PART - I

1

INTRODUCTION

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The focus of the study in this part is directed to the investigation of the effects of pond fertilization with some manures on the growth, production and introduction of three Indian major carps, *Catla catla, Labeo rohita* and *Cirrhinus mrigala* along with the exotic carps *Ctenopharyngodon idella, Cyprinus carpio, Hypophthalmichthys molitrix* and *Carassius auratus* which were normally reared in the 'Jhora' fed fish ponds of Darjeeling hills of West Bengal, India. As it is unlikely that a Switch over from one production technique to another will be cost –effective, an attempt has also been made to study the economics involved.

In Indian pisciculture is an age-old industry. But the rate of production has been found to be less than 600 Kg ha^{-1} $year^{-1}$ (Chakraborty, 1972) and in Darjeeling hills it is far below the level of 600 Kg ha^{-1} $year^{-1}$. This is because of various conditions of factors and "carrying capacity" of a pond. Moreover, the methods so far followed were not based on the scientific techniques. The "carrying capacity" of a pond is not a constant factor, it can be improved by the application of fertilizers (Yashouv, 1961) and modern technology like artificial diets etc.

The productivity of a pond is the resultant effect of the interplay of many factors (Saha, 1978). Banerjee (1976), Ghosh (1978), Saha *et al.* (1979), Patra and Ray (1988), Patra *et al.* (2000) reported that suitable. Physico-chemical conditions are required to make the pond productive.

Production of a fishpond mainly depends on its soil condition and the soil condition is reflected in the water component of a pond. Soil is the store house of nutrients in an aquatic ecosystem. Mineralization and absorption of excess materials are taken up by the soil.

Therefore, it is the first important criteria to detect the soil qualities of a pond and then to fertilize and rectify the soil qualities accordingly. With the application of fertilizers the production of fish can be increased. This is because of the production of fish food organisms. The most important objective, as such, is the growth and production of plankton, the food of major carps.

Chemical factors of the soil which plays an important role in the productivity considered to be essential are : pH, total nitrogen (N), available phosphorous (P), Organic carbon (C), Potassium (K), etc. Besides these C/N ratio is also an important index for soil productivity. The important factors, on the other hand, in the water body are pH, dissolved oxygen, total alkalinity, free carbon dioxide, chlorinity and salinity. Banerjee (1967), Saha (1978), Ghosh (1978) and Saha *et al.*(1979) reported that different levels of temperature, pH and other important factors must be in the optimum level to make the pond productive. The nature and intensity of manuring will, however, be determined (conditioned) by the soil and water quality of a pond.

In different parts of the world, manuring of pond by inorganic and organic fertilizers is being practiced. The manures are being applied either singly or in combination of one with the other. Fertilizers are used in Africa, Europe, Asia and the Far east (Gooch, 1976; Prowse, 1967 & 1968; Vander Lingen, 1967; Wolny, 1967; Mortimer

and Hickling, 1954; Schaperclaus 1959 and Hickling, 1971). Fertilizer specific work has also been done by many other workers (Smith and Swingle, 1939 & 1942; Meehean, 1933; Swingle, 1967; Garg *et al.* 1971; Ghosh, 1975; Allen and Hepher, 1976; Walther, 1977; Jhingran, 1982) has given an account of the work done in India and many other foreign countries.

In India, experiment with different manures has been undertaken by a number of workers. Fertilizers are being use singly or in combination. The noteworthy contribution in these regards are those of Hora (1943, 1946 & 1951); Das, 1949; Alikunhi, 1956; Alikunhi *et al.*, 1971; Hora and Pillay, 1962; Gopal Krishnan and Srinath, 1963; Lakshmanan *et al.*, 1968; Ray and Dawid,1969; Banerjee *et al.*, 1969, 1978 & 1979; Bhimachar, 1971; Singh *et al.*, 1972; Sinha *et al.*,1973; Saha *et al.*,1974, 1975 & 1978 ; Sukumaran, 1976; Natarajan and Varghese,1978; Govind *et al.*, 1978; Sinha,1979 & 1980; Mitra and Gupta,1981; Nandeesha,1982; Gupta,1983; and Mitra *et al.*,1987; Patra and Ray, 1988 and Laha and Mitra, 1987, reported the results of the work carried out for six months using poultry manure and gobar-gas slurry.

The physiological significance of carbon source in fertilized fish pond has been nicely explained by Satomi (1967).

