"B"

INTRODUCTION

The training course commence on the 1st of April 1975, at the Freshwater Fisheries Experimental Station in Kwantun Province. The main types of fish studied under this programme were in four major species of fish cultivated in Kwantun Province, namely Aristichthys nobilis (Big Head), Hypophthalmichthys molitrix (Silvercarp) Ctenopharyngodon idellus (Grass carp) and Cirrhina molitorella (Mud carp). Mention was also made of the other types of cultured fish namely Cyprinus carpio (common carp), Carassius auratus (Gold carp) Ocrassius Megalobrama amblycephala (Wuchang fish) Ophiocephalus argus (snake head) and Tilapia mossambica (lectures were in Chinese with English interpretations whenever necessary, all lectures were illustrated with graphs, tables and figures.

The training course was divided into six parts:
Artificial propagation; Nurture of fry and fingerlings, Adult fish culture, Fish diseases, Reservoir fish culture and Pond construction. Many hours of practice were assigned for the first four topics. The trainees, along with the lecturers and workers participated in the whole course of practice, from artificial propagation up to the stocking of fingerlingers in adult fish ponds. Apart from this, practicals were done in the harvest of marketable size fish. Several ponds were specially allocated for the above practical training. Study tours were arranged in connection with artificial propagation and adult fish culture to two other production units. Visits were also made to reservoirs and lakes, to study and observe some new tecniques in adult fish capture. A number of reference books were made available to the trainee.

Oral examinations and discussions were held at the completion of each part, and a written open book examination was conducted at the termination of the course.

1. ARTIFICIAL PROPAGATI[illegible]

1.1. Introduction

The culture of the four species of fishes namely silv carp, Big Head, Grass carp, and Mud carp which are prevalent in the fresh water bodies of China, did not begin until the

REPORT TO FAO ON THE TRAINING OF

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IN THE PEOPLES' REPUBLIC OF CHINA

ON

FRESH WATER FISH CULTURE

1st April, 1975 - 24th September, 1975

Tang Dynasty (A.D. 618-907). These species were reared for a period of three years, but due to heavy density of stocking they failed to develop their gonads to maturity. Therefore the people had to rely mainly on the Yangtze and the West rivers for fish fry.

Collection of fry from rivers resulted in the following drawbacks:- a) high cost of labour; b) adulteration of desirable fry withheld ones, c) high mortality due to long distance transport. To overcome these obstacles, Artificial Propagation was carried out in 1958.

1.2 Feeding habits and habitat:

Silver carp and Big Head generally live in the upper layers of the water and they feed on phytoplanktons and zooplanktons respectively. Grass carp is a mid-upper layer dweller and chiefly feeds on grass. Mud carp which is a bottom dweller feeds chiefly on detritus.

The most suitable range of water temperature for these types lie between 20-31° centigrade. The dissolved oxygen concentration should be above 2 mg. per litre. These optimum pH. range lie between 7.4 to 8.5.

1.3 Ecological factors for effecting controlling the sexual maturity of brood fish.

1.3. 1 Nutrition:

A balanced nutrition is most essential for the healthy maturation of gonads. Maturity index of the ovary of brood fish is between 3 to 6% before February. But after April it reaches 14 to 22% in Kwangtun Province.

$$\text{Maturity index} = \frac{\text{Weight of gonad} \times 100}{\text{Gross body weight}}$$

Proper nutrition in autumn and spring results in well developed gonads.

1.3. 2 Water temperature - pH and light:

The suitable temperature range for maturation of gonads and spawning lie between 22-29° centigrade. pH should range between 7.4 to 8.5. It has also been found that light plays a very important role in the initiation of the sexual cycle by stimulating the hypophysis.

1.4 Process of artificial propagation :

1.4 1 Culture of Brood fish.

This is the most essential pre-requisite for artificial propagation. Brood fish will fail to attain maturity in time for spawning if the following factors are not strictly adhered to.

PRODUCTION FARM	SILVER CARP				BIG HEAD CARP			
	No.	Max.	Mini.	Ave	No.	Max.	Mini.	Ave.
Kwangtun Experimental Fish Farm	19	1076	778	990	34	2180	728	988
Other Farms	163	1600	800	1196	67	2560	676	888

TABLE I

THE DOSAGE OF HUMAN CHORIONIC GONADOTROPIN IN COMPARISON - INTERNATIONAL UNITS/KG.

The area of the pond in which Silver carp, Big Head, Grass carp are reared should be between 3-6 mu.1 For Mud Carp 2-3 mu. The depth of water should be 1.5-2 metres. The ponds should be cleaned with tea seed cake or Quick lime and the muddy ooze at the pond bottom should be removed. Green manure in the form of rotten vegetables and "Tatsno" 2 is next added to increase the production of planktons. (The rate of application of rotten vegetables is 400-650 Kg/mu. per metre water depth). When the colour of water turns green or brown, brood fish are stocked.

1.4. 1.1 Stocking rates:

(a) Grass carp (major species) 10-13 individuals per mu. (individual weight 8-12 Kg.) 4-6 individuals of Silver carp and 20-30 individuals of Common carp are also cultured in the same pond.

(b) Big Head (major species) 5-6 individuals per mu. (individual weight 7-12 Kg.) 5-6 Grass carps 20-30 common carps are also cultured in the same pond.

(c) Silver carp (major species) 10-15 individuals per mu. (individual weight 3-6 Kg.) Mixed with 6-8 Grass carps and 30-40 Mud carps and 30-40 Common carps.

(d) Mud Carp (major species) 120-160 individuals per mu. (individual weight 0.8-1.4 Kg.) Mixed with 6-8 Grass carps and 3-5 Silver carps.

1.4 1.2 Rearing and Management

Application of food - for Grass Carp as major species, Grass equivalent to 20-40% of the body weight should be Given along with fine food equivalent to 2-4% of the body weight. For Big Head as the major species in addition to base manure, 130-180 Kg/Mu. of vegetable manure are added every 4 to 6 days depending on the weather.

1 - 1 Mu = 666.6 sq. metres 2 - defined in latter chapter

Silver carp as the major species - same as before for Big Head but the quantity of vegetable manure should be reduced to 100-150 KG. per mu.

Mud carp as the major species - 50-80 Kg. of vegetable manure to be added for 3-4 days. 8-10 gms. of rice bran is also to be added per fish.

1.4. 2 Estrualization:

1.4. 2.1 Selection of male and female brood fish

The brood fish (female) which are to be used for the purpose of spawning have to be healthy and in good physical condition. The age of maturity of the female spawners of the four species vary according to the temperature. In the Kwangtung Province the period of maturity for female spawners is as follows:

Grass carp usually		4-5 years
Big Head	"	3-4 "
Silver carp	"	2-3 "
Mud carp	"	2-3 "

The males of the above four species reach maturity one year before the females.

