CHAPTER-TWO
REVIEW OF LITERATURE
Traditional fish culture practices in India have undergone gradual changes during the last few decades. The latest innovation is the integration of fish culture with livestock farming and agriculture, involving the varieties of animals like cattle, pig, sheep, goat, horse, poultry, duck, geese, pigeon, paddy and horticulture (Sharma et al. 1985). Integrated farming involving fish culture and livestock raising is perhaps a logical approach as it results in increased production of high grade animal protein at low cost by recycling the animal waste in fish ponds (Sharma et al. 1979, Jhingran and Sharma, 1980; Natarajan and Sharma, 1980; Sharma et al. 1985; Sharma and Das, 1986; Sharma and Olah, 1986; Tripathi and Mishra 1986; Sharma et al. 1988; Sharma 1990). The importance of organic wastes or manure recycling as the sole nutrient in fish ponds is felt for high fish yield (Garg et al., 1971; Bardach et al., 1972; Whetstone et al. 1974; Sharma, 1974; Allen and Hepher, 1976, FAO, 1977a; Buck et al. 1978; Collis and Smitherman, 1978; Govind et al. 1978; Schroeder, 1978; Taiganides, 1978; Wohlfarth, 1978; Nash and Brown, 1980; Huff et al., 1984; Laha and Mitra, 1987; Gaur et al., 1990). The utilisation of compost and human and cattle urine in coastal pond fertilization as well as in increasing fish production has already been successfully studied. (Banerjee et al. 1975; Banerjee et al., 1977). Most of these literatures have pointed out that the unitary culture has gradually been changed to the integrated culture systems with the production of fish, meat and egg and thereby cash income (FAO, 1977b; Sinha, 1978; Jhingran et al., 1979). Such integration makes a farm an independent unit in addition to fulfilling the demands of input for other structural units (Sharma and Das, 1988; Rath 1989a, 1989b, 1990).

Some excellent contributions are made since the middle part of the twentieth century on the fish livestock interactions with the approaches of livestock manure utilisation in fish culture (Schroeder, 1980), waste treatment and their relation to integrated waste/agriculture system (Nash and Brown, 1980), case studies with detailed economic analyses in the integrated animal fish husbandry system in Hongkong (Sin, 1980), waste composition and degradation in integration of pig livestock and fish production during the utilisation of pig waste in ponds.
(Woynarovich, 1980), proper application of animal manure in fish polyculture system with high fish densities resulting in high fish yield (Moav et al. 1977; Buck et al. 1978; Wohlfarth, 1978; Rappaport and Sarig 1978; Woynarovich, 1979; Cruz and Shehadeh, 1980) and health constraints due to diseases communicable to man due to integration of animal fish farming system in the Philippines (Velasquez, 1954; 1980; Reichenback Klinke and Elkan 1965; Azevedo and Stout, 1974; Campbell and Lasley, 1975). The developmental prospects and patterns with a well developed technology of integrated fish farming in China which have attracted the global attention have been studied by Kumar (1989). Of late, it is felt that the integration of fish culture and livestock rearing holds great promise and potential for augmenting production of animal protein, betterment of economy and generation of employment among the rural masses of India (Jhingran and Sharma, 1980). However, compared to the advancement of integrated livestock cum fish culture system in other countries not much attention has so far been given for recycling of animal waste through fish production in India. Some valuable literatures are available from the case studies and experiments based on such integration of livestock with aquaculture system in India during the recent past so as to develop the technologies of pig cum fish, duck cum fish and poultry cum fish farming systems in respect of economic viability and feasibility at the farmers level (Alikunhi, 1957; Sharma, 1974; Jhingran, 1974; Sinha, 1979; Sharma et al., 1979a, 1979b; Jhingran and Sharma, 1980; Das, 1986; Sharma et al, 1983, 1985; Sharma and Olah, 1986). No scientific attempt has so far been made in Assam on the integration of livestock with fish culture except for the ongoing researches on poultry livestock cum fish culture at AAU, Jorhat (Bhagawati et al., 1991). However, the world-wide feelings for judicious utilization of resources to cover the investment risk through crop diversification have been advanced in many countries(Hickling, 1960; Wolny, 1966; Ling, 1971; Tapiador et al., 1977; Woynarovich, 1979; Delmendo, 1980) Following the technologies for development of integrated systems involving fish production at very low cost are practised and popularized by the pioneer contributions of some workers in China (FAO, 1977a; Taiwan, (Woynarovich, 1979) Philippine (Delmendo, 1980), Hungary (Sharma and Olah, 1986) Hongkong (Sin, 1980) USA (Buck et al., 1978), Malaysia (Ismail, 1980) Thailand (Janesirisak, 1980) Java, (Djajadiredja and Jankaru, 1979), Israel (Kerns and Roelofs, 1977) Singapore (Bardach et al. 1972).

