ground nut, Sunflower etc. by the industry should be minimise. There are fairly large resources of inedible and minor oils in the country which have not been exployted one of them is NEEM.

Estimated production and collection of Neem seeds in the state is given below :

State	No. of trees	Yield per trees	Total estimated % of production (tonns)	Actual collection (tonns)
West Bengal	2,65,000	50 lbs.	2,339	615

3. Karanj or Pongam (Pongamia pinnata syn. P. glabra)

This is an evergreen trees, commonly found in villages, roadsides, banks of rivers and in forests. In localities where it is known to have been cultivated successfully, the absolute maximum shade temperature varies from 100° to 120°F, the absolute minimum from 30° to 60° and the rainfall from 20 to over 100 inches. The fruit or pod is 3 inches long and encloses reddish seeds, each about 1 inch long weighing about 1 gm. The seed contains about 27 to 39 per cent of oil and a resinous substance. Villagers collect the seeds and decorticate them with the help of wooden hammers or by thick sticks. Separation of kernels from shells is done by winnowing processes. The seed is chiefly pressed in expellers though ghanis are also being used. In expellers 24 to 26 per cent of oil and 68 to 72 per cent of the cake are reported to be obtained.

Karanj oil is an acrid, reddish-brown, non-drying oil with the following characteristics :

Specific gravity (32°C)	0.9273
Refractive index (32°C)	1.4774
Saponification value	187.5
Iodine value (Winkler's)	82.9
Acid value	7.5
Acetyl value	14.5
Unsaponifiable matter (%)	2.6

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Myristic	0.23
2.	Palmitic	6.06
3.	Stearic	2.19
4.	Arachidic	4.30
5.	Lignoceric	3.22
6.	Dihydroxy stearic	4.32
7.	Oleic	61.30
8.	Linoleic	9.72
9.	Linolenic	0.46

The oil is chiefly used for leather tanning, lighting and to a small extent in soap making, medicine and lubrication. The cake may be used for manurial purposes.

The chief use of karanja oil is in soaps. The oil has a peculiar odour, has 68 per cent unsaturated fattry acids (iodine value 80) and 2.5 per cent non-glyceride compounds consisting of furano flavonoids such as karanjin (I) (Limaye, 1936), isolonchocerpin (II) (Naik and Bringi, 1973) and pongamol (III) (Rangaswami and Seshadari, 1940). These cause a colour change in the soaps made from karanja oil. The method developed for upgrading karanja oil are: (1) alcoholic alkali extraction which is now unconomical (De's Sa et al., 1955), (2) distillation of the minor compounds under vacuum, and (3) high pressure hydrogenation whereby the structure of the phenolic compounds are changed.

The total number of Karanja trees in the areas where survey has been carried out in the state is estimated stated below:

State	No. of trees	Yield Per tree	Potential Production of seeds (tonns)	Actual Collection of seeds (tonns)
West Bengal	51,600	30-40 lbs.	734	26

Information from C.C.F.

4. Undi (Calophyllum inophyllum)

Undi is an evergreen tree found in the eastern and western coastal regions of India and in the interior parts of West Bengal. The trees grow near the seashore on the sandy places, along the river banks, near the water resources, and in the gardens. The tree starts following after the tenth year. It flowers twice a year in January-February and in June-July. The fruits mature at the end of April or in May and in October-November.

The undi fruits are green and round and turn yellow when mature. The diameter of the fruit is about 3/4 of an inch, with four compartments inside. It is made up of pulp, hard seed coat, soft and coat and kernel which is about half an inch in diameter. The seeds fall from the tree and are collected by picking. The removal of the seed from the outer brittle shell is done by breaking the nuts with a light hammer or by placing the nuts on a hard floor and pressing them with wooden planks. The kernels are very rich in oil content. Dried kernels contain up to 73 per cent of oil. In ghanis the oil yield is about 63 per cent. Undi oil is bluish yellow when it is freshly extracted in a ghani. The oil has the following characteristics :

Specific gravity (15°C)	0.9415-0.9452
Refractive index (15°C)	1.4699-1.4772
Saponification value	191-202
Iodine value	82-98
Acid value	27-78
Unsaponifiable matter (%)	0.25-1.4

The fatty acid composition of the oil is reported to be as under

	Acid	Percentage
1.	Palmitic	15.6-18.5
2.	Stearic	6.1-12.2
3.	Oleic	48.5-53.1
4.	linoleic	15.8-24.1

The oil is mainly used for burning purpose in villages and for varnishing country boats. It is also often used for massaging rheumatic patients and in ointments for wounds. Undi oil can also be used for soap making.

Surveys carried out under the schemes financed by the Indian Central Oilseeds Committee indicate that undi is concentrated in the Southern part of India i.e., in the States of Kerala, Madras, Maharashtra and Mysore.

Central oil seeds commission started their investigation on the same but the data not yet published on the state of West Bengal. Though undi is available in the inerior parts of West Bengal as stated earlier.

5. **Kusum** (Schleichera oleosa syn. S. trijuga)

This tree is found in dry forests in many parts of India, Burma and Ceylon. It occurs in the lower Himalayas from the Sutlej to Nepal, in the Sub-Himalayan tracts and Siwaliks up to an altitude of 3,000 feet, throughout Central India, the East and West Coast regions, the Deccan and Karnatak. The tree bears leaves and flowers early in the spring season. A sample of seed from the Landsdowne forest division of Uttar Pradesh contained 54 per cent of kernels. The oil content in kernel was found to be 57.1 per cent.

Kusum oil is a yellowish-brown, semi-solid fat and has been found by the Harcourt Butler Technological Institute, Kanpur, to possess the following characteristics:

Specific gravity 32/52°C	0.9099
Refractive index 40°C	1.4607
Saponification value	234.3
Iodine value	60.2
Hehner value	88.7
Acid value	31.3
Unsaponifiable matter (%)	2.1
Acetyl value	4.0

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Myristic	1
2.	Palmitic	5-8
3.	Stearic	2-6
4.	Arachidic	20-25
5.	Oleic	60
6.	Linoleic	3-4

The oil can be obtained by expression of seeds or kernels in expellers and hydraulic presses, etc.

The Chief Conservators of Forests in the State of West Bengal have mentioned about the occurrence of kusum trees in the states. The available information is summarised below :

State	Quantity of seeds available	Area where available	Quantity of seeds collected
West Bengal* (13,800 trees)	401 tons		59

* Indian Central Oilseeds Committee Scheme.

6. Khakan (Salvadora oleoides)

This is a small tree or large sharub which grows well in the dry, sandy and saline tracts of Northern India. The tree can stand high temperature and requires about 10 to 24 inches of rain for its growth. It is abundantly found in North Gujarat, Saurashtra, Kutch, Rajasthan and the Pubjab. There are two varieties of khakan, one bearing sweet seeds which are used as cattle feed and the other bearing bitter seeds which are collected and crushed for oil. The fruiting season in June-July. Collection of seed is done by cutting the seed-bearing small twigs of the trees. The twigs are dried and beaten against a hard surface and the seed separated. The seeds are stored after proper drying.

The seeds contain about 42 to 43 per cent of a greenish-brown, pungent oil which has the following characteristics:

Specific gravity 35.5°/15.5°C	0.9205
Saponification value	247.2
Iodine value	14
Acid value	2.02
Solidifying point	31.1°C

That fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Caprylic	4.4
2.	Capric	6.7
3.	Lauric	47.2
4.	Myristic	28.4
5.	Oleic	12.0
6.	Linoleic	1.3

Twentyfive to 30 per cent of oil can be expelled by crushing in the ghanis. Due to low melting point of the oil, extraction is carried out better in the summer season. The oil is similar to coconut oil due to its lauric acid content which is about 47.2 per cent and is, therefore, very valuable for soap making. It would help to reduce the use of coconut oil in the soap making industry.

7) **Pisa** (Actinodaphane hookeri)

Pisa tree is a small evergreen tree found in the warm and moist forests of the lower hills in the eastern and western Ghats and in Assam and Sikkim. It occurs mainly in Ahmednagar, Nasik and Satara districts of Maharashtra State and some parts of Mysore, especially in Kanara and Shimoga districts.

The flowers of pisa are particularly valued for honey in Mahabaleshwar. The fruits mature by the end of May and middle of June. The seeds are small in size and their collection difficult, if they fall on the ground. Seeds are collected mostly by cutting the branches hearing fruits and then plucking them. The pisa seed is surrounded by a pulp with high moisture content and therefore, calls for immediate depulping to avoid the probable growth of fungus in the seed stock. Proper and completely drying of seeds in the shade reduces the chances of deterioration of seeds when stored.

The seed contains 48.4 per cent of a reddish-brown oil which has the following characteristics:

Specific gravity 25°C	0.925
Refractive index 50°C	1.449
Saponification value	255.3
Iodine value (Hanus)	10.9
Acid value	4.0
Unsaponifiable matter (%)	1.92
Acetyle value	11.3
Melting point	43-44°C

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Lauric	96
2.	Oleic	4

The seed contains about 96 per cent of lauric acid, and is, therefore, a suitable substitute for coconut oil in soap making. The systematic cultivation and proper exploitation of pisa, therefore, requires serious attention due to its commercial possibilities.

Pisa trees are also found in the evergreen forests of Mysore State. It is estimated that about 132 tons of seeds are available in the Sirs, Siddapur and Kumta Ranges.

This type of trees also in Assam and Sikim as stated earlier but not been utilize as nonconventional source of oil, proper utilisation of this seeds which are available in the hilly tract tarai and Dwars should be explode to meet the deficite of the state.

8. **Kokum** (Garcinia indica)

The kokum butter is obtained from the seed of Garcinia indica, a tree about 50 to 60 feet in height growing in the evergreen forests of the Western Ghats from Konkan southwards in Mysore (Coorg, Shimoga, North and South Kanara). Madras (Nilgiris) Maharashtra and Kerala. It is also reported to flourish in the evergreen forests of Assam, Khassi and Jaintia Hills and West Bengal. The fruit is about 1 to 2 inches in diameter and is red in colour, sometimes with yellow tinge. The rind of the fruit is acidic in the teste and is used and is used for culinary and medicinal purposes. The fruit contains 3 to 8 seeds. The kernels are crushed for oil.

The seed contains 23 to 26 per cent of an oil with the following characteristics:

Saponification value	189
Iodine value	34.7-36.7
Melting point	39-43°C

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Myristic	0-1.2
2.	Palmitio	2.5-5.3
3.	Stearic	52-56.4
4.	oleic	39.4-41.5
5.	Linoleic	1.7

The seeds are decorticated by beating with a rod. The oil is extracted by boiling the kernels in water. The oil collects at the top and is skimmed off.

Kokum fat is used for burns and injuries as vaseline. It is also used as a substitute for ghee, and in soap manufacture.

The kokum trees mainly available in the district of Ratnagire, Kanara and Surat. Taking 25 per cent of the trees as not bearing fruits and an average yield of 25 lbs. per tree, the total production of kokum seeds was estimated at about 386 tonns. In West Bengal Kokum trees are pre-domenent around Jointiea hills tribel people use the same as ves-line and as a substitute of Ghee.

Proper exploration utiliazation and chemical culture may popularies Kokum fat and as a cooking medium. Which is already a popular fat for the local tribal people.

9) **Nahor** (Mesua ferrea)

Nahor tree occurs in large numbers in the evergreen forests of Burma, Assam, Bengal, Western Ghats and in the Andamans. In the cultivated conditions, it is found chiefly as an ornamental tree under various local names. The flowering season of the tree is February--March, which extends up to April-May in some places. The fruits are borne two months later. The fruit is reddish in colour and contains from one to three seeds.

The nahor seed is about an inch in length and contains a kernel of nearly the same size. The kernel is rich in oil having 46 per cent in Malabar seed, 34.5 per cent in Bengal seed, and 49.8 per cent in Assam seed.

The oil from the Assam seed was found to possess the following characteristics:

Specific gravity (32°C)	0.922
Refractive index (32°C)	1.4674
Saponification value	196.0
Iodine value (Wij's)	90.0
Acid value	10.0
Unsaponifiable matter (%)	3.2

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Myristic	0-1.8
2.	Palmitic	8.0-8.5
3.	Stearic	10.4-15.8
4.	Arachidic	0-1.8
5.	Oleic	55-66
6.	Linoleic	10-20

Nahor oil is used mostly for burning purposes. The dark brown colour and mild pungent odour of nahor oil limits its uses in soap making. Nahor oilcake is rich in nitrogen content and can serve as a good manure.

Nahor occurs mainly in the State of Assam and in Palghat district of Kerala State.

Nahor may be introduce or explode in the hilly tract of Himalaya or in Midnapore which may solve a considerable amount of non-conventional oil of tree origin in the State of West Bengal.

10. Sal (Shorea robusta)

Sal tree is found in the tropical Himalayan region from the Sutlej to Assam, in the Eastern districts of Central India and in the Western Bengal Hills. It is very abundant in Chhota Nagpur and in the Tarai forests of Northern India. The seed is, at present, not being used due to the afforestation work being carried out in certain parts of the country. Season of seed collection is from May to July and the cost of Seed collection is estimated between Rs.5/- to Rs.15/- per md.

The kernel from the seed obtained from the Dehra Dun area was found to contain 14 per cent of fat with the following characteristics:

Specific gravity (99/33°C)	0.8692
Refractive index (40°C)	1.4579
Saponification value	190.0

Iodine value (Wij's)	37.9
Hehner value	94.2
Acid value	10.6
Unsaponifiable matter (%)	0.87
Melting point (°C)	34.7
Titre (°C)	33.4
Reichert-meissl value	1.0

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Palmitic	8.26
2.	Stearic	34.24
3.	Arachidic	12.24
4.	Oleic	41.42
5.	Linoleic	2.73

The oil is said to be extracted by the 'boiling process'. However, in view of the low oil content 'solvent extraction process' would serve the best purpose.

The fat can be used as a substitute for cocoa butter in confectionery, as a substitute of tallow, for textile sizing and in soapmaking. Sal seedcake appears to be a potential source for the production of starch as it contains 31.25 per cent of true starches.

The potientiality of Sal tree not yet estimated in the state of West Bengal - Sal as a forest resource (wood) and its economic estimate earlier stated in the vegitation chapter.

In the national level they potential of Sal seeds 688 thousands tonnes the Directorate of Oil seeds development of Hydrabad estimated the availability was only 12.6 thousand tonnes.

Sal fat is greenish brown, has a typical sal odour and has a glyceride composition which enables its use as such or after fractionation as a cocoa butter extender. Its use for this purpose is affected by the quantity of impurities such as epoxyand dihydroxy-stearic acid triglycerides as they have an influence on the melting and mould release characteristics of the fat (Bringi et al., 1972). While common refining could produce satisfactory grade material from good quality sal fat, very recently technology has been developed for upgrading even poorer quality fat (Bringi et al., 1972). This technology is based on industrial adsorption chromatography. The good quality sal fat has a great demand abroad as cocoa butter extender.

Sal fat used as cocoa butter extender in chocolates.

Problems in use	- Green colour, minor components, viz., epoxy - and dihydroxy-stearic acid triglyceride.
Technology	- Technology for decolourisation and upgrading by adsorption process available.

While it does not seem that sal fat is incorporated in confectionaries in India, the Prevention of Food Adulteration Act has specified the standards for sal fat for use in confectionery. For this purpose the values for 9-10 epoxy and 9-10 dihydroxy stearic acid content in the fat should not exceed 3 per cent. More recently there is a proposal to permit use of sal fat in vanaspati up to 10 per cent.

The total availability can roughly be estimated at about 10 lakh tons of non-conventional oilseeds in the country as detailed below:

		Tonns
1.	Mahua	2,17,566
2.	Neem	4,14,633
3.	Karanj	95,711
4.	Undi	3,798
5.	Khakan	45,943
6.	Pisa	340
7.	Kokum	471

8.	Kusum	934
9.	Nahor	5,699
10.	Sal	2,12,230
		9,97,325

The above approximate assesment of availability of non-conventional oilseeds is based on efforts made from time to time by the Indian Central Oilseeds Committee, Khadi and Village Industries Commission, State Governments and other organisations. It does not include the data where surveys have not been carried out or of the seeds about which information is not available. These figures are thus of the tentative and indicative nature. For example, according to Hindustan Liver Ltd., perhaps, about 30,000 tons or more of mahua oil are being marketed every year while on the basis of the estimates given above, the figures for mahua oil works out to about 15,000 tons (from 41,870 tonns of seeds).

There is, therefore, a need for a concerted, coordinated programme for the survey of various non-conventional oilseeds in the country with regard to their available potential and concentration. In forest areas, it was suggested, the quantities of oilseeds (having an oil content say above 15 per cent) available annually should be determined by regional surveys and the promising among them grouped together according to locality and ripening time. This will not only indicate the total potential of non-conventional oilseeds in the country but also facilitate the collection of seeds.

In view of the large number of non-conventional oilseeds available in the country, it may be difficult, in the initial stages to carry out a resources survey of all the species at a time. It will involve a heavy organisational responsibility in the concerned departments of the State Government who will be charged with the function of implementation the programme as also a heavy expenditure. It was, therefore, felt that survey as well as practical work on collection and utilisation of non--conventional oilseeds should be started on the selected species whose oils are in demand by the industry. From among the species available, the following properties should be fixed for work during the next Five Year Plan period:

First priority	-	Mahua, neem, karanja and undi
Second priority	-	Kusum, khakan, dhupa and kokum
Third priority	-	Nahor
Fourth priority	-	Pisa and sal

However, due consideration might be given to the other species available in abundance, in different States.

Keeping in view the above considerations, it is recommended that a model scheme for the sample survey of non-conventional oilseeds in forest areas with the specific objective of making a survey of the eleven approved species which offer scope for commercial utilisation and collection of requisite data should be drawn up and forwarded to State Governments for drawing up schemes on these lines.

b) Non Traditional Oil Potintial and Projects

The utilisation of oils and fats is generally categorised as (1) household use (2) vanaspati (3) soap (4) paint and industrial use. While the household use includes liquid edible oils, those used for applying to the body and hair and those used for illumination, the industrial use of oils includes lubricants, preparation and use of fatty acids, their derivatives, oleochemicals, etc.

There is a variety of sources for oils but each oil has its characteristic fatty acid, glyceride and non-glyceride composition. They have therefore to be processed to make them suitable for using as edible oils, vanaspati, margarine, soaps, paints, or for other industrial used.

To explore the non-conventional oil there are various sources in our country so far explored and yet to be explored like: Mango tree is planted for the fruit which is valued for its ripe pulp, but the seed kernel gives oil. Sal trees are grown in forest for timber but their seeds give fat. Kusum trees are grown for shellac, as a host for shellac insect, but its seeds yield oil. And there are many other tree like neem, Karanja, mahua which grow in the country. Oil can be extracted from seeds of these trees.

The given details is the national scinerio of the non-traditional oils in India.

1. Rice bran oil

Potential	:	8.0 lakh tonnes
Actual	:	1.5 lakh tonnes

2. Castor oil

Production	:	1,20,000 tonnes

Potential and actual availability of some minor oilseeds and oils ('000 tonnes)

Name of Oilseed	Production	Actually Processed	Oil Produced
Sal	6,000	270	23
Neem	2,000	300	30
Karanja	500	32	8
Kusum	200	12	4

Source: Swaminathan, 1980.

3. Oil palm

Considering the importance of oil palm in augmenting the resources of edible oil, two projects for raising its plantation over as area of 6,060 ha were started in India in early seventies. An area of 3,660 ha in Kerala and 2,400 ha in Andaman and Nicobar Islands is to be covered under the projects. These two sits have been selected keeping in view the rainfall, soil and other agroclimatic conditions. Size of the plantation is proposed to be expanded further in due course depending upon the availability of land and other allied considerations.

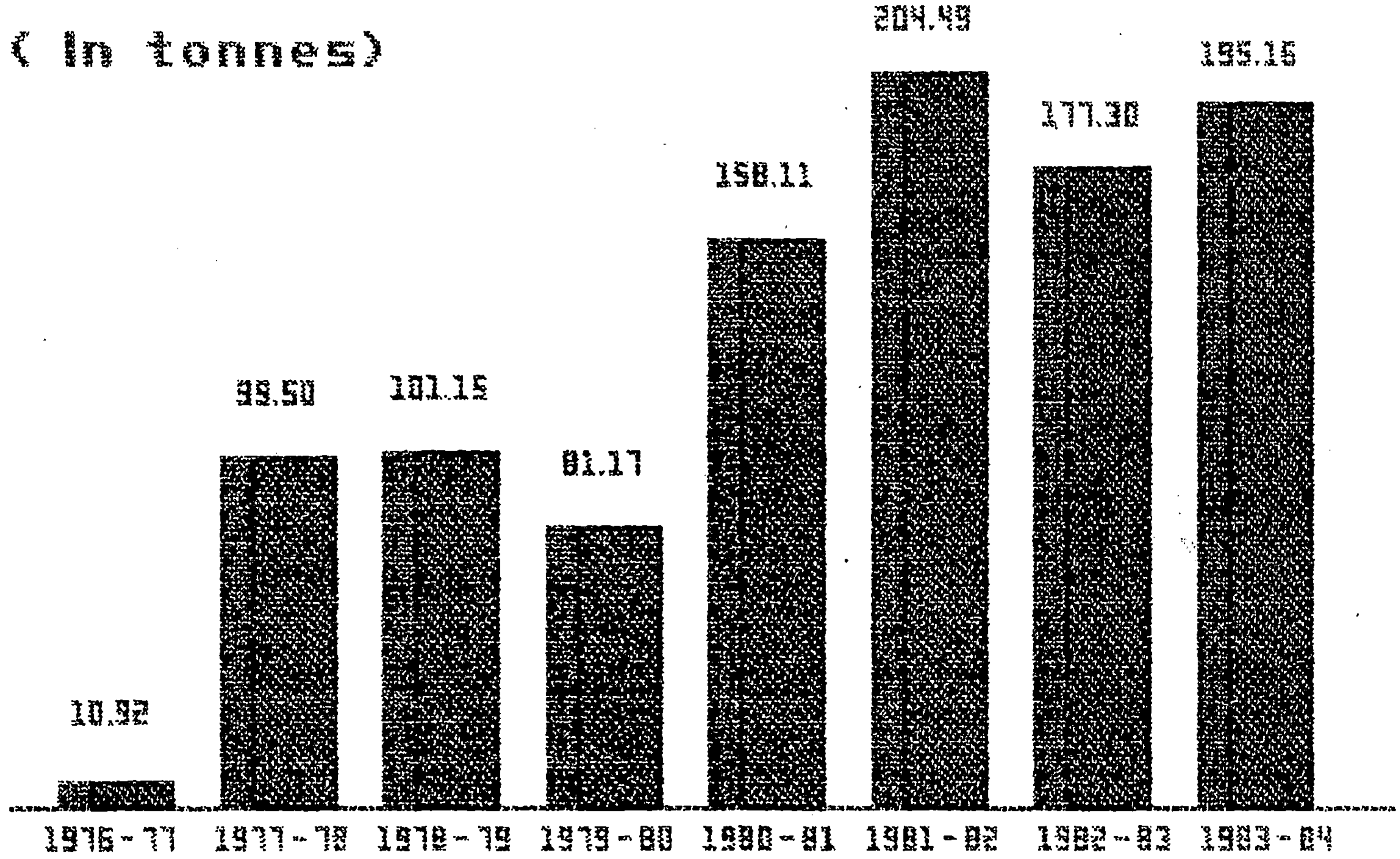
c) Different projects of non-traditional oilseeds development

1. Kerala project

The project was started in 1971 for planting an area of 2,000 ha on forest land in Anchal range of Quilon district. Programme is being executed by oil palm India Ltd. in which Government of India is sharing almost equal finance with Government of Kerala. Under the project an area of 1879 ha has been covered so far after felling and clearing the forest land. A plant having processing capacity of 2 tonnes FFB/hour has been installed to produce oil from mature bunches. Under the Sixth Plan, expansion of oil palm plantation to another 1,660 ha in the same region of 2,000 ha project was initiated during 1980-81. Out of 1,660 ha, the plantation on 1,426 ha has been completed. Besides, State Government of Kerala has also raised the oil palm on an area of 400 ha out of 500 ha targetted area under Western Ghats Development Programme. Another 500 ha area is proposed to be planted under the scheme of Rehabilitation of Sri Lanka Repatriates. Total area under oil palm plantation at present in Kerala State is 3,705 ha. The entire planted area is covered under high yielding tenera variety.

Plantation carried out under 2,000 ha project has begun to yield fruits and crude palm-oil is being produced from them and soilid. Normally 20 kg of palm oil and 2 kg of kernel oil is yielded by fresh fruit bunches (FFB). But due to initial setback in plantation, expected yield of FFB could not be realised from 1971 plantation. Production of palm oil during the period from 1976-77 to 1983-84 is indicated below:

Year	Oil production (tonnes)
1976-77	10.92
1977-78	99.50
1978-79	101.15



Palm oil production

Year	Oil production (tonnes)
1979-80	81.17
1980-81	158.11
1981-82	204.49
1982-83	177.30
1983-84	195.16

Cultivation of oilpalm in India is in infant stage. Lack of expertise in management of crop and inadequate milling facilities are some of the major factors which have limited the yield of oil. Recently several measures have been taken to improve the yield of FFB and oil.

2. Andaman and Nicobar Islands Project

Under 2,400 ha project, an area of 1,000 ha has been planted. Programme is being implemented by Andaman and Nicobar Islands Forests and Plantation Development Corporation Ltd. A small processing plant is also in operation. It is proposed to plant 30,000 ha area in these islands in the near future.

Oilpalm plantation in India has not yet yielded desired results. Therefore, there is a need for further strengthening research and development programmes to enhance palm-oil production. Seed of high yielding tenera variety which has been found suitable for planting in India is imported from either Malaysia or Ivory Coast.

Efforts are being made to produce seed of this variety indigenously. Recently, tissue culture method has been applied to oil palm cultivation in several countries where it has helped in increasing palm oil yield. The method can gainfully be adopted in India as well. Expanding the crop in small holdings around present plantation and raising oilpalm under irrigated conditions are other ways of increasing palm-oil production. With research and developmental efforts coupled with good crop management practices and modern milling facilities, the productions of palm oil can be increased to a larger extent in future.

A few palms were raised in Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu both as ornamental and for experimental purpose in the past. Results are encouraging.

d) Major tree origin - non-traditional oil in India

In the past two decades indigenous technology has been developed for utilising non-traditional oils from tree borne oilseeds for industrial use and in a small way for edibles also. The programme has enabled us to achieve some measure of self reliance, earned foreign exchange by export and employment generation, albeit seasonally, amongst the most deprived rural people engaged in collection. In the following pages I have summarised the processing technology available for upgrading five non-traditionl oils viz., sal, mowrah, neem, karanja and kusum which are widely recognised as offering the greatest scope for increasing oil supply.

The estimate of potential availability of the above oils is 17 million tonnes, with sal alone accounting for 45% of the total. The actual production has fluctuated 3-5% of the potential in the past decade i.e. 50,000 to 80,000 T. Considering the inaccessible areas and wide dispersal a modest target of 30% i.e. nearly 5,00,000 T. Should be our goal but even the meager collection is showing a disturbing decline. The technology mission should have a closer look at the dwindling seed collection and remove the irritants speedily to aim at a practical collection target. The efforts of our sceintists and technologists and the assets created for implementing the technology will be in vain, if we follow the ostritch like attitude in the matter of raw material collection. Liberal fiscal incentives will also spur collection. The availability of edible grade rice bran oil shot up from 20,000 T a few years ago to 1,00,000 T or more now entirely due to fiscal incentive and this example should serve as an eye opender.

1. Sal

The modest collection of sal (about 2000 T oil) in 1970 rapidly picked up and teached a peak of nearly 26,000 T oil (200,000 T seeds) in 1979 and equally rapidly, declined to a few thousand tonnes for reasons mentioned earlier. The harvesting and post harvest practices of processing the seed influence the oil quality. Over the years the practices have been streamlined to obtained satisfactory quality oil).

2. Mowrah

The estimated potential of mowrah kernels is 1.1 million tonnes and oil 400,000 T assuming an average 36% yield. The actual yearly collection (1976-84) ranged 19,000 to 30,000 T. The oil (IV 60-65, S.V. 187-196) has fatty acid composition: palmitic 25, stearic 22, oleic 36 and linoleic 16%. The absence of any unusual fatty acids or non-lipid components are factors facilitating straightforward refining to obtain an acceptable edible fat. The oil is included in the VOP list for vanaspati manufacture.

3. Neem

An estimate of theoretical potential of oil is about 350,000 tonnes on the basis of a conservative recoverable oil yield of 10% from about 3.5 million tonnes of seeds/kernels. The production of the late 70's was around 30,000 T but sharply declined to 11 to 14,000 T during '78-'79 season.

4. Karanja

The theoretical potential of the oil is estimated to be 135,000 T but actual collection has been stagnan at around 4,000 to 6,500 T/year, The oil is mainly used for soaps after sulphonting and sulphation in leather tanning industry. The oil has IV 90: S.V. 185-195 and major fatty acids are palmitic 10 oleic 49 and linoleic 19%.

5. Kusum oil

The potential of the oil is estimated at 66,000 T but the yearly collections are low and fluctuate between 4000 and 5000 T. The oil is unique as it contains only 3.6-3.9% glycerine while normal vegetable oil contains 9-10% glycerine. The chemistry of the oil is now know.

e) Forest trees

In India, many oil bearing trees are being found in the forest and sal (Shorea robusta) is one of the best examples which was commercialised due to better collection methods. Similarly, other oil bering forest trees can be commercially exploited with advantage. The acreage of such trees could be increased through afforestation or reforestation and increasing plant population in a given area of these trees will make the collection easier and cheaper. An attempt has been made to identify suitable areas for various oil bearing forest trees (Table 1) and a brief description of some of promising plants is given.

Table 1 : Oil bearing trees

Local Name	Botanical name/yield	Suggested suitable area for forestation
Pilu	Salvadora oleoides S 45% oil 50 kg seeds/tree	Dry desert area - U.P., Punjab, Rajasthan, Gujarat, M.P.
Kusum	Scheleichera oleosa S/U 40% seed 70% kernel	Dry forests of U.P., Bihar, Orissa
Pisa	Actinodaphne hookerii S 48% oil 20 kg seed/tree	Hill slopes of Sikkim, Western Ghats, Orissa, Konkan
Dhupa	Vateria indica S 25% oil 100 kg/tree	Western Ghats, Maharashtra to Kerala
Kokum	Garcinia indica S/U 40% oil 40 kg kernel/ tree	Western Ghats, Maharashtra to Kerala
Undi	Calophyllum inophyllum S/U 60% oil 2 tonnes/ha	Western Ghats, Maharashtra to Kerala, Andaman

Local Name	Botanical name/yield	Suggested suitable area for forestation
Nahor	Mesua ferrea 75% Kernel 20 kg oil/ tree	Assam, Himalayas, Western, Ghats, Andaman
Karanja	Pongamia glabra 40% Kernel 20 kg oil/ tree	River streams throughout India

Salvadora oleoides, commonly known as pilu is indigenous to India and is grown on dry and desert areas of Uttar Pradesh, Rajasthan, Panjab, Gujarat and Madhya Pradesh. It is an evergreen shrub which grows to a maximum height of 20 feet.

The tree flowers in March and fruits appear in April/May. The fruits are small berries. The seeds are small with greenish yellow dictyledons. The kernel is about half a centimetre and contains about 40-45 per cent oil.

The oil is green in colour, with a melting point at 41°C and a specific gravity of 0.867. Its iodine value is 5.5 and saponification value varies from 243.1 to 245.2. The fatty acid composition of the pilu oil is given below :

Lauric	21.2%
Myristic	52.9%
Palmitic	18.9%
Oleic	5.9%

The oil is used in soap making and in medicines. The oilcake contains 19 per cent protein and is used as cattle feed. The fat can substitute coconut oil and finds use in various industries.

Scheleichera oleosa (Kusum) is growth in Himalayan forests of Uttar Pradesh, Bihar and also in Orissa. It is a large deciduous tree which flowers during February to April and fruits during June-July. The fruits are green and found and contain a reddish brown seed with very little pulp. The seeds are decorticated and crushed for oil extraction. It contains about 57-60 per cent oil.

The oil is yellowish brown in colour with a meltiing point at about 25°C and with a specific gravity of 0.895. The iodine and saponification values vary in the range 53-60 and 220-234, respectively.

The fatty acid composition is as follows :

Saturated acids	34-42
Oleic	57-67
Linoleic	2-5
Free fatty acid as oleic	7.9
Unsaponifiable matter	1.5-3.0

Actinodaphne hookerii or pisa is grown on high altitudes and moist forests of evergreen type. It is found on lower hills of Western Ghats and also in Orissa.

It is a mall evergreen tree and attains a maximum height of 40 feet. It flowers in December/January and fruits in May/June. The fruits are oval shaped and about half an inch long. The seeds are small with brittle shell. Each tree yields about 14 kg of seed. The kernel contains about 48 per cent oil. The fat has solid consistency and is a good substitute for coconut oil. It is yellowis brown in colour with a strong aroma and has a melting point of 43-44°C. The iodine values vary in the range 8.5-10.9 and saponification value is 257.

As much as 90-96 per cent of the fat is lauric acid. The fat is best for the manufacture of detergents and the oil cake is used as manure or cattle feed.

Vateria indica or dhupa is grown in evergreen and semi-green forests of Western Ghats from Maharashtra to kerala. It is an evergreen tree, with a maximum height of 60 feet. It flowers during March/April and fruits during May to August. The fruits are oval shaped brown and hard and measuring 2.5"x1.5". The seeds are enclosed in the thick shelled pods. The kernel is yellowish cream and contains 22-27 per cent oil.

The oil is a white fat with a melting point of 35°C. The iodine and saponification values very between 36-43 and 187-192 respectively.

The fatty acid composition is as follows :

Palmitic	9.7%
Stearic	40.7%
Oleic	42.2%
Linoleic	2.3%

The oil is used in soap-making and the oil cake is used as a manure.

Garcinia indica also known as kokum is grown on coastal belts and Western Ghats in India. It grows to a maximum height of 60 feet. The trees flower in January/February. The fruits are fleshy and 1.5"-2" in diameter and contain black, ovoid seeds. The seeds contain 40 per cent fat.

The fat is greyish in colour with a melting point of 41°C. The iodine value is 35 while the sponification value is 189.

The fatty acid composition is as follows:

Stearic	52-56
Palmitic	2.5-5.3
Oleic	39.4-41.5
FFA as linoleic	1.7

The oil is used as vaseline and also for soap making.

Calophyllum inophyllum (undi) is found in the coastal area and Andaman Islands. It is an evergreen tree with a thick foliage and grows to a maximum height of 40 feet. The trees flower in March/April and the fruits are set in July/August. The fruits are green in colour and about 2" in diameter. The kernel contains 70 per cent oil. Each tree yields approximately 50 kg of dry fruits. The oil is greenish yellow in colour and has strong pungent smell with a specific gravity of 0.941. The iodine and saponification values vary in the range 82-98 and 192-201, respectively.

The fatty acid composition of the oil is as follows :

Palmitic	15-18%
Stearic	6-12%
Oleic	48-53%
Linoleic	15-24%
Unsaponifiable matter	1.3%

The oil is used in soap and varnish manufacture and in prepation of medicines for rheumatism and skin diseases. The oil cake is a good manure. This is unsuitable for edible purposes due to toxic non-fatty constituents.

Pongamia glabra also known as karanja is found in India, Malaya, Seychelles, Pasific Islands. In India, it grows well in Orissa, Karnataka, Maharashtra, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh and Tamil Nadu.

It is an evergreen tree and attains a maximum height of 50 feet. It fruits twice in a year-during September/October and March/April. The pods are flat eliptic, 3" long and enclose one or two kidney shaped brownish red seed. A mature tree yields 40-60 kg of pods per season. The cotyledons contain 30-40 per cent oil.

The oil is dark-brown in colour with a repulsive odour and a specific gravity of 0.839. The iodine and saponification values vary in the range 83-85 and 183-184, respectively.

The fatty acid composition is as follows :

Lauric	1.6%
Myristic	7.9%
Palmitic	3.7%
Stearic	2.2%
Oleic	62.1%
Linoleic	11.9%
Linolenic	5.0
Unsaponifiable matter	3.8-4.4%

The oil is used for soap as well as for tanning and lubrication. Oil cake is a good manure for oranges and paddy.

Mesua ferrae (nahor) is indigenous to India and Burma. In India it grows in forests of Assam, Himalayas, Bengal, Western Ghats and Andaman.

