

## **CHAPTER: III**

# **THEORETICAL BACKGROUND AND CONCEPTUAL ISSUES OF AGRICULTURAL MECHANIZATION**

### **I. INTRODUCTION**

Mechanized agriculture is the process of using different kinds of highly efficient machineries compared to traditional equipments in farm sector. Quality and productivity of crops are increased with the help of these machineries. Use of traditional tools in farming augments cost of cultivation and consumes more farming operation time. The history of agricultural mechanization contains many example of use of tools in farming. All these tools were generally animal driven or driven by human power. The mechanization of agriculture came with the introduction of the plough which was powered by animals. It was invented in ancient Mesopotamia. After that expansion of different farm machineries come along the requirements of different farming technique to produce necessary crops. Requirements of farm machination extensively emerged after introduction of Green Revolution in India. It was happened because old faming technique was not compatible with high yielding seed varieties. As a result of Green Revolution since mid-1960s the total food grain production has increased from a mere 50.8 million tonnes during 1950-51 to 217 million tonnes in 2006-07 and presently it is 247 million tonnes. Similarly productivity increased from 522 kg/ha to more than 1500 kg/ha in the same period. The increase in production and productivity in food grains occurred due to adoption of quality seeds, higher doses of fertilizer and plant protection chemicals. Irrigation also played a major role for this rapid production of farm sector. But increase of cropping intensity and higher quality of inputs could no longer be effectively managed by animate power alone and therefore farmers adopted tractors, power tillers, harvesters, threshers, etc. in farming practice. As a result farmers were started to use farm machineries to get higher production. In this chapter we shall discuss the history and back ground of agricultural mechanization. After that concept and economics of farm mechanization will be discussed gradually. Since we know farm mechanization is an ancient phenomenon it comes very early, near about before 2500 BC in England and in other countries. But in India farm mechanization came far later. Before Independence Indian agriculture was mechanized by the technological development

of England in 1889. After that use of machineries started to increase in India. In this section of our study we shall try to explain background of farm mechanization and different farm machineries used in West Bengal and as well in throughout the nation.

## **II. BACKGROUND OF AGRICULTURAL MECHANIZATION**

Root of Agricultural Mechanization is an ancient phenomenon. People lived in Harappan civilization around 2500 BC (Before Christ) transformed themselves from hunters gatherers to settled farmers-cum-semi-pastoral livestock herdsman. Historians argued that they started to domestication of plants and animals as well as invent tools and implements such as plough, carts, sailboats, fishing hooks, nets and traps, grain storage etc. Gradually they motivated by the farm activities for their livelihood. Harappa civilization, Bronze Age (3000-7000 BC), Iron Age (1000 BC) all bear strong evidence of agricultural mechanization. Before Independence Indian agriculture was mechanized by the technological development of England in 1889 as we have already noted above. Watts and Kaisar introduced plough, corn grinders and chaff cutters at Kanpur Experimental Farm in Uttar Pradesh in 1889. At that time horse drawn and steam tractor operated implements were imported from England. Tractor was used at first in farming in India in 1914. Sardar Joginder Singh, agricultural minister of Punjab Government has introduced the steam tractors for reclamation of waste land in India. The population of tractor reached at 8000 in 1950 and it increased at 39000 in 1960. All these tractors are not only used in ploughing but also are being used in post-harvest processing like transportation, leveling the land, threshing the rice, wheat, maize etc. At the time of independence Indian farmers mostly used bullock drawn implements. They were using small hand tools like spades, pick axe, crowbars, hoe, sickle, and chopper etc. for their cultivation. But few imported implements were powered by horse in farming which was not suitable for bullock power used in India. As a result small scale manufactures were set up in India to suit Indian draft animals. For irrigation watering buckets and for transportation bullock carts were in use. In 1930, India introduced pump-set for irrigation which were imported under the guidance of Central Tractor Organization (CTO) mainly for development of land. With the establishment of Allahabad Agricultural Institute (AAI) in Allahabad in 1942 the development activities in agricultural machinery has accelerated and due to this number of bullock operated plough

namely meston, shabash and wah-wah were introduced in Uttar Pradesh. So numbers of different improved farm machineries has been introduced in farming. Since price of big machineries were expensive, small farmers were not able to use such machineries. It was Singh who has reported in 2001 that “the economics of ownership has been justified by custom hiring for on-farm works as well as for off-farm transport and construction activities. The use of tractor for transportation activities accounted for about 60 per cent for average annual use of 600 hours. Many small farmers also started purchasing tractors due to opportunity of custom hiring. Similarly the ownership of many other farm machineries and equipment’s like tube-well, seed drills and planters was economic due to renting out to other farmers. However, ownership of large thresher, land levelers and combine harvesters is mainly due to custom work”. Mechanization of agriculture also played a vital role in irrigation. As we know first pump-set came in India in 1930. But before those Indian farmers were using different traditional irrigation system like Persian Wheel for irrigation, buckets irrigation etc. which were not adjusted with HYV cropping system. The farmers who were better off invested in tube-well pumps which were mainly powered by diesel engines of 5-10 horse powers for pumping ground water. But this available irrigation system was not sufficient for better use of high-yielding seed varieties. As a result the government of India expanded rural electrification program to install 3-10 horse power electric motors for irrigation. Over the years due to rural electrification majority of irrigation source were converted from diesel engine to motors irrigation, because government has given huge subsidy on rural electrification on farming. As a result cost of cultivation has reduced dramatically and benefits of farming spread out over the nation. It has been estimated that numbers of electric motors operated in water pumping purpose increased from 4 million in 1981 to 20 million in 2010 and it is expected to increase 25 million in 2015. Similarly number of diesel operated irrigation pumps has also increased from 3.3 million in 1981 to 6.7 million in 2010 and expected to increase 7 million in 2015. It is worthy to mention that phenomenal growth of farm equipments used in India emerged due to favorable government policies for promoting machinery manufacturing in private sector.

