PROSPECTS AND PERSPECTIVES OF PROPAGATION OF TROUT CULTURE IN KASHMIR

IRSHAD AHMAD
M. Sc. (FISHERIES MANAGEMENT)

CENTRAL INSTITUTE OF FISHERIES EDUCATION.
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
VERSOVA, BOMBAY - 400 061
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PROSPECTS AND PERSPECTIVES OF PROPAGATION OF TROUT CULTURE IN KASHMIR

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IRSHAD AHMAD

Under the Guidance of

Professor P.ACHARYA

CENTRAL INSTITUTE OF FISHERIES EDUCATION
(Indian Council of Agricultural Research)
Seven Bungalows, Versova
Bombay - 400 061
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IRSHAD AHMAD
CERTIFICATE

This is to certify that IRSHAD AHMAD a student of M.Sc (Fisheries Management), CIFE, Bombay has worked under my guidance for preparation of this dissertation entitled "prospects and perspectives of propagation of trout culture in Kashmir" towards partial fulfillment of M.Sc (Fisheries Management) degree course of the University of Bombay. The work embodied in this dissertation is genuine & original and has not been submitted elsewhere earlier. The candidate has fulfilled all the formalities as required under the status of the Institute before submission of this dissertation.

P. ACHARAYA
SCIENTIST
C.I.F.E.

17th April, 1989.
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CHAPTER - 1.0

INTRODUCTION

From fisheries point of view waters of temperature falling within tolerance limits of trout belonging to the family salmonidae are termed as cold water. In India, however, besides trouts some of the cyprinides of the sub family cyprininae are also included in cold water fishery. The examples of some of these fishes which are widely distributed both in Himalaya and the Peninsular plateau are snow trouts, mahseer, common carp and mirror carp. No doubt, these species are important as sport and food fishes. According to the capacity of temperature tolerance cold water fishes may be distinguished as eutermal (having tolerance of a narrow range of temperature). On this basis Schizothorax plagiotamus, Cyprinus carpio and Barilius bengalis chedra fall under Euthermal catagory. On the other hand the brown trout (Salmo trutta fario) and Eastern broolr trout (Salvelinus fontinalis) are examples of semithermal species which tolerate narrow ranges of temperatures.

The occurence and distribution of cold water fish in addition to temperature are also dependent upon the swiftness of current and the nature of substratum including the plant
and animal communities available in the lake/river/stream beds. Majority of cold water fish are equipped with structures especially adopted for clinging, borrowing or otherwise for withstanding and living in fast water currents from the hills. The cold water fish are ill adopted for feeding in deep and muddy water. Owing to richness of water in its oxygen content the gill openings of the coldwater fish are narrow and number of gill lamellae are greatly reduced so much so that the fish can not survive for long in poor oxygenated water. In India, majority of cold water fish do not form any fishery of commercial importance. However, a few of such viz, snow trouts, (Schizothorax spp and Schizothoraicthys spp) common carp (Cyprinus carpio spp) and few minor carps (Labeo dero and Labeo dyocheilus) are now gaining little commercial importance as food fish in the up-lands. An another, aspect of cold water fishes of up-land is that some of these species mainly provide sports to the visiting tourists. In certain regions of India particularly in Kashmir, sport fishes form an important attraction for tourists to provide the state with revenue.

For trouts, the tolerance range of temperature is between 0°C to 20°C. The most favourable or optimum range of temperature is between 10 to 12°C. Cold water fishes require high oxygen, low carbon dioxide in organic soil, sparse vegetation and protien food. The waters which are
most abundant in trouts are characterized by clear, transparent and shallow waters. The streams which contain silt in large quantities are disliked by the trout fishes. The silty bottom is not favourable for trouts because silt choaks the gills of young trouts and destroy trout eggs in nature.

Kashmir is rightly and appropriately called as "Anglers paradise". The streams of the valley which have slow gradual elevation unlike very stiff elevation, are favourable to trouts. The stiff elevation of land takes more energy of the fish in movements for negotiating torrents and rapids. The valley of Kashmir probably provide many favourable conditions for growth, sustenance and propagation of trouts. The trout, is an excellent game fish and has been introduced in cold waters of Kashmir and other northern and southern hilly states of India like Himachal Pradesh, Sikkim, Arunachal, Meghalaya, Nilgiris, Kodai and Munar hills, for well establishment in the stream waters having temperature ranges from 0 - 20°C. In Kashmir a number of hatcheries have come up since long and sizeable quantity of trout seed is being produced therefore for stocking the cold water natural streams and reservoirs. But extensive areas need further development and stocking with trouts at their young stages of lives. Although trouts breed naturally, owing to their poor survivility from eggs to
adult stage, and also for enormous angling pressure for catching them, the stocks need continuous replenishment. Angling trouts is one of the major sport and recreation activity practised in Kashmir since more than last 80 years. In fact, one of the main attraction of tourists in Kashmir is to go for angling of trouts in the streams. Not only for sports and recreation establishment of cold water fisheries is also necessary for the production of proteins for the people of valley. In fact, Kashmir is one of the coldest part of the country and there is need to provide more protein for the inhabitants of the valley. Propagation of cold water fishery no doubt will help in proper utilization of all water resources, generate more money, more protein and attract more tourists to visit this valley which are the most steady source of income for this state. This aspect requires to draw more attention of the Government.

Considering great demand for sport as well as for table, the National Commission of Agriculture (1971) recomended improvement in trout hatchery practices for increasing survival rate of its seed, to enable stocking in existing trout streams and for expansion of trout fishing areas of J & K and other high altitude waters. The commission also recommended development of breeding and hatchery practices for production of seed for
undertaking commercial trout farming in suitable cold water areas. As a result the state Government initiated a pilot project on commercialisation of trout at Kokernag with the Assistance from Denmark. It is hoped that with the functioning of this project which has started recently the gap of seed supply not only within the state but also for the other states will be fullfilled. Augmentation of Reasearch and development activities for standardization of improved trout culture techniques, evolving pellated feed, and management on scientific lines are some of the immediate needs to be undertaken for the benefit of local population who are mostly poor and deficient in protein. Modern trout culture practices also require to be manned by trained workers with ample knowledge concerning construction of trout hatcheries and ponds, their management, hygeine and also in economics. For Technology Development CIFRI initiated research works on incubation of eggs and rearing of young trout in dry formulated pelleted feed since 1968. The work is still continuing and changes in the techniques are being made (up-graded) keeping in pace with the demand of the present requirement, facilities and availibility of technical knowledge. Some of the results of these research and developmental activities have been adopted in most of the hatcheries commercially. Shegal et al (1974) demonstrated that flushing of hatching troughs with malachite green in the ration of 1 : 200,000 for 30 minutes
results in a very high rate of survival. The cumulative percentage of survival from green egg to swim up fry resulted in as high as 94.9%. The techniques followed by these authors are now being applied on commercial scale in all trout forms of Kashmir. In this way the rate of survival during incubation has considerably improved. The experiments on trial of dry, compound and pelletised feeds are extremely encouraging. Once such feeds are standardised it will be a break through for commercial farming of trouts in the country. Co-ordinated well planned project by the state government in collaboration with other fisheries organisations/universities and research institutes will definitely help in developing cheap and easy to adopt technologies so as to increase the trout fishery and meet the growing demand for proteins as well as for anglers visiting as tourists to this state. The need for standardization of improved trout culture techniques, evolving of pelleted feed and management of nurseries, rearing of Juveniles are the immediate requirements to meet the challenge of propagating and popularisation of trout culture in the Kashmir valley. This dissertation is an attempt to gather, analyse and disseminate the information on. The perspectives, state of art of trout fisheries of the present decade and its future prospects in the valley of Kashmir for use as base line information.
CHAPTER 2.0

ORIGIN OF TROUT CULTURE:

In China trout culture was in practice in a very simple form. To collect the sticky eggs of trouts, Chinese fish farmers in remote past used to place faggots and mats attached to posts in streams. Attached eggs were transferred to other waters for hatching purpose. Later on trouts were introduced in Japan where many additional varieties originated.

In the fourteenth century French monk succeeded in artificial fertilization of trout eggs. However, his claims has been looked upon as doubtful by many who believe that trout eggs have spawned naturally. Thereafter, centuries passed without any progress untill during 1963-1964 Lieutenant stephan Ludwig Jacobi described in details his method of taking the eggs of female and the milt of male, mixing together in water. After fertilization the eggs were buried in gravel and placed in a box with fine frame of parallel wooden or metal bars at the both sides. The box was then anchored in a stream under clear running water.

After the above said stephan experiment, no further attention was paid to trout culture for a long period. Thereafter, two ignorant fisherman Joseph Remy and Antonie Gebin who depended upon the culture of trout in the streams
of Vosgues Mountains took upon the work. As they felt
decrease in trout population in the streams, they started doing
work in their (trouts) natural habitat especially during
spawning season. So assiduously did they pursue these
observations. It is said that in one instance during full
moon phase they kept watch on a school of trout
continuously on their natural habitat for four consecutive
days and nights. However, their works have not been
published. The most noteworthy contribution to trout
culture made during this period was by a Russian who developed
dry, method of fertilizing eggs. This method was developed
by V.P. Urasstri in 1856 but was not published until 1871.

Rainbow trouts are native of the Sacraments river
region on west coast of United States of America but have
been successfully introduced into the water of many other
countries. Brown trouts are native of European waters
and are now a days widely distributed in other countries.
Both the species belong to family salmonidac under order
Isospondyli (equal vertebrae).

In India although there are large number of rivers
and lakes suitable for trout culture. Up to this time only
5780 kms of streams of different states have been brought
under the trout culture system.

The introduction of trout in India was attempted in
the years 1899 first by Mr. F.J. Mitchell who tries to obtain
a consignment of eyed eggs of brown trout (*Salmo trutta fario*) from England. But his attempt failed because of nonavailability of cold room in the ships on the way to India. (In the year 1900 A.D. F.J. Mitchell again tried and was successful in bringing the eyed eggs of the same fish from Howeittonin in Scotland. The swim up fry from these were successfully reared up to adult hood and the first spawning of the brown trout was done in December 1905 at Harwan 20 kms from Srinagar (Kashmir). After this initial success some more successful attempts were made in 1902 and 1904 in transplanting trouts to Harwan from England. In the year 1905-1906 F.J. Mitchell succeeded in establishing a regular trout hatchery at Harwan having a capacity of producing and rearing 100,000 green cons.

It was from Kashmir that eggs of Brown trouts were transffered to other cold parts of the country like Kulu, Simla, Nanital, Shillong etc. (After the success of Brown trout Kashmir, the successful attempts for transferring rainbow trout (*Salmo gairdneri irideus*) in to Kashmir was done in the year 1904.) However, the success of hatching of the eyed eggs of rainbow trout (*Salmo gairdneri irideus*) could be achieved by Mitchell only in (1912).

During past two decades, three other species of Salmonides viz, eastern brook trout (*Salvelinus fontinalis*), hybrid between lake trout and brook trout, bothe from Canada and land locked variety of Atlantic salmon
(Salmo salar) from North America have been transplanted into trout hatcheries of Kashmir. The above salmonides were received as gifts from diplomatic missions of Canada and United States of America to India (De Mellow 1969)

Kashmir is one of the coldest part of the country having a temperature range between 1°C to 25°C favourable for trouts. This beautiful state is situated in the sub tropical North temperate region of Asia between 32° - 37°N latitude and 73° - 80°E longitude. A valley surrounded by high mountains of Himalayas which vary in heights between 1000 ft to 18000 ft above mean sea level. Total area of the Kashmir valley is 8540 sq miles. Most of the water is cold fresh and running which make it suitable for trout. The valley is surrounded at the North end by Republic of China and Turkistan, on the East by Chinese Tibet, on the South by Punjab and Himachal Pradesh and on the West by Pakistan and Afganistan. On the basis of the climatic condition of the state, this state may be divided into three agroclimatic zones which are as follows:

1. Temperate zone:— Entire Kashmir province comes under this zone

2. Tropical zone:— The Jammu province of the state belong to Tropical zone
(3) Alpine zone:- Ladakh and Kargil which are 2000 meters above mean sea level and most of the time remains under very cold temperature] East of these zones have their own type of fish fauna. The fish of Kashmir differ in many respects with those of other plain areas because of the climatic conditions] According to a survey conducted by fisheries department the fish which inhabits the waters of Kashmir valley are as follows:

**Table 1. Fish of Central Asiatic origin.**

**Family:** Cyprinidae.

<table>
<thead>
<tr>
<th>Schizothorax</th>
<th>Progastus</th>
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<tr>
<td>Schizothorax esconicus</td>
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</tr>
<tr>
<td>Schizothorax micropogon</td>
<td></td>
</tr>
<tr>
<td>Schizothorax planiformes</td>
<td></td>
</tr>
<tr>
<td>Schizothorax Hugeli</td>
<td></td>
</tr>
<tr>
<td>Schizothorax punctatus</td>
<td></td>
</tr>
<tr>
<td>Schizothorax nasus</td>
<td></td>
</tr>
<tr>
<td>Schizothorax longipinnis</td>
<td></td>
</tr>
<tr>
<td>Schizothorax curvoformes</td>
<td></td>
</tr>
<tr>
<td>Schizothorax niger</td>
<td></td>
</tr>
<tr>
<td>Ptychobarbus conirostris</td>
<td></td>
</tr>
<tr>
<td>Diphythychus maculatus</td>
<td></td>
</tr>
<tr>
<td>Schizophygopsis Stolizree</td>
<td></td>
</tr>
<tr>
<td>Orienus plagiostoma</td>
<td></td>
</tr>
</tbody>
</table>
Family: Sisoridae

Glyptothesox
Glyptosternum

Family: Cobitidae.