It is an evergreen straight stemed tree and attains a maximum height of 50 feet. It flowers during February/March and fruits from April to August. The fruits are conical, hard and about 3" in diameter and contain two to three shining brown seeds. The kernel is yellow in colour and contains 75 per cent oil. The oil is slightly viscous and dark-brown in colour with a specific gravity of 0.917-0.936. The iodine value and the sponification value vary in the range 85-89 and 197-206, respectively.

The fatty acid composition of the oil is as follows :

Myristic	1.6%
Palmitic	8.5%
Stearic	10.4%
Oleic	11.2%
Linoleic	66.5%

The oil is used for soap making. Oil cake is rich in nitrogen content and is a good manure.

9.14 PROCESSING TECHNOLOGIES

a) Present Position

The vegetable oil industry in India is characterised by widely scattered production units. These are at all levels of technology from simple, traditional bullock driven ghanis to sophisticated solvent extraction plants. Efforts at improved power driven ghanis. The next phase was the introduction of cagepresses first of manually or hydraulically powered type and then electrically powered oil screw presses i.e. expellers.

About forty years ago came the solvent extraction plants which used the oilcake, still containing oil, that are left after expression in ghanis or in screw presses as their main raw material.

Today, pressing of oilseeds is almost exclusively done by continuous screw presses know as expellers.

The vegetable oilseed processing industry by and large is inefficient. Virtually in all fields of vegetable oils processing their is excessive consumption of steam, power, and energy. It also suffers from non-availability of raw material and has to rely extensively on manual operation which has resulted in reduced efficiency in utilisation of full-capacity as is evident from the following Table.

b) Production Capacity

	No. of units	Installed capacity in million tonnes	Utilisation percentage
1. Ghanis	96,000	N.A.	N.A.
2. Oil Millers (Expellers)	15,000	30.00	30%
3. Solvent Extraction Plants	350	11.00	35%
4. Refineries	100	0.80	30%

c) **Screwpress in Oilseed Processing** (Expellers):

If we are first to look specifically at the screw press, the two ways in which it has been used to expel oil from oilseed are: first as a high pressure operation to low residual oil contents; second as a pre-press operation prior to solvent extraction. Figure 1 shows these two operations. In both cases, the four stages which influence pressing efficiency are: (a) seed preparation (b) cooking (c) screw pressing and (d) separation of solids from expelled oil and return to cooker/screw press. Unless all four steps are properly done good results will not be obtained. In high pressure pressing, the objective is to obtain the maximum value of oil and cake with quality, capacity and running costs. In a pre-press operation, the overall objective remains the same but is based on the output of both press and extractor. Often in pre--press operations the degree of rolling is increased and the degree of cooking reduced.

The oil in the seed is contained in sacs of fibrous capillaries. The application of pressure causes the capillaries to be reduced in volume and the oil to be expelled. But by the same effect the capillaries are narrowed, sheared and eventually scaled by the application of increasing pressure. Even the optimum operation of all four steps, puts a practical limit on the residual oil content that can be obtained by a high pressure screw press.

d) **Types of Expellers**

M/s. Anderson was the first company to manufacture and market a continuous screw press. They introduced four ranges which are dual purpose machine and pre-press expellers. The largest of the machines is used solely as a pre-press prior to a solvent extraction plant. This press uses a single horizontal main worm shaft which runs through 66" long by 12" diameter barrel. The capacity is 200 T/Day. The other well known expellers are Dam-man. Croes, The French Oil Mill Company, Krupp Maschinenfabriken. Simon-Rosedowns and the Stock of Amsterdam.

Design of expellers manufactured in India are almost identical to Anderson or French except for some differences in kettles, location of driving, gearboxes and design of worm assemblies on worm shaft. These expellers are identical in their overall features and construction of worm types, compression chambers, end cone etc. Most of the manufacturers in India are manufacturing expellers with a capacity ranging from 1 T/Day to 50 T/Day.

Over the years the extraction efficiency of expellers has greatly improved with respect to expellers feeding, pressing pressure (as high as 1600 kg/cm^2) and reduction in pressing time. Most of the 15,000 mills (expellers) in India have old generation expellers leaving approximately 8 to 10% residual oil in cake. Expellers made in India suffer from obsolescence of design, high wear and tear of critical components, high power consumption, low extraction efficiency and frequent break downs. This is due to inefficient design, poor manufacturing technology and the use of low grade materials.

In contrast, design of oil Expeller has undergone major refinements in industrially advanced countries since it was introduced in the year 1906 in U.S.A. Modern machines have high oil extraction efficiency with residual oil in cake down to 2.5%. The other technological innovations/refinements are; (a) computer optimized main shaft and worm design; (b) Heat treated alloy steel main shaft and barrel bars, stellite coated worms and collars; (c) Integrated vertical and horizontal bouble chamber design with separate drive motors; (d) water cooled main shifts and cage inserts; (e) Hydraulically actuated/motorised end cone adjustment; (f) centrasised lubrication in gear boxes and antifriction bearings and (g) Double speed worm shart design.

e) Solvent Extraction

The unrecoverable oil by mechanical expression of the oil bearing material can most efficiently recovered by solvent extraction. Batch type and continuous extractors are available. The batch type extractors principally in the form of small units (as low as ½ tonne/day capacity) are used for recovery of pharmaceutical oils or other expensive oils where the tonnage of materials handled does not justify the expenses of installing continuous extractors. However, batch type extractors varying from 2-12 tonnes capacity (generally a veritical cylindrical kettle) are being used in the country for extraction of oilseed cakes and rice bran.

The continuous extractors designed for handling large tonnage of material available today are basically the improved versions of the Bollman of Baslat extractor of the percolation type of the Hilderbrandt or 'U' tube immersion type extractors. The most popular extractor design used today is the percolation type such as Potocel, Lurgi (Germany), CMB (Italy), Anderson (USA), French (USA), Desmet (Belgium), Rosedown and Thompson (England) and Gianazzā (Italy). In India, Desmet continuous extractors are popular and are being manufactured within the country. In these plants the residual oil content in the cake is 0.5-0.7%. The range of capacity is 25-500 tonnes/day and most of the plants, particularly soybean processing units are running under capacity utilization. The advances in the solvent extraction have been seen in energy conservation and over increasing size of extraction plants. Solvent extraction process is capital intensive (Rs. 2 million for 25 T/Day plant) and volume is tensive.

f) Refining

The expellers oil is subjected to further processing namely alkali refining for removal of free fatty acids, bleaching for removal of colour and finally deodourization for removal of flavour to obtain a bland oil. In India it is a common practice to consume the ghani and expeller pressed oils like groundnut, mustard, niger and coconut.

Refining is therefore, Limited to most requirements of vanaspati making, certain sections of the population and or handling of solvent extracted oils, which cannot be marketed for edible use without refining. In tropical climates like in India, the expeller pressed oils have better stability compared to refined oils.

g) Refining Technology

The conventional process of alkali refining in most Indian plants, results in losses during refining which depend on the type of oil and the FFA content. This is generally a little more than twice the FFA of the oil. The improvement in the alkali refining process constitutes a short mix/continuous process in which the oil is mixed with alkali only for a fraction of a minute and centrifuged. This process reduces the oil loss. This technology is available in the country and has been adopted by some oil processors.

h) Miscella Refining

This process also uses alkali for removal of FFA from the oil. However, this differs from the conventional processes in that alkali is added to the solvent oil mixture. The refining losses are low as there is practically no entrained oil in the soap stock. This process in best carried out in the solvent extraction plants where the miscella (solvent-oil mixture) could be first refined prior to removal of the solvent from the oil. At present there are no such plants working in the country. A few plants have been imported for refining of rice bran oil and their performances are still to be watched.

i) Physical Refining

This process operates on the principle of distillation of the fatty acids from the oil. The process uses high temperature and low pressure and has not found favour in other countries for the traditional oils. The process has been adopted commercially for his refining losses, One physical refining plant set up for refining of high FFA rice bran oil in Punjab has the problem of extreme darkening of the refined oil. The process has not been found suitable for refining of rice bran oil.

j) Extraction

The Alcon Process described by Penk O Lurgi Cmbh, West Germany claims process advantage in extraction of soyabeans which in view of our current interest in soyabean processing may be of interest. In this process the main differences from the conventional process is the interposing additional facilities of a conditioner tempering apparatus drier and cooler incorporated between the preparational unit and the actual extractor. In Principale this aims at the elimination of enzyme activity by intensified moisture, temperature and time treatment. Enzyme activity begins in the soyabean at average temperatures. The processed crude oil is low in phosphatide contents after water degumming with values ranging between. .03%-.05% (10-17 PPM). It is claimed that such crude oils can be delivered directly to the physical refining which means that the bleaching and deodorization including deacidification by distillation are the remaining refining steps. Another advantage was claimed to be a very low loss of hexane. Due to pretreatment the urease activities of the toasted meal is very low in all cases. The lecithin sludge obtained showed a very low moisture content. The physical refining process is applicable very safely to oil arriving from this process apart from some variation in the consumption of bleaching earth, other utilities such as steam, electric power etc. Practically identical. The flavour, taste storage stability characteristics and other parameters were comparable.

Another Germany Company M/s. Krupp has patented a process (U.S. Patent 4168 May 17, 1977) which has been tried on Canola/Rape Seed Oil in Canada. This is called VPEX Process. In the VPEX process instead of conventional 7 steps starting from seed cleaning conditioning--flaking-cooling-prepress-solvent extraction-desolven extraction, the VPEX process consists of 5 steps viz. cleaning-conditioning-press-splvemt extraction-desolvent extraction. With these modifications, the VPEX was successfully incorporated into this existing operation.

As in the case of extraction of vegetable oils several processes have been described for the weaning of animal fats as tallow. Eearlier there were batches or various continuous extraction processes and the fatty issues from cattle or pig were rendered in a dry process batchwise continuous with the help of various solvent extraction process.

In India slaughter house industry is not very big but recently due to the arrangement of meat supplies to gulf countries, bye-product tallow may be available in larger quantities along with the other bye-products available from animal glands. Two different types of new processes have been installed. In some of these waste heat from the system itself is used and tallow and meal are processed under comparatively low temperature using pre-heaters and low pre-press. These are the Waste Heat De-watering (WHD) of machanical systems. In the WHD systems the material is continuously fed into a low pressure de-watering twin screw prepress which separates the soilid particles and fat and water mixture. The fat/water mixture is directed to the evaporation which is driven by vapours from a drier and evaporated under vaccum. This is a so-called waste heat evaporator. An evaporated liquid is not fed into the drier and mix to the solid from the press. The rest is dried in drier and the fat is removed by high pressure presses.

In the mechanical wet rendering system the materials is pre-broken, pre-heated and pre-pressed and then the solids are directed to the drier and the liquid goes to the evaporating site. It is possible to remove the fat before and after the evaporation. But in any case the fat is removed before the residual liquor which is basically water and the lolid is fed to the drier. The drier acts as a non-fatty particulate solid mixture and produce a low fat content, meal of high quality with high presure presses. Overall the mechanical wet rendering system is slightly better.

Both systems used pre-heaters at 65°C-90°C range. The waste heat de-watering process costs about 50% more than a traditional dry rendering process. However, the good energy efficiency, the qualities of fat and meal allow the return of the cost within 2-5 years. This is a Norwegian Process developed by 'Stored Bartz, A.S. Bergen, Norway'. The firm has introduced 45 such plants in different parts of the world.

k) Physical and alkali refining

Ten common oils including corn, sunflower, canols, soyabean, groundnut, rice bran safflower, coconut, palm kernel and palm have been so compared after being refined by the two processes. While the traditional processing steps in the case of corn oil, sunflower seed oil and canola (rape seed oil) consists of degumming-alkali refining-bleaching-dewaxing and deodorization, in the case physical refining degumming, the steps were bleaching-dewaxing-steam refining-deodorization. While in all other cases colour, stability and various other parameters more or less were comparable but slightly better in the case of physical refining.

The benefits of physical refining compared to the conventional caustic process would be better if crude oil qualities were better. While on the subject of physical refining under Indian conditions one has to take account of the problem of treatment of very high FFA rice bran oils (over 10%-30%) in which of course physical refining after degumming allows recovery of high quantity of fatty acids. However, the oil which has fixed colours and is difficult to remove and the traditional alkali refining and bleaching methods can be resorted to as a further step.

While on the subject of rice bran oil, binary-miscella refining of high acid value rice bran has been introduced as a new approach. There are already 5 such units installed in India-one near Calcutta, three in Andhra Pradesh and one in Punjab. The Calcutta Plant is based on technology supplied by De Smet, Belgium and the other plants are with Japanese (Yashino) Technologies. The processes involved are (1) degumming, (2) solvent dewaxing, (3) binary solvent deacidification, (4) bleaching, (5) deodorization. There is also a single solvent refining process introduced by M/s. Pennwalt India using food grade hexane. In the binary solvent process the solvents are hexane plus alcohol or isopropanol. They both claimed very good process advantages. It is claimed that upto a FFA level of upto 30% a very low refining loss about 1.1 to 1.5 times Wesson loss is achieved. While on the other hand the binary solvent refining process would appear to be attractive, ethyl alcohol, the desired solvent is often scare and its substitute the isoproponol is much costlier. The double solvent process was introduced in Europe under the name 'NEUHI' process as early as in 1955-56 by De Smet and was then only suggested for use in oils having more than 7% FFA.

In the case of rice bran oil in Indian conditions our attention should be diverted more to production of better quality of stabilised rice bran and conversion to huller to sheller mills and if not processed immediately, be subjected to a proven stabilisation process and then use the conventional methods/machineries which are available/manufactured in India.

l) Hydrogenation

Hydrogenation is important to Indian economy as about 1 million M.T. of vegetable oils are used for this process. The parameters of selectivity and trans isomer formation by manipulating with three variants - pressure, temperature and agitation still remain for manipulation. One new development (Hastert, JAOCS, Cannes Proceedings) in the field of equipment has been use of flat bed turbine agitator. One tries to increase hydrogen concentration at catalyst surface by increasing the pressure, temperature and agitation. Increasing the pressure increased the hydrogen concentration at the catalyst surface, and has the effect of increasing the preferential selectivity and transisomer make. Obviously, the rate of reaction is increased in all the three cases.

Since the mode of agitation has not changed appreciable since 50 years there has been little study of mixing techniques which has been shown commercially successful at this time is Buss loop reactor. It employs an injector type nozzle mix on the venturi principle introduced by M/s. Buss Limited Basal, Switzerland.

m) Integrated Expander (Extruder) Technology

Expander Extruder is somewhat like a glorified expeller, but with a difference. The expeller has a long barrel made of hard wear-ing barrel bars, in which a shaft is mounted with worms of different pitch and depth with an arrangement of knife bars for interruption, for uniform mixing. Plain and tapered collars are also mounted on the shaft at certain intervals and the shaft is rotated by a geared motor. The barrel bars are separated from each other by spacer. At the end of the barrel, there is an arrangement made of cones or jaws, which constricts the orifice between the barrel chamber and the shaft to the desired extent.

n) Pre-press Operation

The speed of the worm shaft plays an important role iin the output of an expeller. Higher the speed, higher is the oil content in the expeller cake. Thus in a pre-press operation, output of the expeller can be increased to 200% to 300% by increasing the worm shaft speed with suitable worm arrangement, moisture and temperature condition, leaving 8% to 15% oil in the pre-pressed cake. This pressed cake is subsequently passed through a solvent extractor, after proper preparation and conditioning to remove the oil in the pre-pressed cake leaving about 0.7% oil in the deoiled meal.

o) Expander

In the case of an expander, the barrel or chamber made out of barrel bars in the expeller is replaced by a solid walled cylinder, diameter and length of which is determined by the capacity for which it is designed.

The shaft rotating in the cylinder is mounted with special type of worms, with an arrangement for interruption for uniform mixing. There is also an arrangement to inject live steam and water into the cylinder at certain predetermined distances from the drive end of the shaft. The cone or jaws are replaced by a die plate which has a number of dies of tapered hole on the inside surface at a certain depth and later the holes are straight upto the outer surface of the die.

p) Distribution of Oil Mills in Eastern Region

There has been an unblanced development of oil milling industry in the Eastern Region. The distribution of oil mills together with the installed capacity in Eastern State can be gleaned from the following table:

Number of Oil Mills together with the capacity in Eastern Region

State	Number of Oil Mills	(In 000 tonnes) Installed capacity (in tonnes of oilseeds) for 300 days/shift
Orissa	66	60
Assam	120	156
West Bengal	605	643
Manipur	12	8
Tripura	10	9
Total	813*	876*

*Source: Directorate of Oilseeds Development: Hyderabad.

The aforesaid table indicates that West Bengal is having the largest number of oil mills in the Eastern Region. The oil mills in West Bengal sprang up on historical reasons. The close proximity to market helped concentration of the oil mills in Calcutta. The initial locational advantages do nor more exist.

The oil mills in the Eastern Region differ in their organisational and structural set up. The number of oil mills in West Bengal is more than 600, the majority of which are essentially small and unorganised. These oil mills work intermittently on account of inadequate local production and uncertain supply of quality oilseeds from other producing States. The inflow of oilseeds from the producing States like Gujarat, Andhra Pradesh, Punjab, Haryana, Rajasthan and U.P. have considerable declined in recent years in view of rapid development of the oil milling industry there. The oilseeds producing States are primarily interested in despatching oils to the Eastern Region, the principal consumers of mustard oil and coconut oil in the country, rather than despatching oilseeds in order to be processed in the local mills. Disproportionate railway freight rate between oilseeds and oils is also a factor working against the interest of the oil milling industry in the Eastern Region. The Central Transport subsidy for N.E.R. area is reported to be not adequate for healthy growth of the industry.

q) Utilisation of Oil Cake for extrection of oil

From the privious data we find that the mazor number of oil mills are located in West Bengal which provide the main production require for the Eastern Region in India. A large quantity of edible oil produced in West Bengal are from the traditional Ghanies. Whatever be the method of extrection of oil from the seeds we loose 7% oil in the oil cake. With the help of improved technology we can extract 5% more oil from the seeds.

Thus we may reduce the gap of 5% with the help of modern technology in the state of West Bengal. There are quite a number of solvent extraction units in and arround Burdwan these plants are mainly utilise for soyabean oil extraction on an experimental basis. Special attention should be given in this sector as modernisation of the oil industry in general has remained stagnated because of inadequate resources of the entrepreneurs and the reluctance of the financial institutions in providing finance to oil milling industry presently heading towards sickness. The state of affairs have come to such a pass that efficient processing and extraction of oils have become very difficult. The situation may go beyond redumption if timely action is not take. It is necessary, therefore, that the process of modernisation of this important food processing sector be speeded up.

The need for doing so has become more apparent for Eastern Region which has not been able to keep pace with even initial modernisation in the past due to lack of raw materials, i.e., oilseeds. Since the picture has now undergone some change and is undergoing a change with the increasing production of oilseeds, the sick oil milling solvent extraction industry of Eastern Region in general and West Bengal in particularrequires a special consideration. The modernisation finances should be made available on soft terms. The financial help to Government/Bank/Privet Investment sould help maintaining the required growth of the oil-based industries and this in turn would help recovered of vegetable oil, presently going wastage due to poor extraction efficiency.

AICOPRO APPROVED TECHNICAL PROGRAMME FOR THE YEAR 1990-91

As per approved programme formulated during the Annual Oilseed Workers' Group Meetings, each of the 61 AICOPRO Centres were assigned specific number of demonstrations to be laid out in their mandate crop/crops under real farm situations to highlight the superior productivity potentials and economics of latest crop varieties, production and protection technologies, proven cropping system involving oilseeds either as sequential, inter or catch crops vis-a-vis prevailing farmers practices in the region. The crop wise break up of demonstrations assigned to various AICOPRO centres in their specific mandate crops are listed in Table IX-47.

A total of 1193 demonstrations (kharif 423, rabi/summer 770) of 0.4 ha each with adjacent plots of local practice were assigned of 61 AICOPRO centres. As many as 356 demonstrations during kharif and 747 demonstrations during rabi/summer were conducted in different agroecological situations. (Table IX-47). The centre wise and crop wise details of implementation of the programme has indicated the successful conduct of 92 per cent of the assigned demonstrations (Table IX-48 to IX-55).

The various categories of demonstrations include (i) whole package orientated demonstrations (ii) cropping system oriented demonstrations and (iii) adaptive trials of component technology.

They yields and economics of varius demonstrations carried out under the project in each of the mandate crops are presented in Table IX-60.

(i) Whole package oriented demonstration

These demonstrations were intended to evaluate the productivity potentials and benefits of improved crop technologies over the previailing farmers practices in different oilseed crops and crop growing situations.

The demonstrations undertaken by the various AICORPO centres under a wide range of crop growing situations clearly point out beyond doubt that the existing per hectare yields and incomes from oilseed crops can be pushed up substantially even with the technology currently recommended. As compared to the local practices prevailing with the farmers, the demonstration plots involving the improved technologies registered additional yield to the tune of 41 to 50 per cent in kharif and rabi/summer groundnut, 44 to 71 per cent in kharif and rabi/ summer sesame, 90 per cent in castor, 63 per cent in niger, 53 per cent in sunflower, 71 per cent in safflower, 64 per cent in linseed and and 50 per cent in rapeseed and mustard.

The results of the past three successive years of demonstrations on oilseed crops have conclusively proved the nenefecial impact of improved technology over prevailing farmers practices (Table IX-58).

In many of the crops the additional investment incurred for improved technology towards input and operational costs is only marginal and the benefits acrued from such investment is substantial. From the data on incremental benefit: cost ratio (BC ratio) it is conspicuous that farmers who resorted to the recommended improved technology realised higher incremental B:C ratios to the tune of 11.18 in kharif groundnut (minimum 1.91, mean 6.65), and 29 (minimum=2.06, Mean=7.40) in rabi/ summer groundnut; 9.00 in kharif sesame (minimum=1.70, mean=3.97) and 6.15 (minimum=1.31, mean=2.92) in rabi/summer sesame; 8.99 in castor (minimum=2.05, mean=3.38), 2.18 (minimum-1.53, mean=1.82) in niger; 7.19 in sunflower (minimum=1.88, mean=4.49), 11.83 in linseed (minimum=1.12, mean=4.33) and 12.92 in rapeseed-mustard group crops (minimum=1.04 and mean=7.69).

Similarly the results of the demonstrations carried out from 1988-89 to 1990-91 have also shown beneficial incremental B:C ratios in all the oilseed crops grown under different agro-climatic conditions (Table IX-58).

(ii) Cropping system oriented demonstrations

In recent years, a number of productive and profitable cropping systems involving oilseeds as sequential and intercropping either interse or with other traditional crops have been identified under the AICOPRO network. Some of the most promising cropping systems have been tested under real farm situations to a limited extent in various oilseed producing states. Some of the systems worth mentioning are: intercropping of safflower with traditional rabi crops such as gram, wheat, linseed and coriander in deccan rabi tract, intercropping of pigeion pea with groundnut (Chintamani in Karnataka) in kharif (rainfed), Torai with Gobhi Sarson in Punjab and Madhya Pradesh. Besides, the preformance of Safflower was also evaluated vis-a-vis one or more traditional competing crops in the traditional safflower growing belt (Karnataka and Maharashtra). The trials to evaluate the productivity potential of safflower in non-traditional areas of Andhra Pradesh and Malwa plateau (Indore) of Madhya Pradesh have been laid out during 1990-91 also. For the first time, the performance of sunflower during spring season in the indo-gangetic plains of Uttar Pradesh was evaluated during the current year.

The relative economics of selected cropping systems are presented in Table IX-56.

Safflower as an intercrop with traditional low yielding rainfed rabi crops such as gram has been successful at all the locations (additional net returns over base crop gram: Solapur 5690 Rs/ha, Annigeri: 1700 Rs/ha, Jalgaon: 834 Rs/ha; Incremental benefit cost ratio Solapur: 11.20 Annigeri: 2.72, Jalagaon 2.76) and wheat (additional net returns over base crop wheat : Annigeri : 1427 Rs/ha, incremental benefit cost ratio=1.56) in karnataka and linseed (additional net returns over base crop linseed at solapur: 5767 Rs/ha, incremental benefit cost ratio= 51.95). Similarly at chintamani (Karnataka), intercropping of pigeonpea with groundnut in 3:1 row proportion yield additional net returns to the extent of Rs.8430/ha over corresponding sole crop of groundnut with an incremental benefit-cost ratio of 3.88

Brassica napus, popularly knows as "Gobhi Sarson" has gained importance as an oilseed crop under assured irrigated conditions of Punjab. Intercropping of Gobhi Sarson with Torai has registered additional net returns of Rs.3040/ha in Bhatinda with an incremental benefit cost ratio of 6.15 over the sole crop of Gobhi Sarson. Similarly at Morena (MP), the combination of Torai + Gobhi Sarson has resulted in additional returns of Rs.5817/ha (IB:C=3.53) in comparison with the sole crop of mustard. In sequential cropping, the torai-wheat rotation was found to be more remunarative (additional returns: Rs.9866/ha, additional cost: Rs.3980/ha, incremental benefit cost ratio=2.48) as compared to growing sole crop of mustard at Morena (M.P.).

According to the available results of the demonstrations of the performance of safflower vis-a-vis other rabi crops both in its traditional areas and in non-traditional areas such as malwa plateau of Madhyay Pradesh and Andhra Pradesh, safflower has been found to be a very remunerative crop under residual moisture conditions as well as under minimal irrigation (Table IX-57) as compared to the other rabi crops such as rabi sorghum, gram and wheat in solapur, wheat in Annigeri, gram in Indore, sorghum, gram and coriander in Tandur.

In recent years, sunflower is gaining increasing popularity as spring crop after potato in several parts of Uttar Pradesh. In order to exploit the full productivity potentials of sunflower, in non-conventional areas such as Indo-gangetic belt, the results of as many as 17 demonstrations under real farm situations have revealed the supremacy of sunflower crop with an average net returns of Rs.3443/ha and a IB:C ratio of 1.88 (Table IX-59).

(iii) Adaptive trials of component technology

Under this programme, the newly developed populations/hybrids of sunflower were evaluated against the existing popular varieties in Akola. The results clearly indicated that the new variety/hybrid alone can contribute to the yield increase to the tune of 12 to 26 per cent with an additional net returning from Rs.1095 to 2626/ha. Thus the choice of a right variety alongwith the recommended practices can boost up the production substantially (Table IX-60).

Table IX-47. Progress of Implementation of Frontline Demonstrations in Oilseed Crops During 1990-91

Sl. No.	Crop	No. of Demonstrations Assigned			No. of Demonstrations Conducted			Percentage implementation
		Kharif	Rabi/Summer	Total	Kharif	Rabi/Summer	Total	
1.	Groundnut	156	144	300	149	126	275	92
2.	Sesame	97	89	186	69	78	147	79
3.	Niger	52	-	52	52	-	52	100
4.	Sunflower	-	57	57	-	43	43	75
5.	Castor	118	-	118	86	23	109	92
6.	Safflower	-	85	85	-	85	85	100
7.	Linseed	-	135	135	-	135	135	100
8.	Rapeseed-Mustard	-	260	260	-	257	257	99
	TOTAL	423	770	1,193	356	747	1,103	92

Table IX-48. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91. (Groundnut)

Sl. No.	Name of the Centre	No. of Demonstrations			
		Kharif 1990-91		Rabi 1990-91	
		Assigned	Conducted	Assigned	Conducted
1.	Aliyamagar	6	5	9	14
2.	Amreli	6	6	9	9
3.	Anand	-	-	5	5
4.	Bhavanisagar	-	-	5	5
5.	Chianki	10	27	-	-
6.	Chintamani	10	10	5	-
7	Chiplima	5	-	10	6**
8.	Dharwad	8	8	7	7
9.	Durgapur	10	13	-	-
10	Jagtial	5	-	10	-
11.	Jalgaon	8	11	7	7
12.	Kimagadj	10	10	5	5
13.	Kadiri	10	10	5	5
14.	Khargaon	6	6	9	9*
15.	Latur	10	10	5	-
16.	Mainpuri	10	-	-	-
17.	Palem	6	5	9	9
18	Rahuri	-	-	5	4
19.	Raichur	4	3	15	24
20.	Sriganganagar	10	9	-	-
21.	Vridhachalam	6	1	15	17
22.	Yellamanchili	6	-	9	-
	TOTAL	146	134	144	126

* Diverted to Raipur Centre

** Out of 6,5 demonstrations were conducted by Bhubaneswar

Table IX-49. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Sesame)

Sl. No.	Name of the Centre	No. of Demonstrations			
		Kharif 1990-91		Rabi 1990-91	
		Assigned	Conducted	Assigned	Conducted
1.	Nagpur	2	2	4	4
2.	Amreli	10	13	-	-
3.	Berhampore	-	1	5	5
4.	Bhubaneswar	10	5	15	20
5.	Gurdaspur	10	10	-	-
6.	Hoshangabad	-	-	15	-
7.	Jagtial	10	-	10	-
8.	Jalgaon	5	8	-	-
9.	Mandore	10	14	-	-
10.	Mauranipur	10	8	-	-
11.	Tikamgarh	10	9	-	-
12.	Vridhachalam	10	-	15	25
13.	Yellamanchili	10	-	-	-
14.	Vellayani	-	-	10	9
15.	Dholi	-	-	15	15
	TOTAL	97	69	89	78

Table IX-50. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Niger)

Sl. No.	Name of the Centre	No. of Demonstrations during 1990-91	
		Assigned	Conducted
1.	Chindwara	10	10
2.	Dindori	10	10
3.	Kanke	18	18
4.	Raichur	4	4
5.	Semiliguda	10	10
	TOTAL	52	52

Table IX-51. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Sunflower)

Sl. No.	Name of the Centre	No. of Demonstrations during 1990-91	
		Assigned	Conducted
1.	Akoda	17	17
2.	Bangalore	10	6*
3.	Coimbatore	10	10
4.	Latur	20	10
5.	Kanpur	15	17
6.	Bhavanisagar	6	4
7.	Ludhiana	15	9
8.	Rajendranagar	15	15
	TOTAL	107	69

*Conducted by Dharwad Centre

Table IX-52. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Castor)

Sl. No.	Name of the Centre	No. of Demonstrations during 1990-91	
		Assigned	Conducted
1.	Dantiwada	10	9
2.	Junagadh	20	15
3.	Mandore	10	7
4.	Palem	25	25
5.	Raichur	20	18
6.	Semiliguda	10	12
7.	Tindivanam	10	10
8.	Darsi	13	13
	TOTAL	118	109

Table IX-53. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Safflower)

Sl. No.	Name of the Centre	No. of Demonstrations		
		Assigned	Conducted	Target for 1991-92
1.	Annigeri	15	15	15
2.	Indore	15	15	15
3.	Jalgaon	15	15	15
4.	Solapur	15	15	15
5.	Tandur	25	25	15
	TOTAL	85	85	75

Table IX-54. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Linseed)

Sl. No.	Name of the Centre	No. of Demonstrations		
		Assigned	Conducted	Target for 1991-92
1.	Berhampore	10	10	15
2.	Chiplima	5	13	-
3.	Faizabad	10	12	15
4.	Gursapur	15	15	15
5.	Kangra	15	12	15
6.	Kanke	5	1	15
7.	Kanpur	15	15	15
8.	Kota	10	9	15
9.	Mauranipur	5	15	15
10.	Nagpur	15	7	15
11.	Raipur	15	16	15
12.	Sagar	15	10	15
	TOTAL	135	135	165

Table IX-55. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Rapeseed-Mustard)

Sl. No.	Name of the Centre	No. of Demonstrations		
		Assigned	Conducted	Target for 1991-92
1.	Bawal	15	6	15
2.	Berhampore	15	15	15
3.	Bathinda	15	15	15
4.	Bhubaneswar	15	15	15
5.	Dantiwads	10	10	15
6.	Dholi	15	11	15
7.	Faizabad	10	13	15
8.	Hissar	15	20	15
9.	Jobner	15	15	15
10.	Junagadh	10	9	15
11.	Kangra	5	8	15
12	Kanpur	15	16	15
13.	Khudwani	15	15	15
14.	Ludhiana	15	15	15
15.	Morena	15	16	15
16.	navgaon	15	14	15
17.	Pantnagar	15	15	15
18.	Shillongani	15	15	15
19.	Sriganganagar	15	14	15
	TOTAL	260	257	285

Table IX-56. Production potential and economics of some promising intercropping systems vis-a-vis traditional cropping systems at different location (1990-91)

Sl. No.	Centre	No. Demns	Seed Yield (kg/ha)			Mean gross returns(Rs/ha)		Net returns (Rs/ha)		Addl. cost over role crop(Rs/ha)	Addl. returns over sole crop(Rs/ha)	B:C ratio
			Intercropping system		Sole crop	Inter cropping system	Sole crop	Inter cropping system	Sole crop			
1.	Annigeri	(4)	Wheat+ 733	Safflower 720	Wheat 938	6115	4688	29075	3392	912	1427	1.56
		(3)	Gram - 500	Safflower 300	Gram 625	6700	5000	3418	2342	624	1700	2.72
2.	Bhatinda	(1)	Toria+ 900	G.Sarson 1400	G.Sarson 1800	18090	15050	14613	12107	494	3040	6.15
3.	Chintamani	(10)	Groundnut+ 1398	Arhar 223	Groundnut 830	16435	8005	10255	4000	2175	8430	3.88
4.	Jalgaon	(4)	Coriander+ 878	Safflower 433	Coriander 1126	12661	11258	10711	9616	308	1402	4.55
		(5)	Gram+ 1030	Safflower 500	Gram 1594	11195	10361	8811	9279	302	834	2.76
5.	Morena	(4)	Tona+ 1800	G.Sarson 825	Mustard 2200	21876	16058	14826	10657	1650	5817	3.53
6.	Solapur	(3)	Gram+ 830	Safflower 861	Gram 1192	13912	8222	10890	5708	508	5690	11.20
		(2)	Linseed+ 370	Safflower 873	Linseed 508	12359	6592	9808	4152	111	5767	51.95

Table IX-57. Production potentials and economics of safflower with other competing crops

Sl. No.	Centre	R/I	Crops		Mean seed yield (kg/ha)		Mean gross returns (Rs/ha)		Mean cost of cultivation (Rs/ha)		Addl. returns over FP (Rs/ha)	Addl. cost over FP (Rs/ha)	Net returns (Rs/ha)		Incremental B:C ratio
			IT	FP	IT	FP	IT	FP	IT	FP			IT	FP	
1.	Solapur	R(2)	Safflower	Jowar	1165	1185	11068	5987	2610	2148	5081	462	3458	3839	11.00
		1(1)	Safflower	Jowar	1215	1320	11543	6635	3010	2523	4908	487	8533	4112	10.09
		1(1)	Safflower	Wheat	2010	1530	19095	6120	3123	3583	12979	460	15972	25376	
		R(1)	Safflower	Gram	1725	1280	16338	8833	2610	3065	7559	459	13778	5768	
		I(1)	Safflower	Gram	1940	1550	18430	10695	3075	3505	7735	432	15357	7190	
2.	Indore	LI (8)	Safflower	Gram	966	530	7876	4600	2699	2424	3278	275	5177	2178	11.98
		R(7)	Safflower	Gram	890	520	7226	4496	2648	2172	2730	478	4578	22324	5.11
3.	Annigeri	1(4)	Safflower	Wheat	1375	2470	12720	10680	2328	6555	2040	3732	9897		
		R(1)	Safflower	Wheat	500	1000	4625	4000	1823	1513	625	310	2802	2487	2.02
4.	Tandur	R(2)	Safflower	Jowar	875	1175	7437	3497	2437	2762	3940	325	5000	735	
		R(3)	Safflower	Gram	988	625	8392	5055	2387	2145	3337	2425	6005	2910	13.79
		R(3)	Safflower	Coriander	475	153	4035	1232	2072	1480	2803	590	1969	248	4.75

Table IX-58. Yield and economics of improved technologies in oilseeds in relation to prevailing farmers practices (1988-90 to 1990-91)

Crop	Number of Demonstrations	Mean Yield (kg/ha)		% increase over FP	Mean cost of cultivation (Rs/ha)		Mean Addl. cost over FP(Rs/ha)	Mean Addl. returns (Rs/ha) over FP	Incremental B.C. RAtio
Groundnut, K,RF	209	1299	910	43	4892	3660	1145	3118	2.48
Groundnut K,I	93	1853	1270	46	6056	4550	1524	4691	2.92
Groundnut, R/S,I	305	2179	1629	34	6705	5631	1508	5672	4.74
Mustard, RF	46	9439	596	59	3244	2038	1170	2505	2.60
Mustard, I	339	1763	1327	33	3371	2780	729	3450	6.66
Torai, I	54	1207	819	47	3306	2610	564	3016	12.46
Toria, RF	34	746	437	71	3008	1825	1142	2826	2.50
Sesame,K,RF	159	589	359	64	2229	1579	687	2272	2.83
Sesame R/S,I	105	810	546	48	3315	2413	923	2681	3.33
Sunflower,R/S,I	82	1445	924	56	5112	3749	1164	3824	2.77
Sunflower K	9	1286	814	58	4056	3289	738	2964	3.61
Safflower RF	40	926	498	86	2135	1256	719	2918	5.18
Safflower LI*	10	1157	830	87	1776	1454	320	3539	10.82
Niger, RF	147	422	249	69	1581	882	715	1418	1.99
Castor RF	45	1295	858	51	3182	2150	954	2268	2.76
Castor I	91	2818	2184	29	5389	4720	655	3953	8.90
Linseed RF	166	560	349	60	2111	1369	742	2144	3.36
Lineseed I	140	938	548	71	3156	1856	1168	3267	3.61

* Limiteted Irrigation to improved plots only

Table IX-59. Demonstrable potentials and economics of spring sunflower (Irrigated) under real farm situation in the indo-gangetic belt : Kanpur (U.P.)

