10

Aquaculture and Fisheries

Feedback Copy

Technical and Vocational Stream

Learning Resource Material

Aquaculture and Fisheries

(Grade 10)

Secondary Level

ANIMAL/PLANT SCIENCE

Government of Nepal
Ministry of Education, Science and Technology
Curriculum Development Centre
Sanothimi, Bhaktapur

Publisher : Government of Nepal
Ministry of Education, Science and Technology
Curriculum Development Centre
Sanothimi, Bhaktapur

Layout by Khados Sunuwar

Preface

The curriculum and curricular materials have been developed and revised on a regular basis with the aim of making education objective-oriented, practical, relevant and job oriented. It is necessary to instill the feelings of nationalism, national integrity and democratic spirit in students and equip them with morality, discipline and self-reliance, creativity and thoughtfulness. It is essential to develop in them the linguistic and mathematical skills, knowledge of science, information and communication technology, environment, health and population and life skills. it is also necessary to bring in them the feeling of preserving and promoting arts and aesthetics, humanistic norms, values and ideals. It has become the need of the present time to make them aware of respect for ethnicity, gender, disabilities, languages, religions, cultures, regional diversity, human rights and social values so as to make them capable of playing the role of responsible citizens with applied technical and vocational knowledge and skills. This Learning Resource Material for Animal/Plant Science has been developed in line with the Secondary Level Animal/Plant Science Curriculum with an aim to facilitate the students in their study and learning on the subject by incorporating the recommendations and feedback obtained from various schools, workshops and seminars, interaction programs attended by teachers, students and parents.

In bringing out the learning resource material in this form, the contribution of the Director General of CDC Dr. Lekhnath Poudel, Dr. Tanknath Sharma, Anish Subedi, Mahesh Poudel, Sagar Paudel, Samir Shrma, Suresha singha Dhami is highly acknowledged. The book is written by Balchandra Chaulagai and the subject matter of the book was edited by Badrinath Timsina and Khilanath Dhamala. CDC extends sincere thanks to all those who have contributed in developing this book in this form.

This book is a supplimentary learning resource material for students and teachrs. In addition they have to make use of other relevnt materials to ensure all the learning outcomes set in the curriculum. The teachers, students and all other stakeholders are expected to make constructive comments and suggestions to make it a more useful learning resource material.

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Ministry of Education, Science and Technology

Curriculum Development Centre

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UNIT - ONE
Introduction of aquaculture and fisheries

Learning outcomes

After completion of this lesson students should know about,

- General introduction to fish, fisheries and its types.
- General characteristics of indigenous and improved fish species with their habit and habitat.
- General principle of aquaculture, farm design and pond construction.

Fish

Fishes are the first successful class of the chordates. They are aquatic cold blooded vertebrates which breathe by means of pharyngeal gills, propelling and balancing themselves by means of fins. About 40,000 living spp. of fish are found in the world.

Fisheries

Aquatic organisms, which are exploitable by the public as a common property resource with or without appropriate license is known as fishery. For example: Riverine fisheries, lake fisheries, fishing on rice fields, wetlands etc. Fisheries can be divided into 3 types

a) Capture fisheries
b) Enhance fisheries
c) Culture fisheries or aquaculture

A. Capture fisheries:

The capture fisheries are characterized by the following:

- No stocking
- No management practices (eg. fertilization, liming, monitoring etc.)
- Only harvesting.
- Artificial feeding should not provide.

B. Enhance fisheries

The characteristics of enhance fisheries are as follows:

- Only stocking.

- No management practices (eg. Monitoring & supervision, fertilization, Record keeping, liming etc.)
- Harvesting.

C. Culture fisheries or aquaculture

Aquaculture is derived from two words **'**Aqua' means water and 'culture' means farming. Thus, aquaculture is the farming of aquatic organisms: fish, mollusks, crustaceans, aquatic plants, crocodiles, alligators, turtles, and amphibians. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc.

1.1 Basic principles of fish culture

Fish Culture is being one of the most productive cultural practices. Therefore, fish culture is very common and widely practiced in most countries of the world. This fish culture practice do not only produces nutritious food improving nutritional status but also helps in generating income and provide job opportunities to the number of the people. The fish culture is comparatively easier, thus a person affords to look after larger production areas in compare to other agricultural activities. Moreover, by this practice system, fish is produced at low level in lower cost and the increased in production give economic benefit to the grower. The construction of a water body in the form of small or big pond size do not only facilitates to carry fish culture but it also helps in conserving water to use as per the need arises e.g. to fight against the fire or to save the major agricultural crop by irrigation in drought condition. Sustainable fish culture requires following points that should be followed;

- Production technology should follow scientific manner.
- It should be fully developed and feasible.
- It should be socially acceptable and economically viable.
- Water quality should be managed properly and regularly.
- It should not provide hazardous effect to the environment.
- Feeding should be based on water temperature, body weight and growth stage which will minimize the losses and maximize the profit.
- There should be appropriate stocking density & harvesting techniques.
- There should be good disease management practices.

- Production technology includes the fish husbandry, seed storage, growth, harvesting facility and culturing of species.
- All the production technology should be ecofriendly & maintain species diversity.
- Always stock healthy, disease free, true to type seed.

1.2 Habit & habitat of improved fish varieties

Habit may be define as a usual way of behaving something which dose in regular and repeated way.

A habitat is an ecological or environmental area that is inhabited by a particular species of animal, plant or other type of organism. The term typically refers to the zone in which the organism lives and where it can find food, shelter, protection and mates for reproduction, utilizing the qualities the species has adapted to survive within the ecology of the habitat. It is the natural environment in which an organism lives, or the physical environment that surrounds a species population.

Habit and habitat of fish species helps to know about the nature of fish varieties. It also helps to know about their origin, growth habit, food, shelter, environmental requirement as well as their reproduction behavior. it also helps to differentiate the warm and cold fishes within a improved species.

Habit and habitat of major carps (Indian and Chinese carps)

Carp are a large freshwater fish native to central Asia. Introductions in many countries have helped to make carp the most widely distributed fresh water fish in the world. They are extensively farmed in Europe, Asia and the Middle East, and are a popular angling fish in Europe. Carp are very versatile, and can live in a great variety of habitats including highly degraded areas. Carp are usually found in still or slowly flowing waters at low altitudes, especially in areas where there is abundant aquatic vegetation. They are also found in brackish lower reaches of some rivers and coastal lakes.

They are capable of tolerating a wide range of environmental conditions. They have a greater tolerance of low oxygen levels, pollutants and turbidity than most native fish, and are often associated with degraded habitats, including stagnant waters.

Changes to water flows, declining water quality and other changes to river habitats over the past few decades have negatively affected many native fish while favoring carp. Carp are omnivorous, and their diet varies depending on what is available. They consume a range of small food items such as mollusks, crustaceans, insect larvae and seeds. These food items are sucked up (along with mud and water) from the bottom and filtered out using the gill rakers.

Under suitable conditions, carp are highly prolific. They mature early as early as 1 year for males and 2 years for females and the females produce large numbers of sticky eggs (up to 1.5 million for a 6kg fish).

Habit and habitat of indigenous fish

Rohu

Rohu is a fish of the carp family found commonly in rivers and freshwater, lakes and around Southeast Asia, Pakistan, Nepal, Myanmar and Bangladesh in addition to Thailand. Rohu is the natural inhabitant of freshwater sections of the rivers. Rohu thrives well in all fresh waters below an altitude of approximately 600 m. Rohu is a bottom feeder and prefers to feed on plant matter including decaying vegetation. Rohu attains maturity towards the end of the second year in ponds. The spawning season of rohu generally coincides with the southwest monsoon. Spawning takes place in flooded rivers. The fecundity of rohu varies from 226,000 to 2,794,000, depending upon the length and weight of the fish and weight of the ovary. Spawn may be collected from rivers and reared in tanks and lakes.

Naini / Mrigal

Mrigal inhabits all the major river systems of India, Nepal, Pakistan, Bangladesh and Burma. The adult fish feeds upon filamentous green algae, diatoms, pieces of higher plants, decayed vegetable, mud and detritus. It is basically a bottom feeder and hence suitable for cultivation with column and surface feeder carps in ponds. Mrigal usually attains maturity within 1 or 2 years depending upon the agro climatic conditions of the location. Fecundity ranges between 1, 24,000 to over 1,900,000 depending upon size. Spawning season is linked with the onset and duration of the southwest monsoon. It does not breed in ponds, but can be easily bred in bunds and by hypophysation. It is now being induced to breed twice within the same spawning

season. Rearing of seed is usually undertaken in seasonal or perennial undrainable ponds. Under pond culture conditions it grows to over 1 kg in one year.

Catla/ Bhakur

Catla is the fastest growing Indian major carp species and widely distributed throughout India, Nepal, Pakistan, Burma and Bangladesh. It inhabits the surface layer of water and feeds upon plankton. Adult stages are predominantly zooplankton feeder, occasionally taking in decaying macro vegetation, phytoplankton and smaller mollusks. It attains maturity in the second year of life and carries over 70,000 eggs per kg body weight. It naturally breeds in rivers during monsoon season and under control conditions in bunds as well. It does not breed in ponds. However, it responds well to hypophysation techniques. Seeds are easily reared in undrainable ponds of relatively smaller size. Under composite fish culture in ponds it usually grows to over 1 kg in one year.

1.3 Indigenous & exotic fish species, their identification & body structure

Indigenous fish species

A native fish species that is indigenous to a specific place or regions which are favorable and suitable to that environment and exist from a long period of time is known as indigenous fish species.

Table 1: Indigenous fish species of Nepal & their present status

S.N	Scientific name	Local Name	Status
1	*Labeo rohita*	Rohu	Well establish, warm water fish
2.	*Cirrhinus mrigla*	Naini	Well establish, warm water fish
3.	*Catla catla*	Bhakur	Well establish, warm water fish
4.	*Tor tor*	Sahar	Confined to research station, cool water
5.	*Nelissocheilus hexagonolepis*	Katle	Confined to research station, cool water
6.	*Labeo dyocheilus*	Gardi	Not in culture
7.	*Tor putitora*	Mahaseer	Culture in limited scale, cool water

Rohu: - Labeo rohita

Rohu is considered as tastier fish species among the cultivated carps in Nepal. It is characterized by an elongated and cylindrical body; the body color is dull reddish on the sides and whitish on belly. The big fish attains to 2' - 3' in length. Head is small than its body size and other characteristic are as follows:

- Sub-terminal mouth parts and 1 pairs of maxillary barbells, the lips are thick and fringed
- Column feeder, herbivorous in feeding nature. The fish feed on small plants and decomposed materials of the pond and grows to a large size.
- It attains size of 900 gm at first year and up to 30 kg at maturity.
- Sexual maturity is attained towards the end of the second year.
- Rohu is seasonal breeder and artificial breeding is done by hypophysation. The breeding season is June to August when the temperature is 25-30˚c

***Source** : www.google.com.np/search?q=rohu*

Fig.1: Rohu (Labeo rohita)

Catla/Bhakur: Catla catla

Catla is a fast growing fish among the indigenous cultivated carps. The barbells are absent and lips are non fringed. Body color is grayish to silvery on upper sides and whitish on belly and other characteristic of Catla/Bhakur are as follows:

- Fast growing fish, deep laterally compressed body with massive head.
- Large upturn mouth.
- It is surface Zooplankton feeder but young ones feed both zooplankton and phytoplankton.
- It attains 1-1.5 kg at first year over 1.5 m length and size up to 45 kg.
- Catle is seasonal breeder and artificial breeding is done by hypophysation. The breeding season is June to August when the temperature is 25-30˚c.

***Source** : www.google.com.np/search?q=Catla*
Fig.2: Catla/Bhakur(*Catla catla*)

Mrigal / Naini: - *Cirrhinus mrigal*

Among indigenous fish species mrigal is next in importance to Rohu and catla for culture. This fish is characterized by elongated and cylindrical body and other importance characteristics of the Mrigal / Naini are as follows:

- Small head and sub-terminal mouth one pairs of small barbells are present.
- Thin non fringed lips ,upper jaw is longer than lower jaw
- Marginal and bottom feeder, omnivorous in nature and feeds on detritus mud organisms, decaying plant and animal matter however young ones feed on zooplankton.
- Largest size attains up to 90 cm and 30 kg .time maturity and breeding behavior is similar to rohu and catla.

Source: www.google.com.np/search?q=Naini
Fig.3: Naini (Cirrhinus mrigal)

Exotic fish:-

Exotic fish species are those species that were native to any other place or region, but have been introduce or imported into a new place. An exotic fish is a species that didn't originate in that place or region. It was brought from a foreign place, region or country for culturing.

The exotic and indigenous fish species of Nepal and their present status is given below in the table:

Table 2: Exotic fish species of Nepal & their present status

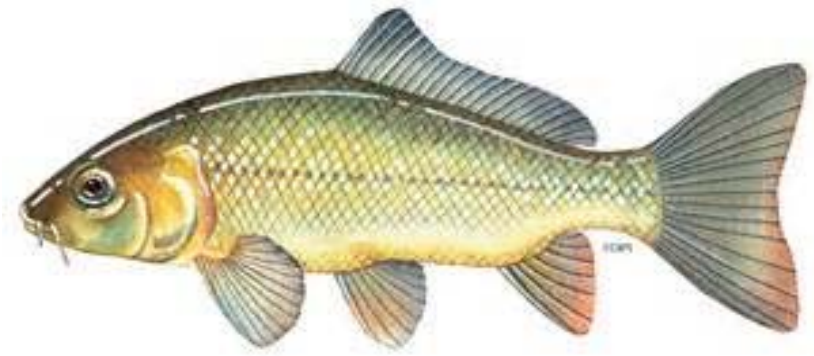
S.N.	Scientific Name	Common Name	Status
1.	*Cyprinus carpio* *-Var communis* *-Var specularis*	Common carp - German carp/ Scale carp - Mirror carp/ Isreali carp	Well established in warm water culture
2.	*Ctenopharyngodon idella*	Grass carp	Well established in warm water culture
3.	*Hypophthalmichthys molitrix*	silver carp	Well established in warm water culture
4.	*Aristichthys nobilis*	Bighead carp	Well established in warm water culture
5.	*Oreochromis niloticus*	Nile Tilapia	Culture in limited scale(warm water)
6.	*Oreochromis mossamibcus*	Tilapia	unauthorized introduction by farmers (Warm water)
7.	*Pontius gonionotus*	Silver barb(Tawes)	Confined to government farm (Warm water)
8.	*Carassius carassius*	Gold fish	Decorative use
9.	*Clarias gariepinus*	African catfish	Culture in limited scale by farmer, warm water fish.
10.	*Oncorhynchus mykiss*	Rainbow trout	Well established in cold water.
11.	*Pangasius hypopsthalmus*	Pangasius/Pangas catfish	Culture in limited scale by farmer, warm water fish.
12.	*Macrobrachium rosenbergii*	Fresh water prawn	Confind to research station.

Common carp: - Cyprinus carpio

Common carp is the most important cultivated fish in the world. Common carp was introduce to Nepal in 1956 & 1960 from India & Israel respectively. There are lots of morphological variations through artificial breeding and natural selection of this species. The general characteristic of the Common carp are as follows:

Under this species two varieties are available i.e. German carp (*Cyprinus carpio var* communis) and Israeli carp(*Cyprinus carpio var* specularis)

- Flat and deep body, small and short head
- Protractile mouth two pairs of maxillary barbells.
- Dorsal fins is long with a sharp spine
- It is a bottom feeder, omnivorous and feeds on insect larvae, worms, molluscs, and detritus, fresh and decayed vegetation and accepts formulated feed also.
- It attains 1-2 kg sizes in first year. It is found up to 18 kg in natural water bodies.
- It attains sexual maturity after 1-2 year.
- Common carp is a multiple breeder & can breed up to 5 times a year
- It can breed naturally on stagnant water but semi natural breeding is carried from Falgun to Baisakh.
- It is bottom feeder fish that feed on detritus, mud and organic matter.
- Two types of common carp are found in Nepal. They are;
  a) Scale carp/German (Cyprinus carpio var. communis)
  b) Mirror carp/Israeli carp (Cyprinus carpio var. specularis)



***Source** : www.google.com.np/search?q=Scale carp*

Fig. 4 : **Scale carp/German** (*Cyprinus carpio var. communis*)

***Source** : www.google.com.np/search?q=Mirror carp*

Fig. 5 : Mirror carp/Israeli carp (*Cyprinus carpio var. specularis)*

Grass carp: - Ctenopharyngodon idella

Grass carp are exotic fish which was introduced in Nepal from India & Japan in 1967 & 1968 respectively. The grass carp is one of the largest members of the minnow family. The body is oblong with moderately large scales, while the head has no scales. There are three simple and seven branched rays on the dorsal fin. Grass carp are silvery to olive in color, lacking the golden hue of common carp, and they have no barbells.

- This is warm water fish thus require water temperature about 22 to 27^0c for successful culture.
- Elongated and cylindrical with large greenish scale
- It has tooth less mouth but has specialized pharyngeal teeth for grasping aquatic vegetation.
- Mouth is sub-terminal with upper jaw slightly longer then lower jaw.
- Gill rakers are short & sparse.
- Grass carp is a column/marginal feeder, Feed aquatic vegetation, column and marginal feeder, herbivorous in feeding habit.
- Fry of grass carp feed on protozoa, rotifers, Nauplius larvae & minute aquatic plants.
- Grass Carp is a voracious feeder & can consume 50 to 60% weight of grass per day of its body weight.

- Digestion of grass carp is incomplete & about half of the food material ingested is excreted as feces.
- It is said to be biological weed controller fish.
- It grows 1-2 kg in first year and up to 50 kg at maturity.
- After 2-3 year it takes sexual maturity for breeding. Artificial breeding is carried out in the month of Jestha – Ashad

***Source** : www.google.com.np/search?q=Grass carp*

Fig.6: Grass Carp(Ctenopharyngodon idella)

Silver carp: - Hypophthalmichthys molitrix

It is an exotic fish introduce in Nepal from India & Japan in 1967 & 1968 respectively. The general descriptions of silver carp are as follows;

- It is warm fish which grow best on 22 to 28^{o} c temperature.
- It is surface feeder.
- It is phytoplankton feeder but young fry feed on zooplanktons.
- Laterally compressed body covered by small silvery scale
- Small head, barbells absents
- Mouth upturned with lower jaw longer then upper jaw
- It attains 1-2 kg at first year& largest size found up to 40-50 kg.
- It takes sexual maturity in 2-3 year of rearing & artificial breeding is done in controlled environment.
- It is highly sensitive fish during handling period. Improper handling lead to high mortality rate in this fish.

***Source** : www.google.com.np/search?q=Silver carp*

Fig.7: **silver carp** (Hypophthalmichthys molitrix)

Bighead carp:-Aristichthys nobilis

This is exotic fish introduced to Nepal from America and Hungary in 1969 and 1972, respectively. The general characteristics of the bighead carp are as follows;

- Flat body, laterally compressed and cover by small silvery scales brownish above
- Head Lone and massive head barbells absents
- Large mouth, upturn with lower jaw longer then upper jaw and the abdominal keel is incomplete.
- The posterior margin of the pectoral fin extends beyond the base of the pelvic fin
- Surface feeder, feed Zooplankton but larvae mainly feed on unicellular phytoplankton, rotifers and nauplii.
- It grow 1-2 kg first year up to 40 -50 kg, maturity 2-3 year
- Artificial breeding is done by hypophysation. The breeding season is May to July when the temperature is 24-28ºc
- It is a docile and hardy fish for transportation and handling.

***Source** : www.google.com.np/search?q=Bighead carp*

Fig. 8: Bighead carp (*Aristichthys nobilis*)

Nile tilapia:-Orechromis niloticus

Nile tilapia is native to most major northern and central African river systems and has been distributed widely throughout the world. This fish was introduced to Nepal from Thailand in 1985. This fish is characterized by,

- The presence of long spiny dorsal fin interrupted lateral line.
- The presence of distinct black stripes on the body and tails
- Presence of long spine dorsal fins interrupted lateral line and presence of distinct black strips on body and tails
- Phytoplankton feeder but also feed on insects.

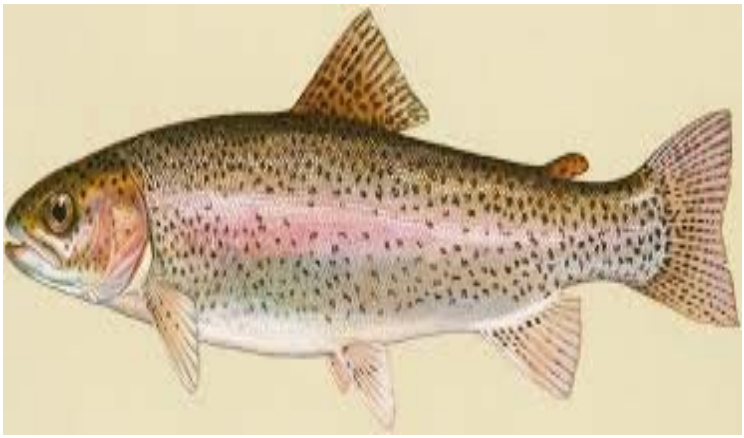
***Source** : www.google.com.np/search?q=Nile Tilapia*
Fig.9: **Nile Tilapia** (*Orechromis niloticus*)

Rainbowtrout: *oncorhynchus mykiss*

The rainbow trout is a high-valued cold water fish and is a member of salmon family.It is native to the USA,but is now farmed globally. It was introduced to Nepal in 1998 from japan.General description of rainbow trout is as follow:

- Body is elongated and laterally compressed with rounded snout.The upper side of the head is blue-green, yellow-green or almost brown.
- The sides are silvery and marked with a bright pink blush to red band and many small black spots.
- Rainbow trout is highly carnivorous and a predator with a varied diet.It feeds on animal matter like insects, mollusks, fish eggs and small fishes etc.
- It needs high protein content feed for culture.
- It attain 200-300g in the first year.
- It is a seasonal breeder matured in 3-4 years and artificial breeding is done by

hypophysation. The breeding season is November to january when the temperature is 9 - 120c.



***Source** : www.google.com.np/search?q=Rainbow trout*

Fig.10: Rainbow Trout (*oncorhynchus mykiss*)

1.4 Farm design & pond construction

Farm design and pond construction is the most important parts of fish farming. Proper farm design and construction make the fish farming profitable. The farm design and construction should be based on scientific and modernization method. During the farm design and construction proper care should be give according to environment and topography which make the farm suitable and attractive. The following points should be considered during the farm design and construction.

- The site should be suitable for fish farming.
- Adequate resource should be available while doing works.
- All the resource should be allocated in a right manner.
- All the scientific method of farm design and construction should be followed.
- The requirements such as pond dike, water inlet, outlet, etc should be design in an appropriate manner.
- The pond should be design in such a way that makes easier to manage the pond culture in a better way.
- The structure such as harvesting pond should be in appropriate place which make harvesting easier.

Steps in pond construction

Fish pond is constructed based on an expert plan. Proper plan with proper designing of constructed pond helps in profitability of fish farming system. Following points should be followed during construction of fish pond.

- The first step involves cleaning of the selected site such as trees, bushes, grass etc and removing it.
- A rope is stretched on poles to demarcate the outer and center portion of the pond.
- Line along the length of the rope is outline to indicate the pond. About 10cm of the surface should be removed from the demarcated area of the pond.
- The top surface soil should be kept on heaps in four sides of the pond which is used in the bottom of the pond later on.
- The next step involves digging out core trench which is 1m wide and 1m deep.
- Core trench is filled with rocks and soil layer by layer which prevent the lateral seepage of water from the pond and also close the hole made by roots of plant, mouse and other reptiles.
- Dike is made above the core trench.
- The soil require for dike construction can be dug out from the center of the outline area of the pond. If the soil selected side is clay, the slope can be lesser on both side of the dike.
- The required amount of soil i.e. use to make the dike of the deepest part of the pond must be strong enough to resist the highest pressure of the water.
- To protect the overflow of water from the pond should be provided drain pipe and inlet provision and emergence spill way should be install and convenient place.
- Both the inlet and outlet are fitted with wire mesh.
- Optimum size of pond in Nepal is 1000-2000 m^2 having harvesting pit of 0.5m to 1m deep per hacter per area.

Teacher tips:

The teacher should prepare a required material for completion of this lesson. Following activities should be carried out during teaching process,

- Should show the power point slide and related video of various indigenous

and exotic fish species.

- Should divide students into groups and ask each group to explain typical characteristic of fish species.
- Should prepare diagrammatic charts of different types of pond design and its construction.

UNIT - TWO
Construction of Fish Pond

Learning outcomes

Pond construction is an important chapter for success of fish farming. After completion of this lesson,

- Students will be capable of survey and layout of various types of fish pond.
- Can select suitable location for fish pond.
- Can construct pond dike, inlet and outlet.
- Can estimate the cost of production for a given size of fish pond.

2.1 Pond survey & layout

Fishes are seen in any natural water bodies e.g. rivers, streams and lakes. Such natural water bodies are either cold where natural fish food is produced less in amount, where as in warm water the fish food is produced more due favorable climatic condition for aquatic environment. Therefore, to increase fish production, a stagnant water body is developed on a suitable land by excavating earth or erecting earthen dike or dikes around it, where water is stored to stock the fish. The stocked fish are cultured and grown under controlled condition. Such water body is called Fish Pond.

Such fish pond is constructed either in plain/flat land or on a sloppy land. In flat areas the simplest way of constructing a fish pond is to excavate the earth to make a depression on the ground and pile the excavated earth/soil systematically around the depression to give a shape of dike. This type of pond is called excavated pond. Again on a sloppy land, a pond is made by building strong dike or dikes on 1,2 or 3 sides to hold water. This type of pond is called dam pond. A fish pond's shape and size depends on the available land, where the pond is to be constructed.

Site selection:-

A fish pond is never constructed haphazardly, as an orderly constructed fish pond is easy to operate and manage too. Therefore, to construct an ideal fish pond, due consideration need to be given on following points;

a) **Suitable Site:** Any flat and sloppy land is suitable to construct a fish pond provided the soil has capacity to retain the water the soil having gravel or stone or sand fails to hold water. A sloppy land is considered as most suited site for a fish pond because such land does not require to construct all the four dikes because of its terrain and turns out economical to construct.

b) **Adequate Water:** Fish lives in water, so a fish pond needs considerable quantity of water not only to the keep the fish alive but also to grow. Therefore, a reliable perennial water source is essential to plan a fish pond.

c) **Closer to Home:** To carry out daily routine works in time as well as to have close supervision and to avoid poaching also the fish pond need to be planned closer to the house, otherwise anything may happen with the water and live fish.

d) **Away from any Shade:** The sun light is very important for the production of natural food in the fish pond. Therefore, a fish pond needs to be built away from the shade or big trees, so that the pond gets sufficient sun light. Moreover, the big trees drop leaves into the pond and make the water quality poor or poorer and minimize the penetration of sunlight in the pond.

e) **Easily Accessible Place:** For a fish pond, the site need to be selected with easily accessible place as the fish culture operation needs several inputs regularly e.g. fish seeds, lime, manure and fish feed etc. They need to be transported as per the need. In case of difficult approach, all the inputs need to be again transported to the farm and the operational cost increases due to this inconvenience. Similarly more difficulties have to be faced during the harvest of the farm product too. An easily accessible place not only minimizes the labour and transportation cost only but it also facilitates in bringing live fish seeds and transporting the farm products.

2.2 Soil Test

Soil quality is important to the prospective farmer that seeks to build a more traditional semi-intensive fish or shrimp farm utilizing earthen ponds. This type of operation relies upon the proper composition of local soils to form stable and watertight earthen ponds. Where land-based aquaculture is concerned, earthen ponds

are considered the most cost-effective way to retain water for fish and shrimp farming operations.

Comprehensive soil horizon analyses at multiple sampling locations within each potential site are performed as part of our overall aquaculture feasibility studies whenever soils may be suitable for earthen pond construction. Soil pH testing is done on-site for all boreholes and at multiple soil sampling horizons. General on-site observations on soil type are also be made. A well equipped soil lab can perform a comprehensive soil texture analysis and soil chemical analysis of all major and minor soil nutrients for multiple samples taken from the most suitable sites. We will then review soil quality test results against optimum criteria for aquaculture.

Soil texture classification is determined by the percentage of sand, silt, and clay in a given sample. From these percentages, soils are then classified by type according to the soil triangle. Soils suitable for earthen pond construction must contain a minimum of 20-30% clay and preferably no more than 30% sand. The best types of soil for aquaculture are classified as clay, silty clay, silty clay loam, and clay loam.

Way to check soil suitability: -

These are three methods of checking soil test for pond construction

i. Squeeze method: -

The following steps should be taken:

- Wet a handful of soil with just enough water to make it moist squeeze the soil.
- Then open your palm
- If the soil retains its shape after opening your palm then, it's good for pond construction.

ii. Water permeability method:-

- Fill the hole with water to the top
- Cover the hole with leaves
- By the next day, the water level should have reduced as a result of seepage
- Refill the hole with water level the next day, if it's still high the soil is impermeable and suitable for pond construction
- If the water has disappeared again, then it isn't suitable for fish farming.

iii. Ground water test:-

To get reliable results, this test should be executed during the dry seasons. The following steps should be taken:-

- Dig a hole to depth of about 1 m
- Cover it with leaves to reduce the rate of evaporation.
- If the hole is covered with pond water the next morning then a pond can be built however you will need more time to drain the pond due to high water
- If the hole is dry by morning, the site is suitable for fish farming because the water levels are not high.

2.3 Water source

Without water, fish can't live so a fish pond needs a considerable quantity of water not only to keep the fish alive but also to grow them. Therefore, it is almost important to examine the water source quantitatively as well as qualitatively before the decision is made to construct a fish pond. A 2" to 4" sized pipe full water in the dry season is considered as enough to operate a good sized pond or a few ponds. The quantity of the water depends on the scale of fish culture activity. Besides the quantity of water, quality of water needs to be also examined,

a) Water Temperature:

The water temperature plays a vital role in the production of fish food in the pond ecosystem and ultimately in the production of fish. The cold water is less productive due to its low temperature. Therefore, in cold water fish culture, supplementary feed becomes essential by thus the cost of production shots up and it turns out beyond the reach of the mass of the people. But in warm water with less efforts, different kinds of plant and animal origin natural fish food is produced and the water is made productive. With the increased fish production, the cost of the product is reduced and the fishes are made available to the mass of the people. Therefore, the water with higher temperature is most preferred. In warm water fish culture, above 20° c to 30°C is considered most suitable for fish culture.

b). Alkalinity of Water:

The alkaline water having pH 7-10 is most preferred in fish culture. The acidic water having pH value below 6 is not at all preferred as such water remains unproductive. Slightly acidic water having pH value 6 or so is manipulated to alkaline by the use of lime, however, such operation increases the cost of production as well as in such water several diseases incidence occur. Therefore, acidic water having pH value lower than 7 is not considered as suitable water for fish culture.

c) Dissolved Oxygen:

In fish culture the water quality is defined by the quantity of oxygen dissolved in the water. The purity of water is defined with the higher dissolved oxygen. The rivers and streams water are naturally aerated and such water naturally contains higher oxygen. In polluted water the dissolved oxygen is less and in such water fish culture is never done. The water having below 4 mg./l dissolved oxygen is not preferred for fish culture.

Thus for the warm water fish culture, a perennial water source with higher water temperature, alkaline nature and higher percentage of dissolved oxygen is considered as a better.

2.4 Appropriate land for fish culture

Land should be confirmed that the proposed land area is suitable. The general conformation of the land should be with slopes not steeper than 2 percent. If wasteland, unsuitable for agriculture or other direct use is selected for a fish pond, the cost of the land will be low. Land elevation and flood level are important factors in determining the suitability of the area for the construction of a fish farm or hatchery. The land should be free from deep flooding; the maximum flood level for the past 10 years should not be higher than the top of the dikes. Observation of the marks left by flood waters on bridges or other structures at the site, or questioning of local people, may give information about the expected heights of floods. The shape and size of available land should be considered: land with a regular shape and extensive enough for future expansion is ideally suitable for a fish farm. It is very

important to know the development plans for the area as it would be unwise to select a site for a project in a region where future industrial activity may cause air and water pollution. Similarly, if a site is adjacent to a heavily populated area, the risk of pollution should be borne in mind. However, some industrial and agricultural wastes may be utilized in fish farming. In such cases, special investigations should be conducted on their utilization or required treatment.

The type and density of vegetation depend partly on the land elevation. Vegetation is also an indicator of soil types and of the elevation of the water table. The type and density of vegetation, its size and the root systems of trees largely determine the method of clearing the site and, therefore, the construction time and cost.

Grassland, abandoned paddy fields, open woodland or land covered with low shrubs and bushes allow cheaper construction than land with very thick jungle or swampy areas with high trees.

2.5 Type of pond used in aquaculture, construction of dyke, inlet & out let.

A fish pond requires water any time. Therefore, a permanent water canal needs to be constructed from the source of water to the pond, Thus it does not need to repair all the time. While constructing the permanent canal, it is better to have two parallel grooves on both sides of the canal wall at certain intervals, so that a screen framed on wooden frame is placed to screen the water and to avoid the unwanted fish or any other animals entering into the pond water

Types of pond used in aquaculture

1) On the basis of construction:

- Earthen pond
- Cemented pond
- Raceways culture

2) On the basis of use:

- Nursery pond
- Rearing pond
- Production pond
- Brood stock pond

3) On the basis of topography:

- - Hole in ground
- - Dam in slope
- - Barrage pond

4) Based on enclosure

- - Fish pond culture
- - Cage culture
- - Pen culture

A) On the basis of construction

a) Earthen fish pond

Earthen ponds are made up by clay soil. It is popularly used in Nepal because it is cheap and easy to construct.

Advantages:-

- It can be easily constructed with relatively lower degree of engineering
- Provision of ample natural food generated with less effort.
- More chances of entry of flood during heavy rain.

Disadvantages:-

- Problem of regular soil erosion
- Higher chances of entry of weed fish and unwanted aquatic weeds.

b) Cemented fish pond**:-**

Pond that is constructed by using cement concrete is called cemented pond. It is generally constructed in research station. It requires higher installation cost so farmers cannot afford this pond.

Advantages:-

- Though initial investment is higher to install cemented pond but over all maintenance cost their after are relatively lower than the earthen pond.
- water turbidity can be effectively regulated

Disadvantages:-

- Higher initial cost for installation
- Problem of higher water temperature in summer

c) Raceways culture

Raceways are pond structure used to culture cold water fishes i.e. trout where growers supply continuously fresh water. Ladder shaped raceways are popular in Nepal.

B) On the basis of use:

a) Nursery fish pond

They are small (100 – 200 sq. m.) and shallow (0.9 – 1m deep) pond. The spawn and hatchlings are kept in this pond until they became fry or fingerlings.

b) Rearing pond

They are quite large (200 – 400 Sq.m.) and deep (1 – 1.5 m.) as compare to nursery pond. Normally fingerlings are reared until they became advanced fingerlings and sometimes it is used as production pond.

c) Production pond:

Pond that is used to rear fish seeds until they became marketable or table size it is large (>400sq. m.) and deep (1.5 – 2 m) pond as compare to others.

d) Brood stock pond

It is used to stock and reared brood male and female fish. Generally this type of pond is used in breeding purpose.

C) Based on topography

a) Dam in slope

During dam preparation, soil is cut from higher slope to fill lower sloppy land to make flat land. Finally pond is constructed on the flat land. Land slope may differ from place to place.

b) Hole in ground

In this type of pond soil is dug out from ground which is used to make dike. it is constructer in higher topography with relatively flat land. Main consideration is that the land should be free from flooding.

D) Barrage pond

Barrage ponds are made by construction wall across the gentle or flat valley. These ponds are usually filled by rainfall or river water. It shouldn't be constructed where water flow is higher with higher water current.

Different pond structures

1. Inlet:

Inlet is a structure which is made to supply water to the pond. A small box like structure is constructed at the top of the pond where wire gauze of fine screen framed on wooden frame is fixed to screen the water. In case, more water is not needed, it is diverted to the main canal by putting a simple wooden plank at the groove made on the wall of inlet box.

2. Outlet

Outlet is a structure which is made to remove the excess water from pond. As an inlet of a pond is important, than outlet is equally important to control and drain the pond water. The outlet structure is constructed within the fish pond at its lowest point permanently. This permanent outlet structure is called - Monk. The outlet is important during cleaning the pond debris and harvesting of fish.

3. Harvesting pit

It is a small pit generally constructed at a center of fish pond to facilitate the harvesting activities easier. It measures about 0.5 m. deep and 0.5 – 1 m wide.

4. Dike of pond

The earthen structure that surrounds total water surface area of pond is known as dike.

Construction of dike of pond

To find out the earth volume for dike of purposed pond cross section area of the dike is calculated at 1st and it is multiplied with its total length required earthen volume equal to cross section area multiply to length of dike

With the selection of a site, a pond or series of ponds is designed on the basis of the landscape. It is designed in such a way that the dike is made by excavating minimum quantity of soil by thus the construction cost is minimized. The fish pond is constructed either by machine or by labor force depending upon availability at a place.

To start the construction work, firstly the site is demarcated by pegging small and big pegs as per the design. Two eight feet high bamboo pegs are fixed at central point

of each dike at a distance of 3'. Both the pegs tips are tied at 7' height with a rope to show the top of the dike which is called Dam Crown. The rope towards the inner side of the future pond is stretched with a ratio of 1:2 slopes and at the point where it touches the ground is fixed with the help of small pegs. The same way, the outer rope is also stretched towards the outer side of the dike at the ratio of 1:1.5 slopes and fixed on ground.

a. Cross section of dike

To avoid the fish kill in summer due to high temperature as well as in winter due to severe cold it is suggested to maintain water level to five feet's for which the pond dikes need to be made six feet high. Therefore, during construction of the pond, the dike needs to be raised to seven feet, so that after the compacting of the soil it turns out as proposed six feet high. The outer slope of the dike is usually maintained at the ratio of 1:1.5 while the inner slope of the dike is maintained at the ratio of 1:2 so that the workers can easily walk on gentle slope for the fish culture operations e.g. liming, feeding manuring and netting etc. In case of common dike of two ponds, both the slopes are maintained at the ratio of 1:2. With the above slopes, the inner side slope ends at 12' distance from the inner bamboo of the Dam Crown, if the dam height is maintained to 6'. Similarly, the outer slope of the dike ends at 9' distance from the outer pole of the Dam Crown; Thus, the properly build fish pond dike base width remains 24' in total (9' outer slope + 3' dam crown + 12' inner slope) while the width of Dam Crown remains to 3'.

b. Clear the Site

The layout of the pond gives a fair idea to be covered by the four dikes of pond as well as the area from where the soil to be excavated and where to fill up. First scrape out about 4" - 6" of top soil need to be scraping out from the site of excavation and the dike site and dump it out of the construction site. Remove all the rocks, trees or tree's roots and bushes from the construction site, so that the filled up soil settle down quickly and yet the dike stronger. In no circumstances, the grass, bushes or roots etc are left along the dikes. If these items are left under the dike, they start decomposing in due course of time and the dike become

weaker. Under such condition there is a danger of water leakage from the dike.

c. Develop Core - Trench if necessary

In case some patches of bad soil detected on the construction site, then it is suggested to dug about 3' wide and 3' deep trench in between the two long bamboo poles along the dikes of the pond as shown in Fig. no. This trench is called Core - Trench. This core -trench is also considered as the foundation of the dike. The core -trench is again filled up with good soil and the refilled soil is well rammed. This way, the dike is made strong and stable and stops the seepage. The core-trench is applicable where ever a doubt on soil quality arises; otherwise it is not very common in practice.

d. Excavation of Earth to build a Dike

While planning a pond itself, the excavation points of the soil is determined and is excavated to the prescribed level. The excavated soil is pilled systematically within the given frame layer and rammed well. If excavation is made by heavy machine, the soil is made compact periodically by machine. Good compact soil makes a strong and stable dike. The Fishery as well as Extension Staff must know the calculation formula to find out the exact quantity of soil to build the four dikes of a particular sized pond so that they can be of some help to the farmer. Presume a pond of 75' length ×75' wide and 6' height and now one has to find out the required quantity of soil for the above sized pond. The above said pond's area totals to 5625 square feet and its height is considered as 6'. The inner slope of the dike is at the ratio of 1: 2 and the outer slope is at the ratio of 1:1.5. To calculate the required quantity of soil to the above specification the following formula is to be adopted.

(Total width of dike + Width of dam crown) / 2 × height of dike ×Total length of dike = Required quantity of soil**.**

e. Turf the Dike

During the construction of the dike attention need to be given for good compaction of the soil. Upon completion of the dikes good variety of grass need to be planted in all dike (inner as well as outer slopes) so that the dike do not erode. Moreover, the turfed grass as it grows; it is also used as a feed to the Grass

Carp. Therefore, while selecting the variety of the grass due consideration need to be given to select a grass having characters of soil holding as well as high nutritive value.

Construction of Water System

A fish pond requires water any time. Therefore, a permanent water canal needs to be constructed from the source of water to the pond, Thus it does not need to repair all the time. While constructing the permanent canal, it is better to have two parallel grooves on both sides of the canal wall at certain intervals, so that a screen framed on wooden frame is placed to screen the water and to avoid the unwanted fish or any other animals entering into the pond water

2.6. Cost estimation for pond construction

Under this heading, the expenses occurred for the establishment of pond e.g. purchase of land, feasibility study, fencing, construction of pond or ponds, water system, approach road and other infrastructures are recorded. Generally the expense which occurs once during the establishment of the activity is only recorded under this heading as shown below;

Table 3: Detail Records on Capital Expenses

S.N.	Particulars	Unit	Quantity	Rate	Total price	Remark
1.	Purchase of land	Sq.m				
2.	Feasibility study	Rs.				
3.	Fencing	Running meter				
4.	Approach road	Running meter				
5.	Pond layout	Men/day				
6.	Pond construction	Men/day				
7.	Water system (Inlet/outlet)	Men/day				
8.	Drainage	Men/day				
9.	Others	Rs.				

Operational Expenses

Under this heading, the expenses occurred for the operation of the fish farm e.g. preparation of a pond, purchase of fish seed and their transportation, purchase of

manure, feed, medicines and their transportation and labour cost etc. These expenses occur every year for the operation of the activities. Therefore, these expenses are called Operation Expenses. The operation expenses are restricted to various production activities for a production cycle only. The efficiency of these expenses is always compared with annual income by the activity. Therefore, the operational expenses need to be oriented towards the production. Moreover, unnecessary expenses in operation reflect the mismanagement too. Therefore, the records of the operational need to be maintained as detail as possible.