In selecting the females those with large and soft abdomens are preferred. Males have to be active and rich in milt.

1.4 2.2 Sex ratio group

In natural spawning under artificial conditions the sex ratio is two males to one female. In artificial insemination it is one male to one female.

1.4 2.3 Estrualizing agents:

(a) Pituitary extract - pituitary of Common carp is used.

Dosage: -3 - 3.5 glands per Kg. of fish or 2-3 mg. per Kg of fish

(b) Human Chorionic Gonadotropin (Table I)

1.4 2.4 Frequency and time of injection

i. Single injection -
ii. Double injection -

The total dose is usually administered in a single treatment, but may also be divided into two injections.

In the latter case (double injection) which is usually given to the female in dosage of the first injection is 10-15% of the total dose.

The interval between the first and the second injections is 6 to 8 hours.

1.4 3 Ecological factors for acceleration of spawning:

i. Running water with a current velocity of 0.2-0.4 M/sec. proves effective

ii. A temperature of 20-30° Centigrade is preferable.

iii. A dissolved oxygen concentration of over 4 mg/litre and a pH range of 7.4 to 8.5 is recommended.

1.4 4 Artificial insemination:

Three methods are commonly practised, namely dry method, semi dry method and wet method. The vitality of spermatozoa is high in the first two methods.

1.5 Practical aspects of artificial propagation

1.5 1 Training of brood fish.

Before selection of spawners they are netted into

a small area in the pond. Two such trainings are usually done but the number may vary according to the species. The significance of training is to excite them which subsequently results in the secretion of mucous and discharge of excrements. This technique is adopted to minimise mortality and the fouling up of water in the spawning pools once the spawners are transferred to them, to enable spawners to withstand the strain of spawning. The duration of training lasts for about five minutes, and is usually done in the morning.

1.5 2. Transfer of brood fish:

The brood fish are transferred to the spawning pool immediately after the last training. Care should be taken during the selection and transfer to avoid any unnecessary exertion. Immediately after selection spawners are carried to spawning ponds in canvas bags containing a little water.

1.5.3 Injection

The average weight of the selected spawners of Silver carp, Big Head and Grass carp ranges between 8-12 kg. during practice. The first injection for the females is prepared by grinding 4 common carp pituitaries and dissolving in 1.5-2 ml. of normal saline. The injections were prepared before the spawners were brought to the spawning pool, and administered prior to releasing into the spawning pool. The individual weights, body length and total length of these fish are also recorded. The second dose is determined according to the weight of the fish. The first injection is usually given in the evening and the second 6-8 hours later so that estrus prior to spawning would commence at daybreak. The injection for male is given when the female receives the second injection. Usually these injections are given at the base of the pec oral fin at an angle of 45° to the body. This named the peritonial injection. Sometimes injections are given to the base of the dorsal fin. This is called muscular injection.

1.5 4 Artificial propagation:

i. Propagation by artificial insemination.

Immediately after the administration of the injection some of the brood fish are transferred to a rectangular cement pond. Four males and four females were introduced into this pond. When estrus commenced at daybreak the females and males were stripped into a clean and dry basin and the eggs and milt were thoroughly mixed and the

fertilized eggs were transferred into the incubation pool.[1]

11. Propagation by natural spawning.

Some of the fish after injection are released into the circular spawning pool. Here, the ratio of male to female is 2:1 respectively. Estrus commenced at daybreak and the males began to follow the females. Eggs are released at this stage and milk too was discharged simultaneously. The fertilized eggs were transferred through a delivery base into the incubation pool.[2]

1.5 5 Incubation and hatching

The following factors were taken into consideration during incubation. The speed of water in the circular incubation pool was maintained at 0.15 metres/second. The dissolved oxygen concentration, water temperature and pH were kept above 4/mg/litre, between 24-30° centigrade and 7.4 to 8.5 respectively.

Constant watch was kept during the process of incubation and hatching. Periodic readings of water temperature, dissolved oxygen and pH were recorded and the embryonic developmental stages of the eggs were observed from time to time. Fertilisation rate was calculated when the development of the fertilized eggs reached gastrula stage, i.e. above 10 hours after fertilization.

The larvae begin to hatch out after about 35 hours and as the larvae began to wriggle within the egg membrane the hatching rate was calculated. The newly hatched out fry are next transferred into "fry cots". These cots are made of silk or linen and were placed in the rectangular pool and the fry in this enclosure were kept till the yolk sacs were absorbed and till their air bladders were developed.

The fry were kept in these net cages for three days and after counting they were transferred into the fry nurturing ponds.

2. Nurture of fry and fingerlings

2. 1 Pond selection and clearing:

The main pre-requisites for a nursery pond are the close proximity to the incubation pool, fresh and rich source of water, and good soil quality. The usual size for fry - a pond is between 1.5-3 mu. and for a fingerling pond between 2-5 mu. The ponds should be 1.5-2 metres in depth rectangular in shape and should be orientated in such a manner so that the photoperiod could be utilized to the maximum.

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[1], and [2] - See under pond construction

In clearing the ponds before stocking common aquatic insects and predatory fishes and various diseases causing pathogens are eliminated. The commonly used pond clearing agents are tea seed, cake, quick lime, bleaching powder, rotinone and croton tiglium.

2.2 Testing of water quality:

Once the ponds have been cleared elephant grass rotten vegetables and "tntsao" (this name applies to a particular set of plants belonging to families Compositate, Solanaceae and Leguminoceae, which easily decays and make water fertile) are added to fertilize the ponds. The fertility of a pond has to be tested before stocking of fry. Big head of the size 0.15-0.25Kg. at the rate of 150 individual per mu are stocked. These fish feed on macro planktons and thus keep the quantity of dissolved oxygen high. If the oxygen content of the pond is low due to over fertility Big head would surface. Therefore by observing the behaviour of testing big head in the mornings the fertility of the ponds could be determined before stocking of fry.

2.3 Stocking of fry

A few days before stocking of fry all save a few testing big head are removed from the pond. Fry are brought from the incubation pools tostocking ponds and are acclimatized before they are released into the ponds.

2.3 1 Stocking rates:

Big head, Silver carp and Grass carp 100,000 to 150,000 individuals per mu.

Mud carp 300,000 to 400,000 individuals per mu.

When production is done on large scale the stocking rates are: Grass carp 200,000 to 250,000 individuals per mu. Big Head 150,000 to 200,000 individuals per mu, Silver carp 200,000 to 250,000 individuals per mu, and Mud carp 350,000 to 400,000 individuals per mu.

2.4 Feeding:

Depending on the quality of water elephant grass and rotten vegetables are added at the rate of 875 to 900 Kg/mu. Fine food in the form of rice bran, pea nut bran caks and wheat bran are also added.