Experiments carried out in different parts of the world, showed that both organic and inorganic manures are suitable for pond fertilization. Among the organic manures, farm yard manures are highly important for pond fertilization and it has good retaintion capacity. Farm yard manures contain both carbohydrate and nitrogen (Mortimer and

Hickling, 1954). Tunney (1980), reported that if animal manures are properly utilized, they would provide a valuable natural resources.

The organic manures used as pond fertilizers are cowdung, pigdung, goat droplets, poultry droplets, oil cake, green manures, compost sewage, slaughter house refuses, night soil etc. In West Bengal, green grass with cowdung, poultry manures, oil cake are used in the fish pond. Mohua oil cake can solve two purposes, it can kill the unwanted harmful organisms, and thereafter fertilize the pond. Cowdung is vastly used in fish ponds. No other organic manures are used so much. Cowdung can increase the plankton density – the fish food organisms. Workers of the Central Inland Fisheries Research Institute examined the growth inducing effect of different fertilizers, both inorganic and organic manures including cowdung (Jhingran, 1982).

The use of poultry is common in countries like China, Israel, Taiwan and South Africa. Le Mare (1948) stated that in Malaya, dropping of dungs are used as to fertilize the pond water. Sklower (1950) reported that poultry manure could be regarded as comparable to that of inorganic fertilizers. In south Africa, cowdung is used at the rate of 500-1000 Kg ha^{-1} (Hay, 1952). Sarig (1955) worked on both poultry and inorganic fertilizer and concluded that inorganic fertilizer are not inferior to poultry manure. The effect of chemical and biological change by using poultry manure has also been studied by Le Roux (1955).

Eight tonnes of poultry manure if produced by 200 birds per annum. This was estimated by Remington and Francis (1955). This will contain 4 percent nitrogen 3.0 –3.5

percent phosphoric acid and 1.0 –2.0 percent potash. Hickling (1971) stated that poultry manure causes gill disease in fish.

Satomi and Oya (1964) found the existance of direct relationship between the C/N ratio in the bottom soil and fish production in the poultry manure treated pond.

Ray and David (1969) made many experiments with poultry manure, pig dung, cowdung, sheep dung and horse dung and concluded that soluble inorganic salt is required for the production of pond fertility and poultry manure is able to supply the required soluble salts.

Besides nitrogen and phosphorous, poultry manure contains many salts which are required for the production of Plankton. It was found that population of Daphnia would require only one week to reach its highest peak under the treatment of water area with poultry manure (Anan, 1975, cited by Jhingran, 1982). In Israel 80 Kg of phosphorous with 5 tonnes of chicken droppings per hectare are commonly used. Eren *et al.* (1977) and Grover *et al.* (1970) observed higher yield of milk fish, cat fish and common carp by using poultry manure alone or poultry manure with inorganic fertilizer. Poultry manure has been reported as superior to any other organic manure (Natarajan, 1977), Zooplankton (Rotifer and Cladoceran) production increased to maximum after 8-10 days of application of poultry manure. This is 50-60% higher than that in other manures. Manjunatha (1977) tried a number of experiments with different manures singly or in combination. The results obtained from different experiment suggested that poultry is most economic. It has been reported by Rappaport *et al.*(1977) from either experiment on poultry, liquid cattle manure, coral manure and chemical fertilizers and suggested that

poultry is the best. According to Tripathi (1978) the excreta of duck and geese can also serve as good fertilizer for pond productivity. Ashwathanarayan (1979) from his study suggested that poultry is the best as a fertilizer of fish pond. Keshavnath *et al.* (1980) have studied the effect of poultry and cow-dung on the growth of hybrid Catla-Rohu and Rohu-Catla. Burns and Stickney (1980) worked on the growth of *Tilapia aurea* by using different doses of poultry manure. He showed that a production of 304.09 Kg ha^{-1} was obtained using 4000 hen wastes ha^{-1} where as in the control pond it was only 40.09 Kg ha^{-1}. Recently Mitra *et al.* (1987) reported that the results of some manures on the growth and production of major carps and pointed out that the poultry manure alone or in combination with pig manure has potentiality in boosting the productivity at cheaper rate. They also mentioned that, although poultry manure in combination with cow dung produced better result than that of the untreated pond, it was costlier than the former two.