Nemacheilus
Nemacheilus
Nemacheilus
Nemacheilus
Nemacheilus

(2) Exotic fishes:

Family Salmonidae

Salmo trutta fario - (Brown trout)
Salmo gairdneri - (Rainbow trout)
Salmo salar - (Atlantic salmon)
Salvelinus fontinalis

(3) Family Cyprinidae

Cyprinus carpio communis
Cyprinus carpio specularis

(4) Family: Poecillidae

Gambusia affinis
In Kashmir, the trout fishery was started in the snow-fed and spring fed streams, lakes and rivers. Till today about 1581 kms of streams have been stocked with trout fingerlings, work on bringing more stream waters and other areas under trout culture are on progress. Recently a joint project namely Indo- U.K. trout project has been started at Kokernag (Kashmir) with the objectives to survey the area and increase trout culture not only in the Government sector but also the project emphasise increases of the interest among the private enterpreneurs.

The name of important snow fed, (a) streams (b) springs and lakes having, trout population are given below:

Table 2.

1. Lidder valley stream
2. Sindh valley stream
3. Bringki valley stream
4. Madumati valley stream
5. Kishen Ganga stream (Gurez)
6. Rambiara Stream
7. Romeshi Stream
8. P erozpore Stream
9. Sasra Stream
10. Pohru Stream
11. Hamal Stream
12. Dachiaram Stream
b) Important trout bearing springs:
   (1) Verinag Spring
2. Kokernag Spring
3. Kotsu Spring
4. Achabal Spring
5. Vishno Spring

c) Important trout bearing high lakes.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name</th>
<th>Height (above m.s.l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kounser nag</td>
<td>13500 ft above m.s.l</td>
</tr>
<tr>
<td>2</td>
<td>Gangabal</td>
<td>11720 ft above m.s.l</td>
</tr>
<tr>
<td>3</td>
<td>Krishensar</td>
<td>12500 ft above m.s.l</td>
</tr>
<tr>
<td>4</td>
<td>Vishensar</td>
<td>13750 ft above m.s.l</td>
</tr>
<tr>
<td>5</td>
<td>Sheshnag</td>
<td>12500 ft above m.s.l</td>
</tr>
<tr>
<td>6</td>
<td>Tarsar Marsor</td>
<td>11900 ft above m.s.l</td>
</tr>
<tr>
<td>7</td>
<td>Nankhul</td>
<td>12450 ft above m.s.l</td>
</tr>
<tr>
<td>8</td>
<td>Shesh Suv</td>
<td>1250 ft</td>
</tr>
<tr>
<td>9</td>
<td>Nat n Suv</td>
<td>1270 ft</td>
</tr>
</tbody>
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CHAPTER 3.0

MANAGEMENT OF TROUT HATCHERY

Artificially propagated trouts are the rainbow trout *Salmo gairdneri*, the steelhead, the cutthroat trout *Salmo clarkii*, the Eastern brook trout or *Charr salvelinus* the lake trout or *Cristivomer namaycush*, and the European brown trout *Salmon salmosalar*.

Regarding the management of trout, one of the most important requirements is the quality water. Trout water should be pollution free, cold and well aerated. However, rainbow trout and brown trout can tolerate a temperature of (29.44°C). The trouts deposit their eggs in pockets in gravel, are fertilized by the male at the time of deposition. At the time when water seeps through the gravel. The eastern brook, rainbow and cutthroat may spawn in lakes. The spawning season in trout varies in different localities depending upon temperature.

Flow rate

For successful management of trout fishery, it is important to know the flow rate of water source particularly the maximum and minimum flow rates. It is imperative to mention that minimum and maximum flow rates occur during drought and flooded conditions respectively in any flowing water. It is easier to know about the flow rate of farms that are already existing than in the newly constructed
because it requires monitoring for a long period.

Government should have flow rate data of the various
flowing water stretches and (should extend information to
commercial fishermen, anglers and farmers on requests.)

Rate of surface flow may be obtained measuring out
the length of river and plotting mark at each point. A
float is thrown at the starting point and the time it takes
to reach other end is noted from a stop watch. The quantity
of water passing through the stream can be calculated through
the known dimension of the vertical wall fitted with gauge.
This gate be obtained by placing a flat plate on the bed of
the out flow and holding with sand bags which are built
to make more or less vertical wall or either side of flow.
This method can be adopted to record total flow running
over an area of known dimension. Formula given below may
be used to calculate the flow of water in Cubic feet
per second on a given spot.

\[ R = \frac{WD \alpha L}{T} \]

Where

- \( R \) = Flow volume in cubic feet per second
- \( W \) = Average width of stream in feet.
- \( D \) = Average Depth in feet.
- \( \alpha \) = Constant factor for bottom type which are 0.9 for
  smooth sand etc. and 0.8 for rough rocks etc.
L = Length of stream section measured.

T = Time in seconds for objects to flow the measured distance. Velocity of flow in feet per sec in a feeding channel may be calculated by using the following formula

\[ V = \frac{ga}{d} \]

Where;

\[ V = \text{Velocity in feet/ sec}, \]
\[ g = \text{gallons per minute}, \]
\[ a = \text{Constant factor (0.408)} \]
\[ d = \text{diameter of water channel in inches}. \]

The basic consideration to be given before construction of a farm is that the farm should not face water scarcity, at the same time it should be so constructed that it does not get overflooded due to heavy rain or snow melting in the upper region. An arrangement of artificial aeration has to be kept at hand, in a farm, to cope up with low flood situations. It is important to remember that the volume of water available, limits the number of ponds or other culture facilities hence places a limitation on the total output of farm in tonnage.

One of the most important factors ment to water supply for a trout hatchery is the temperature. If it is spring water temperature range of water should be between 7.22°C to 12.77°C. Which is most suitable for trout rearing. In most of the trout species temperature between 8.86°C and 11.11°C re preferable. Eastern brook
and cutthroat trouts being little more tolerant to temperature changes may give better results.

If water comes from a stream then it depends upon highest summer and lowest winter temperatures. A maximum temperature of 15.55°C to 18.33°C in summer should be considered not suitable.

WATER QUALITY

As good flow of water is important for trout rearing so is the quality of water. Trouts require best quality pollution free water for survival. If water is neutral or slightly alkaline (as in case of Indian major carps) and pH very between 7 to 8 is considered to be optimal for trout culture. The acid waters having pH below 6.0 should be avoided.

The spring waters are frequently deficient in Oxygen and high in Carbon dioxide. Installation and use of an efficient aerating device may help to cope up with this situation. If water contains hydrogen sulphide or other obnoxious gases that will surely affect the trout culture. Spring waters may have high nitrogen content but are harmless until the water emits gas bubbles, which generally cause fish disease.

The effect of mineral content in the trout water is very limited. Some springs having rich in lime and calcium content have been found to be good for successful trout
hatcheries. For example under U.S. Fish and wildlife service at Lee town, West Virginia, the water spread has a total hardness of 509 parts per million (Scurber 1935) constituted mostly by calcium carbonate. In spite of this the water is showing success in rainbow trout hatchery. However, eastern brook trout and brown trout do not show much success in this water.

Iron probably is not directly harmful to trout. However, in waters with high iron content, iron (when precipitated by direct oxidation or by iron bacteria) do harm to the trout fishery springs in Rocky mountains and states on the pacific coast frequently have their source in volcanic rocks. Such springs are highly mineralized but have been very successful for rearing trout to good sizes for stocking and for commercial purposes. In some places where water works supply water to cities, results of chemical analysis of water may be available. In places where these informations are not available, some water can be piped into a test tank with a few trouts in it to observe their performances.

Borehole water may be super saturated with nitrogen to cause gas bubble disease if used directly. In such cases water should be used sufficiently aerated to eliminate nitrogen before use.
OXYGEN

Water temperature has very important effect on its capacity to hold oxygen. Water containing as much as oxygen it can hold is said to be fully saturated. As the temperature increases, the quantity of Oxygen that can be dissolved in water decreases so that while fully saturated water at 4°C contains 12.86 ppm dissolved oxygen at 20°C it will contain only 9.00 ppm because warm water holds less oxygen than cold water. Both rainbow and brown trout requires a minimum saturation level of 6 ppm. The saturation level of water is also affected by altitude, less oxygen being present in water at high altitudes. Roughly a drop of 0.5 ppm should be allowed for every 300 meters increase in altitude.

During warm weather, the water flow is least and fish are more actives taking more food and more oxygen. Oxygen is also consumed by decaying organic matter. Decay of waste food excreta causes more oxygen deficiency. Summer is the time for proliferation of algal (algal blooms) and other water plants that produce oxygen during day time but absorb it at night when they are unable to photosynthesize.

During summer oxygen level of water may fall to such a low level that fish get asphyxiated. If at such times water flow can not be increased, artificial aeration should
be resorted to and the stocking density of trout should be reduced.

SITE SELECTION

In selecting the hatchery site, the extent and topography of the area available for construction of hatchery requires special consideration. Site for the construction of pond and building should be determined depending on local conditions. For successful operation of hatchery the selection of site should be below that of spring. The source of water should not be less than ten (10) feet above the hatchery site and any elevation above this is most dangerous.

There are many advantages in locating hatchery near the source of the water. In such cases better control can be exerted on the flow and requires short pipe line which lessens the expense and decrease the chances of accidental short fall.

For the construction of ponds and race ways the site should include an area of adequate size with a gradual slope in one direction. The slope will provide better drainage. The volume of water which must circulate through hatchery ponds should be so large that only a small percentage of water is absorbed unless soil is exceptionally porous.
DISTRIBUTION OF WATER

In planning a hatchery, allocation of water supply in right proportion to the various components of the hatchery complex round the year plays an important role. For well balanced hatchery proper supply should be assured for each operation, when needed. Once the amount of water required to operate the tanks, race ways and ponds and their dimensions are known the proportional supply can be maintained by regulating the inlets and outlets within a narrow limit of variations, at different times keeping in view of the available total supply at that time.

SOURCES OF WATER SUPPLY

If the water comes from flowing spring a small concrete reservoir should be build adjacent to the source of supply and pipe line should be laid from source to the hatchery. The reservoir should be surrounded by a low wall to prevent entrance of surface water and should be provided with a spill way to allow overflow of surplus water. If the water supply is derived from a stream, a low dam will be required to form a small pool from which water can be drawn. In case the supply is from a stream it will also be neccessary to take precaution to prevent fish from getting into the supply line and causing serious complication in the hatchery. This may not be necessary where spring water is used. In many instances it is necessary to filt the water before taking into the hatchery to remove sediment and debris. In modern trout hatchery this is a must, particularly when
water is drawn from a stream. Sand filters are ordinarily used for this purpose. In some instances more expensive and more complicated filters have been installed. When the water flows directly into ponds and raceways filters are desirable.

**HATCHERY BUILDING:**

Hatchery buildings to contain troughs for incubation of eggs and also concrete tanks for rearing of advanced fry and fingerlings is the most important component of a trout farm. The hatchery building may also contain a cold storage and also feed rooms where meat is ground and mixed with other constituents of diet (to prepare formulated feed). At Kokernag fish farm in Kashmir such facilities are existing and the hatchery troughs are the most important component in which eggs are incubated and hatched. The standard trough used at federal hatcheries is 16 feet long, 14 inches wide and 6½ inches deep. The troughs are usually constructed of cypress or red wood of 1½ to 2 inches thick but recently aluminium and concrete troughs are used. Aluminium troughs have been found to be satisfactory in use. Concrete troughs being heavier than wooden or metal are not good for satisfactory use.