Sl. No.	District	No., of Demns.	Maximum yield (kg/ja)		Mean yield (kg/ha)		% increase over LT	Gross returns (Rs/ha)		Cost of cultivation (Rs/ha)		Addl. reutnrs (Rs/ha) over LT	Addl. cost (Rs/ha) over LT	Incremental B:C ratio
			HT	LT	HT	LT		HT	LT	HT	LT			
1.	Kanpur (Dehat)	12	1400	900	1163	775	50	9763	6583	5919	4055	3180	1864	1.71
2.	Etawah	3	1500	850	1292	800	62	11242	6800	5633	3960	4446	1673	2.66
3.	Fatehpur	1	-	-	1200	820	46	10200	6970	5800	4095	3230	1706	1.89
4.	Farukhabad	1	-	-	1250	780	60	10425	6630	5550	3606	3995	1944	1.95
	Mean	17*	1500	900	1193	782	53	10090	6647	5847	4015	3443	1830	1.88

*Total

HT = High level technology viz., EC 68414, line sowing (45x20 CM), 80N, 60P_2O_5 kg/ha

LT = Low level technology viz., modern, an early maturing variety, Broadcasting and nil or low doses of fertilizer (10N, 30 P_2O_5)

Table IX-60. Productivity potentials and economics of varietal trials

Crop	Centre	No. of Demns.	Variety		Yield (kg/ha)		% increase over FP	Gross Returns (Rs/ha)		Cost of Cultivation (Rs/ha)		Net Returns (Rs/ha)		Additional returns over FP (Rs/ha)
			IT	FP	IT	FP		IT	FP	IT	FP	IT	FP	
Sunflower	Akola	1(2)	BSH-1	EC 68414	1288	1025	26	12875	10250	4050	3863	8825	6387	2626
		1(1)	BSH-1	SURYA	1400	1250	12	14000	1000	4225	4000	9775	600	4000
		1(2)	MSFH-17	EC 68414	729	629	17	6781	5886	4900	4275	1881	1411	1095
		1(1)	EC 68414	MODERN	1125	1000	13	11250	10000	4075	4075	7175	5925	1250

CHAPTER - X

MAJOR OILSEEDS SCENARIO OF WEST BENGAL

10.1 STATE SCENEARIO OF OIL SEED PRODUCTION FROM CONVENTIONAL AND NON-CONVENTIONAL SOURCES

India is one of the major producers of oilseeds in the world. Yet our vegetable oil economy is beset with the problems of shortage. The demand-supply gap in vegetable oils, once developed to a fightening level necessitating massive imports of edible oils. During 1986-87 and 1987-88, the country imported edible oils to the extent of 15 lakh tonnes and 18 lakh tonnes respectively, while in 1988-89 and 1989-90 it came down to 3.70 lakh tonnes and 6.90 lakh tonnes respectively.

During the current oil year 1990-91, the availability of edible oils in India has been estimated at 49 lakh tonnes, which is higher than the estimate of 47.45 lakh tonnes in 1989-90. If the per-capita consumption is assumed at 6.5 kgs (including 5.3 kgs. of liquid oils and 1.2 kgs of vanaspati) the total requirement of edible oils would be around 54.60 lakh tonnes in 1990-91 to feed about 850 millions of people. The percapita consumption if however, taken at 7 kgs, the total requirement of edible oils would be of the order of 58.80 lakh tonnes.

A recent exercise conducted at Krishi Bhavan reveals that the aggregate production of oilseeds during 1989-90 crop year would be in the neighbourhood of 186.6 lakh tonnes (88.6 lakh tonnes kharif and 80 lakh tonnes rabi) which indicates that the deficit in edible oils would be anything between 6 and 9 lakh tonnes in the current oil year.

Oilseeds Scenario in Eastern Region

In India, the production of oilseeds is not evenly distributed. The production of oilseeds, including copra, is largely concentrated in Western, Northern and Southern States while Eastern Region does not prominently figure in the oilseeds map of the country although greater emphasis has now been placed to increase the production and productivity of oilseeds in Eastern Region, including West Bengal. The Eastern States, comprising seven States namely, Assam, Bihar, Orissa, West Bengal, Manipur, Meghalaya, Nagaland and two Union Territories, Arunachal Pradesh and Mizoram, do occupy a place of importance in the consumption of vegetable oils.

The Eastern Region is marked by a variety of topography and diversity of climate. It covers farflung temperature hills and tropical plains. High rainfalls and humidty has made the environment less conductive to the accelerated growth of oilseeds. The North-Eastern hill region lacks road and quick communication facilities. The region has also a considerable strength tribal population following a primitive agricultural system.

Earlier the cultivation of oilseeds was not given adequate importance in the agricultural strategy of the Eastern Region.

However, there is now a growing awarences of the important role of oilseeds in the economy of Eastern States. It is a happy augury that a beginning has made to augument the production of oilseeds in Eastern States, more particularly, in Orissa, West Bengal, Assam and Bihar under National Oilseeds Development projects, launched in 1984-85. But much leeway has to be covered to make the region self-reliant in respect of vegetable oils. Presently, the production of oilseeds in Eastern States, taken together, comes to about 20% of the total requirement in Eastern Region. Necessarily, the Eastern Region has to depend on other distant producing States for the supply of both oilseeds and oils.

The contribution made by the Eastern States to the total all-India oilseeds area and production can be gleaned from the following table which indicates that the contriution of Eastern States to the total All India production of oilseeds is not a significant one.

The total area under oilseeds cultivation in Eastern Region is about 18.85 lakh bactares, of which 18.59 lakh hectares are in Orissa, Assam, Bihar and West Bengal. The annual average production of all oilseeds, taken together, is estimated at 11.0 lakh tonnes in these four States out of a total production of 11.65 lakh tonnes in the entire Eastern Region. Taking into consideration, tye type of land and suitability of growing oilseed crops, the developmental efforts have been directed in four States, namely, West Bengal, Assam, Bihar and Orissa.

Choice of oilseed crops to fit in different cropping system

In eastern India the rainfall receipts are usually high and some amount of rainfall is received in pre-Kharif season, i.e., between March and May. A fairly good amount of moisture remains stored in the soil after the harvest of Kharif crops. Further, the water table is sufficiently high, between 1-2 m below the ground level in the medium lands in many areas. All these facilitate in growing more that two crops in these predominantly rice based mono-cropped areas, even without irrigation facilities. Most of the oilseed crops have deep roots and can tap the untapped resource of soil moisture present in the soil very well.

10.2 MUSTARD SEED IN WEST BENGAL

Since mustard oil is the most preferred cooking medium in West Bengal, greater emphasis has, therefore, been laid on the production of mustard seed in the State. The production trends of mustard seed/rapeseed can be gleaned from the following table X.1

Table X.1 Production of mustard seed in India and the share of West Bengal

(In lakh tonnes)

Year	India	West Bengal
1980-81	23.00	0.80
1984-85	30.07	1.95
1987-88	34.50	3.34
1988-89	44.10	3.27

As stated earlier, the total consumption demand for mustard oil in West Bengal is estimated at 3.5 lakh tonnes. The production of mustard seed aggregated to 3.27 lakh tonnes which yielded about 1.10 lakh tonnes of mustard oil. West Bengal is, therefore, now in a position to meet about 33% of the total requirement of mustard oil. The production of mustard seed must be raised to 12 lakh tonnes from the present level of 3.27 lakh tonnes to meet the demand without depending on other States for the supply of mustard seed and mustard oil. The state's Technology Mission must therefore, address itself to the task of raising production of all oilseeds including mustard seed to at least 20 lakh tonnes by the end of 1999-2000 A.D. The target set for the production of oilseeds at 9.5 lakh tonnes by the Department of Agriculture by the end of 1999-2000 A.D. needs upward revision as the same is not in tune with the requirement of the State. Greater emphasis should, therefore, be laid to grow at least 20 lakh tonnes of oilseeds in West Bengal by the end of the present decade and this should be the first objective of the Technology Mission.

10.2.i Factors: Limiting rape seeds mustard production in West Bengal

Rape Seeds Mustard play a very important role in the aggricultural economy of West Bengal. Even a little improvement in the average yield rate will have great importants on the total production of the state.

Diseases and Insect Pests

Diseases and pets are one of the major limiting factors in the production of rapeseed-mustard. For successful cultivation, timely control of diseases like alternaria blight, white blister, downy mildew and bacterial blight is essential. Our recommended varieties of rapeseed-mustard are susceptible to these diseases. During the last two seasons, alternaria and white blister have played greater role in reducing the production of this crop. Aphids and sawfly are also taking heavy roll and need to be controlled through breeding and application of insecticides.

Lack of varieties suitable for rainfed conditions

Rapeseed-mustard and usually grown under rainfed conditions but there is no suitable variety which may perform well under moisture-stress conditions. Drought resistance appears to be associated with deep root system, higher root weight, greater root shoot ratio and waxy leaves.

Short-duration varieties

In toria, short-duration varieties are required, so that they may fit in multiple cropping programme between kharif and rabi seasons, Short-duration varieties are also desirable to evade the incidence of aphids and moisture stress condition. However, very short duration variety of rai may not be high yielding due to short reproductive phase.

Lack of stable production

Lack of physiologically efficient plant type in rapeseed mustard has been one of the limiting factors in production advance. The lower grain yield of rapeseed mustard may be attributed primarily to their lower harvest index. The morphological architecture of the plant must be reconstructed in such a way that the total dry matter produced is more efficiently partitioned between grains and vegetative parts.

Non-adoptation of recommended agronomic practices

Non-adoption of recommended agronomic practices like timely sowing, optimum fertilizer application, maintenance of plant population and timely irrigation a month after sowing and at pod-formation stage are also bottlenecks in the production of rapeseed-mustard. These crops are usually grown under low fertility conditions, which is an important factor for low yield in West Bengal.

Causes limiting oil production

One of the causes is low seed-oil content. The oil content in a particular variety is lowered due to delayed sowing, higher dose of nitrogenous and phosphatic lertilisers (Abidi and Tripathi, personal communication), intense drought conditions and increased infestation with aphids. Application of sulphur had an incrreasing effect on seed-oil content. However, a significant positive correlation was found between seed yield and oil yield in Indian mustard var. 'Varuna' (Pathak, R.K. and Tripathi, R.D.

10.2.ii) Measures For Achieving Production Advance

Adoption of package of practices

Generally farmers grow rapeseed mustard on marginal lands and as mixed crop with wheat, barely or gram. In mixed cropping, farmers given more importance to main crop. If package of practices are adopted in pure crop or mixed cropping is done with potato and sugarcane, maximum yields can be obtained. Experimental evidence indicates that with the adoption of complete package of practices, yield can be increased by 255%. By giving a margin of about 100% when this is extended to farmers' fields, yields can be doubled with slight efforts (Verma and Hedge, 1979).

For higher production pure crop under more intensive management conditions should be grown. For intercropping, some agro-techniques developed at Kanpur are suggested (Rathi et al., 1979). The general recommendations are: the optimum time of planting of mustard in northen India is the first fortnight of October.

The delay in sowing beyond October results in drastic reduction in Yield. Mustard has been found to be highly responsive to nitrogen even up to 160 kg N/ha. But for average farmers' conditions 80-120 kg N/ha should be applied under irrigated conditions.

Plant population

For the maintenance of optimum plant population, seed rate of 5 kg/ha, and 45 cm row spacing are recommended for irrigated condition.

Diseases and pest control

Plant-protection measures should be applied timely. Diseases like alternaria blight, white blister, and pests such as aphids and sawfly continue to be a great meance. Benlate as a seed-dresser and Dithane M-45 as sprayproved most effecitve in controlling alternaria blight. Downy mildew can be controlled by spraying Difolaton-80 @ 2 kg/ha 1,000 litres of water.

Supply of seeds of improved varieties

Ensuring the supply of seeds of improved varieties to the cultivators may bring production advance quickly. The supply of pure, disease-free and quality seed is very essential for high productivity.

Extension of cultivation of mustard in saline-alkali soil

Researches conducted at Dalipnagar (Kanpur) have indicated that 'Varuna' rai can be grown successfully in saline-alkali boils compared with rabi oilseeds and cereals. If it is sown on the sides of ridges, 120 kg N coupled with 40 kg P_2O_2/ha are applied and 5 irrigations are given, 10-12 q/ha yield may be obtained. It is suggested that such lands may be covered by appropriate mustard varieties.

10.2.iii) Future Stratecy For Improvement of Rapeseed-Mustard

Need for ideotype for rapeseed-mustard improvement

Genetic improvement of a crop can be achieved by combination of suitable morphophysiological characters to obtain a plant capable of high productivity. Better agronomic practices and nigrogen fertilization can increased yields, if the root system is capable of absorbing large amounts of nutrients and water and if the stalk is strong enough to bear the increased bulk of green matter and higher seed weight.

In breeding for yield for areas of marginal productivity, attempts should be made to bread for type ranging in height between 1 and 1.5 m with stiff stalk and possessing more number of primary and secondary branches with more number of siliqua containing higher seed number and seed weight (Singh et al., 1969; Shivahare et al., 1976; Chauhan et al., 1987). However, a better idea of plant type will emerge if physiological characters are also taken into consideration. For mixed cropping, tall plants with compact branches bearing appressed siliqua and having higher seed number and bold seeds are the most appropriate plant characters. Further studies required in this direction are, study of physiological diversity available among genotypes of rapessed and mustard study of physiological as well as biochemical basis of variation in yield, identification of physiologically efficient genotypes of these crops and characterizing traits for structuring optimum plant type with model characteristics know to influence photosynthesis, growth and seed yield and investivation of micro-environment as encountered under various yield-increasing agronomic on growth and yield behaviour of the different plant types.

Resistance breeding for diseases and insect pests

The main factors limiting the production of rapeseed and mustard are diseases and insect pests. Therefore one of the objectives in Brassica breeding should be development of varieties resistant to diseases like alternaria blight, white blister downy mildew and bacterial blight, and to insect pests like aphids, sawfly and painted bug.

Alternaria along with aphids has become a serious problem for rapeseed-mustard cultivation. Very little work has been done to find out the source of resistance to alternaria. During 1973 out of 56 lines of Indian mustard screened against Albugo candida 'T' 4. was considered tolerant to this disease. Of the various insect pests that attack rapeseed and mustard, the aphid (Lipaphis erysimi Kalt) is most important. Control of aphids is essential for the successful cultivation of rapeseed and mustard. Normally, aphids appear at the inflorescence stage, but there is no specific stage for its attack. Heavy losses are caused every year, if sowing is delaved and crop is left unsprayed with suitable insecticides. The search for aphid resistance or tolerance from the existing genetic stocks of various Brassica species and their wild relatives is of great importance.

Root studies

The root activity has a major influence on drought resistance. The importance of deeply extended root system in exploiting soil moisture has been emphasized by Yadava et al. (1979) in Indian mustard for plant types suited to drought conditions. Richard and Thurling (1978) found increased root weight associated with increased yield under drought conditions. A wide range of variation has been observed for some root characteristics like root length, primary roots, root spread, and root weight. The main finding is that there exists considerable intergenotypic variation for the above root characters and it may be possible to select deeper root system in an early maturing variety.

Breeding for early maturity

Early maturity should be one of the main objectives in Brassica breeding and early types should be preferred over late varieties to avoid heavy losses due to incidence of aphids. Early maturing varieties also evade drought as they complete their life cycle before stress conditions. However, very early varieties may reduce seed yield considerably.

To incorporate earliness in rai, 30 strains were isolated from 78 populations developed as a result of biparental crosses. Strain 1268 produced 1,667 kg/ha and matured in 120 days.

Breeding for non-shattering types

Shattering of matured silique is a great problem in rapeseed-mustard. If shattering losses are controlled by suitable means, delayed harvesting can give higher yield per unit area, as the test weight shows steady increase after yellow-pod stage. Sarson and toria may be left in the field for some time as unlike mustard, they are less liable to shatter (Singh, 1958).

Non-shattering habit is important if rapeseed and mustard are grown as mixed crop, because different maturity periods may result in loss of yield. Mustard crop invariable matures earlier and if shattering resistance is not developed siliqua will shatter, giving lower yield.

Breeding for bold seed size

The importance of seed weight in increasing grain yield has been showin in cereals (Frey and Huang, 1969; Knott and Talukdar, 1971) Ahmad and Zuberi (1973) reported that seed size has a distinct bearing on yield components in Indian rapeseed. Singh et al. (1969) and Shivahare et al. (1976) observed positive correlation and direct influence of seed weight on yield in Indian mustard. Besides, bold seed size will reduce antinutritional compounds compared with small seed varities. Inheritance of seed weight has indicated predominance of non-additive gene action (Lal and Singh, 1974; Chauhan and Singh, 1980).

Breeding for frost resistance

Rapeseed-mustard are very much prone to frost attack. In some years frost attacks the crop at the flowering and fruiting stage and reduces yield severely. Therefore germplasm should also be screened for frost resistance and effective breeding programme may be initiated.

Breeding for high oil content

Oil content in rapeseed and mustard is a character which is less effected by environment. Screening of germplasms strains/varieties for oil content of 769 cultures of Indian mustard, 104 cultures of toria, 99 cultures of brown sarson and 436 cultures of yellow sarson showed oil content of 33 to 49%. Recurrent selection may be useful for improvement of oil content. Genotypes with high oil content should be screened by NMR and combined with high yielding types.

Breeding for improved quality

For starting improvement programme in the quality of rapeseed and mustard, it is essential to know inheritance of the fatty acids and sulphur compounds. The high content of erucic acid in the Indian rapeseed and mustard is not a serious problem here due to low per-caput intake of the oil. Rapeseed-mustard oil contains appreciable levels of linolenic acid (6-10%). The presence of this fatty acid makes oils susceptible to autoxidation, resulting in off-flavour. Lowering the linolenic acid content through plant breeding would be major improvement in the quality of the oil.

The presence of a high percentage of glucosinolates is undesirable and low glucosinolate varieties should be develop. However, without glucosinolates, there will be no pungency in oil and taste has to be developed for oil of low pungency.

While breeding rapeseed and mustard varieties for quality, following objectives should be kept in mind: yellow seed coat colour, oil plus protein more than 73%, linoleic acid content more than 30% and linolenic acid content less than 45%. The glucosinolate content should be very low.

The seed-cost has a low content of fat and protein and high content of fibre. High fibre content contributes to the overall reduction of the feed value of rapeseed-mustard meal.

When edible protein products are to be made from rapeseed meal, the dark colour of the seed-coat is a considerable problem, since most of the protein products will have low eye appeal. Thus low percentage of seed-coat and incorporation of yellow colour in seeds in very important. 'Kl' (yellow-seeded rai) has been developed at Kanpur and researches are in progress to transfer yellow seed-coat colour in the agronomic bases like 'Varuna'.

10.2.iv) Breeding Methods For Improvement of Rapeseed-Mustard

Rapeseed and mustard differ in breeding systems and hence require different breeding procedures for their improvement. Progress in evolving high-yielding varieties of these oilseeds has been very slow. Breeding work has been confined to pureline selection, mass selection, pedigree, mass pedigree and production of composites and synthetics. As the yield potential of the local cutlivars is very low, the increase

Table X-2. Rape and mustard crop production per district in West Bengal 1989-90

District	Area in '000 hectores	Yield rate in kg/hect.	Production in '000 tonnes
1. Darjeeling	1.106	740	0.82
2. Jaopaiguri	10.139	461	4.67
3. Coochbehar	6.829	565	3.86
4. West Dinajpur	48.080	809	38.89
5. Malda	28.704	786	22.56
6. Murshidabad	51.446	849	43.70
7. Nadia	42.900	935	40.10
8. 24 Parganas (N)	30.499	1,064	32.46
9. 24 Parganas (S)	1.631	1,134	1.85
10. Howrah	0.838	513	0.43
11. Hooghly	9.948	1,012	10.07
12. Burdwan	45.434	971	44.12
13. Birbhum	51.387	997	51.22
14. Bankura	12.898	862	11.12
15. Purulia	0.949	954	0.90
16. Midnapur (W)	16.271	892	14.52
17. Midnapore (E)	4.003	862	3.45
Total West Bengal	363.062	894	324.74

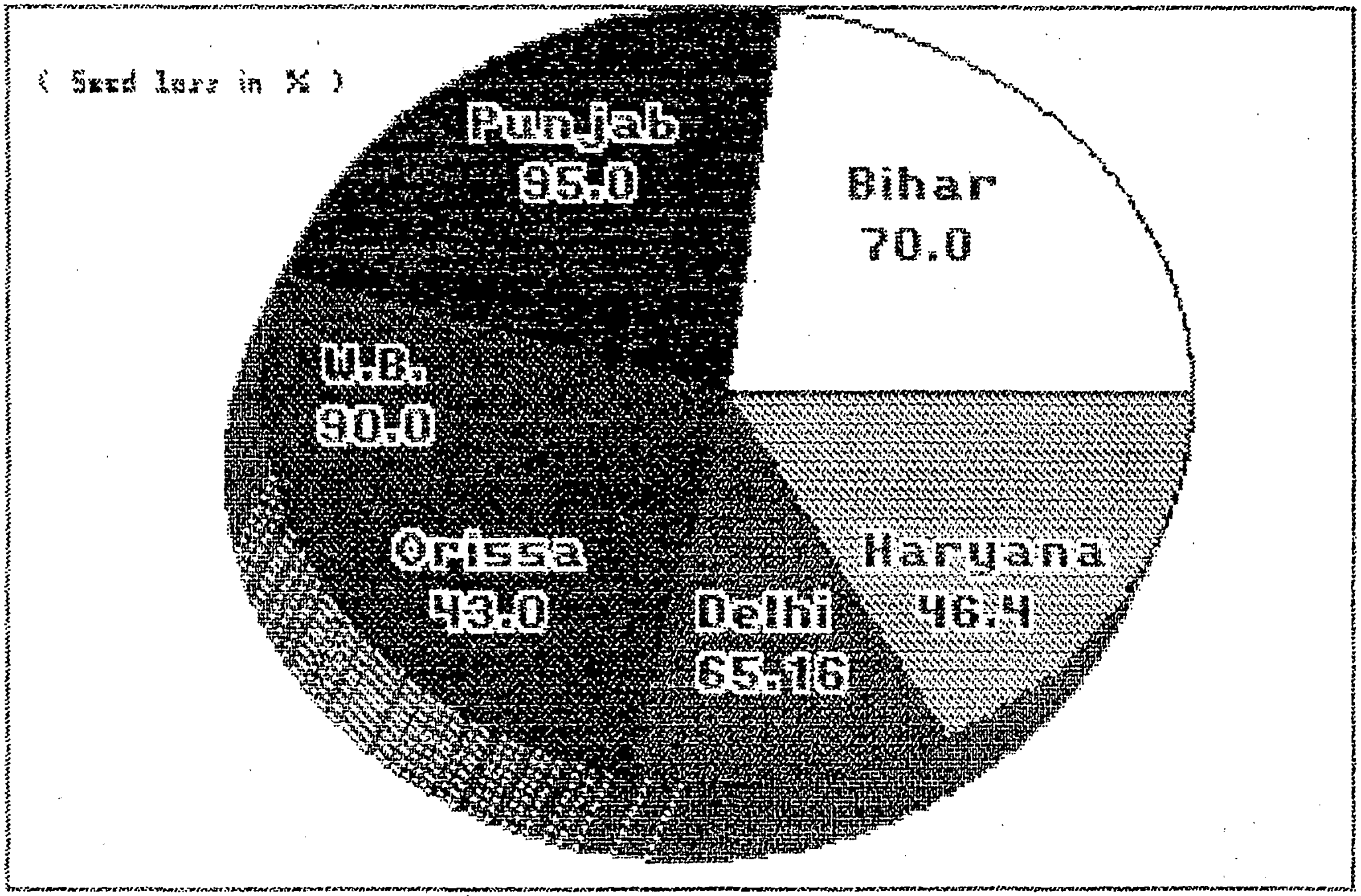
of 5-10% yield potential compared with local varieties is not substantial. There is no scope for achieving breakthrough in yields with these methods. Therefore new approaches for improvement or rapeseed and mustard may be worked out. For cross-pollinated group, multiple crossing programme which would associate a group of genotypes in a single a productive composite/synthetic/elite populations would be an appropriate approach. In self-pollinated group undersirable linkage between characters (seed size, yield, oil content) contributing to productivity may be useful by adopting recurrent selection. Studies of varietal differences concerning root activity and development should be also initiated. The following measures may be adopted for achieving advancement in breeding: (i) a large number of crosses should be made instead of few crosses for faciliating more desirable recombinations, (ii) cytogenetic studies for interspecific gene transfer should be initiated, (iii) interspecific hybridization should be taken up to incorporate aphid resistance from B. tournofortii in Indian rapeseed and Indian mustard, (iv) mutation breeding should be used for aphid resistance and quality improvement, (v) possibility, of utilizing self-incmpatibility should be worked out to produce F_1 hybrids, and (vi) production of male-sterile and restorer lines should be attempted.

10.2.v Topography, Climate and Mustard Oil Seed Production

West Bengal is marked by a variety of Topography and diversity of climate. It covers farflung temperate hills and tropical plains. High rainfall and humidity has been made the environment less conductive to the accelerated growth of oil seeds. More over the expansion of towns and industry gradually encroaching the cultivable land and has also a considerable strength of tribal population following a primitive agricultural system.

10.2.vi) Losses of Yield in Rapeseed and Mustard

Convincing proof showing the importance of insect pests and especially the mustard aphid as a main cause of low yields of rapeseed and mustard is provided by a number of workers from different states of India (Table X-3)



Yield losses in rapeseed and mustard

Table X-3. Yield losses in rapeseed and mustard

State	Seed loss (%)	Reference
Pubjab	95.0	Singh and Sidhu (1959)
West Bengal	90.0	Rout and Pani (1967)
Orissa	43.0	Rout and Pani (1967)
Delhi	78.0-90.0	Peshwani et al. (1968)
	60.0-97.0	Prasad (1978)
	24.0-42.0	Prasad (1979)
	27.5-65.3	Shinghvi et al. (1973)
Bihar	70.0	Chowdhary et al. (1975)

Losses ranging from 24.0% to as high as 95.0% have been recorded from the major mustard-growing areas of the country. No doubt that most of the data have been collected from experimental fields where the infestation is generally high, there are also numerous reports of complete devastation of the crops on the farmers' fields.

Crammer (1967), a world authority on crop losses, has given an estimate of losses in rapeseed in Asia due to insects, diseases and weeds. Based on the data collected from diverse sources, he has estimate 12% loss due to insect in rapeseed.

Table X-4. Annual losses of rapeseed due to differenent pests in Asia (Crammer, 1967)

Actual production ('000 tonnes)	Potential production ('000 tonnes)	Losses by			Total
		insects	diseases	weeds	
1,850	2,721	327 (12%)	217 (8%)	327 (12%)	871 (32%)

Recent data collected in India, both on experimental as well as farmers' fields, have shown that losses due to insects and especially by aphid, are much higher and never less than 25%. However, even under the lower limit of about 15% insect damage the seed loss during 1976-77 and 1977-78 is estimated to be about 233,000 and 243,000 tonnes respectively (Table X-4).

Table X-5. Estimated loss in rapeseed and mustard in India

Year	Actual Production ('000 tonnes)	Potential Production ('000 tonnes)	Losses by insects*
1976-77	1,551	1,784	233
1977-78	1,618	1,861	143

*Based on conservative estimate of 15% loss

To fill the gap between production and demand in the country, the latest available figures indicate that nearly 3,050 tonnes of mustard seed was imported during April December 1976 and 80 tonnes of mustard oil was imported from April 1976 to January 1977. The data on avoidable losses due to insects show that by insect control alone, not only the import of mustard can be stopped but large surplus can be created which can further help reduce the import of other oilseeds and oils.

Recommended control measures

Based on the experience and experimentation, an integrated approach consisting of mechanical and chemical methods has been recommended for the 3 major pests of rapeseed and mustard.

At the initial stage of light and scattered infestation, sawfly larvae can be easily collected and killed by shaking the seedlings and plants over small containers filled with kerosenized water. Their presence can be conveniently detected by typical shot-hole damage on the leaves. This method can also be usefully employed for the painted bug, which can be spotted by its bright coloration. If more that 5% plants are found infested, the crop should be dusted with 10% BHC @ 12-15 kg/ha. However, if part of the crop is also to be used as a vegetable during early stage, it should be sprayed with 0.05% malathion. Care should be taken to treat the underside of leaves.

For checking aphid damage, regular surveillance of the should be undertaken, especially during the flowering stage. Yellow-coloured adhesive traps can prove useful for monitoring. Initial infestation of aphids is generally confined to a few paints and on the upper twigs only. Mechanical control of cutting and destroying the twigs at this stage can considerably reduce the population build-up of the pest. However, if more than 5% plants are infested, the crop should be sprayed with any of the following insecticides @ 800-1,200 litres/ha: phosphamidon 0.025%, methy demeton 0.025%, didethoate 0.03% or endosulfan 0.05%.

The treatment may be repeated after 15 to 20 days, if after survey more that 5% of plants continue to be infested by the aphid colonies.

As far as possible the crop should be sprayed in the afternoon or evening, when the activity of pollinators is low. The crop should not be sprayed if the population of lady bird beetles and syrphid fly larvae is high.

Cost: Benefit Ratio

Highly favourable cost: benefit ratio due to control of mustard aphid has been reported by using different insecticides (Tables X-5 and X-6). In addition to the insecticides already recommended, two more insecticides have also found effective. Chlorpyrifos gave the highest return, while menazon is claimed to be relatively safer for pollinators and predators. Additional data are required on some aspects, especially residues and persistence, before recommending the two insecticides.

Table X-6. Economics of chemical control of mustard aphid

Treatment		Mean yield (kg/ha)	Net additional income due to treatment (Rs.)*
Chlorpyrifos	0.05%	1,125.6	1,361
Phosphamidon	0.05%	970.9	1,245
Menazon	0.35%	901.6	1,117
Malathion	0.05%	527.0	595
Control		184.2	

*After deducting the cost of application.

Table X-7. Economics of chemical control of mustard aphid

Treatment	Increase in yield over control (kg)	Net additional income due to treatment (Rs)*
Chlorpyrifos	1,213	1,991
Phosphamidon	770	1,249
Methyl demeton	891	1,457
Lindane	480	723

*After deducting the cost of application.

10.3 COCONUT PLANTATION/COPRA IN WEST BENGAL

West Bengal is one of the leading consumers of coconut oil in the country. According to trade estimate, the State consumers about 50,000 tonnes of coconut oil per annum but not a single tonnes of copra is produced out of coconuts grown in the State. Imports of copra and coconut oil into West Bengal are mainly made from Southern and Western Regions and to a little extent from Andaman and Nicobar Islands. Coconut oil is mainly used as hair oil in West Bengal. The unorganised soap industry has now discarted the use of coconut oil, as hard fat, because of other chaper substitute. It is estimated that about 80% of the coconut grown in West Bengal is used as a soft drink at pre-matured stage. Green coconuts are brought to Calcutta and sold at attractive prices. The total values of this coconut is estimated at Rs.20 crores per annum. It is stated that the Calcutta Municipal Corporation is required to deploy about 100 trucks daily for the removal of used "dubs".

10.3.i) Copra/Coconut Development Programme of the Association

In West Bengal the plantation of coconut is mostly confined in the Coastal districts of 24 Parganas, Midnapore and in the riverine belts of Howrah and Hooghly.

According to the agricultural experts, coconut oil can well be grown in fertile alluvial loomy soil where adequate moisture and drainage are available. The major bottleneck in the making coconut, a commercial crop like copra, is that the framers are much more interested in quick return by selling green coconuts, ignoring the ultimate colossal economic loss to the West Bengal economy. According to trade estimate, there is net annual outflow of Rs.125 crores from West Bengal to other States on account of import of copra and coconut oil to meet the local consumption demand.

The Copra and Coconut Oil Development Committee of the Eastern India Oil Industry and Trade Association has drawn up a programme to enthuse the framers to grow more matured coconuts in their respective holdings with an assurance of marketing of coconuts at remunerative prices. In keeping with the programme, the Association has already supplied and would be supplying coconut seedlings to the nominated farmers free of cost, under certain conditions. The seedlings supplied 4/5 years back to the nominated farmers of Udainarayanpur, Howrah, have started yielding quality nuts. The wastage of coconuts, at its green stage, need be stopped by the Government through the help of mass media. The Association is fully convinced that the production of milling copra must be started in West Bengal to reduce the dependence of the local copra crushing industry for the supply of copra from Southern States including Andaman and Nicobar Islands. The need for setting up of a Copra Drying Yard, particularly in the areas of Howrah and Hooghly, where the Association has undertaken the programme of coconut plantation requires no renewed emphasis. It is, however, distressing that the request of the Association for setting up of a Copra Drying Yard roughtly costing around Rs.2 lakhs has gone unheeded by the State Government and the Coconut Development Board. Obviously, the Association has its own limitation and its cannot go too far without financial assistance from the Government in this regard.

10.3.ii) Coconut Plantation/Copra in West Bengal

Coconut/copra is one of the most important sources of vegetable oils, yielding upto 65% of oil. Coconut is grown widely in the country but the plantation has come to stay in the coastal areas. The production of coconut, milling copra and account oil in the country can be gleaned from the following table no. X-8.

Table X-8. Estimated Production of Coconuts, Milling Copra and Coconut Oil

Year	Area under coconuts in '000 ha	Production of coconuts (Million Nuts)	Production Milling Copra (in lakh tonnes)	Production of Coconut Oil (in lakh tonnes)
1983-84	1,165.6	5,807.9	2.72	1.72
1984-85	1,183.3	6,912.8	3.56	2.24
1985-86	1,225.6	6,770.3	3.48	2.19
1986-87	1,231.2	6,376.8	3.18	2.00
1987-88	1,428.7	7,562.3	3.82	2.41

Though India in one of the biggest producers of coconut in the world, the per capita availability of coconut is 11 nuts per annum as against 220 nuts in Philippines and 230 nuts in Sri Lanka. The plantation of coconut for making copra, has not, however, made any headway in West Bengal compared to other States of Southern Region. The State-wise production of coconut can be gleaned from the following table (no. X-9).

Table X-9. All India Final Estimate of Coconut 1988-89

State/U.T.	Area (thousand hectares)		Production (million nuts)	
	1987-88 (Revised)	1988-89	1987-88 (Revised)	1988-89
Andhra Pradesh	48.8	52.0	480.3	511.2
Assam	9.1	9.3	79.9	65.9
Goa	23.2	23.2	106.9	107.2
Karnataka	213.1	219.5	1,096.5	1,129.4
Kerala	775.4	866.5	3,346.0	8,841.0
Maharashtra	7.8	7.8	88.9	103.0
Orissa	27.1	27.1	113.7	113.7
Tamil Nadu	189.5	214.2	1,578.3	1,917.8
Tripura	5.6	5.6	3.3	3.3
West Bengal	19.1	19.8	248.5	238.5
Andaman & Nicobar Islands	22.8	23.3	80.0	81.4
Lakshadweep	2.8	2.8	24.8	25.2
Pondicherry	1.7	1.7	22.8	23.2
Total	1,346.0	1,472.8	7,269.9	8,160.8

Scope

Unlike annual oilseed crops, coconut when planted once in the field remain in productive phase for more than 50 years. With normal management practice one can go on getting the yield for many years. Besides the oil yield, these two crops, because of their perennial vegetation, contribute to a greater extent in maintaining the agro-forestry system.

Higher oil yield

Coconut are capable of giving four to seven times more oil compared to groundnut, the most popular oilseed crop in the country. Harry (1984) has compared the average yield of oilseed crops and indicated that oil palm in Malaysia is able to produce 3,895 kg oil/ha while the peanut, rapeseed, safflower and sunflower in U.S.A. produce only 790, 409, 762 and 589 kg oil/ha, respectively.