Prakash and Gupta (1986), showed that comparative growth rates of *Catla catla, Labeo rohita* and *Cirrhinus mrigala* of the Govindgarh lake are studied by means of scales. The relationship between fish length and scale length and time of formation of annuli are estimated. Instantaneous and absolute growth rates of fishes have been calculated separately for each age group. August to October and February to April have been observed as the period of highest growth and winter month as the period of least growth. The growth curve of first year class fishes was affected chiefly by intensity of feeding and of adults by feeding and maturation of gonads.

Mitra *et al.* (1987), showed that the results of the growth and production of three major carps (Catla, *Catla catla,* Rohu, *Labeo rohita,* and Mrigal, *Cirrhinus mirgala)* using poultry alone and poultry in combination with pig or cow -dung were reported. The

use of poultry + pig manure deserved priority in bond productivity and the use of poultry alone came next. A though poultry and cow-dung showed better result than that of the untreated pond, it was found costlier than the former two. The poultry manure alone or in combination with pig manure showed potentiality in boosting up the productivity at comparatively cheaper rate.

Patra and Ray (1987), reported in their work on the poultry manure and gobar gas slurry were selected to show their effectiveness on the growth of *Catla catla* (Ham.), *Labeo rohita* (Ham.) and *Cirrhinus mrigala* (Ham.), Dutta and Goswami (1988), showed that uniformly limed ponds at the Assam Agricultural University, Jorhat, India, were stocked with 6 species of carps (Cyprinidae) at a density of 8000 ha^{-1}, manured every week with cow and pig shed wastes at a rate of 10 tonnes ha^{-1} yr^{-1}. Manured ponds yielded 3 times greater weight of fish without use of supplemental feed, were control ponds. Patra and Ray (1988), showed that the findings are presented of a study conducted to investigate the influence of a combination of pigeon droppings, goat-dung and few cow-dung on the growth and production of Indian Major carps (*Catla catla, Labeo rohita* and *Cirrhinus mrigala*) in fish ponds in West Bengal, India. The use of such organic manures are recommended for increased productions of fish in ponds.

Laha *et al.*(1990) reported that the effects of poultry manure and gobar-gas sherry on the growth, production, protein and lipid contents in (*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*) have been studied. These manures, specially poultry, were capable of enhancing the growth, production, protein and lipid yields of the carps. The poultry manure possessed productive potentiality and capability of increasing the income from a pond at cheaper rate. Tripathi and Datta (1990), reported that Eighteen

ponds (0.15-0.50 ha), in two villages in West Bengal, India 40 Km apart, covering a total area of 5.25 ha were stocked with 6 Asiatic carps; *Catla catla, Labeo rohita, Cirrhinus mrigala, Hypophthalmichthys molitrix, Ctenopharyngodon idella* and *Cyprinus carpio communis* in 3 different proportions (i) 15:28:15:25:15:02 ii) 12.5:18:20:27.5:20:02 and iii) 10:28:10:30 :20:02 at 2 stocking densities of 6,000 and 7,500 fingerlings ha^{-1}. Following each monthly sampling, feeding rates were adjusted based on mean body weight and total stock of each species and the fish fed at 1-3% of the total weight. Grass carp were provided aquatic weeds. Mean growth of individual species was found to depend both on the total density and their individual proportion. A lower stocking density with appropriate combinations is suggested to obtain optimum growth of each species.

Guptal *et al.* (1990) found that the Efficiency of Cattle manure with and without supplementary feed have been determined on the polyculture of Indian and exotic carps in two fresh water ponds in the Damana area of Jammu, during 1986-1987. In both the ponds stocking density used was 8000 fingerlings per hectare which include the Indian major carps *Labeo rohita, Cirrhinus mrigala, Catla catla,* the exotic carps *Hypophthalmichthys molitrix* and *Cyprinus carpio* in the ratio of 2.0:1.5 :2.0 2.5:2.0 respectively. Cattle manure was used at the rate of 7000 $Kgha^{-1}$ in instalments. The pond with supplementary feed i.e., rice from and mustard oil Cake (1:1) was provided at the rate of 3% of body weight. Various physicochemical parameters like pH, dissolved oxygen, dissolved free CO_2, temperature, carbonates, bicarbonates, calcium, magnesium and silicates of both the ponds has also been described. Result obtained showed that the total production 4917 Kg ha^{-1} $annum^{-1}$ and 2583 Kg ha^{-1} $annum^{-1}$ was achieved with and without supplementary feed using cattle manure respectively. Laha and Mitra (1990)