The troughs have supporting framework at convenient height from the floor and the upper end from which water
enters is slightly higher than the foot region. The hatchery is provided with a drainage system. A wire screen is usually placed across the trough a few inches from head end to prevent fish from attempting to leap from the trough, when water enters. A spill way built at the lower end prevents overflow. A better method is to use a pipe screwed into opening in the bottom of trough between the screen and the end of the trough. The water some times carried to the hatchery through an open trough from which a pipe leads to each trough but better practice is to carry water in pipes. This allows the water to enter the troughs under pressure ensuring better aeration. When spring water is used an aerator at the head of each trough is ususally essential, according to shaw (1936) that those aerators which cause a thin sheet of water into the trough under pressure. The troughs are usually set up in pairs, one below the other however in some hatcheries several troughs are arranged in series. The first trough is always at a higher level than second in line. Each trough should have its own drainage. At many hatcheries in addition to the hatching troughs, larger troughs or concrete tanks are provided to which fry and fingerling can be transfered when hatching troughs become over crowded.
Fig. 1. Interior view of Wizard Falls Hatchery, Oregon State Game Commission. Photograph by Joe Van Wormer.

Fig. 2. Hatching troughs arranged in pairs with supply pipes at upper and drainage pipes at lower ends. Fine-meshed wire screens are installed a short distance from each end.
In Kashmir, a trout hatchery consists of stock ponds, breeder ponds, rearing ponds, nursery ponds and ova house. In the nursery and nearing ponds fry and fingerlings are reared. These ponds are cemented long rectangular channels or race ways where as stock ponds may be Kutchas.

Laribal trout hatchery consists of number of cemented stock ponds. The cold water which is allowed to pass through filter bed consisting of gravel and sand and the clear filtered water is then allowed to pass through ova house first and then to various nurseries, rearing and other ponds. In the hatchery all the race ways and ponds having proper in lets and out lets.

LARIBAL TROUT HATCHERY
KASHMIR

HATCHING OVA HOUSE:

The ova house consists of a small house in which long rectangular but comparatively shallow wooden or cemented troughs are arranged in such a way so that water supply is continuous. In these troughs hatching trays of wooden frame and perforated zinc sheet bottom are placed lingerly. The trays remain semi submerged in water. In a tray of size 32 x 37.5 cms, about 2000 to 5000 eggs can be placed. During the period of hatching a continuous flow of clean and cold water is maintained. Variations in temperature or pressure may cause high mortality. A careful watch is
TROUT EGG INCUBATOR AT LARIBAL HATCHERY, KASHMIR.

VERTICAL FLOW INCUBATOR
maintained in the increased troughs during hatching period to ensure that temperature fluctuation does not occur. The incubation period of eggs varies with the temperature, higher the temperature shorter the incubation period and vice versa. The incubation period for brown trout egg at below 10°C is 90-100 days whereas for rainbow trout eggs at 10-12°C. The incubation period is for 60-75 days.

HATCHING IN INCUBATOR:

A simple incubator which is working at the Laribal trout farm consists of a round metallic drum having an inlet at the bottom and a screend out let at the top in the opposite direction. The drum is filled up with 3-4 layers of small rounded pebbles over the bottom for filtering silt suspension. In the middle of the drum a circular tray, made up of a metallic ring fitted with very small meshed neylon cloth is placed. In this tray nearly 30,000 eggs are kept at a time. Water is taken in through the bottom inlets and left out through outlets. In this way a continous water flow is maintained through this incubator device. It needs a suitable level on which the drum is to be placed on. The source of water is at higher level while the outlet of the drum is below for maintaining a continous and effective water flow by gravity. This device has been found as very useful.
Raceway
RACE WAYS:

Race ways though used for large installations, but can also be used on small scale. There are four race ways. Each of them 30 m long and 2.5 m broad with a depth of water of about 0.7 m. A screened sluice controls water flow from upper race way to lower. At least one zone race ways should be placed along side by side. Race ways are easier to manage or control than tanks. But an hygeinic point of views race ways may help in spreading of contagious diseases. If disease occurs in one race way it effects the other in series.

In large race ways, it is difficult to obtain a massive supply of water needed for the race way and it becomes difficult to resort to re-circulation. In fact there is no filter capable of removing viruses and it is improbable that most filters have effect on bacteria or other small organisms.

Nevertheless, a well designed race way system will have most of advantages and only a few disadvantages. Raceways themselves are easily managed and cleaned although the capital expenditure may be greater than in some other installations but the maintenance cost will be lower.
TROUT FARMS IN INDIA

(In India however trout so far are cultured mainly for stocking only in the sport fishing waters. The country has in all 14 trout farms. Jammu and Kashmir has five, Himachal Pradesh has five and states of Uttar pradesh, Tamil Nadu, Arunachal Pradesh and Kerala have one each.)

Trout culture whether it is for producing stocking material for sport fishing waters or for food, it requires spawning or egg taking from healthy brood fish, incubation of eggs, rearing of young fry in nursery ponds, raising of fingerlings in nursery ponds, race ways or circular ponds etc. These operations are carried out in fish farms which have running water facilities of specific characteristics.

(a). Trout population of angling stream may be protected by adopting better management practices. Excessive angling cause reduction of fish population and cause heavy loss to the farm. Angling should be so regulated that it does not effect on the stock adversely. Strict orders regulating fishing as well as angling fee should be imposed on the anglers. Number of fish to be caught and its size limit/angler has to be fixed according to supply and demand requirements.

(b). The ponds which are formed by constructing Kacha boulder bundhs and some thorny bushes and even barbed wire so as to keep the farm off the predators like others, ichthyphagus birds etc.
(c). During the winter season when the water level becomes low and it becomes easy for the predators to prey upon the fish, salvaging operations are to be conducted and the stocks obtained from there are to be released again at safer places.

(d). For the free movement of the fish desilting and deweeding is to be done.

(e). Feeding with insect larvae and introduction of insect larvae in trout infested waters has resulted in quick growth of trouts which otherwise remained stunted. Insect larvae is good feed for trouts.

(f). As we know that breeding season of trout in Kashmir is from October to March, banning of fishing order should be promulgated for this period of the year.

(g). Angling or fishing or juvenile fishes by any method has to be prevented. Juveniles if caught in hooks or traps or nets should be immediately released back in waters.

Development of trout fishery in Kashmir demands stocking of all suitable water area with trouts, for which an annual requirement of 25 million of trout eggs have been estimated while as total trout egg production upto 1980-81 was 1.5 million. It was planned to increase this production upto 4 million by 1985-86 (Department of fisheries Kashmir).
Because of the increased pressure of angling on the streams of Kashmir valley it has become necessary to increase production and stocking in the streams of Kashmir valley.

Table: 3

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of Hatchery</th>
<th>Year &amp; Production in NOS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Achabal</td>
<td>1,40,000</td>
</tr>
<tr>
<td>2</td>
<td>Laribal trout farm</td>
<td>6,15,335</td>
</tr>
<tr>
<td>3</td>
<td>Koker nag</td>
<td>N.A</td>
</tr>
<tr>
<td>4</td>
<td>Tricher</td>
<td>40,000</td>
</tr>
<tr>
<td>5</td>
<td>Ghata hatchery</td>
<td>N.A</td>
</tr>
</tbody>
</table>

Total ova production 7,95,335 11,04,000 10,93,000
Table 4.

POSITION OF TROUT BREEDERS IN THE STATE DURING 1980-81
(GATHERED PERSONALLY FROM DEPARTMENT OF FISH KASHMIR)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of hatchery</th>
<th>Stock Position (Nos)</th>
<th>Size range (cm)</th>
<th>Weight range (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Laribal trout farm</td>
<td>3569</td>
<td>25-60</td>
<td>0.5 - 4.5</td>
</tr>
<tr>
<td>2.</td>
<td>Achabal trout farm</td>
<td>1300</td>
<td>25-50</td>
<td>0.5 - 3.7</td>
</tr>
<tr>
<td>3.</td>
<td>Kokernag trout farm</td>
<td>1164</td>
<td>20-35</td>
<td>0.4 - 1.5</td>
</tr>
<tr>
<td>4.</td>
<td>Tricher trout farm</td>
<td>1178</td>
<td>30-35</td>
<td>0.5 - 3.8</td>
</tr>
<tr>
<td>5.</td>
<td>Papchan trout farm</td>
<td>233</td>
<td>22-40</td>
<td>0.5 - 2.0</td>
</tr>
<tr>
<td>6.</td>
<td>Tschawalgam</td>
<td>168</td>
<td>20-30</td>
<td>0.4 - 1.0</td>
</tr>
<tr>
<td>7.</td>
<td>Expt. Reserch farm Harwan</td>
<td>230</td>
<td>25-30</td>
<td>0.5 - 1.0</td>
</tr>
</tbody>
</table>
Table: 5.

OXYGEN CONTENT OF FULLY SATURATED WATER AT VARIOUS TEMPERATURES.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Temperature (°C)</th>
<th>Oxygen Solubility (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0</td>
<td>14.32</td>
</tr>
<tr>
<td>2.</td>
<td>1</td>
<td>13.92</td>
</tr>
<tr>
<td>3.</td>
<td>2</td>
<td>13.52</td>
</tr>
<tr>
<td>4.</td>
<td>3</td>
<td>13.20</td>
</tr>
<tr>
<td>5.</td>
<td>4</td>
<td>12.88</td>
</tr>
<tr>
<td>6.</td>
<td>5</td>
<td>12.52</td>
</tr>
<tr>
<td>7.</td>
<td>6</td>
<td>12.21</td>
</tr>
<tr>
<td>8.</td>
<td>7</td>
<td>11.91</td>
</tr>
<tr>
<td>9.</td>
<td>8</td>
<td>11.62</td>
</tr>
<tr>
<td>10.</td>
<td>9</td>
<td>11.33</td>
</tr>
<tr>
<td>11.</td>
<td>10</td>
<td>11.10</td>
</tr>
<tr>
<td>12.</td>
<td>11</td>
<td>10.83</td>
</tr>
<tr>
<td>13.</td>
<td>12</td>
<td>10.61</td>
</tr>
<tr>
<td>14.</td>
<td>13</td>
<td>10.38</td>
</tr>
<tr>
<td>15.</td>
<td>14</td>
<td>10.15</td>
</tr>
<tr>
<td>16.</td>
<td>15</td>
<td>9.96</td>
</tr>
<tr>
<td>17.</td>
<td>16</td>
<td>9.76</td>
</tr>
<tr>
<td>18.</td>
<td>17</td>
<td>9.55</td>
</tr>
<tr>
<td>19.</td>
<td>18</td>
<td>9.35</td>
</tr>
<tr>
<td>20.</td>
<td>19</td>
<td>9.16</td>
</tr>
<tr>
<td>21.</td>
<td>20</td>
<td>9.00</td>
</tr>
<tr>
<td>22.</td>
<td>21</td>
<td>8.82</td>
</tr>
<tr>
<td>23.</td>
<td>22</td>
<td>8.67</td>
</tr>
<tr>
<td>24.</td>
<td>23</td>
<td>8.41</td>
</tr>
<tr>
<td>25.</td>
<td>24</td>
<td>8.36</td>
</tr>
<tr>
<td>26.</td>
<td>25</td>
<td>8.22</td>
</tr>
</tbody>
</table>
CHAPTER - 3.1

CULTURE OF TROUT IN KASHMIR:

(a). Wide spread culture of cold water fish like trout throughout the world depends much on the introduction of various nutritious feed rich in proteins and Vitamins (b). A large number of fertilized eggs, fry and fingerlings can be raised from artificially transplanted trouts (c). Through protection of eggs and growing fish against natural enemies and irrational fishing it is possible to maintain an optimum population of trouts in waters where natural spawning occurs. (d). Open water suitable for trout propagation where natural spawning do not generally occur can be populated and repopulated by retransplantation of young trouts.

In India however trouts were introduced by Britshners keeping in view of its recreation and sport value only. Trout culture whether it is for producing stocking material for sport fishing waters or for food, require a stock of healthy brood fish. Stocking materials or trout seed is raised, (through artificial fertilization incubation of eggs and rearing of youngs till those are suitable for stocking in cold waters involving a series of technical operations in hatcheries. Running water supply suitable for trout sustainance is essential for these activities.
WATER SUPPLY:

Source of water for cold water fish farms are generally sluggish streams, swamps, bogs, springs and well water. Water drawn from these resources are often low in dissolved oxygen and high in free carbondioxide. In modern days facilities of aeration may be arranged in different ways to overcome oxygen deficiency of water. Miltry water is not good for trout culture because this type of water lead to gas embolism in blood, eyes and sub-cutaneous areas of the fish- a debility which can cause heavy mortality. Water flowing over lime stones contain calcium and magnessium which are beneficial for fish growth and bone formation. Such waters also have higher bicarbonate alkalinity acting as buffer and preventing ill effects of some contaminating substances, particularly acids.