10.3.iii) Adaptability to a Very Wide Climatic and Soil Conditions

Though coconut is a crop of humid tropics it can be grown under varying soil and climatic conditions from saline sea coast to an elevation of 1,000 metre. It is widely grown in both East and West Coasts and also in central parts of the States of Kerala, Karnataka, Tamil Nadu, Orissa, West Bengal, Maharashtra, Assam, Goa, Andamans and Lakshadweep Islands. Coconut can also be grown under situations such as back water areas along the coast, paddy field bunds, river banks subjected to inundation, and canal bunds n the major irrigation project areas. In these areas, coconut can be grown either is a row planting or block planting according to the conditions available. Coconut growing is having a good potential in areas like Bihar and Uttar Pradesh, which is available in West Bengal.

Available of Production Technology for Higher Yields

Coconut respond well to the management conditions. Simple cultural practices, manuring and irrigation have considerable impact in increasing the yield. Production technologies for better yields are readily available in different coconut growing states.

Even in the black and red soils of maidan tract of Karnataka, and coastal sandy soils of Konkan Coast, manuring has increased the yield considerably. However, hybrids are able to give more yield under normal manurial and good management conditions.

Likewise, though the oil palm yield of 1.4 tonnes of oil/ha/year obtained in Kerala is not a potential yield, better management such as pruning of trees, bench terracing of palm base and mulching the same, split application of fertiliser, and cover cropping the inter spaces, an oil yield of 2 tonnes per ha could be easily achieved (Bavappa, 1982).

Possibility of Raising Innumerable Inter/Mixed Crops

Coconut is a widely spaced perennial crop grown with a spacing of 7.5x7.5 metre (56.25 m^2), the area of maximum spread of roots is only 12.57 $metre^2$ which is only 22.24 per cent of the total area (Nelliat et al., 1974) and this provides 77.76 per cent of its area to other crops. Thecanopy pattern and solar energy utilisation also indicated the possibility of growing compatible inter-crops (Nelliat et al., 1974).

Table X-10. Estimated area for coconut seed gardens and the parents (area in ha)

State	Area to be brought under		Parents proposed
	Dwarfs	Talls	
Kerala	2,000	500	CDO, MDY, Gangabondam, WCT, Laccadive Ordinary, Andaman Ordinary, Philippines Ordinary, Kappadam
Karnatak	200	175	CDO,MDY, Tiptur Tall, WCT.
Tamil Nadu	160	100	CDO, MDY, ECT, AO.
Andhra Pradesh	50	50	MDY, Gangabondam, ECT.
Orissa	240	240	CDO, MDY, ECT, AO.
West Bengal	140	100	MDY,Gangabondam, ECT, AO.
Goa	20	20	CDO, MDY, Benaulim, WCT.

Private sector can play a very dominent role in making available this achievement for the benefit of our farmers. The success met with inestablishing clonal oilpalm gardens in Malaysia from tissues cultured hybrids can be taken as a forerunner in this regard. Until and unless enough seed gardens are established in our country, the demand for the quality seedlings cannot be adequately met. The major crop Research Institutes are likely to take up more fundamental work and the full exploitation of the available genetic material and scientific knowledge has to come from private agencies and voluntary individuals.

10.4 LINSEED

The production of linseed is mainly concentrated in M.P., U.P., Maharashtra, Bihar and Rajasthan which account for about 90% of the total all-India production. The place and position of West Bengal in the total production of linseed in the country can be gleaned from the following table (no. X-11).

Table X-11. Production of Linseed

(In '000 tonnes)

Year	India	Share of West Bengal
1980-81	423.00	19.00
1986-87	316.00	7.00
1987-88	372.00	5.00
1988-89	400.00	6.4

In West Bengal linseed oil is a non-edible oil. It is mostly used as industrial oil in the manufacture of paints, varnish, soap and so on. In West Bengal, linseed is cultivated as a mixed crop in a leisurely fashion in order to restore the fertility of soil. As is well-known, the soap industry is one the main consumers of linseed oil. Since majority of the unorganised soap industry are heavily concentrated in and around Calcutta, the of take of linseed oil is necessarily greater than other

States. Despite heavy demand, it is surprising that productivity of linseed crop in West Bengal.

Table X-12. List of improved varieties of linseed recommended for cultivation in West Bengal

State	Name of variety	Crop duration (days)	Oil content (%)	Average yield (kg/ha)	Special Remarks
West Bengal	B-37	135-145	41.6	350	Dual purpose variety
	B-27	135-145	41.5	832	Dual purpose variety
	B-96	135-145	42.6	700	Moderately resistant to rust

10.5 SESAME SEED

Sesame seed has been a very promising oilseed crop for West Bengal. Since early seventies, the production of sesame seed in West Bengal has increased by nearly 10 folds. The production of sesame seed in West Bengal rose from 0.2 lakh tonnes in 1975-76 to 1.40 lakh tonnes in 1988-89, accounting for about 30% of all India production. The production target of 5 lakh tonnes of sesame seed in West Bengal by the end of Eight Plan, if judged by past performances, would not be unrealistic. But sesame seed of West Bengal origin has some inherrent problems and peculiarities which have restricted the wider usage of sesame oil. This has to be overcome. The problem basically relates to the specifications as enjoined in the PFA Rules and Agmark.

The PFA Rules enjoin two specifications for sesame oil. Mention may be made that there are 24 edible oils, the specifications for which have been laid down in the PFA Rules. As mentioned earlier, sesame oil is the only edible oil which has two types of specifications in the PFA Rules No. 17.11.

One for til (sesame) oil of general variety and the second for till oil, derrived from sesame seed grown in West Bengal, Assam and Tripura. The specification for til oil of general variety and also for till oil of West Bengal, Assam and Tripura origin can be gleaned from the following :

SPECIFICATION FOR GENERAL VARIETY FOR SESAME OIL

B.R. Reading	58.0 to 61.0
Sap. Value	188 to 193
Iodine Value	103 to 120
Acid value not more than	1.5%
Bell test not more than	22°C

SPECIFICATION FOR SESAME OIL DERIVED FROM SESAME OF WEST BENGAL, ASSAM AND TRIPURA ORIGIN

B.R. Reading	56.6 to 65.4
Sap. Value	185 to 190
Iodine Value	115 to 120
Acid value not more than	2.5%
Belt test not more than	22°C

But the specifications for sesame oil derived from sesame seed grown in West Bengal, Assam and Tripura have become meaningless as per Rule 44°C of the PFA Rules which reads as under :

Restriction on Sale of Til Oil, Produced in Tripura, Assam & W. Bengal

Til Oil (Sesame Oil) obtained from white sesame seed, grown in Tripura, Assam and West Bengal, having different standards than those specified for Til Oil shall be sold in sealed containers bearing Agmark Label: where this Til Oil is sold or offered for sale without bearing an Agmark Label the standard given for Til Oil shall apply.

It is evident from the aforesaid specifications that til oil of West Bengal, Assam and Tripura origin cannot sold for about human consumption without Agmark label. But there is no provision in Agmark for grading til oil of West Bengal, Assam and Tripura origin as per Standards laid down in the PFA Rules. Mention may be made that Agmark has only one specification which is applied to general till oil specification and not for the specification of til oil for Assam, West Bengal and Tripura origin, as enjoined in the PFA rules. Obviously, this is one of the most serious inhibiting factors as til oil obtained from sesame seed, grown in West Bengal, Tripura and Assam, Cannot be used for direct human consumption on account of specificational problems. As a result, till oil is used to a limited extent by the local vanaspati manufacturers and the rest is largely used as industrial oils. The restricted usage perhaps stands in the way of realizing remunerative prices by the till seed growers. The Bureau of Indian Standards, on the basis of representations received from different quarters including ours decided to amend the specification for till oil in their meeting held on 3rd and 4th February, 1983 but unfortunately the same is yet to be given effect to by the CCFS and Agmark authorities.

The twin specification problem for til oil can be sorted out by amalgamating the existing two specifications into one in the PFA rules. The Central Government has the power to make rule under section 23 of the PFA Act by issuing suitable notifications in this regard. This is a point deserving serious attention of the West Bengal State Oilseeds Technology Mission and also the Department of Agriculture which are seriously addressed to the task of making the country self-reliant in respect of vegetable oils. The sesame oilcake is mainly used as cattle feed as the same is not ordinarily brought under solvent extraction process. The market for solvent extracted til oil need also be widened.

10.6 RICE-BRAN

Rice bran is a good source of vegetable oil. The larger production of paddy would naturally augment the supply of raw rice bran. The production of rice in the country including West Bengal has shown a persistent increase which can be gleaned from the following table (no. X-13).

Table X-13. Rice production in India and Share of West Bengal

(In lakh tonnes)

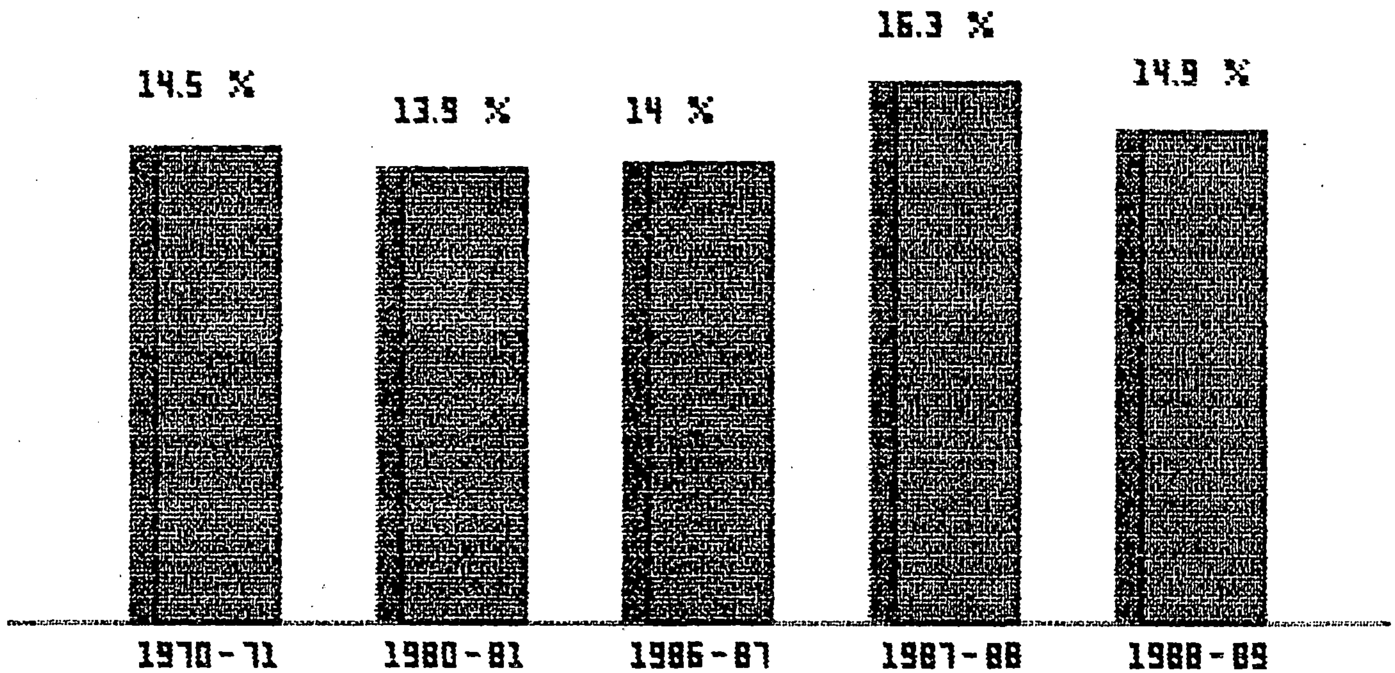
Years	Total Production in India	Share of West Bengal
1970-71	422	61 (14.5%)
1980-81	536	75 (13.9%)
1986-87	606	85 (15%)
1987-88	568	93 (16.3%)
1988-89	760	106 (14.9%)

(The figures in the Brackets denote percentage of production in West Bengal in terms of all India production)

By 1994 the production of rice is expected to reach 800 lakh tonnes. On the assumption of 7% recovery of bran, the total potential of rice bran works out to 56 lakh tonnes. Corresponding to 8.4 lakh tonnes of rice bran oil on the basis of 15% recovery of oil from bran.

According to the Working Group on Oils, Soaps and Detergent, appointed by the Planning Commission, the realisable potential would be lower as currently there are several constraints in augmenting the availability of extractable quality rice bran. The most serious constraint in making larger availability of rice bran may be traced to predominance of rice hullers where recovery of rice bran is ruled out. The Working Group has estimated that no more than 6 lakh tonnes of rice bran will be available in 1994-95.

RICE PRODUCTION IN INDIA & SHARE OF WEST BENGAL



It is likely that 3.5 lakh tonnes of edible grade rice bran oil were likely to be produced and that only 2.5 lakh tonnes of industrial grade rice bran oil might be available to the soap industry by the end of the Eight Fiver Year Plan. The structural set up of the rice mills in India can be gleaned from the following table

As stated above, that rice bran, among the available sources of oils, holds the highest promise in terms of augmenting the availability of oils, both for industrial and edible uses in West Bengal. This, however, requires a pragmatic and co-ordinated approach. A programme be launched for motivating the rice-hullers to adopt modernisation/ modification of their plants and to help them technically and financially to change over to the mini rice mill or modified hullers. An action programme might also be drawn up to modernise at least 25% of the existing rice hullers in West Bengal by the end of the Eighth Plan. The existing levy policy on rice and rice bran, produced by the rice mills, need to be changed so as to ensure increased availability of extractable rice bran. It is suggested that all rice mills upto a capacity of at least 500 kgs per hour be exempted from the levy system.

10.6.i) Rice Bran in West Bengal in Context of National Production

It is well-known the West Bengal has a wide demand supply gap iin vegetable oils. West Bengal being a non oil seed producing area, the gap is quite large and is widening every year. Though the production of rapeseed has increased in last 3/4 years but still a lot can be done and there is every possibility to increase the production of rapeseed to the extent of 10 lakh tonnes without any addition of land. The only effort to be made is to introduce HYV seed because the average production per hectare is in between 800 and 900 kgs. whereas in Gujarat it has already touched 1900 kgs. under NDDB and on the higher side in the world it has reached around 3000 kgs. This is the most important area to be looked into. Over and above, the new oilseeds viz. Sunflower, Soybean and Safflower cultivation in West Bengal, as is being done in other State be introduced.

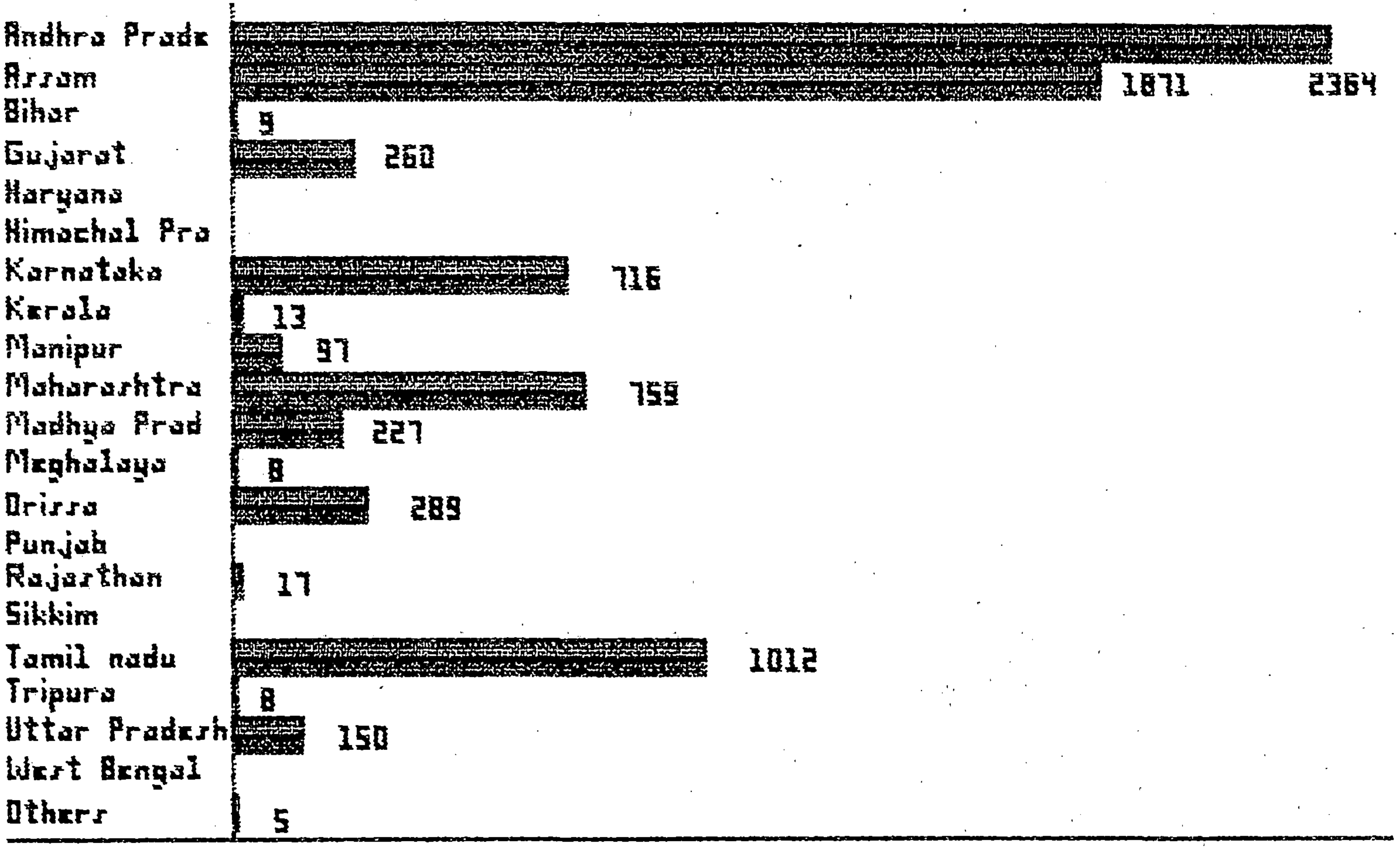
However, immediate solution before West Bengal is to properly restructure the rice milling industry because that area can give a substantial quantity of edible quality of rice bran oil. Andhra Pradesh produces about 11.5 million tonnes of rice as against 11.0 million tonnes in West Bengal. But due to restructuring of rice mills and modernising the Huller mills, the rice bran processed for extraction of oil in Andhra Pradesh was 8.5 lakh tonnes during the year April '89 to March 90 as against only 78,000 tonnes in West Bengal. This has happened because a very large number of Husking mills (Huller mills) are operating in West Bengal. These units have an edge over the rice mills because of fixed price of rice at which the levy rice has to be given to the Govt. and that fix up their purchase price of Paddy. On the other hand, there is no levy on the Huller mills due to which they can buy paddy and sell rice at remunerative rates. Due to this anomally, West Bengal is losing about 7-50 (267-5) lakh tonnes rice bran of which the value today is Rs.300 crores. This 7.5 lakh tonnes rice bran when processed can yield 1.5 lakh tonnes of edible quality rice bran oil, valuing about Rs.300 crores. It is also lossing 6.00 lakh tonnes rice bran extraction of value about Rs.300 crore. With this one can appreciate as to what a colosal loss West Bengal is making. Over and above, due to non-recovery of this, a net foreign exchange loss of over Rs.200 crores is also occuring.

During the period from April to September 1990 Andhra Pradesh has processed 4.6 lakh tonnes rice bran in 6 months producing 70,000 tonnes of rice bran oil and exported 1.37 lakh tonnes of rice bran extractions valuing Rs.16 crores.

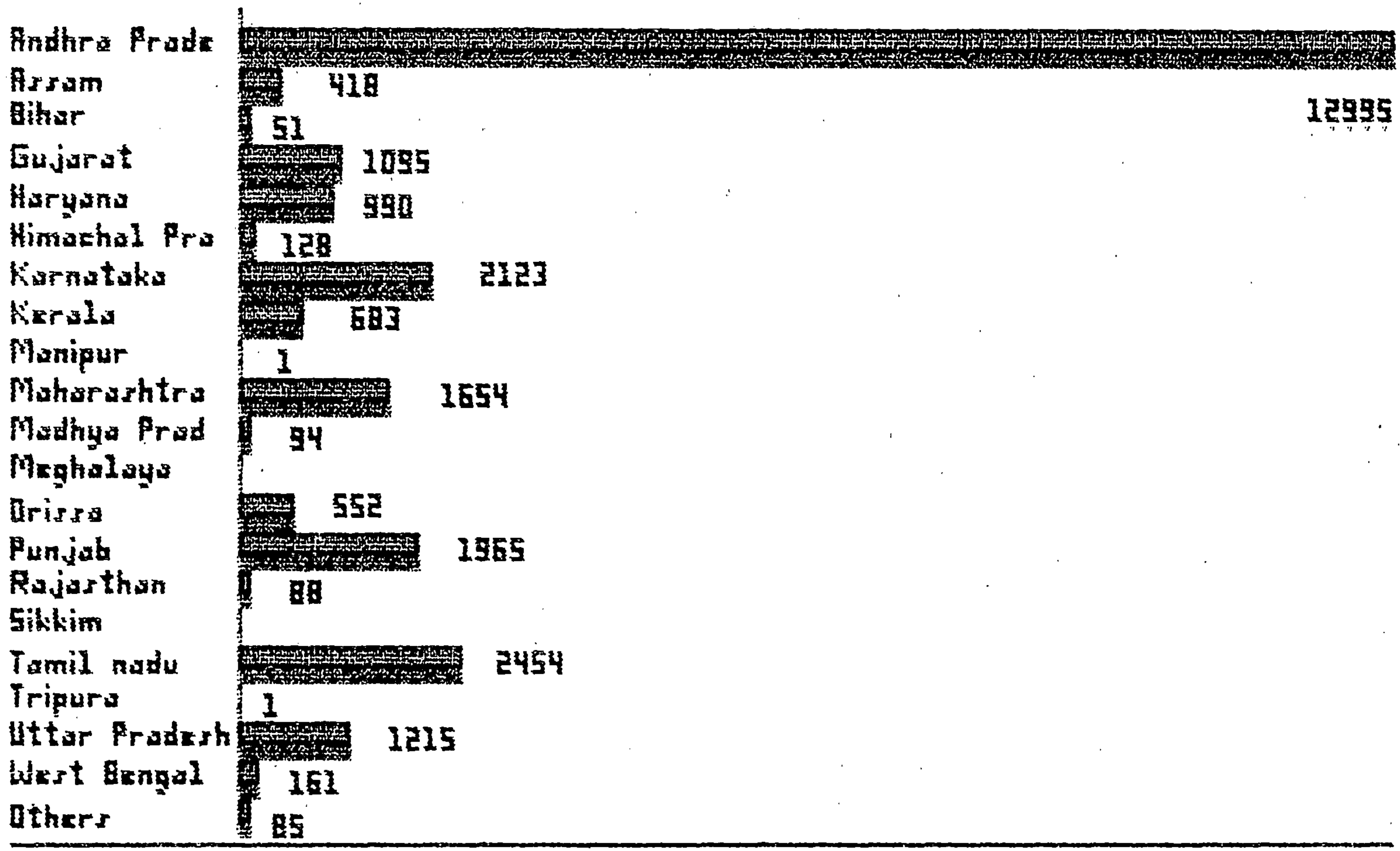
Several states viz., Andhra Pradesh, Punjab, Karnataka, Uttar Pradesh and Maharashtra have realised the necessity of modernising the Huller mills. An immediate programme is being taken to convert Hullers into mini-rice mills or modernised huller mills with a capacity 500 kgs per hour and no levy is being charged on such mini rice mills. This serves as an incentive to the Husking mills to modernise and to start producing rice bran. They get three fold benefits as under:

Table X-14. State-Wise Number of Rice Mills (as on 1.1.1988)

State/Union Territory	Hullers	Shellers	Hullers cum shellers	Modern/ Modernised Rice Mills	Total
Andhra Pradesh	4,609	1,776	2,364	12,995	21,744
Assam	305	14	1,871	418	2,608
Bihar	4,749	63	9	51	4,872
Gujarat	2,105	132	260	1,095	3,592
Haryana	807	-	-	990	1,797
Himachal Pradesh	1,098	10	-	128	1,236
Jammu & Kashmir	-	-	-	-	-
Karnataka	8,181	884	716	2,123	11,904
Kerala	13,270	4	13	683	13,970
Manipur	71	-	97	1	169
Maharashtra	4,444	352	759	1,654	7,249
Madhya Pradesh	3,114	239	227	94	3,674
Meghalaya	85	-	8	-	93
Nagaland	-	-	-	-	-
Orissa	6,398	125	289	552	7,364
Punjab	4,416	442	-	1,965	6,823
Rajasthan	275	22	17	88	402
Sikkim	17	-	-	-	-
Tamil Nadu	13,988	10	1,012	2,454	17,464
Tripura	689	5	8	1	703
Uttar Pradesh	5,707	562	150	1,215	7,634
West Bengal	9,175	37	-	161	9,373
Others	982	1	5	85	1,075
Total	84,485	4,678	7,845	26,753	1,23,761

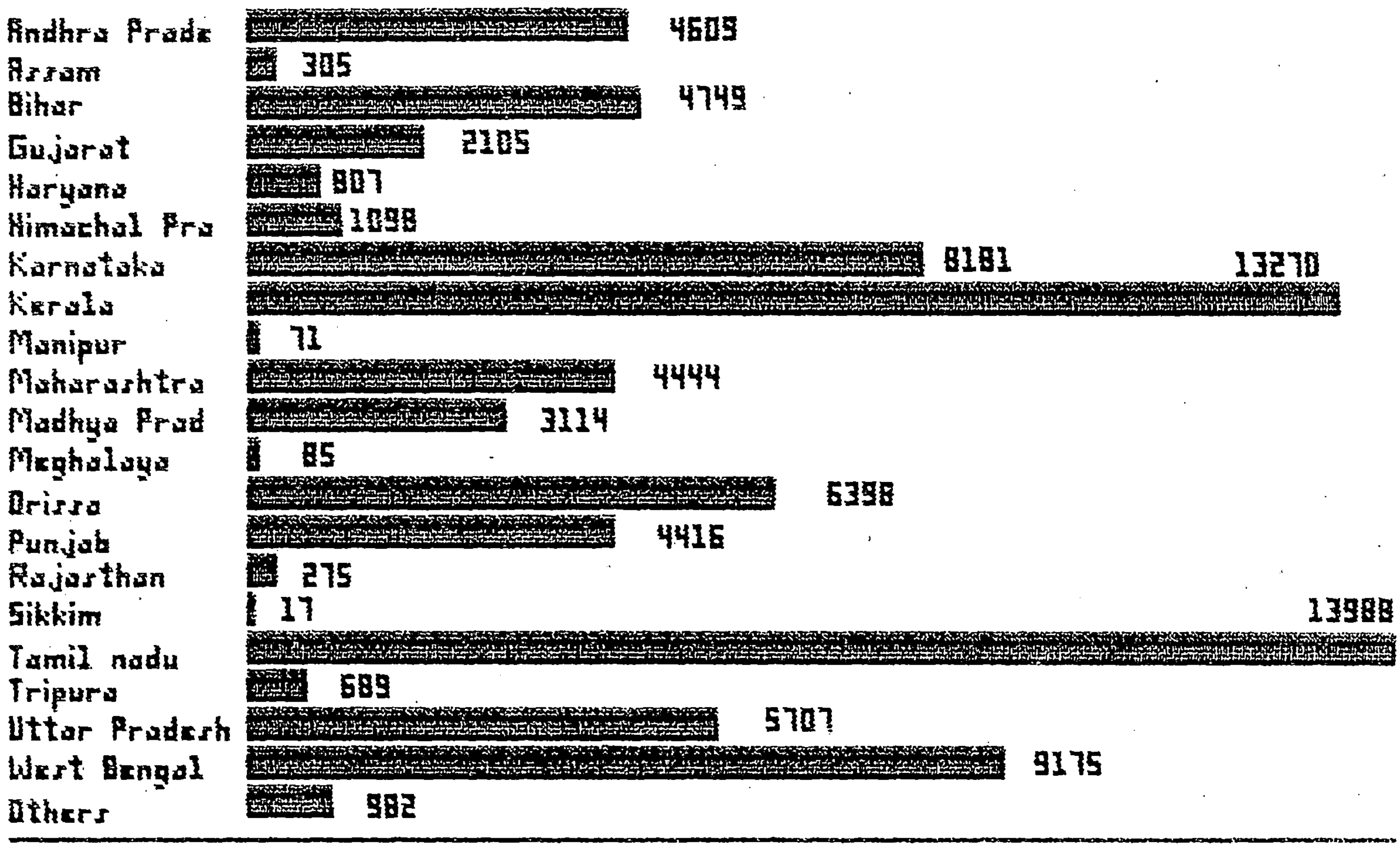


STATE WISE NUMBER OF RICE MILLS
HULLERS CUM SHELLERS

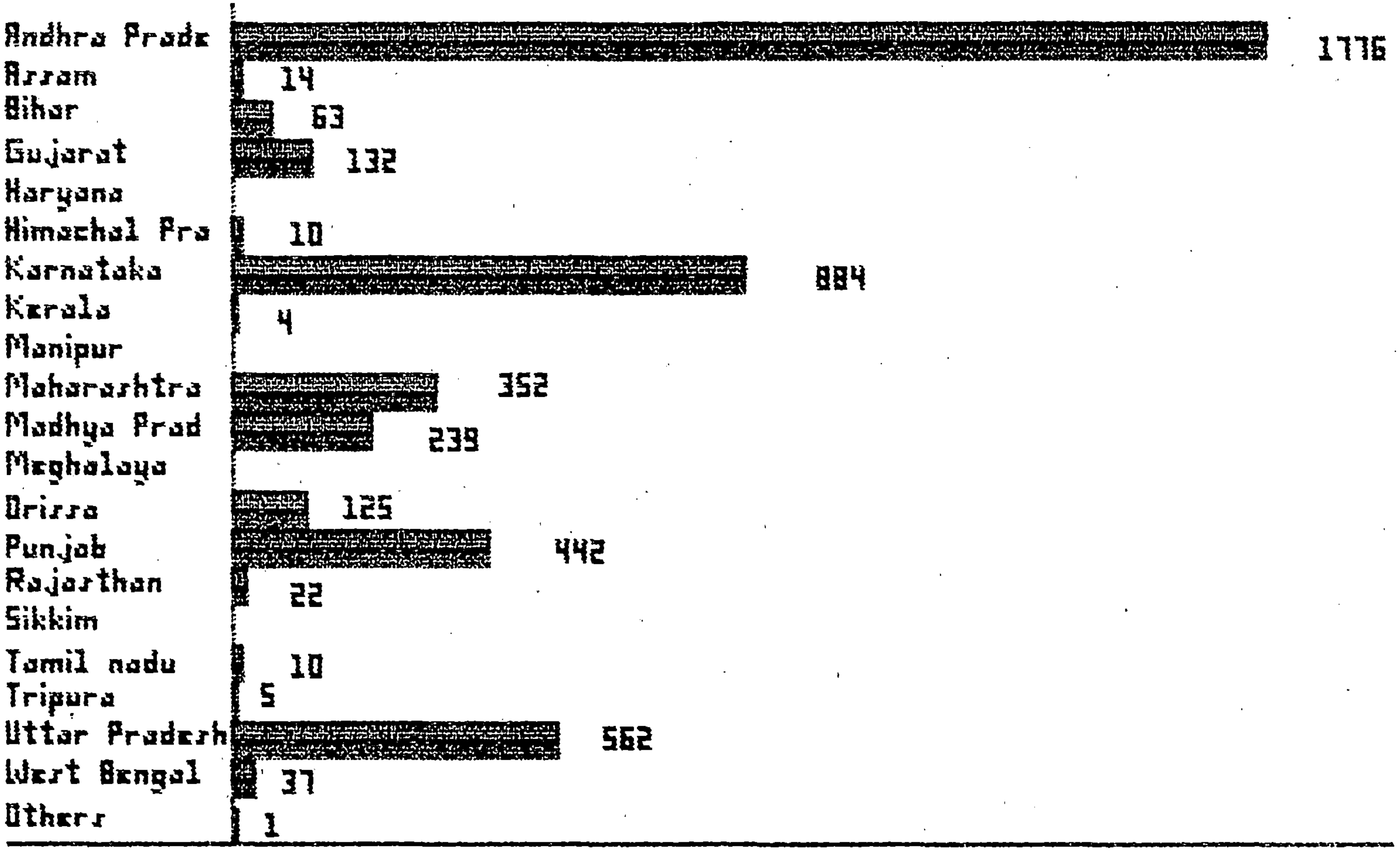


STATE WISE NUMBER OF RICE MILLS

MODERNISED RICE MILLS



STATE WISE NUMBER OF RICE MILLS
HULLERS



STATE WISE NUMBER OF RICE MILLS
<u>SHELLERS</u>

1. Recovery of bran
2. Recovery of extra rice to the extent of 2%
3. The lesser broken rice

The Govt. of West Bengal shold also immediately took into this aspect and devise-ways and means by which the existing Huller mills could be converted into mini rice mills of capacity of 500 kgs per hour and such mini rice mills should not attract the levy, e.g., they should be put to same status as dehusking mills or hullers. The modernisation of one huller can be done in about Rs.10,000/- to Rs.15,000/- as already experimented by Hindustan Level and they modernisation programme is in hand in U.P. and Maharashtra as well.

10.7 GROUNDNUT

In West Bengal, groundnut is largely consumed as nut. In recent years refined groundnut oil has, however, entered into the kitchens of some affluent families of West Bengal but still then the quantity is negligible. The annual consumption of groundnut in terms of "nuts" in West Bengal is estimated at 50,000 tonnes which are largely imported from Western and Southern States.

There is a net outflow of about Rs.35 crores from West Bengal to other States for meeting the consumption-demand for groundnut in the State. It is, however, encouraging that the cultivation of groundnut has been catching the imagination of the farmers of West Bengal. Generally groundnut is cultivated as a second crop after long duration Aman Paddy in the mono-cropped area in the coastal areas and also in the high lands in the sumer season. Since last two years the cultivation of groundnut in the districts of Hooghly, Midnapore, Purulia, Nadia 24 Parganas, Cooch Behar and West Dinajpur has gathered momentum. The crushing of groundnut in West Bengal has however, come to a grinding halt on account of various factors including high incidence of local taxes which has made the end-products quite uncompetitive.

10.8 SOYABEAN CULTIVATION IN WEST BENGAL

The prospect of soybean cultivation in West Bengal is indeed very great. Soyabean is essentially a kharif crop maturing within 90 to 105 days. It is, however, distressing that the cultivation of soybean in West Bengal has not received adequate attention it deserves. Presently, the cropped area of soyabean is only 300 hectares, producing about 200 tonnes of soyabean. The yield per hectare is around 670 kgs. It is stated that a farmer can make a net profit of Rs.3000 to Rs.4000 per acre of soyabean cultivation. There are quite a number of solvent extraction units in and around: Burdwan where soyabean can be cultivated by the farmers profitably. This year the Association has taken a programme to grow soyabean in a small plot of land on an experimental basis in the district of Burdwan for which necessary foundation seed has already been procured. The cultivation of soyabean in the districts of Burdwan, Murshidabad, Midnapore and Purulia deserves special attention of the Department of Agriculture, West Bengal.

10.9 CONSTRAINTS AND OPPORTUNITIES OF OILSEED PRODUCTION IN WEST BENGAL

Constraints in increasing production of cultivated oilseeds:

The year to year fluctuations in production of oil-seeds could be attributed to the following constraints and bottlenecks:

a) Environmental constraints

About 85.7 per cent of the area under oilseed crops is rainfed comprising mostly of marginal and submarginal lands with soils of poor fertility. Pests and diseases also causes substantial production losses.

b) Technological constraints

Paucity of a large range of high yielding varieties, particularly the ones whch could give high stable yields under rainfed conditions and resist or evade pests and diseases. Lack of improved farm implements, low cost technology for control of pests and diseases, appropriate post-harvest technology to prevent post-harvest losses and deterioration in quality, are some of the technological constraints.

c) Socio-economic constraints

Most of our farmers are small and marginal with little wherewithals to invest on various inputs. Further, oil seeds being grown mostly under rainfed conditions, become high risk crops. With the result oilseed crops are grown mostly under poor crop management resulting in low yields. The non-realisation of the benefit of improved crop production technology is therefore, more due to poor economic condition of the farmer.

d) Organisational and infrastructural constraints

Inadequate arrangements for production and distribution of quality seed, timely supply of various inputs, credit, irrigation, transfer of improved technology from research to farmer, storage, grading and marketing of oilseeds coupled with the wide fluctuation in price, some organisational and infrastructural defects stand in the way of achieving a rapid increase in oilseed production.