Table 4: Detail Records on Operational Expenses

S.N.	Particulars	Unit	Quantity	Rate	Price	Remarks
1.	Preparation of food					
	a) Repair & Maintenance	W/D				
	b) Lime	kg				
	c) Water tax	Rs				
2.	Manure					
	a) Organic	Kg				
	b) inorganic	Kg				
3.	Feed					
	a) Supplementary	Kg				
	b) Grasses	kg				
4.	Equipment					
	a) Nets	No.				
	b) Instruments	No.				
5.	Chemicals/Medicines	kg				
6.	Labour cost	W/D				
	a) Skilled Labour-Technician	W/D				
	b)Semi-skilled labour	W/D				
	c) Unskilled labour	W/D				
7.	Any others	Rs.				

Incomes

The income record from the sale of farm product is equally important as the Capital and Operational Expenses. Therefore, the details of income record need to be maintained. The detail records of harvest and income helps in analyzing the farm productivity as well as the cost benefits of the activity.

The income of a fish farm depends on the strategy undertaken for the implementation of the farm for example if a fish pond has been operated only for table fish operation, then the farm provides the income by disposal of produced fish only. But if a farm has been established for fish production to fish seed then it provides income from various activities e.g. by the sale of spawn, fries, fingerlings and yearlings besides the table sized fish. Similarly, the integrated fish farm generates income not only from fish but also from various items of integration too.

Teacher tips:

- Visit nearby fish pond and discuss about the quality of pond water and running water
- Ask them to collect soil samples of different site and compare them.
- Ask them to calculate cost estimation based on local resources and price.

UNIT - THREE

Management of fish pond

Learning outcome:

Management of fish pond plays a vital role for increasing the fish production. After completion of this lesson,

- Student can clean and manage pond sanitation
- Can determine quality of water in pond and use appropriate corrective measure
- Can properly use organic and inorganic fertilizer in fish pond
- Can efficiently manage feeding system

3.1 Cleaning, maintenance and use of lime in fish ponds

Liming is the part of the pond management which has several benefit effect in the pond and fish health. It is usually used in pond for correction of the soil acidity and other several purposes. It enhance the pond productivity and improve pond sanitation and act as prophylactic and therapeutic kill the pond bacteria, parasite, improve pond soil quality and promoting the mineralization. Liming of pond is not always necessary, it can be done when pH is too low or acidic, and when organic matter content is too high, when deposition of pond bottom mud is too high and when there is threat of the oxygen depletion.

Agriculture lime

- (Calcite) $CaCo_3$
- (Dolomite) $CaMg(CO_3)_2$

Hydrated lime

Calcium hydroxide $Ca(OH)_2$

Quick lime

Calcium oxide, CaO

Method of liming:-

- Water-filled pond:- Through inlet or broadcast
- Dried pond:- By broadcasting

Liming dose:-

It is based on soil pH. If the soil pH is low, high amount of lime is required and vice versa. Liming dose at different pH value is given in table.

Table 5: Amount of lime required according to soil pH value.

pH value	4-5	5-6.5	6.5-7.5	7.5-8	8 or more
Amount of lime (kg/ha/yr)	2000	1000	500	200	no need liming

3.2 Preparation and management of the fish ponds

1. Site selection

Suitable site and location should be selected on the basis of soil type water type drainage and topography.

2. Depth of land

It depend upon penetration of the sunlight, cost of construction, minimum depth of water should be 1.25 meter.

3. Size of pond

The economic size of the pond in Nepal 0.5 to 5 hector. The pond should be design in the way that volume of earth available for the pond excavation will be equal to volume of earth required for raising required embankment

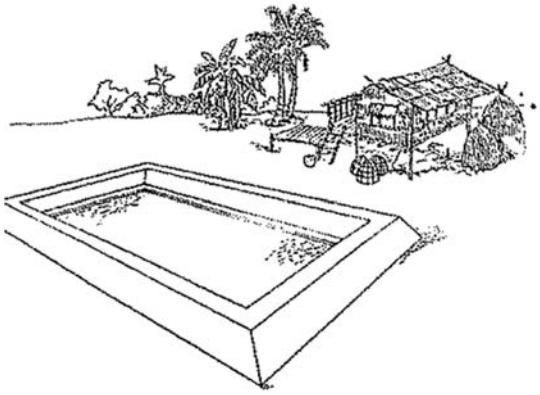
4. Construction of dike of pond

The earthen structure that surround total water surface area of pond is known as dike .to find out the earth volume for dike of purposed pond cross section area of the dike is calculated at 1^{st} and it is multiply with its total length required earthen volume equal to cross section area multiply to length of dike .

Management of fish pond

- Liming of the fish pond
- Technique to develop natural food or fish pond manuring or fertilization
- Organic and inorganic manuring
- Pre and post Stocking and their management
- Periodic fertilization

- Pond environment monitoring
- Fish health monitoring
- Management of the natural resources



Source: *www.google.com.np/search?q=managment+of+fish+pond*

Fig. 11: Management of fish pond

3.3 Use of feedand fertilizer in fish pond and its importance

Feed: Feed is the essential substance for the proper growth and development of the fish. It is two types that is natural and artificial

A) Natural:-

1) Plankton:-

Plankton is an essential food for all fishes and crustaceans during their early life history stages. Phytoplankton are also two types that is phytoplankton contain chlorophyta, cynophyta and zooplankton contain crustacean, insect larva, protozoa.

2) Aquatic animals:-

Aquatic animals commonly used as fish food are snail's clams, insects, aquatic worms, and small crustaceans. Aquatic animal feed are nutritionally complete, rich in protein and are considered to be best natural food for omnivorous and carnivorous fishes.

3) Detritus:-

Living algae /aquatic plants of the pond .If not fed upon by animal, die and slowly settle down to the bottom of the pond .These non-living particulate organic matter covered by microorganisms is called detritus generally represents a good source of

food for fish .The nutritional value of the detritus is enhanced by living bacteria, fungi, attached algae and micro invertebrates which colonies dead algae and detritus aggregates.

4) Aquatic and terrestrial plants:-

Aquatic and terrestrial plant is only used as green manure and compost, but is also ingested directly by herbivorous fishes. There are many aquatic plants which directly serve as fish feed, including Wolffia, spirodela, lemna, hydrilla, Eichhornia, and pistia. The main terrestrial plant used are napier, mulbary, banana, ipil-ipil, peas and beans leaves, etc.

B) Formulated food:

Refer to that food that derived from the plant and animal source like plant feed such as oil cake , grain and animal feed contain bone meal or powder fish meal etc. These foodstuffs are supplemented in the pond to promote the growth of fish species.

- Easily available on reasonably low cost
- Protenious and ready acceptability
- Easy digestibility
- High conversion value
- Easy to transport
- High keeping quality

a. Plant feeds:-

Plant material is the major source of feed for feeding of fish which is divided into following categories:

1) Oil cakes:-

Oil cakes are the major source of protein and lipids in fish feeds. The most common varieties used at present in aquaculture are mustard oil cakes, soybean cake, cotton seed cake, peanut cake, sesame cake and sunflower seed cake.

2) Grains:-

Grains are the major source of carbohydrate in fish feed .They are characterized by low protein content (8-12%), a high content of nitrogen-free extract (55-70%) which is mainly starch and low lipid contents(2-8%) .Grain feeds include rice, wheat, corn,

barley, oats, sorghum, rice bran, wheat bran and wheat flour sweeping.

B. Animal feeds:-

Animal feeds are the major source of protein in fish feeds. Animal feeds with high nutritional value are made from a variety of sources, such as by -products from processing factories, slaughter houses and silk-weaving factories, fish meal, shrimp meal, bone powder, blood power and feather powder. Animal feeds are characterized by high protein levels (40-80%) well balanced amino acids, particularly lysine and methionine and high levels of vitamins.

Table. 6 Nutritional content of plant and animal feeds with its characteristics

Feed type	Crude protein (%)	Characteristics
Mustard oil cake	20-35%	High in methionine, cysteine and tryptophan. Rich in vitamins, particularly, niacin
soybean cake	40-50	Deficient in methionine
Groundnut oil cake	25-30	Low in methionine, cysteine and tryptophan. Rich in vitamins, particularly ,niacin
cotton seed cake	35-45	Rich in vitamins, particularly niacin. contains toxin gossypol
Sunflower seed cake	40-50	Deficit in lysine
B) Grains and Bran		
Rice bran	11-15	
Wheat bran	10-15	Less lysine, Glutamine is rich in glutamic acid .Usually used as a binder.
Corn	7-9	
Rice	7-9	
Barley	10-12	Deficit in Methionine, histidine and tryptophan
Sorghum	10-12	
c) Animal products		
fish meal	55-75	
Trash meal	15-30	
Shrimp meal	40-50	
Blood meal	80-90	

Silkworm pupae powder	65-75	
Feather powder	80-90	

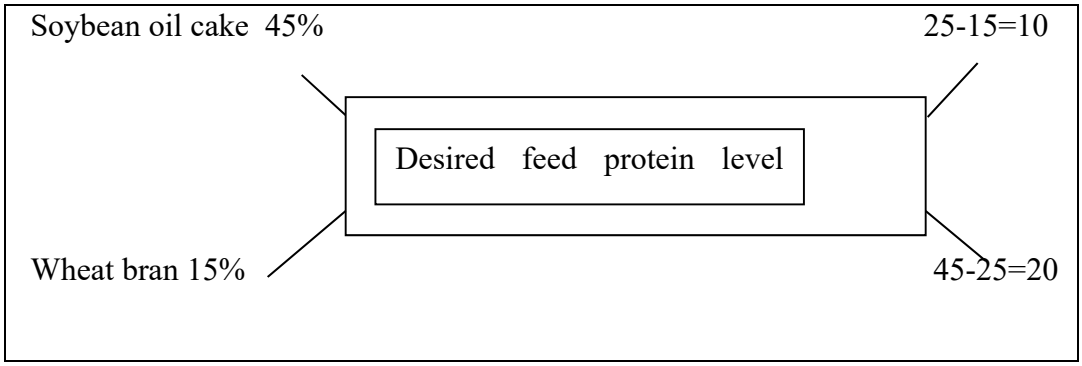
Feed Formulation:-

As no single feed material is a complete feed by itself, it is always advisable to have multi-ingredient feed formula so as to satisfy the pre-established nutrient requirements of the species and age of fish. Raw materials should be selected on their ability to supply particular nutrients (e.g, protein, energy, essential amino-and fatty acids) at the lowest cost. In order to balance the basal feed and protein supplement, the help of square method has to be taken. However, least-cost approach method for balancing the nutrients in feed is also in practice using linear programming method. Square method is easier and convenient in the present situation for dissemination among the rural farmer .The procedure for feed formulation is as follows.

1. Select the local ingredients and determine their protein percentage.
2. Use least cost analysis to select protein and energy sources
3. Balance the digestible energy level.
4. Balance the crude protein level
5. Check the levels of essential amino acids and essential fatty acids in the finished feed and if these do not satisfy the requirements of the fish, repeat steps 3and 4

Example:-

Suppose it is desired to formulate a 25% protein carp feed from soybean oil cake (45% crude protein) and wheat bran (15% crude protein), a square is constructed thus:



The protein level of the feed is subtracted from that of each of the feedstuff in turn and the answer is placed at the opposite corner to the feedstuff ignoring positive and negative signs. The two figures on the right hand side of the square and then added together (10+20=30) . To obtain 25% protein carp feed we need.

Soybean oil cake 10 x 100/30=33.33%

Wheat bran 20 x100/30=66.66 %

Thus, to make 100 kg of 25% protein carp feed we need 33.33 kg of soybean oil cakes and 66.66 kg of wheat bran.

Rate of Feed:

The rate of feed differs from small fish to grown one and brood fish too. The rate of supplementary feed is estimated by the body weight of the fish. As the fish grows, the feed percentage is also increased. Generally the growing fish gets 2 percent to even 6 percent of the body weight but totally depends on the fish culture strategy undertaken in managing the farm. Before the breeding season the brood fish are raised with special care in brood fish pond and they are fed at the rate of 2 - 4 percent of the body weight. While raising brood fish attention should be given not to feed the brood fish in excess because the brood fish deposits the excess of energy in the form of fat, high deposition of fat drastically decreases the quantity as well as quality of eggs. Therefore, excess of supplementary feed should not be given to fish.

When to Feed?

It is always good to feed the fish in the morning, around one time and at one place. Thus the fish get habituated to the system and gets around the feeding spot around

the same time. Thus the feed is utilized to maximum. In case of, higher percentage of feed it is suggested to divide the total quantity of food into two portion and provide morning and evening so that the feed is used maximum and gives good food coefficient rate.

How to Feed?

The supplementary feed may be in pellet or in grinned form. The pellet feed are made with special care. The pellet feed may be of floating or submerge types. Such feed is binded with good binder so that it does not disintegrate for a considerable lime in the water. Generally its quality is determined by its binding capacity in the water, this type of supplementary feed is not available in all areas.

Besides, the pellet form of feed, there are different types of grinned form of commercial feed mixed with certain binder. The binder keeps the feed binded when it is mixed with water; a good binder minimizes the wastage of the expensive feed. Generally the grinned feed is soaked in water and made balls and are placed in feeding platform made of bamboo plank or tin sheet or wooden plank and is dipped in to water. It is suggested to observe the fish while feeding, so that one can know the condition and health of the stocked fish.

Table. 7 Food and feeding habits of cultivated fish species of Nepal

Fish species	Feeding habit	Feeder	Major food item
Common carp	Omnivorous	Bottom feeder	Insect larvae, worms, mollusks, detritus, decayed vegetation, formulated feed.
Silver carp	Planktivorous	Surface feeder	Phytoplankton
Bighead carp	Planktivorous	surface feeder	Zooplankton
Grass carp	Herbivorous	Column/marginal feeder	Aquatic and terrestrial vegetation, formulated feed
Rohu	Herbivorous	Bottom and column feeder	Larger planktons, decaying vegetation , plank tonic and filamentous algae , periphytons formulated feed
Mrigal	Omnivorous	Bottom feeder	Similar to common carp
Catla	Planktivorous	Surface feeder	Zooplankton

Nile tilapia	Omnivorous	Column feeder	Plankton, insects, chironomids, detritus, formulated feed
Silver barb	Herbivorous	Column/marginal feeder	Microphytes, formulated feed
African catfish	Carnivorous	Column feeder	Insect larvae , worms , mollusks , detritus , decayed vegetation , formulated feed
Pangas catfish	Omnivorous	Column feeder	Insect larvae, worms, mollusks, detritus, decayed vegetation, formulated feed
Rainbow trout	carnivorous	Column feeder	Insect ,worms, high protein formulated feed
Fresh water prawn	Detritivorous	Bottom feeder	Detritus, decay matter, formulated feed

Fertilizer

Fertilizer is the natural or synthetic substance that use in pond to increase the production of the natural organism to be eaten by the fish.

Pond fertilization

It is the process of addition of fertilizer to pond to provide nutrient to encourage the rapid growth of the phytoplankton and zooplankton. It is the key factor in increasing the productivity and carrying capacity. The fertilizer use in the fish pond is two types one is organic and another is inorganic fertilizer

Time of the fertilization in fish pond

- If pond is new and good bottom mud has not yet formed
- When pond water is more transparent
- One week or two week interval

Dose of fertilizer

Nitrogen – 0.2 – 0.3 gm/day

Phosphorus- 0.2 gm/day

Manure – 120-150 kg/ha/day

Use of Fertilizer

As the time approaches to use or reuse the fish pond, an initial dose of manure is applied at the rate of 100-200 kg. of cattle dung or 50 kg of chicken litters per ropani. In case, the organic manure is not available, then only it is recommended to use inorganic fertilizer at the rate of 8-12 kg. of nitrogen and 8-12 kg. of phosphorous

per ropani. The organic or inorganic fertilizer is broadcasted throughout the pond. With the broadcasting of manure, the pond is filled with fresh and clean water after screening with fine wire gauze.

The newly filled water is left for few days. By then the effect of fertilizer is distinctly seen with the change of water colour to light or deep green. The greenish colour of the water is the effect of the manuring. The colour is the indication about the growth of unicellular and multicellular microscopic plant cells - phytoplankton. The phytoplankton is followed by unicellular and multicellular animal cells - zooplankton.

With the growth of phytoplankton and zooplankton, the fingerlings or yearlings of different cultivable fish species are stocked in the pond. The stocked fingerlings/yearlings go on feeding the developed natural food and grow faster. In absence of natural food in the pond, the fingerlings/yearlings do not get adequate food and get weak and weaker. Especially the transported fingerlings/yearlings which get exhausted in conditioning and transportation cause high mortality within two or three days with hunger or cannibalism. Therefore, preparation of a pond is very important in fish culture. The preparation of a fish pond need to be carried out by the end of March in cold region while in warmer region within earlier par of February, so that the stocking of fingerlings/yearlings is carried out by the middle of April and by the end of February respectively.

With the stocking of fingerlings/yearlings, the developed natural food of fish is consumed. Accordingly the coloration of the pond water starts changing to normal water colour or muddy colour if additional manure or fertilizer is not applied. Therefore, to provide nutrients continuously in water, application of manure is repeated. It is always better to observe the water colour and as its colour starts changing to light or lighter colour, second or third or fourth application of manure need to be undertaken at the rate of initial dose. As such there is no hard and fast rule on the amount of manure because the effect of manure varies from one place to other place depending on various factors e.g. quality of soil, quantity and quality of water and also depends on the intensity of the sun light too. Therefore, the field worker must be keen observer to note the effect of manure in pond water and changes in

water, so that the field worker can make a judicious judgment about when and how much manure is to be used.

However, a field method has been developed to assess the colour of the pond water for which the worker need to go inside the pond and deep the hand up to the elbow in the water and try to read the fingers and palm put horizontally within the water. If the fingers and palm is distinctly visible, it is to understand that it is already late in application of the manure but if it is not distinctly visible due to greenish or brownish colour of the pond water, then it right time for another application. Never be lazy to observe and test the colour of pond water and never be ideal to apply the manure in right time. The right time application of manure boosts the growth of natural food of fish and the fish grows faster.

3.4 Organic fertilizer

Organic fertilizer is composite in nature and contain natural element required for the metabolic cycle. They are produce locally for example farm animal and agricultural waste. Organic fertilizers may be of following types

I. livestock manure
II. compost
III. Green manure
IV. Night soil

Table. 8 Average elemental composition (%)of human excreta and common livestock manures

Animals	N	P	K
Human			
Faces	3.77	1.89	1.76
Urine	17.14	1.57	4.86
Buffalo			
Faces	1.23	0.55	0.69
Urine	2.05	0.01	3.78
Cattle			
Faces	1.91	0.56	1.40
Urine	9.74	0.05	7.78
Goat and sheep			

Faces	1.50	0.72	1.38
Urine	9.64	0.14	-
Pig			
Faces	2.80	1.36	1.18
Urine	13.20	0.02	10.90
Duck			
Faces	2.15	1.13	1.15
Poultry			
Feces	3.77	1.89	1.76

Advantages:

- The advantage of applying organic manure is to improve the pond soil structure, fertility and water holding capacity.
- Beside N, P, K, organic matter are a potential source of micronutrients.
- It may serve as direct source of food for certain fish species.
- It increases the effectiveness of any inorganic fertilizer by providing the necessary organic matter base.
- It encourages bacterial growth, which in turn favors better production of the zooplankton.
- Manure additions may also help to clarify clay turbidity in pond water.

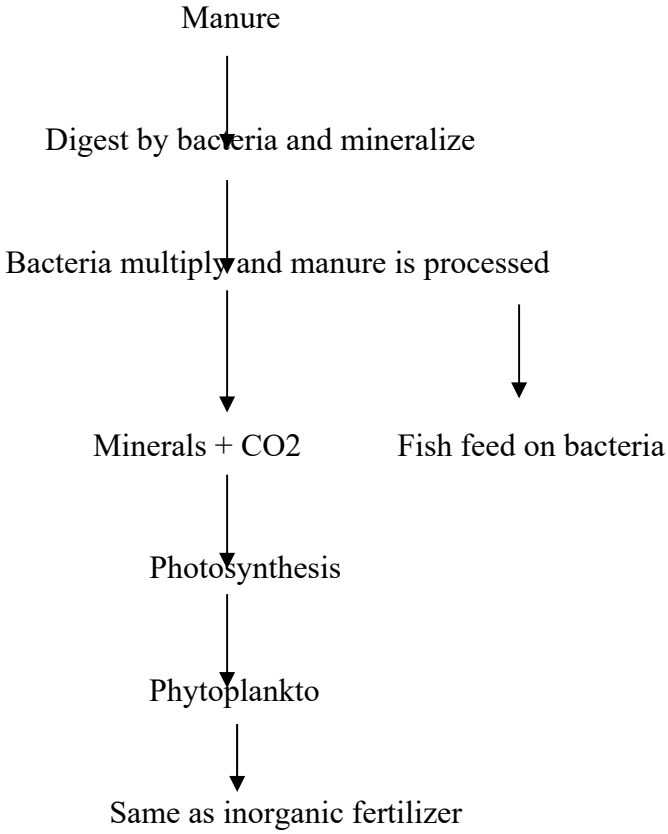
Disadvantages:

- Continual application of organic matter reduces pond depth
- low contents of primary nutrients
- There are aesthetic objections and sanitary concerns related to the fish products from manure ponds
- It is time consuming to collect and apply bulk materials to ponds on a routine basis.
- This procedure results in unpredictable nutrient quality and high biological oxygen demand, which may cause oxygen depletion of pond water when applied at high rates.
- The decomposing organic manure creates unhealthy condition in the pond favoring incidence of some diseases as gill rot.

Impact of organic fertilizer in ponds

The application of organic manure results in the rapid multiplication of plankton through bacterial decomposition and release of nutrients that are leached to the pond water. These bacteria and plankton are the food source for the aquatic animal and filter feeder fish. Sometimes, the manure is also directly consumed by coprophagus fish

After application of organic manure, initially phytoplankton appears and gradually the zooplankton production is dominant. After each manure application, the nutrient content of the water increases resulting in a plank tonic peak.



3.5 Chemical Fertilizer

Chemical fertilizer is the inorganic fertilizer that dissolved in the pond water and provides their nutrient immediately. These fertilizers contain only mineral nutrients and no organic matter they are manufactured industrially to be used in Agriculture for improving crop production and they can be obtained from specialized suppliers.

I) Nitrogenous fertilizers:-

- Urea
- Ammonium sulphate

2) Phosphorous fertilizers:-

- Single super phosphate
- Triple super phosphate

3) Potassium fertilizers:-

- Murate of potash

4) Compound fertilizer:-

- Diammonium phosphate (DAP)

Table. 9 Nutrient content in fertilizer

compound	N%	P%	K%
Urea	46	0	0
Ammonium sulphate	21	0	0
Ammonium Nitrate	35	0	0
Mutate of potash	0	0	60
Single super phosphate(SSP)	0	16-18	0
Triple super phosphate (TSP)	0	48	0
Diammonium phosphate (DAP)	18	46	0

Advantages:-

i. Exact composition of nutrients available
ii. Mineralization is very fast giving quick effect on pond productivity
iii. Easy to transport
iv. Lack of pollution as they need not to undergo any bacterial decomposition, the toxic gases like CH4, NH3,SO2 etc are least possible to pollute the environment.

v. No effect on pond depths

Disadvantages:-

i. Costly, not easily available

ii. slow growth of zooplankton

iii. Effective for short period

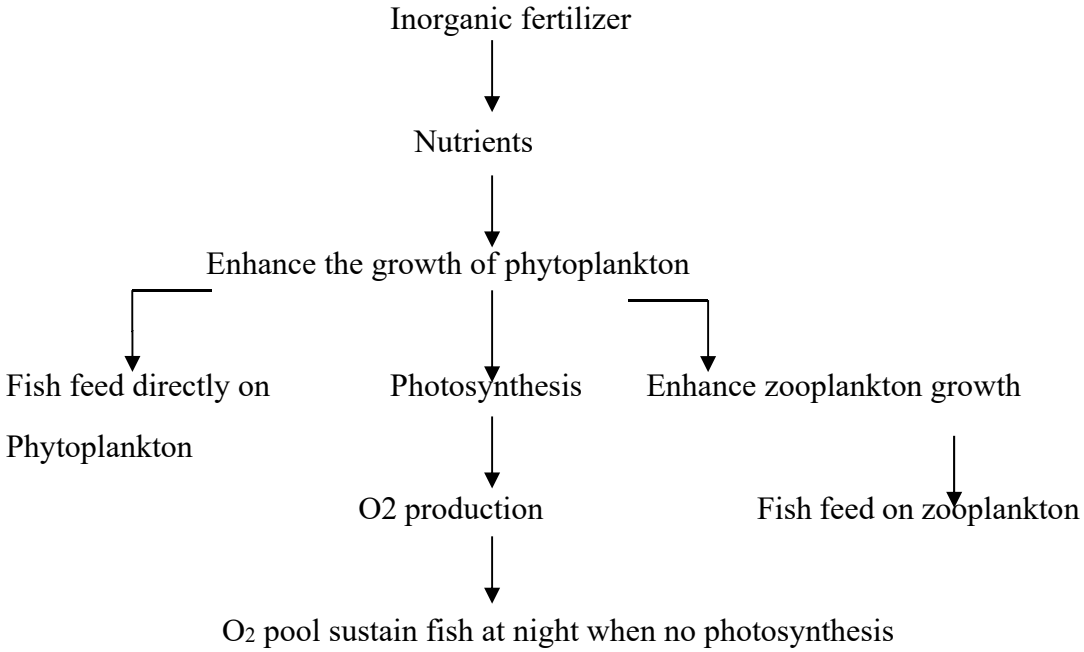
iv. May create water quality problem

Fertilization level depends on secchi disk transparency value

Table.10 Measurement of secchi disk transparency value.

Secchi disc transparency	Management/control
<25 cm	No fertilization, closely observe fish for signs of dissolved oxygen depletion, increase water flow if necessary
25-40cm	No fertilization, regularly observe the fish behavior
40-60 cm	Routing Fertilization necessary
>60 cm	Routing fertilization necessary, possible with an increase dose

Impact of inorganic fertilizer in pounds:-



3.6 Pellet Feed

The formulated feed made of different ingredient in the form of pellet that is used to feed the fish is known as pellet feed. It is economical to feed the fish by minimizing the losses.

Teacher tips:

- Ask about locally available fish feed stuff and their nutritional status
- Show the visuals of ponds cleaning and liming activities

UNIT - FOUR

Importance of water quality in fish culture

Learning outcome:

Water is an important factor for fish culture. Maintenance of water quality is an integral part for the successful in the fish production. After completion of this lesson,

- Student will have general ideas about water quality and its importance in fish culture.
- Student should acquire general knowledge about turbidity, secchi disk , water temperature and its management.

4.1 Water quality (Physical parameters)

Physical parameters of water quality include temperature, dissolved oxygen and turbidity.

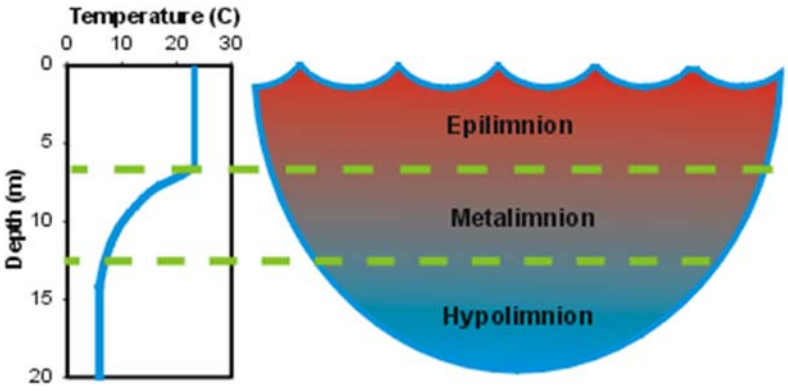
1. Temperature:-

Water temperature in pond generally depends upon solar radiation, air temperature and depth .The absorption of solar energy as light passed through water heats the water, most heats are absorbed with in upper layer. Water has large capacity to hold heats the specific heat capacity of water is unity means 1 cal is required to raised temperature of 1 gm water by 1 ˚c.

Thermal stratification:-

Thermal stratification refers to the horizontal separation of a relatively warmer surface layer of water from the cooler bottom the thermal stratification of lakes refers to a change in the temperature at different depths in the lake, and is due to the change in water's density with temperature. Cold water is denser than warm water and the epilimnion generally consists of water that is not as dense as the water in the hypolimnion. However, the temperature of maximum density for freshwater is 4 °C. In temperate regions where lake water warms up and cools through the seasons, a

cyclical pattern of overturn occurs that is repeated from year to year as the cold dense water at the top of the lake sinks.



Source : *www.google.com.np/search?q=thermal+stratification*

Fig. 11: Thermal stratification

Lake stratification is the separation of lakes into three layers:

1. Epilimnion - top of the lake.
2. Metalimnion (orThermocline) - middle layer that may change depth throughout the day.
3. Hypolimnion - the bottom layer.

Epilimnion:-

The epilimnion or surface lake is the top-most layer in a thermally stratified lake , occurring above the deeper Hypolimnion . It is warmer and typically has a higher pH and higher dissolve oxygen concentration than the hypolimnion .Being exposed at the surface, it typically becomes turbulently mixed as a result of surface wind-mixing. It is also free to exchange dissolved gases such as O_2 and CO_2 with the atmosphere. Because this layer receives the most sunlight it contains the most Phytoplankton. As they grow and reproduce they absorb nutrients from the water, when they die they sink into the hypolimnion resulting in the epilimnion becoming depleted of nutrients.

Metalimnion:-

A thermocline (sometimes metalimnion in lakes) is a thin but distinct layer in a large

body of fluid (e.g. water, such as an ocean or lake, or air, such as an atmosphere) in which temperature changes more rapidly with depth than it does in the layers above or below. In the ocean, the thermocline divides the upper mixed layer from the calm deep water below. Depending largely on season, latitude and turbulent mixing by wind, thermo clines may be a semi-permanent feature of the body of water in which they occur or they may form temporarily in response to phenomena such as the radiative heating/cooling of surface water during the day/night. Factors that affect the depth and thickness of a thermocline include seasonal weather variations, latitude and local environmental conditions, such as tides and currents

Hypolimnion:-

The hypolimnion or under lake is the dense, bottom layer of water in a thermally-stratified lake. It is the layer that lies below the thermocline. Typically the hypolimnion is the coldest layer of a lake in summer, and the warmest layer during winter. Being at depth, it is isolated from surface wind- mixing during summer, and usually receives insufficient irradiance (light) for photosynthesis to occur. In deep,temperate lakes, the bottom-most waters of the hypolimnion are typically close to 4 °C throughout the year. The hypolimnion may be much warmer in lakes at warmer latitudes.

Destratification:

Stratification may be upset by turbulence. This creates mixed layers of water. Forms of turbulence may include wind-sea surface friction, upwelling & down welling. Water stratification occurs when water masses with different properties salinity, oxygenation, density, temperature These layers are normally arranged according to density, with the least dense water masses sitting above the more dense layers. Water stratification also creates barriers to nutrient mixing between layers. This can affect the primary production in an area by limiting photosynthetic processes. When nutrients from the benthos cannot travel up into the photic zone, hytoplankton may be limited by nutrient availability. Lower primary production also leads to lower net productivity in waters.

Water temperature and fish growth:

Fish are cold blooded animal.Their body temperature is about 0.5^{o}c. The temperature

of fish body change with changes in water temperature but when rapid temperature different is more than 5 °c fish way die . The rate of bio chemical process in fish are temperature dependents, oxygen consumption increased with temperature .Temperature of tolerance for fish is 5-42 °c but the range for maximum growth might be from 25-30 °c. For cold water fish optimum temp range is 10-20 °c and warm water fish 20-32 °c.

Temperature management in fishponds:-

- Maintain the pond water depth (not less than 1m)
- Provide temporary shade to the ponds in hot months.
- Avoid fish shading in cold month.
- Avoid fish handling during very high and low temperature.
- Exchange pond water whenever required.

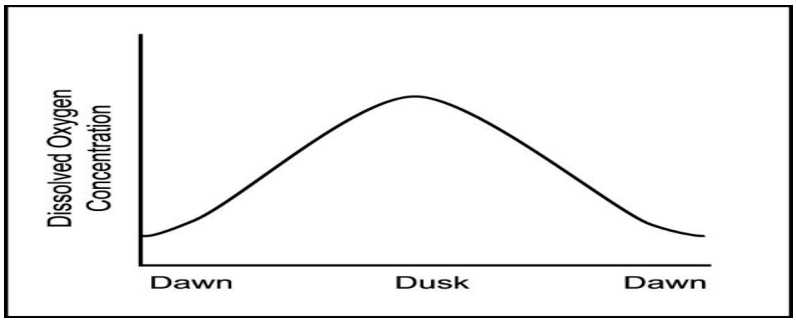
2. Dissolved oxygen:

Dissolved oxygen (DO) refers to oxygen gas that is dissolved in water. Fish "breathe" oxygen just as land animals do. However, fish are able to absorb oxygen directly from the water into their bloods stream using gills, whereas land animals use lungs to absorb oxygen from the atmosphere.

There are three main sources of oxygen in the aquatic environment:

1) Direct diffusion from the atmosphere
2) Wind and wave action
3) Photosynthesis.

Of these, photosynthesis by aquatic plants and phytoplankton is the most important. Oxygen, derived from photosynthesis, is produced during the day when sunlight shines on the plants in the water. Oxygen levels drop at night because of respiration by plants and animals, including fish. These predictable changes in DO that occur every 24 hours are called the diurnal oxygen cycle



Source: *www.google.com.np/search?q=dissolved+oxygen+concentration*

Fig. 12: Dissolved oxygen concentration in ponds fluctuates on a 24-hour

Dissolved oxygen concentration in ponds fluctuates on a 24-hour basis. This fluctuation is called a diurnal oxygen cycle. Dissolved oxygen increases during daylight hours when photosynthesis is occurring and decreases at night when respiration continues but photosynthesis does not.

Oxygen depletion refers to low levels of DO and may result in fish mortality. A concentration of 5 mg/L of water DO is recommended for optimum fish health. Sensitivity to low levels of dissolved oxygen varies with the species specific, however, most species of fish are distressed when DO falls to 2-4 mg/L. Mortality usually occurs at concentrations less than 2 mg/L. The number of fish that die during an oxygen depletion event is determined by how low the DO gets and how long it stays down. Usually larger fish are affected by low DO before smaller fish are.

Causes of Oxygen Depletion:-

Oxygen depletion occurs when oxygen consumption exceeds then the oxygen production. Increases in oxygen consumption can be caused by an over-abundance of aquatic plants or algae in the ecosystem, "turnover" of a body of water with increased organic waste entering the water (i.e., manure from feedlots, septic tank waste water, and excess fish feed), death and decay of organic matter (i.e., plant or algae die-offs), or by certain chemicals (i.e., formalin) that remove oxygen directly from the water column.

1) High water temperature:-

Warm water is much less capable of holding oxygen gas in solution than cool water.

For example, water that is 90°F can only hold 7.4 mg/L DO at saturation, whereas water that is 45°F can hold 11.9 mg/L DO at saturation. This physical phenomenon puts the fish in double jeopardy because at high water temperatures their metabolic rates increase, hence their physiological demand for oxygen increases.

2) Cloudy, Still Weather

Muggy, overcast summer days often precipitate oxygen depletions. During cloudy weather, the intensity of light reaching surface waters is greatly diminished, resulting in a marked decrease in oxygen production from photosynthesis. Oxygen consumption, however, remains unchanged. This results in a net loss of oxygen over each 24-hour period. This loss of oxygen from decreased production is confounded by still, muggy, humid weather common on overcast summer days. Oxygen transfer (from the atmosphere into the water) is minimal because there is little or no wind/wave action. The net result over a period of several days is oxygen depletion and, often, fish kills.

Stratification/Pond Turnover

During hot weather, surface waters warm up more rapidly than deeper waters. As the difference in temperature increases between warm surface water and cool bottom water, a thermocline develops. A thermocline is an area of rapid temperature change that acts as a physical barrier between warm water at the surface (epilimnion) and cold water at the bottom (hypolimnion). When a thermocline is present there is no mixing of surface and deep layers of water. Because photosynthesis and oxygen production only occur near the surface, water in the deep layer becomes devoid of oxygen and develops an oxygen demand. The thermocline can be broken by heavy wind and cold rain, common during summer thunderstorms. When the thermocline breaks down, the oxygen-rich surface waters mix with oxygen-deficient bottom water. If the oxygen demand is sufficient, all DO present will rapidly be removed from the water column, resulting in severe oxygen depletion and a fish kill.

Determine If Low DO Is the Cause of a Fish Kill

- All fish die at approximately the same time (often during the night or in the pre-dawn hours).
- Large fish may be affected more than small fish.

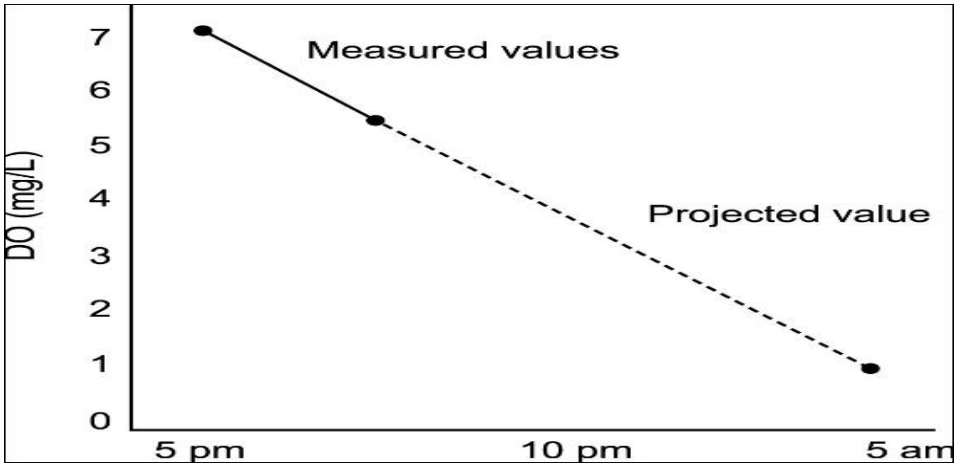
- Moribund fish may be seen at the surface "gasping" for oxygen (this is called "piping").
- Some species may die with their back arched, gills flared and mouth open. This is most commonly seen in hybrid striped bass and, occasionally, in catfish.
- The weather immediately prior to the fish kill may have been hot, still and overcast. A severe thunderstorm may have occurred immediately prior to the fish kill.
- An oxygen depletion event severe enough to result in significant fish mortality is often observed in water with heavy populations of algae or aquatic plants.

Preventing Oxygen Depletion

An oxygen depletion event can be predicted and, therefore, prevented by monitoring dissolved oxygen levels in a pond. The most efficient tool for measuring DO is an electronic oxygen meter. These instruments are available through most aquaculture supply companies at a variety of prices. Chemical test kits are also available. These are more troublesome to run, but are accurate and do not require as great an investment by pond owners.

Commercial catfish farms often hire night oxygen crews to monitor the DO concentration in each pond at two-hour intervals through the night. This is the surest way of avoiding a fish kill caused by low DO. Aeration systems can be turned on if oxygen levels drop below a certain concentration (usually 2–4 mg/L) depending on the fish species.

Monitoring oxygen throughout the night is impractical for recreational pond owners and part-time fish farmers. For these people it is easier to "predict" oxygen depletion by measuring DO levels in the late afternoon (5–6 p.m.) and late evening (8–10 p.m.). The decline in DO during the night can be predicted by graphing DO concentration against time on standard graph paper (Fig 13). If the projected concentration of DO is below 4 mg/L before 7 a.m. emergency aeration is recommended.



Source: *www.google.com.np/search?q=DO+concentration+against+time+on+standard+graph+paper*

Fig. 13: DO concentration against time on standard graph paper

Estimation of potential for dissolved oxygen depletion

If equipment to test DO concentration (meter or test kit) is not available, the following observations and conditions can be used to anticipate oxygen depletion:

- Fish swim at or near the surface gulping air (piping).
- Fish suddenly stop feeding.
- There is a rapid change in water color to brown, black or gray, signifying loss of an algal bloom.
- A putrid odor arises from the water.
- There has been an extended period of hot cloudy weather.
- There is a heavy summer wind and a rainstorm.

Dissolved oxygen is most critical water quality parameter in aquaculture. It is essential to must aquatic organism for their respiration if dissolved oxygen is low aquatic animal will be stressed vulnerable to diseases or they will die. Oxygen solubility in water depends on temperature Do decrease with increase in water temperature

Atmospheric pressure: - oxygen solubility increase with increasing atm pressure

Salinity: - oxygen solubility decrease with increase in salinity

Dissolved oxygen requirements for warm water fish 5mg /lit and 8 mg /lit for cold

water fishes.

3. Turbidity:-

As we mentioned earlier, pond water contains suspended particles of different kinds. Water turbidity is caused by the presence of these suspended particles in varying quantities. Turbidity refers to the decreases ability of water to transmit by light caused by suspended particulate matter in the water. It might be due to phytoplankton suspended particle of silt and clay high concentration of humus feed fertilizer etc.

(a) **Mineral turbidity** is caused by a high content of silt and/or clay particles, which turn the water a light brown, sometimes reddish colour. It may occur when the water supply is turbid or a bottom feeding fish, such as the common carp, stirs up the bottom mud.

(b) **Plankton turbidity** is caused by a high content of minute plants and animals which colour the water in various shades of brown, green, blue-green or yellow-green, depending on which plankton species is dominant.

(c) **Humic turbidity** is caused by the presence of humus, which turns the water a dark brownish colour. Its origin is usually the water supply, although it can also be caused by an excess of organic matter entering the pond.

Effect of turbidity: -

- Reduce light penetration caused siltation of bottom of substrate, effect vision of fish
- Turbidity has little direct effect on fish but excessive turbidity may cause interfere gill function that cause respiration problem
- Cause siltation of bottom substrate- reduce pond depth
- Adsorbs and desorbs the nutrients of pond water.

Turbidity restricts the penetration of sunlight and hence reduces photosynthetic activity which in turn is related to the productivity of water mass.

Measuring turbidity

Turbidity of pond water varies from almost zero to highly turbid, depending on the amount of suspended particles. The method used for its measurement varies according to the kind of turbidity present.