Water from spring is considered to be ideal for a trout farm. Springs are of 3 kinds such as (i) rheocrene, (ii) limnocrene and (iii) helecrene. (i) Rheocrene are running springs in which water emerges through rocks and flows down wards. (ii) Limnocrene springs are first filled by water while, (iii) helecrene springs are those in which emerging water seeps through a layer of earth converting it into a marsh. The Kokernag spring in Kashmir and Heylang spring in Chamoli district of utter predesh are examples of rheocrene type. Gangqi spring in Uttar kashi in Uttar Pradesh and Gupta Garga spring in Kangra valley
of Himachal pradesh are examples of limnocrene type where as Appatani spring in zero district of Arunachal Pradesh is of helocrene type.

For any trout farm the source of water supply play a paramount importance. In Kashmir, water source for trout farming are springs, streams or high altitude lakes amongst which the spring has been found to be the source of most ideal water. In case of scarcity of spring water, water from river, streams are given reference. Some desirable features for water supply for trout farms are:

(a) moderate rainfall on the catchment area
(b) moderate gradient of the catchment area
(c) moderate foliage cover on the catchment area
(d) adequate lime stone and other mineral deposit.
(e) absence of grazing, logging, mining and similar activities in the catchment areas.
(f) Provision of underground pipe lines for hatchery intake to minimise temperature changes.
(g) covering of the water supply channels to prevent surface contamination.

**PHYSICAL CHARACTERISTICS:**

(a) **WATER TEMPERATURE:**

Prime requisite for a successful hatchery is moderate temperature ranging from 1°C - 25°C water temperature in
the stream fed hatcheries of Kashmir ranges between 1.6°C in winter to 19.0°C in summer. The water temperature of the spring fed trout hatcheries at Achabal in Kashmir ranged between 9.6°C and 12.0°C in 1980-81. Lariabal (Kashmir) stream fed trout hatchery is possessing water temperature of 0.5°C in winter and 21°C in summer.

(b) **DISSOLVED OXYGEN:**

Available Dissolved oxygen in winter is inversely proportional to altitude. The average value of Dissolved oxygen in the stream fed trout hatcheries of Kashmir ranged between 7.4 and 10.2 ppm. These values are higher compared to those of spring fed hatcheries where Dissolved oxygen value ranged between 6.5 to 9.4 ppm. ELLIS et al recorded that 10.0 to 11.0 ppm of Dissolved oxygen is the best for trout and that fish show discomfort where Dissolved oxygen was less than 7.8 ppm.
<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Dissolved Oxygen in PPM</th>
<th>Elevation (feet)</th>
<th>Dissolved Oxygen in PPM for Fresh Water in Equilibrium with Air (modified from Bierig &amp; Lewis 1976)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.8</td>
<td>8.9</td>
<td>10.6</td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>8.3</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td>6.9</td>
<td>8.6</td>
<td>11.9</td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>8.9</td>
<td>12.2</td>
<td></td>
</tr>
<tr>
<td>7.3</td>
<td>9.1</td>
<td>11.3</td>
<td></td>
</tr>
<tr>
<td>7.7</td>
<td>9.4</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>7.9</td>
<td>9.6</td>
<td>11.8</td>
<td></td>
</tr>
<tr>
<td>8.0</td>
<td>9.7</td>
<td>12.1</td>
<td></td>
</tr>
<tr>
<td>8.1</td>
<td>9.8</td>
<td>12.2</td>
<td></td>
</tr>
<tr>
<td>8.2</td>
<td>9.8</td>
<td>12.3</td>
<td></td>
</tr>
<tr>
<td>8.3</td>
<td>9.8</td>
<td>12.4</td>
<td></td>
</tr>
<tr>
<td>8.4</td>
<td>9.7</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>8.8</td>
<td>9.4</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>8.9</td>
<td>9.3</td>
<td>12.7</td>
<td></td>
</tr>
<tr>
<td>9.0</td>
<td>9.2</td>
<td>12.8</td>
<td></td>
</tr>
</tbody>
</table>

Note: The data represents the dissolved oxygen in parts per million (PPM) at various temperatures and elevations. The modified values from Bierig & Lewis 1976 are also provided for fresh water in equilibrium with air.
HYDROGEN ION CONCENTRATION: (pH)

In Kashmir the hatcheries and the trout farms which depend upon the waters of melted snow have a pH ranging between 7.2 - 8.0 and spring fed hatcheries have pH between 7.9 - 8.4.

TOTAL ALKALINITY:

All the stream fed farms of the state show an alkalinity range 76 - 95 ppm but the spring fed farm show an alkalinity between 85 - 112 ppm.

FREE CARBONDIOXIDE: All natural waters contain same concentration of free carbondioxide, approximity 2.0 ppm. In the stream fed trout hatcheries free carbondioxide ranges between 0.17 and 0.18 ppm which the hatcheries receiving, spring water possess 2.3 to 2.8 pp, of free carbondioxide. Due to accumulating metabolites in hatching troughs after initial feeding by fry, free carbondioxide ranges 4.9 - 59 ppm.

SUSPENDED SOLIDS: The problem of silt laden waters is of grave nature. If the concentration of silt exceeds 20 ppm it hampers normal development of trout eggs and delays hatching and even cause change in the normal shape of the hatched out fry.

WATER AREA: Varying volume of water will be available from the spring in Kashmir at different seasons to stock newly constructed trouts farms unfortunately. India is still
lacking in gathering adequate information in this respect either it is for Kashmir valley alone or for the country as a whole. As such some relevant information gathered from American sources are quoted below; Pence (1966), estimated that each foot of width of a pool requires 500-750 lts of flowing water per minute. Requirement for trout farming recommended by some other workers are as follows:

1. 100 liters/sec/hac for extensive trout culture
2. 200-300 liters/sec/hac for semi intensive raising of trout
3. 300-500 liters/sec/hac for intensive raising of trout

As per Huet (1970), water requirement of different stages of trout are as follows:

Table. 7

<table>
<thead>
<tr>
<th>Stages of development</th>
<th>Required flow per minute per 1000 units (in ltr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggs (for incubation)</td>
<td>0.5</td>
</tr>
<tr>
<td>Fry up to 3 months old</td>
<td>1.0 - 3.0</td>
</tr>
<tr>
<td>Fingerlings 4-8 months old</td>
<td>4.0 - 8.0</td>
</tr>
<tr>
<td>Fingerlings 6-12 months old</td>
<td>6.0 - 12.0</td>
</tr>
<tr>
<td>Adult 2-3 years</td>
<td>20.0 - 30.0</td>
</tr>
</tbody>
</table>

Generalising the requirement Huet (1970) mentioned that one liter of water per minute per age month is required for 100 fry and fingerlings of trout in a culture system.
TROUT CULTURE PRACTICES IN KASHMIR:

In Kashmir, trout fishery plays a very important role for generating income and development of the state by attracting more and more tourists not only from within the country but also thousands of tourists from abroad visiting the valley for sport angling of trouts. Department of Fisheries of Kashmir state also therefore impart priority and importance on the development of trout fishery. In fact all the species of trouts available in Kashmir are brought from other countries and those are:

1. *Salmo trutta fario* – Brown trout
2. *Salmo gairdnerii* – Rain bow trout
3. *Salvelinus fontinallis* – Eastern brook trout
4. *Salmo salar* – Land locked Atlantic Salmon

Brown trout, *Salmo trutta fario* which was introduced into Kashmir by F.J. Mitchell in 1900 A.D naturally established in some of the snow fed streams (Jhingran and Sehgal 1978). However not much success was achieved of this species due to poor rate of survival at its different developmental states (Sexena and Koul, 1966) in hatcheries Central Inland Fisheries Research Centre in the state, the studies on its propagation and rearing were taken up on scientific lines (Sehgal 1974)
and much progress has been made in standardising various aspects of trout culture (Seghal and Vass 1979). By adopting the scientific methods for culture purpose the department was able to produce table seized fish and sold in the local market at 45 Rs per kg and outside state in some hotels like Bombay, Delhi, Culcutta at the rate of 85 per kg. The state is transporting the fry and fingerlings of trouts to the other parts of the country. Since many years past they are transported in specially fabricated transportation tanks, artificially maintaining required oxygen level.

However in case of the landlocked (Salmo Solar) species survival of hatchlings at fry stage has been found to be very poor and hence the progress in establishing the fishery of this species in Kashmir is not of much success.
Transportation tank

Used in trout hatcheries of Kashmir mainly for transport of trout brooders safely from one place to other. Developed and fabricated indigenously resulted in reduction of indigenously, resulted in reduction of mortality, better spawning and survival of spawn.
Breeding: Trout which matures at the age of 3rd year in the natural condition is little delayed in hatchery and artificial condition and is tried for 4th year in breeding. Brown trout and Eastern brook trout attain faster maturity in snow fed waters. In spring fed waters maturity is delayed. Rainbow trouts attain maturity from February to end of 1st week of March. One on the characteristics of spawning season is the temperature. With the difference in the temperature, it has been found in Kashmir that there is difference in the spawning period of cultivable species of trout reared at different farms at Kashmir. The table below indicates the spawning period of culturable species of trout in Kashmir.
Table: 8

**SPAWNING PERIOD OF CULTIVABLE TROUTS OF KASHMIR**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of Hatchery</th>
<th>Brown trout (Salmo trutta fario)</th>
<th>Rain bow Salmo gairdorei</th>
<th>Eastern trout Salvelinus fontinalis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Harwan</td>
<td>Mid Nov. to 1st week of December</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Laribal</td>
<td>- do -</td>
<td>Feb. to 1st Mid Nov. to week of Mar. 1st week of December</td>
<td>-</td>
</tr>
<tr>
<td>3.</td>
<td>Achabal</td>
<td>December to January</td>
<td>Mid Jan. to December</td>
<td>January</td>
</tr>
<tr>
<td>4.</td>
<td>Kokernag</td>
<td>Mid December to 1st week of January</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5.</td>
<td>Tricher</td>
<td>Mid Nov. to 1st week of December</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 9.

**INCUBATION PERIOD OF DIFFERENT TROUT SPECIES IN KASHMIR**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of farm</th>
<th>Species</th>
<th>Water temp °C</th>
<th>Incubation Period days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Laribal</td>
<td>Brown/Brook</td>
<td>3.5 - 8.5</td>
<td>100 - 120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rain bow</td>
<td>- do -</td>
<td>100 - 115</td>
</tr>
<tr>
<td>2</td>
<td>Harwan</td>
<td>Brown</td>
<td>3.8 - 9.2</td>
<td>100 - 115</td>
</tr>
<tr>
<td>3</td>
<td>Achabal 8</td>
<td>Brown/Brook</td>
<td>9.5 - 16.0</td>
<td>65 - 73</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rain bow</td>
<td>- do -</td>
<td>- do -</td>
</tr>
<tr>
<td>4</td>
<td>Kokernag trout farm</td>
<td>Brown</td>
<td>8.2 - 15.0</td>
<td>72 - 80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rainbow</td>
<td>12.0 - 17.0</td>
<td>60 - 75</td>
</tr>
</tbody>
</table>

Source: Harwan Trout Research Station J&K state.
NATURAL BREEDING:

In nature the mature trouts move in pairs towards shallow or upper parts of the stream, where there are no foaming currents. The male by its prolonged hook like appendage of lower jaw and with the rhythmic motion of the tail clear the pebbles and form pits at the base of our stream, near rocky beds of clear water.

Breeding occurs mostly at the early hours of the morning. At first the eggs are laid by the female, the male fertilize, the eggs sitting over them and discharging milt. After this process the male and female guard these eggs and leave them for further development. As the eggs develop the "Alevins" come out of the shell and the further development takes place. As soon as the swim up fry is formed they wriggle out of the pebbles and seek shelter in flowing water. Due to high torrential currents and other natural calamities and above all due to cannibalistic nature of trout, the survival rate from natural breeding is almost negligible. As a result artificial replenishment of stock in natural streams by seed raised in farms is essential.