2.5 Pond inspection:

It is essential to inspect fry ponds daily in the mornings. Careful observation should be made regarding the surfacing of fry. If surfacing goes on late into the morning steps should be taken to increase the oxygen concentration.

2.6 Transfer of fry:

Fry are transferred into the fingerling ponds when they attain a size of 2-3 cm and the number of days of culture may range from 15-30.

2.7 Nurture of fingerlings:

Before the young fish are transferred into fingerling ponds these ponds too should be cleaned and fertilized.

2.7 1 Stocking of fingerlings:

To obtain healthy fingerlings the size of fish in a pond should be uniform. Scales should be completely formed. Healthy fry swim against the water current and such active fry are most suited for stocking. At this stage the method of culture change from monoculture to polyculture.

2.7 2 Culture of fingerlings:

Although pisyculture is more advantageous in the nurture of fingerlings monoculture could also be adopted.

Monoculture of Grass Carp fingerlings

Stocking	Stocking rate ind./mu.	Size at transfer	Survival rate	Duration of culture(days
3 cm	20,000	4.8 cm	80%	20
4.8 cm	5,000 -	9-12 cm	80%	Sept. & Jan.

Monoculture of Big Head, Mud Carp and Silver Carp

Species	St.size (cm)	St.rate ind/mu	Transfer size(cm)	Sur.rate	Duration of culture
B.H.	3	15,000 - 20,000	6	90%	30 days
	6	4,000 - 6,000	12	90%	30 "
M.C.	3	27,500	5.8	80%	30"
	5.8	9,000	7.5	80%	50 "
S.C.	3	20,000	6-9-5	90%	20-50 "
	6-9.5	800-1,000	12-20	90%	30-40 "

Polyculture is considered to be more economical as available food in the water body can be fully utilized since fingerlings are more selective in their food habits. Two to three species are in one pond in polyculture. In selecting these species, their food habits should be considered.

The following are the possible combinations for polyculture: Grass carp - Big Head, Grass carp - Silver carp, Grass carp - Mud carp, Grass carp - Mud carp and Silver carp.

Stocking rates in fingerlings polyculture

Species	Stocking size (cm)	Stocking rate/ha	size at transfer(cm)	Survival rate	Duration of culture(days
G.C.	8	3,000	12-16	90%	Early July-Jan
B.H.	4.5	15,000	7.5-7.8	90%	Mid July-Jan
C.C.	4.8	3,000	9-10	70-75%	Early July-Jan
M.C.	3	70,000-140,000	3.9-5.8	70%	Early July-March
G.C.	6	5,000	9-12	90%	Early July-Jan
S.C.	5	25,000	8-9	90%	- do -

2.7.3 Feeding:

The fingerlings of the above four species feed on the following:

Wolffia arrhiza:- G.C.

Lemna minor :- G.C.

Spirogela polyrhiza: G.C.

Vallisneria spiralis: G.C.

Various aquatic grasses and tender grass: G.C.

Soya bean, cake, peanut bran cake, rice bran, grain bran cakes are eaten by all except B.H. and S.C.

The optimum temperature for feeding in G.C., M.C., B.H. and S.C. range from 25-30° Centigrade. Feeding during abnormal weather conditions like sudden cooling after a spell of warm weather or vice versa low temperatures, gloomy days, before or after a thunderstorm becomes reduced.

2.7.4 Training and transfer

The fish are nurtured in the fingerling ponds till they attain a size of 16 cm. and are then either transferred to adult fish ponds or sold. However, the size of transfer vary from 3.9-16 cm. depending on the species.

Prior to transfer of fingerlings they are netted in and kept in an enclosure in the pond. This is done in order to condition them to high concentrations, promotes high secretion of mucus and excretion of faeces. This enables the fingerlings to withstand the rigours of long distance transport and further prevents the water in the container from fouling.

2.7.5 Management

Careful watch must be kept on all fingerling ponds. Inspection of ponds to observe the colour water and movement of fish should be meticulously carried out. Regular feeding at fixed times and positions ensure healthy fish. Faeces of fingerlings may cause over-fertility of water and therefore fresh water should be let in occasionally.

Practical aspects in fingerling nurture

The fry hatched during the training course were nurtured by the trainees themselves till they were transferred to the adult fish ponds. This involved the carrying of fry in containers from the hatchery to the fry ponds, inspection of ponds in the mornings, feeding with bran and training of fry and fingerlings before transfer. Records of their growth rates and survival rates were taken and quantities of food both artificial and natural which were applied to each pond was also recorded.

3. Culture of adult fish

The four cultured species namely, Big head, Silver carp, Grass carp and mud carp show the maximum specialization of food habit and habitat during the adult stage. They can be polycultured together with other species such as, Black carp, common carp and Tilapia under controlled stocking rates. Advanced techniques such as Multigrade conveyor culture have been developed in China resulting in tremendous increase of output.

3.1 Factors for high yield:

3.1.1 Surrounding:

The environment of fish has a great effect on output. 2 to 3 metre deep ponds are more preferable as there is more space, dissolved oxygen and plankton and less fluctuations in temperature The area of pond should be 4-10 mu. As for condition of bottom the loamy soil is more preferable than clayey. The pond is built in an open area, so as to ensure sufficient sun light. Prior to stocking, the ponds are cleared thoroughly using tea seed cake and quick lime etc.

3.1.2 Stocking rate:

The stocking rate differs for each species of fish depending on their size. The proper stocking rates are given below: -

	Silver Carp	Big Head	Grass Carp	Mud Carp
Minimum stocking weight* at the early period of culture (Kg/mu.)	3-13	15-18	15-10	15-60
Maximum weight* at the later period of culture (Kg/mu.)	20-30	25-35	60-100	125-150

3.1.3 Polyculture:

Polyculture is practised so as to enable full utilization of water body and nutrients. The four cultured fish have different food habits. Silver carp and Big head feed on phytoplankton and zooplankton respectively. Grass carp, wu Chang fish and bream and herbivores; common carp and Golden carp feed on detritus and

* Total weight of fish

organic matter; Mud carp and mullet on organic matter and algae. Silver carp and Big Head are upper water layer dwellers, whereas Grass carp, bream and su Chang fish are mid water dwellers. Black carp, common carp, Golden carp, mud carp and mullet inhabit the bottom of ponds.

In polyculture of various species mutual benefit among them should be considered and competition should be avoided. The excrements of Grass carp which serves as food for Mud carp also fertilizers the pond and increases plankton which are utilized by Silver carp and Big head. Black carp is cultured with other species to control snails and clams which feed on plankton. Small wild fish can be controlled by culturing few snake-heads. At a controlled rate few common carps are also reared in the same pond which is beneficial to silver carp. Furthermore, the quantity of individuals stocked and total weight should be adjusted in polyculture so as to avoid wastage of water area and to prevent retardation of normal growth.