showed that the effect of manures on the protein contents in 3 Indian major carps *Catla catla, Labeo rohita* and *Cirrhinus mrigala* were investigated for 2 years in 2 identical ponds. One of the ponds was treated with poultry manure and the other was kept was as control without any treatment. The results revealed an upward trend of protein contain in the muscle with the increase in weight of fish, higher protein content in fishes reared in poultry manure treated pond than that of the control. Total protein content was always highest in *L. rohita* (14 multiplied b 6%) and lowest in *C. mrigala* (12 multiplied by 3%). The trend of increment in muscle protein was more or less the same in 2 years. Chakrabarti *et al.* (1990) found that the first batch of fingerlings of Indian and exotic carps was reared for 12 months in the pond at a density of 5,000 ha^{-1} following the management practices of composite fish farming, whereas the second batch was overwintered at stocking density of 2,00,00 ha^{-1} for 6 months after which they were reared as usual for another than 6 months. The average body weight of rohu (*Labeo rohita*) attained at the time of harvest did not differ much between the first and 2^{nd} batch of fingerlings. The final body weight of Catla (*Catla catla*) in the latter group was markedly lower than informer. However, Mrigal (*Cirrhinus mrigala*) and Silver carp (*Hypophthalmichthys molitrix*) grown in the 2^{nd} pond required additional 3 and one months time respectively to reach the weight of the first batch of fingerlings. The mechanism and possible application of this technique have been discussed.

Das *et al.* (1991) showed that the domestic sewage consisting of spent water let out by the college hostel kitchen was effectively utilized as a fertilizing agent in the natural ponds to raise carp culture. The spent water with a microbial count of 3.5 x 10 super (6) ml^{-1} indicated a considerable increase in growth of carps as compared to carps

raised in ponds fertilized with cow-dung over a period of 40 days. The results of the experiment could be of great importance to the farmers of this. North-East Region of India where fish is highly priced, to improve their rural economy. Ranadhir and Tripathi (1991) showed that the comparisons of the cultural operations of three species of Indian major carps and six species of Indian and exotic carps have been done more or less on identical farm practices except for stocking material and feed component. The cost estimates and income are worked out at current levels. It has been identified in economic studies of carp culture that feed is the dominating explanatory variable. Viewing from this angle a profit and loss account of six species production option showed a net gain n income of Rs. 12,950 ha^{-1} a^{-1} and Rs. 7025 ha^{-1} 7^{-1} months (Rs. 12,402 ha^{-1} a^{-1}) through adoption of six species culture at current price levels. The additional cost and loss is more than compensated by production of additional fish of exotic carps. Even the some trend was observed in Gujartal fish farm results also.

Shyam *et al.* (1991) found that this study examined the effects of shading on physico-chemical environments and its resultant impact on the survival of fry and fingerlings, rate of fish production and economic profitability of small tree- lined ponds for two successive years. Four backyard ponds, two shaded with large trees receiving sunlight 5.3 h d^{-1} (0.02 and 0.03 ha) and two unshaded (sunlight 9.5 h d^{-1}, 0.02 and 0.03 ha) were studied during 1981 and 1982. Ponds were stocked with 20-33.3 lakhs spawn ha^{-1} fry-rearing. 70,000 fry ha^{-1} for fingerling rearing and 7000-8000 fingerlings ha^{-1} for table size fish culture with Indian major carps. Water quality parameters and primary production were analysed using standard methods. In shaded ponds, the survival rates of fry and fingerlings were 10.0 – 25.4% and 42.3% and 42.3-53-6% respectively. While in

unshaded ponds, a better recovery was recorded (fry 37-38% and fingerlings 72.3-80.4%). Similarly the rate of fish production was 36-94% lower in shaded ponds in comparison to the unshaded ones.