ARTIFICIAL BREEDING: To increase the trout fishery in the state as well as in the country such culture methods should be adopted which are successful and on modern scientific technology. The operations which are required for artificial breeding are discussed below.
CARE OF BROOD STOCK: For obtaining healthy eggs the brood fish must receive adequate care including provision of balanced diet. In India eggs are segregated parent wise and required care is not taken which result in poor quality of seed production in most of the hatcheries. According to Shegal et al (personal) sex wise segregation of brood fish and nutritive feeding of brooders (a) 1% to 2% of body weight will improve number as well as quality of trout eggs to a great extent. A, present in Kashmir stocked brood trouts are mostly fed with trash fish on silk worm puppae. Feeding is stopped about a week before the actual about a week before the actual stripping. With the application of improved practices in the hatchery, the survival of brown trout (Salmo trutta fario) up to swim up fry stage has been increased to 80.5%. By administering orioer diet, a growth rate of 3.30 g (X : 15 g) with 25 - 40% survival has been obtained up to fingerling stage. In case of brown trout Salmo trutta fario the following practices are followed.

SEGREGATION:

In all the hatcheries of Kashmir the male and female breeders are segregated about 2 - 3 months earlier to stripping and reach separately.
SELECTION OF BREEDERS:

MALE: During breeding season in case of males a hook like appendage is developed. The coloured spots on the body becomes very prominent. The ripe male oozes milt with gentle pressure on its belly. Milt which precipitates on mixing with the eggs is doubtful for its viability.

FEMALE: Soft velvet like vent of a female indicates that the fish is fully ripe. Hard vent indicates that the female is not ready for spawning. A fully mature female has shining yellow petal like ridges at the operculum and prominent spots on body.

The brown trout—Salmo trutta fario breeders, segregated sex wise, 2-3 months before breeding are kept in separate ponds. The stock is fed 2-3% body weight on deviscerated and partially boiled fish balls prepared out of cyprinus Carpio, puntius Conchonius, crossocheilus latex etc. Breeding by stripping is done during November-December and milted by "dry method". Estimation of fertilization, volume and weight of eggs are male and prophylactic treatment is given to save the breeders from infections. The eggs are then stocked in hatching trays and all the necessary care is taken during incubation period of 85-110 days. To prevent fungus infection melachite green treatment (a) 1:2,00,000 for 30 minutes is given to eggs as mycocide 2-3 times a week during the incubation period up to aleuin
stage and the hatching trays and troughs are cleaned and disinfected with 5% potassium per maganate solution.

(a) The fry are reared in cement nursery ponds of various dimensions usually of size (2.5 m$^2$) and fed according to water temperature and body weight as recommended by Lettriz (1969). After pre-feeding on liquid diet, the tender fry are fed with artificial diets (a) 8-10% body weight, 4 to 6 times a day, from sunrise to sunset.

(c) The fingerlings are stocked in the cemented growing ponds usually 30 m$^2$ and are fed with different artificial diets (a) 2-8% body weight, 3-4 times a day. Rate and frequency of feeding depend upon the water temperature weight and acceptance by fish and turbidity level.

(d) To have an idea of the different types of artificial trout feed, five different types of formulated feed have been described in the following table.
# TABLE 10.

**TABLE SHOWING INGREDIENTS USED TO PREPARE FIVE DIFFERENT FEEDS FOR TROUT (QUANTITY/KG)**

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Feed No 1</th>
<th>Feed No 2</th>
<th>Feed No 3</th>
<th>Feed No 4</th>
<th>Feed No 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fisl meal (g)</td>
<td>500</td>
<td>400</td>
<td>-</td>
<td>380</td>
<td>-</td>
</tr>
<tr>
<td>Bone meal (g)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>Soyabean meal (g)</td>
<td>200</td>
<td>-</td>
<td>-</td>
<td>150</td>
<td>-</td>
</tr>
<tr>
<td>Wheat bran (g)</td>
<td>50</td>
<td>150</td>
<td>150</td>
<td>220</td>
<td>130</td>
</tr>
<tr>
<td>Wheat St rch (g)</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mustard oil cake (g)</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Silk worm pupae (g)</td>
<td>-</td>
<td>200</td>
<td>700</td>
<td>-</td>
<td>800</td>
</tr>
<tr>
<td>Brewer's yeast (g)</td>
<td>35</td>
<td>40</td>
<td>70</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Shark liver oil (g)</td>
<td>30</td>
<td>40</td>
<td>10</td>
<td>30</td>
<td>-</td>
</tr>
<tr>
<td>Dried skimmed milk(g)</td>
<td>40</td>
<td>50</td>
<td>50</td>
<td>55</td>
<td>-</td>
</tr>
<tr>
<td>Vitamin mixture (g)</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Mineral mixture (g)</td>
<td>30</td>
<td>10</td>
<td>10</td>
<td>-</td>
<td>10</td>
</tr>
</tbody>
</table>

Feed No 1, 2 and 3 are formulated after Vass et al (1981)

Feed No 4 has been formulated by shegal et al (1976)

Feed No 5 has been formulated by sunder et al (9182).
(e) To avoid any incidence of disease in the fingerlings and onward stages the fish ponds are cleaned and disinfected with potassium permanganate solution (2-3%) and the fish stock is treated with 2-3% sodium chloride solution.

Study of the feeding experiment indicate that there are three major and crucial stages in trout farming which require careful and close attention. These stages are (i) from green egg to swim-up fry (ii) from swim-up fry to fingerling (iii) from fingerling to a table size fish. Studies which were carried out during 1975-81 at various farms indicated a positive increase in fecundity as a result of artificial feeding. Results are as follows:
<table>
<thead>
<tr>
<th>Trials</th>
<th>Experimental Stock</th>
<th>Control stock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>* No of eggs</td>
<td>* No of eggs</td>
</tr>
<tr>
<td>I</td>
<td>1,458 - 1,481</td>
<td>1,231 - 1,263</td>
</tr>
<tr>
<td></td>
<td>(1,470)</td>
<td>(1,251)</td>
</tr>
<tr>
<td>II</td>
<td>1,467 - 1,508</td>
<td>1,251 - 1,286</td>
</tr>
<tr>
<td></td>
<td>(1,491)</td>
<td>(1,263)</td>
</tr>
<tr>
<td>III</td>
<td>1,469 - 1,497</td>
<td>1,239 - 1,271</td>
</tr>
<tr>
<td></td>
<td>(1,484)</td>
<td>(1,257)</td>
</tr>
</tbody>
</table>

* figures in parenthesis indicate average number.
1. **Green Egg to Swim Up Fry Stage**:

Brown trouts reared on mass scale with artificial feed at Laribal and Harwan trout hatcheries, on an average during a year yield 2,42,567 eggs by stripping while 1,38,000 eggs from control spawners. In experimental fishes the fertilization was 96.9% while in control fishes it was 94.2%. The average number of green eggs from the spawners of 23/- 363 mm in length and 211-560 g in weight ranged between 8-10 eggs/cc by volume and 9-12 eggs/gm by weight. (Phyam sunder et al 1986).

The hatchery with 2,500 - 3,000 eggs/tray which approximately come to 12,500 - 15,000 eggs/trough (200 X 33 X 10 cm). The cumulative survival from green egg to eyed ova stage eyed ova to aleuin (see fry stage) and aleuin to swim up fry stage 88.8% in experimental stock. The trays were regularly cleaned and treated with KMnO₄ solution or malachite green.

(a) 1: 2,00,000 for 30 minutes by flush method. The total incubation period ranged from 85-110 days at a water temperature of 35 - 8.6°C. The green eggs of brown trout when stocked at two different densities (a) @ 3,000 and (b) @ 2,500 per tray indicated that percentage of survival was less in tray stocked @ 3,000 because of over crowding. The factors responsible for losses during the incubation period were (a) fungus (29.5%), white spot (18.6%) soft egg...
condition (2.8%) and silt (7.6%) at the green e. and eyed ova stages. (b) blue.sal (27.6%) white spot (4.9%) and silt (10.4%) at aleuini stage. (c) body deformities (4.8%) and other cause (26.3%) at swim up fry stage.

2. SWIM UP FRY TO FINGERLING STAGE:

The swim up fry of brown trout (80-100 mg in weight) were initially feed on boiled and finally with minced hen's egg yolk and shrimmed milk in the rate of 1:1 with a pinch of common salt (a) at the rate of 6% body wt every two hours farm sun rise to sun set during first 30 days when the stock was in hatching troughs. In the 2nd month they were transfered to nursery ponds and fed on 1:1 mixture of wet feed and diried feeds. It was foud in different experiments that there were differences in the increase in lengths weights feed conversion ratio and survival while using different feeds.

(i) In the first experiment with feed No 1 with 31% crude protein level was tried for 300 days. At the end the fish recorded a weight of 2-15 gms with an average, of 7.5 gms. The conversion ratio of 2.2 and food efficiency of 49% was obtained while the overall survival varied between 20-25%.

(ii) In the second experiment feed no 2 and 3 with 35% and 48% protein level were tried for 280 days. The fish attained an average weight of 10 g with 35% protein diet, while with 48% the fish grew to averagee weight of 15 g.
The survival during the entire rearing period ranged between 31-35% with 35% protein diet while 30-35% with 48% protein diet.

(iii) The third experiment was on the impact of two stocking densities on survival of brown trout by giving only 35% protein diet. The results showed that during the first three months, the fry stocked at 200/m² recorded 65-80% survival while fry stocked at 400/m² gave only 60-65% survival.

According to Huet 1972, the survival from fry to fingerlings would be mediocre if below 15%, good in between 15-24%, very good between 25-40% and excellent if over 40%. Lecren (1961) also reported a survival of 30-40% from fry to fingerlings in U.S.A and U.K.

(3) FINGERLING TO TABLE SIZE:

Experiment on raising brown trout from fingerlings to table size in the farms within a reasonable rearing period were taken up for the first time. Feed Nos 4 and 5 (see table) were prepared and brown trout fingerlings (average weight, 38 g) were stocked in two ponds (A and B). The fishes in pond A were fed with feed No 4 and the second pond B with feed No 5 for a period of 380 days. The feed were applied at the rate of 2-8% body weight. The feeding was given 3-4 times a day because according to Tack (1966) several feeding
are better than just one feeding in a day. In pond B sheep/goats meat was given. In addition to regular ingredients in the dry pelletised feed No 5, terramycin @ 5,000 - 10,000 units/kg was also administered as Garbincv et al (1968) recommended antibiotics to control diseases and help in growth. At the end of experiment, the growth attained was 165 g with 28% protein fed and 320 g with 47% protein feed.

The following are the techniques adopted for specific rearing of brown trout in farms and hatchery and its results in brief are as: sexwise segregation of spawners feeding them on nutritive diet helped to increase quantity of eggs by about 17-18% per kg of body weight in brown trout fry reared in the farm (240 - 300 days) to produced stockable trouts.

Three formulated feeds containing different protein levels (Feed No 1-3) were given which gave conversion factors of 1.8 - 2.2. In 300 days the fish grew up to 55 - 100 mm with feed of 31% protein level and size of 55 - 135 mm and 60 - 150 mm in 280 days with 35% and 48% protein diets. The cumulative survival during three years from swim up fry to fingerling stage ranged between 25 - 40% when stocked at lower densities. The results obtained clearly indicated that there is great scope of developing a trout culture system which would help in raising much needed healthy stocking materials from the farms to increase the natural stream population on the one hand and produce
table size fish in shortest possible period on the other hand. The proposition is both commercially and economically viable.
CHAPTER - 4.0

**BIOLOGY OF TROUT:**

All the cultivable species of trout have similarities in their food and feeding habits. There are many who believe that trouts do not feed unless they surface to hunt insects. The belief is wrong. The food and feeding can be studied under two headings

(1) Natural

(2) Artificial

4.1 **NATURAL FEEDING**

The trout is carnivorous and feed on aquatic animals and smaller fish living in the weed and mud at the bottom of lakes, river and streams. Trout also take no aquatic insects such as moths, flies, caterpillars etc as their food. Trout often graze on the beds of weeds where the aquatic life is richest. In spring and summer they spend much of their time in mid-waters hunting nymphs as they arise to the surface to hatch out. During the winter months they continue to feed but digestion slow down and therefore they eat less and hardly put on any weight.

Studies on the food spectrum of brown trout have been made by various authors like Pentalow (1932), Slack (1934), Allen (1938) Frost (1950) and Hopkins (197). However Khan (1938), Khan and Tanden (1941), Sehgal (1970), Kumar et al (1978) have worked on ecology of various trout streams of Himachal Pradesh and Kashmir respectively and
the work done by sehgal et at 1971-74 on the streams of Kashmir, the information regarding food and feeding of trout in Kashmir is decidedly limited. The study made by sehgal et at (1974) on the food and feeding habits of trout in some trout streams of Kashmir recorded main constituents of brown trout to be the development stages of Trichoptera (Caddislarvae), Ephemeroptera and placopteran (nymph). Percentage of Ephemeroptera, placopteran nymph and Trichopteron (caddislarvae) insects in the gut contents of trout collected from the spring fed and stream fed streams are 10.2%, nil, 20 to 30% and 50 to 75%, 0.6 to 4.7% and 78.6 to 81.5% respectively.