If too many Silver carps are reared in the same pond with Big heads, the growth of zooplankton will be hindered hence, the growth of Big heads will be seriously affected. Therefore, these two species should be cultured under strictly controlled stocking rates.

3.1.4 Fertilizer and Fodder

Generally, grass, wolffia, duck weed and Vallisnaria are supplied as green fodder and silk worm pupae, soya bean cake, pea nut residue cake and brans as find food at the rate of 99.44% and 0.56% respectively.

3.1.5 Control of diseases:

Various pathogens infect the adult fish and may cause serious diseases. Timely treatment and adopting effective disease preventing techniques ensure health of fish and thus increase the output.

3.2 Advanced Culture methods:

3.2.1 Multi grade Conveyor Culture

Culture of fingerlings and adult fish in serially graduated ponds so as to increase output and number of harvests is known as Multi grade Conveyor Culture, and it has been in operation in China since 1958.

In this method 35% of total area of ponds is utilised for raising fingerlings and the rest for adult fish. Hence, every 1.86 mu of adult fish pond will be supplied by 1 mu of fingerling pond. The harvesting and stocking is carried out in rotation. The fingerlings from storage pond are transferred to small size fingerling pond after raising them to the required size, and are cultured in medium size fingerling pond, large size fingerling

pond and in fattening pond. In all the instances transference is carried out successively from preceding pond after they have attained the required size. Therefore as the fish are harvested transference and stocking can be carried out simultaneously.

Multigrade culture has many advantages over the ordinary less grade culture (see Table)

Grade	Method of culture	Stocking size ind/Kg.	Stocking density ind/mu.	Total wt. of stocked fish Kg/mu	Days of culture	Survival rate	Harvesting size ind/Kg.	Harvest at mu. kg/	Total net output kg/mu.	Average net put kg/mu/month
1	less grade culture	4,000	5,000	1.25	300	85.2%	25-27	163.2	102.6	16
2		25-27	1,000	38.46	360	99%	6	150	111.54	9
1	multi-grade culture	4,000	30,000	7.5	35	95%	660	41.91	34.41	29.49
2		660	8,000	11.76	150	99%	40-60	144	132.2	26.45
3		40-60	2,700	54	180	95%	16-18	150.3	90.88	16.15
4		16-18	800	47-85	180	95%	6	126.67	79.6	13.2

Large size fingerlings are cultured. The quantity of fingerlings reared is also higher. It is convenient to determine the stocking density as harvesting and stocking is carried out in rotation. The fish can grow faster yielding a higher output. As the fish in fattening pond are harvested and it is stocked with equal amount of large size fingerlings, the number of harvest per year is more than that of in less grade culture. The duration of cultivation is comparatively shorter hence, the survival rate is higher. The table size is comparatively uniform and harvesting date can be decided easily. The planned production is facilitated and supply to the market may be carried out systematically.

However, the stocking density is comparatively higher than in less grade culture, demanding more hbour power. On the other hand as large number o ponds are required, multigrade culture can be practised only in large fish farms.

3.2 2 Mixed age culture:

This culture method is practised in hilly and village areas where only a few ponds are available. Large, medium and small size fingerlings can be cultured together in the same pond. When the fish have reached table size they are harvested according to the season and small size fingerlings are stocked in place of them.

Species	Stocking									
Stocking rate ind/mu. Date	Big head size cm.	ind.	Silver Carp size cm.	ind.	Grass Carp size cm.	ind.	Mud Carp size cm.	ind.	Common carp size cm.	in
Feb.-March	10-17	60	10-13	120	10-17	70	3.6-4.8	1,000	7.5	20
June	10-17	60	10-13	120	10-17	70	-	-	-	-
September	10-17	60	10-13	120	10-17	70	3.6-4.8	1,000	-	-

Table process of mixed-age culture

The fingerlings stocked in September of the previous year should be harvested three times beginning from June within 50 days. They reach 0.01-0.04 Kg. during this period. The fingerlings stocked in February are harvested in three times beginning from August when they reach 0.5 Kg. and those stocked in June should be harvested in three times beginning from October when they reach 0.25 kg. in weight. Common carp and Mud carp are harvested in December.

3.3 Management

Feeding of adult fish should be carried out carefully, according to the season, weather, water quality and activity of fish. In ponds where stocking density of Big head is low, the water may become clear when the weather is cloudy or rainy. Large number of water fleas may appear near the edges of the pond. The dissolved oxygen content decreases and there will be only very few phytoplankton. To prevent deterioration of water quality, water should be renewed and aerated. Dipterex is used to control excess water fleas whenever necessary. Fertilizer is applied to assist the growth of phytoplankton.

Large size of Big heads should be stocked to control water fleas and excess humus should be removed as precautions.

To prevent intense growth of blue-green on the water surface, large size Silver carp and Big heads should be stocked. The ponds can be treated with 0.18-0.2 Kg. of copper sulphate.

In deep dug, old ponds the water may become acidic and in such case a water should be treated with quick lime at the rate of 70-100 Kg/mu.

Furthermore, specially in summer and in autumn the fish may surface seriously and death may occur due to depletion of dissolved oxygen. Ponds should be cleared to remove excess humus. Renewal of water also may be necessary. Food and fertilizer application should be carried out evently. Humus will settle down when the water is treated with 0.5-3.0 Kg. of alum dissolved in water.

4. FISH DISEASES

4.1 INFECTIOUS DISEASES:

4.1.1 Diseases caused by bacteria

4.1.1.1 Gill rot:

Symptoms: A general darkening of the body. Gill filaments turns greyish white in colour and disintegration of operculum and branchial cartilage.

Pathogen: Myxococcus piscicola:

Injury and infection:

Disease is paralleled with Haemorrhagic Septicaemia. Usually common in March and October. Grass carp is easily affected by this disease. Silver carp, Big head and Common carp are also susceptible to this disease. The bacteria are usually common in over fertile ponds where the contents of humus at the pond bottom is great.

Prevention and treatment

a. Healthy fingerlings of the same source must be stocked in the ponds.

b. Removal of excess humus periodically from the pond bottom.

c. The ponds are disinfected with bleaching powder in a fixed term after stocking. During the infectious season disinfection is carried out once in thirty days. The dosage of bleaching powder is one part per million. The disinfection is also carried out of the pond edge every other seven days, the average dosage being 0.25 Kg/mu. The feeding area is sprinkled with salt the dosage 0.25 Kg/feeding area (app. 25 sq. meters).

4.1 1.2 Enteritis:

Symptoms:

Congested ventral and lateral sides. Red spots appear on the belly. The ventral and anal fins are bloodshot. Inflammation of the cloaca which appears reddish. A yellow liquid seeps out through the cloaca on gentle pressing of the abdomen. A general decay of the mucosa cells of the intestine which later becomes full of bloody pus. The intestine then appears purple.