The Swine manure utilization and its recycling in the aquaculture system have been intensively studied with different culturable fish species that suggest a cost effective fish culture technique in the light of polyculture system (Le mare, 1952; Maar, 1956; Hickling, 1970; Campose and Sampaio, 1976; FAO, 1977a; Petcharoeon and Charoensrisuk, 1977;
Buck et al. 1978, 1979; Delmendo, 1980; Woynarovich, 1979, 1980; Cruz and Shehadeh, 1980; Sharma and Olali, 1986). Cruz and Shehadeh (1980) studied integrated pig-fish system with Tilapia carps and live fish to enumerate the density optimization and yield considering various performance test and designing some experimental facilities to show relationship of pig pens to fish pond. They have highlighted the impact of water quality and the environment on the fish densities, fish growth status and fish yield.

Besides, some very useful experiments have been conducted in the recycling of pig manure in fish ponds to integrate pig farming with fish culture which show very encouraging results and give a successful base for maintaining an economically viable system for the small farmers who have small land base but surplus labour under Indian conditions (Jhingran and Sharma 1978, 1980; Sharma et al., 1978, 1979a, 1979b, 1985; Natarajan and Sharma, 1980; Sharma and Olah, 1986; Sharma and Das, 1988; Sharma et al. 1988). The valuable contributions of Sharma et al., (1988) give a successful base for carp pig farming to standardise the technique and to make it an economically viable enterprise under local conditions.

A combined research effort in India and Hungary to develop production systems that give an optimum return to the farmers by judicious utilization of pig waste in polyculture system has been made by Sharma and Olah (1986). Woynarovich (1980) has emphasized the biological basis of pig waste utilization in fish ponds with reference to waste composition and degradation by examining the chemical characteristics of piggery wastes, waste loading in fish ponds, piggery waste delivery techniques, fish stocking rates, species composition and economic aspects of the piggery wastes utilization.

Integration of domestic birds, duck (goose) poultry (hen, chicken) has not yet been properly achieved in India. However, among European countries large scale experiments were initiated in Hungary, Czechoslovakia and East Germany during early 50's to determine optimal husbandry methods for raising ducks on fish ponds when monoculture of common carp was the only type of fish culture. The Central Europe perhaps has gone for extensive duck farming production activities with number of experiments initiated in Hungary and German Democratic Republic (Woynarovich, 1979) China is one of the very important countries for adopting the integrated system with the various combinations of pig, duck, goose and fish. The integrated animal fish husbandry system in Hongkong has been established through different case studies on duck-fish and goose-fish systems with particular emphasis on production and economic analyses of the returns on capital investment (Sin, 1980). Before that Sin and Cheng (1976) have described the major fish culture management systems
in Hong Kong with monoculture of some carnivorous fishes and polyculture of herbivorous fishes, through duck fish integrations, Lau (1972, 1973), emphasized basic requirements and management of duck farming in Hong Kong. Lin (1940) probably initiated the association of fish and ducks in ponds without the knowledge of management techniques which is followed by subsequent works aimed at duck farming and its disease control methods described by Anon, 1972; Chan, 1972; Lau 1972, 1973; Mui, 1969; and Wong 1969, 1972a, 1972b. The nutritional effects of duck droppings as fertilizer for fish ponds in China has been suggested by Lo, 1970 which is followed by the literature available on the management techniques and economics of polyculture and duck - fish systems (Sin and Cheng, 1976). Duck cum fish culture has been tried in Nepal and Vietnam with the assistance of the FAO and UNDP with encouraging results. Shimura and Delmendo (1969) and Delmendo (1980) have studied in detail the integration of duck and fish culture in Philippines along with various types of livestock fish integrations while obtaining high productivity of Laguna de Bay lake by using duck manure from the commercial duck farms on its shore. Delmendo and Gedney (1974) had designed aquaculture in enclosures in the lake under duck - fish integration for making full use of high productivity of water caused by the duck manure.