### **III. CONCEPT OF AGRICULTURAL MECHANIZATION**

Agricultural mechanization requires use of appropriate machinery for ensuring timely field operations and effective application of various crop productions. These machineries are

driven by using human, animal and mechanical power. Machineries also required for reducing drudgery in agriculture. Besides it is cost effective and eco-friendly in production. It also helps in post- harvesting operations and improvement of quality of farm produces by growing crop under controlled environmental effect. Over the last few years, there has been considerable progress in agriculture mechanization. It is generally believed that the benefits of modern technology have been restricted to farmers with large land-holdings. Yet the fact remains that even small farmers are adopting and utilizing selected farm equipments for efficient farm management through custom hiring. Mechanical equipments for various farm operations like tillage, sowing, irrigation, plant protection and threshing etc. are generally being used by the farming community. Moreover, reliance on animal power in farm work continuously has been deteriorating. It is well known that improved land and labour productivity resulting from use of mechanical power which gives also higher production. Improved implements such as MB (Mould Board) plough, peddler, disc harrow, peg tooth harrow, spring line harrow being more efficient have been adopted compared to traditional equipments. After that use of more mechanical equipments such tractor, power tiller, rotavator, thresher, harvester gives more good result in farming. Further, use of sowing or planting devices is also registering a higher growth due to their impact on proper use of seed and fertilizer. The number of draft animals has also shown a decline as a consequence of farm mechanization.

It is worth mentioning that mechanization is the backbone of present agriculture. Farming sector is suffering from two great problems one is lack of labourer and another is small land holding. Rural peoples are not interested to work in farm sector rather they are going to do non-farm jobs in the sectors like- constructions, manufacturing, hotel waiter, tiny business etc. So labour shortage is one tremendous problem of farming. On the other hand, farmers having small landholding are not able to occupy bullock for cultivation. They take help of machineries on rent for cultivation. Modern farming system delivers multi-cropping strategy where technological implements are only way of cultivation. Traditional and indigenous farming tools are not compatible with this farming system. The President of India in her address to the nation on the eve of Republic Day on 25th January, 2011 said,

*“...small farmers are leaving farming, because of poor returns and scarcity of agricultural labour. In such a situation, it would be advantageous to think of modernization and mechanized farming....”*

Farm mechanization has been helpful to bring about a significant improvement in agricultural productivity. Thus, there is strong need for mechanization of agricultural operations. Normally, there are good chances to reduce the cost of production if farm operations are mechanized as it saves labour, both human and animal. In the absence of mechanization, the ever-increasing wage rate of human labour and cost of maintenance of draft animals could have increased the cost of production much higher. Further, large scale production means less per unit cost on the farms which comes from mechanized farming.

It is true that farm mechanization has shown good results in the form of raising the agricultural production and improving the standard of living of cultivators within very short period. But a number of arguments have been advanced against farm mechanization such as:

1. Small size and scattered holdings of the farmers stand in the way of mechanization. As a result of this, farm machinery generally remains underutilized.
2. Majority of small cultivators are poor who are not in a position to purchase the costly machinery like tractors, combine harvesters etc.
3. The use of tractor operated machinery may render some of the draft cattle population surplus. Studies under AICRP on energy requirement indicate that tractor owning farms do use draft animals for certain jobs. Like-wise farms using animate sources of farm power, use tractor on custom service for certain jobs
4. Lack of proper knowledge of farmer to purchase farm machinery, operation and maintain of these makes uneconomical and risky too.
5. There is great shortage of diesel in the country as a whole. Thus, to use so extensive oil based farm machinery is not desirable.
6. The lack of repair and replacement facilities especially in the remote rural areas is another hindrance in efficient small farm mechanization.

7. Due to the seasonal nature of agriculture, the farm machinery remains idle for much of the time.

#### **IV. ECONOMICS OF FARM MECHANIZATION**

Over the years, the share of human and animal power in agriculture has been reduced drastically, paving the way for a variety of equipment to emerge. Many of these are driven by tractors, diesel engines or tillers. Several of the traditional processes of agriculture have been transformed with the advent of mechanization. For example:

1. Land development, tillage and seedbed preparation, together account for a major share of power utilization in the crop cycle. From animal driven plough and blade harrow, the process is now being transformed by utilization of tractor driven devices.
2. Sowing and planting as a process, though not power intensive, has traditionally been sub-optimal due to the complexity of drilling of land and then uniformly sowing the seeds. This process is now being transformed by modern seed drills and planters.
3. Irrigation of farmland has been largely automated and the use of diesel and electric motors and pumps is now well established.
4. Similarly, the activities pertaining to plant protection, harvesting and threshing are being automated, largely with the help of sprayers and tractor mounted equipment, respectively.

It is worthy to mention that there has been considerable progress in agricultural mechanization. It is generally believed that the benefits of modern technology have been restricted to farmers with small land-holdings. Mechanical equipments for various farm operations like tillage, sowing, irrigation, plant protection and threshing etc. are generally being used by the farming community to get more productivity and production. The number of draft animals has also been used to get benefits of farming. Farm mechanization shrinks the cost of farming by reducing man days in work, saving fertilizer, seeds and by using

proper irrigation in rainfed areas. It also enhanced cropping intensity and boost income of farmers. The following Table shows the economic advantage of agricultural mechanization.