Pathogen: Aeromonas punctata

Injury and infection:

Usually endangers Grass carp of one to two years old. The disease is common from April to June and from September to October. The disease reaches the climax in May and June. This disease results mainly from incorrect feeding which affects the metabolism of the fish. Decaying food is a carrier to the pathogen.

Prevention and treatment:

a) Application of fresh food in fixed time and quantity.

Disinfection of ponds with bleaching powder.

b) The fish are fed with granular mix of wheatbran, rice bran and sulfaguanidine (ratio 80:20:1) successively for six days, with a dosage of 5 gm./50 Kg. of fish on the first day and 2.5gm./ of fish from the second to the sixth day.

4.1.1.3 Haemorrhagic septicaemia:

Symptoms:

The affected fish are locally inflamed and congested. The scales fall off and red spot appear on the body. The ends of fin rays may be eroded due to bacterial action and therefore fin rays appear irregular. Sometimes the gill cover may be congested with red spots. The diseased fish are solitary in behaviour.

Pathogen: Pseudomonas fluorescens:

Injury and infection:

All four species namely Silver carp, Grass carp, Big head and Mud carp are affected. The disease often breakout after stocking or gathering of fish. The bateria infect the wounds which are caused due to careless handling. The disease is common in early winter and early spring.

Prevention and treatment:

a) The fish are stocked during winter and this prevents the widespread of the disease;

b) Careful handling of the fish during catching and gathering;

c) Application of sulfurdiozin and bleaching powder are found very effective. The concentrations to be used are 1/400 and 1/400,000 respt. - in the laboratory. In practice 1 p.p.m. of bleaching power is found effective in killing all bacteria.

4.1.2 Diseases caused by fungi.

4.1.2.1 Dermatomycosis = infection of skin:

Symptoms:

Appearance of wooly greyish white tufts on the affected parts. The fish loses apetite and swims alone on the surface. The diseased fish appear very thin and weak.

Pathogen:

Several species of water moulds are the causale of this disease.

a) Saprolegnia monoica

b) Saprolegnia ferax

c) Saprolegnia parasitica

d) Achlya klinsxualis

e) Leptolegnia cordata

f) Aphanomyces laevis

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Injury and infection:

Between February and May the disease is specially due to the attack by Saprolegnia and achlya species and from May to August, due to the attack by Leptolegnia and Aphanomyces species. The mould can infect only the injured parts of fish. The fungal growth being rapid at 20°C or below. Therefore wintering fish may be easily affected. The under-developed embryos are susceptible to this disease especially when artificial propagation is carried out in early spring.

Prevention and treatment:

Evidence of any sort of mechanical abrasion due to frostbite during winter. Wintering fish must be stocked in wintering ponds as early as possible. Any kind of antipollogistic drugs could be used to heal the wounds of wounded fish. Generally the infected fish are immersed in Malachite green solution (Conc. 1/15,000) for 1-5 mins. The following chemicals could also be used for immersion of fish a 3-3% solution of NaCl - immersion 2-5 mins.

4.1.2.2 Branchimycosis - Gill mould:

Symptoms:

The gills would be infected with mycillia if the disease is acute, and they appear pale red in colour. The body of the diseased fish turns black and the fish perspire with difficulty. They also suffer from serious anemia. Later the gill filaments decay and fall off.

Pathogen:

Branchiomyces sp.

Injury and infection:

Fingerlings of Grass carp, Big head and Mud carp are susceptible to this disease. Specially fingerlings of 5 inch. in body length of Big head and Mud carp are easily affected. The disease breaks out during May and July in ponds where water is fouled up.

Prevention:

a) Cleaning and moistening of ponds are essential;

b) Fertilizers may be applied frequently but in lesser quantity;

c) Freshwater is added if the ponds are too fertile and if this is impracticable it is advisable to stock the fish in a sterile pond.

4.2 INVASIVE DISEASES

4.2.1 Diseases caused by Protozoa

4.2.1.1 Trichodiniasis

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Symptoms:

The disease occurs in the gills and the skin, the gill infection being more serious. The epithelial cells of the gills secrete mucous due to irritation. If the infection is serious Trichodina could be found abundantly on the edge of the gill lamellae. The infection brings about an increase in melanin content on the body surface. The fish may die of suffocation in serious cases.

Pathogen:

Trichodina bulbosa - attacks Grass carp fry

Trichodina reticulva) attacks mud carp fry
Trichodina nigata)

Injury and infection:

Fry of grass carp and mud carp are mostly affected. The disease is common during May and September. Infection usually appears 7-30 days after stocking of fry.

Prevention and treatment:

a) The correct quantity of food is added since any excess brings about fermentation of food and the reproduction of this parasite;

b) The carriers of this parasite such as wild fish and tadpole must be eradicated;

c) A mixture of ash or sulphate and ferrous sulphate in the proportion of 5:2 is found effective at a concentration of 0.7 ppm.

4.2.1.2 Cryptobiosis - infection of gill filaments.

Symptoms:

The disease endangers the fry stage. The diseased fry are weak and thin, the body colour being weak due to by increase of melanin.

Pathogen:

a) Cryptobia branchialis

b) Cryptobia agitata

Injury and infection:

C.Branchialis attacks Grass carp fry and C.Agitata mud carp, fry. The parasite attaches to the gill filaments of the host and brings about its dissolution by secreting toxic substances. Much mucus is also secre from the gill filaments due to irritation.

Prevention and treatment:

Same as for Trichodiniasis

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4.2.1.3 Ichthyophthiriasis - infection of skin and gills.

Symptoms:

White specs appear on the infected areas due minute blister formation. This is seen mainly on the body surface. When gills are infected they turn dark red due to congesting of veins.

Pathogen:

Ichthyophthirius multifilis

Injury and infection:

Several species of fish of different ages are infected. But usually the victims are at the fry and fingerling stage. The common period is between March and April. The disease is mainly due to heavy stocking.

Prevention and treatment:

This parasite can remain viable in water for a period of time and as such after the pond clearance the fry should not be stocked for at least 10 days. The ponds must be cleared effectively. In prevention Mercurous acetate is found to be effective. The fingerlings are bathed in a solution containing 2 ppm. of Mercurous acetate for 1-2 hrs. before stocking. Sprinkling a solution of Mercurous acetatate at a concentration of 0.1 ppm. in the ponds is found to be effective in controlling the disease.

4.2.1.4 Myxobolosis:

Symptoms:

Found in almost all species of freshwater fish, especially in the intestine of Grass carp. In such a case sporocysts are found in the intestinal mucosa. The fish loses its apetite and sto feeding. When gills are infested the body colour turns black due to an increase of melanin.