4.2 ARTIFICIAL

The growth and health of young trout depend upon quantity and quality of food they receive. Fine ground meat and fish are easily accepted by the trout fingerlings. With the increase in growth and size the fingerlings readily accept coarser food particles, loss of feed at this stage is also more. In some hatcheries before grinding fish flesh livers and other soft organs of fish are thrown in water. In case of fingerlings more care and attention is needed. Before grinding livers should be skimmed and all fat and connective tissues should be removed. The objective in preparing feeds for feeding is to produce a mixture usually of meats and dry meals. The food should be in such condition that it should not go waste which will effect the hygienic condition of water. To increase the taste 1%
to 2% of salt is added. However, some trout culturists feed dry feed alone instead of a mixture with fresh meat. During the early stage when feeding is started, feed should be applied at least 4 to 5 times/day. With the passage of time as fish grow number of feeding should be decreased. Two meals a day normally in the evening and morning are sufficient for larger fingerlings.
### TABLE 12.

**TABLE** *SHOWING AMOUNT OF FEED REQUIRED FOR YOUNG TROUTS.*

<table>
<thead>
<tr>
<th>Water temperature in degrees C°</th>
<th>Number of fish per pound</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2,542 or Fewer</td>
</tr>
<tr>
<td>Less than 1 in</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-2 cm</td>
</tr>
<tr>
<td>4.44</td>
<td>6.0</td>
</tr>
<tr>
<td>5.55</td>
<td>6.5</td>
</tr>
<tr>
<td>6.66</td>
<td>7.0</td>
</tr>
<tr>
<td>7.77</td>
<td>7.5</td>
</tr>
<tr>
<td>8.88</td>
<td>8.5</td>
</tr>
<tr>
<td>10.0</td>
<td>9.4</td>
</tr>
<tr>
<td>11.11</td>
<td>10.4</td>
</tr>
<tr>
<td>12.22</td>
<td>11.4</td>
</tr>
<tr>
<td>13.33</td>
<td>12.5</td>
</tr>
<tr>
<td>14.44</td>
<td>13.5</td>
</tr>
<tr>
<td>15.55</td>
<td>14.5</td>
</tr>
</tbody>
</table>
As natural food organisms are not available to trout reared in hatcheries artificial feeding is must for them. Artificial feed which are locally available, cheap, nutritive and acceptable by young trouts should be used. Trout is readily adaptable to intensive artificial feeding. The principle involved in trout feeding are (i) the feed must be taken by youngs immediately after broad casting. (ii) overfeeding must be avoided i.e. feed should be provided up to normal level of satiation to ensure rapid growth and better health. Excess feed cause fouling if control. (iii) Broadcast of feed should be uniform if necessary automatic mechanical dispenser should be used. (iv) frequency of feeding should progressively decrease with the increase in the age of the fish from fry to trout stages. In India first attempt to prepare artificial feed for trout was made by Seghal et al (1976). Three feeds were formulated and prepared in the laboratory by hand-operated noodle making machine. The ingredients also contained essential Vitamins and mineral mixture, Halver (1972) recorded increased growth in fish as a result of artificial feeding.
<table>
<thead>
<tr>
<th>FEED A</th>
<th>FEED B</th>
<th>FEED C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish meal 55</td>
<td>Fish meal 40</td>
<td>Silk worm pupae 70</td>
</tr>
<tr>
<td>Soyabean meal 20</td>
<td>Silk worm pupae 20</td>
<td>Wheat bran 15</td>
</tr>
<tr>
<td>Wheat bran 05</td>
<td>Wheat bran 15</td>
<td>Brewers yeast 07</td>
</tr>
<tr>
<td>Skimmed milk 04</td>
<td>Mustard oilcake 10</td>
<td>Skimmed milk 05</td>
</tr>
<tr>
<td>Breakers yeast 3.5</td>
<td>Brewers yeast 04</td>
<td>Mineral 01 mixture</td>
</tr>
<tr>
<td>Shark liver oil 03</td>
<td>Shark liver oil 04</td>
<td>Vitamin mixture 01</td>
</tr>
<tr>
<td>Mineral mixture 03</td>
<td>mineral mixture 01</td>
<td>Vitamin 01</td>
</tr>
<tr>
<td>Vitamin Mixture 03</td>
<td>Vitamin 01</td>
<td></td>
</tr>
</tbody>
</table>

Feed A Total = 96.5  
Feed B Total = 90  
Feed C Total = 100
During 1979 experiment was carried out for 300 days with a stock of 80-100 mg size youngs with a diet. Having 31% protein content. After the close of experiments in December the fish increased in weight from 2-15 g on an average of 7.5 g. A feed converts in ration of 2.2 and food efficiency of 49% was obtained. As stated earlier in 1980 the two feeds with protein level of 35% and 48% were taken up for experimental work up to 250 days. After completion of time the fish increased from initial average weight of 90 mg to an average of 10 g with 35% protein diet. While with 48% protein diet the fish grew to an average weight of 15 g. Shegal et al. (1976) reported by different workers from Europe is 2.0 for Oregon pellets (Hubble, 1963), 2.0 for standard corn land pellets (Phillips et al. 1954) and 1.8-2.1 for dry pellets (Phillips et al. 1954). Halver (1972) stated that feed coefficient of 2.0 was reasonable. The energy content calculated for three feeds were 1950 cal/kg 2349 calories and 3 94 calories, having 31%, 35% and 48% protein. It is observed that about 4278, 4698 and 5569 calories are required to produce a kg of fish for three feeds. In India trouts are fed manually broadcasting on whole of the pond from one side of the pond but in U.S.A, Europe and Japan mechanical and automatic methods of feeding have been developed. The economics of trout feeding depends largely on cost of feed, its utilization and conversion ratio (food quotient). Shegal and Joshi (1975)
found conversion ratio be 11.8 when fresh fish was given to brown and rainbow trout at Harwan trout farms in raceways, in an area ranging 3.5 - 9.0 m² and having a water inflow of 60-2010 lt/minute showing a conversion ration in rainbow trout with feeds containing identical protein levels, was found to be 1.8, 1.5 and 1.7 respectively food efficiently (Grain in weight x 1001 weight of the food given) was height (67.3%) in brown trout with pellets containing 39.0% crude protein. (Food efficiencies of brown and rainbow trouts increasing rates of body weight (final weight) / initial weight growth rates per day (food efficiency/ number of feeding days). In relation to crude protein percentage in different formulated feeds in Brown trout and Rainbow trout have been given in the following table.
The feeds which are generally given in the raceways, ponds and springs in different trout hatcheries of Kashmir is well balanced. Amount of each constituent (in gms) in one kg of formulated feed is as follows:

1. Fish meal  380 gms
2. Soyabean  150 gms
3. Brewers yeast  100 gms
4. Dried skimmed milk  55 gms
5. Bone meal  50 gms
6. Wheat bran or fine rice polish  220 gms
7. Shark liver oil  30 gms
8. Halvers vitaminmixture  15 gms

The schedule time for applying these feeds on the farms of Kashmir are as under:

<table>
<thead>
<tr>
<th>Stage of fish</th>
<th>No of times fed daily</th>
<th>% of body weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fry</td>
<td>5 times</td>
<td>10%</td>
</tr>
<tr>
<td>Small fingerling</td>
<td>4 times</td>
<td>5-7%</td>
</tr>
<tr>
<td>Medium and large fingerlings</td>
<td>2-3 times</td>
<td>3-5%</td>
</tr>
<tr>
<td>Adults</td>
<td>1-2 times</td>
<td></td>
</tr>
</tbody>
</table>

Source: Research Centre Harwan Kashmir
<table>
<thead>
<tr>
<th>Factors</th>
<th>Species</th>
<th>28.0%</th>
<th>35.0%</th>
<th>39.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food efficiency</td>
<td>Brown</td>
<td>51.0%</td>
<td>56.8%</td>
<td>67.3%</td>
</tr>
<tr>
<td></td>
<td>Rain Bow</td>
<td>58.3%</td>
<td>69.2%</td>
<td>57.3%</td>
</tr>
<tr>
<td>Increase rate of body weight</td>
<td>Brown</td>
<td>1.8</td>
<td>2.4</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Rain Bow</td>
<td>2.1</td>
<td>2.8</td>
<td>2.8</td>
</tr>
<tr>
<td>Growth rate/day in percent</td>
<td>Brown</td>
<td>0.68</td>
<td>0.63</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Rain bow</td>
<td>0.84</td>
<td>0.80</td>
<td>0.71</td>
</tr>
<tr>
<td>Conversion ratio</td>
<td>Brown</td>
<td>2.0</td>
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<td>1.4</td>
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<td></td>
<td>Rain bow</td>
<td>1.6</td>
<td>1.5</td>
<td>1.7</td>
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</table>
CHAPTER - 5.0


As whole of the Kashmir because of the diverse Agro climatic condition the state fisheries Department undertook several measures aiming at increase of fish production, protection of natural resources and provision of food fish for common people. There is high demand of fish amongst the local people of the Kashmir valley.

But from 1977 onwards more emphasis was laid on boosting of fish production in the state and some measures were taken. An extensive survey was conducted in all the 14 Districts of the state to access the fisheries resources. To add to the technical efficiency 14 persons were trained with modern fish farming technology at various institutes of the country.

To case the tremendous pressure both on angling as well as on sport fishery the following progress could be achieved.

ACHIEVEMENTS:

(i) Construction of 4 new model modern hatcheries could be completed on scientific lines.
(ii) Before 1977 the survival rate of trout at fry stage was very poor and was ranging between 2-5%. With the introduction of modern scientific methods the survival of trout at fry stage could be raised to 90%.

(iii) The existing holding capacity of a stock of 3000 trouts was significantly increased to hold a stock of 1,50,000 trouts as a result from 1985 the department of fisheries was able to bear heavy angling pressure.

(iv) 18 new trout beats have been opened and 15 existing beats received and ré-stocked.

(v) Intensive and extensive measures have been taken for improvement of existing trout streams with the result the number of rods issued have been increase 2 folds in the last three years.

(vi) For the first time ponds were constructed and about 3.00 lac fingerlings have been distributed in Jammu Division to progress farmers.

(vii) The far flung areas like Gurez, Tulil, Mugal Maiden have been brout under trout culture.

(viii) Dry and economically fish seed has been evolved and made available to farmers.

New fish farm completed/constructed/rearing completion in the kashmir valley.
I. Name of the farm       Place where constructed

(A) Nearing Completion

1. Pandach        in Srinagar
2. Harwan         in Srinagar
3. Jagigund       in Achabal
4. Trigam         in Sonawari

(B) The following more construction initiated:

1. Balpora        in Shopian
2. Manasbal       in Baramulla
3. Gowerpora      in Budgam
4. Chatlum        in Pulwama

(C) Hatcheries Remodelled/Constructed

1. Laribal        in Dachigam
2. Achabal        in Anantnag
3. Popchan        in Bandipora
4. Tangmarg       in Baramulla
5. Khandyal       in Gurez
6. Kokernag       in Anantanag
7. Tricher        in Anantanag
(D) New trout streams/Beats opened.

1. Nambal in Anantnag 4 beats
2. Kulgam in is that 3 beats
3. Panzath in Quazigund 2 beats
4. Athwatoo in Bandipora 2 beats
5. Gurez 4 beats
6. Drangyari in Baramulla 1 beat
7. Aribal in Tral 1 beat
8. Heerpora in Shopian 1 beat
9. Doodgana in yasmarg 1 beat

II VILLAGE TROUT-FISH FARMING PROJECT:

(a) A village Trout fish farming project in Kokernag has been initiated with the assistance of European Economic community at a cost of ₹1.37 crores. The project started on May 1984 and will be completed in three phases, under the close supervision of foreign experts duputed by the Fish farm. Development International. The project manager/Engineer is stationed at kokernag. The project aims at

(b) An estimated projection of

(i) 5,000,000 eggs (ova)
(ii) 5 gn fingerling 4,50,000
(iii) 250 gm and above trout 4,00000.