**Table 3.1: Economic Advantage of Mechanization in per cent**

Operations		Performance
Increase in productivity up to		12-34
Seed-cum-fertilizer drill facilitates	Saving in seeds	20
	Saving in fertilizer	15-20
Enhancement in cropping intensity		5-22
Increase in gross income of farmers		29-49

*Source: Report of the Sub-Group on Agricultural Implements and Machinery for Formulation of 9th Five Year Plan, Govt. of India.*

The above Table shows the economics of farm machinery uses. It has shown that if farmers use improved machineries on farming, productivity will increase up to 12-34 per cent compared to traditional farming. Similarly, mechanized farming save 20 per cent seeds and 15-20 per cent fertilizer. It also augments 5-22 per cent cropping intensity compared to old farming system. Further it is estimated that farmers can earn up to 29-49 per cent more income in mechanized farming.

Economic advantage of mechanized farming also can be highlighted by the following Table where labour requirement on irrigated low land rice farming has been shown. In this Table level of mechanization has been divided in to three sections namely traditional technique, intermediate technique and advanced technique. Similarly, number of farm operations such as land preparation, bund making, sowing, irrigation, weeding and harvesting has been taken to show labour requirement on different farming system. Since we know that use of more labourer require as payment of more wages it enhances cost of farming. Labourer requirements along with different farming system have been shown in the following Table.

**Table 3.2: Labour Requirements on Irrigated Low Land Rice Farms (India) at Different Level of Mechanization (Man-Hours per Hectare)**

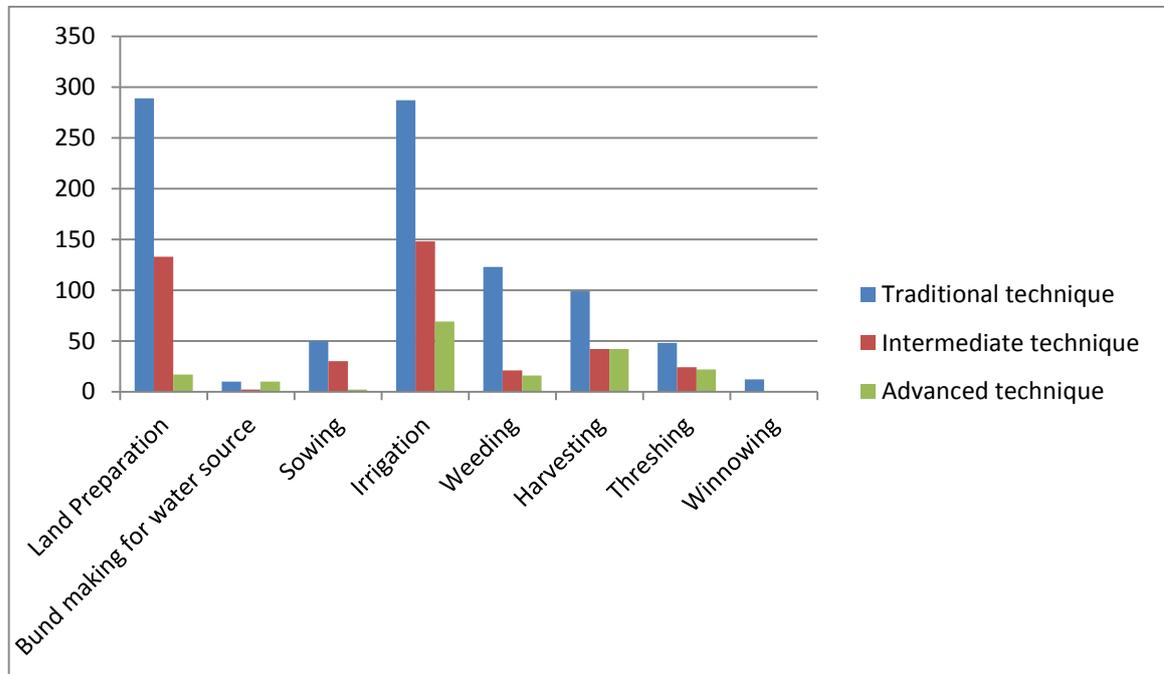
S.L	Operation	Level of Mechanization		
		Traditional Technique	Intermediate Technique	Advanced Technique
1	Land Preparation	289	133	17
2	Bund making for water source	10	2	10
3	Sowing	50	30	2
4	Irrigation	287	148	69
5	Weeding	123	21	16
6	Harvesting	99	42	42
7	Threshing	48	24	22
8	Winnowing	12	0	0
9	Total	918	400	178

*Source: Compiled from BARTSCH, WH, Employment effects of alternative technologies and techniques in Asian crop production: a survey of evidence, World Employment Programme, Paper WEP 2-22, ILO, Geneva, 1973, p 113. Quoted in AA Bodenstedt et al, "Agricultural Mechanization and Employment", Research Centre for International Agrarian Development, Saarbrucken, 1977, p 31.*

We can see in land preparation labour requirement per man days is 289 in traditional farming, 133 in intermediate farming and only 17 in advanced technique. Similarly, in other works like sowing, irrigation, weeding, harvesting and in threshing labour requirement is very low in advanced farming compared to traditional farming. We can see only in bund making for water source labour requirement is same in both traditional and advanced farming but labour requirement is only 2 in intermediate farming. Finally we can see labour requirement is more or less low in advanced farming. As a result, farming cost is less in advanced farming compared to traditional farming and inter-mediate farming. The picture

of economic advantage of modern mechanized farming has been shown in the following diagram.