10.9.i) Strategy

The overall strategy adopted in the Sixth Plan consisted of the following :

1. Increase in productivity of oilseed crops through varietal replacement, increased use of quality seed of improved varieties, increased use of fertilisers (including micronutrients and bio-fertilisers), large-scale plant protection measures and other improved agronomic practices.
2. Expansion of area under oilseed crops, particularly rabi-summer groundnut and rapeseed-mustard.
3. Expansion of area under oilseed crops in various double/multiple cropping and inter-cropping systems, particularly the two non-traditional oilseed crops, soybean and sunflower.

4. Distribution of large number of minikits of oilseeds crops to farmers.

5. Organising demonstration on improved package of practices on farmers' fields.

6. Price support.

10.9.ii) Following Incentives and Support Service have been Provided in the State

1. Seed subsity.

2. Subsidy on plant protection chemicals; equipment and spraying charges and also plant protection vans (full cost) for rapeseed-nystard ub areas civered by special projects.

3. Free distribution of seed and fertiliser minikits.

4. Subsidy on rhizobium culture besides assistance for strengthening of microbiological laboratories for production of culture.

5. Subsidy on phosphatic fertilisers, gypsum, irrigation and sprinkler sets for groundnut in special project areas.

6. Increased subsidy for demonstrations.

7. Subsidy on improved farm implements.

8. Assistance for production of breeder's seed.

9. Special provision to provide market support to farmers and staff for implementation, etc.

10.9.iii) Opportunities for Future Development

During the Seventh Plan, more quantity of edible oil will be required for consumption. Accordingly, it is proposed to enlarge the programmes and accelerate the pace of oilseeds production.

The broad strategy adopted in this approach will be :

1. Increasing the productivity through varietal replacement, use of quality seed, mass scale plant protection measures, increased use

of chemical and biofertilisers and other improved agronomic practices.

2. Extension of irrigated area under oilseed crops.
3. Extension of area under oilseeds by introducing them in double/ multiple sequence cropping.
4. Distribution of large number of minikits.
5. Increased support to strengthen the seed production programme.
6. Increased use of implements for larger coverage and popularisation of fertilisers in potential area.
7. Increase support to stre organising village demonstrations, on-farm training, provision of incentive price through cooperative marketing etc.

Special projects have been proposed to be taken up on groundnut, rapeseed-mustard, soybean, sunflower and safflower in the State.

10.10 POSSIBILITIES OF OIL SEED PRODUCTION IN WEST BENGAL

10.10.i) Possibilities of Oilseed Crops in Different Agro-Climatic Zone

I. Hill zone

Replacement of campestris type with medium to late maturing Funeea varieties.

II. Teesta and Tarai alluvial region

*Improvement in productivity of rape-mastard by substitating of low yielding local Torai with improved one or with yellow sarson (excepting Cooch Behar and contiguous part in Jalpaiguri)

*Replacement of campestris with juncea when soil pH is around 6.

*Extension of sesame acreage as jute substitute.

*Improving productivity of niger with the use of improved varieties.

*Extension of linseed acreage as Payra crop in paddy field.

*In Cooch Behar and contiguous part of Jalpaiguri improvement in yield through better agronomic practices.

III. Red laterite and gravelly undulating region

*Extension of kharif groundnut as substitute to low yielding direct seeded paddy.

*Extension of groundnut as intererop in Arahar.

*Extension of niger as post-kharif crop.

IV. Gangetic alluvial region

*Extension of area under summer groundnut.

*Extension of sesame as jute substitute and pre-kharif crop after harvest of potato/winter vegetable.

*Extension of area under linseed through payra.

*Extension of rape-mustard as intercrop in autumn plasted sugar cane.

*Improvement in productivity of rainfed mustard.

*Improvement in productivity of late sown mustard.

V. Vindya alluvium

*Extension of rape-mustard area through intercropping with wheat, in autumn planted sugar cane.

*Extension of rape-mustard is rainfed areas with modern technology as substitute of jute.

*Extension of sesame as a rainfed 2nd crop in paddy field.

*Extension of groundnut with bunch type varieties as summer irrigated crop.

VI. Coastal region

*Extension of sunflower and safflower as 2nd crop after paddy.

*Extension of rape-mustard in non-saline areas where short duration H.Y.V. paddy in grown.

10.10.ii) Scenario of Oilseeds

Area	Mustard	2.946 lakh hectares
	Sesame	0.869 lakh hectares
	Groundnut	0.121 lakh hectares
	Total	3.936 lakh hectares
Production	Mustard	1.769 lakh tonnes
	Sesame	0.625 lakh tonnes
	Groundnut	0.143 lakh tonnes

Requirement	10.75 lakh tonnes of rape and mustard to produce 3.60 lakh tonnes of mustard oil. The existing of production of 1.769 lakh tonnes of mustard seeds yield 0.58 lakh tonnes of mustard oil
Deficit	3.02 lakh tonnes
Import from other states	3 lakh tonnes of mustard oil
Other edible oils imported	0.3 lakh tonne of Groundnut oil and 0.15 lakh tonnes of Sesame oil

Figures refer to 1986-87. (These figures refer to figures supplied by AE)

Status : Strength

- Growing awarences among farmers, necessity to raise oil seed crops vis-a-vis production.
- Growing confidence among farmers, that an oilseed crop can be

raised profitably without affecting his main cropping system in irrigated areas and possibility of raising a short duration. Toria and yellow sarson with residual moisture in unirrigated areas.

- Extension and Research Support with superior varieties and new production technology
- A well knit oilseed development programme and planned approach.
- Support from Govt. of India

Status : Weakness

- Laek of availability of area in time for oilseed cultivation
- Lack of credit facility
- Unstable/fluetuating market price of oilseeds
- Unrealistic price support
- Lack of organised agency to buy the produce
- Poor utilization of rice bran produced by the rice mills and rice hauller mills of the State.
- Swelling population.

Objectives to Increase Production of Oilseeds From

- 2.36 lakh tonnes in 1984-85 to
- 4.30 lakh tonnes in 1989-90 and
- 9.50 lakh tonnes in 1999-2000 AD

by area and productivity approach

Area Approach *Increasing the area under oilseed crops from

3.89 lakh hectares in 1984-85 to
5.40 lakh hectares in 1989-90 and
10.50 lakh hectares in 1999-2000 AD

Productivity Approach *Raising the productivity of oilseed crops from

607 kg/hectare in 1984-85 to

796 kg/hectare in 1989-90 and

900 kg/hectare in 1999-2000 AD

Table X-15. How will target be achieved by 2000 AD

	(Lakh tonnes)
Increase oilseed production from bringing additional area under the crop	1.00
Increasing the productivity	1.00
Additional irrigated areas	0.50
Crop substitution	1.40
Modern crop technology	1.00
Better Dry Farming	0.30
Existing	4.30
Total	9.50
Additional Production of Vegetable Oil	
Better recovery of oil from oilseeds	0.20
Better extraction	0.60
Rice bran oil	0.20
Total	1.00
Other Sources (tree origin)	
Total supply of vegetable oil	10.50

10.10.iii) Does the State compare with the rest of India and World Average

Oil Seed Crop	Productivity in kg/hectares			
	State Average	State highest average for any district in 1984-85	Average for India	World Average
Rape and Mustard	670	956 (Nadia)	659	1,262
Sesame	617	1,284 (Bankura)	283	N.A.
Groundnut	875	2,100 (Bankura)	759	1,122

Status

Experience	Strength and Weakness Position
1. Research support from ICAR and State Agricultural Universities (SAU)	Fair
2. Research support from Research Wing of Agriculture Department	Strong
3. Linkage between SAU and Extension	Fair
4. Linkage between State Research Institute and Extension	Strong
5. Extension support to farmers	Strong
6. Seed supply system	Fair
7. Crop loan support system	Weak
8. Plant protection system	Strong
9. Price support system	Very weak
10. Strong system	Very weak
11. Processing	Weak

12. Regulated market agencies	Weak
13. Past record of Oil Seed Cultivation	Fairly strong

Status

OTHER WEAKNESS

80% of the Oilseed Crop in the State in raised in non-irrigated areas in poor soils and marginal management.

The majority of Oilseed growers are small and marginal farmers. Susceptibility to pests and diseases.

Dearth of good quality seeds, certified seeds of the 3 major oilseed crops are not readily available in the market.

Fluctutations in the price of oilseeds disappoint the grows.

Lack of storage facilities compels the farmers to sell in the bayers market at low price.

Exploitation by middlemen and speculators.

10.10.iv) Strategy for Stepping up Production

Extending the area under short duration Kharif HYV paddy to facilities early release of land for higher coverage of short duration rape and mustard.

Increasing the irrigated oilseed area by creating new irrigation reasources through higher public and pricate investment on LTDWs and MDTWs.

Improved new crop technology to motive farmers.

Modern post-harvest technology for better processing and storage.

Strong support system to farmers extension activities to be strengthened.

Input support like timely supply of credit, seeds at reasonable prices, fertilisers, pesticides are to be ensured.

Farmers training through T&V system.

Transfer of technology through demonstrations and other extension media.

Publicity and extension support for awareness of the farmers.

Remunerative prices and procurement support.

Efficient storage, processing and marketing leading to reduced unit costs and making possible payments of higher prices to farmers.

Stabilising Oilseed Production

Raise proportion of irrigated lands under oilseeds in the districts of West Dinajpur, Malda, Murshidabad, Nadia, North 24 Parganas, Birbhum, Midnapur (East). Improved rainfed farming in the unirrigated districts of Purulia, Bankura, Birbhum, Midnapore (West), Western Part of Burdwan, Coastal North 24 Parganas and South 24 Parganas intercropping.

Propogation of Short duration drought tolerant varieties in the districts of Purulia, Bankura, Birbhum, Midnapur (West), Western part of Burdwan.

Crop substitution by groundnut and sesame in the districts of Murshidabad, Nadia, North 24 Parganas, Hooghly, Burdwan, Good marketablility of the oilseed.

Important Varieties of Oilseed Crops in West Bengal

Crop	Varieties in Cultivation	Varieties in the pipe line
Rape and Mustard Yellow Sarson	Benoy (B-9)	YSB-19-7-C YSB-NC-1
Toria	Agrani (B-54) Panchali (TCW-3)	
RAi	Sita (B-85) Bhagirathi (RW-351) Sarama (RW 85-59)	RW4-C-6-3/11 RW-2-2 RW-29-6
Sesame	Tilottama (B-67)	Ekangi (Hybrid) Imp. Sel-5 BT-9-4-1 BT-25-4-3 BT-1239-3

Table X-16. Targets of Area Production and Productivity of Different Oilseed Crops

Crop	1988-89			1989-90		
	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
EDIBLE						
Rape-mustard	360.0	218.0	605	365.0	290.25	795
Sesame	90.0	58.0	644	124.0	98.00	787
Groundnut	21.0	24.0	1,143	22.0	28.0	1,300
Sunflower/Safflower	2.0	1.2	600	2.5	1.5	600
Nigar	5.0	2.5	500	5.0	3.0	545
NON-EDIBLE						
Linseed	20.0	6.0	300	21.0	9.0	435
Other Oilseeds	2.0	0.3	150	0.5	0.25	500
	500.0	310.0	620	540.0	430.0	796

Table X-17. Status of Available Technology

Crop	Best available varieties	Yield/ha. achieved in Govt. Farm	Average yield/ha. achieved in State Legel demonstration trial	Average yield of the crop in State during 1985-86
1. Toria	B-54 (Agrani)	10.0 qtls (RF)*	8.0	-
	12.0 qtls (RF)			
2. Yelow Sarson	B-9 (Binoy)	12.0 qtls (IR)*	16.0	7.06
	YSB-19-7-C	22.0 qtls (IR)		
3. Mustard	B-85 (Seeta)	20.0 qtls (IR)	17.0	
	RW-351 (Bhagirathi)	25.0 qtls (IR)*		
	RW-85-59 (Sarama)	25.0 qtls (IR)**		
	RW-4-C-6-3/II	15.0 qtls (RF)***	Not tried extensively	
4. Sesame	B-67 (Tilottama)	10.0 qtls (IR)	8.5	5.88
	Imp. Sel-5	12.0 qtls (IR)*		
5. Groundnut	J-11*	18.0	16.0	12.0
	AK-12-24*	20.0	-	-
	JL-24	19.0	-	-

IR=Irrigated; RF-Rain fed; *-Latest improved variety developed at State Research Station, Berhampore and recommended by co-ordinated project for Commercial Cultivation in Eastern India; **-Suitable for late sown situation; ***-Bred at State Research Station, Berhampore and recommended for rainfed agriculture in whole of Eastern India by co-ordinated project.

Groundnut	J-11, JL-24, AK-12-24
Sunflower	Modern, EC 68414, EC 68415

Status : Weakness

80% of Oilseed Crops are grown under rainfed condition. Majority of oilseed growers small and marginal farmers with poor resources and using low level of inputs.

Oilseed Crop subjected to natural hazards.

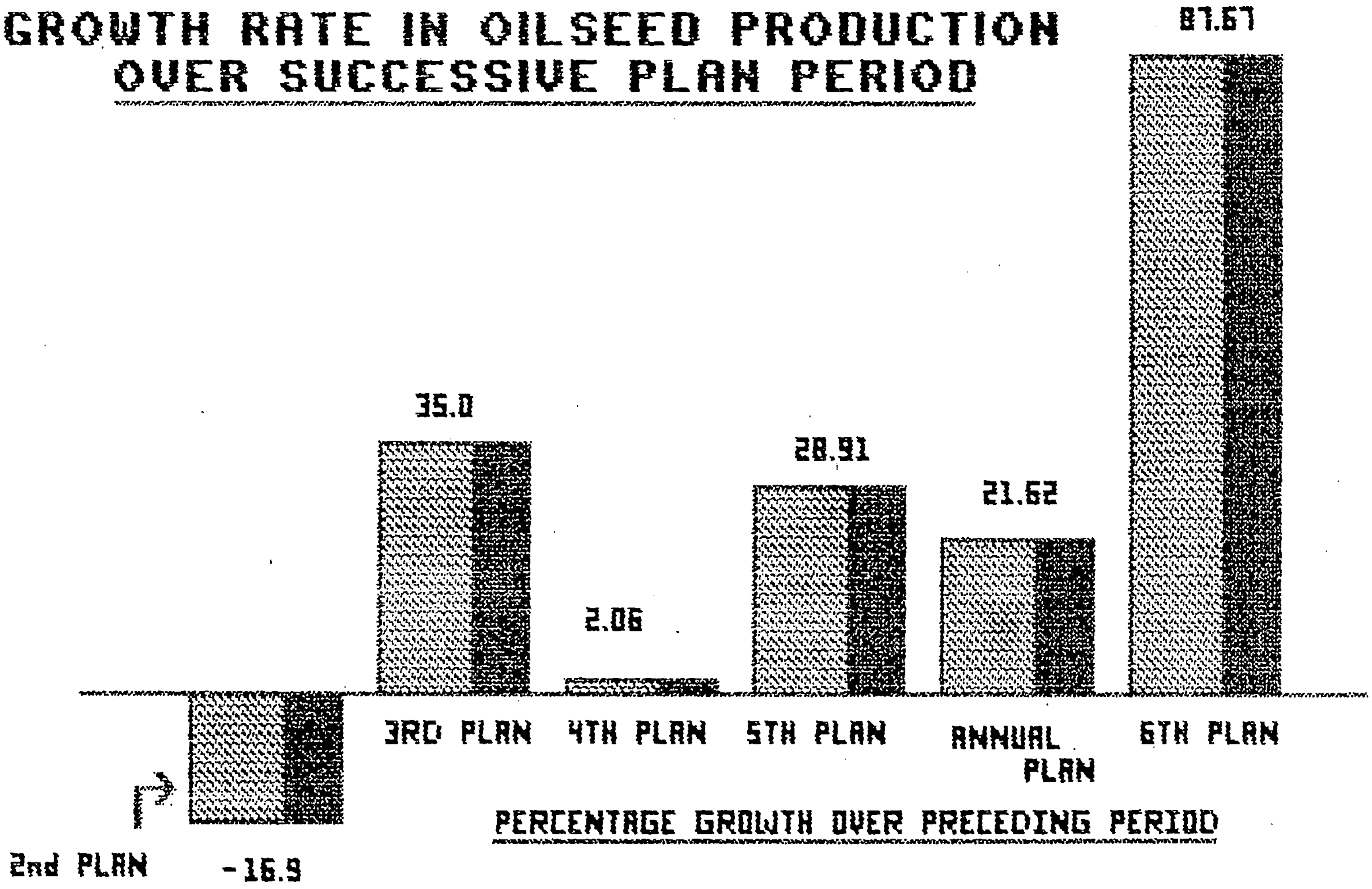
Table X-18. Growth Rate in Oilseed Production over Successive Plan Period

Period	Total Production in '000 tonnes during the period	Average of five years	Percentage growth over preceding period
1st Plan Period	275.8	55.16	
2nd Plan	229.1	45.83	-16.9
3rd Plan	309.3	61.86	35.0
4th Plan	315.7	63.14	2.06
5th Plan	407.0	81.40	28.91
Annual Plan	99.0	99.00	21.62
6th Plan	29.0	185.80	87.68

Table X-19. Sources of Additional Production In 1989-90 Over Previous Year

Sources of Additional Production of Oilseeds ('000 tonnes)	
Cultivation in irrigated area	40.00
Crop substitution	40.00
Improved technology	30.00
Better Dryland Farming	10.00
	120.00

GROWTH RATE IN OILSEED PRODUCTION OVER SUCCESSIVE PLAN PERIOD

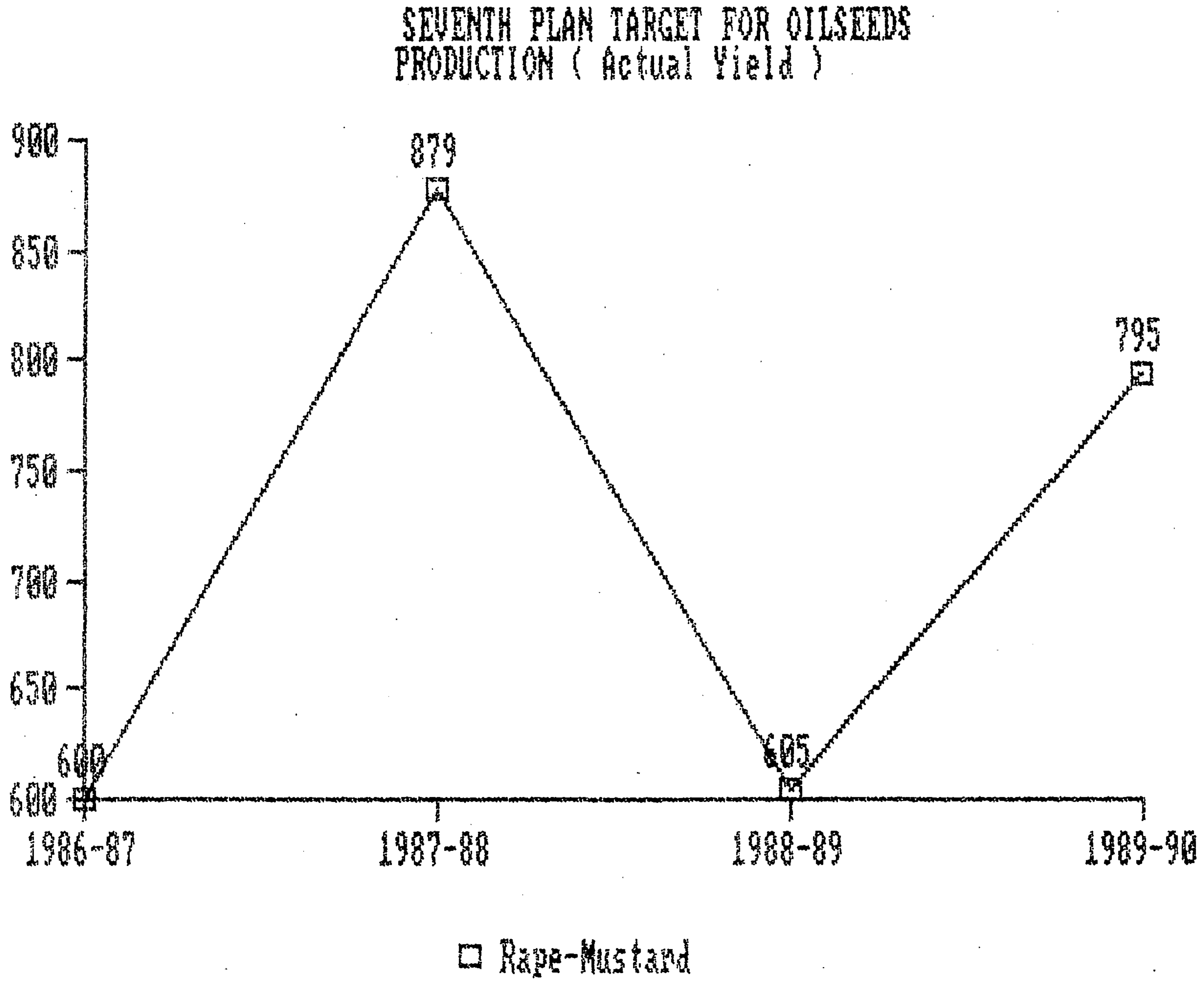


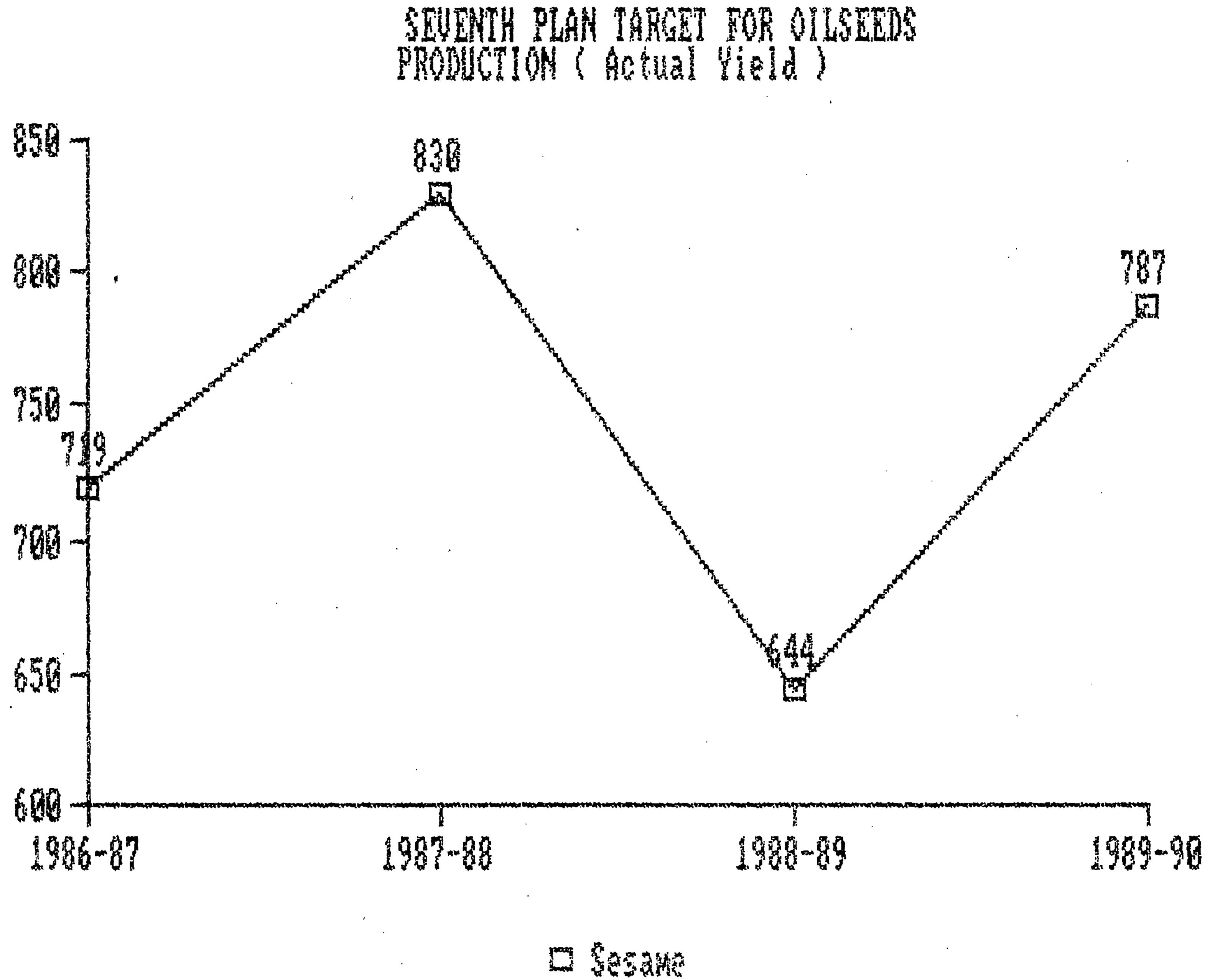
PERCENTAGE GROWTH OVER PRECEDING PERIOD

Table X- 20. Seventh Plan Target For Oilseeds Production

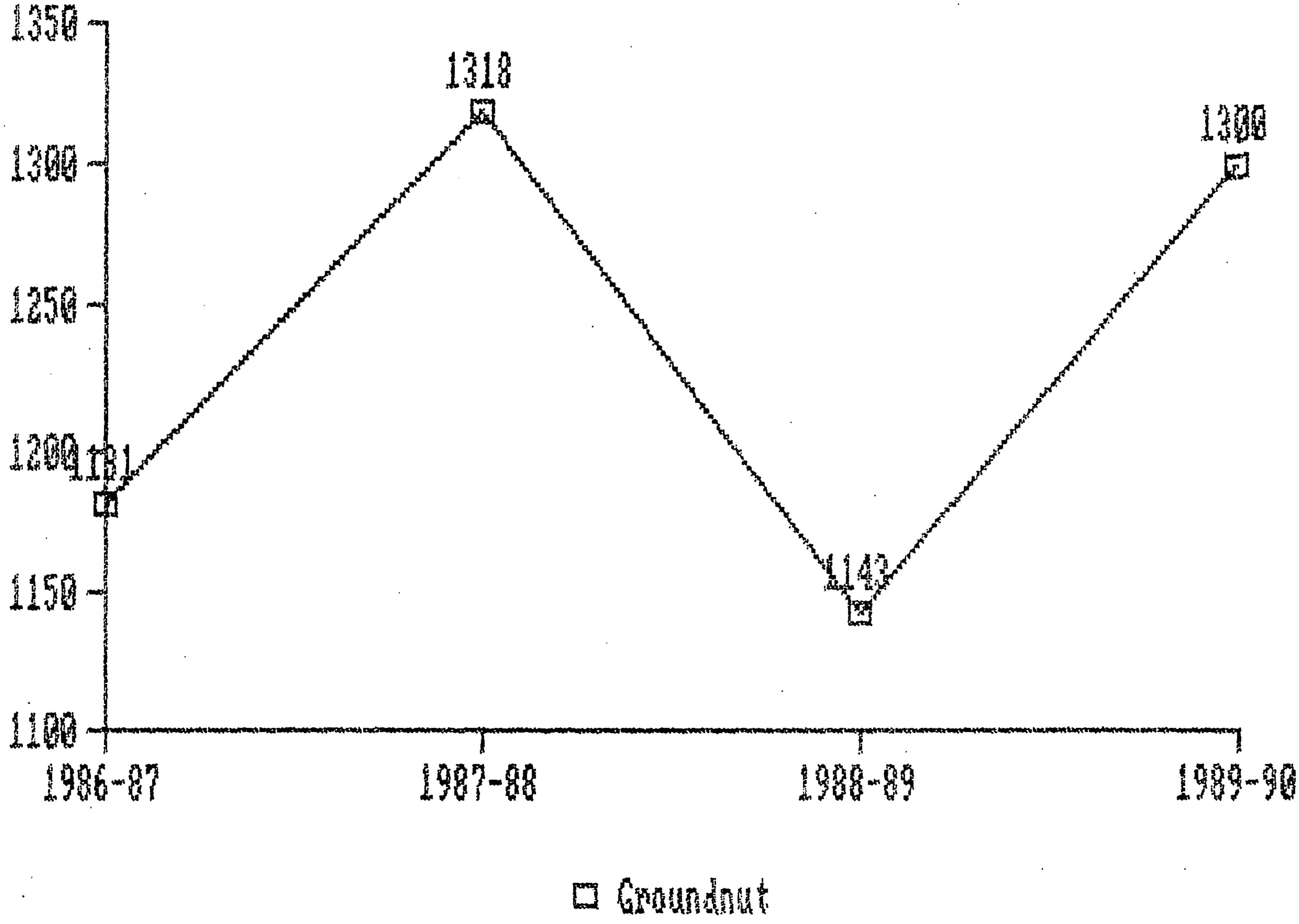
Crop	1986-87 (Actual)		1987-88 (Actual)		1988-89 (Target)		1989-90 (Target)	
	Production	Yield	Production	Yield	Production	Yield	Production	Yield
EDIBLE								
Rape-Mustard	176.94	600	334.03	879	218.00	605	290.25	795
Sesame	62.51	719	139.10	830	58.00	644	98.00	787
Groundnut	14.35	1,181	24.38	1,318	24.00	1,143	28.00	1,300
Sunflower	0.784	598	1.098	673	1.20	600	1.50	600
Niger	2.07	338	2.025	381	2.50	500	3.00	545
Other Minor Oilseeds	-	-	0.036	249	-	-	-	-
NON-EDIBLE								
Linseed	6.76	314	5.05	270	6.00	300	9.00	435
Other Oilseeds	-	-	0.078	709	0.30	150	0.25	500
			505.798	857	310.00	620	430.00	796

Production in '000 tonnes, Yield in kg. per ha.

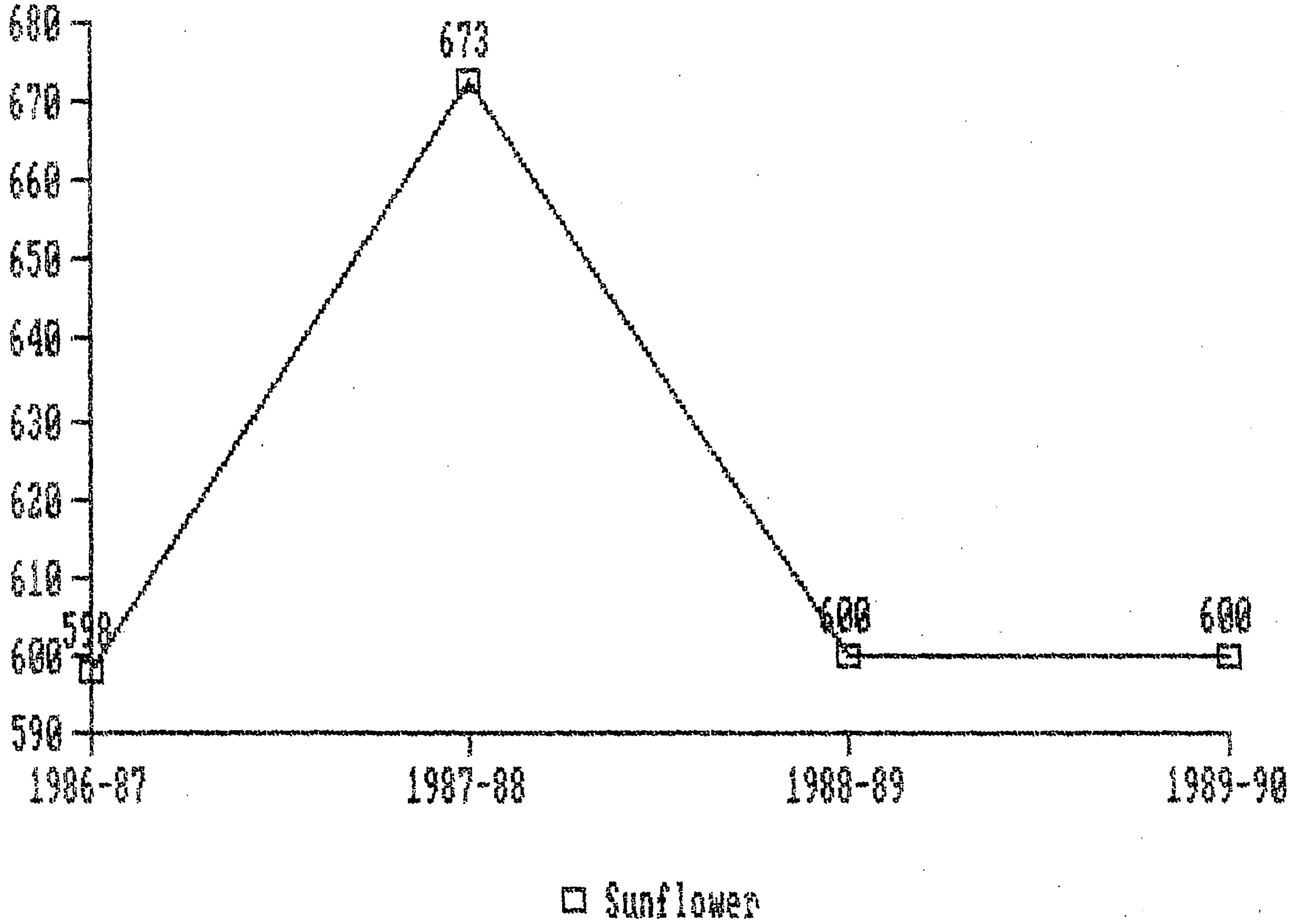

SEVENTH PLAN TARGET FOR OILSEEDS
PRODUCTION (Actual Yield)
900
850
800
750
700
650
600
879
795
600
605
1986-87
1987-88
1988-89
1989-90
Rape-Mustard


SEVENTH PLAN TARGET FOR OILSEEDS
PRODUCTION (Actual Yield)
850
800
750
700
650
600
719
830
644
787
1986-87
1987-88
1988-89
1989-90
Sesame

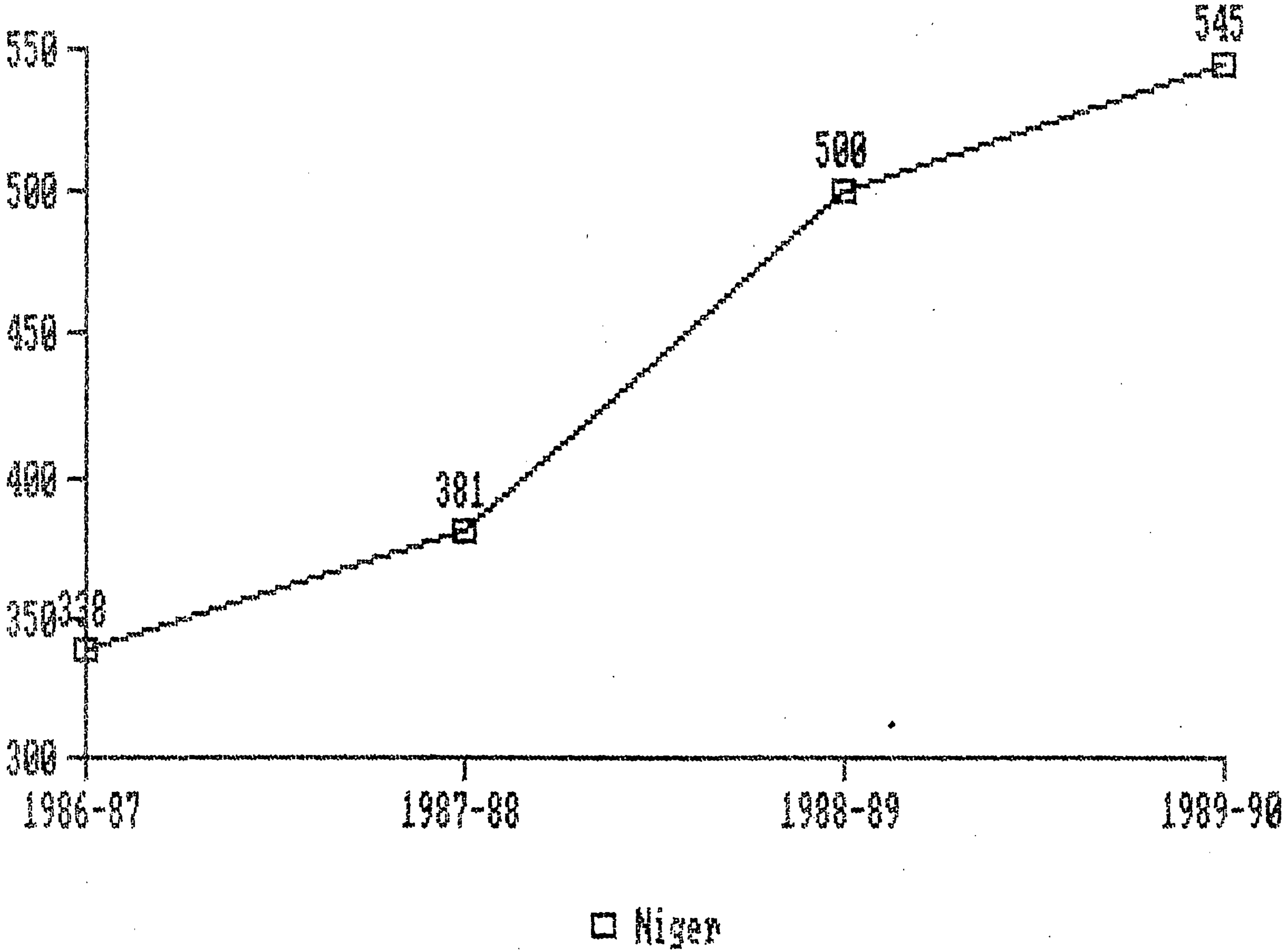
SEVENTH PLAN TARGET FOR OILSEEDS
PRODUCTION (Actual Yield)