Pathogen:

a) Myxobolus koi

b) Myxobolus artus

c) Myxobolus tricostatus

Injury and infection:

Victims are usually fry of Grass carp and Common carp, M.artus infects and intestine of Grass carp. fry. M.tricostatus, gills of Grass carp and M.koi infects the skin of fud carp. Grass carp fry are usually infected before it reaches 25 mm. in body length. Infection occurs mainly due to heavy stocking.

Prevention:

Since the spore can remain viable up to a period of 6- the following prev entive measures should be taken:

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a) low stocking density;

b) Hastening the growth of fry by applying the correct quantity of fertilizer and food;

c) Culture in rotation with adult fish;

d) The immediate removal of any diseased fish from the fry pond.

4.2.2. Diseases caused by flat worms (Monogenoidea)

4.2.2.1 Dactylogyrosis

Symptoms:

Brings about disintegration and swelling of the gill filaments. A secretion of much mucous is also seen in the gills bringing about anemia.

Pathogen: a) Dactylogyrus lamellatus) infects Grass carp
b) Dactylogyrus vastator)

c) Dactylogyrus shrjabini) Infects Silver carp
d) Dactylogyrus nobilis) infects Big head

Injury and infection:

The disease is commonly seen in Grass carp. The parasites mainly adhere to the gill filaments and sucks blood thus damaging the gill filaments.

Prevention and treatment:

It is advisable to bathe the fingerlings in a solution of potassium permanganate of concentration 1/50,000-1/100,000. The time of bathing 15-30 mins. The ponds are disinfected with 0.1 ppm. of Dipterex crystals (90%). If dipterex powder (2.5%) is used the suitable concentration is 3 ppm.

4.2.2.2 Gyrodactylosis - infection on body surface

Symptoms:

The epithelial cells of the infected parts mainly damaged. The infected fish shows eating and jumping desperately due to irritation. Sometimes eyes may also be attacked and in serious cases the fish goes blind due to keratitis.

Pathogen:

a) Gyrodactylus ctenopharyngodonis - parasitic on Grass carp

b) Gyrodactylus elegans - parasitic on common carp and Red carp

c) Gyrodactylus hypophthalmichthys - parasitic on Big head and Silver carp

d) Gyrodactylus medius) parasitic on Common carp
e) Gyrodactylus kobayashi)

Injury and infection:

The disease is common during the months of March and April since the reproductive rate of the parasite is rapid during these months. In serious cases the parasite sucks blood from the host's body.

Prevention and treatment:

same as for Dactylogyrosis

4.2.3 Diseases caused by Annelworms (Oestoidea)

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4.2.3.1 Bothryocephalosis

Symptoms:

In the infected fish the first curve of the fore part of the intestine is back curved and full of tapeworms. In such a case the fish are very weak and the occurrence of malignant anaemia is common. Also the head bone of the diseased fish is triangular in shape and the degree of melanotic pigments increased.

Pathogen:

Bothriocephalus rokkonensis

Injury and infection:

The most serious affected is Grass carp. Black carp, Silver carp and Mud carp are also be effected. The development of tapeworm has a corelation with the different feeding habits of Grass carp at different stages. Grass carp of 80 mm. in body length are the most seriously affected as they feed on zooplanktons especially cyclops.

The mortality rate may be as high as 90%.

Prevention and treatment:

Since the life cycle from the egg to the adult stage has to go through cyclops this factor should be taken into account in prevention.

The incubation period of the eggs at 22.5°C is 10 days and the longevity of the cyclops at this temperature is 35 days, the Grass carp fingerlings which are nurtured at 22°C must be stocked approximately after 30 days to avoid the outbreak of the disease.

Calcium oxide 1/2,000 concentration is applied to the pond at 225 kg/mu/metre water depth to kill the eggs. Dipterex crystals at 1 kg/10 kg. of food is used in the disinfection of food.

4.2.4 Diseases caused by Copepods

4.2.4.1 Lernaeosis

Symptoms:

The diseased fish have a large number of Lernaeus adults in their gill filaments. In such cases the gill filaments swell and turns white.

Pathogen:

a) Lernaeus ctenopharyngodontis - infects gills of Grass carp and Black carp

b) Lernaeus polycolpus - Big head and Silver carp

c) Lernaeus undulatus - Common carp and Ctenopharyngodon idellus

Injury and infection:

Cause serious injury to adult fish of relatively large size, especially to Grass carp of 2-3 years old. In the infection the gill filaments are severely injured and undergo dissolution. The blood

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capillaries are also subjected to digestion.

Treatment:

Before stocking the fish are disinfected with Dipterex solution of concentration 1:1000 for 10-30 minutes.

Copper sulphate and ferrous sulphate in a ratio of 5:2 and at a concentration of 0.7 ppm. is used to disinfect the water.

4.2.4.2 disease caused by Lernaea

Symptoms:

Usually occurs on the skin of the fish. The larva into the body and only a part of the body of the worm is seen outside. This brings about bleeding. The seriously infected fish loose appetite and gets emaciated.

Pathogen:

a) Lernaea cyprinacea Attaches common carp and Black Carp

b) Lernaea quadrimaeifera) infects Grass carp

c) Lernaea ctenopharyngodonis)

d) Lernaea polymorpha - infects Black carp and Silver carp.

Injury and infection:

Fry fingerlings and adults may be infected. The parasite secrete digestive enzymes which dissolves the scales of the fish and enables it to go through the skin, and suck blood and body fluids. The wounds thus formed are next subjected to bacterial action.

Prevention and treatment:

a) Prevention of the development of the larvae. For this purpose, Dipterex solution (crystals) is used at 0.2 pp.

b) The fish could be bathed in 10 g of $KMnO_4$ dissolved in water for 10 mins. This process is repeat 6 six times.

c) Improvement of water quality with the application of green fodder at the rate of 400 kg/mu/metre water depth at interval of 7-10 days would suffice.

4.2.4.3 Argulosis

Symptoms:

The worm generally creeps on the body surface and is viable to the naked eye. It can infect the eyes of the fish and in severe cases the fish swims madly in water.

Pathogen: Argulus japonicus

Injury and infection:

By its cunning actions it can cause anaemia in the diseased fish.

Treatment:

Dipterex powder (2.5%) at a concentration of 4 ppm. is used to splash the water in the ponds. If Dipterex crystals are used (90%) the concentration is 3 ppm.

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5. RESERVOIR FISH CULTURE

Reservoirs consist of large water bodies constructed for purposes of agriculture, hydro-electric power and irrigation. They could be divided into three categories - large, medium and small. After 1961 these expanses of water were used for the cultivation of fish. The fish nurtured in ponds or "reservoir coves" up to the fingerling size are stocked in these reservoirs. One of the main obstacles in the stocking of reservoirs with cultured fishes is the presence of predators.