**Figure-3.1: Labour Requirements on Irrigated Low Land Rice Farms (India) at Different Level of Mechanization (Man-Hours per Hectare)**



In the above diagram blue bar shows labour requirement in traditional farming. It is higher in all types of farm operation. Red bar shows the labour requirement in inter-mediate technique which is higher in land preparation and irrigation farming operation. Similarly labour requirement in advanced farming has been shown by the green bar. It is very low compared to other technique of farming on all types of farming operation. So it is clear that labour cost is far little in advanced farming and it brings economic advantage.

## V. EXTENT OF AGRICULTURAL MECHANISATION IN INDIA

Progress of agricultural mechanization has been related with the overall production of farm sector. Intensity of mechanized farming has been increasing along with growth of agricultural sector in India. Till 1950, very few farmers possessed improved farm

implements like tractor, power tiller, combine harvester, power thresher, etc. better to say heavy agricultural tractors and machineries were imported by government for land reclamation and development of large government farms. The picture changed quickly during the early sixties with the introduction of high yielding varieties of wheat and other crops which needed improved farm machinery and better irrigation facilities. The progressive farmers soon realized that the traditional water lift and wooden made farming tools are not sufficient to cultivate with this high yielding farming infrastructures. As a result Indian farmers gradually responded to farm mechanization technology especially after Green Revolution in 1960s. High yielding varieties with assured irrigation and higher rate of application of fertilizer gave higher yield and better economic returns. This enabled the farmers to start adopting mechanization. It will be more meaningful if we say the old model farming system was inefficient to absorb the speed of new farming system. That is why the demands of improved farm implement have been increasing dramatically. Demand of tractor and other implements in the country was met through importation until 1961. After mid-1960s numbers of tractors and other machineries started to produce in the nation with indigenous technology.

The agricultural machineries may be divided into five broad categories. These machineries are as follows:

1. Under the land development, tillage and seedbed preparation machines are:-
  - a) Tractors b) Levelers c) Ploughs d) Dozers e) Scrapers
2. Under sowing and planting the available machines are :-
  - a) Drill b) Seeder c) Planter d) Dibbler e) Transplanter
3. Under weeding, inter-cultivation and plant protection usable machines are :-
  - a) Shovel/ plough b) Harrow c) Tiller d) Sprayer e) Duster
4. Under harvesting and threshing essential machines are:-
  - a) Harvester b) Duster c) Digger d) Reaper e) Sheller f) Sickle/ Dao
5. For post- harvesting and agro- processing machines are:-

- a) Seed extractor b)Dehusker c)Huller/Dehuller d)Cleaner e)Grader f)Mill  
g)Dryer

Tractorization is one of the most important parts of farm mechanization in India. After introduction tractor it has been used in different field of farming say, transplanting, ploughing, harrowing, harvesting, digging etc. Side by side use of power tiller also occupied big part of farm mechanization. Farmer who are small and whose land holding is scattered, tractor is not suitable for use. As a result in that small farming power tillers has been played important role. In the following Table we present population of tractor and power tiller used in India.

**Table 3.3: Time-series population of Tractor and Power tillers in India**

Year	Tractor	Power tiller
1951	8500	--
1961	39.000	2
1971	176000	13008
1981	594000	15406
1991	1304000	34614
2001	2759936	93884

*Source: GoI, 2002*

Data collected from Agricultural Statistics, 2002 show time series population of tractor and power tiller of India in Table no (2C). We can see that from 1951 to 1961 there were only 8500 tractors in farm operation. In 1961 only 2 power tillers were introduced in farm sector along with 39000 tractors. After that both tractor and power tiller has been increasing dramatically in agricultural sector to help producing adequate amount of food grain in India.

We know that improved seeds, fertilizers, pesticide requires to developed farm sector to get higher level of productivity. Machineries used in farm sector are three types namely, bullock drawn implements, mechanical, and electrical. The following Table shows the implements like steel plough, cultivator, puddler, sowing device, cane crusher etc. are bullock drawn introduced in India.

**Table 3.4: Trends in Growth of Population of Bullock Drawn Implements (in millions)**

Growth of Population of Bullock Drawn Implements					
Implements	1966-67	1971-72	1981-82	1991-92	2000-01*
<b>Steel plough</b>	3.52	5.36	6.69	9.60	11.70
<b>Cultivator</b>	-	-	4.26	5.79	6.54
<b>Puddler</b>	2.72	1.69	2.32	2.37	2.81
<b>Sowing devices</b>	1.14	4.09	5.62	6.74	8.26
<b>Cane crusher</b>	0.65	0.68	0.69	0.75	0.73
<b>Sprayer and duster</b>	0.21	0.44	1.55	1.79	1.86

Source: Singh G. (2000) *Agricultural Situation in India, January 2000*.

Note: \* Estimated

The above Table shows that still bullock operated implements are used in farm sector to a large extent. Use of steel plough, puddler, sowing device are increasing significantly. Although productivity of these traditional farming equipments is very low, farms are still using them due to lack of credit and small landholding.

Indian farmers were using few mechanical and electrical types of farming at the equipment beginning of independence along with bullock drawn equipments. But use of these implements increased the introduction of after high-yielding seed varieties, pesticides, and fertilizers. Farmers understood that to get higher productivity and quality production improved machineries are needed. Indian government started to import these improved machineries initially and then started to produce with indigenous technology. The following Table shows the farm power availability of Indian farmers.