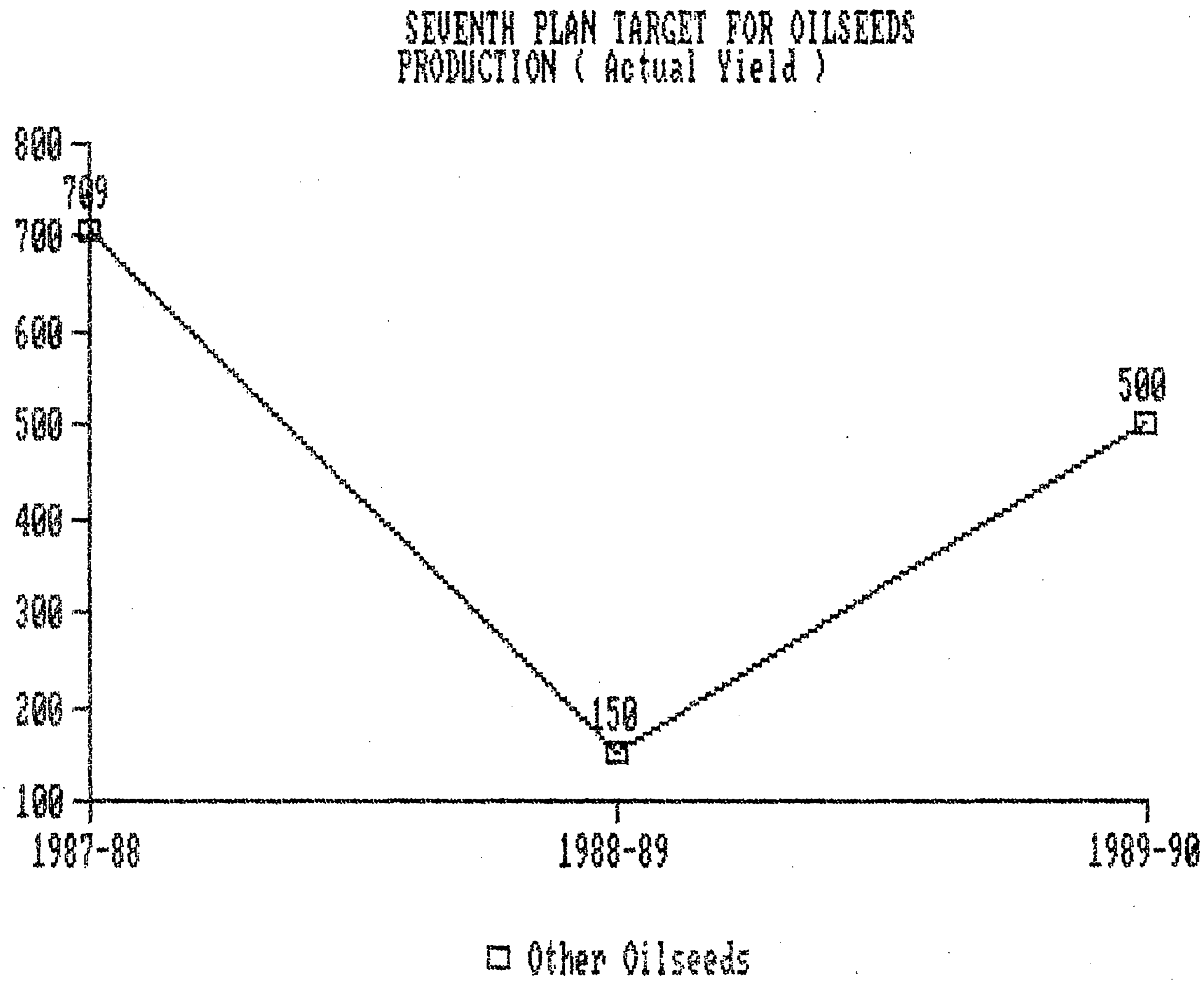


SEVENTH PLAN TARGET FOR OILSEEDS
PRODUCTION (Actual Yield)



SEVENTH PLAN TARGET FOR OILSEEDS PRODUCTION (Actual Yield)




SEVENTH PLAN TARGET FOR OILSEEDS
PRODUCTION (Actual Yield)
800
700
600
500
400
300
200
100
709
150
500
1987-88
1988-89
1989-90
Other Oilseeds

SEVENTH PLAN TARGET FOR OILSEEDS
PRODUCTION (Actual Yield)

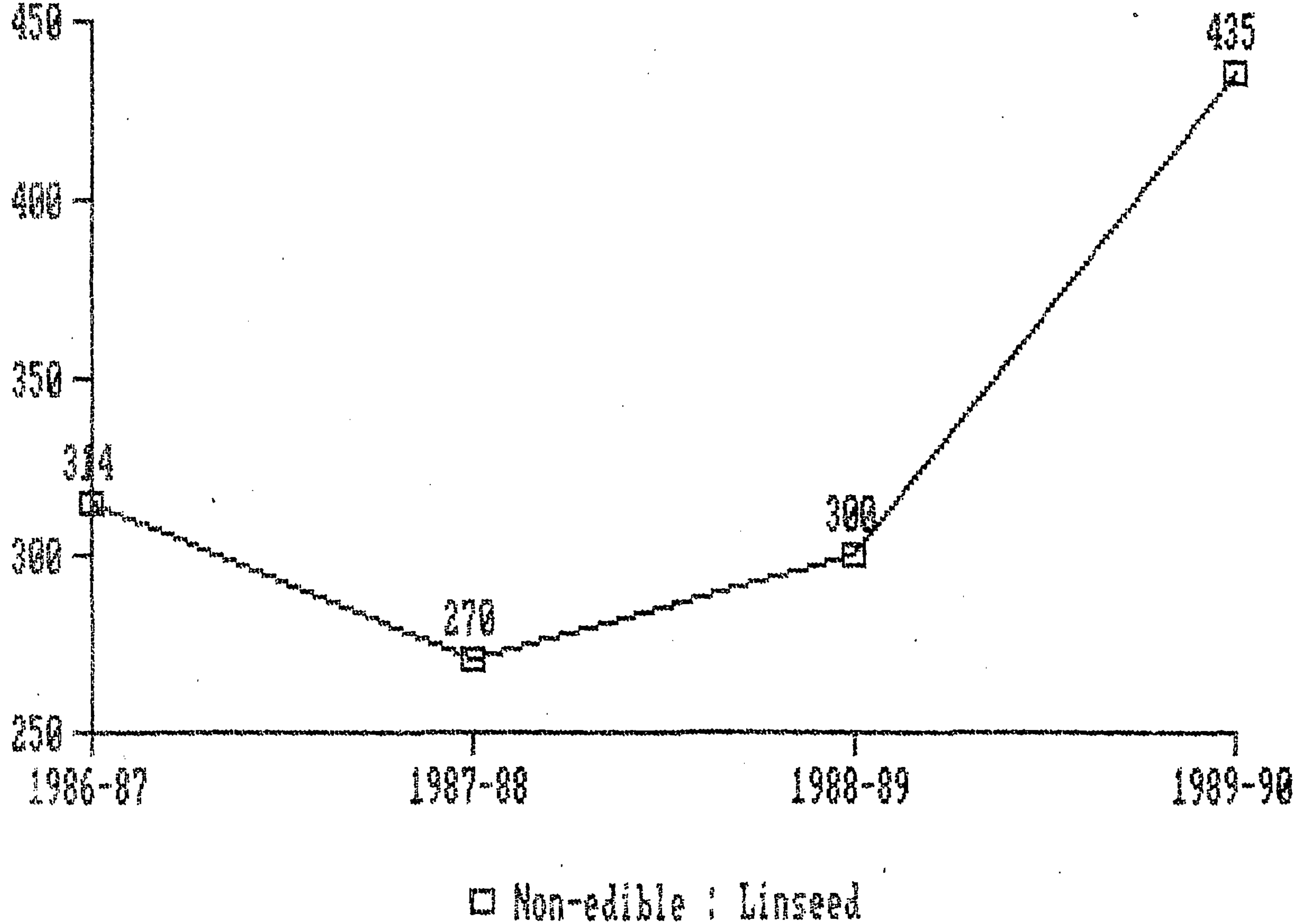


Table X-21. Componentwise Breakup of Different sub-projects of N.O.D.P. During 1988-89

Components	Rape-Mustard		Sesame		Groundnut		Total	
	Physical	Financial (Rs.)	Physical	Financial (Rs.)	Physical	Financial (Rs.)	Physical	Financial (Rs.)
1. Production of Foundation Seeds	20 ha	20,000	10 ha	10,000	6 ha	6,000	36 ha	36,000
2. Stocking and Propositioning of Seeds	1,300 qts.	16,000	-	-	1,300 qts.	15,500	2,600 qts.	31,500
3. Supply of Input Kits	5,550 nos.	1,11,000	1,500 nos.	30,000	1,900 nos.	4,36,000	8,950 nos.	5,77,000
4. Supply of Farm Implements	103 nos.	39,000	-	-	200 nos.	1,00,000	339 nos.	1,41,000
5. Block Demonstrations	1,500 ha	9,00,000	2,000 ha	6,00,000	1,000 ha.	11,80,000	4,500 ha	26,80,000
6. Supply of P.P. Equipment	1,600 nos.	4,80,000	380 nos.	1,14,000	535 nos.	1,60,500	2,515 nos.	7,54,500
7. Mobile P.P. Squad	-	40,000	-	30,000	-	23,000	-	93,000
8. Soil Testing	-	32,000	-	16,000	-	15,000	-	63,000
9. Pay and Contingency	-	-	-	-	-	-	-	-

Table X-22. Componentwise Physical and Financial Breakup of Different Sub-Projects of N.O.D.P. During 1987-88

Components	Rape-Mustard		Sesame		Groundnut		Total	
	Physical	Financial (Rs.)	Physical	Financial (Rs.)	Physical	Financial (Rs.)	Physical	Financial (Rs.)
1. Production of Foundation Seeds	26 ha	26,000	7 ha	7,000	3 ha	3,000	36 ha	36,000
2. Stocking and Prepositioning of Seeds	1,600 qts.	31,000	-	-	-	-	1,600 qts.	31,000
3. Input kits	3,000 nos.	54,000	1,400 nos.	21,000	200 nos.	3,00,000	4,600 nos.	3,75,000
4. Supply of P.P. Equipments	2,000 nos.	6,00,000	550 nos.	1,65,000	1,000	3,00,000	3,550 nos.	10,65,000
5. Mobile PP. Squad	-	2,00,000	-	1,00,000	-	-	-	3,00,000
6. Block Demonstration	1,240 ha.	7,44,000	1,927 ha.	5,78,000	850 ha	10,06,000	4,017 ha.	23,28,000
7. Implements	130 nos.	39,000	-	-	200 nos.	1,00,000	330 nos.	1,39,000
8. Soil Testing	-	50,000	-	50,000	-	-	-	1,00,000
9. Pay and Contingency	-	-	-	-	-	-	-	1,22,000
		17,44,000		9,21,000		17,89,000		44,96,000

Table X-23. Componentwise Breakup of Sub-Projects of N.O.D.P. during 1989-90

Components	Rape-Mustard		Sesame		Groundnut		Total	
	Physical	Financial (Rs.)	Physical	Financial (Rs.)	Physical	Financial (Rs.)	Physical	Financial (Rs.)
1. Production of Foundation Seeds	20 ha.	20,000	10 ha.	10,000	10 ha.	10,000	40 ha.	40,000
2. Stocking and Prepositioning of Seeds	-	15,000	-	-	-	15,000	-	30,000
3. Supply of Input Kits	6,000 nos.	1,20,000	3,000 nos.	60,000	2,000 nos.	4,30,000	11,000 nos.	6,10,000
4. Block Demonstration	3,000 ha.	12,00,000	3,000 ha.	9,00,000	1,200 ha.	14,40,000	6,200 ha.	35,40,000
5. Supply of P.P. Equipment	1,600 nos.	4,80,000	400 nos.	1,20,000	550 nos.	1,65,000	2,550 nos.	7,65,000
6. Farm Implement	100 nos.	30,000	-	-	240 nos.	1,20,000	340 nos.	1,50,000
7. Soil Testing	-	35,000	-	10,000	-	20,000	-	65,000
8. Pay and Contingency	-	-	-	-	-	-	-	-
		19,00,000		11,00,000		22,00,000		54,50,000

Table X-24. Componentwise Physical and Financial Target of Oilseed Production Thrust Project (1987-90)

Components	1987-88		1988-89		1989-90	
	Physical	Financial (Rs.)	Physical	Financial (Rs.)	Physical	Financial (Rs.)
1. Seed Production	4,000 qts.	12,00,000	1,900 qts.	5,70,000	2,000	6,00,000
2. Plant Protection Measures (Distribution of Plant Protection Chemicals on subsidy)	4,000 ha.	4,00,000	4,800 ha.	4,80,000	5,000 ha.	5,00,000
3. Distribution of Plant Protection equipments	1,000 nos.	3,00,000	700 nos.	2,10,000	800 nos.	2,40,000
4. Demonstrations	-	-	2,600 ha	17,00,000	2,600 ha	17,00,000
5. Distribution of Gypsum/Pyrites	-	-	3,150 ha	6,30,000	3,500 ha	7,00,000
		19,00,000		35,90,000		37,40,000

Table X-25. Componentwise Physical and Financial Target of Oilseed Production Thrust Project (1987-90)

Components	1987-88		1988-89		1989-90	
	Physical	Financial (Rs.)	Physical	Financial (Rs.)	Physical	Financial (Rs.)
1. Seed Production	4,000 qrs	12,00,000	1,900 qts.	5,70,000	2,000 qts.	6,00,000
2. Plant Protection Measures (Distribution of Plant Protection Chemicals on subsidy)	4,000 ha.	4,00,000	4,800 ha.	4,80,000	5,000 ha.	5,00,000
3. Distributin of Plant Protection equipments	1,000 nos.	3,00,000	700 nos.	2,10,000	800 nos.	2,40,000
4. Demonstrations	-	-	2,600 ha	17,00,000	2,600 ha	17,00,000
5. Distribution of Gypsum/Pyrites	-	-	3,150 ha	6,30,000	3,500 ha	7,00,000
		19,00,000		35,90,000		37,40,000

Strategy for Farmers' Support

Provide support to farmers, through the State and National Oilseed Development Programme

Strengthening the extension system for transfer of technology to farmers.

Streamlining the agencies for supply of inputs - Seeds, fertilizer, insecticides, credit, irrigation and other inputs.

Main Activities

1. Increasing supply of quality seeds
2. Timely and adequate supply of required inputs
3. Proper serveillance of pests and diseases
4. Transfer of technology through Block Demonstrations
5. Creation of additional irrigation resources and optimum use of irrigation water
6. Crop substitution
7. Soil testing and efficient use of fertilizers
8. Improved dryland farming techniques
9. Training of extension personnel and farmers
10. Dissemination of improved technology through mass media.

National Oilseed Development Project

The special project will support oilseed farmers of -

10 Districts
112 Blocks

Rs.44.96 lakhs shared by State and Centre on 50:50 basis duration 7th plan

Flexible project subject to State requirement approved by State level committee.

Oilseed Production Thrust Project

The project will support oilseed farmers of

8 District
96 Blocks

Rs. 35.9 lakhs 100% subsidy from Govt. of India duration 1987-88 to 1989-90

* Emphasis of Full Flexibility For Quick Results

* Special Thrust on

- Demonstration
- Seed Production
- Plant Protection
- Soil Amendment

Credit Support

OBJECTIVES

To provide adequate credit support to farmers through Banking Institutions, Co-operative, Commercial and Rural banks for raising oilseeds production in the 10 N.O.D.P. Districts

Status : Strength

A large net work of Co-operative Credit Societies

-	State Co-operative Bank	1
-	Central Co-operative Bank	20
-	Primary Agricultural Credit Societies	7,400
-	Commercial Bank Branches	1,908
-	Rural Banks (Gramin Bank)	722

Crop Insurance Schemes - Covering oilseeds-Premium rate one percent of the sum insured whereas premium rate for cereals 2% of the sum insured.

50 per cent of the premium on crop insurance for small and marginal farmers is subsidised by the Centre and State on 50:50 basis.

During the year 1985-86, the total short term loans disbursed are as below:

		(Rs. in Crores)
1.	Co-operatives	51.91
2.	Commercial Banks	10.00
3.	Rural Banks	7.00
4.	Collectors	3.91

of the above amount, about 2% flowed for oilseed production.

Table X-26. Credit Requirement for Oilseed Crops from 1988-89 to 1989-90

Year	Requirement of Credit (Rs. in lakhs)
1988 - 89	400.00
1989 - 90	425.00

Table X-27. Recuirement of Foundation Seed for Production of Certified Seeds

Sl. No.	Crop	Requirement (in Quintals)		
		1987-88	1988-89	1989-90
1.	Rape and Mustard	6.0	6.0	7.0
2.	Sesame	6.0	6.5	7.0
3.	Groundnut	50.0	60.5	70.0
4.	Sunflower	2.5	2.5	3.0

Table X-28. Requirement of Certified/Quality Seeds of Different Oilseed Crops

Sl. No.	Crop	Requirement (in Quintals)		
		1987-88	1988-89	1989-90
1.	Rape and Mustard	-	4,000	4,500
2.	Sesame	-	500	1,000
3.	Groundnut	-	6,000	7,000
4.	Sunflower	-	150	170

Status

1. Low Production Due to
   - Use of poor quality seeds and
   - Lack of High Yielding varieties.

2. The rate of replacement in rape and mustard 15%, sesame 5% and groundnut nil.

3. Shortage of foundation seeds of sesame and groundnut, resulting short supply of certified seeds.

4. High cost of certified seeds and farmers' reluctance to pay high price due to rescurce constraint.

5. Unless supported by State Govt. it is doubtful whether popularisation and large scale sale of certified seeds in 1989-90 possible without sizeable subsidies.

Fertilizers Support

To increase use of fertilizer on Oilseed Crops on cost effective basis. To supply recommended types of fertilizers and Rhizobium in time. Soil testing and technical advices.

Low use of fertilizers and bio-fertilizers in Oilseed crops due to unattractive returns and raising of crop in marginal lands. Inadequate profits at sale points as a result of low turnover and high risk.

- Demonstration on use of fertilizers and biofertilizers for profitable return, in the Block Demonstration under both rainfed and irrigated condition.
- Preparation of supply plan for the district in consulation with lead manufacturers/agencies.
- Opening of now fertilizer outlets.
- Persuation for advance stocking of fertilizers.
- Soil testing and advices for efficient fertilizer use.

Table X-29. Targets for Fertilizer Distribution

('000 tonnes)

Year	N	P	K
1987-88	30	15	15
1988-89	42	21	21
1989-90	46	23	23

Plant Protection Support

OBJECTIVE

- To minimise crop damage by insect pest and diseases.

STATUS

- Oilseed crops affected by a number of pests and diseases.
- Insect pest and disease, one of the major constraints for increasing the oilseed productivity.
- 10-20% Production less each year due to pestsand disease.

Major Insects Pests and Diseases of Oilseed Crops

Crop	Insect Pests	Diseases
1. Rape and Mustard	Aphids	Alternaria leaf blight
	Leaf webber	Club root
	Mustard sawfly	White rust
2. Sesame	Leaf roller and Capsule borer	Phyllody
	Hawk moth	Stem rot

	Bihar hairy caterpillar	
3. Groundnut	Leaf minor	Tikka
	Red hairy caterpillar	Collar rot
	Termites	
4. Sunflower	Bihar hairy caterpillar	Leaf blight
	Head damaging pest	Collar rot
	Heliothis armigers	
5. Linseed	Linseed Budfly	Rust
	Semilooper	
	Cutworm	
	Termites	

1. Cultural Practices
   a) Raising of pests and diseases tolerant/resistant varieties
   b) Timely sowing
   c) Threshold level pest monitoring.
   d) Identifications of endemic area.
2. Pest Surveillance and Monitoring
3. Campaign on Control Measures
   a) Seed treatment
   b) Plant protection measures based on surveillance.
   c) Organisation of mobile squad.
4. Timely supply of Insecticides
   a) Insecticides : Advance stocking of recommended insecticides in dealers outlet.
   b) Equipment : Servicing, repair of existing equipment at SAO's level. Advance stocking at dealers point.

c) Financial Assistance

Release of plant Protection Chemicals and equipment on subsisidies.

5. Training of Extension Functionaries at Field Level on the Insect Pest/Disease behaviours, Identification and Control Measures.

6. Publicity

a) Radio broadcast/telecast.
Talk on control measures of major insect pests and diseases.

b) Issue of technical bulletins.

c) Warnings over Radio/TV.

It is a common practice in India that the Irrigation facilities are mainly provided for paddy cultivation. In isolated cases at central and southern India the irrigation was provided for other serial too.

At the present infrastructure of irrigation in the state of West Bengal all the cannels deep - tube well shallow tube-well, etc. are mainly provided for the production of paddy. According to the state plan scheme to increase the irregation under oil seed crop to obtain additional production has been given a significant priority for the increase of oil seed production with a greater irrigation support in the state.

Targets

- To bring 3.65 lakhs hectares area of oilseeds under irrigation, during 1987-88 and 4.60 lakh hectares by the end of 1989-90.
- To achieve an additional production of 0.76 lakh tonnes from irrigated area in 1989-90 over 1987-88.

Total oilseed production of West Bengal 1986-1990

District	1986-87			1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P
1. Darjeeling	-	-	-	-	-	-	0.020	500	0.010	-	-	-
2. Jalpaiguri	0.849	586	0.509	0.817	598	0.489	0.807	616	0.497	0.932	600	0.559
3. Cooch Behar	2.500	334	0.835	2.400	335	0.804	2.811	400	1.124	2.900	450	1.305
4. West Dinajpur	1.110	214	0.237	0.430	230	0.099	0.560	236	0.132	0.545	236	0.129
5. Malda	0.155	246	0.038	0.095	242	0.023	0.125	304	0.038	0.165	275	0.045
6. Murshidabad	0.615	905	0.557	0.570	1600	0.912	0.707	1372	0.970	0.386	912	0.352
7. Nadia	0.620	1697	1.052	3.282	1987	6.521	3.313	1500	4.970	3.025	1723	5.212
8. 24 Parganas (N)	0.417	914	0.381	0.878	1232	1.082	1.735	1253	2.174	1.566	1450	2.270
9. 24 Parganas (S)	0.815	750	0.611	1.248	744	0.929	0.920	752	0.692	0.894	764	0.683
10. Howrah	0.191	607	0.116	0.205	615	0.126	0.133	1045	0.139	0.017	941	0.016
11. Hooghly	1.748	1800	3.146	2.168	1800	3.902	2.149	1649	3.544	2.044	1500	3.066
12. Burdwan	0.390	908	0.354	0.417	1007	0.420	0.610	1134	0.692	0.637	1188	0.757
13. Birbhum	0.591	1678	0.992	0.720	1700	1.224	0.500	1500	0.750	0.400	1500	0.600
14. Bankura	0.120	739	0.089	0.380	482	0.183	0.102	549	0.056	0.690	610	0.421
15. Purulia	4.149	608	2.522	4.638	677	3.139	4.563	1274	5.814	4.431	945	4.186
16. Midnapore (W)	0.828	899	0.744	1.252	1169	1.464	1.494	925	1.382	1.294	897	1.161
17. Midnapore (E)	4.862	1071	5.208	6.198	1017	6.301	7.347	1039	7.361	6.665	1036	6.908
Total West Bengal	19.980	870	17.391	25.698	1075	27.618	27.896	1097	30.615	26.591	1041	27.670

A = Area in '000 hectares. B = Yield rate in kg/hectare. C = Production in '000 tonnes

Crop wise Production of Oilseeds in West Bengal

Crops	1986-87			1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P
Til (Sesamum)	86.892	719	62.505	165.779	830	139.143	69.283	569	39.440	87.107	719	62.551
Rape and Mustard	294.857	600	176.940	379.895	879	334.030	378.483	864	327.060	363.062	894	324.740
Linseed	21.556	314	6.764	18.701	270	5.050	16.739	383	6.441	11.742	261	3.070
Groundnut	12.147	1181	14.347	18.498	1318	24.381	20.633	1328	27.395	19.009	1264	24.036
Castor	0.155	525	0.081	0.110	709	0.078	0.102	1075	0.110	0.082	1075	0.088
Sunflower	1.311	598	0.784	1.631	673	1.098	1.227	641	0.787	1.200	696	0.835
Niger	6.117	338	2.070	5.313	381	2.025	5.859	392	2.300	6.243	432	2.694
Others	0.250	436	0.109	0.146	247	0.036	0.075	310	0.023	0.057	300	0.017
Total Oil Seeds	423.285	623	263.600	590.073	857	505.841	492.455	819	403.556	488.502	856	418.081

A = Area in '000 hectares. B = Yieldrate in kg/hectare. C = Production in '000 tonnes

Fina Estimates of Rape and Mustard Crops of West Bengal for the Year 1986-1990

Districts	1986-87			1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P
1. Darjeeling	0.116	463	0.05	0.318	693	0.22	1.024	814	0.83	1.106	740	0.82
2. Jalpaiguri	7.292	407	2.97	9.695	543	5.26	9.456	514	4.86	10.139	461	4.67
3. Cooch Behar	7.500	279	2.09	6.487	259	1.68	7.665	689	5.28	6.829	565	3.86
4. West Dinajpur	45.092	448	20.22	56.784	769	43.66	47.648	991	47.21	48.080	809	38.89
5. Malda	20.925	580	12.13	30.059	692	20.80	28.109	661	18.30	28.704	786	22.56
6. Murshidabad	52.165	565	29.47	55.192	802	44.28	56.257	932	52.46	51.446	849	43.70
7. Nadia	30.585	749	22.92	41.919	889	87.25	45.981	859	39.12	42.900	935	40.10
8. 24 Parganas (N)	22.556	640	14.43	29.370	820	24.07	32.883	617	20.28	30.499	1064	32.46
9. 24 Parganas (S)	1.906	452	0.81	3.970	821	3.26	1.848	942	1.74	1.631	1134	1.85
10. Howrah	0.628	621	0.39	1.928	581	1.12	1.764	504	0.89	0.838	513	0.43
11. Hooghly	14.325	785	11.25	13.149	972	12.78	15.689	1046	16.41	9.948	1012	10.07
12. Burdwan	27.147	737	20.02	49.472	1436	71.05	48.893	942	46.04	45.434	971	44.12
13. Birbhum	45.525	622	28.31	49.488	854	42.28	51.175	877	44.89	51.387	997	51.22
14. Bankura	9.862	805	7.94	15.381	1001	15.39	12.745	912	11.63	12.898	862	11.12
15. Purulia	0.561	673	0.38	1.742	276	0.48	0.192	927	0.18	0.949	954	0.90
16. Midnapur (W)	5.723	383	2.19	8.363	744	6.22	12.595	992	12.50	16.271	892	14.52
17. Midnapur (E)	2.949	455	1.37	6.578	643	4.23	4.558	974	4.44	4.003	862	3.45
Total West Bengal	294.857	600	176.94	379.895	879	334.03	878.483	864	327.06	363.062	894	324.74

A = Area in '000 hectares. B = Yield rate in kg/hectare. C = Production in '000 tonnes

Final Estimates of 'Ground Nut' of West Bengal for the year 1986-1990

District	1986-87			1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P
1. Darjeeling	-	-	-	-	-	-	-	-	-	-	-	-
2. Jalpaiguri	0.114	560	0.064	0.034	550	0.019	-	-	-	-	-	-
3. Cooch Behar	-	-	-	-	-	-	-	-	-	-	-	-
4. West Dinajpur	0.010	300	0.003	-	-	-	-	-	-	-	-	-
5. Malda	-	-	-	-	-	-	-	-	-	-	-	-
6. Murshidabad	0.615	905	0.557	0.570	1600	0.912	0.707	1372	0.970	0.386	912	0.352
7. Nadia	0.620	1697	1.052	3.252	200	6.504	3.313	1500	4.970	3.025	1723	5.212
8. 24 Parganas (N)	0.258	1156	0.298	0.671	1427	0.958	1.448	1416	2.050	1.242	1653	2.053
9. 24 Parganas (S)	0.041	1225	0.050	0.048	1225	0.059	0.050	1225	0.061	0.070	1225	0.086
10. Howrah	0.053	1000	0.053	0.056	1010	0.057	0.091	1297	0.118	0.013	1130	0.015
11. Hooghly	1.748	1800	3.146	2.168	1800	3.902	2.148	1650	3.544	2.044	1500	3.066
12. Burdwan	0.348	940	0.327	0.390	1050	0.410	0.535	1250	0.669	0.580	1275	0.740
13. Birbhum	0.561	1750	0.982	0.695	1750	1.216	0.500	1500	0.750	0.400	1500	0.600
14. Bankura	0.120	739	0.089	0.256	537	0.137	0.029	956	0.028	0.590	662	0.391
15. Purulia	2.572	783	2.014	3.182	806	2.564	3.232	1658	5.359	2.985	1199	3.579
16. Midnapore (W)	0.463	1250	0.576	1.017	1332	1.355	1.260	997	1.256	1.057	997	1.054
17. Midnapore (E)	4.624	1110	5.133	6.159	1012	6.288	7.320	1041	7.620	6.617	1041	6.888
Total West Bengal	-12.147	1181	14.347	18.498	1318	24.381	20.633	1328	27.395	19.009	1264	24.036

A = Area in '000 hectares. B = Yield rate in kg/hectare. C = Production in '000 tonnes

Final Estimates of Kharif Til (Sesamum) of West Bengal for the Year 1986-1990

District	1986-87			1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P
1. Darjeeling	60	200	12	15	200	3	0.015	200	0.003	0.125	500	0.062
2. Jalpaiguri	-	-	-	-	-	-	-	-	-	0.089	392	0.035
3. Coochbehar	320	465	149	300	470	141	0.450	550	0.248	-	-	-
4. West Dinajpur	420	512	215	388	428	166	0.392	375	0.147	0.423	420	0.178
5. Malda	200	400	80	152	375	47	0.090	356	0.032	0.145	336	0.049
6. Murshidabad	580	550	319	417	506	211	0.778	517	0.402	0.547	633	0.346
7. Nadia	672	551	370	598	538	322	0.530	532	0.335	0.570	518	0.295
8. 24 Parganas (N)	66	689	45	150	632	95	0.140	629	0.088	-	-	-
9. 24 Parganas (S)	-	-	-	-	-	-	-	-	-	-	-	-
10. Howrah	-	-	-	-	-	-	-	-	-	-	-	-
11. Hooghly	-	-	-	-	-	-	-	-	-	-	-	-
12. Burdwan	30	400	12	10	380	4	-	-	-	-	-	-
13. Birbhum	25	400	10	52	425	22	0.030	430	0.013	0.010	435	0.004
14. Bankura	67	500	34	247	545	135	0.419	529	0.222	1.435	335	0.481
15. Purulia	364	377	137	492	365	180	0.469	306	0.144	0.662	411	0.272
16. Midnapur (W)	261	400	104	255	310	79	0.178	484	0.086	0.006	500	0.003
17. Midnapur (E)	65	250	16	90	234	21	0.100	335	0.035	0.100	375	0.038
Total West Bengal	3130	480	1503	3166	454	1436	3.591	489	1.755	4.112	429	1.763

A = Area in '000 hectares. B = Yield rate in kg/hectare. C = Production in '000 tonnes

NB.: Based on DAO/PAO's reports

Final Estimates of Winter Til (Sesamum) of West Bengal for the Year 1986-1990

District	1986-87			1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P
1. Darjeeling	150	500	75	150	500	75	0.015	200	0.003	0.125	500	0.062
2. Jalpaiguri	260	500	130	20	165	3	-	-	-	0.000	550	0.050
3. Cooch Behar	-	-	-	-	-	-	0.425	540	0.230	0.250	445	0.111
4. West Dinajpur	367	551	202	441	404	178	0.455	578	0.263	0.094	498	0.047
5. Malda	132	175	23	100	345	34	0.075	338	0.025	0.147	340	0.050
6. Murshidabad	437	517	226	472	240	113	0.735	584	0.429	0.421	725	0.305
7. Nadia	460	620	285	595	418	249	0.460	550	0.253	0.425	930	0.395
8. 24 Parganas (N)	30	900	27	25	950	24	0.098	470	0.046	-	-	-
9. 24 Parganas (S)	-	-	-	-	-	-	-	-	-	-	-	-
10. Howrah	-	-	-	-	-	-	-	-	-	-	-	-
11. Hooghly	-	-	-	-	-	-	-	-	-	-	-	-
12. Burdwan	-	-	-	-	-	-	-	-	-	-	-	-
13. Birbhum	10	400	4	10	425	4	0.030	430	0.013	0.031	436	0.005
14. Bankura	696	497	346	1364	330	450	0.292	599	0.175	1.390	417	0.580
15. Purulia	456	465	215	508	476	242	0.428	396	0.169	0.580	398	0.231
16. Midnapur (W)	100	500	50	30	517	16	0.165	464	0.077	0.024	496	0.012
17. Midnapur (E)	75	370	28	90	320	29	0.100	348	0.035	0.100	348	0.035
Total West Bengal	3182	507	1612	3805	372	1417	3.278	524	1.718	3.651	515	1.883

A = Area in '000 hectares. B = Yield rate in kg/hectare. C = Production in '000 tonnes

NB.: Based on DAO/PAO's reports.