Suspended solids measurement method:-

If it is a mineral turbidity (brownish water), you will need the help of a laboratory to determine the weight of material suspended in a given volume of water. This figure is called the total suspended solids (TSS), which is usually expressed in milligrams per liter (mg/l). When taking samples, be careful not to disturb the water too much, as you can increase the TSS very easily. Also, do not take the water only from the surface, as it is often much less turbid.

Table. 11: Amount of total suspended solids (TSS) present in pond water

TSS (mg/l)	Mineral turbidity
Less than 25	Low
25-100	Medium
Over 100	High

Measurement of plank tonic turbidity

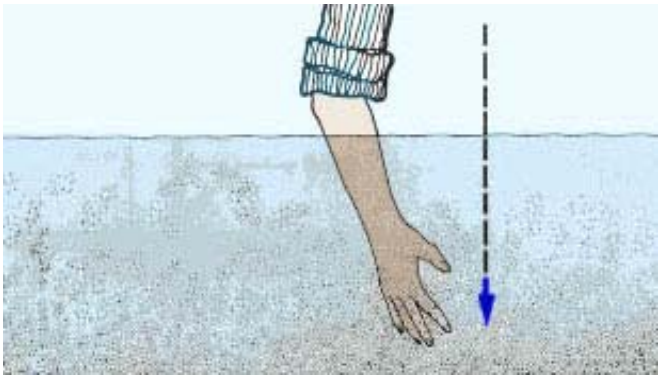
If it is plankton turbidity (greenish water), you can estimate the level yourself using the two simple methods described below. They will also give you an estimate of the potential fertility of your pond.

Measuring plankton turbidity with your arm

This is a very simple method which does not require any special equipment. Stretch one arm, and immerse it vertically into the water until your hand disappears from sight.

Note the water level along your arm:

- If it is well below your elbow, plankton turbidity is very high;
- If it reaches to about your elbow, plankton turbidity is high;
- If it reaches well above your elbow, plankton turbidity is low.



Source: *www.google.com.np/search?q=Turbidity measurement*

Fig. 14: Measurement of plank tonic turbidity by arms.

Measuring turbidity with the Secchi disc transparency

The Secchi disc is a very simple tool which can be used to give a better estimate of turbidity. It is particularly useful in green-colored ponds to estimate plankton turbidity. This measurement is then called the Secchi disc transparency.

You can easily build a Secchi disc yourself. Proceed as follows.

(a) Cut a round disc about 25 cm in diameter from a piece of wood or metal, such as a pounded tin can for example.

(b) On its surface, mark two lines to make four quarters. Paint this black and white using matt paint to prevent glare.

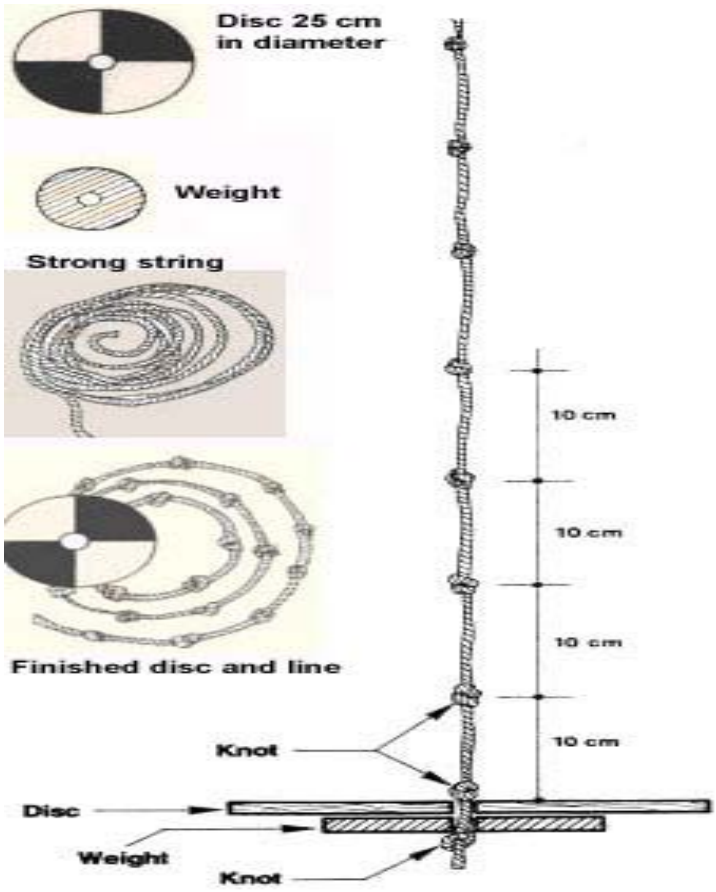
(c) Drill a small hole at the centre of the disc. Through this hole pass a line or a piece of string about 1 to 1.5 m long.

(d) Below the disc, attach to the line a small weight such as a long bolt or a stone.

(e) Fix the disc at the bottom of the line, against the bottom weight, by knotting the line around a small piece of wood or metal, across the top of the disc.

(f) Mark the rest of the line with knots or tightly tied coloured thread at 10 cm intervals.

Note: instead of using a line, you may also attach the disc from its centre to a graduated vertical stick about 100 cm long.



***Source** :www.google.com.np/search?q=Preparation+of+secchi+disc*

Fig. 15: Preparation of secchi disc

Measuring the Secchi disc transparency

To measure the Secchi disc transparency, proceed as follows.

(a) Slowly lower the disc into the water.

(b) Stop when it just disappears from sight.

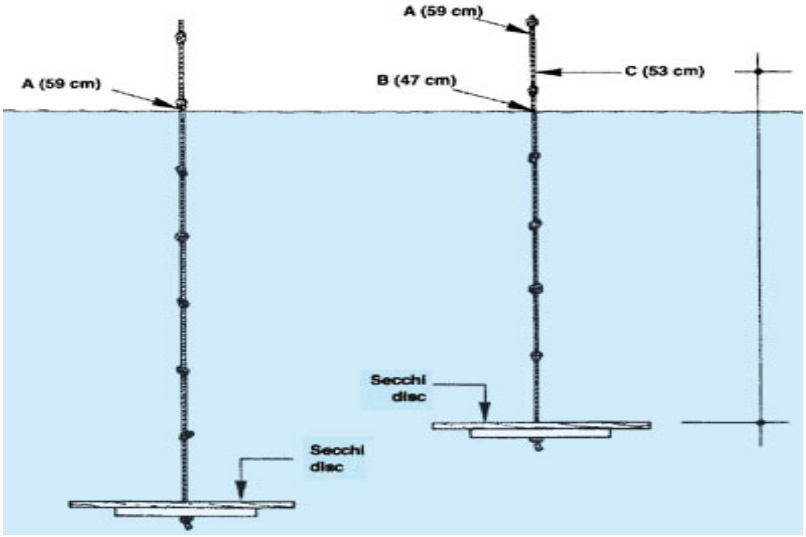
(c) Note at which point the line breaks the water surface. Mark this point A.

(d) After noting at which point along the line the disc just disappears, lower the disc a little and then raise it until it just reappears. Mark this point B.

(e) Mark point C, midway between points A and B.

(f) Measure the transparency of the water as equal to the distance from the top of the disc to this point C, counting the knots along the line. This figure is the

Secchi disc transparency.



Source: *www.google.com.np/search?q=sacchi+disc+transparency+method*

Fig. 16: Measurement of water turbidity by secchi disc transparency method.

If the Secchi disc transparency is:

- Less than 40 cm reading there is too much plankton and your fish are in danger during the night when oxygen is not produced by photosynthesis and when too much oxygen is consumed by the respiration of this plankton,
- 40 to 60 cm reading the fish production will be the best
- Over 60 cm reading there is too little plankton, and your fish do not have enough natural food to eat.

Controlling turbidity

There are several ways to control water turbidity, at least partly, depending on the kind of turbidity present.

(a) To control mineral turbidity, you may use:

- A settling basin
- A water filter
- Organic matter spread throughout the pond at the rate of 20 kg/100 m2 (two to three treatments may be necessary);
- Alum (aluminum sulphate) or gypsum (magnesium sulphate), at a rate of 1 to 3 kg/100 m^2, testing a small area first.
- Use of positively charged electrolytes such as aluminum sulfate@5-10 mg/lit, copper sulphate@0.5 mg/lit, and calcium sulfate @500 kg/ ha to reduce the turbidity caused by the suspended particles of silts and clay

(b) To control plankton turbidity:

- A water filter
- Adequate liming (500 kg /ha to prevent acidic condition due to humid substance)
- Adequate fertilization
- By netting
- By using rakers

4.2 Water quality (Chemical Parameters)

pH:-

It is defined as negatative logarithm of hydrogen ions concentration, it indicated whether water is alkaline and acidic .It is measured in scale ranges from 0-14 p^H value of neutral water is 7.A pH below 7 is acidic and above 7 is alkaline. The acid and alkaline death points are approximately pH 4 and pH 11, respectively. Water with pH values ranging from about 6.5-9 at day break is most suitable for fish production. Water pH is considered a master variable in water as it controls many chemical processes that take place. It specifically affects on availability of natural food, survive & growth & development of fish. You can use methods and tools to measure the pH of water similar to those you used to measure the pH of soil.

Effects of pH

High pH:-

- Damage cornea and lens of eyes
- Damage gill filament
- Disturb the blood acid-base balance
- Slow growth rate
- Alkaline death

Low pH:-

- Reduces appetite
- Inhibits fish growth, ceases reproduction
- Reduces tolerance to toxic substances
- Excessive production of mucus on the gills which interferes with respiration
- Increase toxicity of metal like Al, and H2S, CH4etc
- More attack of parasites and diseases
- Acid death

Measurements of PH can be done by different methods like

- PH indicator paper
- Colour comparator
- pH meters

a) pH indicator paper:

A thin strip of paper (such as chemically treated litmus paper) is partly dipped into the water to be tested. The colour of the paper changes and this new colour are compared to a colour chart, which gives the pH value according to the colour obtained. You can buy litmus paper cheaply from some chemists

b) Colour comparator:

Cheap water-testing kits can be bought from special chemical suppliers. They usually include a number of liquid indicators. A few drops of one of these colour indicators are added to a small water sample, and the new colour of the solution is compared with a set of standard colours supplied with the testing kit

Fig. 17: Water-testing kits
Source: www.google.com.np/search?q=Water-testing+kits

c) pH meter:

Such equipment provides the easiest way for determining the water pH, even in the field, but it is relatively expensive. The pH value is directly read from the meter after placing the glass electrodes in a water sample. Such electrodes are very fragile and should be well protected when being transported. They should be accurately calibrated in buffer solutions of known pH, at regular intervals.

Fig. 18: Analog and Digital pH meter
Source: www.google.com.np/search?q=digital+ph+meter

pH managements:

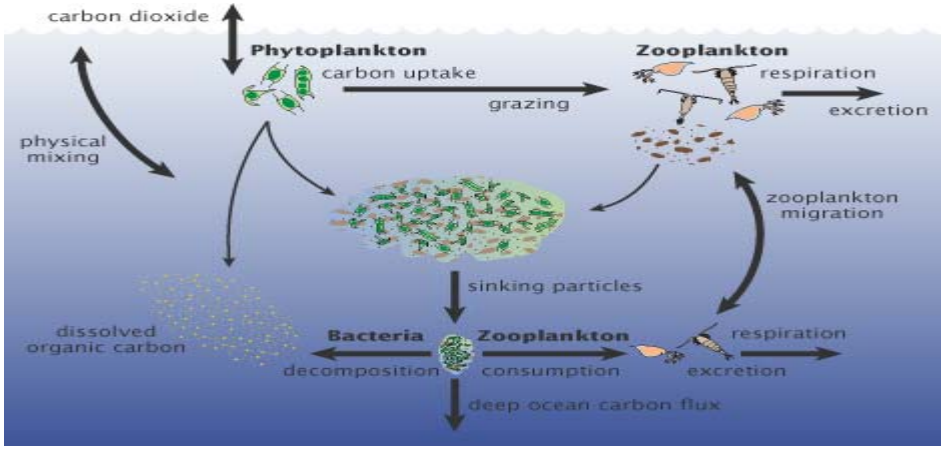
- Low pH liming the pond @ 500-1000 kg /ha /yr depending upon the pH.
- High pH use carbonic fertilizer (compost), nitrogenous fertilizer (urea, ammonium sulfate) etc.

4.3. Biological Quality of water (Limnological)

Plankton:-

Plankton is the community of minute plants or animals suspended floating or weakly swimming in normal water. Two types of plankton are generally available in the aquatic environment. They are as,

- Phytoplankton: - Plant origin
- Zooplankton: - Animal origin



Source: *www.google.com.np/search?q=Phytoplankton%26+Zooplankton+cycle*

Fig.19: Phytoplankton& Zooplankton cycle

a. Phytoplankton:-

The word Phytoplankton is derived from two Greek word (Phyto & plankton), Phyto, means plants & plankton means community. These are autotrophic, prokaryotic algae emerge near the water surface where they get sufficient light to support photosynthesis. The important groups are diatoms, cyanobacteria, dinoflagellates and coccolithophores**.** Most phytoplankton are too small & even cannot be seen with nacked eye though when present in large number some varieties may be noticeable as coloured patches on the water surface due to presence of chlorophyll within their cell & necessary pigment in some species.

Phytoplankton play a significant role in stabilizing the whole pond ecosystem & in minimizing the fluctuation of water quality. A suitable phytoplankton population in enriches the system with oxygen through photosynthesis during day light hours and lower the levels of co_2, NH_3, No_2 and H_2S.A healthy phytoplankton bloom can

reduce toxic substances since phytoplankton can consume NH_4 and tie-up heavy metals.It can prevents the development of filamentous algae since phytoplankton can block light from reaching the bottom.A healthy bloom also provides proper turbidity and subsequently stabilizes shrimp and reduce cannibalism.it decreasese temperature loss in winter & stabilizes water temperature.

Some of phytoplankton present in pond is as follows

1. Cyanophyta
2. Euglenophyta
3. Chlorophyta
4. Chrysophyta
5. Xynthophyta
6. Bacillariophyta
7. Pyrophyta

Role of phytoplankton:-

The role of phytoplankton in fish pond are as follows:

- Major food for phytoplankton feeder
- Base of the food web in fish pond.
- Makes water turbid and prevents the growth of undesirable aquatic weeds through shading
- Major source of dissolved oxygen in water.
- Density of Phytoplankton in particular fish pond also affect the physical &chemical properties of water.

b. Zooplankton:-

The term zooplankton derive from two greek word i.e. zoon means animals and plankton means community. These are small protozoan's or metazoans (e.g. crustaceans and other animals) which population in the water determines the biological quality quality of water they feed on other plankton and telonemia.They also feeds on eggs & larvae of some larger animals such fish, crustaceans, and annelids.

Different types of zooplanktons present in pond are as follows:

1. protozoa
2. Rotifera
3. Ostracoda
4. Cladocera
5. Copepoda
6. Worm like zooplankton

Role of zooplankton:-

The role of zooplankton in fish pond are as follows:

- Major food item for larvae or juveniles of most fish species
- Major food for zooplankton feeder
- They act as secondary product of food web on particular fish pond.
- Density of zooplankton in particular fish pond also affect the physical & chemical properties of water.

Teacher tips:

- Ask student to collect water sample from different sources and compare and categories them.
- Conduct group discussion about physical, chemical and biological properties of various water sample.

UNIT - FIVE
Fish Culture System in Nepal

Knowledge about the fish culture is an important part of fish farming in aquaculture. After completion of this lesson,

- Student will have general concept and ideas about monoculture, polyculture, integrated fish farming and fingerlings production in paddy field.

5.1. Monoculture

Monoculture is the system of fish farming in which only one fish species is reared in the single water body. Monoculture of high value and marked oriented fish species is common practice throughout the world. The typical fish reared in this way are trout, tilapia, catfish, carps etc.

Mono – sex culture

Mono - sex culture is the system of culturing either male or female of single fish species. It is practiced in prolific breeding fish species like tilapia and also in brood stock pond.

Advantages of monoculture and mono-sex culture

- This practiced is best for new beginners
- Feeding of single fish species is much easier than polyculture.
- Diagnosis and treatment activities are easier.
- Pond management activities are also easier.
- Research and experimental practices are easily carried-out.
- It is easy to know their habitual activities like feeding, living etc.
- Different age's fishes can stock on single water body.
- Selective harvesting of marketable fishes is easily practiced.

Disadvantages of monoculture

- All three layer of pond isn't utilized
- Total natural feed of pond layers isn't utilized.
- It isn't profitable business

5.2 Polyculture of fish & its importance

The concept of polyculture of fish is based on the concept of total utilization of different steps and spatial niches of a pond in order to obtain maximum fish production per unit area. Different compatible species of fish of different tropic and spatial niches are raised together in the same pond to utilize all sorts of natural food available in the pond.

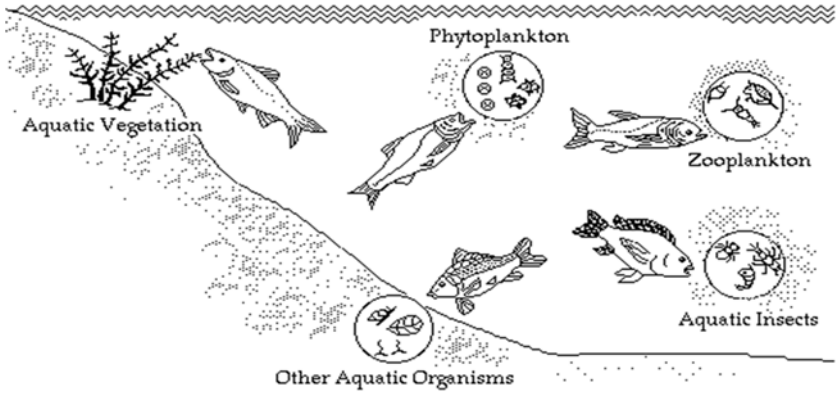
In general, undrainable pond is characterized by its diversified environment comprising of various natural fish food organisms (Phytoplankton, Zooplankton, Periphyton, Macrophytes, Benthos and detritus) at different strata of pond water column as well as in the bottom. Selection of species in polyculture is thus very important. There should be a compatible combination of species with diversified feeding habit that should include planktivorous surface/column feeders to benthic/ detritivorous bottom feeders as well as omnivorous to macro vegetation feeding fish species.

The possibility of increasing fish production per unit area, through polyculture, is considerable, when compared with monoculture system of fish. Different species combinations in polyculture system effectively contribute also to improve the pond environment. Algal blooming is common in most tropical manure fed ponds. By stocking phyto planktophagus Silver carp in appropriate density certain algal blooming can be controlled. Grass carp on the other hand keeps the macrophyte abundance under control due to its macro vegetation feeding habit and it adds increased amount of partially digested excreta which becomes the feed for the bottom dweller copro fagous common carp. The bottom dwelling mrigal, common/mirror carp help re-suspension of bottom nutrients to water while stirring the bottom mud in search of food. Such an exercise of bottom dwellers also aerates the bottom sediment. All these facts suggest that polyculture is the most suitable proposition for fish culture in undrainable tropical ponds.

Polyculture works:-

Ponds that have been enriched through chemical fertilization, manuring or feeding practices contain abundant natural fish food organisms living at different depths and locations in the water column. Most fish feed predominantly on selected groups of

these organisms. Polyculture should combine fish having different feeding habits in proportions that effectively utilize this natural food. As a result, higher yields are obtained. Efficient Polyculture systems in tropical climates may produce up to 8,000 kg of fish per hectare per year.



Source: www.google.com.np/search?q=Polyculture+system

Fig. 20: Polyculture system

Fish used in polyculture:-

Combinations of three Chinese carps (bighead, silver and grass carp) and the common carp are most common in Polyculture. Other species may also be used. While fish may be grouped into broad categories based on their feeding habits, some overlap does occur. Polyculture systems have tremendous potential and our endemic Schizothoracid species can be utilized effectively in composite fish culture.

Factors affecting species selection and stocking rates:-

1. Water temperature.
2. Market value of fish.
3. Pond fertilization practices.
4. Feeding habits of fish.
5. Potential of uncontrolled spawning in grow-out ponds.

Stocking rates for polyculture systems:-

Examples of stocking rates for Polyculture systems used in various countries are presented in Table: 12. Modification to suit conditions in other locations may be necessary.

Table: 12 Number of fish stocked per 100 m^2 of pond surface area in Polyculture systems used in various countries.

SPECIES	CHINA	INDIA	MALAYSIA	THAILAND	PANAMA	SIERRA LEONE
Bighead carp	1	-	1	3	10	-
Silver carp	12	-	1	3	-	-
Grass carp	2	-	3	3	-	-
Common carp	17	-	1	6	10	-
Rohu	-	38	-	6	-	-
Mrigal	-	6	-	-	-	-
Catla	-	19	-	-	-	-
Tilapia	-	-	-	63	100	160
Notopterus	-	-	-	-	-	16

Intensive polyculture of fish is the latest and improved technology of fish farming. There are many advantages and disadvantages of intensive polyculture of fish which are described below.

Advantages

- Maximum fish production is possible in intensive polyculture.
- More profit from fish farming is possible.
- Creates many employment opportunities.
- Intensive polyculture of fish is fully controlled by the farmer.
- More fish can be cultivated and produced from small place.

Disadvantages

- Intensive polyculture of fish is very expensive and risky.
- In this system the probability of diseases is most.
- These farming systems get obstructed due to lack of better facilitated artificial farm.
- It is not possible to make the fish big sized in this system.
- Intensive polyculture needs highly experienced employee.

5.3 Importance of integrated fish farming (Fish cum livestock)

Integrated farming:-

Integrated farming is commonly and narrowly equated with the direct use of fresh livestock manure in fish culture. However, there are broader definitions that better illustrate potential linkages. Indeed, the term 'integrated farming' has been used for integrated resource management which may not include either livestock or fish components. Our focus is the integration of livestock and fish, often within a larger farming or livelihood system. Although housing of livestock over or adjacent to fish ponds facilitates loading of wastes, in practice livestock and fish may be produced at separate locations and by different people yet be integrated. Distinguished between the use of manures produced next to the fishpond and elsewhere on the same farm. A wider definition includes manures obtained from off-farm and transported in bags, e.g. poultry manure, or as slurry in tanks, such as for pig and large ruminant manure. Integrated farming involving aquaculture defined broadly is the concurrent or sequential linkage between two or more activities, of which at least one is aquaculture. These may occur directly on-site or indirectly through off-site needs and opportunities, or both. Benefits of integration are synergistic rather than additive; and the fish and livestock components may benefit to varying degrees (The term "waste" has not been omitted because of common usage but philosophically and practically it is better to consider wastes as "resources out of place

(1) Poultry cum fish farming

This type of culture can be practiced either by directly building the poultry house at the top, or on a diversion of the pond in case of a big pond. However, the size of the pond should always be put into consideration before erecting a poultry house. That is, a very big poultry house built on a small pond should be discouraged since the droppings from the birds may be too much and may thus contaminate or pollute the pond. A poultry housing about 25-35 birds 3 should be ideal for a pond of 15m x 10m x 1.5 i.e. 225M for stocking catfish in a situation where the fish pond is secondary in consideration to the poultry. It is better to construct the pond separately and then feed the fish manually with the poultry droppings (10,-15 kg dry weight/week for same size of pond). However in a situation where the poultry is

secondary, 2 in which case there is a large fish farm to a small poultry attachment, then supplementary feeding from other sources should be considered since the droppings alone from the poultry may not be sufficient for the fish to utilize. Poultry house on posts above a fish pond. If the size or the poultry is proportional to the pond, additional feeding of the fish may not be necessary. In all circumstances, a close study of the pond and fish should always be made, especially if the birds are afflicted with one form of disease or another, this could affect their feeding habits and consequently less droppings. It should be noted that some poultry diseases may also cause infections to the flesh and skins of the fish. The poultry house floor should be made in such a way that the dropping should fall directly inside the pond Plank arrangement on the floor of the poultry house.

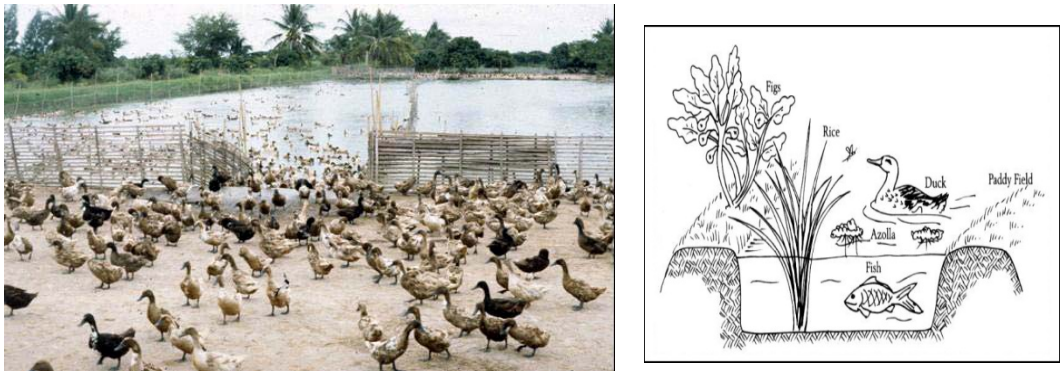
Source: *www.google.com.np/search?q=Poultry+cum++fish+farming*

Fig. 21: Poultry cum fish farming

(2) Duck cum fish farming:

Ducks can be reared in the vicinity of the fish pond by leaving the birds to move on the water bodies. The pond open to ducks can be stocked at the rate of 45 3 fingerlings per cubic meter (5 fish/m), the fish being average of 10g each at stocking period. The droppings continually manure the pond and a huge quantity of phytoplankton (minute-fish food of plant origin) will be readily available. The ducks

also clear the ponds by rooting up water plants and eating some of the fish predators such reptiles, amphibians and water snails. Apart from the direct manuring of the Pond, ducks further produce additional droppings during their rest periods when they converge in their house. The duck house must be constructed in a lower enough form to allow them always go out to swim and come back to the house without any hindrance whatsoever. The materials to be used for the pillar of the house should be hard wood that will last several years' better still, concrete cement or iron rods. Feeding of the ducks should be done inside their house. Regular supplementary feeding of the ducks should be ensured to avoid the hungry ducks searching for food. However, supplementary feeding for fish may not be necessary unless feeding: is for a purpose, such as feeding the fish to attain the required size at a targeted time.



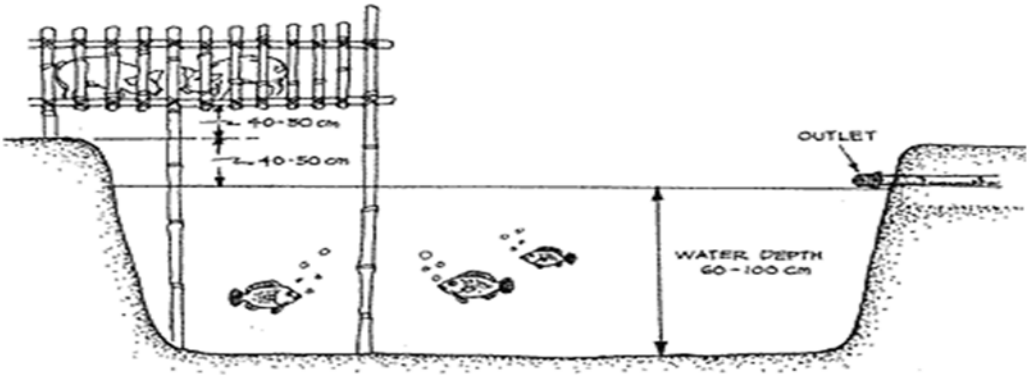
Source: *www.google.com.np/search?q=Duck+cum++fish+farming*

Fig.22 : Duck cum fish farming

(3) Pig cum fish farming:-

The combination is less obvious than the earlier mentioned ones but gives much larger yield of fish and appears to be an easier technique. Though pigs are not water animals, they like taking baths and every time they have access to a pool or pond they usually lay there and all their excreta, manures the water directly. In this kind of combination, three arrangements of the piggery can be adopted either directly by the side of the pond or on a sloping shore or on pilings above the pond. The main point is to let the garbage pour continually into the water. It is recommended that 45-50 pigs be stocked per hectare of fish pond or 0.6-0.8 tons of pig droppings per hectare per week. Simple pig sty on the bank of fish pond Best results are obtained when the fish species cultured are hardy and can withstand low dissolved oxygen.

Mud-fish (Claries) and Tilapia meet these requirements. Carp or Hetorobranchus bidorsalis can be reared in larger integrated fish/pig ponds. 6 7 It is good to take note that some pig diseases such as tape worms (Diphyllobathrium) in pig are transferable to fish and in some cases to man, so keep a good hygiene and de worm -your pigs regularly.



Source: *www.google.com.np/search?q= Pig+cum++fish+farming*

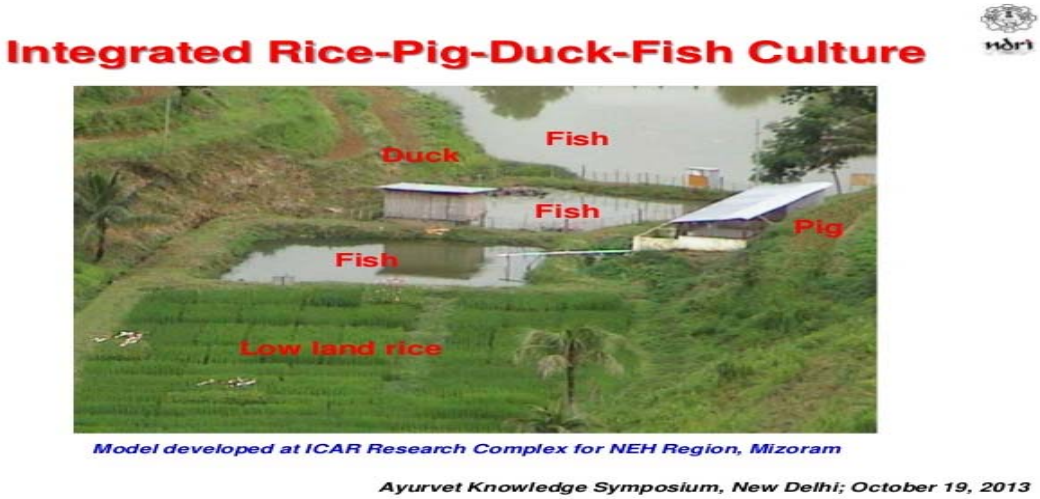
Fig. 23: Pig cum fish farming

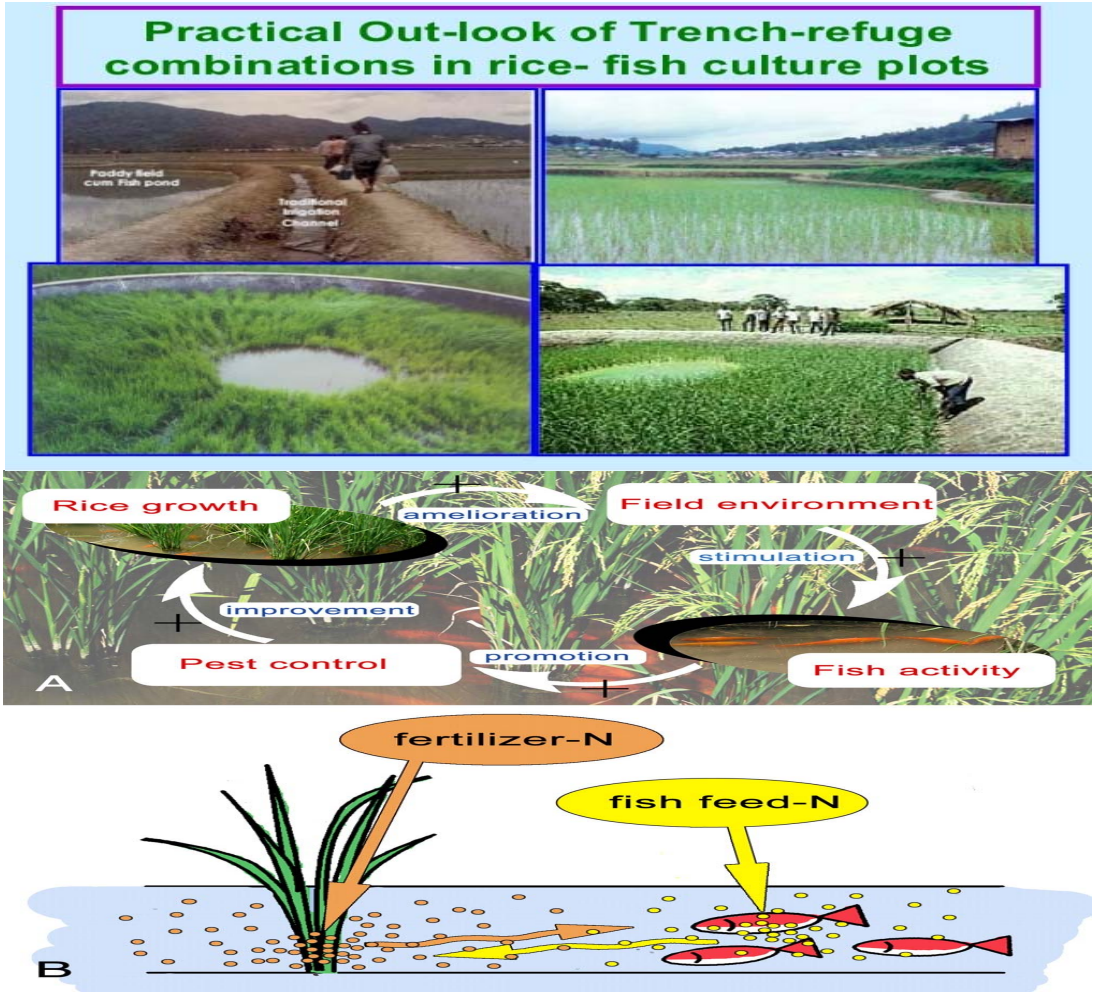
(4) Fish/Cattle/Goat/Sheep Combination

This culture combination entails constructing a fish pond near cattle ranch or pastures land and collecting the cow, sheep, or goat droppings and feed the required quantity into the pond. This dung thus manures the pond or are taken directly as food by the fish In this culture combination fish pond can only ‘be considered secondary in an already established ranch where the dung are considered as wastes. 400 goat/sheep or 30 cattle can be stocked for 1 hectare fish pond.

(5) Fish Culture in Rice fields:-

Fish culture in rice fields is a complementary practice of the rice culture in wet land.Wet land being defined, among others as land subject to excessive wetness, to the extent that the wet conditions influence the possible land uses. They range in Nigeria from river and lake flood plains in the north to the south. Areas of swampy rice cultivation can be stocked with Mud catfish (claries) and bony fish (Tilapia). Fish pond grown with Rice the rainfed low land rice grown areas can also be intercropped with fish. Experience has shown that this combination has a chance of big success only in the area where the technique of flood rice culture is ready established and where the rice farmer gets the water completely under his control. In so doing, he can prevent wild fish from coming into the paddies and also control loss of production which could occur in the case of over-flooding. Good fish for combination should be able to tolerate high temperature and low dissolved oxygen content of the water: · It should be the fast growing type to reach table size after a short time. The type of rice to be cultivated too, must be the lowland (Water-logged type). The International Institute for Tropical Agriculture (IITA) has different varieties of this type.





Source: *www.google.com.np/search?q=rice+cum++fish+farming*

Fig. 24: Fish culture in Rice field

The general requirements of fish recommended for integrated aquaculture are:

- It should have a short food chain i.e. should not be feed-type specific. ·
- It should be hardy to withstand stress. ·
- It must be able to tolerate adverse conditions such as temperature variations, low dissolved oxygen etc. ·
- It must be disease resistant. ·
- It must be fast growing and a good feed converter (good food conversion ratio).
- It must be the generally sought-after type ·

- If rearing is for commercial purpose, it should have good market value.
- The widely recommended species that meet almost all these requirements are Tilapia the mudfish (Claries) and the Africa Carp (Cyprinus carpio).
- It is advisable that a fish farmer going to start a integrated system of fish farming in a large scale it should be start initially on small scale for effective monitoring and control.

5.4. Fingerlings production in paddy field

Fish farming with paddy is an economical method to gain profitability. The combination of both fish and paddy become successful when grow in a right manner. Similarly the production of fingerlings become an popular now a days in many fish culture country. By stocking brood fish of Nile tilapia (Oreochromis niloticus) GIFT strain and fertilized eggs of common carp (Cyprinus carpio) in rice field during boro season farmer can produce a large numbers of large size quality fingerlings. They can sell these fingerings to traders and neighbours and/or use for early stocking in own ponds and rice fields for grow-out to get higher food fish production. The farmer can produce enough fish to eat regularly for household consumption. In order to produce quality fingerlings of Nile tilapia (GIFT) and common carp successfully it needs to follow some basic steps as explained below:

Rice field preparation

- Once it has been chosen based on rice field to use it is very important to repair any low dikes so that fish cannot escape from the plot when the water level raises. Raise the plot dikes to about 1 hand's (1.5 feet) height above the surface level of the plot. If the dikes are already high it may need only to do repairing (checking for any holes or breakage in the dikes)
- Before stock fish in the plot it needs to make a small ditch where the fish can shelter from predators. The ditch should be at least 5 X 5 hands (7.5x7.5 feet) in area, with a depth of 2.0 hands (3 feet). It is best to make the ditch in a suitable corner of the plot where rice productivity is low.

Stocking and feeding of Nile tilapia brood fish:-

Need to stock Nile tilapia brood fish at a density of 3 fish/decimal from own source or from neighbours who reared quality brood fish following good management

practices (as mentioned above) or from the satellite brood fish rarer who reared brood fish in cages. Field trainer should tell farmers when the brood fish are ready to collect and where to collect them from. For collection of brood fish from the source and to transport to the rice field plot site for stocking it is better to do using large aluminum patil filled with sufficient water early in the morning.

- Place the pot gently into the ditch in rice plot. The fish will swim out into the ditch when they are ready.
- The best period for stocking Nile tilapia in boro rice plot is between mid February to end of March
- If possible should feed the fish in the ditch every morning and every afternoon so that they can grow quickly. Need to feed about one handful of rice bran each time. Observe the fish carefully to see whether they eat it all. Other feeds like mustard oil cake also use along with rice bran as feed.

Stocking Fertilized Eggs of Common Carp:-

If there is a pond in the community of farmers which has common carp they can also stock its fertilized eggs to grow fingerlings in the same rice field with Nile tilapia together.

In order to do this the following points need to be considered:

- Common carp produce eggs mainly between mid February and the end of March.
- Put a water hyacinth in a pond where there are common carp brood fish.
- Observe whether common carp brood fish has exerted their eggs by checking the roots of water hyacinth every few days
- Once see eggs collect the hyacinth in a aluminum bowl and need to place it into the ditch of the rice plot
- The eggs will hatched out naturally and spawn of common carp will produce in the ditches
- It needs to apply fine rice bran on regular basis to feed the spawn on regular basis (2-3 times per day) initially until it become fry, later like Nile tilapia similar sorts of feeds and can be done together in the same plot.

Observation of the Rice field

In order to get success in quality fingerling production of Nile tilapia (*Oreochromis niloticus*; GIFT strain) and common carp (*Cyprinus carpio*) it needs for the farming households to do regular observation or monitoring of their rice field. During observation of the rice plots the following things need to be considered:

- Check the ditch in the rice field regularly to see whether any fry have appeared. Any member of household (husband, housewife or children) can do this.
- Check the water level in the rice field while observing the fry and try to make sure the water level doesn't fall below 5-6 inches. Once fry have appeared they should be able to move freely out of the ditch into the rice plot to feed and return to the ditch again to take shelter
- Normally when a rice field has fish stocked in it they will eat all of the insects and other pests so it is normally not need to use any pesticides. Farmer should always avoid using any pesticide in plot after fish have been stocked in it. However, if there is a severe pest infestation in the plot farmer can use pesticides bringing all the fish to the ditch. In order to do these farmers must make a strong dyke around the ditch of about 1 foot high. Leave and opening about 1.5 feet wide in the dyke so that the fish can swim into it.
- Drain the plot so that all the fish move back to the ditch. Then close the dyke so that they cannot swim back into the field. Use the pesticide. Wait at least 3 -5 days after using the pesticide. Then make an opening in the ditch so that the fish can return to the field.

Harvesting of fingerlings:-

- When the fingerlings in your plot are large size (at least 1.5-2 inch) long they are ready to be sold or stocked into your own pond.
- Farmers need to talk to fingerling traders or grower farmers and inform them those fingerlings ready for sale.
- Arrange a time with the customers when harvest the fingerlings
- Drain the rice plot. As the water level goes down the fish will swim to the ditch
- Harvest fingerlings from the ditch by gently using a mosquito net to catch them. Sell the larger fingerlings but return any fish less than 1inch long to the

ditch so that they can grow bigger size.

- Leave the adult fish in the ditch.
- Gradually increase the water level in the rice plot and keep checking the plot and feeding the brood fish as you did before
- The brood fish will produce more fingerlings which you can also harvest and sell
- Fingerings can be harvested about once every three weeks.
- Try to keep a record of how many fingerlings you sell, the dates when you sold them and how much money you made.
- Production of fingerlings is usually highest during the months of May, June and July.

Teacher tips:

- Make a field visit to different fish culture system i.e. monoculture, polyculture and fingerlings production in rice field
- Slide show and visuals presentation of different integrated fish farms

UNIT - SIX

Common fish disease, Prevention & treatment

Learning outcome:

Knowledge about common fish disease and its management is an important parts for successful fish farming. Completion of this lesson student,

- Can identify diseased and healthy fish
- Can identify and differentiate different fish disease
- Can adopt preventive measure to control different fish disease

6.1. Fish disease, identification & control measure

Disease is a abnormal from the typical normal state of health of a fish. Disease may be classified as infectious diseases and noninfectious disease. Infectious diseases are cause by microorganism such as protozoa, bacteria, fungi, virus, worm or crustaceans. Similarly, noninfectious disease includes nutritional deficiencies, dietary toxicity, and water quality problem.

Fish Diseases can be classify into 4 general group including bacterial infections, fungal infections, parasitic or protozoan infections, and viral infections.

Bacterial Diseases: Bacterial diseases are usually characterized by red streaks or spots and/or swelling of the abdomen or eye. These are best treated by antibiotics such as penicillin, amoxicillin, or erythromycin.

Fungal Diseases: Common fungal infections often look like gray or white fluffy patches.