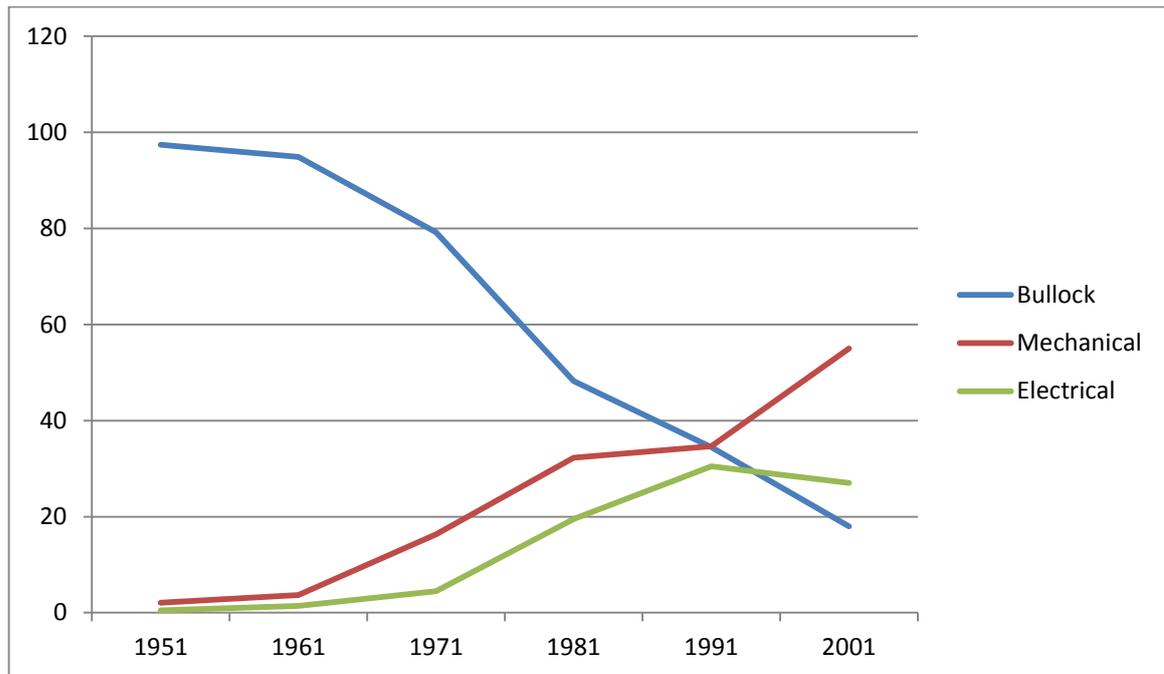
**Table 3.5: Farm Power Availability of India Farmers**

Year	Farm power in kw/ha	Source wise in percentage		
		Animate	Mechanical	Electrical
1951	0.25	97.4	2.1	0.5
1961	0.31	94.9	3.7	1.4
1971	0.36	79.2	16.3	4.5
1981	0.63	48.2	32.3	19.5
1991	0.92	34.5	34.7	30.8
2001	1.35	18.0	55.0	27.0

*Source: GoI, 2002*

The available data shown in the above Table tells that sources of animal power has been decreasing decade to decade where as sources of mechanical and electrical power has been increasing gradually. Although farm power availability has been going up, the percentage of electrical and mechanical sources of farm power has been rising consistently. In 1951 when farm power availability was 97.4 per cent, in animal farming its goes down at 18 per cent in 2001. Similarly, percentage of mechanical and electrical farm power availability was 2.1 and 0.5 in 1951 and it goes up at 55 per cent in mechanical and 27 per cent in electrical farming in 2001. This indicate that farm sector of India is habituated with the use of mechanical equipments to expand their level of production. In the figure given bellow we have shown the trends of farm power availability in different farming techniques.

**Figure: 3.2: Farm Power Availability of India Farmers**



In the above line diagram blue line shows the trend of animate or bullock farming. It shows that farm availability on that farming is decreasing gradually. On the other hand, red line shows the trend of mechanical farming which shows increasing trend. That means across the year farm power availability is increasing. Electrical farm power availability is indicated by the green line. It shows that up to 1991 electrical farm power has been increasing and after that is going down gradually.

To know the expansion of agricultural mechanization we can divide farm mechanization in to tractive, stationary and other categories of farming. In the following Table we have categorized mechanical farm power into three parts. These are: (1) tractive power under which tractor, power tiller, and combine harvester, (2) stationary power under which electric pumps and diesel pumps are used and (3) others under which power sprayers are used. In case of tractive mechanization use of tractor comes first. We can see use of power tiller started after 1961-62 whereas combine harvester introduced in farming operation after 1981-82. In case of stationary farming electric pump and diesel pumps were introduced since beginning of planning period. But use of power sprayer and duster which is part of other types of machinery mentioned in the given Table were implemented in farming from 1971-72.