The first phase of the project has been completed and commissioned and the second phase is expected to be started in the current years.
### Table 15

#### III. TARGETS:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Item</th>
<th>Unit</th>
<th>7th 5yr plan 85-90</th>
<th>1984-85 Achievements</th>
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<th>86-87 Proposed targets</th>
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<tr>
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<td>Fish production (in land)</td>
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<td>Fish feed production</td>
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<td>(a)</td>
<td>Food fish</td>
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<td>3.00</td>
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<tr>
<td>(b)</td>
<td>Trout fry</td>
<td>million</td>
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<td>6.</td>
<td>Hatcheries</td>
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<td>Nursery area</td>
<td>Hact</td>
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Cumulative figures item (1-7)
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<tr>
<th>Sr. No.</th>
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<tr>
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<td>21.00</td>
<td>1978-79</td>
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<td>35.90</td>
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<td>1981-82</td>
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Plan wise allocation and utilization of fund (in lakh rupees) from 1st to 7th five year plan, in the next page.
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<tr>
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<th>Utilisation</th>
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CHAPTER - 5.1

SPORT FISHING IN KASHMIR

ANGLING OR SPORT FISH:

If I, than an angler may protest, Fishing is sweet pleasure, of sport the best; of exercise the most excellent, of recreation the most innocent; But now the sport is marked; and wot we why?

Fishes decrease – for fisheries multiply

"Epigram" De piscatione 1958

He seek the younge swannes: herones, duckes
Cotes and many other folues with thyrbrodes; And yf the angler take fysche: surely thenne is there no man marier than he is in his spyryye
Dame Juliana Bernors, 1596.

Angling is lincesed, trout fishing licencess for a specific fishing heat is given per day. Only fly mesh is allowed. Use of live baits, spoons and spinning rode is strictly prohabited. An angler is allowed to catch 6 trouts/day/rod.

Since the trout is stenothermal and the water temperature is of critical signficance, hence the fish is restricted to the upper reaches of various streams of Kashmir. Since most of the streams in Jammu and Kashmir except a few like verinag and Kokernag (Spring fed), are snow fed. Thus provide,
suitable habitat for brown trout which have got fully established in these streams and hence provide the sportic fun to thousands of sports men every year during angling season.

Angling for trout both in running as well as in still waters may be divided into those in which an artificial bait or lure is used as in fly fishing, spinning and trolling and those which depend upon the use of natural bait.

In Kashmir the most common method of fishing in trout streams is by fly fishing. This is the only fishing method permitted by the state government.

In fly fishing the lure (fly) is an artificial representation of some trout food organisms usually an insect. In dry fly fishing the artificial fly floats on the surface of the water and is intentionally coast to a fishing fish. In wet fly fishing the artificial fly is submerged. The angler usually though not necessarily fishes in water then casts to a particular fish of these two methods, wet fly fishing in the oldest, dry fly fishing was introduced in 1851 and nymph fishing dates from the beginning of the present century.

In the spinning and trolling the tail may be either artificial or natural. In spinning this tail is flung into the water while in trolling the angler gently pulls the tail through water by drawing.
Fishing for trout with rod and line and with an artificial or natural tail has been practiced since 12th century and is described as early as 1946. The essentials for equipment for angling rod line, red and cost have been the same although alternations in their pattern and usages have occurred over last five centuries until 19th century when the favourite wood for the rod was Hazel, thereafter Hichory and green heart.

Trout fishing is a sport which rotates high diverse tastes and pursuits. It is a source of recreation to millions of tourists who visit different trout waters of Kashmir with fact increasing urban population there is an accentuated search for out-door reservation and the trout angling answers to this need though to a limited extent.

Kashmir being known as 'anglers paradise' has recorded 12½ lbs catch in a day near Harwan. The angling is done on day to day permit against a licence fee of Rs. 50/- for foreigner and Rs. 25/- for an Indian. The angling season starts from 1st April up to end of September in all types of water. The main trout stream divided into several regions called as Beats. Each beat is given under the charge of one or two gaurds depending upon location and necessity.

Kumar et al has observed the decline in the catches during angling season in the two streams of Kashmir i.e.
Sindh and Lidder. The author said that is the three beats of the Sindh stream, taking 1969 as the base year for analysis of trout catch there was a fall or 78.5% in fishing days, 79% in the number of fishing rods operated, 92% in the number of trout angled, 91.9% in the weight of fish caught 68.3% average number of fish per rod. The successful angler catching full quota were 87% during 1969 while in 1972 it was found to be 40 - 60% only.

Similarly in the Lidder stream where only two beats (Lidder, whan and yonger) were studied taking 1969 as base year there was a fall of 40.6% in fishing days, 38.3% in the rod operations 58.0% in the number of fish caught, 56.0% in the weight of fish caught 30% in the average of fish per rod by 1972. The range of successful angler have declined from 98% during 1969 to 60 - 82% in 1972.
DESCRIPTION:

The Laribal trout hatchery which spread over an area of 40 kanals (1 kanal = 5400 sq. mtr.). The capacity of the ova house of this hatchery for rearing geen eggs of on specise of trout is 3,60,000 per operation. The hatchery has various units which comprises of water source and the settling tanks, the feeding canals and the ova house and the seed rearing unit comprises of nursery ponds, fry ponds, raceways and circular pools.

WATER SOURCE AND THE SETTLING TANKS:

The source of water in the Laribal Trout Hatchery is the spring "Tarsar" being originated 80 km away from the Hatchery. The Tarsor spring is perennial in nature and it reaches to the hatchery in the farm of a stream. According to Jhingram and segal (1978) the physio chemical parameters of the water were as follows:

- Temperature 5.0 - 18.8°C
- pH 7.3
- Dissolved oxygen 6.2 ppm
- Silicates 78.0 ppm
- Alkalinity - 79.0 ppm.

The settling tank: receives water from main stream. It has five chambers each separated from each other by a 3 ft wide concrete wall. Each chamber leads in to the others through a 3 ft wide out let. The main inlet of the settling
CHAPTER - 6.0

PROBLEM OF TROUT CULTURE IN HATCHERIES FARMS IN KASHMIR

CASE HISTORY OF FEW HATCHERIES:

The valley of Kashmir is the "Heaven on the Earth" as it is called, is situated in the midst of the Himalayan range at an altitude of over 1500 m ASL. Nature has embellished this valley with peerless beauty and attractive ecological peculiarities. The valley is bounded by tall and towering mountains which remain snow-clad during the months of December to March. On the outset of spring the snow melts, clear and cool water flows down the stream and intercept the valley.

After the successful introduction of trout in the valley in all three trout hatcheries were established in the state, one each at Harwan, Haribal and Achabal of which the first one is at present not in working condition while the other two said hatcheries are effectively working to meet the burning demand of the valley and attract more foreigners for angling. Now let us study the case history of all the three hatcheries of the state in detail.

LARIBAL TROUT HATCHERY:

The Laribal Trout hatchery is located 1708 m above mean sea level (Jhingran 1978). It is situated amidst the National park at Dechigam 2 kms away from the Historical Mughal Garden Harwan.
tank is guarded by a square iron sieve which prevents entry of twigs/leaves, straws, floating debris etc if any big particles flowing with water. The small sized impurities, silt etc settles at the bottom of each chamber and clear water flows through the main outlet. The outlets are provided with fine iron sieves which arrest the last possible impurities, if any in the water. In this way clean and transparent water is drawn to one entire hatchery complex.

**FEEDING CANALS:**

There are four feeding canals each 3 ft wide. The biggest canal (canal No 3) is about 1000 ft in length and 2 ft in height, feeds nine stocking ponds or the raceways. The canal No 2 feeds sixteen nurseries. The fourth canal running besides canal No 3 feeds forty fry rearing pools. All the four canals are guarded by iron mesh to prevent the entry of impurities to the hatchery/pools.

**OVA HOUSE:**

The ova house of the Hatchery which is two storied building. The lower storey occupies the hatching unit which contains hatching troughs and trays.

**VERTICAL FLOW INCUBATOR:**

It consists of used oil drum connected to the water supply by a hose. In the drum a metal wire with small pebbles is arranged at a point where the intake serves as
filter. The pebbles are used to act as barrier against incoming dirt which may find their way into the hatchery tray along with water current. Above this filter, hatching tray is hung with nylon twine over a wedge. This tray is used for incubation of eggs. Excess of water flows out through outlet let at the top.

ACHABAL TROUT HATCHERY (CASE HISTORY)

LOCATION:

The Achabal Trout Hatchery lies at the base of a small mountain called "Rakhi Mountain". The hatchery is located at an altitude of 1621 m above (msl) and is very near to the historic Achabal Garden about 60 km from Srinagar.

DESCRIPTION:

The Achabal Trout Hatchery is the biggest Trout hatchery in the State having an area of 30-35 Kanals (1 Kanal = 5400 sq meter). The hatchery has the capacity to rear 4,80,000 seedlings from one species per operation. The hatchery comprises of two main units: the hatching complex of two main units the hatching complex and seed rearing pools. The former comprises of (i) water source and settling tank (ii) ova house while as the latter comprises of fry pools, stocking ponds and circular pool.
WATER SOURCE AND THE SETTLING TANK:

The water source of the hatchery is the perennial spring "Achabal Nag", situated in the premises of the hatchery. It is helocrene type of spring. The chemical parameters of water as mentioned by Shingran and Shegal (1978) are as follows:

- pH = 7.9
- D0₂ = 9.4 ppm
- pree CO₂ = 2.3 ppm
- Alkalinity = 86.0 ppm
- Silicate = 0.47 ppm

Settling tank (100¹ x 50¹ x 5¹) is concerate structure having 6 chambers 5 being rectangular and the 6th triangular in shape. Each chamber leads in to the other through a 3 feet diameters out let suspended particles settle down at the bottom and clear water goes to the units of the hatchery.

OVA HOUSE:

It is one storeyed building occupying the raw concreate cement type of hatchery, the units of which are hatching troughs and hatching trays.

HATCHING TROUGHS: are 32 in number arranged in 4 parallel rows. Each row is divided into 2 subrows, each having 4 troughs. The troughs rest on stone bars. Each trough can accommodate 5 hatcheng trays.
HATCHERY OPERATION:

Both the rainbow trout and the brown trout are taken for breeding here. Stripping in case of Rainbow is usually started from Jan/Feb where as brown trouts are stripped from 25th Nov. and operation ends on 25th Dec. The incubation period for green egg to swim up fry in case of brown and Rainbow trouts are 76 and 85 days respectively.

HARWAN TROUT HATCHERY

LOCATION:

The Harwan Trout Hatchery is the oldest hatchery in India. It has constructed by Mitchell in 1905-06 (mitchell, 1918). It is located at an altitude of 1708 m (msl) (Jhingran 1983) and is about 8 km away from sringer very near to historical Mugal Gardan.

DESCRIPTION:

It is the oldest hatchery in the state with seed rearing Capacity of 3,60,000 egg, of one species only per operation units. The hatchwery may be described under two units, the hatching complex comprising of (i) water source (ii) ova.house and the seed rearing unit Comprising of stocking ponds and nursery ponds.
WATER SOURCE:

The water source of the hatchery is a stream. The physio-chemical parameters of the water of the stream as mentioned by Jhingran and Schgel (1978), are as follows:

- **Water temperature range** = 16-19.8°C.
- **DO₂** = 8.7 ppm
- **pH** = 7.5
- **free CO₂** = 1.8 ppm
- **Total alkalinity** = 84.0 ppm
- **Silicates** = 0.78 ppm

OVA HOUSE:

The ova house of the hatchery is a two storyed building. The lower storey occupies the hatchery unit which comprises of hatching troughs and trays.

HATCHING TROUGHS: Are of R.C.C type, 24 in number and arranged in parallel rows. Each trough can hold 5 hatching trays.

HATCHERY OPERATION:

At this hatchery, stripping operation is not carried out but eggs broughts from the larival Trout hatchery are reared here.
CHAPTER - 7.0

PROBLEMS OF TROUT CULTURE IN HATCHERIES /
FARMS IN KASHMIR

In India, particularly in Kashmir, trout farms face innumerable problems in running hatcheries. Some of these problems of Kashmir hatcheries are as follows:

(1) **High percentage mortality of Trout hatchling during incubation**: Incubation stage is the most crucial stage in trout farming. The average range of percentage of survival from green egg to fry stage has been observed to be 5-10% in case of rainbow trout and 2-5% in case of brown trouts. Reason for high percentage of mortality and such a slow survivability has been attributed to increase in pH, hail storm and variation in temperature.

(2) **High cost of artificial feed**: The quality feeds of animal origin essential for trouts, in bulk are not easily available in Kashmir. Whatever available are very costly. High cost of feed makes trout rearing expensive and uneconomical such animal feed can not be stored for long time and this have to be procured fresh in required quantity regularly. The other reed used in the state are silk worm pupae which alone do not form a balanced diet and also is expensive.
**Slow growth:** Metabolic process of trouts in Kashmir due to low temperature range is too slow to expect faster growth.

(4) **Low Fecundity:** Because of very low fecundity (1500-2000 egg/kg body weight) a large number of breeders are required to be maintained to raise requisit number of fish seed. The breeding operations and incubation period are lengthy involving very careful handling and fry is produced after 4 months. These are all forbidding negative factors.