Duck-fish and poultry-fish integration systems are still in infancy and in an experimental stage in India. Sharma et al., 1979; Jhingran and Sharma 1980, Natarajan and Sharma 1980, Sharma et al., 1985; Yadava et al., 1986; Sharma and Das, 1988; Mahapatra and Das Mahapatra 1991, have made the most valuable contributions pertaining to the high yield of fish by making use of duck manure, regeneration of high content of nitrogen and phosphate in duck droppings, development of technology, on the system for Indian conditions and economic viability of the system.

Although poultry industry today is well developed and the poultry excreta itself is a rich source of nutrients, poultry cum fish culture integrated system is not adequately developed in India. However, CIFRI, 1986; Daryanani, (1989-90); Das (1981, 1986, Sharma et al., 1985) have clearly been described the procedure and management of poultry cum fish culture. The effectiveness of raw chicken and pig manures as a direct food of fishes has been tested in a variety of fish like common carp, (Shiloh and Viola, 1973; Campose and Sampaio 1976; Kerns and Roclofs, 1977) Tilapia (Stickney and Simmons, 1977) Tilapia with cattle manure (Collis and Smith, 1978, Vander lingen, 1960) Channel catfish (Fowler and Lock, 1974), Gold fish (Lu and Kevern, 1975) and Clarias (Kittisarn, 1964). Banerjee et al., (1979), has emphasized the manural potentiality of poultry droppings in aquaculture system. The use of poultry manure as fertilizer in rearing major carp fry is
studied by Banerjee et al., (1969) and Bhatkar (1989-90). Indeed, poultry wastes are also 
used as feed in poultry rations (Flegal and Zindel, 1971; Ichhponani and Lodhi, 1976) and 
cat fish rations (Fowler and Lock 1974). Utilization of poultry manure as potential plankton 
producer has been studied by Ray and David (1969).

Experiments tried in Israel with dried manures incorporating into standard feed 
pellet yield considerably significant result for replacement of high priced feed components 
while thoroughly investigating the various aspects of manure loaded fish pond like fish growth, 
ecological implication food web dynamics and impact of poultry manure on ecosystem 
involving fish culture in manure loaded fish ponds have become the tool for determination of 
fish growth. (Schroeder, 1980).

A four member team from India visiting China in 1988 found that the integrated 
fish farming approach with livestock, particularly with high yielding variety of duck and 
poultry, had promoted full utilization of animal wastes in fish production for rural development 
in China through a number of integrated bird-fish farms like Holei in Wuxi, Quing Pu in 
Shanghai (Joseph, 1990)

The International Centre for Living Aquatic Resources Management and Central 
Luzon State University integrated Animal fish Farming Project during 1978-1981 at Nueva 
Ecija, Philippines conducted 18 remarkable experiments which have become a basis of 
scientific designing of integrated fish farm, optimisation of stock, control of disease, 
maintenance of the ecological parameters and economics. Hopkins and Cruz (1988), have 
published their valued contributions on livestock fish integrations resulting from their seven 
experiments on pig-fish, two experiments from duck-fish and four experiments on poultry-
fish integrations while looking at detailed ecological and fisheries aspects of such integrations.

The contributions on the growth dynamics of Indian Major Carp species with 
reference to the food and feeding biology of *Catla catla* (Raj, 1931; Chacko and Kuriyan, 
1950; Thomas, 1887, 1897; Menon and Chacko, 1956; Karamchandani and Mishra, 1974), *Cirrhina mrigala* (Jhingran, 1959) and *Labeo rohita* (Das and Ray, 1989) under Indian 
water conditions are noteworthy. Some valuable references are also available on the biology 
of *Cirrhina mrigala* (Jhingran 1952, 1957 and 1959; Chakraborty and Singh, 1963; Kamal, 
1967), *Catla catla* (Natarajan and Jhingran, 1963) and *Labeo calbasu* (Ramamohana Rao 
and Hanumantha Rao, 1972). The fish yield statistics of IMC species in relation to the 
application of supplementary feed and inorganic fertilizers have been drawn from various