**Table 3.6: Population Growth Trends in Mechanical Farm Power Sources in India**

Year		51-52	61-62	71-72	81-82	85-86	91-92	95-96*	00.01*
Tractive Power	Tractors	0.008	0.031	0.119	0.513	0.746	1.244	1.734	2.599
	Power Tillers	-----	-----	0.016	0.032	0.040	0.060	0.082	0.122
	Combines	-	-	-	-	0.002	0.003	0.005	Na
Stationary Power	Electric Pumps	0.020	0.100	1.535	3.203	4.192	6.019	7.464	9.525
	Diesel Pumps	0.083	2.230	1.443	3.061	3.742	4.800	5.528	6.466
Others	Power Sprayers/ Dusters	-	-	0.045	0.124	0.185	0.200	0.250	Na

Note: \* Estimated

Source: 1. *Power availability in Indian Agriculture, 2000, CIAE, Bhopal, India*

2. *Agricultural Research Data Book 2003, IASRI, New Delhi*

(( *Mech of agri.....Authopr- Dr. Kulkarni*).

Government of India started to produce tractor and power tiller after Green Revolution period with large extent to meet high demand of these farming equipments. Demand for tractor was very high because it is not only used in tilling purpose but also used in different farming activities like transplanting, threshing, harvesting etc. So demand of tractor was so high that producer met this huge demand from stock of previous year production. The demand for power tiller also was too high because of fragmented land. Huge population reduces the landholding as a result small farmers tilling their arable land by power tiller. The following Table shows the production and sale of tractor and power tiller across the years in India.

**Table 3.7: Production and Sale of Tractor and Power Tiller in India**

Year	Production		Sale	
	Tractors	Power Tillers	Tractors	Power Tillers
1986-87	80369	3325	80164	3209
1987-88	92092	3005	93157	3097
1988-89	109987	4798	110323	4678
1989-90	121624	5334	122098	5442
1990-91	139233	6228	139831	6316
1991-92	151759	7578	150582	7528
1992-93	147016	3648	144330	8642
1993-94	137352	9034	138796	9446
1994-95	164029	8334	164841	8376
1995-96	191392	10147	191329	10147
1996-97	222769	11000	222769	11000
1997-98	260815	12200	254279	12200
1998-99	261609	18840	262351	14880
1999-00	278556	16891	173181	16891
2000-01	255690	16018	254825	16018
2001-02*	214000	16000	221000	16000
2002-03*	168000	16000	170000	16000

Note: \*Data for 2001-2002& 2002-03 are estimated figures.

- Sources:
1. Tractors Manufacturers Association, Lodhi Road, New Delhi.
  2. Indian agriculture in Brief, 27 editions, Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India.
  3. Agricultural Research Data Book 2003, IASRI, New Delhi

The sale of tractor and other farm equipment has increased to get higher production. Very recently more than 250000 tractors are manufactured every year by 13 manufactures in India. These tractors are available in different horsepower ranges of less than 25 to more than 55 horsepower. The year wise production and sale of tractor and power tiller has been shown in the above Table and we can see healthy trends upto 1999 to 2000 for tractor and up to 1998 to 1999 for power tiller. After these periods production and sale of tractor and power tiller was reduced due to droughts and floods. Sale of tractor was region specific.

Punjab, Haryana, Western UP, constituted major tractor market whereas tractor sale in Tamil Nadu, Rajasthan, Karnataka, Andhra Pradesh have shown consistent growth since 1980s. But sale of tractor was very low in eastern States like, Bihar, West Bengal, Assam, Orissa etc. due to various socio- economic, agro-climatic and other reasons.

## **VI. EXTENT OF AGRICULTURAL MECHANISATION IN WEST BENGAL**

Mechanization of agriculture promote higher output in farm sector but for that the necessary ingredients are moderate land holding, irrigation facility, sufficient fertilizer and pesticide and high yielding seed varieties. Similarly we can say mechanization of farm is determined by access to institutional credit, government extension support services and experience of the farmers. But all the above factors relating to boosting up farm mechanization are not available equally in all states in India. As a result there is heterogeneity in farm productivity in different states due to different level of mechanization. Three strong factors by which farm mechanization is determined are level of land holding, availability of credits and level of education of farmers. In West Bengal more than 80 per cent farmer are marginal landholders that does not support required level of agriculture mechanization in this state. In a survey reported by IIT Kharagpur conducted on socio- economic parameters and status of agriculture mechanization of West Bengal by it is observed that 41 per cent cultivators fall under low income class; 52 per cent cultivators fall under low middle class; and about 7 per cent cultivators fall under high middle class. This report showed that the implements used by the cultivators are desi plough, wooden leveler, long handle spade, row maker, and Khurpi etc. Since major portion of the farmers are belong to small and middle categories, they are not able to use mechanized implements. Some of them are using these improved machineries on custom hiring system on rent. At present in West Bengal, the prevalence of small and marginal farmers in the agricultural scenario prevents them from exploiting the maximum benefits of the modern agricultural implements. In the following Table we are giving some extent of farm productivity along with farm power availability of different states in India.