5.1 Stocking of fingerlings.

5.1.1 Selection of stock species:

Fish that have short food chains, and fast growth rates, with minimum or no competition for food are selected for stocking. Good adaptibility to the specific conditions is also called for.

In Kwangtung Province the species of fish stocked in reservoirs are Silver carp, Big Head, Grass carp, Red carp, common carp, black carp, Bream and Wuchang Fish (Megalobrama amblycephala). Of these, the former four constitute the major stocking species.

5.1.2 Stocking density, size and ratio:

Stocking of fingerlings in reservoirs depend on the available food in the water body, and the fluctuations of its hydrological and hydrochemical conditions. The quantity of fish stocked should be in proportion to the quantity harvested.

i) Stocking density ranges from 100 to 400 - 500 individuals per mu

ii) Stocking size of red carp fingerlings over 5 cms. For Big Head, silver carp, black carp and grass carp fingerlings - over 13 cms.

iii) In Kwangtung province Silver carp and Big Head account for 60 - 90% of the total stock and are in the ratio of 2:3 respectively. Red carp accounts for the remainder. Grass carp and Wuchang fish make up to 10% if there is a good Vegetation in and around the pond. Black carp is stocked sparsely since snails are not found in abundance. Common carp and gold carp are put for less than 10% of the total stock.

5.1.3 Stocking methods:

There are two methods of stocking fingerlings in reservoirs.

i) Direct stocking: In this method fingerlings are nurtured in ponds till they attain a size of 10 cms. and are then stocked in reservoirs. It is also called two grade stocking.

ii) Multigrade stocking: In this method fingerlings are nurtured in ponds up to 10 cms. and are then transferred into a small area in the reservoir which is barricaded by an earth bund where they are reared till they attain weight of 0.25 kg. and are released

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into the reservoir. These barricades could also be constructed out of either metal or synthetic fibres.

5.1.4 Stocking in coves: Fingerlings are stocked in coves at a slightly higher rate than to ponds, as the coves are better aerated than ponds.

5.1.5 Fertilization of coves: It is more or less the same as for ponds. Base fertilizer is added one week before stocking. Rice bran and pea nut bran cake are added into 'floating trays' made of bamboo. For nurture of 10,000 fingerlings from 5-13 cms. size 2,000 to 4,000 Kg. of green fodder and 150 to 200 Kg. of fine food may be used.

5.2 Catching of fingerlings: Two to three days before catching feeding is stopped. They are either caught by luring them to a fixed location where feeding tray is set or by driving into a standing net out. This is accomplished by making sounds. Retreat is prevented by using screen nets.

5.3 Elimination of predatory fishes and birds: Prior to stocking fingerlings in reservoirs action must be taken to eliminate predatory fishes and drive away pernicious birds. The former comprises of Elopichthys bambusa, Siniperca chautsi, Erythroculter ilishaeformes, Ophiocephalus argus, Parasilurus asotus, Pseudobagrus fulvidraco, Hemiculter leucisculus and Clarias fuscus etc. These could be eliminated by drawing nets. The latter is eliminated by destroying their nests in vicinity of the reservoir.

5.4 Fishing in reservoirs:

A rational fishing operation is carried out by considering the quantity and size of fish at the proper fishing period using proper gear. The fishing quantity depends on the reproduction rate of fish. Overcatching and undercatching should be avoided and catching and stocking has to be done in rotation.

The fishing period is selected at a time when the fish has attained maximum size, utilizing all the available food and when the pernicious influence is minimum.

Catching of fish is done immediately after they reach their first sexual maturity. The optimum age composition of silver carp, Big head and common carp with respect to catching is 3-4 years, and that of Grass Carp and black carp 4 years, while for Mud carp is 3 years.

5.5 Fishing methods:

The common methods of fishing in reservoirs in Kwangtung Province are Beach seine, Purse seine, Drag nets and standing nets.

standing net is the latest method used in China. It is consisted of two converging nets, a bag form net and bag net. At first, fish are driven into a certain area by setting nets but is not to prevent retreat. The bag net is fixed at a suitable distance away from the screen net and guide nets are laid from the screen net to the mouth of the converging nets. Fish are driven into the bag net by making various sounds at the surface and under water. Finally, the fish are scooped out of the bag net.

The trainees were taken to Kao Ling county in Kwangtung Province to observe the catching of fish by the standing net method in a reservoir. The entire operation in all its stages was shown and explained to the trainees. The catch on this particular day amounting to a little more than five metric tons.

Farm Classification

For the convenience of study, fish-farms in the mainland China can be categorized into three types, depending mainly on the purpose of production:

1. General fish farms:
   In these farms "complete - culture" is practised generally. This is comprising of the culture of breeding "stocks", artificial reduction of fry by pituitary treatment, nurture of fry and fingerlings and rising them to the market size.
2. Fry farms:
   Large scale production of fish fry and distribution of them among the fish farmers is the sole purpose of fry farms.
3. Experimental fish farms:
   Scientific experiments and research are being carried out with the aim of increasing production, through solving the problems which come across during practice.

Section 1 Selection of a site.

Before undertaking constructional work a suitable site should be selected. Following are the important factors to be considered:

a) Water source and water quality: A continuous supply of unpolluted good quality water is of prime importance;

b) Soil quality: Soil influence the growth of fish. Of all the soil types loam soil is the most preferable, for engineering work, fish culture, and also a good bottom. Wedge form is suitable for the construction of dykes.

c) Topography: Due consideration should be given to topographical and transport facilities.

Section 2 Planning:

Planning should be done according to the topographical conditions of the locality in an economical manner. Depending on the degree of production and site, the size, allocation of land and rational arrangement of land should be practised.

Overall disposition of buildings, spawning pools, incubation pools, fish ponds, etc., should be for easy management.

Section 3 Designing:

a) Spawning pools: Usually circular in shape. Depth 1.5 m. and diameter ranges from 6-10 m. Always the egg collecting pools are constructed adjacent to the spawning pools. Generally the dimensions taken as 10 x 3 m. and the bottom of it should be 30 cm. below the bottom of the spawning pool.

b) Incubation pools: There are three different types of incubation pools namely, circular incubation pools, single circular incubation pools, and semicircular incubation pools.

c) Stocking ponds: The size and the depth varies according to the type of fish culture size, fry culture, fingerling culture etc. For all rectangular shape is suitable with a ratio of 2:1 or 3:2. Ponds should be orientated so as to get the maximum amount of sunlight. The ponds which serve the same purpose should be of the same size for convenience of management.

d) Supply and drainage systems: For healthy growth of fish water should be kept fresh all year round. This water should be supplied and drained whenever necessary.

i) Inflow channel:

This may include the following three kinds:-

A. Main channel supply to the whole fish farm.

B. Secondary channel supply to two different areas.

C. Branched channel - supplies the individual ponds.

Calculation of required rate of flow in a channel:

The required rate of flow is given by the following equations:

$$\text{The desired rate of flow of water in the channel} = \frac{A \times W}{D \times H \times 3600}\ m^3/sec.$$

A = Total area of all the fish ponds which are to be supplied by this channel (m^2).