Parasitic Diseases: The most common parasitic disease called "Ich" can be treated most effectively with copper or malachite green in the right dosage. Most treatments will have copper as an ingredient. Many water treatments like "Aquari-Sol" will also contain copper as an ingredient. If the treatment you use is an anti-biotic or copper based, remember to remove all carbon from the filtration system.

Viral disease: Over 125 different viruses have been documented in fishes (Noga 2010), but most of them have been in aquaculture food fishes, as that is where the

most resources are focused. Symptoms of piscine viral infections overlap those resulting from some other diseases, so positive identification is difficult with aquarium fishes. Although vaccines are available to protect some species of food fishes from some viruses, it needs to be understood that no medications are available to treat active viral diseases in any fish.

Signs of disease

- Fish becomes restless or abnormal
- Loss of balance and fish is unable to maintain its position in the column of water
- Fish tends to lie on its side either resting at the bottom or floating at the surface
- Gills appear pale
- Bloody and bulging eye
- Swelling the abdomen
- Tail and fins do not seem to function normally with vigor
- Erosion of scale, fins, gill lamellae or part of skin.
- Slowly down or complete stoppage of feeding.

6.2. Fish disease caused by parasite, their treatment & control measure

6.2.1 Parasitic Diseases

6.2.1.1 Fish louse (Argulus)

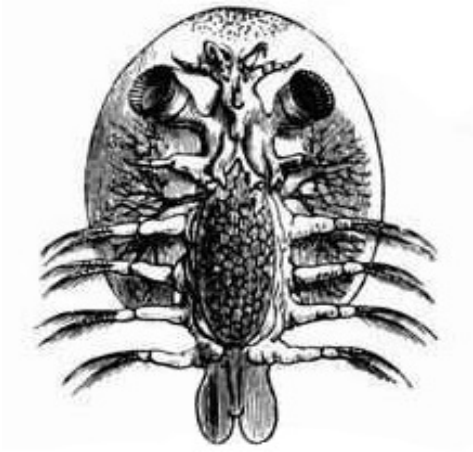
Causal Organism: *Argulus foliaceus*

Argulus are a crustacean parasite in the subphylum Crustacea. Argulus is a member of the Branchiura class, which are all crustacean parasites. Argulus are one of the largest external parasites in ponds. Because of their size and visibility to the naked eye, they are also known as fish lice. The fish lice range in size from 5mm to 10mm in length. Even though they are quite large it can be difficult to see them sometimes because they like to hide in more sheltered areas on the fish host. The fish lice are round or oval in shape and almost flat. Kind of like a flattened horseshoe crab. The fish lice can move quite quickly and can swim between hosts.

Symptom of disease

- Symptoms include patches of irritated skin, gills and fins with small red holes.

- The argulus has hook like limbs and a sucking feeding apparatus, they can cause open wounds that can lead to secondary infection.
- This feeding apparatus releases enzymes to digest the host and this can also contribute to illness for the host fish.
- Fish also continuously rubs itself against other objects or jumps out the water.
- Act as vector for fungal & bacterial diseases.



Source: *www.google.com.np/search?q=Fish+louse*

Fig.25: Fish louse

Control Measures

- The most successful and effective treatments against lice are organophosphates.
- Using three treatments over the estimated life cycle of the parasite almost always eradicates lice. At typical summer pond temperatures of 68 degrees F or higher, treatments at 10-day intervals will kill existing adults and juveniles as well as
- Pond treatment with Dipterex @0.25 ppm . repeat this treatment twice weekly until no parasite is observed.
- 3-5 minutes bath in 2% common salts solution.
- Indefinite treatments in pond with 0.25 ppm potassium permanganate
- Glacial acetic acid solution 500-1000 ppm bath for 5 minutes
- Removal parasites by forceps followed by a bath in weak KMnO4 soln for 2-3 mins

- Use of sticks as a egg traps
- Leave pond empty for some period.

6.2.1.1 White spot or ichthyophthiriasis

Causal Organism: Ichthyophthirus multifiliis

Ich is a protozoan disease that is often called 'white spot disease.' The scientific name for the disease is ichthyophthiriasis and the causative agent is Ichthyophthirius multifiliis. It is wide spread in all freshwater fish but appears to be more common in aquarium fish, possibly due to the closer contact and stress involved with aquarium species.it may be oval shape having a U or horse-shoe shaped nucleus.

Disease symptoms

- The symptoms of ich are very evident and usually include characteristic white spots on the body and gills.
- In severe condition, the entire body of fish is covered with nodules/cysts.
- The fish will become more irritated and may try to rub or scratch against the sides and bottom of the tank.
- This disease may also cause respiratory distress, severe agitation, loss of appetite, and eventually death.

Source:*http://edis.ifas.ufl.edu / ich parasite*

Fig. 26: Mature "Ich" parasite.

Control measures

Control of this disease is very difficult because of the parasites' unusual life cycle and the effect of water temperature on its life cycle.

All incoming fish should be quarantined for at least three days when temperatures are 75 to 83°F.

To prevent the spread of disease, the pond should be treated with quick lime @ 500kg/ha.

Pond should be treated with $CuSo_4$ @ 0.5ppm weekly.

Infected fish should be treated with 2-35 common salt solution for about 2-3 min for 0ne week.

6.2.2 Bacterial diseases

6.2.2.1 Tail rot or fin rot

Causal Organism: Flexibacter columnaris.

This is a serious disease of young salmonids, catfish and many other fish. The bacteria are thin rods, (0.5- 1.0 microns in diameter, and some 4-10 microns long). Their most noticeable feature is an unusual "gliding" motion, which is not observed in other species. In wet mounted specimens they can be seen piled up into large columns which have given one of the common names to this infection.

Symptom of diseases

This is a highly communicable disease. Lesions usually first appear as small white spots on the caudal fin and progresses towards the head. The caudal fin and anal fins may become severely eroded. As the disease progresses, the skin is often involved with numerous gray white ulcers. Gills are a common site of damage and may be the only affected area. The gill lesions are characterized by necrosis of the distal end of the gill filament that progresses basally to involve the entire filament. infections are frequently associated with stress conditions. Predisposing factors for Columnaris disease are high water temperature (25°C-32°C.), crowding, injury, and poor water quality.

Fin rot is fairly easy to diagnose, though ideally you want to catch it when the disease has barely progressed as it will be much easier to treat.

- The first signs of the disease are milky white areas appearing in the fish's fins or tail, particularly around the edges.
- The fins develop a rather ragged appearance as the disease begins to eat the tissue.
- Eventually the disease eats all the clear fin membrane away, leaving just the fin

rays.

- If the fin rot has affected the fish's tail (also called tail rot), it may work its way through to the body of the fish.
- Secondary infections or diseases are common in advanced cases of fin rot, bringing new symptoms to the afflicted fish such as white cotton wool-like tufts or streaked patches of red.

***Source**: www.google.com.np/tail.com*

Fig. 27: Tail rot or fin rot

Control measure

- The ideal way to eliminate the occurrence of columnaris is to alleviate stress in the cultured fish population.
- The bacteria thrive on organic wastes and these can be controlled by regular water changes.
- Disinfection of the equipments and utensils to prevent spread of the infection.
- Salt (5-10 ppm) can be used to control the disease in hatchery tanks and to reduce the chance of infection during transportation.
- Use orally oxyteracycline or terramycine @ 7.5g per 100 kg feed per day for 2 week.

6.2.2.2. Red Pest

Causal Organism: Bacterium anguilarum

Red pest is a disease that affects fish and that can cause bloody streaks on the fins, tail and body of the fish. Blood streaks do not have to appear in all these areas for it to be red pest; it will sometimes only affect the body or fins. The disease can in severe cases cause the fins and the tail to fall of. Red pest disease usually infects

already weakened fish and is uncommon in healthy fish in well kept in pond.

Disease symptom

It symptom appears on bloody streaks on its body,fin & tail.

- Red streaks from red pest can occur on any of these areas of the fish.
- It will sometimes only affect the body or fins.
- In sever cases, the tail to rot away or fin falling
- Red pest disease can infect a healthy fish but is much more common in fish with other health issues.

***Source**: www.google.com.np/red pest*

Fig.28: Red pest

Control measure

- Remove or separate all the diseases infected fish from the pond.
- To check the spread of the disease the equipment & utensils must be disinfected.
- The best method to treat the red pest is to feed the fish food in a required dosed with antibiotics (Adding about 1% antibiotic).
- If the fish is too sick, ingest the antibiotics @ 10 mg per liter of water.
- If the water quality is poor, take appropriate steps to remedy the water problems.

6.2.3 Viral disease

6.2.3.1. Lymphocystis

Causal organism: virus

Lymphocystis disease is a common viral infection which affects the skin and fins of saltwater and freshwater fish. Although it is serious, it does not cause any health problems; the disease only disfigures the fish.

They live and transmit only in the living host. They attack on tissue of fish body and break down the system of body and finally fish will die.

Diseases Symptoms

- The viral infection causes growths on the skin or fins, which look similar to cauliflowers.
- It last up to four weeks (depending on species involved, water temperature, and other variables) and then the enlarged cells rupture or slough off and release the viral particles into the water.
- Infected, fish may become slowed or weakened, or more visible, and thus be more prone to predation or attack.

Source: www.google.com.np/

Fig. 29: Lymphocystis ()

Control measure

- Separate the infected fish from the pond as soon as possible.
- All the equipments used in fish culture should be disinfectant properly to avoid the spreading of virus.
- Sanitation of fish pond at a regular interval.
- Fish should remain quarantined for at least 1 month after recovery.

6.2.4 Fungus disease

Saprolagneasis/water mould disease:

Causal Organism: Saprolegnia parasitica

It is fungal disease of fish. Fungal attacks always follow some other health problem like parasitic attack, injury, or bacterial infection. These diseases attacking dead eggs and matter in the water& Indirect contact through several sources, including, the water supply, transport vehicles, movement of staff between aquaculture facilities

and farm equipment, such as nets. The disease is transmitted through direct contact between diseased fish or fish eggs and healthy one. The scientific classification of Saprolagneasis/water mould disease are,

Symptom of disease

- The symptoms are a gray or whitish growth in and on the skin and/or fins of the fish. Eventually, if left untreated, these growths will become cottony looking.
- .In severe cases, 80% of body may be covered with fungal growth.
- In early infections, skin lesions are gray or white in color with a characteristic circular or crescent shape, which can develop rapidly causing destruction of the epidermis.
- Lethargy of fish and loss of equilibrium.
- Scales are lifted away from body surface of fish.
- Neccrosis of fins and membranous part of gills may occur.
- Respiratory manifestations appear on fish when infection is associated with gills.
- Fish shows abnormal movement.

Source: *www.google.com.np/water mould disease*

Fig.30 : Saprolagneasis/water mould disease

Control measure:

- Remove or separate the all diseases infected fish from the pond.
- Safe handling of fish during transportation
- Overcrowding of fish must be prevented.
- Preventing the introduction of new fish to the fish farm until known that fish are free from disease.
- Disinfection of the equipments and utensils to prevent spread of the infection.
- In case of partial infection, dipped into 1:10 formalin solution or 1% potassium dichromate solution.
- Fertilized eggs treatment with 3-4% formalin or 1-5 % salt for 10 minutes.
- Dipping treatment of 0.3% Nacl or 1:2000 copper sulphate splution for 5 – 10 min.

6.2.5 Non infectious disease

6.2.5.1 Asphyxiation:-

It occurs due to low oxygen level on pond water. Low oxygen level is frequently a problem mainly during summer season due to heavy algal bloom. large no. of fishes die when the oxygen level goes below 4mg/lit. Of water fish start to die which is seen early in the morning at the pond surface. If dead fishes aren't removed on time then it causes further secondary infection

Symptom:-

The fish show the sign of suffocation. Mainly fish comes to the surface and gulping bubbles frequently.

Mouth is seen wide open with gills and operculum raised.

Mass mortality of fish is seen in the morning at the surface of pond.

Control:-

The oxygen level can be increased by using aerators, releasing ducks, by swimming or by applying sprinkler irrigation.

Proper stocking or thinning out of over stocked fish

Liming of pond @ 500 kg/ ha if the problem is create by turbid water.

Replace the pond water by fresh and clean water.

2) Gas bubble/air bubble/gas embolism:-

Cause: due to high oxygen level in fish pond

Symptoms

It occurs when the atmospheric pressure along with rainfall increase solubility of all atmospheric gases. This problem mainly affects small fishes. Appearance of gas bubbles on skin, gills, mouth of fish and fish swim at an angle of 45 ^{o}c. It occurs in rainy season.

Control measure:

- Stop watering to the pond
- Stop releasing birds

Teacher tips:

- Slide presentation of different disease sample
- Give priority for locally available resource to biological control measure

UNIT - SEVEN

Type of net used in aquaculture & their protection

Learning outcome:

After completion of this lesson student,

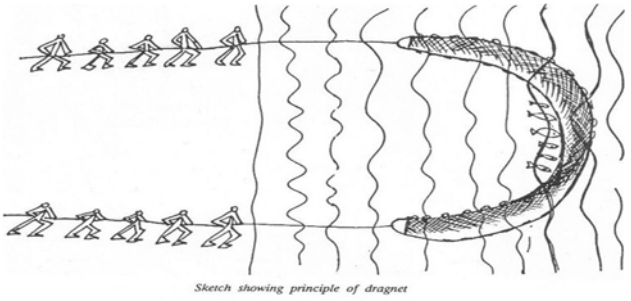
- Will be familiar with different types of net
- Can determine appropriate type of net for different growth stage
- Can properly use different types of net

7.1. Fry net

Fry net is generally used in hatchery house. In this process new born fry are drawn through a tube from the maternity section into the nursery section. Fry are kept separate, alive and healthy.

7.2. Drag net

It is one of the most common used net in fish farms. This net is shaped like a wall of enormous length .the upper margin of the net is supported by a strong rope (head rope) and is lined with float line. The lower margin is the foot rope and is provided with sinkers, to keep net in position .Two ends of the net slowly dragged by two parties of fishermen. A variety of livings in the mid water and near bottom are caught.



***Source** :www.google.com.np/search?q=drag+net*

Fig. 31: Drag net

7.3. Gill net

Gill net is locally known as Mahajaal .it is wall-like net with float is attached to the head and sinkers fixed horizontally overnight. Next morning the fishes are collected.

More than two fishermen overnight. Next morning the fishes are collected. More than two fishermen operate the net. Gill net mainly used in running water of river and streams to catch of direction or anti direction of water current.

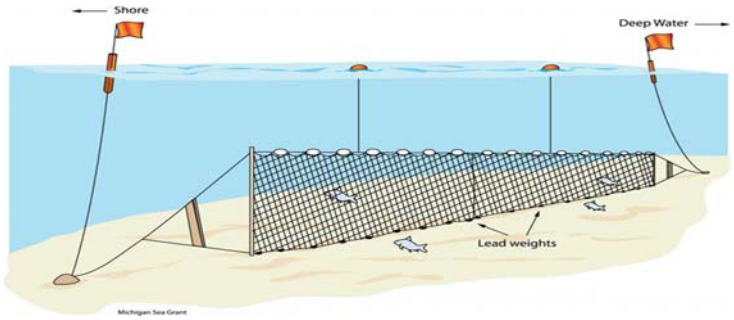


Fig. 32 : Gill net

Source :www.google.com.np/search?q=Gill+net

7.4. Cast net:

It is circular net having the shape of an umbrella. It is skillfully thrown over water fully expanded, but is held by a cord attached its center. The perimeter, being weighted with sinkers, rapidly starts sinking dragging the entire net towards the bottom. The circumference is inwardly recurved so as to form an inner circular pocket around the perimeter, which prevents the escape of fishes. The net according to the size is operated by one or many persons. It is used in plain waters of terai and valleys where the current of water is slow.

Fig. 33: Cast net

Source :www.google.com.np/search?q=Cast+net

Teacher tips:

- It is possible to make a visit to fishing site using various types of nets.
- Slide show of various methods of fish harvesting technique.

UNIT - EIGHT
Utilization of village ponds in fish culture

Learning outcome:

After completion of this lesson students,

- Can properly manage and utilize old ponds.
- Will be familiar with aquatic weeds and fish predators and can control them.

8.1. Management & utilization of old ponds

Fish farming is possible in the aquatic environment. A larger number of fish farming in Nepal is practiced in old and poor fish pond. Culturing the fish in the old pond does not give a satisfactory yield. Management and utilization of old fish pond helps to minimize the cost of production in one hand and increase the production in other hand. For proper management and utilization of old fish pond following point should be followed:

a) Proper pond preparation:

- Draining and leveling of pond bottom.
- Eradication of competitors and predators by poisoning or manually.
- Check the dike leakage to prevent unnecessary loss of nutrient and water.
- Application of lime if necessary.
- Application of fertilizer to condition the soil and generate growth of natural food.
- Installation of fine meshed (6mm) screens at the gate to prevent the entry of predatory and competatory species.
- Maintenance of water depth to ensure the growth of sufficient fish food and good water quality.

b) Proper handling of fish stock

- Unnecessary stress in handling is avoided to prevent mortality.

c) Proper pond management

- Subsequently application of fertilizers (organic and inorganic) to sustain desirable growth of natural fish food.
- Occasional water freshening to maintain good pond water.

- Applying supplemental feed if natural food is insufficient.
- Routine management as daily routine, weekly routine, monthly routine and after each cropping/ draining management is needed.

8.2. Aquatic weed and the control method

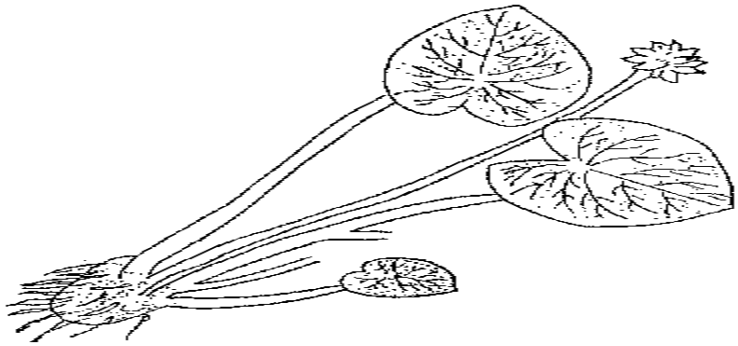
Generally, the vegetation grown in water is called Aquatic Plants or Weeds. There are many different types of aquatic weeds. In the day time the aquatic weeds generates oxygen by means of photosynthesis while in the night they also consume oxygen from the pond water and compete with the stocked fingerlings/yearlings. There are many different types of aquatic weeds and they are broadly classified under three main headings;

a) Emergent Type: Those aquatic plants/weeds which grow at the bottom of the pond and remain under the water and completes the whole life cycle. These aquatic weeds are Hydrilla, Vallisneria, and Chara.

Source: *www.google.com.np/search?q= Vallisneria*

Fig.34: Hydrilla **Fig.35:** Vallisneria

b) Sub-mergent Type: Those aquatic plants or weeds which grows at the bottom of the pond however, the leaves as well as flowers floats on the water surface and completes the life cycle like Nymphaea.



Source: *www.google.com.np/search?q= Nymphaea*

Fig.36: Nymphaea

d) Floating Type: Those aquatic plants or weeds which grow at the surface of the water and remain floating in the water surface are called Floating weeds. These weeds complete the life cycle above the water surface. The floating type of aquatic weeds are; Lemna, Wollfia, and Water Hycainth etc.

Source: *www.google.com.np/search?q= Lemna*

Fig. 37: Lemna

Source: *www.google.com.np/search?q= Water Hycainth*

Fig. 38: Water Hycainth

Besides the above aquatic weeds, a number of other lower aquatic plants in the form of thread are also grown which are called Threaded Algae. With the manuring, such threaded algae are very common in a fish pond. Generally these aquatic weeds grow excessively when the pond is very shallow. The excessive growth of such aquatic

weeds is harmful to stocked fish in different ways;

1) The floating weeds grow on the water surface of the pond it spreads all over the water surface. Thus it prevents the penetration of light and lowers the water temperature. Under such condition the natural food of fish is not produce adequately and the fish either grow slowly or retards the growth.
2) In a fish pond organic or inorganic manure is applied to produce natural food of fish but in presence of aquatic weeds, the weeds utilizes the manure in maximum and the weeds grow faster than the natural food of fish. Thus the fish don't get sufficient food for their growth.
3) The excessive growth of the aquatic weeds in a fish pond turns out a good shelter for the fish predators to hide or to protect themselves and causes a big loss of stocked fish.
4) The excessive growth of aquatic weeds in a water body does not harm the stocked fish in day time, however, in the night time all these aquatic weeds absorb oxygen of water and causes serious deficiency of oxygen and the fish may even die in lack of oxygen and
5) The decomposition of the excessive weeds in a fish pond deposits silts and it turns out the water body into swampy and thus it shortens the life of a fish pond.

   Besides the aquatic weeds, threaded algae are also common. The excessive growth of the threaded algae do not only hinders the movement but also entangles the fries and fingerlings and the fish die. The excessive growth of threaded algae also may cause of oxygen deficiency.

Knowing all these disadvantages of different aquatic weeds in a fish pond, they should not be encouraged to grow them in a fish pond. These aquatic weeds are controlled by the use of chemicals e.g. Copper Sulphate, 2-4-D etc., however, the use of chemical requires accurate dose of the chemicals and definite procedures. Any small mistake may cause total loss of the stocked fish. But today the problem has been very much simplified by the introduction of Grass Carp. In any pond or water body where aquatic weeds are seen it is highly recommended to introduce the Grass Carp and it cleans the aquatic weeds biologically within the short period. Therefore,

it is recommended to use appropriate number of Grass Carp in the pond so that the fish production is increased by controlling the aquatic weeds.

8.3. Fish predators & control methods

The predators are the animals that prey on other animals. Fish have variety of predator which is exposed on serious problem during fish farming. They are listed below;

a) Predatory fishes

b) Amphibian predators

c) Reptilian predators

d) Avian predators

e) Mammalian predators

a) Predatory fishes and their control:-

Predatory fishes are the fishes which prey upon the other fishes. Predatory fishes also compete for food and space. Some of the other predatory fishes breed on the pond just earlier than the major carps spawn (egg production) the commonly occurring predatory fishes in the pond are as follows;

Murrel, magur, singhi, kabai, bhuhari, tengra

- Weed fish:-Economically small size fish that naturally occurs or accidently introduce into the pond which do not grow to large size are called weed fish. Eg. Minor carp, Rosbora, Mora, Chelba etc.

1. Control pond drying:- Completely eradication of unwanted fishes if possible only by draining out the water and drying the ponds. Completely drain out water. Pond should be exposed in the sun for a week or months.

2. Poisoning pond:- The pond that are not easily drained out of the pond, poisoning should be done with high precaution to avoid harmful effect in the human health, livestock and environment.

Use the pronox at 30litre/hectare in which one part chemical and five part water. It is effectiveness for 5-10 days of application.

b) Amphibian predators:-

Amphibians may also create serious problems in fish farming. The larger frog and its species are the predatory amphibians. They breed profusely in the pond that may compact with major carps for food and space. Frogs to some extend also feed on hatching and eggs. Tadpole also compact with the fingerlings for food and space.

Control Measures:-

- By destroying the eggs of frog and tadpole by using net. We can minimize the number of frogs by application of quicklime in the fish pond. Also destroy the eggs and tadpoles of frogs.
- Predatory aquatic insects:-Many aquatic insects either by larvae and adults may not only prey upon fish hatchlings and the fry but also compete for food and space. Most common insects are water bettle; graind water bug and dragon fly nymphs etc.
- Control:-For successful fish farming pond must be kept out of aquatic insects always before stocking. So must insects can be controlled by using drag nets, wire nets around the outlets and inlets points.

c) Reptilian predators:-

Water snake and tortoise are common reptiles that occur in fish ponds. Generally they directly feeds on fingerlings and even table fish and significant number of fish can be reduced by reptiles. Among them snake is more problematic.

- Control:-Snake can be controlled by making snake traps. These snakes are led into the enclosures through forwarded entrance where escaping is very difficult for killing the fish. Another way of controlling the snake entering into the fish pond is placing the bamboo sticks around the dike where we can trap within the bamboo hole.

d) Avian predators:-There are number of birds which pray on various stages of fish and create serious problems in fish farming. Among them most harmful are kingfisher, cranes, sea gull etc.

- Control:- For the control of predatory birds different methods have been practiced all over the world which varies from place to place. Some of the

practices are beating of drums, using the robot like structure, using different colors of rebins, produce large sound etc.

e) **Mammalian predators:-**With the exception of human there is only one serious mammalian predator i.e. 'otter'. They stay in periphery of pond and cause severe damage

Teacher tips:

- Visit nearby village pond and ask them to discuss about better utilization of these pond.
- It is possible to collect different aquatic weeds used as fish feed and demonstrated class room.
- Demonstrate sample or slides of different fish predators in class room.

UNIT - NINE

Fisheries extension, Marketing & preservation

Learning outcome:

After completion of this lesson students,

- Will have the knowledge about present status of fish farming in Nepal.
- Will be familiar with fish extension activities in the country.
- Will have knowledge about fish harvesting, grading, packaging and preservation.
- Can prolong the shelf life of the fisheries product using different devices.

9.1. Present Fisheries extension in Nepal

National development policy has carried out earlier from the past 2013 B.S. Among the developmental period agriculture sector has been given highest priority from the fifth five-year plan. The Government, recognizing the importance of aquaculture in improving the nutrition of the people through increasing production of fish in a relatively short period compared with other sectors of animal husbandry, has given considerable priority to the development of fish culture. This has resulted in the adoption of crash programme of development over and above normal development plans, but a comprehensive assessment of aquaculture development possibilities in the country and their role in rural development, socio-economic improvement and increased employment opportunities, is still to be completed.

At present, small-scale as well as large-scale fish production operations in the private sector will continue to receive full protection and support from the Government, with the main aim of maintaining the present level of fish production on the one hand, and increasing the level of productivity on the other. Greater participation by the private sector in the aqua-culture industry is anticipated by continued demonstration of economic viability, if necessary even in their own ponds.

The Directorate of Fisheries Development (DOFD) under department of agriculture, Ministry of agriculture & co operatives is responsible for fisheries & aquaculture extension related policy & implementation. It is also coordinates with national&

international with focus on fisheries extension (FFP 2000).The directorate performs its work through the following major institution.

- National inland & agriculture development program.
- The general Agricultural Extension Agency is now responsible for fisheries extension work
- Central fish laboratory
- Fisheries development centers established in different districts.
- Fisheries development & training center
- District agriculture development agriculture offices.
- Agriculture development bank for credit facilities & services.
- Establishing new public sector demonstration fish farms in suitable areas in different parts of the country, improving hatchery techniques and providing training and equipment.

9.2. Harvesting method

Farmed fish can be harvested in several ways & several methods according to needs, situation & pond condition. These methods are;

A. Harvesting by draining the pond

B. Using the basket trap

C. Using the hooks & baits

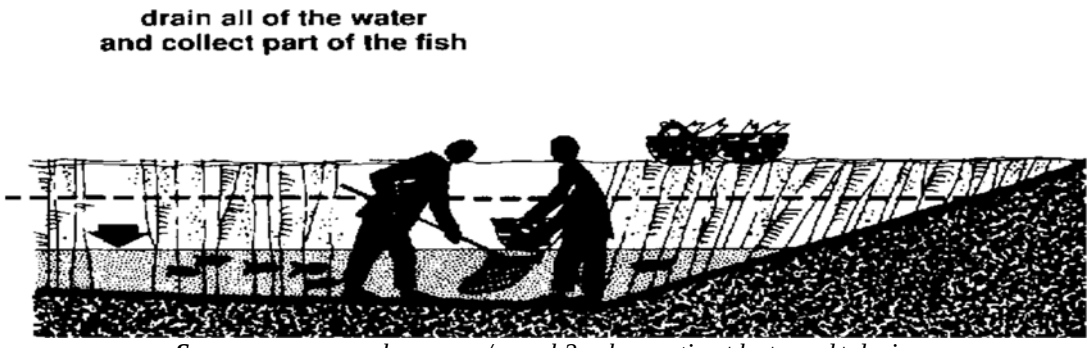
D. Using cast net

E.Poisoning

F. Looping

A. Harvesting by draining the pond

This method of harvesting is the simplest & most effective. Water is let out of the pond by opening the lowering pipes at the outlet. As the water level drops & the water moves towards the deeper end of the pond, the fish drift with it. Finally, all the fish collects at the outlet & is collected by hand or with a net.



Source: *www.google.com.np/search?q=harvesting+by+pond+drain*

Fig.39: Drain pond

as the pond drains, the water level falls at the shallower end of the pond. All the fish drifts towards the dreeper end. When the fish has gathered in a small area at the deep end the farmer then collects the fish in a container.

For this method the pond should have been constructed well with a good slope. Harvesting is made much easier if a depression is made at the point of outlet as a "harvesting bay".

This method of harvesting is suitable for both small & large pond. For the largest ponds it is used in combination with seining. Fish collected from the mud tends to be dirty & it dies quickly. Pond fish should be marketed live & clean.

During the harvesting there should be two containers with water. The first bucket is for washing off mud from the fish. Then the clean fish is put in another container with clean water to keep it alive. The water for washing the fish should be replaced with clean water when it gets dirty.

B. Using bucket trap

The baskets are important in harvesting small ponds where the farmer cannot afford the more expensive gear. The basket is made from twigs, cane or climbing plants. The trap is left in a stream in a fixed position. Several elongated conical bamboo traps of approximately 1.5 m in length and 0.25 m in circumference are used in the hills of Nepal. Their size varies from place to place. They are used in very fast waters.

Source: *www.google.com.np/search?q=harvesting+by+basket*

Fig.40: Basket

Attributes of the basket

- The trap is placed with the open end facing the main pond water. It is given enough time (30 min to 1 hr) for the fish to enter.
- The gear is sample to make or cheap to buy. It is easy to operate, but it is limited to only small ponds (not suitable for ponds of more than 200m^2).
- The basket cannot harvest all the fish from the pond. Finally the pond should be drained in order to harvest all the fish.
- The basket is cheap & made to use local materials.

C. Using Hooks

The hook for the line is usually made from the metal of an umbrella. The hooks are attached to the line. Bait is small pieces of fish, earthworms, bread or flour or fish fry. A single man may operate several rods at the same time.

Source: *www.google.com.np/search?q=harvesting+by+hook & line*

Fig. 41: Hook & line

The hook & line cannot harvest all the fish from the pond. Most of the fish still remain in the ponds. The pond should finally be drained to completely harvest the

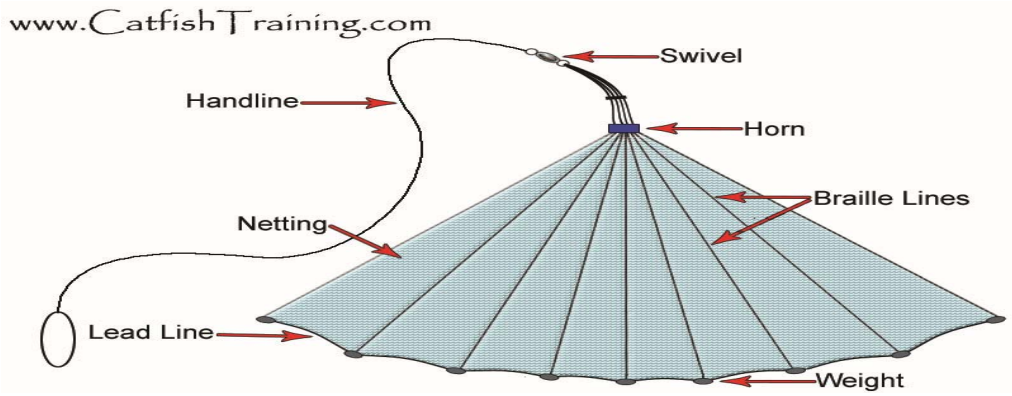
pond.

Attributes of the hook & line

- It depends on luck & the operator cannot choose the fish to catch.
- it is not very selective & smaller fish may be caught leaving the larger ones
- It injures fish & may not be suitable for sampling fish that will be returned into the pond.
- It catches a few fish at a time, depends on luck. Finally the pond must be drained to remove all the fish.
- Only suitable for small ponds (up to 10×20m).

D. Cast net

A cast net is a net made like an umbrella. It is tied on a rope. It opens out when cast over the ponds. As it sinks deep into the pond the mouth is closed, trapping whatever fish that will be in the water space enclosed.



Source: *www.google.com.np/search?q=harvesting+by+Cast net*

Fig. 42: Cast net

Cast net attributes

- The cast net is cheap.
- It is simple to operate, but requires training in the skills.
- Does not require large labour force (only one person).
- Catches by chances & the operator does not have much choice of the fish to catch.
- It does not harm fish, the fish can be returned into the pond.

- Its operation is limited to only small ponds. (10×20m0 & is time wasting for longer ponds.

E. Poisoning:

Leaves of *Sapium insigne*, *Agave Americana* are crushed and thrown in the water. Bark and roots of *Dalbergia stipulacea* are also used for poisoning fish. The crushed leaves and fruits of *Adhatoda vasica* and *Randia dumentorum* are commonly used in ditches for catching fish. *Pithecallobium bigeminum* is also used for fish catching. These are common plants in the Terai. *Edgeworthia gardneria*, *Polygonum flacidum*, *P. hydropiper*, *Ficus pumila* and *Acacia pennata* are also used as fish poison. More recently, pesticides such as Aldrin, Thiodine, BHC, Malathion, and DDT have also been used.

F. Looping:

Looping, locally called `paso', is practised in the Trisuli (Rajbanshi, 1976) and Sun Koshi rivers. The loop is made from a nylon thread. A single line may support 3-5 loops. The size of loop regulates the size of catch. A coloured lead weight functions as bait. Live bait such as fish, shrimp, earthworms, stonefly and may fly larvae are also used in looping in the Trisuli and Sun Koshi. When a fish detects the slowly moving coloured lead it mistakes it for insect larva, approaches the lead and enters into the loop where it gets stuck by its dorsal and pectoral fins. Fish are looped in the afternoon and evening, when fish up to 6 kg may be captured. Paso is used from September to April, when the stream water is clear and cold and the fish start their upstream migration. This method captures *Schizothorax* (asla), *Labeo angra* (Thailand) and some other fish.

9.3. Use of ice for fish transport

The most recent development is the keeping and transporting of fish in a state of hibernation. In this method, the body temperature of live fish is reduced drastically in order to reduce fish metabolism and to eliminate fish movement completely. The method greatly reduces death rates and increases package density, but careful temperature control should be exercised to maintain the hibernation temperature.

The overall reason for icing fish is to extend fresh fish shelf life in a relative simple way as compared to storage of un-iced fish at ambient temperatures above 0°C. However, extension of shelf life is not an end in itself; it is a means for producing safe fresh fish of acceptable quality.

Ice is used to make fish safe and of better quality to consumers. It is also used because otherwise the current fish trade at local and international level would be impossible. Shelf life is extended because there is a strong economic reason to do so. Fishermen and fish processors who fail to handle fresh fish appropriately ignore the essence of their business. The inability to recognize fresh fish also as a trade commodity is at the root of misunderstandings and difficulties linked to the improvement of fish handling methods and prevention of post-harvest losses.

Ice should also be utilized in relation with chilling rooms to keep fish moist. It is advisable to keep chilling room temperature slightly above 0°C (e.g., 3-4°C).

Ice is utilized in fish preservation for one or more of the following reasons:

(i) ***Temperature reduction.*** By reducing temperature to about 0°C the growth of spoilage and pathogenic micro-organisms is reduced, thus reducing the spoilage rate and reducing or eliminating some safety risks.

(ii) ***Melting ice keeps fish moist.*** This action mainly prevents surface dehydration and reduces weight losses. Melting water also increases the heat transport between fish and ice surfaces (water conducts heat well than air): the quickest practical chilling rate is obtained in slurry of water and ice.

If, for some reason, ice is not utilized immediately after catching the fish, it is worthwhile keeping the fish moist.

(iii) ***Advantageous physical properties.*** Ice has some advantages when compared with other cooling methods, including refrigeration by air. The properties can be listed as follows:

(a) *Ice has a large cooling capacity.* The latent heat of fusion of ice is about 80 kcal/kg. This means that a comparatively small amount of ice will be needed to cool 1 kg of fish.

For example, for I kg of lean fish at 25°C, about 0.25 kg of melted ice will be

needed to reduce its temperature to 0°C (see Equation 7.c). The reason why more ice is needed in practice is mainly because ice melting should compensate for

(b) *Ice melting is a self-contained temperature control system.* Ice melting is a change in the physical state of ice (from solid to liquid), and in current conditions it occurs at a constant temperature (0°C)

(iv) Convenience. Ice has a number of practical properties that makes its use advantageous.

They are:

(a) It is *a portable cooling method.* It can be easily stored, transported and used. Depending on the type of ice, it can be distributed uniformly around fish.

(b) *Raw material to produce ice is widely available.* Although clean, pure water is becoming increasingly difficult to find, it is still possible to consider it a widely available raw material. When there is no assurance that freshwater to produce ice will be up to the standard of drinking water, it should be properly treated, e.g., chlorination.

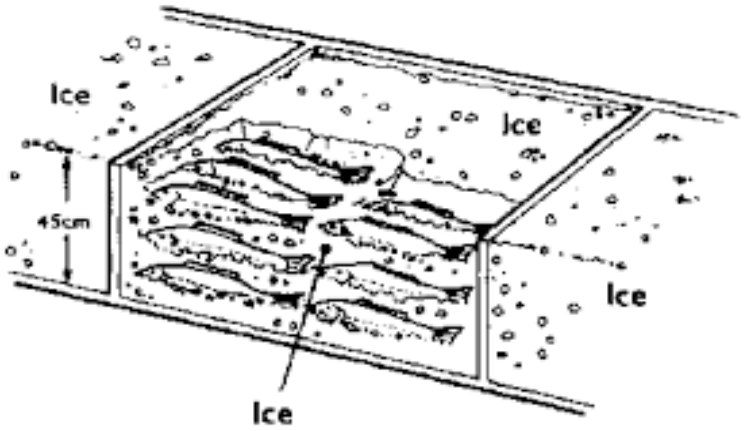
Clean seawater can also be utilized to produce ice. Ice from seawater is usually produced where freshwater is expensive or in short supply. However, it should be remembered that harbor waters are hardly suitable for this purpose.

(c) Ice can be a relatively cheap method of preserving fish. This is particularly true if ice is properly produced (avoiding wastage of energy at ice plant level), stored (to avoid losses) and utilized properly (not wasted).

(d) *Ice is a safe food-grade substance. If* produced properly and utilizing drinking water, ice is a safe food substance and does not entail any harm either to consumers or those handling it. Ice should be handled as food.

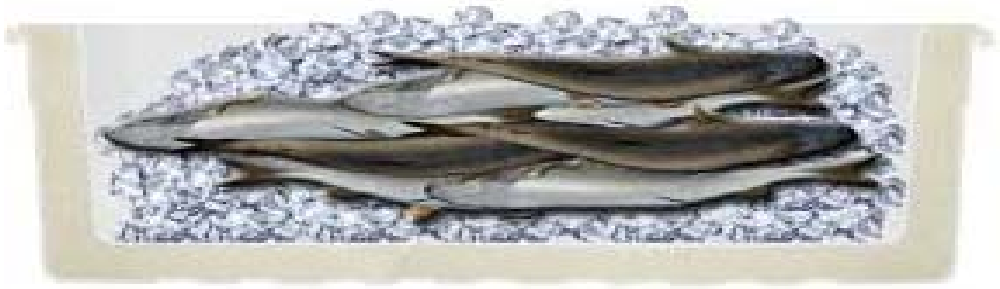
Table.13: Physical characteristics of ice utilized in chilling fish

Types	Approximate Dimensions (1)	Specific volume (m^3/t) (2)	Specific weight (t/m^3)
Flake	10/20 - 2/3 mm	2.2 -2.3	0.45-0.43
Plate	30/50 - 8/15 mm	1.7 - 1.8	0.59-0.55
Tube	50(D)- 10/12 mm	1.6 - 2.0	0.62-0.5
Block	Variable (3)	1.08	0.92
Crushed block	Variable	1.4 - 1.5	0.71 -0.66



Source: *www.google.com.np/search?q=Ice+use+in+fish+transportation*

Fig.43: Ice use in fish transportation



Source: *www.google.com.np/search?q=Ice+use+in+fish+preservation*

Fig.44: Ice used in preservation

Advantages of ice preservation:

- Fish preservation time can be extended by using ice. Ice reduces the fish body temperature & keeps the body cool for longer time without damage.
- Ice is used as good preservatives due to its melting point o^{0c} and landed heat 80 calorie/gm.
- Water formed due to ice melting, cleans the mucous & other materials of the fish body.
- Due to high relative humidity of ice, it is very good for preservative ice. Ice is very cheap & very effective's preservatives.

9.4. Fish packaging method

Fish should be handled hygienically and chilled from the time of capture or harvesting until they are packed.

Whole fish and fillets should be kept in ice while waiting processing and smoke products should be held in a chill room at 0^0c ideally and air blast chiller should be provided in a processing line, either before or after the packaging machine since the fish may warm significantly during the packaging operation

Layering of products within a pack should be avoided. A single filler or portion is more fully exposed to the action of the gases. Layering is unavoidable when packing sliced smoked products salmon, but the products doesn't gain the full benefits of the modified atmosphere. Wet fish products that are likely to exude can be laid on a pad of absorbent paper inside the pack. Pack with faulty seals can be detected by pressing dam with the hands, faulty packer will collapse. Packed should be clearly labeled according to existing regulations and should be marks with a sell by a consumed by date

Packing of fish are,

- Modified atmosphere packaging
- Vacuum packaging
- Active packaging

1) Modified atmosphere packaging

It as the enclosure of fish products in gas-barrier materials, in which the gaseous environment has been, extends the shelf-life & retard the deterioration of fish product under refrigeration.

2) Vacuum packaging

- It is used for long term storage of dry foods & the shelf life.
- It has good barrier properties towards oxygen & water & can be easy sealed.
- Air is removed under vacuum & the package is sealed.
- The products kept under a lower o_2 atmosphere with less than 1% inbiting the growth of aerobic spoilage microorganisms, particularly Pseudomonas spp, & Aeromonas spp.
- Vacuum packaging could prevent oxidative rancidity & improve organoleptic quality of fish.
- Vacuum packaging effectively extends the shelf life of fishery products by maintaining their odor & flavor.