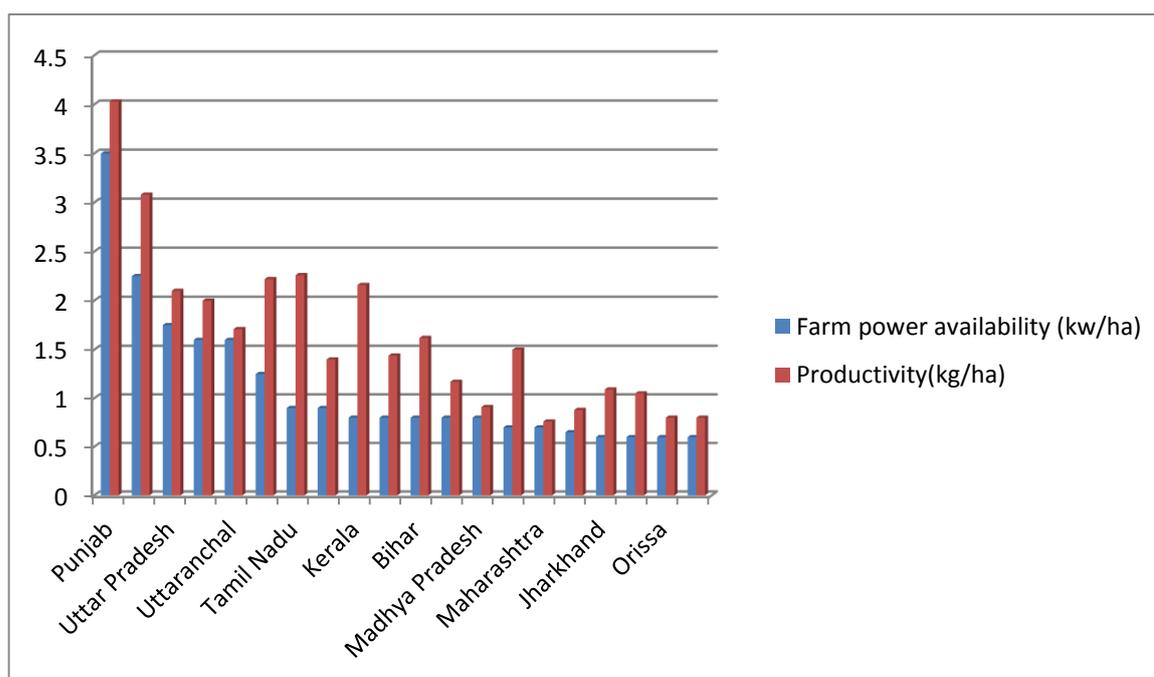
**Table 3.8: Farm Power Availability and Average Productivity of Food Grains in India in 2001**

Sl.No.	Name of the State	Farm power availability(kw/ha)	Foodgrain productivity (kg/ha)
1	Punjab	3.50	4032
2	Haryana	2.25	3088
3	Uttar Pradesh	1.75	2105
4	Andhra Pradesh	1.60	1995
5	Uttaranchal	1.60	1712
6	West Bengal	1.25	2217
7	Tamil Nadu	0.90	2262
8	Karnataka	0.90	1406
9	Kerala	0.80	2162
10	Assam	0.80	1443
11	Bihar	0.80	1622
12	Gujarat	0.80	1169
13	Madhya Pradesh	0.80	907
14	Himachal Pradesh	0.70	1500
15	Maharashtra	0.70	757
16	Rajasthan	0.65	884
17	Jharkhand	0.60	1095
18	Jammu & Kashmir	0.60	1050
19	Orissa	0.60	799
20	Chhattisgarh	0.60	799
21	All India	1.35	1723

*Source: GoI, 2002*

It is clear that food grains productivity per hectare more or less has been increasing along with farm power availability per hectare in different states of India. The above information tells us that food grains productivity per hectare (4032 kg/ ha) in Punjab is in the top position along with the highest farm power availability (3.50 kw/ha). Similarly Haryana, Uttar Pradesh, Andhra Pradesh occupies 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> position on productivity having 3088 kg/ha, 2105 kg/ha and 1995 kg/ha with 2.25 kw/ha, 1.75 kw/ha and 1.60 kw/ha farm power availability respectively. West Bengal occupied 6<sup>th</sup> position having 1.25 kw/ha farm power availability and 2217 kg/ha productivity. We can see that Maharashtra is in the lowest position having 757 kg/ha food grains productivity with 0.70 kw/ha farm power availability. So we can conclude that productivity has been increasing along with farm power availability in different states of India. The relation between farm power availability and food grain productivity has been shown in the following bar diagram (figure-3)

**Figure:3.3: Farm Power Availability and Average Productivity of Food Grains in India in 2001**



As we know farm power availability is higher in Punjab and Haryana, food grain productivity is also the highest in these two states. It has been shown by blue and red bar in the above figure. Productivity of food grains is quite better in West Bengal followed by Uttaranchal and Uttar Pradesh along with higher farm power availability. Similar performance of food grain productivity for different states has been shown by the different size of blue and red bars.

It is worth mentioning that all types of improved farm machinery are not using in West Bengal. Few rich farmers are using such big machineries in agriculture. Till a major portion of farmers are using bullock operated wooden indigenous equipments. Among power machineries mostly tractor, power tiller, harvester, pump set, motor, and few combine harvester are used. A major part of marginal farmers are using machineries on custom hiring system. The following Table shows extent of farm equipments used in West Bengal. We can see bullock operated manual implements is dominating major work of farming in West Bengal. However power drawn and tractor and power tiller operated implements also are used in a large extent.