Markanday and Saran (1991) found that the studies were made in a pond (0.53 ha) fed with waters (1-1.5 m). After liming the pond (300 Kg ha^{-1}), it was stocked with 6000 fingerlings of Catla (*Catla catla*), Rohu (*Labeo rohita*), Mrigal (*Cirrhinus mrigala*) and common carp (*Cyprinus carpio*). The pond was manured with liquid bio-gas slurry daily at the rate of 30,000 Kg ha^{-1} a^{-1}. About 10,054 Kg of green fodder (berseen, maize, hybrid napier) was provided for grass carp during the period of 9 months. Water quality parameter were analysed and found to be normal throughout the experiment. Grass carp (*Ctonopharyngodon idella*) attained maximum growth of 1610 g followed by common carp and Silver carp (*Hypophthalmichthys molitrix*) attaining 1325g and 980 g respectively. Among Indian major *carps* rohu attained 620 g while catla and mrigal recorded 585 and 533 g respectively.Bandopadhyay *et al.* (1991) reported in this investigation an attempt was made to study the growth., survival and production of grass carps *Ctenopharyngodon idella* by rearing in the plastic cages. Fish were reared in three circular cages (each volume of 3 cu.m.) made up of hollow aluminum frame enclosed with nylon net (6mm mesh) installed in a 2 ha water body. Grass carp fingerling were stocked at 33,50 and 67 per cu.m. in different cages. The total production range of *C. idella* was found higher than *Cyprinus carpio* and *Catla catla*, as reported from cage culture in India waters.

Patra (1993) showed that the importance of organic manures (Pigeon droppings, goat-dung and raw cow-dung were used in the ratio of 02:02:06 and 10,000 Kg ha^{-1} yr^{-1}.)

to correct the nutrient deficiencies in pond and utilization of supplementary feed (mustard oil cake, fishmeal and rice bran, 57:13 :30 and at 4.500 Kg^{-1} ha^{-1}) for the fish, *Catla catla* (Ham.), *Labeo rohita* (Ham.) and *Cirrhinus mrigala* (Ham.), have reported in the present investigation to ilucidate their potentialities in boosting up the productivity in rural areas and at a comparatively cheaper rate. The experiment was conducted in three ponds, control pond (without manure and feed) experimental pond sub (1) (with manure but without feed) and experimental pond sub (2) (with manure and feed), in the district of Bankura, West Bengal for a period of 11^{th} months. All the ponds were stocked with induced breed fry, collected from Ramsagar (Bankura). At 10,000 + 10% ha^{-1} (Average weight and total length : Catla 2.5 g and 3.1 cm. Rohu, 1.5 g and 4.8 cm. Mrigal, 2.9 g and 6.1 cm. Respectively), the ratio being 4 Catla : 3 Rohu : 3 Mrigal. Mahalingam and Raj Kumar (1993) reported that the commercial fishing is conducted in the Vellore Fort Moat. The Moat has a perennial source of fresh water - rain water. But sewage pollutes the freshwater, particularly during the summer months as the freshwater level goes down. Major carps, particularly *Catla* sp., *Labeo* sp. etc., thrive and produce very good revenue. Seed of the major carps are being cultured in cages and released into the moat at fingerlings stages. Mortality is also noticed during summer months.

Elangovan and Lethi (1994) reported that the food utilization and growth rates of catla, rohu and tilapia in mixed rearing were studied. Although catla exhibited considerable loss of weight when reared individually, it maintained it's body weight with marginal increase when reared with rohu and tilapia. The growth rate of rohu decreased significantly ($P<0.05$) from 8.58 plus or munus 1.08 in individual rearing to 0.48 plus or minus 0.02 g cal g^{-1} live fish day^{-1} when it was reared with catla, but the rate increased

significantly ($P<0.05$) to 11.05 plus or minus 0.95 g cal g^{-1} live fish day^{-1} when it was reared in combination with catla and tilapia. Rohu consumed 107.98 plus or minus 3.86 g cal g^{-1} live fish day^{-1} in individual rearing but exhibited a feeding rate of only 41.50 plus or minus 2.65 g cal g^{-1} live fish day^{-1} in combination with tilapia. Despite this low feeding rate rohu did not show a significant ($P>0.05$) production in the growth rate, because of a significant ($P<0.05$) increase in the food conversion efficiency from 7.89 plus or minus 0.99 individual rearing to 16.14 plus or minus 1.60 in combination with tilapia. Presence of catla and rohu positively influenced the energy budgeting in tilapia. Even though the feeding rate of tilapia decreased significantly ($P<0.05$) from 191.66 plus or minus 3.55 in individual rearing to 102.99 plus or minus 12.14 g cal g^{-1} live fish day^{-1} when reared with catla, the growth rate increased significantly ($P<0.05$) from 24.92 plus or minus 4.07 to 43.93 plus or minus 8.9 g cal g^{-1} live fish day^{-1}. The increased growth even at a low level of feeding is attributed to the decreased metabolic rate.