Source: *www.google.com.np/search?q=Vacuum+packaging*

Fig.45: Vacuum packaging

3) Active packaging

- It is a technique used for extending the shelf life of fish by addition of active agents heat absorb or release a compound in the gas phase.
- Compounds in packaging include co_2, o_2, water vapour or volaties.
- Active agent can be useful in a package such as oxygen or carbon dioxide scavengers, moisture absorber & oxygen or carbon dioxide emitter.
- Active packaging systems have also been studied, in which specific bioactive

substances are combined with the packaging material or within the package resulting in the retardation of the microbial growth & lipid oxidation.

- It was the reported that the use of carbon dioxide emitters in fish can control the G/P ratio & volume reduction compared with traditional MAP.

Packaging should protect the product from contamination and prevent it from spoilage, and at the same time it should:

- extend shelf life of a product
- facilitate distribution and display
- give the product greater consumer appeal
- facilitate the display of information on the product

9.5 Fish Transportation method

Fish farmers who obtain their seed stock mainly from overseas and as such rely heavily on good packing condition covering 8-12 hr transportation time to maximize fish survival and quality. For example, a loss of 505 of the stock would immediately double the price of the remaining line ones and this adversely affects the economics of production, white fish may be transport marketing fish live from their farms to landing points where the fish are picked up by Lorries fitted with live tanks. The produce is than transferred to restaurants where fish command higher price live.

The principle of live fish transportation: -

The transportation of live fish involves the transfer of large number of biomass of fish in a small volume of water during transportation; fish are subjected to handling stress and may die or worse, survive to provide a stunted, marketable crop. The principles governing packaging, handling and transportation of live fish are essentially to minimize stress.

Major stress factors:-

1) **Dissolved oxygen (DO):-**

   The presence of dissolved oxygen does not presuppose an absence of stress as other adverse factors can still exist with high Do eg: high water temperature, fish density (number and size) time of last feeding (level of starvation) and transportation time. It is therefore important to keep the teansportwater cool and

fish biomass at an optimum, with due consideration for possible delays in transportation and the need for additional oxygen by the fish starving the fish prior to the packing would also slow down ammonia accumulation and minimize unnecessary uptake of dissolved oxygen.

2) **Ammonia (NH3):-**

Ammonia is excreted by fish and is reported to be toxic at low concentration of 0.6 ppm. Ammonia excretion by fish decrease as it's concentration in water increases, resulting in high blood ammonia. High blood ammonia elevates blood ph which affects enzyme catalyzed reactions affecting metabolism. Starvation and lowered temperature reduce ammonia excretion.

3) **Carbon dioxide (CO2):-**

Fish becomes distressed when carbon dioxide (from respiration) accumulates rapidly in water since the blood is unable to carry oxygen under these conditions. Low level of carbon dioxide (3-6 ppm) may be beneficial since it prevents the buildup of unionized ammonia. Carbon dioxide is also amild anesthetic and may be considered in alleviating stress during transportation.

4) **Handling:-**

Stress during handling and packing may be so severe as to cause chronic and acute mortalities poor handling and packing procedure may also cause some regulatory and metabolic disfunction. Therefore it is important to proceed gently and quickly**.**

5) **Water temperature:-**

Water temperature greater than 20 ^{o}c accompanied by declining dissolved oxygen and increasing ammonia, creates hostile environments. This is the likely situation if fish are over-packed or transportation is delayed under tropical conditions. Temperatures that are too low (<18°C) can cause thermal shock, especially in young fish. Stressed fish usually succumb to diseases after 1–2 weeks, if not already dead on arrival.

Methods of alleviating stress

1) **Reducing transport water temperature:-**

This prevents thermal stress and improves oxygen stability. Ice should be used in the correct quantities and this depends on fish species and size and also the transportation period. Alternatively, cooled water (18°C) can also be used by lightly sedating the fish in 18°C water prior to packing, and then using water at the same temperature for transport. Under air freighting conditions, this temperature increases by about 1–4°C after 12–14 hours, and fish are usually alive.

2) **Insulation:-**

The use of insulated containers like Styrofoam boxes, newspaper lagging helps to maintain the temperature of transport water, being poor heat conductors. They also reduce vibration.

3) **Anesthesia:-**

Anesthesia prevents fish hyperactivity. The oxygen consumption of newly-packed fish elevates for 30–60 minutes and declines as fish acclimate to the new environment. The first 30–60 minutes after packing is therefore important. Some anesthetics used are MS-222, carbonic acid, benzocaine and phenoxyethanol. However the use of certain chemicals for anaesthetizing food fish is not to be recommended.

Fish transport method:-

Two basic transportation systems are available for transportation of fishes i.e.

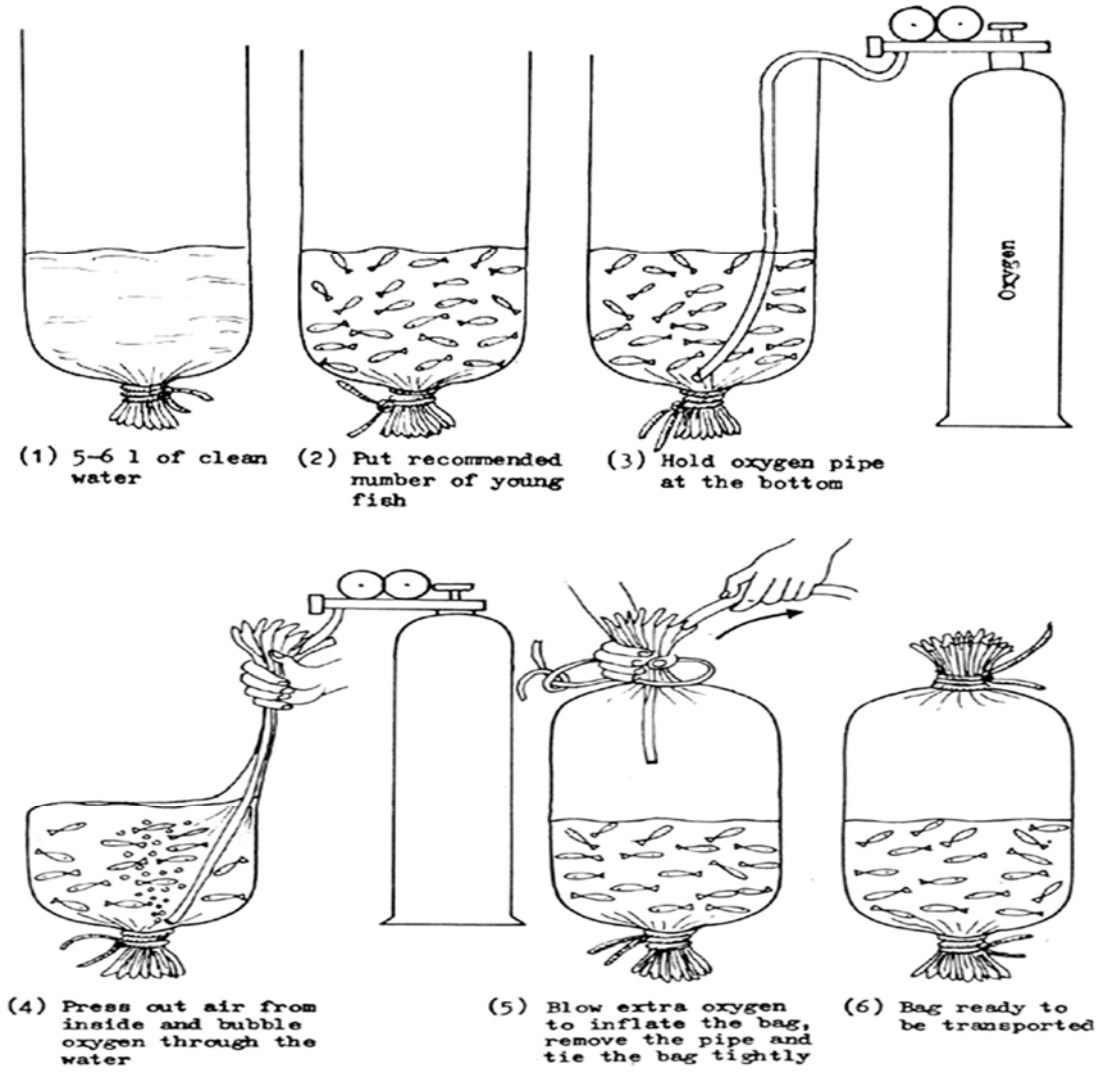
The closed system of transport:-

1) **Polythene bags under oxygen pressure:-**

Packing of fish in polythene bags under oxygen pressure where fishes are transported in water field open carried of true. Transport of fish seedlings in poly bag field with limited water and oxygen reduces the volume and provides economical advantage in closed system with pressured oxygen atmosphere inside the bags. Oxygen content water not a limiting factor usually larger size fishes in higher quantity can only be transported with open carrier of trucks up to a short distance which can be covered maximum on 11-14 hr.

2) **Plastic bag: -**

It is widely used methods for fish transportation. A bag plastic of 16-18 unit capacity is generally used 1/3rd portion of the bags are filled with clean cool water and carefully introduce in required number.

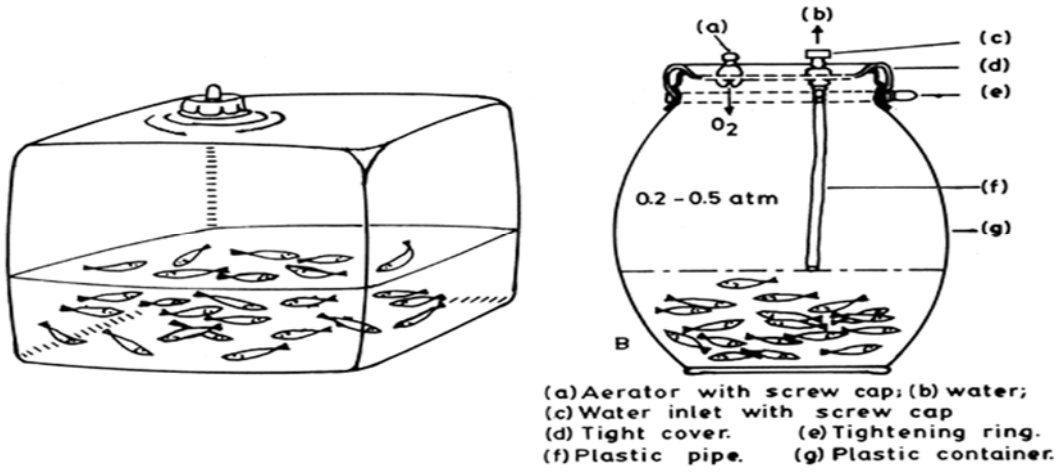


Source: *www.google.com.np/search?q=live+fish+trasportation*

Fig.46: Fish transportation methods in plastic bags

3) Plastic tanks:-

200-500 litres of plastic tanks are used with regular supply of oxygen and 500 lits tanks 5000 to 10000 of fry of 1-3 g size can be transported in 8-10 hrs.



***Source**: www.google.com.np/search?q=plasti+tank+trasportation*

Fig.47: Plastic tanks

Open system:-

In open system, the containers are not sealed. Container may be earthen that plastic pots or tin container of various shape and size. The seed carries should be prevent overcrowding. Larger surface will also facilated mixing of atmospheric oxygen in water.

Types of containers used in open system:-

a) Earthen pots:-

Earthen pots of about 20 lit. capacity are used for transportation of fish seed. Earthen pots are generally used for short transportation which need frequently exchange of water in every hour. dead fish have to remove immediately to avoided pollution and contamination. This is the traditional method of fish transportation, now it is replaced by closed system.

Fig.48: Earthen pots

Source: www.google.com.np/search?q=earthen+pot

b) Plastic pots:-

These are made up of plastic other producer are same as earthen pots.

c) Metal pots:-

Metals which are non ratable types are used for this transportation other process are same as above**.**

9.6. Importance of fish marketing

To make fish available to consumers at the right time and in the right place requires an effective marketing system. Fishermen who catch fish by laboring overnight (from common-property water bodies) do not usually sell fish in retail markets. At the break of day, they take their catches to places where Beparies, or retailers, meet them and bargain by the lot. . A fisherman, as a seller, cannot negotiate favorable prices for himself mainly because:

- he meets buyers (intermediaries) one at a time and at different times,
- he cannot keep fish for a long time because the product is highly perishable,
- he has no specific place to sit in the market to sell his fish.

Therefore, a fish farmer does not encounter a market with many buyers but rather a situation in which he meets more fellow sellers than buyers. This is particularly the

case in remote villages. In areas that are well connected by roads and rail, fish farmers contact wholesalers in secondary or higher secondary markets directly and negotiate prices and quantities of fish. Fifty-five percent of fish sellers deal in fresh fish in rural primary markets, 17% sells live fish, and sellers of dry fish constitute 7%. Some vendors of small, fresh fish may be the fishermen themselves, who sell directly to the consumers or to the Beparies.

Fish-marketing channels

Domestic markets and distribution of fish are dominated by a large number of intermediaries. All fish traded internally and for export pass through private channels. Fish distribution usually involves four levels.

Primary markets

Markets located in villages, district headquarters or at a crossroads are considered primary markets They are usually near areas where fish are caught. Fishermen bring a variety of fishes (dominated by small fish from both open-water capture and from ponds) to the primary markets.

Fifty-two percent of such primary rural markets are held twice a week, 28% three times a week, and 20% are held daily. Of all these markets, 80% are open during morning-hours, particularly for trading milk, vegetables and fish (Market Survey, M-AEP, 1995) and are attended by a relatively small number of sellers and buyers compared to the usual afternoon markets.

Secondary markets

The Beparies take the fish bought from the Nikaries/fishermen/primary markets/landing points to the nearest riverport markets by road, river or rail to sell to wholesalers or through Aratdars. From these secondary markets/assembly points the distribution of fish moves through different channels to urban markets/higher secondary markets by commissioned agents for wholesalers/Aratdars, or by other kinds of Beparies

Higher secondary markets

From secondary markets/fish assembly points, Beparies bring fish to the higher secondary markets serving large areas of consumer/terminal markets. The higher

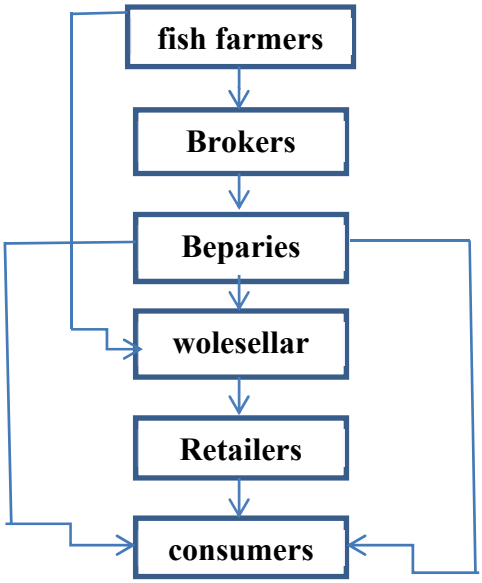
secondary market may consist of one or more wholesale markets or centres, where Aratdars deal in fish. These markets are well connected by road, river and rail. Higher secondary markets have trading connections with several secondary markets. Markets in district headquarters can be considered as higher secondary markets that are connected with several secondary markets for the supply of fish.

City or terminal markets

Paikers/retailers buy fish from wholesaling centres of higher secondary and secondary markets. They sell fish directly to consumers either through fixed stalls or by vending from head/rickshaws. From the start of the distribution channel for fish - at the secondary markets to the city or terminal markets - intermediaries operating on different levels perform marketing functions like cleaning, sorting, boxing, icing, re-packing and arranging of transportation, etc. At each market level, wholesalers and retailers may be supplying fish to local consumers.

The dominant marketing channels (product route to ultimate consumer) for freshwater fish for domestic consumption are as follows:

The marketing channel for cultured fish starts with the fish farmer, passes through a number of intermediaries and ends with the ultimate consumer. Major intermediaries who enter the fish marketing chain are Beparies, Aratdars and retailers. Fish farmers do not sell fish directly to consumers in the market.



***Source**: www.google.com.np/search?q=Fish+marketing+channel*

Fig.49: Domestic marketing channel of riverine fish

9.7 Fish preservation methods: salting, smoking, freezing & canning

Fish preservation is the very important aspect of the fisheries. fish preservation means storing or conserving the fish in fresh, dried and in preserve form for further use without degrading the quality. it includes following practices:

1) **Salting:-**

   Salt prevents the degradation process of microorganisms as we kept our food in hygienic form. in salting the salt water penetrate the fish tissue until the salt solution filled it. it works as osmosis absorption process.

2) **Smoking:-**

   This process give the fish a desirable flavor and odour as well as preserving it. smoking is usually done through four process

   i. Cleaning the fish
   ii. Brining
   iii. Drying and
   iv. Smoking

3) **Freezing:-**

   Freezing is the chilling process under low temperature near to 0*C. In freezing either fishes are put on refrigerator or on ice. Keeping fish in ice prevents the growth of microorganism.

4) **Drying:-**

   The process of removing water content from fish tissues until the moisture of the fish is extracts. Solar drying is practices by using the heat of sun.

5) **Canning:-**

   Canning fish offers advantages over freezing as it can be stored at room temperatures for long periods. In addition, any bones remaining in the flesh become softened especially if you use one and one-half teaspoons of vinegar in each canning jar.

   One mistake that many make when canning fish is to use canning jars larger than 1 pint. This is very dangerous, as enough heat does not build up during the canning process to allow the destruction of *Clostridium botulinum* spores,

which can lead to botulism poisoning. Thus, it is extremely important to use only 1 pint jars or smaller during the canning process. Before canning your fish, the jars must be thoroughly cleaned but it is not necessary to sterilize them.

The fish should be cleaned and washed thoroughly before canning. It takes about 25 to 35 pounds of whole fresh fish to fill about a dozen pint jars with boneless fish. The fish should be cut into desired size pieces so that they will easily fit into the canning jar It is recommended to lightly brine (1 cup of salt per gallon of cold water for 15 minutes) the fish before packing into the canning jars as it firms the flesh to produce a more desirable product. Drain the brined fish and fill the pint jars leaving 1-inch headspace. Once fish is packed into the jars, wipe the jar rims and adjust the lids. Depending on your taste, tomato juice or other mixtures can be added to the fish before the canning process.

Source : www.google.com.np/search?q=Fish+canning

Fig.50: Caning of fish

9.8 Cost benefit analysis of fish farming

Economic analysis of fish farming is an important aspect for the benefit of fish farming. Economic of the fish farming is sub divided into two groups for the detailed analysis. For the micro level analysis cost of production and cost benefit ratios of fish farming in ponds. Farming involves two types of cost i.e. fixed costs and variable costs. Fixed costs are non recurring in nature and generally remain fixed in the particular crop season. Variable costs are of recurring type and have to be incurred in every production period. Variable costs are also known as operation costs or working costs. Therefore, it is necessary to analysis the cost benefit of fish farming.

a) Cost of production

The profit is the motive behind all the activities of farmers whether they adopt commercial system of farming or traditional farming. Cost of production of fish has been measured with the help of the survey data. The capital should be emphasized in such a way that cost does not become fixed until they have been incurred. As far as fish farming is concerned the cost on material which represents the purchase of Fish Seeds, Manures, Fertilizers, Supported food material and other material. The cost incurred on machine represents the cost of Engine pump, Inlet and outlet of water system. The cost incurred on labour charges includes the payments made on processes fish farming and harvesting of fish.

b) Fixed Cost of Production:

Fixed cost is often perceived as non variable costs, also known as cost of establishment. It is the cost which remains unaffected by changes in the volume of output. These are the expenses, which must be met irrespective of the quality of production. These are the costs of providing the conditions for production. This cost provides physical or human capacity, which assists but is not included in actual production. Since this cost remains the same up to a certain level of volume, naturally it becomes less in amount per unit as production increases. Rental lease of pond, cultural practices, layout, manures, and fish seeds and its stocking, nets and farm implements, farm house cum packing shed, irrigation scheme inlet filter chamber out let system etc. are the heads of expenditure. Generally this period is of about 9 to 12 months.

c) Average Cost of Production

Average Cost of Production and Returns per Hectare from Dams and Tank. It is important to analysis the relationship between the average cost of production and returns. For analyzing the both cost and returns from one hectare area of dams and tanks following method should be carried out.

While studding the economics of the fish farming various items such as economic rent or lease of the land or dam for contract, cost of fish seeds including transportation, cost of fertilizers and food materials, transportation

charges for marketing and cost of harvesting are considered as a cost of production. Whereas on the return side due to weight of harvested carp, present market price and about 10 per cent market price fluctuation is considered for calculating the cost benefit ratio.

1) Cost of Lease:

Land is the major parts of fish farming system so, that land is either available from the personal source or taken on lease for certain period of time with a certain costs. The cost of lease land depends on various factors such as place, cultivable land, resource and so on.

2) Transportation of the Fish Seed:

Fish farming system is preferred in many place and region depending upon environmental and topographical condition. In Nepal carp fish is cultured in terai region. The process of breeding is not available nearby place as the carps require certain environment for breeding. The fish seeds of the major carps are brought from the different far hatchery. So that the per hectare cost of seeds will be increase by transportation charges.

3) Feeding and Manuring:

For the proper growth of the fish stocked, proper and timely feeding is essential. The maximum large size of dams and tanks for stocking of fish seeds is generally affecting on feeding and manuring. The feed includes the residue of ground nuts, soybean, husk of the wheat and rice, lime, phosphate, cow dung manure; dry cow dung etc which will adds the cost of production.

4. Transportation and Marketing:

Fish marketing in Nepal at many places is controlled by middle men, as results the fishermen get very low price for their produce even when the consumers pay high price. The transportation and marketing of fish also required a certain amount of cost that increases the cost of production.

Table.14: Average Cost of Production and Returns per Hectare from Dams and Tank Area

Sr. No.	Cost Components	Expenditure in Rs.
Cost of Production Table -A		
1	Cost of Lease , Contract	20000
2	Cost of Fish Seeds Including Transportation Charges	1000
3	Cost of Fertilizers Including Organic and Inorganic with Food Material	1500
4	Transportation Charges for Marketing of the Products	1500
5	Cost of harvesting Diesel, Packing and Mentainence of Tools etc.	2000
	Grand Total	26000
	Cost Benefit Ratio Table –B	
1	Total Production of major Carps In Rupees 300 x @ Rs.250	75000
2	Probable Price Fluctuation (About 10 %)	7500
3	Net Returns (Output) (1-2)	70000
4	Total Cost of Production Expended (Input) From Table -A	26000
5	Net Profit (3 - 4)	44000
6	Input- Output Ratio	1:2.69

Return from Fish Production:

The culture of fish in ponds have very well developed and contributing to the fish production in the country. The fresh water resource comprises the water bodies of different sizes. However the large water bodies like dams and tanks are not suitable for intensive fish culture. The fish in dams and tanks under study, mixed culture is in practice. The major carp group of fish like Catla, Rohu, and Mrigal are raised in the dams and tanks. About 8 to 9 months period is required for the full growth of these fishes. The per hectare production of fish of major carp is 300 Kg. of different size and weight. The market rate of the major carp depends upon the weight of the fish and it ranges between Rs. 250 per kilogram.The total return from marketing the produce comes to about Rs 75,000. However the market price of the fish changes from time to time and place to place. So such fluctuation in a price is considered about 10 percent which comes Rs. 7500. Hence Rs. 75000 total return minus Rs.

7500 =70000 as a gross returns, minus Rs. 26000 as total cost of production, which to Rs. 44000 as a net profit. Based fact the calculated cost benefit ratio is 1:2.69 it indicates that, the fish farming in dams and tanks is economically viable and profitable.

Teacher tips:

- Collect various data's about present fisheries activities and ask them to discuss about it
- Collect and demonstrate various fish packaging system practiced in different countries
- Demonstrate the preserved fish product

UNIT - TEN
Fish brood management & breeding method

10.1 Introduction of breeding

Breeding is process of producing offspring. In case of fish it is the process of producing of the offspring by the mating of the male and female fish.

10.2. Type of breeding

- Natural breeding

  It is the process of the breeding in the natural environment of the pond when the condition is favorable as example in natural breeding of the common carp in the presence of the aquatic vegetation where the attachment of the egg occur, when the temperature is suitable then spawning is occur

- Semi- artificial breeding

  In this process the kakaban is use for the attachment of the egg and it is collected and introduce in the spawning pond and gentle flow is provided then the brood fish is released after that spawning occur . Breeder is put in the evening and spawning is over by the next morning.

- Artificial breeding

  This kind of the process is done when the condition are not favorable. breeding is obtained by restoring of hypophysation it is done when the large quantity of fry is to be produce in this system ripe female are 1st anesthetized inserting mouth with cotton wool dipped in MS222 and the vent is sutured with wax cotton to prevent discharge of egg . the injection is given to the male and female generally pituitary extract 2.5 to 3.7 mg/kg an injected male and female is kept in the tank for 24 to 26 hours at 18 to 20 degree Celsius , at 1st female is stripped by gentle squeezing in the abdomen and male are also stripped in same manner an the milt is poured in egg and mixed using feather then fertilization occur

Brood fish:

Sexually mature male and female fishes are called brood fish. Mature male and

female have ability to produce milt and eggs for breeding.

Brood fish selection and production method

Selection of brood fish

- Fish seed selection for brood fish production
- Selection of brood fish six month before breeding or at the time of breeding

Brood fish selection is done by determining phenotypic character of fish body. Selection is done before six month of breeding by determining the following characteristics;

- 2 – 3 year old brood fish having 4 – 5 kg body weight is best for breeding.
- Body should be thick and scale should be have arranged regularly on the skin
- The reproductive organ i.e. vent could be well developed
- Brood fish having higher growth rate from same aged fish is selected
- Brood fish should be healthy, vigorously growth and cleaver
- Selection is done in winter season (i.e. mangsir – poush)
- Inbreeding is restricted for brood fish production and selection.

Selection of breeding male:-

Select healthy mature breeding male with 4 -5 kg body weight

Check the brood male is ready to breed or not. For this hold the brood and slightly press above the vent on abdomen, milky white fluid runs through the vent

Take the milt in water

If milt is whity, thin and easily spread on water then the male is suitable for breeding

If milt is yellow, thick and do not spread on water male isn't ready for breeding.

Selection of breeding female:-

Select healthy breeding female with 4- 5kg body weight

While pressing slightly above the vent on abdomen, female discharge eggs and it is selected for breeding

Breeding techniques of common carp:-

Common carp breeding techniques differ from Chinese carp and Indian major carp

because it can breed naturally in stagnant water when pond is provided with aquatic vegetation. Breeding time of common carp in terai is Falgun – Chaitra and for hill is Chaitra – Baisakh. In natural breeding mortality rate of hatchling is high so that semi natural breeding technique is carried – out. Normally Inducing the P.G by injection isn't carried out in semi natural breeding of common carp.

Cyprinus carpio is a fresh water fish and it belongs to the Carp group. It is a Cyprinid fish. Its original home is China. In China, this fish has been cultured in ponds since many centuries. The fish has laterally compressed body. The middle part of the body adjacent to dorsal fin is the widest portion than any other parts. The anterior portion of the body gradually slopes down and ends to a small head. The anterior most part of the head has a mouth. The mouth is protractible and is used to suck the food from the bottom of the pond. On the both sides of the mouth the fish has a pair of small barbell. Behind the mouth the fish has a pair of nostril pores and a pair of big eyes. At the posterior portion of the head a big bone - Operculum lies which covers and protects the delicate respiratory organ - the Gills. The fish has dorsal pectoral pelvic, anal and caudal fins. Just in front of the anal fin, the anal and genital pore forms a depression.

The Brood Fish:-

The sexually matured grown up fish which is raised with special care for breeding purpose is called Brood Fish. The Common Carp sexually matures within a year in warmer climatic condition and easy to breed in stagnant water when the water temperature exceed over 20 °C. However, under good management and under controlled condition, a fish of one year is not bred as they are small in size and such fish produces less number of eggs. Therefore, a fish of three to five years old and big sized fish is selected and specially raised as brood fish, the selected and specially raised fish of big size is only used for breeding purposes. Such big fish produces large number of eggs, fries and fingerlings. For breeding purpose the male and female fish are selected in 2: 1 ratio respectively. Generally, the brood fish - male as well as female arc selected strictly on the basis of following characters;

a) The body is proportionate,
b) No part of body is deformed or abnormal,
c) The scales are uniformly distributed throughout the body,
d) Lateral lines remain single and continuous line along the body.
e) The fish which grows fast and
f) The fish is free from parasite and disease.

Segregation:-

The Common Carp not only sexually matures but also breed in stagnant water when the water temperature exceeds over 20" C. Therefore, attention need to he given in breeding of Common Carp, otherwise, they bred wildly and thus the stock or strain get rapidly degenerated in its size and weight. Therefore, under good management, the male and female fish having good characters are selected one or two months before the breeding season and are segregated into two separate male and female ponds. They are raised with special attention. During the segregation the male and female fish are identified very strictly and accurately because one simple mistake in identification of either a male or female spoils the whole segregated stock of brood fish. Therefore, one needs to be accurate and strict in identification of the male and female. Moreover, the segregated male and female brood stock is repeatedly checked at certain intervals just to avoid the mistake in judging the sex of the fish.

The identification of the male and female of Common Carp is not difficult, if it is practiced. Generally at the early stage of its maturation the fish show orange coloration on the lower portion of caudal fin and anal fin. The coloration turns deep and deeper as it proceeds to maturation. The male of Common Carp is generally identified with its elongated body as compared to the female. The male is further confirmed by its genital opening in concave form. As the development of gonad advances, so the other character become more and more distinct and identification become easier. Therefore, in its early stage of gonadal development, the segregated male and female brood fish are checked repeatedly. With the development, the male fish's operculum and the pectoral fins upper surface develop some tubercles and turn rough in compare to the female. Moreover, the mature male oozes out white milt from its genital opening on even slight pressure on abdomen. Similarly, the female possess genital opening with convex surface. As its matures, the female become

more easy in identification with its swollen belly. At this stage, its genital opening bulges out and forms distinct convex surface. It even protrudes bunch of eggs even on slight pressure on belly. The brood fishes are generally raised in a pond which is specially made deeper than any other pond and is called Brood Fish Pond. The ideal size of the brood fish pond ranges from three to four canals or even more. In case of less number of brood fish requirement, the cultivable fish are also raised in one or two canal pond. General generally the brood fish pond is rectangular in size and made deeper than other ponds. While raising the brood fish, the water of brood fish pond is often changed with fresh water to stimulate the brood fish.

Rate of Stocking:-

After the segregation the male and female fish, they are raised separately into two brood fish ponds with special attention at the stocking rate of 240 - 280 Kg. of brood fish per 4 kanals of brood fish pond (1200 - 1400 Kg/hectare of water body), with proper fertilization and feeding so that they get plenty of natural as well as supplementary feed and yet well nourished. The healthy brood fish gives good quality of eggs which produces healthy fries. Such healthy fries have higher survival rate too.

Preparation of Breeding Pond

As the water temperature exceeds 20 ° C, preparation of breeding pond is carried out. The breeding pond is left dry before the breeding season. During this lime the repair of the pond's dike, inlet and outlet are undertaken. About 10 Kg. limes is broadcasted throughout the pond.

At the same time a thin strips of bamboo are prepared and good quantity of terrestrial grass or fiber of Coconut or synthetic fiber are collected. The thin strips of bamboo are interwoven in such a way that a 4' × 6' sized mat is made. On such mat long green grasses or fiber of Coconut or synthetic fiber are placed to form a mattress and on lop of such grasses or fiber another bamboo mat is placed and tied. The mattress of green grasses or fiber is called kakabon. A number of such kakaboons are prepared and stored under shade until the breeding season starts.

With the rise of water temperature, the breeding pond is filled up with fresh water after screening at morning time. A number of kakaboons are fixed horizontally on

the vertical bamboo pegs around the shore of the breeding pond. Generally, the kakaboons are fixed at or around 3' 6" - 4" high from the bottom of breeding pond and 4" -6" below the surface of the water. After filling the water, the breeding pond is left for whole day, so that the sill settles down and the water remains clear and warmer too.

Breeding

With all the above preparations, the breeding pond is ready to receive specially raised male and female brood fish. First, the female pond is netted and well developed females are selected on the basis of bulged stomach due to eggs, soft belly and reddish and swollen vent. Two females of about 3-5 kg. body weight are selected for a breeding pond of 1 - 2 canal. Similarly, the male pond is netted and four males are selected. The selected males ooze out white milt even with a gentle pressure on belly. The selected males and females are released in well prepared breeding ponds at evening.

The fresh water, higher water temperature and kakaboons stimulate the long segregated males and females of Common Carp for breeding. The male starts escorting the female fish within a couple of hours of release in the breeding pond. By next morning, the male starts chasing the female and mating process starts with flashing of water and the male starts rubbing its body with female. The male fish starts driving the female towards the kakaboon where the female starts laying out the eggs and simultaneously the male oozes out the milt contain spermatozoa which fertilizes the released eggs. The fertilization lakes place outside the body. The eggs in which the spermatozoa gets in are fertilized, where as others remain unfertilized and they get spoiled. The Common Carp's eggs are sticky in nature, so the eggs slick to the grasses or fibers of kakaboons.

The mating process of Common Carp continues for hours until the female is not exhausted with eggs. After few hours of mating process, the pond turns out calm and quite. At this stage the exhausted male and female need be provided with supplementary food at one end of the pond, otherwise, the exhausted and hungry brood fish may start eating their own eggs. Therefore, the exhausted brood fish are either netted out gently from the breeding pond or they are led with supplementary

feed.

With the fertilization of the egg, the egg starts swelling and embryo starts developing In due course of time the developing embryo attains eyed stage. By this stage the brood fish need to be netted out from breeding pond, if nursing of the fries is aimed to be carried out in the same pond. But if the hatching and nursing of the fries is aimed to be carried out in other pond theft the kakaboons with eyed egg embryo are transferred either early in the morning or late evening to specially prepared nursing pond, where the egg hatches out to hatchlings and the hatchlings grow to fries and fingerlings.

10.3 Nursing method of hatching fry and fingerlings

After the egg are hatched left until three day after hatching during this period they do not need food then after collection and measurement the fry transplant to the nursery pond . nursery pond should be free of predator and parasite, weed and should have natural food of the zooplankton or formulated food like soybean powder and finally powder oilcake and rice bran are provided in 1:1 ratio 4 to 5 times daily nursery pond are usually netted out from 2 to 3 week stocking advance fry are restocked are transferred to rearing pond in combination with compatible species for the fingering rearing.

Teacher tips:

- Slide show and visual presentation on fish breeding.
- Slide show and visual presentation of fish hatching.

UNIT - ELEVEN
Improved fodder grass used in grass carp

Learning outcome:

Completion of this lesson student,

- Can identify useful improved grasses use in grass carp farming.
- Can be cultivating different useful grasses for grass carp farming.

11.1 Berseem grass/ Egyptian clover:-

B.N: Trifolium alexandrium

Origin: Berseem probably originated in Syria.

Berseem is one of the most important forage and has been rightly described as the king of grass. Berseem is one of the most important leguminous forages in the Mediterranean region and in the Middle-East. Berseem is an annual, sparsely hairy, erect forage legume, 30 to 80 cm high. Berseem has a shallow taproot. Its stems are hollow, branching at the base, with alternate leaves bearing 4-5 cm long and 2-3 cm broad leaflets. Flowers are yellowish-white and form dense, elliptical clustered heads about 2 cm in diameter. The flowers must be cross-pollinated by honey bees to produce seeds. The fruit is a pod containing one single white to purplish-red seed. Berseem is a variable species that can be classified into four cultivars groups according to their branching behavior and subsequent productivity. Highly branching and productive types are Miscawi and Kahdrawi. Berseem is a fast growing, high quality forage that is mainly cut and fed as green chopped grass for grass carp. It is slightly less drought-resistant but does better on high moisture and alkalinic soils. Moreover, Berseem can be sown in early autumn and can thus provide feed before and during the colder months. It is very productive when temperatures rise after winter. The seeds are abundant under favorable conditions. Berseem can also be made into silage with oats or be fed chaffed and mixed with chopped straw. Grazing is possible though less common than cutting. Berseem clover can also be used as green manure crop.

Source: https://www.google.com/search?q=berseem+grass

Fig.51: Berseem

Nutritive value:

It is high quality nutritious leguminous forage that contains 22.28% digestive minerals, 3.13% nitrogen, 17.5 – 19.5 % crude protein, 2.71 % lipid, 14.42 % fiber and 88.80% organic matter.

Climate:

Berseem is mainly valued as a winter crop in the subtropics as it grows well in mild winter and recovers strongly after cutting. It does not grow well under hot summer conditions. Berseem has some frost tolerance, down to -6°C and as low as -15°C for some cultivars. Berseem can grow in areas where annual rainfall ranges between 550 mm and 750 mm. It can withstand some drought and short periods of water logging.

Soil:

It is moderately tolerant of salinity and can grow on a wide range of soils, though it prefers fertile, loamy to clay soils with mildly acidic to slightly alkalinic pH i.e. 6.5-8.

Cultivars:

Pusa Giant, Bardan, Meskabi, B.L- 10, B.L- 22 etc.

Land preparation:

Land should be well preparing before sowing of grasses. One deep ploughing with two shallow is suitable for grass cultivation. Removal of weed and other inert material during the land preparation.

Propagation and planting:

Berseem is only propagated by seeds and is usually sown in early autumn. It can be

sown on a conventional seedbed or be direct drilled. Berseem can be sown alone or in combination with other species. It is mixed with grass (ryegrass). Berseem can be integrated into a rice-wheat cropping system, as a winter and spring feed. It is then sown before or just after rice harvest.

Nutrient management:

Application of manure @ 25 tons/ha and 200:50:50 kg NPK/ ha gives a satisfactory yield. In case of nitrogen urea should be apply in 2-3 splits doses.

Irrigation:

Under irrigation, Berseem must be sown earlier and irrigated on a weekly basis at the beginning. Ten to 15 irrigations are generally necessary for fodder production

Harvesting:

It is high quality green forage. Berseem should be cut 50 to 60 days after planting and then 6 – 8 subsequent cuttings are taken at every 30-40 days intervals. The highest yield of protein with a relatively low yield of fiber was obtained by cutting the plant at a height of about 40 cm. Five to six cuttings can be done under irrigation and one or two at the end of the cool season in dry land.

Yield:

It yields about 60 to 80 metric ton green grass per hectare of land.

11.2. Napier grass

B.N: *Pennisetum purpvreum*

Origin: Tropical Africa

It is also known locally as elephant grass. This large cane like perennial grass attains naturally at a height of 6 to 8 feet. It is a nutritious fodder grass used to feed grass carp to obtained better quality production. Its distinctive features are aggressiveness, long life, drought resistance, high productivity, and ability to recover after being cut. Napier grass is a leafy, branching, vigorous-growing perennial, attaining, under favorable conditions, a height of 10 to 15 feet at maturity. It has a strong, extensive fibrous root system which enables the plant to become quickly and permanently

established in the soil. The leaf blades are usually 1 to 1.5 inches wide and 2 to 3 feet long. The leaf carries conspicuous ligules consisting of a fringe of fine hairs about three-eighths of an inch in length. Tillering in this species is profuse, and often as many as 50 to 100 stalks are produced from a single plant. When the plants approach maturity numerous fine branches appear, growing out from the leaf axils of the main stems. These branches as well as the main stems bear terminal condensed

Panicles or seed heads which are golden yellow to tawny in color and from 5 to 10 inches in length. The inflorescence is made up of a large number of spikelet borne singly or in groups of 2 or 3 on short branch lets, the branch lets being arranged spirally on the central axis. Each spikelet consists usually of a single fertile terminal floret and a second empty lemma or sterile floret, together with a pair of outer glumes of unequal length. The group of spikelet on each branch let is subtended by involucres of bristles which are longer than the spikelet and arranged in a whorl. These involucres of bristles fall with the matured spikelet and evidently aids in the dissemination of seed by the wind and by animals.

It has been observed that when blooming begins the stigmas emerge from 2 to 4 days before the stamens. This, it seems, would tend to promote cross-pollination and may account in part for some of the partial sterility observed in this species.

Source: https://www.google.com/search?q=napier+grass

Fig.52: Napier Grass

Climate:

It is only grown in the frost-free regions of Nepal but can resist drought condition.

Napier grass is truly a tropical species, but it is very adaptable in nature and can be grown successfully in the subtropics and even in the warmer sections of the Temperate Zone. The yields of grass will vary with the length of the growing season. One or two cuttings may be made per season in the cooler sections where it is grown, while 5 to 7 cuttings are common in the tropical regions. In Nepal it is adapted to the climatic conditions found at elevations of from sea level up to about 4,000 feet. At the higher limit of these elevations the growth is much slower and the plants are much smaller, ideal conditions being found only below 2,500 feet.

Soil Requirements

Napier grass has been grown successfully on a wide range of soil. Soils of good fertility with high water table are preferable. Many of the upland residual soils of Nepal like silt loams and clay loams, fairly fertile and well drained, as well as the medium to deep ash soil types are quite suitable to the growing of this crop.

Varieties:

Joint, moth, thin, C.O – 3, Bana grass, French Cameroon, clone 13 ,Kakamega 1, Kakamega 3, Machakos hairless, Uganda L14, Soghor Nandi L13, Kitui L7, Ex-Mariakani and Kakamega 8 , Pakistan Hybrid etc. are popular varieties of napier grass.

Preparation of land:

Although Napier grass is aggressive and perennial in nature, competing very well with most weeds, it becomes well established in perfect stands only if planted in a thoroughly prepared seed bed. On new land or land that has been out of cultivation for some years, several plowings may be necessary. The soil should be allowed to aerate thoroughly after the first plowing, and it should be disked several times to kill as many weeds as possible. This procedure of plowing and disking should be repeated once, twice, or more if necessary, in order to get the soil in a good physical condition as well as to rid it of weeds which will come up after the first plowing. On more improved lands it may be that one plowing will be all that is essential. Thorough harrowing, however, is bound to pay, for if the plantings are weedy a good stand is hard to establish and maintain. Time spent in preparation of the soil is usually well repaid in the subsequent ease of management and the greater yields obtained.

Manuring and fertilization:

Apply farm yard manure at the rate of 5 to 10 ton per hectare of land as well as apply Inorganic nitrogen fertilizers at the rate of 60 - 90 kg N per hectare land.