Final Estimates of Summer Til (Sesamum) in West Bengal for the Year 1986-1990

District	1986-87			1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P
1. Darjeeling	0.050	233	0.01	-	-	-	0.112	105	0.01	-	-	-
2. Jalpaiguri	0.747	233	0.17	2.929	509	1.49	0.454	175	0.08	0.480	198	0.10
3. Cooch Behar	0.906	233	0.21	0.830	356	0.30	0.180	105	0.02	0.247	445	0.11
4. West Dinajpur	5.580	240	1.34	7.846	300	2.35	6.077	99	0.60	4.025	169	0.68
5. Malda	0.157	233	0.04	0.032	356	0.01	0.022	105	0.002	0.192	198	0.04
6. Murshidabad	3.459	500	1.73	10.295	731	7.53	1.724	429	0.74	6.368	525	3.34
7. Nadia	4.712	1231	5.80	14.030	1131	15.87	6.803	745	5.07	5.058	631	3.19
8. 24 Parganas (N)	3.567	1172	4.18	13.924	911	12.68	8.366	1014	8.48	3.000	900	2.70
9. 24 Parganas (S)	0.274	998	0.27	1.099	926	1.02	0.375	1014	0.38	0.286	861	0.25
10. Howrah	2.243	424	0.95	7.001	1071	7.50	4.758	540	2.57	3.372	813	2.74
11. Hooghly	11.651	880	10.25	34.492	1198	41.32	6.373	700	4.46	16.766	927	15.55
12. Burdwan	10.599	672	7.12	19.535	780	15.23	6.911	276	1.91	10.688	697	7.45
13. Birbhum	2.918	504	1.47	6.356	566	3.60	3.289	356	1.17	3.818	343	1.31
14. Bankura	16.551	773	12.79	19.861	624	12.40	7.021	580	4.07	11.616	664	7.71
15. Purulia	0.230	747	0.17	0.123	881	0.11	0.024	548	0.01	0.138	802	0.11
16. Midnapore (W)	10.477	858	8.99	11.703	655	7.67	7.905	740	5.85	8.199	870	7.13
17. Midnapore (E)	6.459	604	3.90	8.752	824	7.21	1.186	422	0.50	5.919	1105	6.54
Total West Bengal	80.580	737	59.39	158.808	858	136.29	61.580	583	35.922	80.172	735	58.95

A = Area in '000 hectares. B = Yield rate in kg/hectare. C = Production in '000 tonnes

Final Estimation of 'Niger' of West Bengal for the year 1986-1990

District	1986-87			1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P
1. Darjeeling	-	-	-	-	-	-	0.020	500	0.010	-	-	-
2. Jalpaiguri	0.755	590	0.445	0.783	600	0.470	0.807	616	0.497	0.932	600	0.559
3. Cooch Behar	2.500	334	0.835	2.400	335	0.804	2.811	400	1.124	2.200	450	1.305
4. West Dinajpur	1.100	213	0.234	0.430	230	0.099	0.560	236	0.135	0.545	236	0.120
5. Malda	0.155	246	0.038	0.095	240	0.023	0.125	300	0.038	0.165	275	0.045
6. Murshidabad	-	-	-	-	-	-	-	-	-	-	-	-
7. Nadia	-	-	-	-	-	-	-	-	-	-	-	-
8. 24 Parganas (N)	-	-	-	-	-	-	-	-	-	-	-	-
9. 24 Parganas (S)	-	-	-	-	-	-	-	-	-	-	-	-
10. Howrah	-	-	-	-	-	-	-	-	-	-	-	-
11. Hooghly	-	-	-	-	-	-	-	-	-	-	-	-
12. Burdwan	-	-	-	-	-	-	-	-	-	-	-	-
13. Birbhum	0.030	325	0.010	0.025	325	0.008	-	-	-	-	-	-
14. Bankura	-	-	-	0.124	373	0.046	0.073	385	0.028	0.100	300	0.030
15. Purulia	1.577	322	0.508	1.456	395	0.575	1.331	342	0.455	1.446	420	0.607
16. Midnapore (W)	-	-	-	-	-	-	0.132	125	0.016	0.155	125	0.019
17. Midnapore (E)	-	-	-	-	-	-	-	-	-	-	-	-
Total West Bengal	6.117	338	2.070	5.313	381	2.025	5.859	392	2.300	6.243	432	2.694

A = Area in '000 hectares. B = Yield rate in kg/hectare. C = Production in '000 tonnes

Final Estimates of 'Sunflower' of West Bengal for the year 1986-1990

District	1986-87			1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P
1. Darjeeling	-	-	-	-	-	-	-	-	-	-	-	-
2. Jalpaiguri	-	-	-	-	-	-	-	-	-	-	-	-
3. Cooch Behar	-	-	-	-	-	-	-	-	-	-	-	-
4. West Dinajpur	-	-	-	-	-	-	-	-	-	-	-	-
5. Malda	-	-	-	-	-	-	-	-	-	-	-	-
6. Murshidabad	-	-	-	-	-	-	-	-	-	-	-	-
7. Nadia	-	-	-	0.030	550	0.017	-	-	-	-	-	-
8. 24 Parganas (N)	0.159	524	0.083	0.207	599	0.124	0.287	431	0.124	0.324	669	0.217
9. 24 Parganas (S)	0.774	725	0.561	1.200	725	0.870	725	725	0.631	0.825	725	0.597
10. Howrah	0.138	460	0.063	0.149	465	0.069	0.042	505	0.021	0.004	335	0.001
11. Hooghly	-	-	-	-	-	-	0.001	200	0.0002	-	-	-
12. Burdwan	0.002	810	0.002	0.006	750	0.005	-	-	-	-	-	-
13. Birbhum	-	-	-	-	-	-	-	-	-	-	-	-
14. Bankura	-	-	-	-	-	-	-	-	-	-	-	-
15. Purulia	-	-	-	-	-	-	-	-	-	-	-	-
16. Midnapore (W)	-	-	-	-	-	-	-	-	-	-	-	-
17. Midnapore (E)	0.238	317	0.075	0.039	322	0.013	0.027	411	0.011	0.048	411	0.020
Total West Bengal	1.311	598	0.784	1.631	673	1.098	1.227	641	0.787	1.200	696	0.835

A = Area in '000 hectares. B = Yield rate in kg/hectare. C = Production in '000 tonnes

Final Estimates of Linseed Crops of West Bengal for the Year 1986-1990

Districts	1986-87			1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P
1. Darjeeling	0.198	256	0.05	0.149	298	0.04	0.457	315	0.14	0.476	180	0.09
2. Jalpaiguri	0.229	259	0.06	0.220	298	0.07	0.789	342	0.27	0.939	149	0.14
3. Cooch Behar	2.533	391	0.99	1.187	415	0.49	2.940	435	1.28	2.014	333	0.67
4. West Dinajpur	5.334	171	0.91	5.220	121	0.63	3.370	199	0.67	3.527	150	0.53
5. Malda	2.795	351	0.98	3.598	366	1.32	2.745	317	0.87	1.060	180	0.19
6. Murshidabad	2.766	318	0.88	0.879	231	0.21	1.113	506	0.56	0.630	216	0.14
7. Nadia	4.996	464	2.32	4.937	385	1.90	4.583	552	2.53	2.527	439	1.11
8. 24 Parganas (N)	0.188	401	0.08	0.099	332	0.03	0.028	506	0.01	0.021	381	0.01
9. 24 Parganas (S)	0.005	401	0.002	-	-	-	-	-	-	-	-	-
10. Howrah	0.005	208	0.001	0.014	205	0.003	0.005	139	0.001	-	-	-
11. Hooghly	0.005	208	0.001	-	-	-	-	-	-	0.042	337	0.01
12. Burdwan	0.293	208	0.06	0.014	205	0.003	0.392	139	0.05	0.026	337	0.01
13. Birbhum	0.127	198	0.03	0.200	205	0.04	0.191	139	0.03	0.116	337	0.04
14. Bankura	0.803	199	0.16	0.249	321	0.08	0.068	139	0.01	0.173	337	0.06
15. Purulia	0.733	178	0.13	1.817	121	0.22	0.045	139	0.01	0.170	337	0.06
16. Midnapur (N)	0.546	201	0.11	0.100	205	0.20	0.067	139	0.01	-	-	-
17. Midnapur (E)	-	-	-	-	-	-	-	-	-	0.021	337	0.01
Total West Bengal	21.556	314	6.76	18.701	270	5.05	16.793	383	6.44	11.742	261	3.07

A = Area in '000 hectares. B = Yield rate in kg/hectare. C = Production in '000 tonnes

Final Estimates of 'Castor' of West Bengal for the year 1986-1990

District	1986-87			1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P
1. Darjeeling	-	-	-	-	-	-	-	-	-	-	-	-
2. Jalpaiguri	-	-	-	-	-	-	-	-	-	-	-	-
3. Cooch Behar	-	-	-	-	-	-	-	-	-	-	-	-
4. West Dinajpur	-	-	-	-	-	-	-	-	-	-	-	-
5. Malda	-	-	-	-	-	-	-	-	-	-	-	-
6. Murshidabad	-	-	-	-	-	-	-	-	-	-	-	-
7. Nadia	-	-	-	-	-	-	-	-	-	-	-	-
8. 24 Parganas (N)	-	-	-	-	-	-	-	-	-	-	-	-
9. 24 Parganas (S)	-	-	-	-	-	-	-	-	-	-	-	-
10. Howrah	-	-	-	-	-	-	-	-	-	-	-	-
11. Hooghly	-	-	-	-	-	-	-	-	-	-	-	-
12. Burdwan	-	-	-	-	-	-	-	-	-	-	-	-
13. Birbhum	-	-	-	-	-	-	-	-	-	-	-	-
14. Bankura	-	-	-	-	-	-	-	-	-	-	-	-
15. Purulia	-	-	-	-	-	-	-	-	-	-	-	-
16. Midnapore (W)	0.155	525	0.081	0.110	709	0.078	0.102	1075	0.110	0.082	1075	0.088
17. Midnapore (E)	-	-	-	-	-	-	-	-	-	-	-	-
Total West Bengal	0.155	525	0.081	0.110	709	0.078	0.102	1075	0.110	0.082	1075	0.088

A = Area in '000 hectares. B = Yield rate in kg/hectare. C = Production in '000 tonnes

Other oilseed production of West Bengal 1986-1990

District	1986-87			1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P
1. Darjeeling	-	-	-	-	-	-	-	-	-	-	-	-
2. Jalpaiguri	-	-	-	-	-	-	-	-	-	-	-	-
3. Cooch Behar	-	-	-	-	-	-	-	-	-	-	-	-
4. West Dinajpur	-	-	-	-	-	-	-	-	-	-	-	-
5. Malda	-	-	-	-	-	-	-	-	-	-	-	-
6. Murshidabad	-	-	-	-	-	-	-	-	-	-	-	-
7. Nadia	-	-	-	-	-	-	-	-	-	-	-	-
8. 24 Parganas (N)	-	-	-	-	-	-	-	-	-	-	-	-
9. 24 Parganas (S)	-	-	-	-	-	-	-	-	-	-	-	-
10. Howrah	-	-	-	-	-	-	-	-	-	-	-	-
11. Hooghly	-	-	-	-	-	-	-	-	-	-	-	-
12. Burdwan	0.040	618	0.025	0.021	215	0.005	0.075	310	0.023	0.057	300	0.017
13. Birbhum	-	-	-	-	-	-	-	-	-	-	-	-
14. Bankura	-	-	-	-	-	-	-	-	-	-	-	-
15. Purulia	-	-	-	-	-	-	-	-	-	-	-	-
16. Midnapore (W)	0.210	400	0.084	0.125	250	0.031	-	-	-	-	-	-
17. Midnapore (E)	-	-	-	-	-	-	-	-	-	-	-	-
Total West Bengal	0.250	436	0.109	0.146	247	0.036	0.075	310	0.023	0.057	300	0.017

A = Area in '000 hectares. B = Yield rate in kg/hectare. C = Production in '000 tonnes

Final Estimates of Kharif Pulses in West Bengal For the Year 1987-1990 (Soyabean)

District	1987-88			1988-89			1989-90		
	A	Y	P	A	Y	P	A	Y	P
1. Darjeelin	0.280	500	0.140	0.278	500	0.139	0.380	600	0.228
2. Jalpaiguri	-	-	-	-	-	-	-	-	-
3. Cooch Behar	-	-	-	-	-	-	-	-	-
4. West Dinajpur	-	-	-	-	-	-	-	-	-
5. Malda	-	-	-	-	-	-	-	-	-
6. Murshidabad	0.143	953	0.136	0.153	543	0.083	0.070	822	0.058
7. Nadia	-	-	-	0.008	500	0.004	0.007	500	0.004
8. 24 Parganas (N)	-	-	-	-	-	-	-	-	-
9. 24 Parganas (S)	-	-	-	-	-	-	-	-	-
10. Howrah	-	-	-	-	-	-	-	-	-
11. Hooghly	-	-	-	-	-	-	-	-	-
12. Burdwan	0.017	1060	0.018	0.004	1000	0.004	0.002	1000	0.002
13. Birbhum	0.081	550	0.045	0.067	635	0.042	0.027	635	0.017
14. Bankura	0.052	615	0.032	0.025	500	0.012	0.030	500	0.015
15. Purulia	-	-	-	-	-	-	-	-	-
16. Midnapur (W)	-	-	-	-	-	-	-	-	-
17. Midnapur (E)	-	-	-	-	-	-	-	-	-
Total West Bengal	0.573	647	0.371	0.535	531	0.284	0.561	628	0.324

A = Area in '000 hectares. Y = Yieldrate in kg/hectare. P = Poduction in '000 tonnes.

*Month Crop is not grown during 1988-89 and 1989-90.

To bring 3.65 lakhs hectares area os oilseeds under irrigation, during 1987-88 and 4.60 lakh hectares by the end of 1989-90

To achieve an additional production of 0.76 lakh tonnes from irrigated area in 1989-90 over 1987-88.

For attaining self sufficiency by 1990-91 special emphasis should be given for improving small irrigation systems in West Bengal to increase oilseed production upto 0.50 lakh tonnes.

CHAPTER - XI

YIELD GAPS AND CONSTRAINTS ANALYSIS OF OIL SEED PRODUCTION IN WEST BENGAL

11.1 THE METHOD

Cobb-Deuglas Production Function as a Method of Gap Analysis

Cobb and Douglas tried to find out the actual form of the production function prevailing in the manufacturing industry of the United States by statistical methods. They obtined a production function of the following from:

$q = AL^{\alpha} C^{1-\alpha}$ where q is the output of the manufacturing industry, L is the quantity of labour employed, C is the quantity of capital employed and A and α are constants ($0 < \alpha < 1$).

The Cobb-Douglas production has been widely used in economic models for its simplicity. The production function is homogeneous of degree one and is subject to constant return to scale. If labour and capital are increased α times, output will also increase α times. This is seen as follows:

$$
\begin{aligned}
A(\lambda L)^{\alpha} \; (\lambda C)^{1-\alpha} &= A.\lambda^{\alpha} L^{\alpha}.\lambda^{1-\alpha}.C^{1-\alpha} \\
&= A.\lambda^{\alpha+1-\alpha} L^{\alpha} C^{1-\alpha} \\
&= A.\lambda.L^{\alpha} C^{1-\alpha} \\
&= \lambda.1.
\end{aligned}
$$

It can be shown that the elasticity of output with respect to L is equal to α and elasticity of output with respect to C is equal to $(1-\alpha)$.

Proof: Since $q = A.L^{\alpha}.C^{1-\alpha}$

$\text{Log } q = \log A + \alpha \log L + (1-\alpha) \log C.$

Differentiating partially with respect to log L we get

$$\frac{\partial \log q}{\partial \log L} = \alpha \text{ . } \quad \text{i.e.,} \quad \frac{\partial q/q}{\partial L/L} = \alpha \text{ .}$$

Similarly $\dfrac{\partial \log q}{\partial \log C}$ $1 - \alpha$.

It can be seen that the marginal productivities of L and C depend on the ratio of the two factors

$$q = AL^{\alpha}.C^{1-\alpha}$$

$$\therefore \frac{\partial q}{\partial L} = A.\alpha L^{\alpha-1}.C^{1-\alpha}$$

$$= A.\alpha.L^{-(1-\alpha)} \; C^{1-\alpha}$$

$$= A.\alpha.(\frac{C}{L})^{1-\alpha}$$

Thus $\frac{\partial q}{\partial L}$ depends only on the ratio $\frac{C}{L}$

Again $\dfrac{\partial q}{\partial C} = AL^{\alpha}(1- \;)C^{-\alpha}$

$$= A(1-\alpha). \; (\frac{L}{C})^{\alpha}$$

This again shows that $\frac{\partial q}{\partial C}$ also depends on the ratio $\frac{L}{C}$ or, its reciprocal $\frac{C}{L}$. Thus both the marginal productivities of capital and labour depend on the ratio of the two factors.

The general form of the Cobb-Douglas production function is given by $q = AL^{\alpha}C^{\beta}$ where A, α and β are constants. In the special case $\alpha+\beta=1$ and the production function is homogeneous of degree one giving constant returns to scale. If $\alpha+\beta > 1$, there will be increasing returns to scale and if $\alpha+\beta < 1$, there will be decreasing returns to scale.

GAP ANALYSIS

11.2 RESUME

The study is undertaken to assess the yield gaps on common oil seeds for kharif and rabi seasons and to identify the technological and socioeconomic constraints responsible for these yield gaps in the districts of West Bengal.

The concepts of yield gaps used are:

Gap I	:	Between Research Station and Demonstration farms
Gap II	:	Between Demonestration farms and Progressive farms
Gap III	:	Between Research Station farms and Progressive farms
Gap IV	:	Between Progressive farms and Average Sampled farms
Gap V	:	Between Research Station and the Average yield realised by farms.

The data relates to the year 1989-90 and covers 150 farms of different size namely, medium and large besides 25 demonstration poots and 25 progressive farms.

The exponential function of Cobb-Douglas type is employed to measure the contribution of Bullock Labour, seed cost, pesticide cost, Nitrazen, phosphorus and Technology index to yield gap.

The yield gaps are conspicuous in kharif season in relative terms, while they are more conspicuous rabi absolute terms. It is observed that technology, seed, pesticides, Bullock labour, nigtrogen, phosphorus are the most important factors explaining yield gap in order of mention.

The regression co-efficient of technology index is negative implying that the increased adoption of improved technology reduce the yield gap.

The reasons attributed by the farmers for the yield gaps are incidence of pests and diseases, lack of own funds, high cost inputs, lack of timely supply of these inputs and rainfall, dewfall. It is suggested that more demonestrations, subsidised supply of inputs, timely supply of inputs, credit facilities, technical know how and proper marketing facilities help in reducing this gap.

Key words-yield gap, Cobb-Douglas function, technology index, socio economic constraints, regression coefficient, demonestration farm, research station farm, progressive farm, pooled farm, large farms, medium farms, small farms.

11.3 INTRODUCTION

There is a saying that research efforts are to be concentrated on identifying the farmers who are left behind, providing explanation for their logging behind and setting forth what should be done to help them. Any attempt to understand the basic problems in the adoption of recommended technology package assumes special significance. This steppneeds a scientific evaluation of the extent of yield gap, the causes and constraints thereof. The present study is undertaken to assess yield gaps on main oil seed farms when compared to those of research stations, demonestration plots and progressive farms and identify technological as well as socio-economic constraints responsible for yield gap at the oil seed front in the state of West Bengal.

11.4 METHODS

A stratified random sample of 150 farms comprising of 55 farmers for kharif season and 95 farmers for rabi seasons was drawn from the selected villages where agricultural activity on oil seeds prodominate. Out of 55 farms in kharif, there are 20 small farms (Less than 2 hectares), 20 medium farms (2 to 4 hectares), and 15 large farms (more than 4 hectors) 38 small farms, 35 medium farms 22 large farms are selected for study during rabi season. Besides, 15 demonestration plots in each season, 15 progressive farms in kharif and 15 in rabi are also considered. The data required is collected for the period 1989-90, through a pre-tested questionnaire using survey method.

The following concept of yield gaps are used in the study.

Gap I : The difference between the yields obtained in research station farm and demonestration farms.

Gap II : The difference between yield obtained on demonestration plots and that obtained on progressive farms.

Gap III : The difference in yield obtained on research station and that obtained on progressive farms.

Gap IV : The difference between yield obtained by the progressive farms and average yield realised by sample farms.

Gap V : The difference in yield on Research Station and the average yield realised by the farms.

The yield gap is the cumulative effect of biological and socio--economic factor, with some other geophysical conditions related to it.

Due to the limitations of the data in socio-economic factors, the functional analysis was restricted to examine the contribution of only biological factors to the yield gap.

The model specified as follows :

$$Y = a\ B^{61}\ S^{62}\ P^{63}\ N^{64}\ PS^{65}\ TI^{66}\ u$$

Y = Yield gap in kilogram

B = Gap in bullock labour in pair days

S = Gap in seed cost in Rupees

P = Gap in pesticide cost in Rupees

N = Gap in nitrogen in kilograms

PS = Gap in phosphorus in kilogram

TI = Technology Index

a = Intercept

61...66 = are partial regression coefficients.

u = Error term

11.5 RESULTS AND ANALYSIS

It is found that the yield obtained in Rabi season was more than double the yield in kharif. The yield per unit area obtained on different farms in both the seasons are presented in the Table XI-1. From a comparison of the yield, it is inferred that small farms recorded the lowest and research stations recorded the highest in both the seasons.

Table XI-1. The average yields obtained on different farms in kharif and rabi seasons (1989-90) in West Bengal

Sl. No.	Farms	Kharif Qts/ha	Rabi Qts/ha
1.	Research Stations	10.00	23.50
2.	Demonestration plots	6.25	20.50
3.	Progressive Farms	5.00	18.50
4.	Small Farms	2.50	10.00
5.	Medium Farms	3.00	12.00
6.	Large Farms	4.50	14.50
	Pooled Farms	6.37	23.16

The yield gaps between different farms are given in Table XI-2 were the gaps were more conspicuous in rabi season compared to that of kharif. The yield gaps ranges from 0.50 to 8.50 quintals per hectare in kharif and 3.50 to 16.00 quintals per hectare in rabi season. The highest and the lowest on the range of gap occur in gap IV and gap V in kharif and gap III and gap V in rabi.

Table XI-2. Yield gaps between different farms in Kharif and Rabi (1989-90) in West Bengal

Sl. No.	Yield gaps	Kharif Qts/ha	Rabi Qts/ha
1.	Gap I		
	Research Station Vs Demonestration Plots	3.75	3.50
2.	Gap II		
	Demonstration Plots Vs Progressive Farms	1.00	3.25
3.	Gap III		
	Research Station Farms Vs Progressive Farms	5.00	7.00
4.	Gap IV		
	a) Progressive Farms Vs Large Farms	0.25	2.75
	b) Progressive Farms Vs Medium Farms	1.75	4.75
	c) Progressive Farms Vs Small Farms	2.25	7.75
	d) Progressive Farms Vs Pooled Farms	1.42	5.08
5.	Gap V		
	a) Research Station Vs Large Farms	6.25	10.75
	b) Research Station Farm Vs Medium F Farms	7.75	12.75
	c) Research Station Farms Vs Small Farms	8.25	15.75
	d) Research Station Farms Vs Pooled Farms	7.42	12.08

Functional analysis was employed to know the factors responsible to the gap in yield. It may be noted here that the functional analysis in not complementary to the tabular analysis. As stated earlier, the functional analysis was restricted to examin the contribution of only biological factors. The estimate functions for different yield gaps in kharif and rabi season are presented in Table XI-3.

11.5.i) Kharif Season

The functional analysis brings out that the bullock labour (gap V small and pooled farms) seed (gap II, gap IV and gap V) presticides (gap I, gap III, and gap IV) and technology (gap I, gap II and gap IV) are the most important factors influencing yield gap in kharif season. Nitrogen and phosphorus applications have not contributed to the yield gap. Technology has a negative effect on yield gap implying that the yield gap will be reduced with the increased adoptation of technology on all farming stations.

In case of gap IV it was not statistically significant which means that the level of technology adopted by progressive and average farms are same. The results reveal that one per cent increase in bullock labour in pair result in 0.38 per cent and 0.35 per cent increase in yield gap on small and pooled farms respectively in case of gap IV while it results in 0.48 per cent and 0.25 per increase in yield gap on small and pooled farms respectively in case of gap V. One per cent change in seed cost in accompanied by 0.34 to 0.80 per cent change in yield gap on different type of farms (gap II, gap IV and gap V). One per cent change in pesticide use is accompanied by 0.57 to 0.81 per cent change in yield gap (gap I, gap III, gap IV and V) while this range varies from 0.64 to 0.88 in case of technology.

11.5.ii) Rabi Season

The similar trend is observed here in Rabi season. One per cent increase in bulock labour results in 0.20 to 0.30 per cent increase in yield gap. While the gap ranges from 0.25 to 0.65 per cent due to one per cent increase in seed. One per cent increase in pesticides result in an increase of 0.31 to 0.60 per cent increase in yield gap. Nitrogen variation in yield gap significantly only in case of gap V and pooled farms to a range of about 0.30 per cent for every one per cent increase in it. Phosphorus variation in yield gap on small and pooled farms only (gap IV and gap V). As expected technology has a negative sign implying that the adoptation of improved technology reduce the yield gap.

The variation in yield significantly only in case of gap V. This implies that the average farmer does not apply all recommended instructions in case of Rabi season.

For the said reason, the technology, seed, pesticides, bullock labour, nitrosen, phosphorus explain variation in yield of oil seed culture on different farms when compared to research station and progressive farms in the order of mention.

It may be noted that the technology index is negatively correlated with other independent variable also. The simple correlation coefficients between the independent variables indicated the presence of multicollinerity, that they are not serions enough alter the results presented.

11.6 Constraint Analysis

The opinion survey formed the basis for the constraint analysis. Thus, the generalization are the feedback of the farmers engaged in oilseed farming in the state of West Bengal

In view of the skill of the farmers more or less the common are the lack of knowledge.

1) Adaptation of high yield varieties

It is observed that only five farmers are using high yielding varieties out of 95 sampled farms. The causes of non-adaptation of high yielding varities are presented in Table IX-4.

In kharif season about 55% of the farmers explained the major reason for non adaptation of high yielding varieties as continued crop failure. Due to the mal rhythm of rainfall in last five years there was no urge for the farmers to take up high yielding varieties. Risk proneness indicated by 23 per cent of sampled farms and non-availability in proper time by nearly 23 per cent of sampled farms are the other seasons expressed for non adoption of improved varieties. In Rabi season the major reasons expressed by the farmers are non-availability in time (expressed by 31 per cent of samples farms) and risk proneness (by 30 per cent of sampled farms). The main other seasons are lack of awareness, low prices for the product, high seed cost, and other socio economic problems.

2) Adaption of Fertilizer Sechedules

In case of kharif, 70 per cent did not want to apply due to continuous crop failure, as kharif crop in always being hit by drought while 30 per cent did not have knowledge about adaptation of fertilizer schedule.

In rabi season, the major constraint explained by the farmers is non-availability in time (expressed by 32 per cent of sample farms) while 17 per cent expressed lack of awareness about fertilizer schedule, about 13 per cent expressed shortage of own capital. High cost of seed (expressed by 10 per cent of samples farms) lack of credit facilities (expressed by 10 per cent of sample farms) risk proseness and lack of local availability (expressed by about 8 per cent of sampled farms) are other reasons.

In case of small farmers the main reasons are lack of knowledge, continuous crop failure, shortage of own funds and lack of availability in time in the order mentioned. The major constraint attributed by large farmers is lack of availability in time. The reasons expressed by medium farmers are lack of knowledge, continuous crop failure, high prices for fertilizer and non availability in time.

3) Adoption of plant protection measures

In case of kharif, the main reason is that most of the farmers do not want to take risk due to continuous crop failure 36 farmers (67.15% attributed risk proneness while 20 farmers (35.50%) indicated lack of awareness.

In rabi season 20 farmers (21.92%) attributed the season being lack of awareness and high cost of pesticides about 17 farmers (18%) lack of own funds about 10 farmers (9%) expressed traditional belief and lack of technical guidance and about 6 farmers (6%) lack of availability locally.

The major constraints for small, medium and large farmers were lack of awareness and risk proneness.

The reasons attributed by farmers for yield gap are summarised in Table XI-5.

In case of kharif, the major reason for yield gap is the amount of rainfall received. From the constraint analysis it was revealed that 20 farmers (43.5%) felt inadequate rainfall, 16 farmers (30.12%) expressed incidence of pest and 8 farmers (15.38%) felt high cost of inputs as the xeasons for yield gap.

In case of rabi the major reason for yield gap is the incidence of pests. The results revealed that 20 farmers (20.83%) attributed the yield gap to the incidence of pests. 15 farmers (15.63%) to high cost of inputs. 12 farmers (12.5%) expressed non-availability of inputs in time, 10 farmers (10.42%) expressed lack of own funds, 12 farmers (12.5%) said non-availability locally and 10 farmers (10.42%) opined lack of credit facilities.

The main input constraints are improved varieties, selection of proper seeds, seed treatments, increasing seed rates, due application of fertilizers proper plant protection measures are the main reasons for the low yield rate.

11.7 RECOMMENDATIONS FOR REDUCING THE YIELD GAP

The recommendations stated here are based on the remarks survey of farmers. Most of the farmers wanted subsidised supply of inputs as it is the first recommendation as about 80 per cent of sampled farmers. This is more or less same in case of small farmers. The inputs like seed, fertilizers pesticides etc. are essential in agricultural production which are not adequately available. Besides, the prices are high in input market. For the said reasons most of the farmers are not applying fertilizer and pesticides to the oil seed production like rapementard, goowad nut, saflower etc.

Lack of credit is the next important suggestion. That, about 75 per cent of the sampled farmers are not having the said facility. The feeling is more in case of small farmers. Short term credit is the most essential to small and medium farmers to adopt the latest technology like application of adequate fertilizers and adopting suitable plant protection measures.

Timely supply of inputs is another issue suggested about 68 per cent of sampled farmers. This feeling is more among the large farmers. Delay in input service delay in agricultural operations which in turn reduces the yield.

It is also suggested to improve the existing extension service to help for achieving higher productivity. There is and extension gap contributing to the existing yield gap. 60 per cent of sampled farmers do not have proper guidence from the extension service.

55 per cent of the sampled farmers ever had any demonstration in the area. If more demonestrations are organised on scientific lines more farmers will be convinced to adapt the latest technology, which is the most important factor for higher productivity.

The produce must be marketed to assure a remunerative price to farmers. Organising the marketing of produce is another suggestion put forth about 36 per cent of sampled farmers and there is a need to remove the present irregularities in marketing system.

As yield gaps were studied earlier by employing three gap model Swaminathan, 1977; in international Rice Agro-economic Net work, 1978, and four gap model studied by Venkateswarlu 1978 and Suryanarayana, 1980. The five gap model studied by G.P. Sunandini, T.D.J. Nagabhusanam etc. in 1985-86. In all the above works single crop was taken up for study.

In this analysis the main type of oil seed crops considered like mustard seeds, sesamum, ground nut, niger, and soyabean, though soyabean is cultivated in West Bengal in small plots on an experimental basis in a very few districts. So, if any constraints which is not applicable to the other cropping system was deleted from the survey criteria. But more or less the problems related to the yield gap are almost same.

Table 11.3 Estimated Functions of Different Yield Gaps in Kharif and Rabi Seasons

Particulars	Estimated Function						
			K H A R I F S E A S O N				
Gap I	Y = 4.6421	B-0.2437	S-0.3269	P-0.5816*	N-0.2286	PS-0.2614	T-0.6450*
	R^2 = 0.6508						
Gap II	Y = 5.6196	B-0.1360	S-0.8106	P-0.0060	N-0.0306	PS-0.0615	T-0.0762
	R^2 = 0.4855						
Gap III	Y = 5.8327	B-0.2860	S-0.2933	P-0.6555***	N-0.2450	PS-0.3226	T-0.6666***
	R^2 = 0.6266	n = 15					
Gap IV							
a) Small Farms	Y = 5.0640	B-0.4582***	S-0.5250***	P-0.0010	N-0.1155	PS-0.1462	T-0.1716
	R^2 = 0.6416	n = 20					
b) Medium Farms	Y = 2.1850	B-0.3801	S-0.5960***	P-0.0060	N-0.1105	PS-0.1216	T-0.1344
	R^2 = 0.5614	n = 20					
c) Large Fams	Y = 2.6917	B-0.1805	S-0.4916	P-0.0040	N-0.2055	PS-0.2514	T-0.1410
	R^2 = 0.5613	n = 15					
d) Pooled Farms	Y = 5.5020	B-0.3335***	S-0.4951	P-0.0002	N-0.2610	PS-0.0725	T-0.1564
	R^2 = 0.6752	n = 55					
Gap V							
a) Small Farm	Y = 1.8967	B-0.4642*	S-0.6260***	P-0.8112***	N-0.0137	PS-0.0840	T-0.8919***
	R^2 = 0.8870	n = 20					
b) Medium Farms	Y = 0.4870	B-0.2247	S-0.4375**	P-0.6410***	N-0.1658	PS-0.1658	T-0.6519***
	R^2 = 0.6539	n = 20					

Table XI-3. (Contd.)

Particulars	Estimated Function						
	KHARIF SEASON						
c) Large Farms	Y = 3.6650 R^2 = 0.7447	B-0.1895 n = 15	S-0.3300*	P-0.6650***	N-0.1411	PS-0.2608	T-0.5780
d) Pooled Farms	Y = 0.6241 R^2 = 0.9671	B-0.2625* n = 55	S-0.3979**	P-0.5949	N-0.0093	PS-0.3651	T-0.6258***
	RABI SEASON						
Gap I	Y = 4.9168 R^2 = 0.5696	B-0.1488 n = 15	S-0.3913***	P-0.1402	N-0.0925	PS-0.1489	T-0.0442
Gap II	Y = 3.8560 R^2 = 0.4955	B-0.8101 n = 15	S-0.2603	P-0.3419	N-0.1764	PS-0.1603	T-0.2628
Gap III	Y = 0.8488 R^2 = 0.5926	B-0.1785 n = 15	S-0.3915***	P-0.3177*	N-0.1585	PS-0.1889	T-0.2658
Gap IV a) Small Farms	Y = 0.9242 R^2 = 0.7806	B-0.0975 n = 38	S-0.3662***	P-0.4215	N-0.0466	PS-0.3302**	T-0.1345
b) Medium Farms	Y = 1.8265 R^2 = 0.6266	B-0.0347 n = 35	S-0.4966***	P-0.4614***	N-0.0121	PS-0.1207	T-0.1266
c) Large Farms	Y = 1.5425 R^2 = 0.6113	B-0.0712 n = 22	S-0.710	P-0.3115*	N-0.0217	PS-0.1226	T-0.1162
d) Pooled Farms	Y = 0.5387 R^2 = 0.7778	B-0.2369*** n = 95	S-0.2715***	P-0.3169***	N-0.0365	PS-0.2416	T-0.1105

Table XI-3. (Contd.)

Particulars	Estimated Function						
			RABI SEASON				
Gap V							
a) Small Farms	Y = 0.2603	B-0.2955*	S-0.4805**	P-0.5964***	N-0.0242	PS-0.3406*	T-0.6162***
	R^2 = 0.9728	n = 38					
b) Medium Farms	Y = 2.2982	B-0.1242	S-0.6075***	P-0.6108	N-0.0955	PS-0.1296	T-0.5618***
	R^2 = 0.6916	n = 35					
c) Large Farms	Y = 5.1650	B-0.1039	S-0.4366	P-0.5112***	N-0.0835	PS-0.2302	T-0.3720***
	R^2 = 0.7115	n = 22					
d) Pooled Farms	Y = 0.7875	B-0.2115**	S-0.2965***	P-0.3168***	N-0.2265***	PS-0.2665***	T-0.3066***
	R^2 = 0.7608	n = 95					

* Indicates significance at 10% level
** Indicates significance at 5% level
*** Indicates significance at 1% level

Table XI-4. Reasons for non adaption of high yielding varities

Sl. No.	Reasons	KHARIF				RABI			
		Small	Medium	Large	Pooled	Small	Medium	Large	Pooled
1.	Lack of awareness	-	-	-	-	12	6	-	18 (18.75)
2.	High Cost of Seed	-	-	-	-	-	5	-	5 (5.21)
3.	Risk Proneness	6	3	2	11 (22.77)	20	6	2	28 (29.17)
4.	Non availability time	-	4	8	12 (23.07)	7	10	12	29 (31)
5.	Susceptable to Pests and diseases	-	-	-	-	-	-	-	-
6.	Continued crop failure	15	10	4	29 (64.63)	-	-	-	-
7.	Low Price	-	-	-	-	-	-	-	16 (16.67)

(Figures in parentheses indicate percentage to total)

Table XI-5. Reasons identified by the selected farmers for the yield gap

Sl.No.	Reasons/constraints	Kharif	Rabi
1.	BIOLOGICAL		
a)	Variety	-	-
b)	Weed infestion	-	-
c)	Incidence of Pests	16 (30.13)	20 (20.83)
d)	Incidence of diseases	3 (5.77)	6 (6.25)
e)	Irrigation water management	16 (28.85)	20 (32.66)
f)	Amount of Rainfall received	20 (43.51)	-
g)	Soil fertility variation	6 (7.25)	2 (2.08)
II.	SOCIO ECONOMIC AND TECHNICAL CONSTRAINTS		
a)	Lack of own funds	4 (7.69)	10 (10.42)
b)	Lack of credit facilities	6 (6.25)	10 (10.42)
c)	Traditional belief	-	3
d)	High cost of inputs	8 (15.38)	15 (15.63)
e)	Lack of knowledge about technology	5 (5.63)	6 (6.25)
f)	Non availability of inputs in time	10 (15.38)	12 (12.5)
g)	Non-availability locally	3 (5.77)	12 (12.5)

(Figures in parentheses indicate the percentage to the total number of respondents).

Table XI-6. Suggestions for reducing the gap

Sl. No.	Recommendations	Number of Farmers			
		Small	Medium	Large	Pooled
1.	More demonstration	17 (25.00)	28 (51.92)	30 (83.30)	75 (54.50)
2.	Subsidised supply of inputs like seeds fertilizers and pesticides	47 (78.33)	34 (65.38)	25 (69.44)	106 (79.33)
3.	Timely supply of inputs	33 (55.00)	32 (61.53)	29 (80.55)	94 (67.78)
4.	Availability of crop production and marketing credit	54 (90.00)	36 (69.23)	20 (55.55)	104 (74.62)
5.	Availability of technical help in greater degree	33 (55.00)	30 (57.33)	21 (58.33)	84 (59.66)
6.	Organisation of the marketing produce	28 (40.60)	16 (30.77)	9 (25.00)	53 (35.81)

Figure in parentheses are percentage to total number of respondents in each category.

CHAPTER - XII

REVIEW ON CONSUMPTION OF FATS AND OILS IN WEST BENGAL

As the population of India is growing and standard of living improving the domestic production of vegetable oils is not keeping pace with the growing demands and requarements.