Jayaraman (1997) showed that the average figures per hectare reported by the respondents were 888.11 Kg annual yield, Rs. 19.961 (US$665.37) gross income, Rs. 9.397 (US$313.23) total cost, and Rs. 10,564 (US$352.13) net income. The highest mean yields for ponds less than, 1 ha each were related to the highest levels of adoption inputs recommended, indicating that the wide yield variations were due largely to gaps in input adoption. Widespread and successful culture of the 3 Indian major carps – Catla (*Catla catla*), Rohu (*Labeo rohita*), Mrigal (*Cirrhinus mrigala*) – as against the 6 species combination recommended under composite fish culture, pointed to a research gap. As expected, among the 3 market channels found, the one in which farmers sold live fish directly to consumers fetched a 33% higher price and consequently more incomes. A two

– pronged approach of strengthening research on relevant feed problems (like species mix, optimal input mix, disease control, feed and supply of credit) and extension support for widespread dissemination of technology to fish farmers would bridge research and extension gaps, and maximize output from the fish ponds. Saha *et al.* (1997) showed that the Indian major carps (IMC) i.e. *Catla catla, Labeo rohita* and *Cirrhinus mrigala* juveniles at a ratio 4:5:1 were cultured in flow through system consisting 27 nos. of 10m super(3) capacity cisterns with stocking densities from 0.2 to 0.4 million ha^{-1} and flow rates from 3 to 91 sec^{-1} for 3 months. The net bio-mass gain per unit volume over the culture period was linear to the stocking densities. Highest production 65 t ha^{-1} yr^{-1}. was obtained from the system at as stocking density 0.4 million ha^{-1} and flow rate 91 sec^{-1}. The growth rate of the species was found significantly high in lower stocking densities and higher flow rates. The pooled length – weight relationship for different species and some water quality parameters are also reported in the paper.

Sarangi and Dorai raj (1998) found that the fish culture in the ponds of A & N Islands yielded a poor production of 200-1000 Kg ha^{-1} $year^{-1}$ due to water of low pH, low productivity and want to proper technical know how suitable for Island condition. The soil pH of the ponds varied from 5.7 to 6.6 with water pH varying from 5.7 to 7.8 during various months of a year. The ponds were stocked with three Indian major carps and their hybrids, bighead carp and grass crap in a stocking density varying from 2,500 to 16,800 fingerlings per hectare. The fish production ranged from 3038.8 Kg ha^{-1} $year^{-1}$ to a record production of 5091 Kg ha^{-1} $year^{-1}$. The results indicated a production almost more than 5 times higher can be achieved from the rainfed ponds with proper polyculture system using the available resources of the Islands. The results obtained are discussed

with emphasis on production of stress in pond water quality, selection of seed, feed and feeding system. Jena *et al.* (1998) reported that a field trial was under taken in six earthen ponds for a period of 90 days to evaluate the growth and survival of Indian major carps and exotic carps separately and in combination at stocking density of 2.06 lakh ha^{-1}. The results demonstrated higher mean growth and survival levels in treatments with Indian major carps (12.40 g, 85.1%) over the exotic carps (11.31 g, 59.4%) when grown separately. Among the species reared, mrigal and silver carp showed higher growth rates than other species in respective treatments. Rearing Indian major carps and exotic carps in combination, this treatment showed improved performance with respect to growth, bio-mass production and feed conversion ratio.

Patra *et al.* (2000) found that the incorporation of *Nechamandra* leaf meal instead of fish meal diet of *Labeo rohita.*

As indicated earlier that cow-dung is extensively used in carp culture. But the literature indicates paucity of work on the use of other farmyard manure in India and also in West Bengal.

A perusal of the above literature leads inexplorable to the conclusion that fertilization of pond with farmyard manure of any kind is an effective means for the development of pisciculture. But which one is to be given priority for adoption remains yet an unsettled problem as no universally acceptable ranking order has been established. The task is no doubt very difficult because on cannot ruled out the probability that ranking of different manures in terms of yield may differ according to the differences in soil and climatic conditions. As such ranking order will have to be the location specific.

For that reason research should be carried out in actual fields in different rural areas rather than in cement cisterns in the laboratory. The focus of this investigation is directed towards the introduction and popularization of Indian major carps culture in the hills of Darjeeling and adjoining areas.