Methods of Propagation and planting:

Napier grass is propagated largely by vegetative means, either using stalk cuttings or root-clump divisions. Stalk cuttings for planting are best secured from a field which has been cut a few months previous to the time the planting material is needed. Well-developed hard stalks are best, not less than 3 or 4 months of age and not older than 8 to 12 months. The stalks at this stage are well supplied with buds located at the nodes or joints just beneath the leaf sheaths. Seed canes may be planted full length or cut into pieces having from one to several nodes. Unless planting material is very scarce, it is advisable to plant only cuttings having at least 2 or 3 nodes each or, better still, canes with 4 or 5 nodes. A very successful method is to cut seed canes into lengths of 3 to 5 feet and lay the pieces end to end in the bottom of furrows plowed out about 4 feet apart. The furrows are then filled, covering the canes with 3 or 4 inches of soil, and the grass soon germinates. With this method of planting, a plant should appear at intervals of from 12 to 18 inches, or less, and a good stand should thus be obtained under favorable growing conditions.

When planting on irrigated land the furrows may be made deeper than is necessary for good coverage. The seed canes are planted in the bottom of the furrow, covered with 4 or 5 inches of soil, and the furrow is not completely filled. The grass can then be irrigated, using the planting furrows to carry water, and germination is hastened by applying water a day or two after planting.

Another method of planting, if less seed material is available, is to use stalk cuttings with 2 nodes each and to space them about 2 feet apart in the row, planting horizontally in the bottom of furrows. If single-node cuttings are used, the pieces may be pushed into the soil at an angle of about 60° with the surface of the ground. This method is not recommended unless planting material is very difficult to obtain and good care can be given to the field after germination starts.

Planting With Root Clumps

A large plant with 50 or more tillers offers a good source of material for planting with root-clump divisions. After the top growth has been removed the root clump

may be dug out and divided into a large number of pieces, each of which may be planted separately. If this system of planting is used, rows should be spaced about 4 to 6 feet apart and root divisions planted in hills about 2 feet apart in the row. There is usually very little difference in yields obtained by either the root- or stem-cutting methods.

Weed control:

New plantings of Napier grass should be cultivated at frequent intervals until the grass has become well established. If the field is kept free from weeds until the Napier grass gets a good start, little trouble will be had, for this crop competes very successfully with the most persistent types, including dubo. At intervals of 6 months or a year a good plowing or sub soiling treatment between the rows would doubtless produce very favorable results. In pastures the cultivation treatments are usually limited to the earlier stages in the establishment of the stand of grass with possibly an occasional sub soiling or plowing to rejuvenate old stands. More of this sort of treatment would no doubt be well worth while.

Rainfall/irrigation:

With a well-distributed rainfall of from 50 to 100 inches per year excellent yields can be obtained. In many regions where Napier grass can be grown, however, the rainfall is neither not nearly so heavy nor as well distributed. In these drier sections, having an annual rainfall of from 20 to 40 inches, irrigation is essential for high yields. A furrow system is quite satisfactory, applying water about every 10 days during the dry weather. Napier grass will withstand extremely dry conditions, remaining somewhat dormant and recovering immediately when enough moisture is supplied, but its growth and yield are greatly reduced unless sufficient moisture is available throughout the season. This can be understood readily when one realizes that Napier grass cut for green fodder contains from 85 to 90 percent of water, and that from 75 to 100 tons of such fodder are often cut from an acre in a single year.

Harvesting:

Napier grass grown as a green feed (soiling crop) for grass carp. The first cutting may be made when the grass has reached a height of 4 to 5 feet. Under favorable growing conditions this first cutting can be made about 60 to 80 days after planting,

depending on the temperature, length of day, and available moisture present. It has been observed that a much more rapid growth takes place during the warmer months, particularly when the days are longest.

The grass may be cut close to the ground level, for the new growth comes out from the crown of the plant. The grass should not be allowed to mature, for the stalks begin to lignified rapidly and the digestible nutrients per ton of fodder are lowered markedly. The protein content in particular decreases rapidly and the fiber increases as the plant approaches maturity. Some fisher men in Hawaii cut Napier grass when it stands about 3 feet in height. At this stage it is very palatable and has a higher protein content than most grasses cut for green fodder. If the grass is cut in a very immature stage continuously over a long period the yield may be lowered and the root reserves may become so depleted that the stand will be permanently injured.

The best stage at which to cut and the number of cuttings that should be made per year to obtain the maximum yield and palatability are not definitely known. For grass carp, however, it is important that the grass be cut while it is still very palatable so that the stalks as well as the leaves will be eaten without much waste. If it is fed with alfalfa or other high-protein roughage, it can be fed in a slightly more mature stage than when it is the sole source of protein. When grown under irrigation, 5 or 6 cuttings can be obtained each year and a good stand successfully maintained. Such stands should give good ratoons for 5 to 6 years or more, particularly if some attention is given to fertilization and cultivation during that period.

When the grass is succulent and soft the whole stalks can be fed without much waste. If harvested at a more mature stage, the grass should be cut or chopped before feeding. Taking the waste or uneaten portions from the mangers of the dairy cows and feeding it to young cattle, dry stock, or horses might bring about a more efficient use of the fodder in many instances.

Yield:

Yields depend on agro-ecological zone and management but on average Napier grass can give 12 to 25 tons/ha of dry matter yield.

11.3. Sudan grass

B.N: *Sorghum sudanense*

Origin: tropical and subtropical regions of eastern africa

Source: *https://www.google.com/search?q=sudan+grass*

Fig.53: Sudan Grass

Sudan grass is one of the highest yielding summer annual forage grown in Nepal. They are warm season grasses, unlike most of our forage species which are cool season grasses his is a fine stemmed and leafy plant with very quick re growth. It is best used for pasture or in multiple cut systems. If used in a one cut system, yields will be less than that of Sorghum. Forage quality will be high due to low fiber content if cut frequently.

Nutritive value:

It is high quality nutritious forage grass that contains 18% digestive minerals, 1.63% nitrogen, phosphorus 0.41%, potassium 2.14%, 16.8 % crude protein & calcium 0.43%.

Cultivars:

Piper sudan, S.S.G.59-3, swet sudan

Land Preparation:

A uniform seedbed is necessary to obtain a good stand of Sudan grass. High spots in the field cause uneven irrigation and the stand will not be uniform. Low spots in the field will scald, decreasing the stand and reducing yield.

Planting:

Planting starts in late February and continues through July first. The amount of early planting depends on weather conditions These warm season grasses must be planted into warm soil, which generally means delaying planting until the end of May or first of June. A seeding rate of 15 kg/ha should be planted at a depth of 2-3.5 cm in 18-36 cm rows.

Fertilization:

The fertilizer requirements of Sudan grass depend upon the residual soil nutrient.The general recommended dose of fertilizer is 60:40:30 kg NPK per hector in case of fertile soil and 80:60:40 kg NPK per hector for less fertile soil.At the final land prepation 1/2 dose of N and full PK should be applied and remaining nitrogen is applied in two split doses at the tiwe of first and second cutting.

Irrigation:

Sudan grass requires ample soil moisture. However, care must be taken not to over - irrigate or the Sudan grass will scald if standing water is left on a field several hours during period of high heat. The first crop will require 4 - 5 irrigations to harvest. Subsequent crops will require 3 - 4 depending on re- growth potential.

Weed Control:

Weeds do not generally cause serious problems in sudangrass if it is planted at the appropriate time of year and the crop emerges and grows vigorously. Very few herbicides are registered for this crop. Low rates of atrazine have been used for water grass and purslane control when heavy weeds are present.

Harvesting:

The first cut will be ready for harvest about 60 days from planting. The plants should

be over 65 cm (26 inches) in height, and just before head emergence when cut (usually early August). For a faster recovery of aftermath growth, leave at least 10 to 18 cm (4-7 inches) of stubble when harvesting. Optimum growth of these plants occurs under hot, moist conditions. A second cut should be ready 30-35 days later.

The crop may also be harvested just once, at the hard dough stage, to get maximum volume in a one cut system. You will sacrifice yield that you could have captured under a 2 cut system. If this is your goal you should reconsider corn silage as it would yield more in a one cut system. At cutting, the crop is about 70-75% moisture and requires wilting before ensiling. Once Sudan grass begins to flower, the quality and feed value drops drastically. As the crop matures, protein content drops rapidly, while fiber levels increase. This decreases the feed energy value and fish digestibility. Sudan grass can contain as much protein than other fodder grass, but only if harvested at the vegetative stage and not flowering.

Yield:

Yields vary with season, moisture and warmth, and are higher in hot summers than in cool ones. In general 5- 7.5 tones green grass per hectare is obtained.

11.4. Para grass

B.N: *Brachiaria mutica*

Origin: Africa

***Source**:https://www.google.com/search?q=para+grass*

Fig.54: para grass

Para grass is also known as African wonder grass or Buffalo grass. Para grass is a rapid summer growing perennial non – legume grass. It is a creeping and stoloniferous grass, generally around 1 m tall. It produces runners and throws a broad hairy flag. It can grow in both semi-aquatic situations and on deep soils in non-swampy areas. The stems are hollow and robust, creeping in a prostrate growth habit. Stems stand erect towards the ends, and sprout new roots wherever the nodes touch

the ground. Leaf blades are hairy and dark green in colour. They are usually up to 15 cm long and less than 1 cm wide, tapering to a long, fine point. The leaf sheaths are also hairy, particularly where they join the stem. Flower heads are up to 18 cm long and are made up of several spikes, each about 5 cm long. Seeds cluster thickly along each of these spikes.

Nutritive value:

Actively growing para grass can have very high nutritive value with 14 – 20 % crude protein

Climate

It is a tropical grass but can be cultivated on sub – tropical region at an altitude upto 1200 MASL. It requires Mean annual temperature about 16 - 21°C.Warm season growth only, with growth restricted by temperatures below 15ºC. It is very sensitive to frost. Leaf is killed by frost but plants can recover. Humid to sub-humid regions with 1,200–4,000 mm annual rainfall is suited.

Soil:

Well adapted to a wide range of soil types from sandy to clay soils of moderate to good fertility. Suited to poorly drained (swampy or seasonally waterlogged) land in the tropics and warmer subtropics, but will also grow productively on free-draining soils in high rainfall environments. Tolerates moderate salinity, low pH to 4.5 and high levels of trace elements normally produced under water-logged conditions.

Varieties:

Sao Palo, Comum, Fino, Medellin, Parana, Aguada, Lopori etc.

Sowing time:

It is a rainy season grass grown in the month of June - July but in irrigated condition, growers can grow in the month of March - April.

Planting Distance:

30cm x 30 Cm

Seed/seedling rate:

This grass can be grown from seed as well as seedlings. About 10 – 15 kg improved seed is sufficient to plant one hectare of land. Similarly 10,000 sets of cutting are

required for one hectare of land.

Sowing method:

Para grass is usually sown by partly burying sections of the stem in loose, moist earth. Stem cuttings about 25 cm long are planted, preferably as two to three-nodes loops at 1-m spacing, or cuttings can be broadcast and disc- harrowed in. Where seed is used, it can be sown in the ashes of a burn or well- prepared seed-bed, or directly into wet areas. Sow seed no deeper than 1 cm and roll after seeding.

Manure and Fertilizer:

10 ton FYM is applied on a hectare of land, It responds readily to nitrogen. About 500 kg/ha of phosphorus should be applied prior to planting with subsequent top-dressings of 120-250 kg/ha per year for a few years. Nitrogen applied toward the end of summer or in autumn will give better winter growth. It tolerates high aluminum.

Harvesting:

60-90 days 8-9 cuttings in a year

Yield:

The yield depends upon type of soil, its fertility and availability of adequate water in time. The yield also depends upon quality of seeds, seed rate, fertilizers used, and weeding done and general agro climatic conditions. About 100 to 200 tones green grasses are obtained per hectare per year.

11.5. Rye grass

B.N: *Lolium spp*

Origin: They are indigenous to temperate europe , Asia, and North Africa, but are grown worldwide.

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Ryegrasses are the most widely grown cool-season forage grasses in Nepal. They have numerous desirable agronomic qualities. They establish rapidly, have a long growing season, are high yielding under favorable environments when supplied with adequate nutrients, possess high nutrient contents, and can be used to feed grass carp. The ryegrasses are considered to be high quality forage and their high digestibility makes them suitable for herbivorous fishes.

Source: https://www.google.com/search?q=lolium+grass

Fig.55: Ryegrass

Climate:

Ryegrasses are the most widely grown cool-season grasses in the world. They have numerous desirable agronomic qualities. They establish rapidly, have a long growing season, and are high yielding under favorable environments. Ryegrasses are heavy users of water and their performance is less than optimum during a drought or periods of extended low or high temperatures. Para grass is adapted to high-rainfall tropical and subtropical conditions, but on an average it requires 1500 mm annual rainfall.

Soil:

Ryegrass will tolerate a wide range of soils but performs best on loam soils with high fertility. Ryegrasses grow best when the soil pH is at least 6. Growth is also satisfactory at lower soil pH when it is not desirable to maintain high soil pH.

Cultivars:

Lamora, roper, Bhutan, khumal, rasuwa etc.

Sowing methods:

Conventional seeding

For high yields, annual ryegrasses must be sown in a firm, fine, and level seedbed as early as possible in the spring. Rolling the field prior to seeding is recommended to firm the seedbed after cultivation. Seeding rates of 20-25 kg/ha for diploids and 25-35 kg/ha for tetraploids is adequate for good stands. Use the heavier rates given for broadcast sowing. Monitor the rate of seeding carefully, because the flow rate of seed varies considerably depending on the cultivar and the type of seeder used. Seed

shallow at a depth of about1 cm, and, to ensure good germination, cover the seed and firm the soil after seeding. Culti - packer seeders and grain drills do a satisfactory job of seeding ryegrasses. Broadcast seeding works well, but light chain harrowing and rolling after seeding are necessary.

Reduced tillage

If annual ryegrasses are grown in the same field in two or more consecutive years, use reduced tillage after the 1st year. Because annual ryegrasses are usually winter killed, cultivate only lightly to remove dead matter and prepare the seedbed. No-till drills are excellent for seeding in such fields. Grain drills do a satisfactory job; direct the seed through the discs and adjust the tension on discs to obtain a seeding depth of about 1 cm. broadcast seeding is not dependable under reduced cultivation unless good seed coverage is obtained. The yields with both conventional and reduced tillage are usually equal but reduced tillage seeding is considerably faster. The cost of establishing ryegrass with reduced tillage is lower than with conventional seeding.

Weed control:

Many broadleaf weeds can suppress the seedling growth of annual ryegrasses. Control such weeds by timely defoliation or by spraying with herbicides. The following herbicides are suitable for broadleaf weed control in annual ryegrasses. Herbicides and rates of application for controlling broadleaf weeds in annual ryegrass 2,4-D amine up to 0.84 a.i per kg per hectare or MCPA sodium up to 1.26 a.i per kg per hectare. In some instances, a cereal grain crop sown at low rate (50-75 kg/ha) reduces weeds and increases dry matter yields in the first harvest. To minimize competition on ryegrass, cut or graze cereal-ryegrass mixtures at the vegetative to early dough stage of the cereal crop. Weeds are not usually a problem after the first cutting because ryegrass grows vigorously. With reduced tillage, it may be necessary to suppress weeds with preplant applications of glyphosate.

Fertilization:

Adequate soil fertility is the key to producing annual ryegrasses. A soil test will specify the type and amount of fertilizer required. Farmyard manure worked into the seedbed before seeding is a good source of nutrients for annual ryegrasses. A small application of nitrogen at seeding is usually necessary .Apply more nitrogen 100

kg/ha at the tillering stage in early summer to boost the growth. Apply additional nitrogen as necessary for vigorous growth and good quality until late fall. For pasture, smaller but more frequent applications of nitrogen result in a uniform pasture availability and lower nitrate content in forage. Regular applications of nitrogen throughout the growing season are essential for the good growth of annual ryegrasses. The required amounts depend on factors such as the rate of application of farmyard manure at seeding and intended use. Fertilizer rates adjusted for applied manure are available as a part of soil test value.

Nitrogen fertilizer for ryegrass:

An application of ammonium nitrate at 100 kg/ hectare after emergence is usually required for good growth. Additional nitrogen fertilizer may be required to maintain production during the growing season.

- At seeding time applied at the rate of 40 to 50 kg nitrogen per hectare
- At start of tillering time applied at the rate of 35 to 40 kg nitrogen per hectare
- After first defoliation applied at the rate of 50 to 65 kg nitrogen per hectare
- After subsequent defoliations applied at the rate of 35 to 50 kg nitrogen per hector.

Harvesting:

Harvesting activities depends upon the temperature, length of day, and available moisture present in the field. Under favorable growing conditions this first cutting can be made about 50 to 60 days after planting and 5 – 6 subsequent harvesting are taken at 25 – 30 days interval per year.

Yield:

It yields about 23-62 metric tons green grass per hector per year.

Teachers tips:

- Demonstrate different cultivated grasses used as fish feed.
- Slide show and visual presentation in cultivated grasses.

UNIT - TWELVE
Fish farming in natural water bodies

Learning outcomes:

After completion of this lesson student,

- have general ideas about conservation and management of natural water bodies.
- can identify different fish species found in natural water bodies.

12.1 Natural water resource in Nepal:

Nepal is under the general influence of the sub- continental climatic pattern. It has two distinct seasons. The summer- monsoon season and the dry winter season. The summer- monsoon season which lasts from the June/July to September/October brings about the 90% of the total rainfall. The winter rains account for about 10% of the total rainfall. The average annual precipitation of Nepal is about 1516 mm. The precipitation varies from 210 mm in Jomsom in Mustang district which is a dry region to about 5460 mm (1974) in the wet region of Pokhara. There are different water resources in Nepal. They are as follows.

a) Surface Water

Precipitation that doesn't soak into the ground or return to the atmosphere by evaporation or the transportation is called surface water. It forms streams, lakes, wetlands, and artificial reservoirs. Hence the source of the surface water is from river runoff and the floods. Depending on their sources of the dry - season discharge, the river of Nepal is of three grades. The first Grade Rivers are the Karnali, Narayani and the Sapta Koshi along with some of their tributaries, having their sources in the snow and glaciers in the Himalayan Region.

b) Ground Water

Some precipitation infiltrates the ground and fills the pores in soil and the rock. The subsurface area where all available soil and the rock spaces are filled by the water is called the zone of the saturation and the water in these pores is called ground water.

Although ground water resources are still under investigation, so far the most prospective sites of the ground water resources lying mostly in the Terai and in some mountainous valleys as well. For drinking and other purposes people have made wells static water tables of the aquifers lie normally between 3 $ 10 m from the ground surface in the eastern and Central Terai with yield between 100 $ 300 m3/hr.

c) Lakes, Spouts and Hot Springs

There are innumerable lakes and ponds, covering about 2% of the total runoff. Most of the oxbow lakes are found in Terai. There are several hot springs known as " Tatapani" and similarly hot suppurated water exists about 1KM south of kodari check post in Sunkoshi valley. In Janakpur also there are three hot springs containing sodium, potassium, sulphate, and carbonate and chlorine ions.

There are about 6000 rivers in Nepal. 1000 of which are more than 11 kms long and about 100 of them are longer than 160 kms. The total length of all streams and rivulets exceeds 45,000 km. Thus the drainage density expressing closeness of spacing of channels is approximately 0.3 km per sq km. It is expected that for the next couple of decades this natural water resources particularly during the rainy season will not change. Moreover, the mountainous terrain along with the summer monsoon produces disastrous flood in Nepal.

However, the resources may decrease substantially during the winter and springs months due to less precipitation. The water use during dry period is extensive and unqualified and makes it difficult to establish a relationship between rainfall and runoff. Water is mainly used in Nepal for the agricultural domestic, industrial and the commercial purposes.

Natural water resource as “any spring, stream, pond, lake or wetland that was historically present in a natural state but may have been physically altered over time.” Examples of a natural water body include:

- Ponds constructed in natural springs, wetlands, streams, ponds, or lakes; and
- Ponds created by damming a stream.

Following five requirements of state law must be met:

- The land next to the water body must be owned, leased or controlled by owners of the fish farm.
- There must be no public access to the water body except for fishing by the public for a fee.
- No substantial public interest exists in the body of water.
- No public or private rights in the body of water will be damaged.

Fish found in natural water body of Nepal:-

The aquatic ecosystems of Nepal offer excellent habitats to at least 186 indigenous and 11 exotic fish species of high economic, environmental and academic value. Among the total of 186 fish species, 59 have been considered as cold water fish. The most important indigenous cold water fish species are katle (Neolissochelius hexagonolepis), Chuchee asala (Schizothoraichthys spp), Snow trout (Schizothorax spp) locally also known as asala, mahseer (Tor spp.). Schizothorax moleshowrthii and S. progastus are considered as delicious fish in Nepal. Snow trout are herbivorous but Tor spp. are omnivorous. High altitude lakes in Himalayas are characterized by snow trout fish also there are some undescribed species of snow trout are found in these lakes. There was successful artificial rearing for the species N. hexagonolepis, Tor tor, T. putitora, sahar (*Tor* spp), katle (*Neolissocheilus hexagonolepis*) and snow trout (*Schizothoraichthys* spp and *Schizothorax* spp). They are excellent from the economic and sport fishery point of view, but many other species are fished for subsistence. Cold water fisheries offer a great opportunity for self employment and income generation among poor people living along rivers, lakes and other natural waters. Normally they are widely scattered and not organized. About 400 000 beneficiaries are engaged in this subsector. As the watersheds inhabited by the important species are shared by a number of nations, a regional cooperative effort is a necessity to share experiences and initiate collective actions to conserve and manage these shared aquatic resources.

Importance, Management Issues, Developments and Policies:-

Fishing is one of the important and traditional ways of sustaining for low economic community like tharu, Majhi, Malaha, Dunuwar, Kewat, Bote, Musahar, Mukhiya, Darai, Kumal, Dangar, Jalari and others. Development, production strategies and

policies for aquaculture are strongly affected by budgetary plan of country, which targets on production and gross domestic production (GDP) there were some early fish cage culture programme started in 1972 by Nepal Government in collaboration with FAO, UNDP and Ministry of agriculture and co-operatives). In 1990s the aid agency from Japan and Nepal government worked together and formulated a plan for prevention of exploitation of water bodies and establishment of efficient type of aquaculture farming for lake, reservoirs and river system fish species. The object of that project was to work for indigenous fish species, establish the raceway fish culture and socio-economic perspective of possible fish production in potential water bodies. Nepal Agriculture Research Council (NARC) is also working for breeding and culturing technology for fish species like rainbow trout .Nepal government established 13 fisheries development centre with four centres dedicated for cold water fishery. Economically important fish were identified and rearing had been started with training for people working for cold water fisheries. In the Nepal government three year interim plan of 2007/08 to 2010/11 it was given prime importance for fisheries development and sustainable fish production.The current fisheries development policies are to increase commercialize production with proper management and conservation of indigenous fish species, also improved marketing network for fresh fisheries product along with good post-harvest techniques. Challenges of fisheries and fish production In salmonids rearing and farming disease like fin rot, hepatoma, fungal problems in fertilized eggs, presence of watery fluid in stomach and physical disordered like blunt snout, twisted alevins, abnormal gills, degenerated operculum and blindness were observed by Godawari Fisheries Research Centre during introduction of salmonids like rainbow trout There is no good technological development in fish and fisheries management. No proper management strategies applied for water bodies' management throughout country for indigenous and other fish but there was a case of successful participatory fisheries management in PhewaLake. Lack of skilled and experienced manpower, poor management and unhygienic practice of fish farming are the major cause of disease to fish and failure of commercial high monetary value salmonids aquaculture. Also low investment monetary and lack of good quality cage and net material are other challenges of fisheries management in the developing country like Nepal. There are

many fish species which would be commercially and economically important but there is lack of research on behavior, propagation, population dynamics and biology of these indigenous species.

12.1 Conservation and management of natural water body:-

Water conservation encompasses the policies, strategies and activities made to manage fresh water as a sustainable resource, to protect the water environment, and to meet current and future human demand. Population, household size, and growth and affluence all affect how much water is used. Factors such as climate change have increased pressures on natural water resources especially in manufacturing and agricultural irrigation. Standing water bodies include a wide variety of aquatic habitats such as lakes, pools, ponds and tarns. They are refuges for rare protected aquatic plants and animals (amphibians, reptiles, birds, etc.) and are therefore key elements of a biotope network. At appropriate sites, they can be networked with other wetlands and with flowing waters. Standing water bodies are often drained or filled in so that they can be used for other purposes, making their conservation particularly important. Management interventions may be helpful in keeping smaller standing water bodies clear; they may also be conducive to various siltation stages and beneficial to habitats and the transformation of nutrient-rich and silted-up water bodies into near-natural ecosystems. The creation of standing water bodies (e.g. as protected areas for amphibians) is also an option, although conservation should take precedence over the creation of new small water bodies.

The goals of water conservation efforts include:

- Ensuring availability of water for future generations where the withdrawal of fresh water from an ecosystem does not exceed its natural replacement rate.
- Energy conservation as water pumping, delivery and waste water treatment facilities consume a significant amount of energy. In some regions of the world over 15% of total electricity consumption is devoted to water management.
- Habitat conservation where minimizing human water use helps to preserve freshwater habitats for local wildlife and migrating waterfowl, but also water quality.

Managements:-

The Water Resources Management Division is responsible for water resources management as per provisions of the Environmental Protection Act and the Water Resources Act. The Division has programs to protect, enhance, conserve, develop, control and effectively utilize the water resources of Nepal. About 97% of the total available water on earth is contained in ocean and hence saline in nature. Out of the balance 3% which is available as fresh water about 2% is contained in ice inaccessible region and 0.75% as ground water. Out of remaining 0.25%, only about 0.01% is available in lakes and rivers at any given time and the rest occurs as glaciers and snow. The total water contained in the atmosphere is still less and is of the order of 0.001% of the total available water. Therefore the surface water which can be readily utilized by the society is very small. Even the surface runoff that flows in the river of the world mostly goes wasted since it flows down to the ocean in absence of the proper storage for the source. It is estimated that about 96% of the total annual surface runoff goes and join the sea and is thus not to put any worthwhile use. This large scale wastage of the surface water flow is done true in Nepal because out of 225 billion cubic meter of annual surface flow, only 2% is utilized in our country and the rest drain down to Indian plain passes through the large Genetic plains of India and enters Bangladesh before it finds drain down to the Bay of Bengal and join the sea. managements of natural water resource.

- Development and management of water resources shall be undertaken in a holistic, systematic manner, relying on integrated water resources management.
- Water utilization shall be sustainable to ensure conservation of the resource and protection of the environment. Each river basin system shall be managed holistically.
- Delivery of water services shall be decentralized in a manner that involves autonomous and accountable agencies (e.g., public, private, community and user-based agencies).
- Economic efficiency and social equity shall guide water resource development and management. · Participation of and consultation with all the stakeholders shall constitute the basis of water sector development.

- Sharing of water resource benefits among the co-riparian countries shall be on an equitable basis for mutual benefit.
- Institutional and legal frameworks for coordination and transparency shall be an essential feature of water sector management.
- Wider adoption of the best existing technologies and practices, and rapid innovation and adaptation of both institutional arrangements and new technologies, shall be ensured.

12.3. Identification of fish species released in natural water bodies

Among the total of 186 fish species, 59 endemic and 2 exotic have been considered as cold water fish most of them are fished for subsistence and for sport. Most of them inhabit the streams and river in midhill valleys. Some of cold water fish are revised as follows:

List of cold water fish with revised classification

Super class - Gnathostomata
Class - Actinopterygii
Subclass - Neopterygii
Division - Teleostei
Subdivision - Euteleostei

I. Order Cypriniformes

Family - Cyprinidae
Subfamily - Danioninae
Tribe - Oxygasterini
Genus - *Securicula* Gunther
1. *Securila gora*
Genus - *Salmostoma* Swainson
2. *Salmostoma acinaces*
3. *Salmostoma bacaila*
Genus *Barilius*
4. *Barilius barila*
5. *Barilius barna*
6. *Barilius bendelesis*
7. *Barilius bola*

8. *Barilius guttatus*
9. *Barilius radiolatus*
10.*Barilius shacra*
11. *Barilius tileo*
12. *Barilius vagra*

Tribe - Danionini

Genus - *Chela*

13. *Chela laubuca*

Genus *Esomus* Swainson

14. *Esomus danricus*

Genus *Brachydanio*

15. *Brachydanio rerio*

Genus *Danio*

16. *Danio aequipinnatus*
17. *Danio dangila*
18. *Danio devario*

Subfamily - Cyprininae

Tribe - Cyprinini

Subtribe - Tores

Genus - *Tor*

19. *Tor mosal*
20. *Tor putitora*
21. *Tor tor*

Genus - *Naziritor*

22. *Naziritor chelynoides*

Genus - *Neolissocheilus*

23. *Neolissocheilus hexagonolepis*

Tribe - Systomini

Subtribe - Poropurtii

Genus - *Chagunius*

24. *Chagunius chagunio*

Subtribe -Systomi

Genus - Puntius

25. *Puntius conchonius*

Tribe - Semiplotini
Genus - *Semiplotus*
26. *Semiplotus semiplotus*
Tribe - Labeonini
Subtribe - Labeones
Genus - *Labeo*
27. *Labeo angra*
28. *Labeo dero*
29. *Labeo dyocheilus*
30. *Labeo gonius*
Subfamily - Oreininae (Schizothoracinae)
Genus - *Schizothorax*
31. *Schizothorax richardsonii*
32. *Schizothorax sinuatus*
Genus - *Schizothoraichthys*
33. *Schizothoraichthys esocinus*
34. *Schizothoraichthys curvifrons*
35. *Schizothoraichthys labiatus*
36. *Schizothoraichthys macrophthalmus*
37. *Schizothoraichthys nepalensis*
38. *Schizothoraichthys niger*
39. *Schizothoraichthys progastus*
40. *Schizothoraichthys raraensis*
Genus - *Diptychus*
41. *Diptychus maculatus*
Subfamily - Garrinae
Genus - *Garra*
42. *Garra annandalei*
43. *Garra gotyla*
44. *Garra lamta*
45. *Garra lissorhynchus*
46. *Garra nasuta*
47. *Garra rupicola rupicola*
Genus - *Crossocheilus*

48. *Crossocheilus latius*

Family - Psilorhynchidae

Genus - *Psilorhynchus*

49. *Psilorhynchus balitora*

50. *Psilorhynchus sucatio*

Genus - *Psilorhynchoides* Yazdani,

51. *Psilorhynchoides homaloptera*

52. *Psilorhynchoides pseudecheneis*

Family - Balitoridae

Subfamily -Balitorinae

Genus - *Balitora*

53. *Balitora brucei*

Subfamily - Nemacheilinae

Genus - *Acanthocobatis*

54. *Acanthocobatis botia*

Genus - *Nemacheilus*

55. *Nemacheilus corica*

Genus - *Schistura*

56. *Schistura beavani*

57. *Schistura rupecola*

58. *Schistura scaturiginia*

Family - Cobitidae

Subfamily - Botinae

Genus - *Botia*

59. *Botia almorhae*

60. *Botia lohachata*

Subfamily - Cobitinae

Genus - *Acantophthalmus*

61. *Acantophthalmus pangia*

Genus - *Lepidocephalus*

62. *Lepidocephalus guntea*

II Order - Siluriformes

Family - Schilbeidae

Subfamily - Schilbeinae
Genus - *Pseudeutropius*
63. *Pseudeutropius atherinoides*
64. *Pseudeutropius murius batarensis*
Genus - *Clupisoma*
65. *Clupisoma garua*
Family - Amblycipitidae
Genus - *Amblyceps*
66. *Amblyceps mangois*
Family - Sisoridae
Genus - *Bagarius*
67. *Bagarius yarelli*
Genus - *Glyptosternon*
68. *Glyptosternon reticulatum*
69. *Glyptosternon maculatum*
Genus - *Glyptothorax*
70. *Glyptothorax annandalei*
71. *Glyptothorax cavia*
72. *Glyptothorax conirostre*
73. *Glyptothorax gracile*
74. *Glyptothorax indicus* Talwar
75. *Glyptothorax kashmirensis*
76. *Glyptothorax pectinopterus*
77. *Glyptothorax telchitta*
78. *Glyptothorax trilineatus*
Genus - Euchiloglanis
79. *Euchiloglanis hodgartii*
Genus - *Myersglanis*
80. *Myersglanis blythi*
Genus - *Pseudecheneis*
81. *Pseudecheneis sulcatus*

12.4. Enclosure & cage culture in natural water bodies

Enclosure and cage culture:-

Pen culture:-

A Pen is defined as "a fixed enclosure in which the bottom is the bed of the water body" Pen is to be distinguished from the Cage which in turn is defined as "an enclosure with bottom and sides of netting or bamboo etc., whether floating at the surface or totally submerged." The word 'pen' here is also used synonymous with 'enclosure' as it is used in enclosure culture.

Advantages and Disadvantages of Pen Culture:

The advantages and disadvantages of pen culture are in some cases common as those for cage culture. Obviously the pens are much larger and are stationery as their walls are fixed. It also appears that in large pens the culture will be less intensive, even though small pens can vie with the cages in this respect. The taxability (or mobility) of the cage is its most definite advantage over the pen, but the later has the benefit that there can be interchange between the organisms within, with the natural bottom - at times of an inclement condition in the bottom the pen is decidedly difficult. Let us now enumerate the advantages and disadvantages of pen culture.

Advantages:

i. **Intensive utilization of space:**

As we have mentioned the requirement of a pen can be small (a few square metres) or large (over 100ha in the case of the largest milkfish pen), but in all cases the space given is intensively utilized. Even in the large milk fish pens utilize space intensively and their production is 4 – 10 times higher than the natural production. We have already referred to the high production (per unit area) above, that productions even in the large pens are much higher, not only because of the intense culture practices adopted, but also due to other factors such as protection from predators.

i. Safety from predators:

Within the enclosure the predators can be excluded. Before stocking the predators will have to be removed; in the larger pens this would be more difficult, but in smaller pens this can be done as efficiently as in the cages (see also discussion following).

ii. Suitability for culturing many varied species:

Under artificial culture provided suitable environmental conditions are maintained, with artificial feeds, many varieties of species can be cultured as in the cage.

iii. Ease of harvest:

Even though in the large pens the harvest may not be as easy as in the cages, it would be definitely more controllable and easier than in the natural waters.

iv. The flexibility of size and economy:

When compared with the cage, pens can be made much larger and construction costs will be cheaper than that of the cages.

v. Availability of natural food and exchange of materials with the bottom:

Since, as pointed out earlier, the bottom of the pen is the natural bottom, unlike the cage which kept either on the bottom or floating, has always a netting/ screen separating the cage from bottom; the pen culture organisms are at an advantage that while enclosed they can procure food/exchange materials.

Pen culture as cage culture is economical multiple use of same water body

Disadvantages:

i) High demand of oxygen and water flow:

Since the fish cultured are stocked in high density they deplete oxygen very fast and a good flow of water through the pen either by natural means or artificially by pumping is demanded for healthy and fast growing fishes.

ii. Dependence on artificial feed:

Since high density (biomass) is to be sustained in a restricted area, for high production artificial feeding is necessary, increasing the cost of production.

iii. Food losses:

Part of the feed is likely to be lost uneaten, and drifted away in the current, but the loss here would be less than in floating cages.

Pollution:

Since a large biomass of fish are cultured intensively a large quantity of excrements accumulate in the area and cause a high POD - also substances such as ammonia and other excreted materials, if not immediately removed/ recycled. They pollute the water and cause damages.

Rapid spread of diseases:

For the same reason of high stocking density in an enclosed area, any disease beginning will spread very quickly and can cause immense mortality of stock and production decline.

Risk of theft:

Since the fish are kept in an enclosed area, 'poaching' and thefts can take place more frequently than in natural waters, but perhaps less than those from cages.

Conflict with multiple use of natural waters:

In locations where a pen is constructed to the requirement of higher water level for eg. In a lake/reservoir, would be against the interest, for eg. For irrigation water supply; enclosures can interfere with navigational routes and also with recreational activities, such as swimming, boating etc.

Types of pen:-

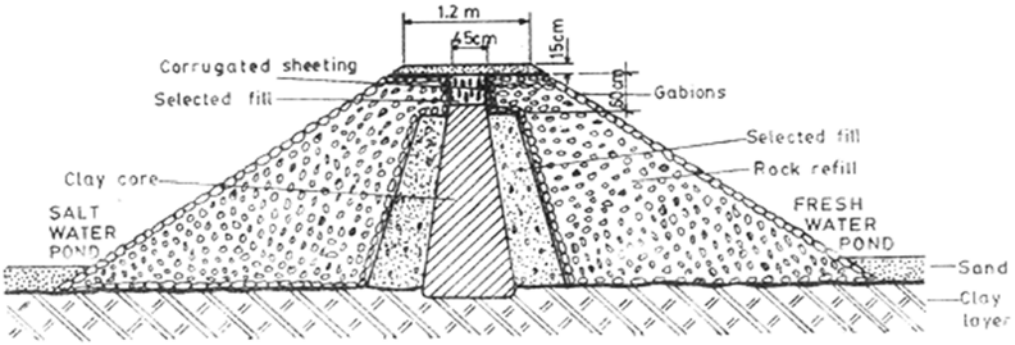
1. Rigid pens
   a. Embanked pens
   b. Net enclosures
2. Flexible pens (netting)
3. Outer barrier nets.

1. Rigid pens:-

a. Embanked Pens

Intertidal enclosures such as those at Adoike in the Inland Sea in Japan and Ardtoe in Britain are examples of rigid enclosures which have stone-pitched or concrete

walls as embankments since such embankments are costly; such intertidal enclosures are not being built lately.

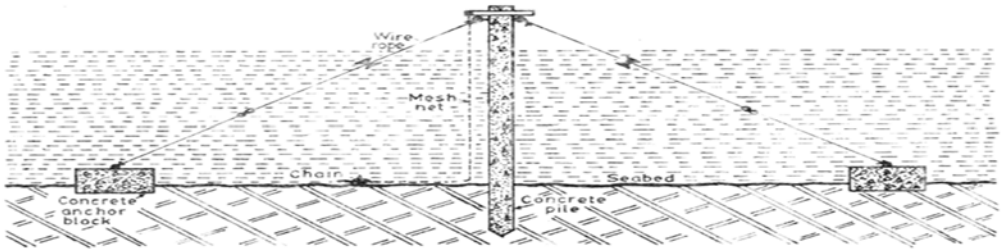


Source: www.google.com.np/search?q=embanked+pen

Fig.56: Embanked pens

b. Net Enclosures

We have already referred to the several rigid net enclosures (including barrier nets) in our review of pen culture in various parts of the world. While the gross descriptions have been given earlier we shall now refer to certain specific aspects of design and construction here. The extended length of the barrier as provided by the shape of the barrier ensures better circulation. A vinyl covered wire not (15mm square mesh) is stretched between steel piles and smaller concrete blocks on two sides of the barrier restrain the net barrier. The barrier also incorporated floating boom for passage of boats.

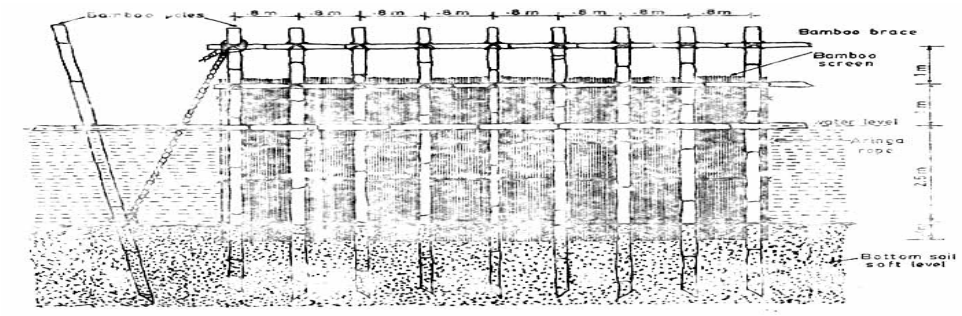


Source: *www.google.com.np/search?q=net+enclosure*

Fig.57: Net Enclosures

2. Flexible Enclosures

Most of the buoyed fish net enclosures known are bag nets with a bottom net - as per our definition this enclosure is a 'cage' (and not a pen/enclosure) even if the bottom net may rest on the floor. In fabricating the flexible enclosure care was taken to make use of locally available simple materials (cf. Bamboo mat replacement), even though Japanese 9.5mm (3/8") nylon net, which has antifouling properties and long life as opposed to the one-year life Philippine nylon net, was used. Concrete block sinkers weighing 500kg were spaced 30m apart and were placed from a boat and a chain link raiser chain was provided from the sinker for attachment to the net to allow settlement in the soft sediment. The average depth of Laguna de Bay varied from 3 to 5m and therefore a 7.5m height of net was chosen to allow billowing due to water current and wave motion. In the case of the bamboo pen the fencing stretched above water surface to prevent fish from jumping, but in the present net, a 2.5m horizontal flap was provided on top with float, which effectively prevented fish jumps and also helped as a fish seal when water level rose unprecedented, for the top floats help adjust the stretching of the net into a vertical wall.



Source: *www.google.com.np/search?q=flexible+enclosure*

Fig.58: Flexible Enclosures

Cage culture:-

Cage fish culture is a new area of fish culture in Nepal. Fishermen did not know about it although they have been using some cage-like bamboo traps for fishing. Cages for keeping common carp breeders in the Pokhara Valley lakes of Nepal was started in 1972 as the Government fish ponds near the lake suffered occasionally from water shortage. Later, a few cages introduced by the J.O.V.C. Services were

used for rearing fish but remain as demonstration cum-study unit. In 1975, an Integrated Fisheries and Fish Culture Development Project in the Western Development Region of Nepal were started by the Government and UNDP/FAO. Under the project, many types of cages both locally made and imported ones have been tried in an attempt to increase the fish production from the three major lakes of Pohara Valley. The lakes lie in mid-hilly region and have been reportedly overfished. The primary aim was to engage some 300 landless local fishermen families in fish cultivate.

Like most other types of aquaculture, cage culture began in Southeast Asia, although it is thought to be of comparatively recent origin. It seems to have developed independently in at least two countries. the oldest records of cage culture come from Kampuchea where fishermen in and around the Great Lake region would keep *Clarias spp*. catfishes and other commercial fishes in bamboo or rattan cages and baskets until ready to transport to market. In captivity, the fishes were fed kitchen scraps and were found to grow readily. This traditional method of culture has been practiced since the end of the last century, and is now widespread throughout the lower Mekong area of the country. From here it has spread in recent year to Viet Nam, Thailand and other Indo-Chinese countries.