Different estimates were given by the Tata consultants for the Civil Supplies Department and the Ministry of Agriculture Although these estimations are to be reviewed constantly in the light of per capita requirements of different strata of society as well as the needs of the industry, there is no denial of the fact that we need more. Oil and that we have to significantly increase the oilseed production in the state. One has to keep in the mind also that vegatble oil consumption is highly income elastic and is influenced by purcassing power dietary habits and patterns etc. The data collected by the National Nutrition Monitoring Bureau (NNMB) of the I.C.M.R. is pertinent (Table 1).

Table XII-1. Average Consumption of Fats and Oils in Different Groups (gms/consumption unit/day)

	Consumption unit = Adult male Sedentary worker
Urban	
1. High income group	46
2. Middle income	35
3. Low income group	22
4. Industrial labourers	23
5. Slum dwellers	10
Rural	

The ICMR Expert Group has recommended the intake of fats and oils of 30-35 gms/consumption unit/day and this includes both the visible and non-visible fat.

Fat is a necessary ingredient in the diet and its is of values to the body in a number of ways. Animal fats such as butter and ghee contain vitamin A. But the vitamin is lost to varying degrees during the process of cocking. Hydrogenated oil (Vanaspati). Now popular in India as a cooking medium does not formally contain vitamins. However under Government regulations the vanaspati that is sold in the market should contain 700 International units of added vitamin A per ounce and most manufacturers add in addition 50 international units of vitamin Dper ounce of vanaspati.

Fat is a conventrated source of energy and it supplies per unit weight more than double the energy furnished by either protein or carbohydrate, some fats especially vegetable oils provide what are called "essential fatty acids" - linoleic and arachidonic acids to the body. Like vitamins the essential fatty acids also play a role in several metabolic reactions, and a deficiency of these acids in the diet leads to a skin condition know as phrynoderms (toad skin) in which skin becomes rough and thick horny papules of the size of a pin head erupt in certain areas of the body notaboly thighs buttocks, arms and trunk.

The fat content of a normal diet is made up mostly of the pure fats and oils consumed as such. However the foodstuffs that are oilseeds and nuts soyabean and avocado pear. Cereals pulses and vegetables contain negligible amount of fat.

In recent years there has been a revival of interest in the nutritional aspects of fats in view of their role in infuencing the levels of a substance known as cholesterol in the blood. The presence of exvcessive amounts of cholesterol in blood causes laying down of the substance under the lining of the blood vessels leading to a condition I known as atherosclerosis in which the blood vessels are narrowed and hardened. The coronary arteries supplying blood to the heart are thus affected and coronary heart disease results. Extensive observations on population groups have shown that consumption of diets in which fats supply more than 30 per cent of the calories in the diet may result in an increase in blood cholesterol. While ths may be true with persons leading a sedentary life physical activity and vigorous exercise appear to help pesons to tolerate higher levels of fat in the diet without which increase in the blood cholesterol.

Apart from the quantity of fat the quality of far in the diet also deterin mines blood cholesterol levels. Some fats like groundnut oil sesame oil or safflower oil which contain a high proportion of poly-unsaturated fatty acids do not increase blood cholesterol levels very much even when consumed in large quantities. On the other hand certain fats like butter ghee coconut oil and hydrogenuted vegetable fats (vanaspati) which v contain a high proportion of saturated a fatty acids have been shown to cause considerable elevationing the levels of blood cholesterol when consumed in large amounts. In the provess of hydrogenation of groundnut oil or cotton seed oils good portein of the unsaturated fatty acids are converted to the saturated type. The consumption of unsaturated fats like gingelly oil or safflower oil along with saturated fat in a diet can help in minimising the effects of the latter in raising the blood cholesterol.

In addition to the quantity and quality the mode of consumption of fat also appears to influence the cholesterol content of blood. At the same total daily intake consumption of smaller amounts of fat a number of times during the course of the day has been shown to cause less esevation of cholesterol content as compared to consumption of large amounts of far at a time.

The quantity of fat that should be included in a well balanced diet is not known with any degree of certainty. However it appears desirable in the present state of knowledge that the daily intake of fat should be such that it contributes not more than 15 to 20 per cent of the calories in the diet. A total of about 40 to 60 gms of fat can therefore, be safely consumed daily and in order to obtain the necessary amount of essential fatty acids, the fat intake should include at least 15 gms of vegetable oils.

But in tropical climatic condition in no case more than 25 gms fat/oil should be consumed from the visible and non visible sources by a sedimentary adult worker perday.

Consumption of Fats from the Non Visible Sources

Foodstuff may be broadly classified as cereals, pulses nuts and oil seeds, vegetables, fruits, oil, milk and milk products and flesh foods. Among the common foodstuff in West Bengal the presence of fat and the style of intake play a major role on consumption of fats and oils rate.

The consumption of various foodstuff and their fat content and possible intake given in Table XII-2

Table XII-2

Sl. No.	Name of the foodstuff	Fat/100gm	Consumption gm/perintake
1	2	3	4
	CEREAL GRAINS AND PRODUCTS		
1.	Job Stears Coix lachryma	6.0	10.00
2.	Maize Dry Zea mays	3.6	10.00
3.	Rice Parboiled Handdpounded Orya sativa	0.6	150.00
4.	Rice Parboiled Milled Oryza sativa	0.4	150.00
5.	Rice Raw Handpounded Oryza sativa	1.0	150.00
6.	Rice Raw Milled Oryza sativa	0.5	150.00
7.	Rice Flakes Oryza sativa	1.2	150.00
8.	Rice Puffed Oryza sativa	0.1	150.00
9.	A Samai Panicum miliare	4.7	20.00

1	2	3	4
10.	Sanwa Millet Echinochloa frunentavea	2.2	150.00
11.	Wheat Bulgar Triticum aestivam	1.6	35.00
12.	Wheat (Whole) Triticum aestivum	1.5	100.00
13.	Wheat Floor (Whole) Triticum aestivum	*1.7	75.00
14.	Wheat Foour (Refined) Triticum aestivum	0.9	75.00
15.	Wheat Germ Triticum aestivum	7.4	35.00
PULSES AND LEGUMES			
16.	Bengal Gram (Whole Cicer arietinum	5.3	20.00
17.	Bengal Gram Dhal Cicer arictinum	5.6	20.00
18.	Bengal Gram (Roasted) Cicer arietinum	5.2	30.00
19.	Black Gram Dhal Phaseolus mango	1.7	30.00
20.	Green Gram (Whole) Phaseolus aureus roxh	1.3	20.00
21.	Green Gram Dhal Phasealus aureus roxb	1.2	35.00
22.	Horse Gram Dolichos bifoorus	0.5	50.00
23.	Kheasari Dhal Lathyrus sativus	0.6	30.00
24.	Rajmah Phaseolus vulgaris	1.2	15.00
25.	Redgram Dhal Cajanus cajan	1.7	20.00

Table XII-2 (Contd.)

1	2	3	4
26.	Soyabean Glycine max merr.	19.5	05.00
LEAFY VEGETABLES			
27.	Amaranath Tender Amaranthus gangeticus	0.5	25.00
28.	Bamboo Tender Shoots Bambusq arundinacea	0.5	25.00
29.	Beet Greens Beta vulgaris	0.8	12.00
30.	Bengal Gram Leaves Oicer arietinum	*1.4	10.00
31.	Cabbage Brassica oleracea var	0.1	100.00
32.	Carrot Leaves Daucus carota	0.5	10.00
33.	Cauliflower Greens Brassica oleracea var	1.3	100.00
34.	Curry Leaves Murraya koenigii	1.0	01.00
35.	Lettuce Lactuca sativa	0.3	15.00
36.	Mata Sag (Lupu) Antidesma diandurum	4.8	20.00
37.	Mayalu Basella rubra	0.4	30.00
38.	Mustard Leaves Brassica campestris var	0.6	20.00
39.	Neem Leaves Tender Azadirachta indica	3.0	00.10
40.	Parwar Sag Trichosanthes dioica	1.1	20.00

Table XII-2 (Contd.)

1	2	3	4
41.	Patua Sag Corchorus capsularis	1.1	10.00
42.	Potato Leaves Solanum tuberosum	0.9	15.00
43.	Pumpkin Leaves Cucurbita maxima	0.8	15.00
44.	Radish Leaves Raphanus sativus	0.4	10.00
ROOTS AND TUBERS			
45.	Beeta Root Beta vulgaris	0.1	15.00
46.	Carrot Daucus carota	0.2	15.00
47.	Khamealu Dioscrea alata	0.1	50.00
48.	Onion Big Allium cepa	0.1	30.00
49.	Potato Solanum ruberosum	0.1	150.00
50.	Radish Pink Raphanus sativus	0.3	50.00
51.	Radish Rat Tailed Raphanus sativus	0.3	50.00
52.	Rdish Table Raphanus sativus	0.1	75.00
53.	Radish white Raphanus sativus	0.1	50.00
54.	Sweet potato Ipomoea batatas	0.3	30.00
55.	Tapioca Manihot esculenta	0.2	15.00

Table XII-2. (Contd.)

1	2	3	4
56.	Tapioca Chips Dried Manihot esculenta	0.3	20.00
57.	Water Lily Red Nymphaea nouchali	0.3	50.00
OTHER VEGETABLES			
58.	Beans Scarletrunner Phaseolus coccmeus	1.0	15.00
59.	Brinjal Solanum melongena	0.3	50.00
60.	Broad Beands Vicia faba	0.1	17.00
61.	Cauliflower Brassica cleracea var	0.4	60.00
62.	Cluster Beans Cyamopsis tetragonoloba	0.4	15.00
63.	Cucumber Cucumis sativus	0.1	75.00
64.	Dhum Stick Moringa oleifera	0.1	27.00
65.	Figs Red Ficus cunia	0.6	50.00
66.	French Beans Phaseolus vulgaris	0.1	25.00
67.	Ladies Fingers Abelmoschus esculentus	0.2	50.00
68.	Lotus Stem Dry Nelumbium nelumbo	1.3	50.00
69.	Mango Green Mangsfera indica	0.1	25.00
70.	Mogra	0.5	20.00
71.	Onion Stalks Allinum cepa	0.2	50.00

Table XII-2. (Contd.)

1	2	3	4
72.	Papaya Green Carica papaya	0.2	30.00
73.	Peas Pisum sativum	0.1	20.00
74.	Pink Beans Phawselus sp.	0.4	15.00
75.	Plantain Flower Musa sapientum	0.7	20.00
76.	Plantain Green Musa sapientum	0.2	30.00
77.	Plaintain Stem Musa sapientum	0.1	25.00
78.	Pumpken Cucurbita maxima	0.1	30.00
79.	Pumpkin Folowers Cucurbita maxima	0.8	15.00
80.	Tomato Green Lycopersicon esculentum	0.1	30.00
NUTS AND OILSEEDS			
81.	Almond Prunus amygdalus	58.9	10.00
82.	Cahshewnut Aancardium occidentale	46.9	20.00
83.	Coconut Dry Cocos mucifera	62.3	15.00
84.	Coconut Fresh Cocos nucifera	41.6	75.00
85.	Groundnut Arachis hypogaea	0.1	25.00
86.	Groundnut Roasted Arachis hypogaea	39.8	100.00

Table XII-2. (Contd.)

1	2	3	4
87.	Jungli Badam Sterculia foetida	35.5	20.00
88.	Musterd Seeds Brassica nigra	39.7	05.00
89.	Niger-Seeds Guizotia abyssnica	39.0	05.00
90.	Pistachio Nut Pistacia vera	53.5	05.00
91.	Walnut Juglans regia	65.5	10.00
92.	Cardamom Elettaria cardamomum	2.2	05.00
CONDIMENTS AND SPICES			
93.	Chillies Dry Capsicum annum	6.2	01.00
94.	Chilles Green Capicum annum	0.6	02.00
95.	Coloves Dery Syzygium aromaticum	8.9	00.10
96.	Coloves Green Syzygium aromaticum	5.9	01.00
97.	Coriander Coriandrum sativan	16.1	01.00
98.	Garlic Dry Allium sativum	0.1	03.00
99.	Ginger Fresh Zingiber officinale	0.9	04.00
100.	Pepper Dry Piper nigrum	6.8	01.00
101.	Turmeric Curcuma domestica	5.1	02.00

Table XII-2. (Contd.)

1	2	3	4
F R U I T S			
102.	Apple Malus sylvestris	0.5	100.00
103.	Avocado Pear Persea americana	22.8	15.00
104.	Bael Fruit Aegle marmelos	0.3	15.00
105.	Baincha Folacorurtia indica	1.8	50.00
106.	Banana Ripe Musa paradislaca	0.3	128.00
107.	Black Berry Rubus fruticosus	0.5	75.00
108.	Cape Gooseberry Physalis peruviana	0.2	50.00
109.	Cherries Red Prunus cerasus	0.5	25.00
110.	Figs Ficus carica	0.2	50.00
111.	Grapes Blue Variety Varis vinifera	0.6	75.00
112.	Grapes Pale Green Variety Vitis vinifera	0.6	75.00
113.	Grapefruit (Marshs Seed:Ess) Citrus paradist	0.1	75.00
114.	Grapefruit (Triumph) Citrus paradish	0.1	25.00
115.	Guava Country Psidium guajava	9.3	100.00
116.	Guava Hill Psidium cattleyanum	0.2	100.00
117.	Jack Fruit Artocarpus heterophyllus	0.1	200.00

Table XII-2. (Contd.)

1	2	3	4
118.	Jamb Safed Eugonia malacensis	0.4	125.00
119.	Lemon Citrus limon	0.9	02.00
120.	Lemon Sweet Citrus limetta	0.3	02.00
121.	Lichi Nephelium longuna	0.2	150.00
122.	Lime Citrus aurantifolia	1.0	05.00
123.	Lime Sweet Malta	0.2	50.00
124.	Lime Sweet Mosambe Cirtrus sinensis	0.5	50.00
125.	Mahua Ripe Bassia longifolia	1.6	100.00
126.	Mango Ripe Mangifera indica	0.4	500.00
127.	Orange Citrus aurantium	0.2	200.00
128.	Orange juice Citrus aurantium	0.1	100.00
129.	Palmyra Fruit Ripe (Mesocarp)	0.2	50.00
130.	Palmyra Fruit Tender Borassus flabellifer	0.1	100.00
131.	Papa Gardenia latifolia	3.1	100.00
132.	Papaya Ripe Carica papaya	0.1	150.00
133.	Phalsa Grewia asiatica	0.9	100.00
134.	Pine Apple Ananas comosus	0.1	150.00

Table XII-2. (Contd.)

1	2	3	4
135.	Plum Prunus domestica	0.5	105.00
136.	Star Apple Eugenia javanica	0.2	100.00
137.	Strawberry Fragaria vesca	0.2	75.00
138.	Tomato Ripe Lycopersicon esculentum	0.2	50.00
FISH AND OTHER SEA FOODS			
139.	Bacha Eutropiichthysvacha	5.6	100.00
140.	Bali Kanakda Dried	9.0	35.00
141.	Bam Mastochembelus armatus	0.9	100.00
142.	Baspta Machli Ailia coilia	4.4	50.00
143.	Bata Small Varieties	2.5	75.00
144.	Bale Glassogobius Giuris	0.6	75.00
145.	Bhanger Fresh Mugil tade	8.8	100.00
146.	Bhetki Fresh Lates calcarifer	0.8	125.00
147.	Bhole	1.1	100.00
148.	Boal Wallago attua	2.7	100.00
149.	Bugda Chinghri	1.6	75.00
150.	Cat Fish Arius sona	0.0	75.00
151.	Chela Chela phulao	4.3	80.00

Table XII-2. (Contd.)

1	2	3	4
152.	Chital Natopterus chilral	2.3	100.00
153.	Crab (Muscle) Paratelphusa spinigera	1.1	80.00
154.	Crab Small	9.8	70.00
155.	Fesha Fresh	1.9	50.00
156.	Foullui Notopterus notopterus	1.0	50.00
157.	Herring India Pellona brachysoma	3.2	125.00
158.	Hilsa Clupea illisha	19.4	135.00
159.	Kalbasu Labee calbousu	1.0	100.00
160.	Katla Catla catla	3.4	100.00
161.	Kholshe	3.9	60.00
162.	Khoyra, Fresh Gonialosa manminna	3.0	60.00
163.	Koi Anabas testudineus	8.8	75.00
164.	Kucha Vetki	3.8	80.00
165.	Lada Ophiocephalus punctatus	0.6	75.00
166.	Mackerel Rastrelliger kanagurta	1.7	75.00
167.	Magur Clarias batrachus	1.0	75.00
168.	Mahasole Barbus tor	2.3	80.00
169.	Mrigal Cirrhinus mrigala	0.8	100.00

Table XII-2. (Contd.)

1	2	3	4
170.	Oil sardine Sardinella longiceps	2.0	80.00
171.	Pabda Callichrous pabo	2.1	75.00
172.	Pakal	1.2	100.00
173.	Pangas Pangasius pangasius	1.0	75.00
174.	Parsey (Fresh) Mugil parsia	5.9	60.00
175.	Pomfrets, Black Formio niger	2.6	100.00
176.	Pomfrets, White Stromateus sinensis	2.6	100.00
177.	Prawn Penaeus sp.	1.0	75.00
178.	Puti Barbus sp.	2.4	50.00
179.	Rohu Labeo rohita	1.4	100.00
180.	Sardine Sardinella fimbriata	1.9	80.00
181.	Sarputi Barbus sarana	9.5	75.00
182.	Shark Carcharias sp.	0.4	50.00
183.	Shrimp (Small, Dried)	8.5	25.00
184.	Singhi Saccobranchus fossilis	0.6	75.00
185.	Sole Ophiocephalus striatus	2.3	80.00
186.	Tapsi (Dried) Polynemus paradiseus	12.1	50.00

Table XII-2. (Contd.)

1	2	3	4
187.	Tangra (Fresh) Mystus vitatus	6.4	75.00
	OTHER FLESH FOODS		
188.	Becon (Raw)	65.00	150.00
189.	Becon (Fried)	55.00	150.00
190.	Beef Meal Bos taurus	10.3	150.00
191.	Beef muscle Bos taurus	2.6	150.00
192.	Buffalo Meat Balbus bubalis	0.9	150.00
193.	Duck Anas platyrayncha	4.8	100.00
194.	Egg Duck	13.7	50.00
195.	Egg Hen	13.3	50.00
196.	Fowl Gallus bankiva murghi	0.6	125.00
197.	Goat Meat Capra hyrchusb	3.6	150.00
198.	Liver Goat Capra hyrchusb	3.0	35.00
199.	Liver, Sheep	7.5	35.00
200.	Mutton, Muscle	13.3	125.00
201.	Pork, Muscle Sus Cristatus Wagner	4.4	100.00
202.	Milk, Buffalo's	8.8	125.00
203.	Milk, Cow's	4.1	180.00
204.	Milk, Goat's	4.5	100.00
205.	Curds (Cows's Milk)	4.0	125.00

Table XII-2. (Contd.)

1	2	3	4
206.	Butter Milk	1.1	25.00
207.	Skimmed Milk, Liquid	0.1	150.00
208.	Channa, Cow's Milk	20.8	75.00
209.	Channa, Buffalo Milk	23.0	75.00
210.	Cheese	25.1	
211.	Kheer	12.2	25.00
212.	Khoa (Whole Buffalo Milk)	31.2	15.00
213.	Khoa (Skimmed Buffalo Milk)	1.6	15.00
214.	Khoa (Whole Cow Milk)	25.9	15.00
215.	Skimmed Milk Powder (Cows' milk)	0.1	10.00
216.	Whole Milk Powder (Cow's milk)	26.7	15.00
217.	Butter	81.0	30.00
218.	Ghee (Cow)	100.0	15.00
219.	Ghee (Buffalo)	100.0	15.00
220.	Hydrogenated Oil (Fortified)	100.0	25.00
221.	Cooking Oil (Groundnut, Gingella, Mustard, Coconut, etc.)	100.0	25.00
222.	Biscuits, Salt	32.4	10.00
223.	Biscuits, Sweet	15.2	10.00
224.	Bread, Brown	1.4	30.00
225.	Bread, White	0.7	30.00
226.	Coconut, Tender Cocos mucifera	1.4	25.00

Table XII-2. (Contd.)

1	2	3	4
227.	Coconut Milk Cocos nucifera	41.0	30.00
228.	Groundnut Cake Arachis hypogaea	7.4	60.00
229.	Mango Powder	7.8	10.00
230.	Mushroom Entoluma macrocarpom	3.1	10.00
231.	Pappad Vitis quadrangularis	0.3	05.00
232.	Sago	0.2	15.00
233.	Sugar Cane Juice	0.2	125.00

From the above mentioned foodstaff we consume 12% to 20% of the total fat consumption per day. More over the of intake may increase the presence of fat and oil. Like if we eat 100 gm of fried potato we will consume 19 gm oil with the same. Thus the nature of consumption and diets are increasing our fat consumption.

From the stratified random sample survey at important towns of West Begnal during summer and winter among the different income group the findings are -

1. Consumption of edible oil and fat is higher in winter than in summer among all income graps.

2. Due to various dietary habits consumption of edible oil and fat unit per day is varying in different towns among the same income group.

The result has been dirived from the random sample survey among the three income groups.

a) Higher Income Group = above Rs.6,000.00

b) Middle Income Group = Rs.2,000 to Rs.5,500

c) Low Income Group = Rs.2,000 (below)

At 35 towns among each income group one hundred persons was asked on their food habit and consumption of edible oil per day. The results on the nature of intake of edible oil is given in the Table XII-3.

Table XII-3. Consumption of Fat and Edible Oil in 35 Towns of West Bengal

		Summer gm.	Winter gm.	Average gm.
1.	ASSANSOL			
	High Income Group	65	68	66.50
	Middle Income Group	55	65	60.00
	Low Income Group	10	15	12.00
2.	BURDWAN			
	High Income Group	70	76	73.00
	Middle Income Group	60	65	62.50
	Low Income Group	8	12	10.00
3.	RANIGANJ			
	High Income Group	66	75	70.50
	Middle Income Group	53	63	58.00
	Low Income Group	7	10	8.50
4.	DURGAPUR			
	High Income Group	70	78	74.00
	Middle Income Group	63	70	66.50
	Low Income Group	10	18	9.00

Table XII-3. (Contd.)

	Summer gm.	Winter gm.	Average gm.
5. BANKURA			
High Income Group	75	83	79.00
Middle Income Group	57	66	61.50
Low Income Group	6	9	7.50
6. BISHNUPUR			
High Income Group	72	85	78.05
Middle Income Group	55	63	59.00
Low Income Group	5	8	6.50
7. PURULIA			
High Income Group	60	72	66.00
Middle Income Group	51	60	55.50
Low Income Group	4	7	5.50
8. ADRA			
High Income Group	62	70	66.00
Middle Income Group	50	60	55.00
Low Income Group	4	8	6.50
9. RAGHUNATHPUR			
High Income Group	67	75	71.00
Middle Income Group	61	67	64.00
Low Income Group	3	8	5.50
10. BOLPUR			
High Income Group	60	70	65.00
Middle Income Group	56	67	61.50
Low Income Group	7	11	9.00

Table XII-3. (Contd.)

	Summer gm.	Winter gm.	Average gm.
11. SURI			
High Income Group	67	75	71.00
Middle Income Group	60	66	63.00
Low Income Group	7	10	8.50
12. SAINTHIA			
High Income Group	70	81	75.50
Middle Income Group	66	72	69.00
Low Income Group	8	11	9.50
13. KANDI			
High Income Group	71	80	75.05
Middle Income Group	58	63	60.50
Low Income Group	10	15	12.50
14. BERHAMPORE			
High Income Group	73	82	77.50
Middle Income Group	63	70	66.50
Low Income Group	10	13	11.50
15. LALGOLA			
High Income Group	71	83	77.00
Middle Income Group	55	65	60.00
Low Income Group	13	20	16.50
16. KRISHNAGAR			
High Income Group	66	70	68.00
Middle Income Group	56	66	61.00
Low Income Group	7	11	9.00

Table XII-3. (Contd.)

		Summer gm.	Winter gm.	Average gm.
17.	RANAGHAT			
	High Income Group	65	70	67.00
	Middle Income Group	50	62	56.00
	Low Income Group	9	15	12.00
18.	NAWADIP			
	High Income Group	70	72	71.00
	Middle Income Group	66	69	67.50
	Low Income Group	10	16	13.00
19.	KANCHARAPARA			
	High Income Group	67	72	69.50
	Middle Income Group	56	60	58.00
	Low Income Group	9	15	12.00
20.	NAIHATI			
	High Income Group	65	72	68.50
	Middle Income Group	60	66	63.00
	Low Income Group	8	14	11.00
21.	MALDA			
	High Income Group	68	72	70.00
	Middle Income Group	58	65	61.50
	Low Income Group	10	17	13.50
22.	GAZOL			
	High Income Group	67	73	70.00
	Middle Income Group	56	63	59.50
	Low Income Group	7	12	9.50

Table XII-3. (Contd.)

	Summer gm.	Winter gm.	Average gm.
23. RAIGANJ			
High Income Group	63	70	66.50
Middle Income Group	65	61	58.00
Low Income Group	9	13	11.00
24. BALURGHAT			
High Income Group	65	72	68.50
Middle Income Group	61	68	64.00
Low Income Group	9	16	12.50
25. SILIGURI			
High Income Group	70	85	77.50
Middle Income Group	65	75	70.00
Low Income Group	8	13	10.50
26. JHARGRAM			
High Income Group	58	62	60.00
Middle Income Group	50	56	53.00
Low Income Group	5	11	8.00
27. KANTHI			
High Income Group	67	72	69.50
Middle Income Group	58	65	61.50
Low Income Group	6	10	8.00
28. MADINIPUR			
High Income Group	68	75	71.50
Middle Income Group	55	62	58.50
Low Income Group	7	12	9.50

Table XII-3. (Contd.)

	Summer gm.	Winter gm.	Average gm.
29. HOWRAH			
High Income Group	70	82	76.00
Middle Income Group	65	73	69.00
Low Income Group	10	14	12.00
30. CHANDARNAGAR			
High Income Group	68	76	72.00
Middle Income Group	63	70	66.50
Low Income Group	9	15	12.00
31. TARAKESWAR			
High Income Group	65	72	68.50
Middle Income Group	55	60	57.50
Low Income Group	7	10	8.50
32. DANKUNI			
High Income Group	65	70	67.50
Middle Income Group	60	67	63.50
Low Income Group	6	11	8.50
33. MOGRAHAT			
High Income Group	70	78	74.00
Middle Income Group	60	68	64.00
Low Income Group	12	20	16.00
34. CANNING			
High Income Group	66	76	71.00
Middle Income Group	55	62	58.05
Low Income Group	7	12	9.05

Table XII-3. (Contd.)

	Summer gm.	Winter gm.	Average gm.
35. CALCUTTA (Central)			
High Income Group	65	70	67.50
Middle Income Group	55	62	58.50
Low Income Group	9	11	10.00

CHAPTER - XIII

SUMMARY AND CONCLUSION

Once there was a time when India was one of the chief oil seed producers in the world. But in Course of time India failed to produce oil seed proportionately with its growth of population. As a result India had to import 18 lakh tonnes of edible oil in the year 1987-88.

Notwithstanding the projected target of edible oil is 49 lakh tonnes for the 1990-91. Yet there is a doubt to meet the demand. To meet the deficial the index on per-capita oil consumption is 6.5 kg per annum. The projected population in the 1990-91 will be 850 million and on the basis of above index the requirement will be 58.80 lakh tonnes. Therefore, the deficiet will be approx 9 lakh tonnes.

West Bengal is one of the share holders of this deficit. We know that land is a limiting factor in West Bengal and the farmers of West Bengal are fragmented in various agricultural practices with various rituals on methodofcultivation and Crop selection. They are following such traditional practice for long years. For this reason this is not possible to increase the yield rate of oil seed and also the extension of land for oil seed cultivation.

Of the total land used for oil seed cultivation in India, West Bengal possesses only 1.5% and the state produces only 3.2% of the edible oil produced in India. During the year 1990-91 there is deficit of edible oil which amounts to 3.5 lakh tonnes. My research work is on how to meet this deficeit.

Since 1947 we are thinking over the problem to meet the deficitof edible oil. But it remained static till 1966. From 1967 ICAR paid attention to this problem and in 1973 they appointed a Project Director for the same. In the year 1979 research work on groundnut at national level started at Junagarh.

During the Sixth Five year plan and later Govt. adapted 20 point programme on the oil seed production.

For the first year of the Seventh Five year Plan West Bengal made a radical change in the field of agriculture, but it was concentrated only on paddy. Later on due to awarances of the state agricultural department the production of edible oilseeds increased from 2.36 lakh tons in 1984-85 to 5.44 lakh tons by 1989-90. Still the deficit was 4 lakh tons.

On the basis of the above context I have considered the geographical situation and the geological background of West Bengal in Chapter III. Here I have been discussing the geomorphology and the slope of the land by which the surface topography, availability of agricultural land, growth of density and population is governed.

Bengal delta has taken a dominant part in the field of surface topography. We find varied relief setting of West Bengal from the range of the Himalayas to the Bay of Bengal which is made of the alluvials from the flow of the rivers which have come from Chotanagpur plateaue and the Himalayas.

In the IVth Chapter I have discussed regarding the climate of West Bengal. Agroclimatic zones of West Bengal have been determined on the basis of distribution of rainfall and temperature with the geomorphological characteristics.

The chief theme of the Vth Chapter is about the soil of West Bengal, which is guided by geology, geomorphology and climate. The classification of soil which we find in West Bengal is mainly characterised by the allivials of varied quality and quantity and age and its various mixtures.

In the VIth Chapter, the vegetation on the basis of soil and climate has been discussed. The forest resource has also been considered, as various oil seeds from tree origin, which can meet the deficeit of edible oil in West Bengal.

In the VIIth Chapter I have considered the cultivation of various oilseeds of national and international standard according to agro-climatic zone condition.

All these oil seeds have been classified in three categories, crop, tree and other.

I have also made that classification of oilseeds, its yield rate, oil content etc.

In the VIIIth Chapter I have discussed the oilseed scenerio and the comparative study of various oilseed production in national and international level.

In the IXth Chapter my discussions are regarding the oil seed and edible oil production in India, cultivation of various oilseeds in different states, its main constrants, its agricultural methods, standard of seeds, agricultural practice, use of fertiliser, crop insurance, market, various administrative problems, problems of the farmers, trading problem etc.

The discussion has also included the minor oilseeds from tree origin, their chemical analysis, edibility, the geographical distribution of the trees and its possibilities of explorability in West Bengal. Besides, it has considered the other sources of edible oil, the present position of oil press technology, solvent extraction and chemical analysis and modernisation of oil mills.

In the 10th Chapter the light has been thrown on the districtwise oil seed production in West Bengal for the last five years with a comparative study of national and eastern region. Besides that the views and target of the technology mission on oilseed department of agriculture, Govt. of West Bengal, their various datas, analysis and projects and their target till the end of this decade have been analysed along with the expected budget. But it is found that the deficiency will remain yet the total achievement is performed.

In the XIth Chapter, in Cobb Douglos method I have analysed the gap on yield reta in West Bengal. I have tried to find out the variation on yield rate where I surveyed 150 agricultural farms of different characters. In this context I presume that the lack of awareness, administrative lapse, traditional agricultural system, want of market, lack of economic support etc. are responsible for the gap.

In the XIIth Chapter I have discussed on the consumption of edible oil and how high rate of fat and oil consumption creates health hazards in Indian climatic condition, our food habit, cooking practice and the non-visible sources of fat and oil in the common pulses cereals and foodstoffs commonly used in West Bengal.

I have surveyed in 35 towns of West Bengal among three different income groups and their consumption of fat and oil in summer and winter.

The main constraints in the way to accelerate oil seed production in the State of West Bengal are :

Preponderence of rainfed cultivation.

Inability/hesitation on the part of the farmers to use modern inputs due to high risk for yields and prices.

High cost and inadequate availability of certified seeds.

Susceptibility of oil seed crops to pest and diseases which causes substantial losses.

Inadequate use of improved agricultural implements for proper placement of seeds and fertilisers.

Problems of price support particularly in time of bumper production.

Measures:

- Increasing productivity of oilseed Crops through adoptation of improved agronomic practices, such as vertical replacement, use of quality seeds, application of fertiliser in recommended dose, needbased timely plant production measures, irrigation and providing protective irrigation to rainfed crops wherever possible.

Proper marketing system.

Proper price policy.

Genetic improvement in yield potential of seeds, drought resistance, immunity from pests and diseases and shorter duration of cultivation period.

Intercropping - Linseed Ground Nut with sunflower, potato with mustard, Sugarcane with soyabean, mustard etc.

Relay cropping, paddy - Linseed, Sorghum - Safflower.

Extension of Safflower, Mustard Sunflower to dry land.

Replacement of low yielding seeds.

Introduction of hybrid Sunflower of short duration in suitable districts.

Popularisation of groundnut varieties responsive to irrigation and early maturity. Introduction of protoplasts, fusion, technology for genetic improvement.

Encourage large scale organised seed industry for foundation seeds and hybrids.

Encouragement of Sesame, Sunflower and Soyabean Cultivation.

Guarantee, procurement and price support.

From the technological point of view, the following measures are proposed for adoptation:

Shifting of rice milling from hullers to shellers.

Modernise and improved hullers to produce bran containing more oil and less silica.

Encourage low cost stabilisers to inhibit lipase.

Encourage solvent extraction of mustard and other oil cakes to extract oil fully from oilseeds.

Optimise fatty matter in soaps without losing performance to reduce consumption of fats.

Better use of non edible oil for new and useful petro-chemical.

Permit new technologies such as inter stratification in the vanaspati industry to improve product quality and nutritional value.

Permit in Corporation of colour and flavour in table margarine as a low cost substitute for butter.

Allow flovouring of oils through blending of different edible oil with a view to improving acceptibility organoleptically and nutritionally.

Produce Single cell oil by genetic manipulation and farmentation.

Distribution of plant protection equipment, improved farm implements, sprinkler setts etc.

Increasing production of Rhizobium Culture for use as per need.

Organising seed village.

Demonstration of improved technology in former's field.

Distribution of input kits to weaker section.

The area covered under oilseeds cultivation to be increased on to have more land under cultivation of oilseeds or other oil bearing materials.

Choice of oil seed districts. Most of the districts in the State grow one or more oilseeds Crops to meet the local demand. All the districts are not suitable for each and every type of oilseeds cultivation. To give special thrust when resources are limited, it is necessary to classify the districts according to yield and risk rate.

Rice bran is a good source of edible oil. During the year 1989 West Bengal produced 106 lakh tons of rice, which was 14.9% of the national production. But out of which only 0.20 lakh tons was used for R.B.O. production. Efforts should be made to increase the rice bran oil production with the help of improved technology.

West Bengal is having a little quantity of edible oil from the tree origin. With the help of cooperative and other good management the oil bearing seeds of Mahuya, Karanga, Undi, Kusum, Sal etc. may be collected and with the help of improved technology these tree origin oil may be used as edible oil and can reduce the deficit of edible oil upto 10%. Forest Department is also advised to join with the movement for better plant protection, plantation and exploitation of such type of trees to meet the deficit of the state.

In case of marketing of edible oil in the state of West Bengal, the disproportionate railway freight rate between oil seeds and oil is also a major factor working against the oil milling industry in the state of West Bengal and the Central Transport subsidy is not adequate for hilly regions of West Bengal for the growth of the industry.

Whatever measure may be adopted for increasing the production of edible oil in West Bengal, there is a traditional practice of using mustard oil as the primal fundamental cooking medium.

As for climatic and physiographic condition of West Bengal, the growth of population is 2.5% per year. Besides West Bengal has to share its oil production with other neighbouring states. Excepting conventional cooking medium, there is a need to popularies non-conventional cooking mediums. The government and other business organisations should make a publicity in this respect.

From the survey at national level and state level it has been found that a major section of high and middle income group are consuming a huge amount of fat and edible oil from the visible and non-visible sources. This mal distribution may come down after awaring the public regarding the less consumption of fat and edible oil and with the help of this effort some advantages also may be found to reduce the gap.

Proposed target in attaining self sufficiency by 1990-91

Increase oilseed production from

		Lakh Tonnes
a)	Additional area under the Oilseed crop	0.75
b)	Increasing the production	0.70
c)	Modern crop technology	0.80
d)	Crop substitution	1.50
e)	Additional irrigated area	0.25
f)	Improving small irrigation system	0.50
g)	Better Dry Farming	0.20
h)	Existing	4.30
	Total	9.00

Additional production

a)	Recovery of more oil from oil seeds	0.35
b)	Better extraction	0.85
c)	Rice bran oil	0.60
	Total	1.80

Other Sources

a)	Tree origine	0.20
	Grand Total	11.00

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