(5) **Incidence of disease:** Due to extraordinary long duration of egg hatching the trout eggs are often subjected to various diseases and natural calamities.

The diseases commonly encountered in the state inflicting heavy mortality are fungus (Saprolegina) causing "white spot" disease in the soft egg condition at green and eyed ova stages and white spot at aleuun stages. In case of adults fin rot or "Ich" disease and whirling diseases due to deficiency of vitamins are prominent.

(6) **High Oxygen requirement:** The trout in nature live in highly oxygenated cold and clear water. In most of the hatcheries due to various reasons continuous supply of fresh cold and clear water cannot be stagnant pond waters of trout farms resulting in very poor realisation.
(7) **Silt and Turbidity:** Trout youngs are very sensitive and susceptible to mortality due to chocking of gills by silt. Heavy rains and snow fall in the upper strechs of stream causes to carry silt laden water often infilcting mortality of stock. This is difficult to control.

(8) **Predators:** Certain birds and mammals are enemies of trout eggs, fry and adults. These birds and mammals causes heavy damage to the fish farmers. The major predators which effect the fish farms of Kashmir are as follows:

(i) **Otters** *(Lutra lutra):* Web footed, natural otters are armed with sharp teech. Large fishes are their main prey. These animals cause destruction of fish.

(ii) **Water shrew** *(Neomys fondiens schreber)* These are little rodents and is worst enemy of trout eggs and fry in hatchery or some times killing all the fry in the hatching troughs in a single night.

(iii) **Water Vole** *(Arvicolina amphibius);* The water vole is a complete vegetarian animal and is not direct enemy of trout. How ever undermining banks with its burrowings give rise to leaks. Terriers are the best solution tosuch a problem.

Apart from these there are also some ichthyophagus birds which damage trout especially in shallow waters or ponds. Among birds kingfisher *(Alcedo athins)* Herons, wild ducks and swans are most damaging creatures.
(1) **King fisher (Alcedo atthis):** King fisher either sits on the branches of the tree or tree trunks and plunge like lightening on its prey. It preys upon fry and fingerlings. Hence to protect from king-fisher ponds are covered with wire retting.

(2) **Herons:** Herons live round shallow streams and these birds fish during the day and clear rights. They can swallow whole fish measuring between 15 and 20 cms destroying great quantities in large ponds and race ways.

(3) **Ducks and swans:** These also play an important role for decreasing the trout fry and fingerlings in the streams of the valley when the fish is in the fry stage the ducks and swans during their search for their food in the streams act as an easy prey.

**PROBLEMS IN NATURAL WATERS:**

(1) **Topographical:**

In Kashmir Natural waters inhabiting the trout are subjected to swift torrential currents in the rocky terran, littered with big boulders and steep falls, consuming too much energy of fish innegotiation on the way.

(2) **Peculiar breeding habits:**

The breeding habit, the breeding season and prolonged incubation of embryo in some cases about 4 months are sources of major handicaps for natural propagation or trout, in streams. These problems restrict Natural recruitment of trout in wild water and negligible.
(3) **Low Fecundity:**

On the otherhand Fecundity of trout is very low ranging from 1500-2000 egg/kg body weight which is too low.

(4) **Carnivorous and Cannabolistic:**

The cold waters due to less temperature haveless productivity and less organic decompostion. The trouts are mostly carnivorous in feeding habit. Food has to be hunted and grasped with much efforts. As a result trouts are canibaolistic in nature especially during winter months when availability of natural food is negligenceible. Because of the feeding habits at the higher level of food chain culture of trout is expensive and because of cold environment habitat and continous energy expense against current the growth of trout in nature is slow.

(5) **Prolonged winter/Cold weather:**

Due to geographical location almost throughout the year Kashmir valley expermennts very cold weather and also snow fall. During these period temperature falls up to -2°C to 4°C. Low temperature also reduces all physiological activities and also the growth rate of fish. Because of low temperature and cold weather the survival of trout in kashmir is very less.
(6) **Turbidity:**

The hill streams in habiting trout during winter with crystal clear water have no turbidity and such condition prevails for more than 9 months in a year, thus fish is acclimatised to lowest turbidity. The turbidity suddenly increases in rainy season when rain water brings all the dirt, sand and other impurities from catchments. This sudden change of the turbidity exceeds the tolerance limit of trouts choking their gill causing mortality.

(7) **Shrinkage of trout Streams:**

Expension of water supply schemes in the rural areas by the Public Health Department is undoubtedly a serious problem to trout waters which has not only disturbed the ecological balance but also polluted these water resources. Thus causing "biological imbalance". The effect of pollutants indicate a serious situation.

(8) **Effect of pesticides:**

Paddy is the main crop cultivated in Kashmir, the excess agricultural water ladden with pesticides and herbicides etc is directly discharged in trout streams. This has adversely affected trout fishery in some of the areas.
CHAPTER 7.1

SUGGESTION FOR IMPROVEMENT IN TROUT FARMING IN THE STATE

In India though there are plentiful resources, the fishery development had little impact on the economic growth of the upland areas. Now the need to develop the fishery has been realised. But for the development of fisheries resources in the form of cultivable water are the first and the foremost requirement. Here are some suggestions which should be taken into consideration.

(1) Old practices of trout rearing should be changed by introducing modern techniques and facilities in existing hatcheries. (2) Keeping in view of the increased requirement of trout seed capacity of all the hatcheries are to be increased and new trout farms have to be established. (3) Research and development activities should be intensified and package of easily acceptable, economically viable techniques should be developed. Technology should be suitable for adapting under the local conditions. It is necessary to organise a research institute which will exclusively deal with research and development of cold water fisheries including trout fishery.

Trout culture in the state is mainly done to ful fill the stocking requirement of streams, ponds, for angling by the tourists but no attention has been paid for culture of trout on commercial links for food production. Most of the streams in the Himalayas are wide and carry large
volumes of water during March to October and alternation of physical, chemical and biological condition is difficult. Most of the biological conditions are affected indirectly by physical changes of the streams. However some of the changes in the physical conditions can be accomplished by human effort to improved streams for fish such as (i) Provision of spawning and survival facilities. (ii) Creation of shelter and feeding ranges (iii) augmentation of food supply.

In the United States, Europe and Japan, the cost involved in stream improvement in certain case is met by the private clubs. Also levy of a tax from immediate beneficiaries is made a source for improving the trout streams.

In India in trout fishery states right for collection of stones gravel and sand from the streams for building purpose wests with departments other than the fisheries. With the indiscriminates removal of these material from river beds the spawning beds of trout are affected and ecological balance is also distruned. Thus for the future development due regard should be paid to spawning requirements of trout in exploiting the river bed for collection of building material. Also due to deforestation and resultant soil erosion streams become loose-boulder-bedded and more flood prone with water heavily laden with silt. These are also unfavourable for the reproduction and propagation of trout. Madmati stream of
Kashmir valley has eventually become devoid of trout because of non adoption of soil conservation measures. Now the time has come to examine the prospect of trout culture as a commercially viable source of food production as practiced in other countries.

(3) In trout culture maximum mortality occur from egg to fingerling stage. Research activities should be intensified to prevent mortality at this stage of life.

(4) Standardised dry compound pelleted feed with locally available and cheap ingredients should be prepared in adequate quantity and made available to entrepreneurs at cheaper rates.

(5) Improved and fast growing strains of trout should be improved/developed for culture in India.

(6) Unfortunately trouts are restricted within the places of tourist attraction although there is no derth of space for trout culture in Kashmir. Now with the development of facilities in the state suitable areas should be selected for establishment of trout farms to increase the fishery of the state.

(7) Attempts for rejuvenating and modernising trout angling facilities and also for extension of facilities more sports should be taken seriously. Most of trout streams in India are not well-connected by roads and wherever the roads are but they are not smoothly motorable. All important fishing beats for trout should be connected with main high way by smooth motorable roads. At place,
where facilities for trout fishing are available competities in trout angling can be introduced to attract anglers from country as well as also from abroad. According to new practice in Kashmir the total number of fish caught and the lure used are entered in a Department log Book. At the time of issueing of fishing permit a proforma for detailed information and also a receipt of fee Rs.30 for 3 fishes is also issued.

(8) A suitable education programme to educate interested students, entrepreneurs and fishermen about trout culture conservation etc should be drawn only in collaboration with state fisheries Department and Government of Indian Ministry of Agriculture. The student should be trained in latest techniques practiced in countries advanced in trout culture.

(9) To check poaching/illegal fishing, existing fisheries act should be amended in order to effect heavy penalties and imprisonment to low breachers.

(10) Watch and ward for ensuring proper conservation and protectiin spawning grounds of trout streams should be strengthen. Trout fishing equipment are difficult to procure and at the same time are costly. In order to encourage and popularise trout fishing equipments have to be provided on hire.

(11) In order to have positive population increase, waters should be stocked with trout fingerlings instead of eyed ova or swim up fry stage.
(12) Indo-U.K Project constructed at kokernag should work on the modern technologies which after success may be implemented to other farms of the state and subsequently to be transferred to other parts of the country.

Lastly the premier institute like C.I.F.E Bombay should take up collaborative pilot projects with Directorate of Fisheries Jammu and Kashmir to develop commercially viable trout hatcheries as demonstration centres. These centres may serve as the nuclear for trout fishery propagation.
CHAPTER - 8.0

CONCLUSION:

The credit for introduction of trout in Kashmir goes to foreigner namely F.J. Mitchell who have successfully transplanktive the rainbow trout (Salmo trutta fario) from scotland to Kashmir valley mainly for sports and recreation. Since then trout fishery has developed up to some extent in the streams but wide distribution of fish is yet restricted due to many constraints, most important of those constraints are poor survival rate in the hatcheries, lack of nutritional diets, defective setting up of farms, unsatisfactory water supply and limited number of trout hatcheries to cope up with the demand of seed. The poor survival in the hatcheries is due to rough handling of trout eggs, poor maintenance of brood stock, and silty water supply.

Production of cheap but nutritious formulated feed having higher conversion values, appetence value and stability are important requisite criterion for trout feed. Though CIFRI and stage fisheries has developed some feed rich in nutritional requirement, these are used only in the Government farms. These are costly and are not available in bulk and local fish farmers can not afford to spend so much on feed.
Adequate research and developmental activities to prevent high mortality due to congenital pathogens and nutritional deficiencies have not so far been taken up in respect of trouts. Mortality on trouts due to disease in very high.

CAPTURE (SPORT FISHERY)

Trouts have mainly been treated as one of the most important fish of valley providing recreation to thousands of tourists as well as local anglers who visit the valley every year. Trout has been used as a good source of revenue for state fisheries department, but not has been treated as a source of protein food for the local people. Since last few years the fish has been depleting continually due to illegal fishing, dynamiting, catching of undersized fishes & brooders again the deforestation causing heavy soil erosion has also aggravated the situation. Measures like stocking of streams with young trouts, strict enactment of the ban on spinning and that of bag limit, is also lacking amendment of the existing regulation laws, by imposing heavy penalties on defaulters should come into exsistance.

For the supply of adequate number of hatcheries should be increased several times. Trout fishery because of less survival, low growth, high cost of feed and high standard of management is not economical to culture for food.
State fisheries department with food deal of effort is able to produce table size fish to sell once in a week in the market at the Rate of ₹.45/kg for local people. Except a limited number of high families the common local people can not afford to purchase this fish at such a high cost. The supply is also limited and irregular. Trout are also supplied by the Fisheries Department to a few five star hotels of some cosmopolitan cities like Bombay, Delhi, Madras, Calcutta at the rate at least ₹.85/- for each kg.

Hence after considering the prospects and constraints of Trout fishery, its status, future requirements, and constraints for development it appears that trout is not economically viable for culture purposes for supply of food for common consumer. There should be other local species and exotic fishes viz. common carp, Indian trout, Barilius bendelisis which should be given preference. As common people during winter and also during religious festivals like "Shivratri" are in great demand of fish, and common carp and indigenous fishes showing encouraging growth should be adopted for culture purpose to meet this very high demand of nutritional requirement of local people.
However, propagation of trout culture cannot be neglected because of its latest foreign exchange earning capacity from thousands of tourists visiting Kashmir valley every year and other big capital hotels of India. Trout culture needs to be encouraged to meet its present demand by tourists in future. For this it is very necessary to promote research, education and developmental activities through strengthening and expanding existing cold water Fishery Research centres, formulation of cheap nutritious feed, and installation of modern trout hatcheries so that streams can be adequately stocked. Trout hatcheries which are already functioning should be modernised and expanded. A group of supervisory staff members should be trained at suitable centres of other countries where trout culture is developed.
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