**Table3.9: Machineries Used in Agriculture in West Bengal**

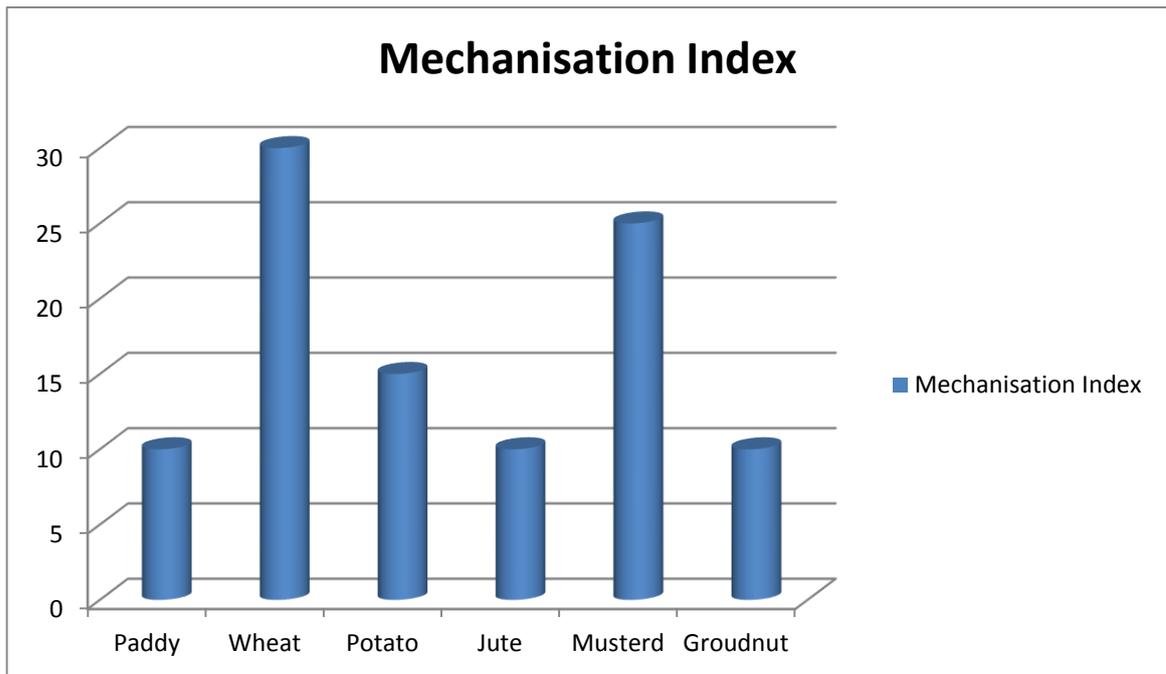
Implements	2006-07	2007-08	2008-9	2009-10( Targeted)	2010-11 ( Targeted)	2011-12( Targeted)
Manually Operated/ Bullock Drawn	14941	29852	35071	49310	61520	85830
Power Drawn	2409	5716	27332	38330	54325	73075
Tractor & Power Tiller	3540	3860	5625	6175	7150	9400
Total	20890	39428	68028	93815	122995	168305

*Source: GoI, 2002*

The above Table shows that in spite of the availability of different farm machineries farmers of West Bengal are using manually operated and bullock drawn farm implements on their farming. We can see that the use of such machineries has increased from 14941 in 2006-07 to 85830 (targeted) in 2011-12. On the other hand, use of power drawn and tractor and power tiller operated machineries also increasing extensively.

It is noticeable that use of farm equipments varies with different crops production. For some crops like boro paddy, wheat, mustered, potato, oil seeds etc. mechanization has been far better than other crops produced in West Bengal. Cultivation of other crops like jute, sugarcane, groundnut, cotton etc. also take helps of machineries to get higher productivity. In the following figure we have made an attempt to explain mechanization index on some selected crops producing in West Bengal.

**Figure 3.4: Level Farm Mechanization for different types of Crops**



*Source: GoI, 2002*

We can see that in case of wheat production mechanization plays dominant role. It is worth mentioning that wheat production through machination attracts the attention of the Government of West Bengal. Major area of Dinajpur and some other districts are producing wheat in a large extent. This cultivation has started as an alternative of high yielding boro cultivation. Boro cultivation requires heavy irrigation and fertilizers. So cost of cultivation is very high. On the other hand, wheat cultivation does not require much irrigation, fertilizers, pesticide, etc. and side by side use of combine harvester reduce the cost of harvesting which was a main problem of wheat cultivation prior to mechanization. We can also see that for potato and mustard seed cultivation mechanization index has given good result compared to paddy, jute and groundnut cultivation in West Bengal.

## VII. SUMMARY

In this chapter we found that farm mechanization is not a new phenomenon. People lived in Harappan civilization around 2500 BC (Before Christ) transformed themselves from hunters gatherers to settled farmers-cum-semi-pastoral livestock herdsman. Historians argued that they started to domesticate plants and animals as well as invent tools and implements such as plough, carts, sailboats, fishing hooks, nets and traps, grain storage etc. Gradually they are motivated by the farm activities for their livelihood. Before Independence Indian agriculture was mechanized by the technological development of England in 1889. Watts and Kaisar introduced plough, corn grinders and chaff cutters at Kanpur Experimental Farm in Uttar Pradesh in 1889. At that time horse drawn and steam operated tractor operated implements were imported from England. In 1914, India brought tractor at first in farming. Sardar Joginder Singh, agricultural minister of Punjab Government has introduced the steam operated tractors for reclamation of waste land in India. Agricultural mechanization speeds up after introduction of green revolution. As long as we knew that introduction of Green Revolution occurred in India in 1960-62 extend the role of agricultural mechanization. Improved seeds, fertilizers, pesticide requires developed agro- mechanism to get higher level of productivity. Farm mechanization not only gives higher productivity and quality crops but reduce cost of cultivation. But expansion the expansion of farm mechanization is heterogeneous in nature across the states. Punjab, Haryana, Uttar Pradesh achieved higher mechanized farming compared to other states. In West Bengal farm mechanization takes place for some common crops say, Paddy, Potato, Mustard, Wheat etc. But numbers of crops existing outside the mechanized farming belt due to small landholding, lack of credit and absence of knowledge.