The total natural production of fish from the lakes and rivers in the Pokhara Valley has been estimated to be around 23–25 tons per year. The catch consists of indigenous species of which mahaseer (*Tor tor*), catle (*Barbus hexagonolepis),* asla (*Schizothorax spp.)* and baam (*Mastacembelus spp.)* are most sought after by the consumer. The bulk of the catch, however, consists of smaller species of fish which are consumed when the better quality fish are unobtainable. In recent years some stocking has been carried out in the lakes of the Pokhara Valley with common carp and Chinese carps, as well as the Indian major carp rohu (*Labeo rohita*). These have recently begun appearing in small numbers in the fish catches and have been readily accepted by the consumer.

On the basis of statistical studies the catches from the three major lakes for the period March 1977 - February 1978 have been estimated to be 7.5 t for Phewa, 5.5 t for

Begnas and 3 t for Rupa. Ferro (1979b) estimates that the natural production could be raised to about 20 t in Phewa, and about 15 t each for Begnas and Rupa, through appropriate stocking and adoption of conservation measures. Ferro (1979b) also mentioned that cage fish culture could be more effective in harvesting the lakes than natural fishing. Plankton is available in the lakes and could be utilized by plankton feeding fish while others, such as the grass carp and common carp, would depend on feed introduced into the cages.

Construction and Design of Cages

Bamboo cages

Cages from locally available material like chicken wire mesh and split wood were tried. These were set in shallow water about 2-2.5 m deep. These did not work well because of fluctuating Lake water level even as the chicken wire mesh started rusting after 6 months only. At present, split bamboo cages with enamel painting are under study. They are of 10 m3 size (2 x 2 x 2.5 m3) and 8 m3 (2 x 2 x 2 m3) size. Durability tests of such cages with coal tar painting are being planned. The bamboo could last for about 2 years as a float as well as for framing material using knotless polyethylene net.

source: *www.google.com.np/search?q=bamboo+cage*

Fig.59: Bamboo cage

Iron angle and netlon plastic cage

Iron angles of 13 mm or 19 mm were welded together to form a frame of 4 x 4 x 2.5 m3 and netlon plastic mesh of 10 mm or 5 mm was fixed with the nylon twines in the angle-iron frame. Four 200- liter empty oil drums were mounted in welded frames to float the cage at a depth of 2 meters making the productive volume of the cage 32 m3 or 4 x 4 x 2 m3 . The cage was divided into two compartments by a

partition of netlon mesh so that fish of different sizes could be kept separately. The cages were provided with a top cover of chicken wire mesh or old nets. Walkways of woods and bamboo were made by fixing them on the drums. The durability of such cages has been estimated to be about 10 years with minor repair and maintenance**.**

Source: *www.google.com.np/search?q=iron+angel+cage*
Fig. 60: Iron angle and netlon plastic cage

The advantages of cage culture of fish are as follows:

Since there is constant circulation of water through the meshes of the cages, there is relatively less accumulation of metabolic wastes, and constant renewal of oxygenated water within the cage. This enables higher stocking rates and consequently, higher production per unit volume than in ponds. The raising of fish in cages also reduces the risk of predation by carnivorous fish and other animals. The main constraint would be feed, which has to be introduced in the case of species depending on non-plank tonic food. In contrast to natural fishing, where fishermen have to depend on chance, raising fish in cages enables a predictable and more assured source of income. Better management and control of stocks is also possible.

12.5 Design & construction of raceway

Raceway culture:-

A raceway, also known as a flow-through system, is an artificial channel used in

aquaculture to culture aquatic organisms. Raceway systems are among the earliest methods used for inland aquaculture. A raceway usually consists of rectangular basins or canals constructed of concrete and equipped with an inlet and outlet. A continuous water flow-through is maintained to provide the required level of water quality, which allows animals to be cultured at higher densities within the raceway

Freshwater species such as trout, catfish, tilapia are commonly cultured in raceways. Stocking densities for raceways are usually higher than for other culture systems. Densities of 10 to 15 fish per cubic foot are not unusual for raceway systems. These high densities have distinct disadvantages including: more rapid disease spread less reaction time when problems occur, and large volumes of effluent with dilute fish wastes.

Advantages of raceways can include:

- Higher stocking densities.
- Improved water quality
- Reduced manpower
- Ease of feeding
- Ease of grading
- Ease of harvest
- Precise disease treatments
- Collection of fish wastes
- Less off-flavor

Raceway construction:-

In-Pond Raceways consist of rectangular boxes that can be constructed in various sizes and from several types of materials depending on the intended use. The smallest IPRs have been used for production of fish fry and were only about 84 cubic feet in volume (6x4x3.5 feet). The largest to date have been used for commercial production of catfish and were approximately 670 cubic feet in total volume (24x8x3.5 feet). IPRs have been constructed from marine and treated plywood, plastic sheets, and plastic liners. Each of these materials has advantages and disadvantages. Plywood becomes saturated with water and extremely heavy unless coated with non-toxic

water-resistant marine paint. Plastic sheets (usually 1/4 inchthick) expand and contract with heat, making their shape irregular. Plastic liners (80 mil) cannot be walked in (during harvest or grading) and may collapse due to wave action. A frame around the outside of the IPR is used for attachment of the plywood or plastic. Both treated lumber and metal frames have been constructed. All IPR materials, including screws and nails, need to be water-resistant and non-toxic. Although treated lumber contains some toxic compounds, these have not been a problem in the IPRs because of the high water exchange rates. However, it may be advisable to coat the wood with non-toxic marine paint. The IPR is designed to float in any body of water; therefore, a recommended component is a dock or pier for ease of management (e.g., feeding, water testing, etc.). It is possible to anchor the IPR to a stationary pier or to the pond bottom if water levels do not fluctuate. However, if anchored to the pond bottom without a dock, then daily activities must be conducted from a boat. The IPR pier should be constructed of walkways (3 to 4 feet wide) to allow access to all sides of the IPR and provide space for attaching equipment.

Size

A raceway is most often a rectangular canal with a water current flowing from a supply end to an exit end. The length to width ratio is important in raceways. To prevent the fish stock from swimming in circular movements, which would cause debris to build up in the centre, a length to width ratio of at least six to one is recommended. If the width is too large this could result in a feeble current speed which is not desirable .The length of a raceway unit is usually constrained by the water quality or by how much stock a unit can hold for ease of management. The average depth of a raceway for fin fish, such as rainbow trout, is about one metre. This means each section in a raceway should be about 30 m long and 2.5–3 m wide. The landscape should slope to one or two percent, so the flow through the system can be maintained by gravity. The raceway should not be curved, so the flow will be uniform

12.6 Trout culture & production technology

Rainbow trout (Oncorhynchus mykiss) is a cold-water carnivorous sport fish of North America, which was taken to California, Alaska, Asia and Europe during

different periods of 19th century. Among which, Japan is one of the largest producers of rainbow trout, where this species was introduced in 22 1877. Rainbow trout requires high protein feed and well oxygenated water for its cultivation. In natural habitat it feeds on aquatic insects, small crustaceans and small fish. Nevertheless, it can be cultured using artificial feed containing high animal protein. Trout can survive within a temperature range of 0-25°C. However, it grows best at the water temperature range of 10-20°C. Normally, the trout attains commercial size of 200-300gm within 14 to 20 months. Its growth depends on the quality and quantity of feed, suitable temperature and dissolved oxygen concentration in the water. Considering the suitable climatic condition and abundance of cold water, juvenile brown trout (Salmo trutta) were introduced from India for the first time during late 1969; and Rainbow trout (Oncorhynchus mykiss) from the United Kingdom in 1971. They were distributed in two places. Few hundred juveniles were kept in Godawari in a cement tank and the rest of them were transported to a newly established Trishuli Trout Hatchery (which was established in Nuwakot district on the bank of the river Trishuli). Its objective was propagation, rearing and releasing of trout into suitable hill streams to establish sport fishery for tourism development. However, mass mortality was occurred in Trishuli within the few months of their arrival. Since the Trout Hatchery was established in the king's interest, the mass mortality of trout created a big issue for the Ministry of Agriculture along with Department of Agriculture ., after a thorough investigation of all possible reasons of mortality came to a conclusion that the trout was introduced without proper preparation of physical facilities such as:

- Ponds were leaking with earthen bottom,
- Proper pellet high protein feed was not available,
- Only buffalo meat/liver was fed, and
- The water was highly silted.

The trout commission recommended that the existing facilities (ponds, water resources, human resources, and feed) were not suitable for trout culture; and the trout farming program was dropped until rehabilitation of Trishuli Fisheries Station. Activities in Trishuli station were resumed as usual from 1974. Exotic carps were

breed and distributed for pond culture and paddy cum fish culture for few years

Presents situation

Nepal has quite appropriate for fisheries of rainbow trout fish as we have plenty of cold water and slopes. Although farmers have been attracted to it in recent times, it has not been moved ahead for lack of government investment and awareness among farmers. The Ministry of Agriculture Development had recently undertaken feasibility study of rainbow trout fish keeping in 54 districts of the country and had thought of forwarding it as a 'one village one product' scheme.Nepal Agriculture Research Council (NARC) had forwarded a programme to run 'mission rainbow trout' campaign but it has not reached to the farmers as expected.

Recently, it has been started in Sindhupalchok, Kavrepalanchok, Dolakha, Solukhumbu, Kathmandu, Lalitpur, Baglung, Rasuwa, Dhading, Makwanpur, Gorkha, Kaski, Manang, and Mustang districts commercially.

Teacher tips:

- Ask a student to prepare a list of different natural water bodies found in Nepal which can be used for fish culture.
- Slide show and visual presentation on trout culture.
- Diagrammatic representation in chart paper about design and construction of raceway

UNIT - THIRTEEN
Ornamental Fish & aquarium management

Learning outcome:

Completion of this lesson student,

- Can identify ornamental fish species.
- Can properly handle and manage aquarium.

Aquarium:

Displaying of ornamental fishes & other aquatic organism having attractive physical appearance rearing on transparent on glass with provision of fish water, dissolve oxygen & nutritious food. It is established for recreation & attraction.

However the rariti of these small fish & manageability makes them more preferable for being kept as pets. Colour shaped & variety of the small fish is predominate criteria for the home aquarium. Experience aquarium keepers preference to join for reared species & varieties of ornamental fishes

Ornamental fish:

Ornamental fishes usually mean attractive colour full fishes of various characterize which are kept as pet in confined space of & aquarium or a garden pool for fun & friendship. Some of the commercial important species are golden fish, Silver dollars, guppy, blood parrots, angel fish, rain blow fish etc.

All water living animals of pices which are kept as pets & decorative pices can be called ornamental fish. The term aquarium pets are used to denote the small pets kept at home now days. It is receptacle by the term ornamental fish.

For proper function of aquarium following management practice should be adopted:-

- Do not feed too much a too little feed fish look always hungry but excess food will cause water quality problem.
- Always use clean & fresh water.
- Regular check up of water PH hardness & temperature & water.
- Always buy & stock healthy fish which shows no sign & symptoms of stress

& disease.

- These fish from tropical regions require maintain of water temperature in the cooler climate.
- It is necessary to check regularly & maintain the P^H of water as they requirement.
- Most of the fish do not tolerate loud noise very well so keep the tank position away from loud noise sources.
- Also some fishes are shy & should be kept away from extremely busy location.
- When cleaning aquarium glass & equipments, always use clean sterilize & warm water & sterilize & equipments like pad, sponges etc.Never use detergents, shop or spray cleaner.
- These small aquarium pets have to be kept in displayable containers with at least one of the side with transparency.
- It is necessary to maintain marine condition if the pets are of the marine origin.
- Maintain the dissolve oxygen in the aquarium by the use of aerators.
- Avoid overcrowding in tank.
- Putting on aquarium in a brightly light area can also cause excessive growth of algae.
- Light should be left on for 10 to 14 hours a day & the fish should have a period of darkness to rest.
- Be sure the tank is located in an area that avoids extreme temperature of fluctuation of temperature. In extreme condition fish get die from heat & in low temperature fish also get die from chill.

Water Quality and Management

- Appropriate Tank capacity/Tank size
- Maintaining a Balanced Nitrogen Cycle
- Aquarium Cycling
- Changing the Water
- Vacuuming
- Algae Removal
- Avoid Overfeeding

- Water Conditions test
- Water Temperature maintenance
- Water Hardness balance
- Water pH maintenance
- Salinity checking
- Gas Exchange in the Aquarium
- Preventative Care
- Moving Aquarium Safely

Ornamental fish species:-

a) Bichirs and red fish

b) Cat fish:-

- sea cat fish
- Bagrid cat fish
- Banjo cat fish
- Pencil cat fish
- Talking cat fish
- Shark cat fish
- Gobies
- Barbs
- Danios

Teacher tips:

- Slide show on different types of aquarium with different fish species.
- Show visual presentation on aquarium.

UNIT - FOURTEEN
Problems Associated with fish culture in Nepal & their solution

Learning outcome:

After completion of this lesson student,

- Will able aware about the existing problems of fish culture in Nepal.
- Will be familiar with problems and opportunities regarding fish culture in Nepal.

14.1. Problems & opportunities in fish production

Nepal is rich in water resources. About 600 rivers, 100 of lakes and thousands of ponds are present which provides opportunities to culture many indigenous and exotic fishes successfully here.

Opportunities:

- It is profitable business which provides 3 times more profit per unit area than other agriculture enterprises
- Only 1.5% of water bodies are utilized for fish culture business so there is a great opportunities to culture many fish species by utilizing unusage water body.
- Culturing fish in old village ponds improve the livelihood of rural peoples.
- Fish provides good economic returns means for poverty alleviation.
- Large numbers of exotic and indigenous fishes are being culture in Nepal which field is expanding day by day.
- Climatic diversity of Nepal favors culture of exotic fishes.
- Nepalese market demand is higher due to festival occasion, party etc.
- Technical manpower is increasing in aquaculture that is about to directly help on urban and rural fisheries.

14.2. Problems & solutions in fish production of Nepal

Problems and challenges in fish culture of Nepal:

- Skilled manpower are not yet employed on fisheries extension in rural areas of Nepal.
- Farm size are small, land is fragmented & no proper land management.
- Out of total land 2.7% is covered by water but only 1.5% water resource is used for aqua culture.
- Basic modern technology input like seeds,fertilizer,breeds 7 feeds are in short supply.
- Reliable irrigation facility is not available.
- Human resource for aquaculture have no technical knowledge of aquaculture, still are involved in this field.
- Rearing of fish like trout, carps needs special structure that is not affordable to marginal farmers of Nepal.
- Farmer's incur higher cost of production than in India. As as result, products are not competitive in national & international markets. There is no easy access to the market.
- Proper transportation, power facilities are not reachable to lot of parts of country which causes blockage of marketable products to market on many areas.
- Interest on agricultural credit is high & credits not available on time.
- Huge amount of production from fishes die due to diseases, pesticides problems by lack of knowledge.
- Not utilizes the village pond in Nepal.
- Lack of government policy and action.
- Poor extension in fish farming.
- Lack of quality feed, healthy fish seeds, medicines, fish culture equipments in time.
- Poor water supply system and management.

Teacher tips:

- Point out the problems related to fish culture and discuss about way of their solution.
- Collect reference about current situation, governmental plan, policies and different activities regarding fish culture development in Nepal.

PRACTICAL NO. 1
Identification of External Organs of Fish

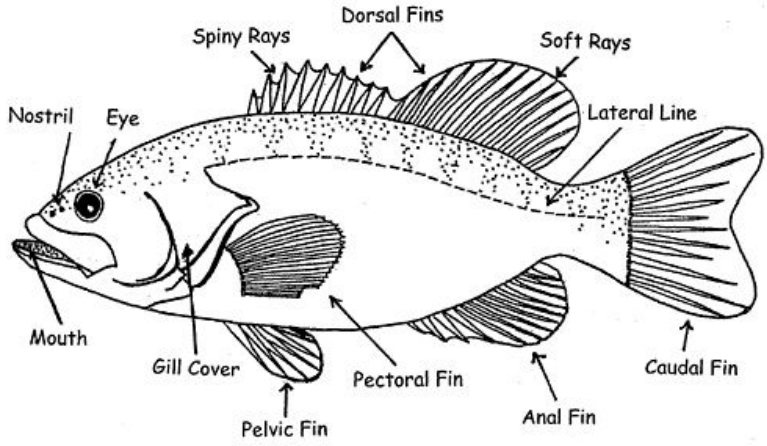
Objectives:-

- To be able to identify the external organs of fishes
- To know structural differences of external organs of fishes

Introduction:

Fishes are the first successful class of the chordates. They are aquatic cold blooded, gill breathing vertebrates which propel and balance themselves by means of fins. In the different types of water systems of the world there exists a large number of fish species differing widely in shape, size, habits and habitats.

Inspite of many variations, body of fishes is generally fusiform and streamlined. However, in puffers the body is globe shape and in eels is of serpentine for. The ground plan of body is bilateral symmetrical with prominent lateral line system. Appendages of fishes comprise the fins and the cirrhi (flaps of flesh). Paired fins are pectorals and the pelvic (ventrals) while dorsal, anal and caudal fins are unpaired fin. In some forms there are two dorsal fins- an anterior rayed dorsal; and a posterior soft adipose dorsal fin (e.g. *Mystus sp.)* In case of order- perciformes (e.g. *Nandus sp*.) there are two dorsal fins, the first being spiny and second being soft, supported by fin rays. Cultivated carps of Nepal include both indigenous and exotic fishes. These are Rohu *(Labeo rohita), Bhakur (Catla catla), Mrigal (Cirrhina mrigala), common carp (Cyprinus carpio), Silver carp (Hypophthalmichthys militrix), bighead carp (Aristichthys nobilis) and Grasscarp (Ctenopharyngodon idella).*



Sourcs: www.google.com.np/search?q=external+morphology+of+fis

Fig.1: External Morphology of fish

The external morphology of fish can be divided in two parts i.e. Head and body regions.

1. Head regions

Snout:-

Snout is the anterior most parts of the fish. It is rounded or obtuse in most cases. There is much variation to the shape of snout.

- Pointed and sharp(Eels)
- With a groove across the top
- Tubular with jaws at tip
- Smooth in most cases
- Overhanging the mouth

a) Lips:- The bone of the upper and lower jaw is covered by lips. Mostly they are thin smooth membranes but in some cases they may have pores, stripes or modified to form a sucker like disc in *Garra* species. Depending upon the shape of mouth the lips may be terminal (in front) or inferior (beneath the head).

b) Mouth:- Mouth is the main organ which fish use while feeding. The position and shape of the mouth depends the type of food a fish eats and the level at which it swims.

c) **Teeth :-** Most fish have teeth on jaws and plate.in addition to these teeth some fish have pharyngeal teeth also.

d) **Barbells: -** Barbells are slender, whisker like tactile organs near the mouth. They are found in fish like catfish, carps etc, they house the taste buds are used by fish to find food.

e) **Nostrils: -** Nostrils are pair of apertures or slits on the snout of the fish. They are openings for the smell organs leading to the nasal canal on the skull.

f) **Eye :-** Eyes are mainly used by fish for seeing, food, enemies and predators.

g) **Operculum and gills:-** Operculum along with gills forms breathing apparatus for the fish.

On each side of fish there are slits called gills. The gills are composed of comb-like filaments, the gill lamellae, which help increase their surface area for oxygen exchange. In bony fish, the gills lie in a branchial chamber covered by a bony operculum.

Body regions:

a. **Fins:-** Fins are thin appendages on the body of fish.They are made of bony spines protruding from the body of fish with skin covering them and joining them together in case of bony fish

i. **Dorsal Fin:** Dorsal Fin is a single fin present on the top of the body (viewed from top) also known as dorsal side. The dorsal fin serves to protect the fish against rolling, and assists in sudden turns and stops. When the top of rays is connected with membrane they are called soft, else they are called hard spines.

ii. **Caudal Fin:-** Caudal or tail fin is located at the end caudal peduncle of the fish. The caudal peduncle is the narrow part of the fish's body to which the caudal or tail fin is attached.

iii. **Anal Fi :-** he anal fin is located on the ventral (lower) surface behind the anus. This fin is used to stabilized the fish while swimming. Anal fin is usually a single fin, but can be paired also.

iv. **Pectoral Fins:-** The pectoral fins occur in pair and are located on each side, usually just behind the operculum (gill cover),

v. **Pelvic Fins:-** Pelvic fins occur in pairs and are found on the ventral (lower) side

of the fish below the pectoral fins and are homologous to the forelimbs of tetra pods.

vi. **Lateral Line:-** The lateral line is a sense organ used to detect movement and vibration in the surrounding water. For example, fish can use their lateral line system to follow the vortices produced by fleeing prey.

vii. **Skin:-** The skin of fish consists of live cells; there is very superficial amount of keratin in outermost layer. It is generally permeable.

iv. **Scales:-** The outer body of many fish is covered with scales. The scales originate from the mesoderm (skin), and may be similar in structure to teeth.

Materials Required:

1)Freshly killed or formalin preserved fish

2)Tray

3)Forceps

4)Needle

5)Gloves

Procedure

- Take a freshly killed or formalin preserved fish and identify its major body parts. Count the fin rays and lateral line scales.

Conclusion: …….. :
……. :
……. ?

PRACTICAL NO. 2

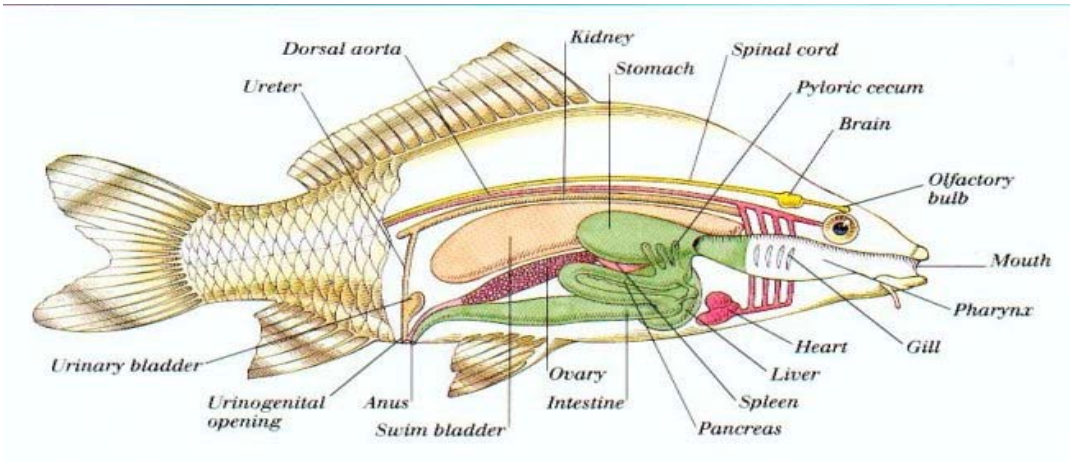
Identification of Internal Anatomy of Fish

Objectives:

- To be able to dissect the fish to study their internal organs
- To be able to identify the internal anatomy of fish
- To know the location of the internal organs

Introduction:

Anatomy generally refers to the internal organs of the body. By anatomy it is meant the study of the internal organs of a living body. Study of such organs is essential because careful examination of internal organs either by visual inspection or with the aid of suitable optical equipments provides general ideas about the location of these organs and causes of mortality of the fish as these organs are also responsible for carrying various internal parasites. The internal organs of the fish have following parts:



Source: www.google.com.np/search?q=internal+anatomy+of+fish

Fig.2: Internal Anatomy of Fish

a) **Spine:**
The primary structural framework upon which the fish's body is built; connects to the skull at the front of the fish and to the tail at the rear. The spine is made up of numerous ***vertebrae*****,** which are hollow and house and protect the delicate spinal cord.

b) **Spinal Cord:**
Connects the brain to the rest of the body and relays sensory information from the body to the brain, as well as instructions from the brain to the rest of the body.

c) **Brain:**
The control center of the fish, where both automatic functions (such as respiration) and higher behaviors ("Should I eat that critter with the spinning blades?") occur. All sensory information is processed here.

d) **Lateral Line:**
One of the fish's primary sense organs; detects underwater vibrations and is capable of determining the direction of their source.

e) **Swim (or Air) Bladder:**
A hollow, gas-filled balance organ that allows a fish to conserve energy by maintaining neutral buoyancy (suspending) in water. Fish caught from very deep water sometimes need to have air released from their swim bladder before they can be released and return to deep water, due to the difference in atmospheric pressure at the water's surface. (Most freshwater anglers in Florida need not concern themselves with this!) Species of fish that do not possess a swim bladder sink to the bottom if they stop swimming.

f) **Gills:**
Allow a fish to breathe underwater. These are very delicate structures and should not be touched if the fish is to be released!

g) **Kidney:**
Filters liquid waste materials from the blood; these wastes are then passed out of the body. The kidney is also extremely important in regulating water and salt concentrations within the fish's body, allowing certain fish species to exist in freshwater or saltwater, and in some cases (such as snook or tarpon) both.

h) **Stomach and Intestines:**
Break down (digest) food and absorb nutrients. Fish such as bass that are ***piscivorous*** (eat other fish) have fairly short intestines because such food is easy to chemically break down and digest. Fish such as tilapia that are ***herbivorous*** (eat plants) require longer intestines because plant matter is usually tough and fibrous and more difficult to break down into usable components. A great deal about fish feeding habits can be determined by examining stomach contents.

i) Pyloric Caeca:
This organ with fingerlike projections is located near the junction of the stomach and the intestines. Its function is not entirely understood, but it is known to secrete enzymes that aid in digestion, may function to absorb digested food, or do both.

j) Vent:
The site of waste elimination from the fish's body. It is also the entry to the genital tract where eggs or sperm are released.

k) Liver:
This important organ has a number of functions. It assists in digestion by secreting enzymes that break down fats, and also serves as a storage area for fats and carbohydrates. The liver also is important in the destruction of old blood cells and in maintaining proper blood chemistry, as well as playing a role in nitrogen (waste) excretion.

l) Heart:
Circulates blood throughout the body. Oxygen and digested nutrients are delivered to the cells of various organs through the blood, and the blood transports waste products from the cells to the kidneys and liver for elimination.

m) Gonads (Reproductive Organs):
In adult female bass, the bright orange mass of eggs is unmistakable during the spawning season, but is still usually identifiable at other times of the year. The male organs, which produce milt for fertilizing the eggs, are much smaller and white but found in the same general location. The eggs (or ***roe***) of certain fish are considered a delicacy, as in the case of caviar from sturgeon.

N) Muscles:
Provide movement and locomotion. This is the part of the fish that is usually eaten, and composes the fillet of the fish.

Materials Required:

1)Live fish

2)Microscope

3)Glass slides and cover slips

4)Two dissecting needles

5)Heavy and light scissors

6)A scapel with blade replacement

7)Euthanizing material

Procedure:

- Take a live fish which has been killed just prior to proceeding with a n internal examination. Euthanasia can be performed by thrusting the blade of a scapel or knife through the top of the skull to the points where the skull attaches to the first vertebrate.
- Anesthetics can be used but must be in a greater concentration than is usually acceptable for anesthesia. Tricane methanesulfonate (MS-222) at 100-200 mg/l has been found to be satisfactory.
- After eithanizing the fish, lay down on the dissecting tray with the ventral surface upwards. Fix the fish by proper pinning.
- Now make a longitudinal incision in the body wall from the vent to pectoral girdle. Cut transversely at each end of the longitudinal incision. Pin down the cut flaps.
- Examine the internal organs of the fish.

Conclusion: ……..?

PRACTICAL NO.3

Differentiate Between Male and Female Fish

Objectives:-

- -To be able to identify male and female fish.
- -To be able to selected suitable managements practices of fish.

Introduction:

Identification is the process of differentiating the male and female fish. It is important for controlling the sex ratio, brood fish management, proper rearing and spawning induction as well as for fertilization. Differentiation in the male and female fish is somewhat difficult. The more common characteristic of both male and female fish is similar but there are some specific characters which differentiate the male and female fish. Normally the pectoral fins are the main indicators for the sex identification. Therefore, it is important to be aware of the differences between male and female fishes. The common characters of male and female fish are as follows;

Male fish

Male fish shows one of the common phenomena about being males i.e; attractiveness. Male fish are more colorful, which is usually a main cause for their attractiveness. Ornamentation has a strong relationship with the condition of the male, and female attracts to the best looking one naturally. In many instances, the males are smaller with long fins. Guppy males would be a prime example for long fins. The mouth parts give an important distinction in males having thicker lips with a more pronounced appearance. The more common characteristic of male female are as follows:

- Colourful and attractive appearance
- No distinct belly
- Usually small and slender bodies
- Long fins in general and pointed pectoral fins in particular
- Pronounced and thicker lips
- Tubercles *on the operculum*

Female fish

The presence of female reproductive system is an important aspect to differentiate from the male fish. Female fishes are being less attractive. They always have the upper hand in selecting the mating partner, despite their dull and less colorful appearance. Females are large in size as compare to male fish. The belly is very distinctive and it sometimes sticks out as in an obese person, especially during spawning season. More other common characteristic of female fish are as follows:

- Less colorful and dull looking appearance compared to a male
- The belly is distinctive
- Usually larger body
- Short fins in general and blunts pectoral fins in particular
- The lips are not as thick as in males and mouth is not prominent
- No tubercles on the operculum

Table: 1 Identification of male and female breeder fish

SN.	Character	Male	Female
1.	Pectoral fin	The mature male has roughness in the inner surface of pectoral fin.	The mature female have smooth inner surface of pectoral fin
2.	Scales	Rough with sandy texture.	Smooth and silky.
3.	Operculum	Rough and sandy out growth.	Smooth.
4.	Abdomen	Rough and firm and not too soft to the touch.	Bulging out on both sides or puffy and palpable.
5.	Vent	Concave generally white in color.	Convex projecting like a small papilla reddish or pinkish in color.
6.	Pressure on abdomen	On slight pressure above the vent on the abdomen, milky white fluid runs out through the vent which is called sperm or mitt.	On slight pressure on the same region yellowish discharged or a few ova or eggs may come out through the vent.

Materials Required:

1)Scoop net (both ends open)

2)Hammock

Procedure:

- Catch brood fish of different sexes carefully with the help of scoop net (both ends open) without any injury.
- Keep them in hammock and test must be performed exactly in the sequence described above in the text to segregate them.

Conclusion: ……?

PRACTICAL NO.4

Layout and Design of Fish Pond

Objectives:-

- To be able to know about the layout of fish pond.
- To know the technique and design of fish pond.
- To be able to know the knowledge about construction of fish pond.
- To acquire knowledge about different pond structures.

Introduction:

Layout and design are two important aspects for the successful fish farming. With the modern fish farming system layout and design play a vital role in management and production of fish. Good layout with appropriate design helps in management of fish pond for a longer period of time which will becomes economical to the fish growers. Before layout and design of fish pond following points should be followed:

Site selection: -

A typical fishpond is a drainable water body with provision of water inlet and outlet system. The success and profit ability of fish pond depends on site selection. The following factors are taken consideration in the selection of fish pond site.

a) **Water: -** Availability of sufficient water to fill the pond and maintain the required level throughout the production phase is one of the essential requirements for site the selection. The water should be free from pollutants. It should be near to fishpond. It should be adequate and permanent. The desirable PH should be 6.5-8.5.

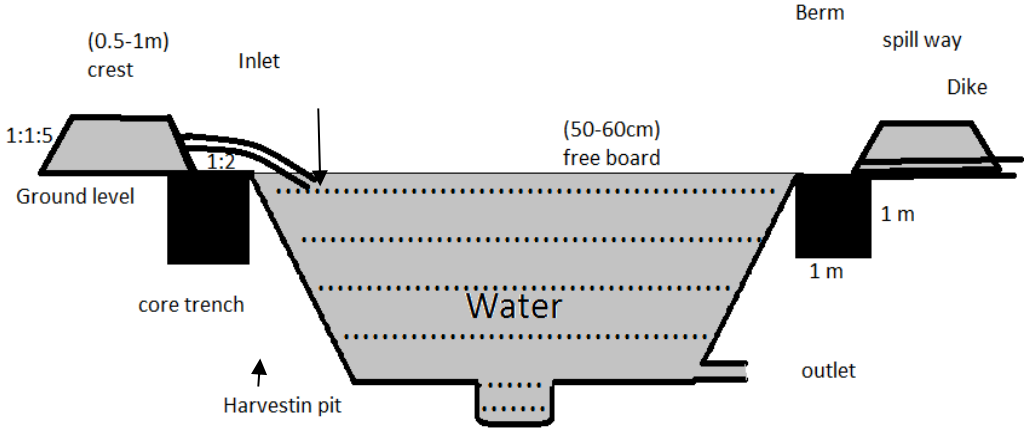
b) **Soil: -** Clayey soil is the best soil for fish pond construction because it has higher water holding capacity. Clay loam and silty loam are also consider as the fertile soil but we can also successfully culture the fish in sandy clay, silty clay, loam soil and clay loam sol but main consideration is the percentage of clay content should be higher than other components. Sandy soil is not suitable for fish pond.

c) Topography: - the general features of pond area may be flat, hilly, upland, lowland etc. the facility of inlet and outlet system depends on the orientation of the land. Topography of a selected area suggests as about the size of pond, type of soil, labor requirement, and facilities installment. We can construct fish pond in every topography except steep slope.

d) Road facilities: - the site should have transportation facility all the year round. It is essential for carrying the fish farming inputs into farm and send back the outputs from the farm.

e) Market: - the fish pond should be established near the market as far as possible to purchase required inputs in the farm and to sell the products from the farm market should be easily available.

f) Labor: - It is also one of the essential components of fish farming since; it is one of the governing factor in overall profit making of this business. So, cheap efficient labor should be available nearby the site.



***Source**: www.google.com.np/search?q=cross+section+view+of+pond*

Fig.4: Cross section view of pond

Components of pond: -

1) Dike: - Dikes are the protective structure of fish pond. It is essential for both drainable and non-drainable pond.

2) Berm: - A platform like space between dike and watery area known as berm.

A firm and sufficient wide berm adds stability of the dike and helpful for opening net in the pond.

3) **Free board:** - It is a additional height of the dike is provided as a safety or prevent overflow/topping by wave action or causes. There should be at least (50-60 cm) free board.

4) **Spill way:** - It is a structure which is used for drain the excess water from the pond. It is fixed loam above the required water level in one side of the pond this outlet water is used for irrigation purpose.

5) **Crest:** - It is upper most part of the dike. The wide of the crest is generally 1 m. It helps in easy movement of human.

6) **Inlet:** - The inlet pipe should be 15- 20 cm above the water level. It is always placed on opposite side of the outlet.

7) **Outlet/mouth:** -It is used to drain water from the pond.

8) **Harvesting pit:** - It is constructed to easy, collection of fish from the pond. During harvesting, water is drain from the outlet and whole fish shelter, on harvesting pit from where selection of harvesting can be done.

9) **Core trench:** - It is a structure which protects seepage of water from the pond. Core trench is 1m length and 1 m depth. It is filled with good clay soil, layer by layer.

Material Required:

1) Measuring tape

2) Pegs

3) Spade

4) Scale and paper

5) Rope

Procedure:

- Take a required material for layout and design of the pond
- Select a site for a pond culture
- Measure a length and width required for the pond
- Dig a peg in the a measured placed
- Keep the rope in the layout field

- Appropriate design should be followed in the pond culture.

Conclusion: ……..?

PRACTICAL NO. 5

Identify the Different Equipment and their Used in Fish Culture and

Objectives:-

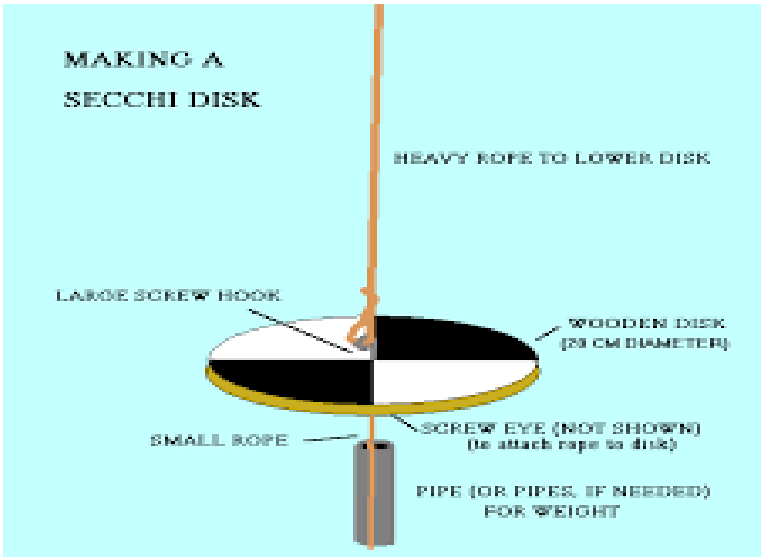
- To be able to identify different equipment used in fish culture.
- To be able to know the equipment used in fish culture and fish breeding.

Introduction

There is different equipment used in fish culture and breeding program. The common equipment used in fish as well as breeding program are as follows:

a) Secchi disk:-

The Secchi disk is a weighted disk, 20cm in diameter, and painted with alternate black and white quadrants. The average of the depths at which the disk disappears and reappears is the Secchi disk visibility. Desirable range for fish culture is 25-40 cm.



Source: www.google.com.np/search?q=Secchi+disk

Fig.5: Secchi disk

b) pH meter:-

The PH is define as the negative logarithm of the hydrogen ion activity and indicates whether the water is acidic or alkaline reaction and measured on a scale of 0-14. The instrument used in measuring such scale is known as PH meter. This helps to determine the acidity and alkalinity of the pond water. Such equipment provides the easiest way for determining water pH, even in the field, but it is relatively expensive. The pH value is directly read from the meter after placing the glass electrodes in a water sample. Desirable pH for fish culture is 6.8-8.6 broadly 6.5-9.

c) Fertilizer :-

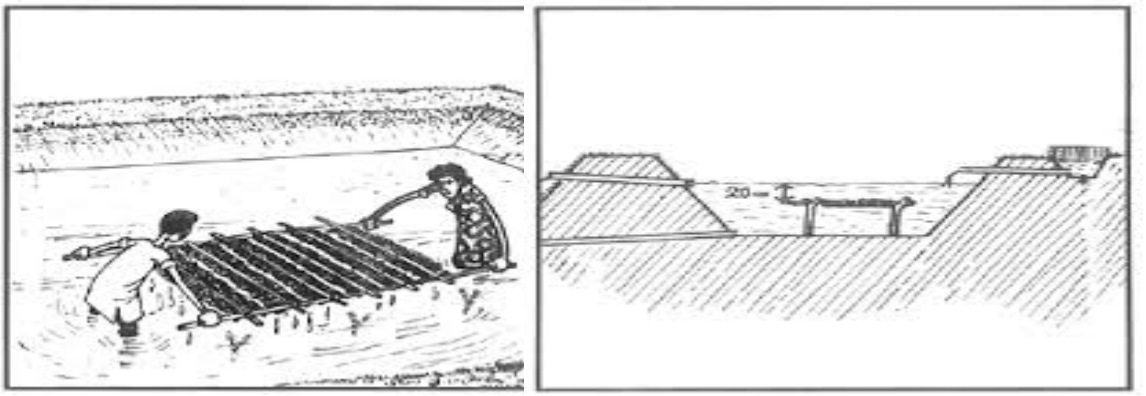
Fertilizer is one of the key factors in increasing the productivity and maximum carrying capacity. In ponds fertilizer is aimed to developing natural food and saving formulated feeds. Fertilizers are natural or synthetic substance that is used in ponds to increase the production of the natural organisms to be eaten by the fish. The fertilizer used in the fish culture is of two categories; Organic fertilizer and Inorganic fertilizer.

d) Lime :-

Lime is the material that is used in pond management which has several beneficial effects on the pond and health of the fish. The application of lime is not a type of fertilization but it is usually applied to ponds for correction of soil acidity and other several purposes. Generally agricultural lime, hydrated lime or slaked lime and quick lime or burnt lime are used in fish pond liming.

e) Kaka ban:-

The kaka ban is mat –like structure made of by dry grasses, pine tree branches, beaten palm bark or leaves. Kaka ban is rectangular structure having a length of 1.5-2 m in width. For spawning, the kaka ban are fixed about 20-30 cm below the water surface, propped upon bamboo/ wooden sticks.



Source: www.google.com.np/search?q=kaka +ban

Fig. 6 Kaka ban

f) Aerators :-

Aerator is the instrument which is used in increasing the oxygen level to pond water. Dissolved oxygen is the most critical water quality parameter in fish culture. It is essential to most aquatic organism for their respiration. It is also necessary during the process of decomposition. The level of dissolved oxygen present in water is most important factors in water quality. Similarly, when the level of oxygen is lower than the optimum condition than the aerators instrument is used to maintain the oxygen in the pond.

Source: *www.google.com.np/search?q= Aerators*

Fig.7: Aerators

g) Fish feeder: The instrument used in feeding the fish in pond is known as fish

feeder. This instrument helps to minimize the food requirement by avoiding food loss inside the fish pond.

h) Nets: These are fish harvesting apparatus used to collect fishes from water bodies. Different kinds of fish nets are available in the market. They are:

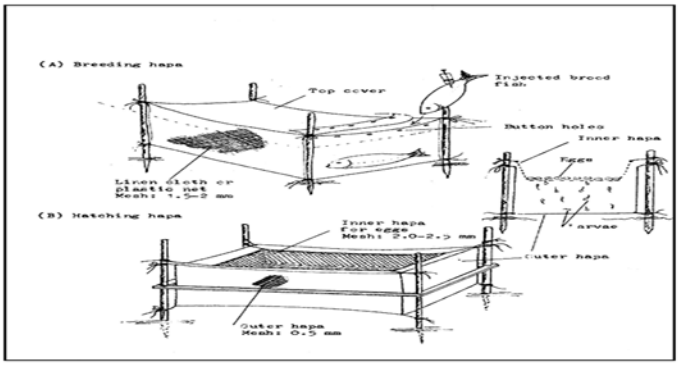
- Caste net
- Drag net
- Fry net
- Gill net
- Hook etc.

i) Incubation tank :-

Incubation tank is the place where fertilized eggs are collected. The fertilized eggs are generally collected after water hardening in the incubation tank and transferred to special incubating devices for hatching.

j) Hapa:

Hapa is a smooth muslin cloth mainly used in fish hatchery to prepare breeding structure. A breeding hapa is generally made of fine cloth in the standards size of 3.5m × 1.5m × 1m for large breeders and 2.5m × 1.2m × 1m for breeders weighing less than 3 kg. All side of the breeding hapa are stitched and closed expect a portion at the top for introducing the breeders inside. The hapa is used for fish breeding.