W = Average water depth (m)

D = Duration in days for water supply

H = Hours of water supply per day.

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Average depth of water (m)	0.4	1.0	2.0	More than 3.0
Loose clay	0.55	0.4	0.40	0.50
Moderately Solid Clay	0.70	0.85	0.95	1.10
Solid Clay and Clayey loam	1.30	1.20	1.40	1.50
Moderately solid	0.60	0.70	0.80	0.85
Turf Slope	1.50	1.80	2.00	2.20
Bricks with Cement Milk	1.60	-	2.30	2.50
Stones or rocks with Cement Milk	2.90	-	4.00	4.40
Wodden Channel	Less than 2.50	-	-	-

TABLE - 2

THE MAXIMUM PERMITTED AVERAGE VELOCITY IN FPS IN AN UNLINED CHANNEL FOR

SOILS AND SURFACE CONDITIONS.

Practically always, leakage and seepage are encountered and the loss is 10-30% of the total. Especially in sandy loam the loss from seepage amounts to 25-30%. Thus an average value of 1/3 is usually taken. Therefore the required rate of flow in the channel $= \frac{\text{Desired rate of flow}}{1 - P_L}$

where P_L is the percentage of loss.

Safety speed of flow:

According to the type of soil and erosion protection speed of flow should be regulated. The following table gives the detailed figures.

Gradient of the channel:- Table II

According to investigations, the following are the suitable gradients:

Branched channel - 1/300 - 1/750

Secondary channel - 1/750 - 1/1500

Primary channel - 1/1500 - 1/3000

Cross section of the channel:-

If the channel is made of bricks or of stones usual shape of the cross section is rectangular, but if it is earth the shape should be trapezoidal.

Cross sectional area is given by the following equation:

$Q = V \times W$

Where, Q = Rate of flow (m^3/sec.)

V = Flowing speed (m/sec.)

W = area of cross section (m^2)

The height of the channel should range from $\frac{1}{2}$ - 2/3 of that of the breadth.

ii) Inlet channel:Generally the inlet is open trough shaped or an underground pipe made of bricks or cement. The water flow is regulated usually by wooden planks.

iii) Outlet: The following speed of the outflow channel should be considered in determining the size of the outlet.

iv) Outflow channel: Designing and other requirements are same as for the inflow channel. The outflow channel should be 50cms. below the pond bottom. The area of cross section should be larger than that of the inflow pipe.

v) Flow preventing dykes: Fish farms which are located by the side of the river or lake should have flood preventing dykes. The dyke should be higher than the maximum water level of the river.

Section 4 Landing lotting: Before starting construction work lotting out of the land should be done.

a) Plane lotting: At first demarcating lines are marked on the

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according to the design. Correct orientation and positioning is essential.

b) Section letting: In section letting the framework of the dyke should be constructed according to the design.

Section 5 Construction:

a) Ponds: In the construction of ponds usually, the volume of earth excavated will account only a very small percent of the total volume. Depending on the specific conditions of the soil, digging should be done.

b) Dykes: After clearing the foundation side, the soil should be removed up to a depth of 15-20 cms. It should be filled with good quality soil. Construction is done layer by layer. A layer of 25-40 cms. should be raised down to 15-20 cms.

Water content of the soil used for construction should neither be too high nor too low. Construction of inlets, outlets and underground pipes should be carried out simultaneously. After the construction of the dykes the strength should be checked.

c) Channels: Always digging is done from lower position to higher position. Digging can be done in two ways - lengthwise and breadthwise.

Conclusion

Freshwater fish culture plays a major role in the implementation of the crash programme for the development of inland fisheries in Sri Lanka. Sponsored by FAO/UNDP and hosted by the Chinese government the above training program forms an integral step in the realisation of this project. As Sri Lanka still lacks sufficient stocks of fast growing, large sized culturable freshwater fish, the introduction of Grass carp and Big head into her inland water bodies would narrow the gap of protein deficiency among the broad masses of the country.

The techniques of artificial propagation and fish culture in Kwangtung Province could be applied in Sri Lanka for the following reasons:-

1. Sri Lanka is a tropical country with a climate most suitable for an uninterrupted propagation and culture of the above type of fish, and therefore the knowledge gained could be used most beneficially for the development of freshwater fish culture.

2. Favourable results in artificial propagation could be obtained as most of the available water are unpolluted and their option temperatures are constant throughout the year. Fluctuations are negligible.

Simple and inexpensive techniques were used in artificial propagation, and these methods could easily be applied in our country. In the nurture of the fry and fingerlings, freely available rotten vegetables

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and leguminous plants could be applied to ponds in order to promote the growth of plankton. Very little artificial food need be used. As plankton is cultured in the pond itself, water is stagnant and hence these ponds require very little water for replenishment. This is economical because constant replenishment or running water require the working of water pumps and is also labour consuming.

In the polyculture of adult fish, maximum utilization of the different food habits of species could be made use of. The bighead and grass carp could be stocked with the very abundantly found silver carp in some ponds. The former feeds on plankton whereas grass carp feeds on tree fodder and Tilapia on detritus. Therefore there is no competition for food.

Fingerlings could be stocked in all the water bodies of the country, and this would increase the fish potential in them. It would be possible to prevent the outbreak of any fish diseases by making use of the knowledge gained from this course. Apart from these, the method of training fish before transport could be used for the transport of fry and fingerlings of freshwater fish and brackish water fish.

We feel that this training program is most beneficial to a country like Sri Lanka which has to base all her new projects on an economic footing.

General Comments

The training course, was conducted in an atmosphere of sincerity and friendship. The teaching staff and the workers were most keen to impart to us all that they knew on the subjects concerned. The staff of the training institute, lecturers and the workers joined us in all the practical classes.

Combining theory with practice was stressed at all times, and sometimes practice on artificial propagation was repeated till we mastered the various techniques. It must be mentioned here, that the workers extended their unstinted support at all times during practice. Friendly discussions were held in the lecture room and on the field in which lecturers and workers participated.

During study tours, efforts were taken by the training staff to place before us all available data relevant to the subject. Interpretations of lectures were good. All lectures had been translated in advance and the interpreters always had the particular lecture in Chinese and its english translation by his die during lectures.

Interpreters were available at all times after lectures to help us discuss any problem with the lecturers. Most of the interpreters were young, and still showed much skill in the interpretations and translations.

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