Source: *www.google.com.np/search?q=Hapa*

Fig.8: Hapa

k) Measurements tape:- The instrument that is used to measure the length,

breadth, height is called measurement tape. This device is generally used during the time of pond layout.

l) **Spade:-** The equipment that is used to digging the soil is known as spade. It is also used to clean the pond as well as to remove the weeds.

m) **Plastic sheets:** Plastic sheet are generally used for transportation of fry and fingerlings from one place to another.

n) **Water source:** The source where the water is obtained. Water source may be natural such as lake, river, ponds etc and others is artificial source such as tube well, borings.

Material Required:

1)Secchi disk

2)Measuring tape

3)PH meter

4)Nets

5)Fertilizer

6)Lime

7)Feeder

8)Spade

9)Plastic sheet

10) Water source

Procedure:

- Collect a required material for identification of equipment used in fish pond.
- Put a equipment and material in a sequential order.
- Identify each material with its name and function.
- List out all the equipment with its function used in fish pond.

Conclusion: ……..?

PRACTICAL NO.6

Fish Seed Packaging and Transportation

Objective:

- To be able to know the method and technique of fish packaging and transportation.
- To acquire the knowledge about the fish packaging and transportation.

Introduction:

Fish seed, fry and fingerlings come from hatcheries and nurseries which are often located far away from the ponds and tanks in which the fish are to be reared. The seed therefore needs to be transported as economically as possible in a healthy condition and without mortality.

The traditional method of transport uses open containers and people splashing with hands or legs to put oxygen into the water. On long journeys on trains, trucks and bicycles they may change the water from time to time. Often fish seed is then carried on slings along small roads and paths for delivery to villages and right to the ponds of fish farmers. While this system is still prevalent and has actually laid the foundation of aquaculture in the country, it is expensive. An attendant can handle only two containers and has to travel along with the seed, exchange water and almost continuously agitate it for aeration. In the process, the seed gets heavily stressed. It suffers mortality either during transport or soon after stocking. Being weak, it easily falls prey to parasites and predators.

Modern methods of transport have done away with open containers, which are voluminous and heavy, and the need for attendants, water exchange and agitation for oxygenation. The seed is now packed in plastic bags filled with 1/3 water and 2/3 oxygen. The plastic bags are kept in light tin containers or cardboard cartons and transported long distances by road, rail or air.

Conditioning in transportation of live fish:-

Successful transport of live fish depends on the condition of the fish. During transportation fish may get injured from mechanical damage which can lead to disease infection or dead. So, in order to avoid heavy loss of fish seed they need to be subjected to conditioning before transportation to long distance. The principle behind conditioning is that the fish should get food with themselves and should give diffused oxygen during packing and transportation. Conditioning helps fish to get acclimatized with limited volume of water in live condition with limited oxygen.

Container for transportation may be non- rust able iron boxes, plastic canes or cloths bags. Cloth or plastic container are common type of container which is use for transportation because of its efficiency, portability and cheaper to purchase. A common method of conditioning is to store the fish seed in a cloth container in a pond about 30-35 cm deep in the water. Conditioning involves the earlier starvation till just before transportation. The period of starvation depend on the size and health of fish seed. The fish seed are generally subjected to 8-48 hours of conditioning. The optimum temperature of water for conditioning carps is between 25-29 degree centigrade. Duration of conditioning of brood fish depends on the time of digestion of food. Generally 48 hours of starvation of brood fish is preferred before transportation. During conditioning and transportation fish seed should not be handled with bare hand to protect the fish seed from external injury and disease infection. After proper conditioning fish are transported on either closed or open vessel.

Method of packing and transportation of fish seed:

Two systems are used for transporting fish seed and brood fish. In open carriers fish seed are carried without oxygen where as in closed carriers fish seed are carried with artificial aeration.

1) Open system:

In open system containers are not sealed. Containers may be earthen pots, plastic pots or tin carriers of various shape and size. The fish seed carriers should be designed in such a way that they have increased surface area to prevent overcrowding. Larger surface area will also facilitate the mixing of atmospheric oxygen in the water.

Types of container that are used as open system are:-

a) **Earthen pot:-**

Earthen pots of 20 liter capacity are used for transportation of fish seed. Earthen pots are generally used for short transportation along with frequent exchange of water in every 3 hours. Dead fish have to be removed immediately to remove pollution and contamination. This is the traditional method of fish transport ad has now been replaced almost universally by close system containers especially plastic bags.

b) **Plastic pot:–**

These containers are made up of polythene other procedures are similar to earthen pots.

c) **Metal pots:-**

Metals which are of non- rust able is used for this type of transportation. Other procedures are similar to earthen pots.

2) Closed system

In closed system, the containers are sealed with oxygen. Containers may be plastic bags, plastic tanks or aluminums or galvanized iron sheet boxes.

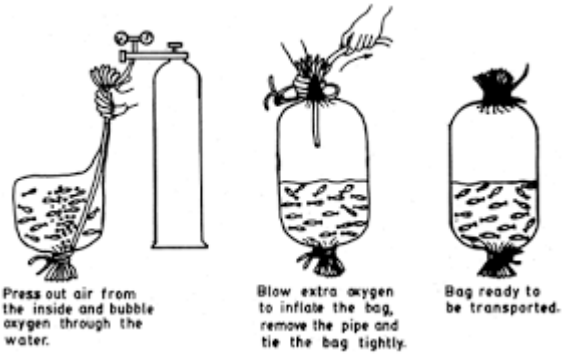
Types of containers that are used in closed system of live fish transportation are:-

a) Plastic bag:

It is widely used method for live fish transportation. Plastic bags of 16-18 liter capacity are used. 1/3rd portion of the bags are filled with clean and cool water along with well-conditioned fish. That is carefully introduced.

Table: 2 Packing density of fry/fingerlings of fish for 12 hrs journey in 16-18 liter capacity bag

Size (gram)	Average (No)	Range (No)
1	5500	1000-10000
2	2200	500-5000
3	600	200-1000
4	330	200-500
5	235	75-300
6	80	50-200
7	70	25-100
8	40	25-50



Source: *www.google.com.np/search?q=Fish+transportation*

Fig.9: Transportation of live fish in polythene bags

A tube from the oxygen cylinder is allowed to pass into the water inside the bag and the portion of about 10cm from the top is folded and tied with rope after filling oxygen. The bag is inflated with oxygen, as soon as the inflated condition is obtained; the mouth of the bag is tied tightly with rope such that escaping of oxygen means of flame if possible. It is advisable to keep each bag individually in card boards or metal boxes to avoid plastic rupture during transportation. Before stocking the fish into the pond, safely adjust the water temperature by splashing water into the bag and letting or allowing fish to swim on their own.

b) Plastic tank:–

200-500 liter capacity plastic tank are used with regular supply of oxygen. In 500 liter tank 50000-100000 fry of 2-3 gram size can be transported to 8-10 hours. Other procedure is similar to plastic bag.

Material Required:

- Plastic
- Rope
- Oxygen cylinder
- Water
- Knife
- Fry and fingerlings

Procedure:

- Take a required material for fish packaging.
- Take Plastic bags of 16-18 liter size capacity for used.
- 1/3rd portion of the bags are filled with clean and cool water along with well-conditioned fish.
- A tube from the oxygen cylinder is allowed to pass into the water inside the bag and the portion of about 10cm from the top is folded and tied with rope after filling oxygen.
- The bag is inflated with oxygen, as soon as the inflated condition is obtained.
- Then the mouth of the bag is tied tightly with rope such that escaping of oxygen means of flame if possible.
- After that keep each bag individually in card boards or metal boxes to avoid plastic rupture during transportation.
- After that it becomes ready for transportation.

Conclusion: ……..?

PRACTICAL NO.7

Identification of Planktons and Weeds Consumed by Grass Carp

Objective:

- To be able to identify the planktons and weeds consumed by grass carp.
- To acquire the knowledge about the planktons and weeds consumed by grass carp.

Introduction:

Grass carp is herbivorous in feeding habit. Excessive growth of aquatic plants in ponds, lakes, rivers and irrigation and drainage systems can be managed with grass carp. Biological weed control by grass carp is preferred because of its ability to control a wide variety of submersed and floating vegetation. The benefits of using grass carp for plant control include longevity of the method, constant feeding activity against the growing weeds, low long-term costs, and the potential for conversion of weed biomass to fish protein.

Grass carp feed voraciously on aquatic plants and can consume large quantities in a relatively short time. Food sources within the first two weeks of hatching mainly include rotifers, protozoans, cladocerans, insect larvae, and other zooplankton species. Grass carp transition to filamentous algae before feeding exclusively on macrophytes starting approximately at 1 month of age. Adult grass carp will consume preferred plant species to scarcity before moving to those less desired. Soft-leaved submerged plants such as, Curly leaf pondweed or hyacinth, are most preferred, while filamentous algae, floating vegetation, and firmer leaved submerged plants, like Eurasian water milfoil or Water shield, are less preferred. If vegetation is low, grass carp will utilize animal food sources such as crayfish, detritus, and zooplanktons.

Material Required:

- Planktons
- Weed
- Water
- Nets

Procedure:

- Take a required material for identification of planktons and weeds.
- Collect planktons and weed from the grass carp ponds.
- Identify the planktons and weed present in the pond.
- List out the planktons and weeds present in the pond ecosystem.

Conclusion: ……..?

PRACTICAL NO.8

Use of Chemical and Medicines in Fish Farming

Objectives:-

- To be able to know about the different chemical and medicines used in fish farming

Introduction

There are different types of chemicals and medicines being used in fish farming. Chemicals are used either for pond treatment or for fish disease treatment. The use of chemicals or medicine for fish disease depends upon the type of fish disease either it is fungal, bacterial, virus or any other organism. There are number of chemicals or medicines used in now a day's in fish pond are as follows;

- Potassium dichromate dose 1%
- Formalin dose 3-4%
- Salt dose 1-5 %
- Malachite green dose 5 g/lit
- Oxytetracycline or terramycin dose 7.5 g /100 kg of feed
- Copper sulphate dose 500 ppm
- Dipterex dose 0.2 ppm(pond treatments)
- Acitic acid dose 5%
- Glacial acitic acid dose 500-1000 ppm
- Lime dose 500 kg /ha

Material required:

- Chemicals
- Syringe
- Cotton
- Water
- Forceps
- Blade

Procedure:

- Collect all the required material for identification of chemicals or medicines.

- Identify the medicine according to the disease treatment.
- Label the medicine to treatment according to chemicals.
- Take an amount of medicines for any fish diseases.
- Take a syringe to inject the medicine to the fish body.
- Safely inject the medicine to the fish body.
- After injecting the medicine proper care should be given to the injured fish.

Conclusion: ……?

PRACTICAL NO.9

Perform Methods of Fish Seed Stocking, Growth Check-up, Feed Fertilizer and Lime Application

Objective:

- To be able to perform the methods of fish seed stocking, growth check-up, feeding, fertilization, and lime application
- To develop the knowledge about fish pond management

Introduction:

Fish pond management is the key factors for the success of fish production. Proper management of fish pond helps to minimize the cost of production and increase the profit ness as well. Fish pond management include, fish seed stocking, growth check-up, feeding, fertilization and lime application. Some methods of fish pond management are as follows;

Methods of fish seed stocking

Stocking means putting fish into the pond and it marks the beginning of a production cycle. It is among the most stressful processes the fish go through in the course of production. The process of stocking referred to here, starts with the collection of fingerlings from the hatchery, transporting them to the farm and, finally, putting them into the pond. Poor stocking procedures, are among the major causes of low survival in grow-out ponds. They result in disease, reduced growth and mortality. However, because the ensuing mortalities do not occur normally until after about three days, and many of the fish that die do not actually come up to the surface, many farmers do not recognize it as a serious factor. Upon draining the pond the farmer often experiences many fewer fish than the number stocked. This makes most farmers think the fish were either stolen, predated upon or the said number was not received. Farmers who do not realize that most of their fish died within the week following stocking, tend to overfeed and can lose a lot of money. For this reason, a month of nursery phase is recommended. After 1 month, the small nursery pond is harvested and the fingerlings, which by this time are larger and more resistant to

handling, are weighed and counted into the larger production pond. Successful stocking depends upon the quality of fingerling, how they are stocked and when they are stocked.

Quality of Fingerlings

The third most important factor, that affects production and returns in pond culture after nutrition and environmental (water) quality, is the quality of fish stocked. Stock quality does not just refer to the genetic makeup of the fish. It also refers to the general health, relative size and other physical and physiological characteristics of the fish. Practically, every farmer should be in position to assess the physical characteristics and physiological status of good fingerlings. Poor quality stock will give poor production performance regardless of other factors.

Physical Characteristics

- The fingerlings should be of a uniform size and color.
- Physically active and stress free seed.
- Uniform length about 10 cm long and weighs about 10 – 25 gram.

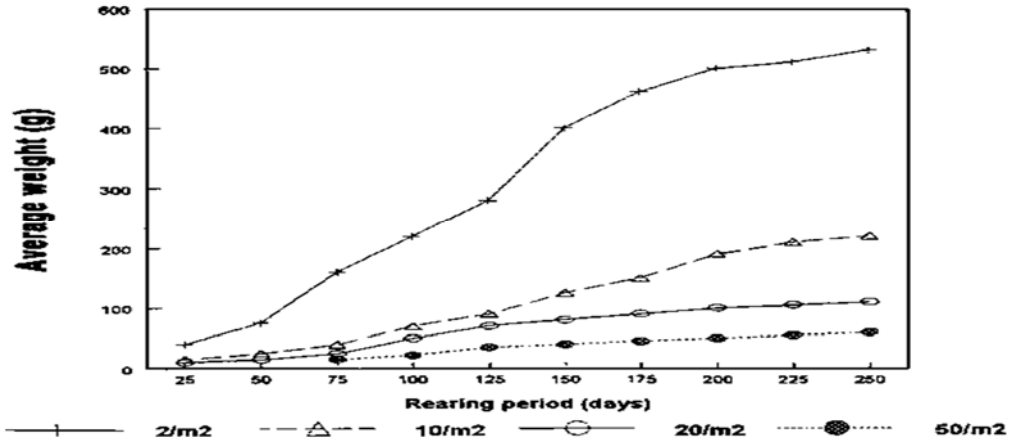
Method of stocking inside the pond

Stocking should be done in a manner that minimizes stress to the fish. Stress results in mortalities and disease outbreaks. Therefore, do not pour the fish straight into the ponds. Acclimatize the fish first over 15 to 30 minutes and gently release the fish into pond. This helps them adapt to the differences in water quality between the transport container and the pond without shocking the fish. When fish are shocked by the sudden changes in water quality, they become stressed or die. Temperature, oxygen, mineral content and pH are the key parameters for which acclimation needs be done for catfish fingerlings**.** Pouring fish from a bag or throwing them into the pond can be stressful. It is best to let them swim out of a bag or out of a net by themselves

Growth rate and growth check up of fish

Fishes exhibit a 'determinate' type of growth in short-lived species of warmer regions and an 'indeterminate' type in long-lived species of colder regions. Growth is measured in units of length and weight and is best represented as the specific growth rate. The relationship between weight and length provides an index of the state of

well-being of a fish (condition factor 'K'). Growth could also be measured by using certain other criteria such as glycine uptake by scales, hepatosomatic index, RNA: DNA ratio and protein retention in the tissues. Nutrition, including the quality and quantity of food, plays a significant role in growth regulation. A number of environmental factors, such as temperature, oxygen concentration, salinity and photoperiod, influence the rate of growth. Recent data suggest that genotypes, hormones and physiological conditions of the individual are also equally important endogenous regulators of growth. Fish growth is checked at 20 days intervals, the fish is responding the amount and quality of food properly or not.



Source: *www.google.com.np/search?q=Relationship+weight+rearing+pond*
Fig.10: Relationship between weight and rearing period of fish

Feeding

Feeding is much important in artificial means of culturing of fish. A suitable and adequate food supply is essential for proper growth and development of fish from fry to brooding stage. If the feeding is deficient in essential nutrients, particularly the amino acids, vitamins and minerals the growth period and egg development is adversely affected, ultimately leading to the failure in ovulation. Feeding material of fish may be either natural i.e.; phytoplankton or zooplanktons and artificial i.e.; granular feed.

Fertilizer

Fertilizer is one of the key factors in increasing the productivity and maximum

carrying capacity. In ponds fertilizer is aimed to developing natural food and saving formulated feeds. Fertilizers are natural or synthetic substance that is used in ponds to increase the production of the natural organisms to be eaten by the fish. The fertilizer used in the fish culture is of two categories; Organic fertilizer and Inorganic fertilizer.

Liming:-

Liming is the material that is used in pond management which has several beneficial effects on the pond and health of the fish. The application of lime is not a type of fertilization but it is usually applied to ponds for correction of soil acidity and other several purposes. Generally agricultural lime hydrated lime or slaked lime and quick lime or burnt lime are used in fish pond liming.

Material Required:

- Fish seed
- Fish feed
- Fertilizer
- Lime

Procedure:

- Take a material required for performance testing.
- Select a proper place for rearing feed stocking.
- Record a growth rate of a stocked fish seedling.
- Apply a required amount of fertilizer and lime in the stocked fish pond.
- Observed a fish pond at a regular interval.

Conclusion: ……?

PRACTICAL NO.10

PERFORM WATER QUALITY TEST

Objectives:

- To be able to know physical, chemical and biological quality of water
- To be able to correct water quality suitable to fish culture

Introduction:

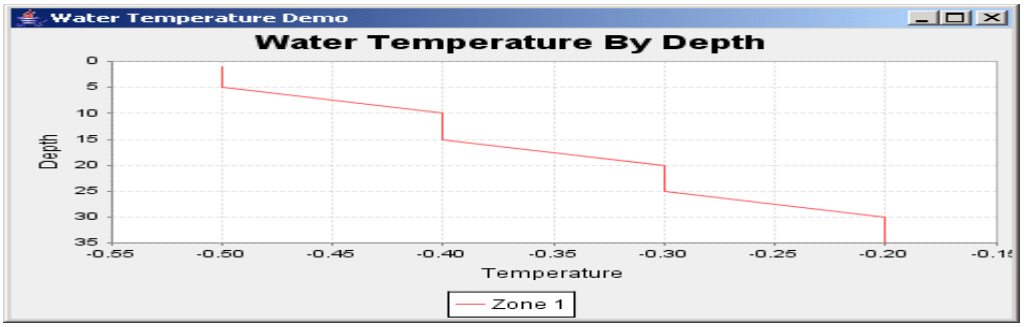
Water is an integral part of fish farming. The testing of water quality is important aspect for the success fish farming. Testing of water quality helps to manage the pond in a better way. It also helps to avoid the pond related problems in fish farming. Some of the important parameter used in water quality testing is as follows:

1)Temperature:-

Water temperature in pond generally depends upon solar radiation air temperature and depth. The absorption of solar energy as light passed through water heats the water, most heats are absorbed with in upper layer in water has large capacity to hold heats the specific heat capacity of water is unity means 1 cal is required to raised temperature of 1 gm water by 1 degree Celsius

Water temperature and fish growth:-

Fish are cold blooded animal their body temperature is about 0.5 ^{o}c. The temperature of fish body change with changes in water temperature but when rapid temperature different is more than 5 ^{o}c fish way die .The rate of bio chemical process in fish are temperature dependents, oxygen consumption increased with temperature .Temperature of tolerance for fish is 5- 42 ^{o}c but the range for maximum growth might be from 25-30 ^{o}c. For cold water fish optimum temp range is 10-20 ^{o}c and warm water fish 20-32 ^{o}c.



Source: *www.google.com.np/search?q=measurement+water+temperature+pond*

Fig.11: Measurement of water temperature in the pond

2)Dissolved oxygen:-

Dissolved oxygen is most critical water quality parameter in aquaculture. It is essential to must aquatic organism for their respiration if dissolved oxygen is low aquatic animal will be stressed vulnerable to diseases or they will die .oxygen solubility in water depends on temperature Do decrease with increase in water temperature .

3)Atmospheric pressure: -

Oxygen solubility increase with increasing atmosphere pressure

4)Salinity: -

Oxygen solubility decrease with increase in salinity. Dissolved oxygen requirements of fish 5mg /lit for warm water fish 8 mg /lit for cold water

5)Turbidity:-

Turbidity refers to the decreases ability of water to transmit by light caused by suspended particulate matter in the water. it is might be due to phytoplankton suspended particle of silt and clay high concentration of humus feed fertilizer etc.

Effect of turbidity: -

Reduce light penetration caused siltation of bottom of substrate, effect vision of fish.

Turbidity measurements:-

- Secchi disk visibility method
- Suspended solids measurement method
- Nephelometric method

6. pH:-

It is defined as negative logarithm of hydrogen ions; it indicated whether water is alkaline and acidic .It is measured in scale o-14. pH value of neutral water is 7.

Measurements of pH can be done by,

- PH indicator paper
- Colour comparator
- pH meters

Effect of low pH:

- Reduce appetite.
- Inhibits fish growth, ceases reproduction.
- Reduce to clearance to toxic substances.
- Excessive production of mucus on the gills which interferes with respiration.
- Increases toxicity of metals like AL and H2S, CH4 (methane).
- More attack of parasites and diseases.
- Acid death.

Effect of high pH:

- Damage cornea and lens of eyes.
- Damage gill filament.
- Disturb the blood acid-base balance.
- Slow growth rate.
- Alkaline death.

Material Required:

- Water
- PH meter
- Secchi disk
- Thermometer
- Bucket

Procedure:

- Take a water sample from the fish pond.
- Take a required material for water quality testing.
- Test a water pH with the help of pH meter.
- Test a water temperature with the help of thermometer.
- Measure a turbidity of water in the pond with the help of Secchi disk.
- Records all the data obtain from water quality testing.

Conclusion: ……?

PRACTICAL NO.11

Preparation of Water Snake Trap to Control the Snake in the Pond

Objectives:-

- To be able to know the predatory mechanism of water snake
- To be able to prevents fish pond from water snake
- To be able to prepare snake trap and use it properly in the fish pond

Introduction:-

The water snake is a common reptile in fish pond. It is very common in warmer climatic condition where as it is rarely seen in colder region. The water snake may be small or big in size. It has big mouth to swallow even the bigger prey. It has two sharp fangs to hold the prey. The water snake is not a poisonous one; however, people get afraid of it as its bite is very painful. The water snake likes to hunt the fingerlings as well as bigger fish too. The snake can be seen preying even in the day light; however, it likes to prey in the night. The water snake causes a considerable loss of fingerlings as well as yearlings of even 6" - 8". Therefore, once the snake is observed in and around the fish pond, immediately preventive measures need to be undertaken,

Under the preventive measures, firstly the bushes around the fish pond need to be cleared. These bushes arc considered as shelter place of a snake. By clearing the bushes also it minimizes the water snake around the fish pond and secondly an effective snake trap needs to be prepared and operate it to trap the water snake.

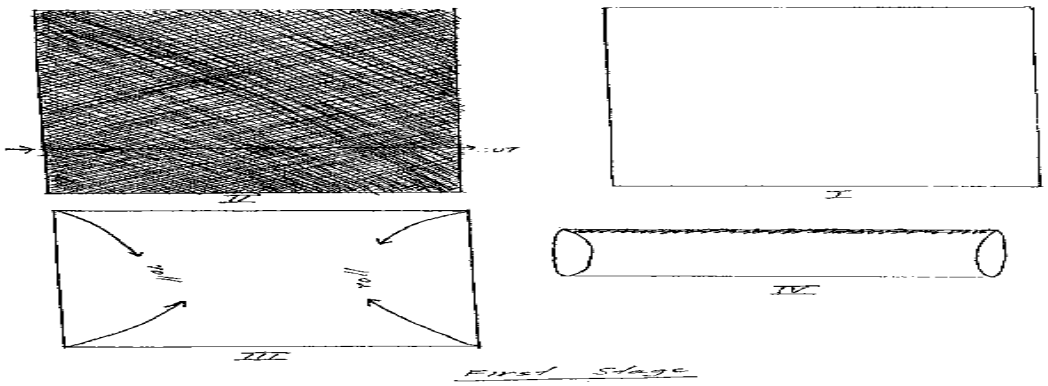
The Snake Trap:

The snake trap is a simple barrel type of structure. It can be made with locally available small mesh sized wire gauze. It is so simple that one can easily prepare it. To make the snake trap only two items are required. One is small mesh sized wire gauze found in a roll with a width of 4' at the cost of Rs. 30 per running feet and secondly only 20 -25 feet of fine wire at the cost of Rs. 5.00 only.

How to make a Snake Trap?

First stage for preparation of snake trap

- Take 4' feet of above mentioned sized wire gauze from the local market
- And cut out one feet width out of it.
- The bigger sized wire gauze of (3'×3') rolls back to give a shape of barrel
- Both the end of barrel need to be overlapped. The overlapped portion of the barrel is stitched with fine wire from one end to other, so that the barrel shape stands firmly. This completes the first stage of Snake Trap.



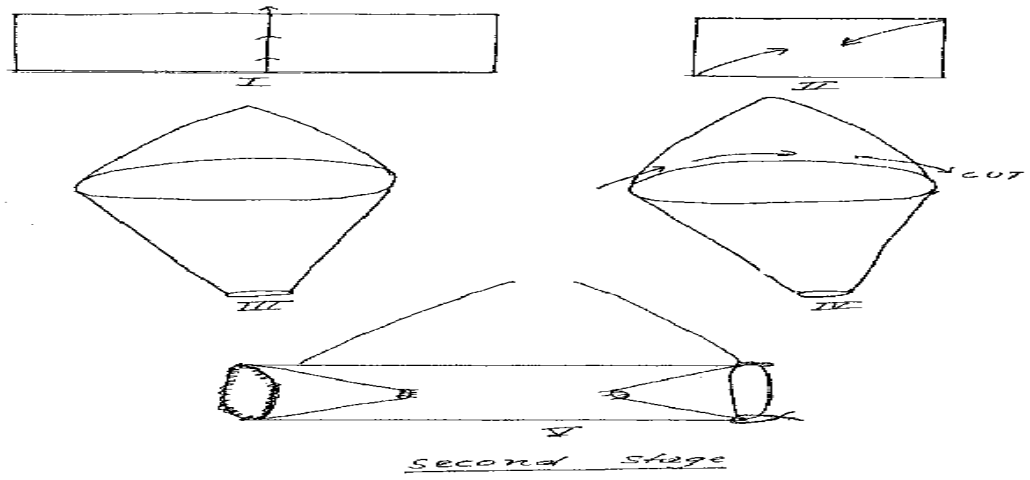
***Source**: www.google.com.np/search?q=snake+trap*

Fig.12: First stage of Snake Trap

Second stage for preparation of snake trap

To complete the second stage, take the one foot wide cut piece of wire gauze and further cut it into two pieces

- Take one cut small piece of wire gauze and fold it diagonally
- In such a way that the one end remains with big circle with a wing while the other ends will have 1-1.5 inches hole only.
- Thus it turns out as a "Funnel". The over lapping side is again stitched with fine wire so that it remains firm. The wing like structure of bigger circle is cut in such a way that the given structure turns out as "funnel"
- The second piece of cut wire gauze is also made the same sized funnel. Two funnel shaped structures are inserted into both the end of the barrel shaped structure, so that the narrow hole remains inside the barrel, while the wider portion fits in with the mouth of the funnel.



Source: *www.google.com.np/search?q=snake+trap*
Fig.13: Second stage of Snake Trap

In case of some deference in the size of the barrel and funnel, one needs to adjust so that the bigger circle of funnel gets adjusted exactly with barrel opening. While fixing the funnel with the barrel, the end with 1" hole is directed towards the inner side of the barrel. It is better to check whether the wire at the 1" hole are sharp or pointed enough or not? If not, it is advised to cut out one mesh of wire and make them pointed. One of the wider end of the funnel and the opening of the barrel are tightly woven around the circle with fine wire, so that the funnel does not come out. These funnel shaped structure is fixed in second end of the barrel at two or three points by fine wire, so that in case of need, this funnel structure can be taken out with least effort, otherwise the funnel remains intact with the barrel. At the both end of the snake trap either with fine wire or nylon rope is tied in such a way that the snake trap can be uplifted holding the wire or rope. Now the snake trap is completely ready and is ready for its operation.

How to operate?

The operation of a snake trap has been found effective even in the day light, however, it is usually used at evening or night operation. The snake trap is fixed along the dike of the pond in such a way that half of the funnel hole of the snake trap is dipped under water and other half remains above the water. It is regulated with the help of wire or nylon rope tied on snake trap and a peg fixed on the dike of the pond. After

fixing a snake trap, it is covered with some grasses or twinges of bushes to camouflage it. No bait is necessary in snake trap, however, some people prefers to put some live frog or wild fish as bait inside the trap to be sure to see a snake trapped.

In the night, when a snake comes out of its hole in search of its prey, it encounters with the trap and it attempts to peep inside the snake trap through the hole of runnel and gets trapped. As the snake try to peep inside the trap through the hole of funnel and does not see anything in it and tries to go back but the pointed wire of the funnel tip pricks the ventral surface of the snake body and forces to get into the trap. One should not surprise to see two or more snake in the same trap next morning.

Next morning, examine the snake trap, if snake is not found in the trap, one can leave the trap as it is or place it again at evening at other place. But in case, a snake is trapped, the snake remains alive. The water snake is non-poisonous, however, no one like to handle a live snake. Therefore, the snake trap with snake need to be dipped into the water, just loosing the wire or rope tied on the snake trap. The whole snake trap gets easily dipped in the water due to the snake's body weight. After 15 to 20 minutes the snake gets drowned in water and die. Once it is confirm that the snake is dead take out the snake trap from water and take out one of the funnel which is not fixed properly but simple tighten two or three points so that the dead snake is taken out of the snake trap. The dead snake is buried in a ditch.

Again fix the funnel with the snake trap and prepare it for next operation. This way the water snake problem is minimized to greater extent and stocked fish is saved to grow and gain higher economic returns from fish culture.

Material Required:

- Wire gauze
- Conical shape tin
- Rope

Procedure:

- Take a required material for preparation of snake trap.
- Follow all the technique give above for preparation of snake trap.
- After completion of making snake trap fit it near in the fish pond to trap the snake.
- Regular monitoring should be follow in the snake trap around the fish pond.

Conclusion: ……?

PRACTICAL NO.12

Preparation of Pellet Feed for Fish Culture

Objective(s):

- To be able to identify the feed ingredient for pellet feed preparation.
- To be able to know the method of pellet feed preparation.

Theory:

Fish feed is one of the most expensive inputs for a small scale aquaponic unit. Feed is also one of the most important components of the whole fish farming ecosystem which sustains the fish growth. Therefore it is necessary that farmers or growers should know about the fish feed composition. Also, if commercial pelleted feed is not available, it is important to understand the methods to produce it on the own farm. Moreover, homemade feed is useful when specific diets are needed to improve fish growth.

Composition of Feed

Fish feed consists of all the nutrients that are required for growth, energy and reproduction. Dietary requirements are identified for proteins, amino acids, carbohydrates, lipids, energy, minerals and vitamins. A brief summary of major feed components, compositional tables and formulations is presented as a guide for the feed preparation process.

Proteins

Dietary proteins play a fundamental role for the growth and metabolism of animals. They are made of 20 different amino acids, reassembled in innumerable combinations to provide all the indispensable proteins for life and growth. Recommended protein intake of fish depends on the species and age. While for tilapia and herbivorous fish the optimal ranges are 28–35 percent, carnivorous species require 38–45 percent. Juvenile fish require higher-protein diets than adults owing to their intense body growth.

Carbohydrates

Carbohydrates are the most important and cheapest energy source for animals. They are mainly composed of simple sugars and starch, while other complex structures such as cellulose and hemicellulose are not digestible by fish. In general, the maximum tolerated amount of carbohydrates should be included in the diet in order to lower the feed costs. Omnivorous and warm-water fish can easily digest quantities up to 40 percent, but the percentage falls to about 25 percent in carnivorous and cold-water fish. Carbohydrates are also used as a binding agent to ensure the feed pellet keeps its structure in water.

Lipids

Lipids provide energy and essential fatty acids (EFAs) indispensable for the growth and other biological functions of fish. Fats also play the important role in absorbing fat-soluble vitamins and securing the production of hormones. Fish, as other animals, cannot synthesize EFAs, which have to be supplied with the diet according to the species' needs. Deficiency in the supplement of fatty acids results in reduced growth and limited reproductive efficiency. In general, freshwater fish require a combination of both omega-3 and omega-6 fatty acids, whereas marine fish need mainly omega-3. Most diets are comprised of 5–10 percent lipids, although this percentage can be higher for some marine species.

Energy

Energy is mainly obtained by the oxidation of carbohydrates, lipids and, to a certain extent, proteins. The energy requirements of fish are much lower than warm-blooded animals owing to the reduced needs to heat the body and to perform metabolic activities. However, each species requires an optimum amount of protein and energy to secure best growth conditions and to prevent animals from using expensive protein for energy.

Vitamins and minerals

Vitamins are organic compounds necessary to sustain growth and to perform all the physiological processes needed to support life. Vitamins must be supplied with the

diet because animals do not produce them. Vitamin deficiencies are most likely to occur in intensively cultured cages and tank systems, where animals cannot rely on natural food. Degenerative syndromes are often ascribed to an insufficient supply of these vitamins and minerals.

Minerals are important elements in animal life. They support skeletal growth, and are also involved in osmotic balance, energy transport, neural and endocrinal system functioning. They are the core part of many enzymes as well as blood cells. Fish require seven main minerals (calcium, phosphorus, potassium, sodium, chlorine, magnesium and sulphur) and 15 other trace minerals. These can be supplied by diet, but can also be directly absorbed from the water through the skin and gills. Supplementing of vitamins and minerals can be done according to the requirements of each species.

Table 3: Common feed ingredient sources of the most important nutrient components

Nutrient components	Feed ingredient sources
Protein	Plant-based sources: algae, yeast, soybean meal, cottonseed meal, peanuts, Sunflower, rapeseed/canola, other oil-seed cakes. Animal-based sources: fishery by-products (fishmeal or offal), poultry by-products (poultry meal or offal), meat meal, meat and bone meal, blood meal.
Carbohydrates	Wheat flour, wheat bran, corn flour, corn bran, rice bran, potato starch, cassava root meal.
Lipids	Fish oil, vegetable oil (soybean, canola, sunflower), processed animal fat.
Vitamins	Vitamin premix, yeast, legumes, liver, milk, bran, wheat germ, fish and vegetable oil.
Minerals	Mineral premix, crushed bone.

Homemade fish feed formulations for omnivorous/ herbivorous

Two simple methods for a balanced fish feed containing 30 percent of CP are provided below. The first formulation is made with proteins of vegetable origin, mainly soybean meal. The second formulation is mainly made with fishmeal. The lists of the ingredients for each diet are expressed in weight (kilograms), enough to make 10 kg of feed. A simple step-by-step guide on preparation of the pelleted feed is then provided.

Table: 4 List and relative amounts of ingredients for 10 kg of fish feed using vegetable-based protein, including proximate analysis

Feed ingredients	Weight (kg)	Percentage of total feed (%)	Proximate analysis	%
Corn meal	1.0	10	Dry matter	90.9
Wheat flour	4.0	10	Crude protein	30.0
Soyabean meal	1.5	15	Crude fat	10.5
Soybean oil	0.2	2	Crude fibre	2.1
Fish meal	3.0	30	Ash	8.3
Vitamin and minerals premix	0.3	3	Nitrogen free extract	34.5
Total amount	10.0	100	-	-

Table: 5 List and relative amounts of ingredients for 10 kg of fish feed using animal-based protein, including proximate analysis

Feed ingredients	Weight (kg)	Percentage of total feed (%)	Proximate analysis	%
Corn meal	1.0	10	Dry matter	91.2
Wheat flour	1.0	10	Crude protein	30.0
Soyabean meal	6.7	67.2	Crude fat	14.2
Soybean oil	0.2	2	Crude fibre	4.8
Wheat bran	0.7	7.8	Ash	4.6
Vitamin and minerals premix	0.3	3	Nitrogen free extract	28.3
Total amount	10.0	100	-	-

Material Required:

1. Weighing scale
2. Grinder
3. Metal sieve (0.2-0.4 cm mesh)
4. Mixing bowl
5. Meat mincer
6. Mixing spoon
7. Aluminum baking tray (40×40 cm)

Procedure:

- Gather the utensils required for feed preparation.
- Gather the ingredients according to requirement shown in above table.
- Purchase previously dried and defatted soybean meal, corn meal and wheat flour. If these meals are unavailable, obtain whole soybeans, corn kernels, and wheat berries. These would need to be dried, de-hulled and ground. Moreover, whole soybeans need to be toasted at 120 °C for 1–2 minutes.
- Weigh each ingredient following the quantities shown in the recipes above.
- Add the dry ingredients (flours and meals) and mix thoroughly for 5–10 minutes until the mix becomes homogeneous.
- Add the vitamin and mineral premix to the dry ingredients and mix thoroughly for another 5 minutes. Make sure that the vitamins and minerals are evenly distributed throughout the whole mixture.
- Add the soybean oil and continue to mix for 3–5 minutes.
- Add water to the mixture to obtain soft, but not sticky, dough.
- Steam-cook the dough to cause gelatinization.
- Extrude the dough. First divide the dough into manageable pieces, and pass them through the meat mincer/pasta maker to obtain spaghetti-like strips. The mincer disc should be chosen according to the desired pellet size.
- Dry the extruded dough by spreading the strips out on aluminum trays. If available, dry the feed strips in an electric oven at a temperature of 60–85 °C for 10–30 minutes to gelatinize starch. Check the strips regularly to avoid any burn.

- Crumble the dry strips. Break or cut the feed on the tray with the fingers into smaller pieces. Try to make the pellets the same size. Avoid excessive pellet manipulation to prevent crumbling. Pellets can be sieved and separated in batches of homogeneous size with proper mesh sizes.
- Store the feed. Place the fully-dried feed pellets into airtight plastic containers soon after they have been broken into pieces to prevent them absorbing humidity.

Conclusion: ……

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PRACTICAL NO.13

Rearing of Fish Hatchling

Objective(s):

- To be able to know the method of rearing fish hatchling.
- To be able to know the technic of rearing the fish hatchling.

Theory:

Fish rearing is an important aspect for the success of fish farming. Commercially rearing of fish starts from brood fish management, spawning, incubation, hatchling, nursery pond management and finally transfers to the commercial cultivation pond with proper care and management. Some of the work which is common practice during hatchling rearing starts from,

Spawning of fish:

Lay of eggs by sexual matured female fish is called spawning. After injection of pituitary gland extract to the sexual matured male and female spawning is done spawning period depends on water temperature. If we provide first inject at 4pm and another at 6 hours difference then spawning will takes place early in the morning in case of spawning eggs are collected from the breeding tank by slowly lifting of eggs that are transferred to incubating tank. The fertilized eggs become opaque and looks like pearl and semi-buoyant (partially emerged). The suitable size of spawning tank is 3-4 meter diameter and one meter depth that can hold up to 2500 liter of water. The spawning tank may be circular or rectangular but circular spawning tank is very suitable and convenient.

Incubation and hatching:

The fertilized eggs are transferred into the incubator for hatchling production. Water is continuously flown into the incubation tank through a pipe. This water flows the eggs continuously around the incubating tank and eggs strikes the water continuously. The rate of flow of water into the incubating tank is 2-3 liter water per minute. Hatchling time depends on water temperature.

Table: 6 Hatchling time requirement according to water temperature.

SN	Fish	Temperature(in celcious)	Hatchling time (hrs)
1	Grass carp, silver carp, bighead carp	22-25 26-28	32-35 24-28
2	Rohu ,Naini, mrigal, catla	26-31	16-18
3	Common carp	18-20 20-22 28-31	110-144 70-80 46-48

If fungi and bacteria attacks the eggs then hatchling is sooner but such hatchling are immature and have high motility rate. Pre-mature hatching is also caused by increasing in temperature (above 30ºc) premature hatching can be effectively controlled by adding 5-8 gram of tonic acid in 10ltr of water. The solution is poured into the incubating tank along with water current for effective dilution. Tonic acid solution makes the egg shell stiff and prevents from bacteria fungal infection.

Hatchling rearing:

From the incubating tank hatchling are pass into rearing tank through the out flow of pipe. In the rearing tank they are reared for 3 days until and unless they are transfer to specially prepared nursery pond where they can start feeding natural food.

In the beginning of the hatchling are fed with yellow part of egg called yolk. In this condition hatchling are susceptible to several fungal and bacterial disease so to prevent them from such disease, they are dipped into the solution of potassium per magnet (KMNO4) for1/2 hrs.

Transfer to nursery pond:-

Hatchlings are transfer to the nursery pond when the young fry starts feeding. The nursery pond should be free from weeds predators and parasite, and should have natural food of zooplanktons in abundance which from the main food of the young fry formulated feed in the form of soybean powder or finely powder oil cake and rice bran are provided in 1:1 ratio 4-5 times daily. The nursery ponds are usually netted out after 2-3 weeks of stocking and the advanced fry are restocked or transferred to rearing pond.

Causes of mass mortality of hatchlings in nursery pond:

- There may be difference in physiochemical condition of water in nursery that can cause mass mortality.
- If suitable food is not available at required time and duration.
- Predatory fishes and aquatic weed fishes may be present in the pond.
- Over growth of phytoplankton may decrease the oxygen demand of hatchling.
- Fry and fingerlings of different size when stocking together may lead to death of small fry or fingerlings.

Material Required:

- Spawning tank
- Kakaban
- Incubation
- Potassium per magnet (KMNO4)
- Nursery pond
- Soybean powder
- Oil cake
- Rice bran

Procedure:

- Gather all the required material for rearing of hatching.
- Collect the spawn required for hatching from the spawn tank.
- Keep the spawn in incubation for hatching the eggs by maintaining the suitable temperature.
- After certain period of time the eggs will hatch and produce the fry and fingerlings in incubation tank.
- After hatching of fry and fingerlings it should be pass into rearing tank through the out flow of pipe.
- In the rearing tank they are reared for 3 days until and unless they are transfer to specially prepared nursery pond where they can start feeding natural food.
- In the beginning of the hatchling are fed with yellow part of egg called yolk.
- In this condition hatchling are susceptible to several fungal and bacterial disease so to prevent them from such disease, they are dipped into the solution

of potassium per magnet (KMNO4) for1/2 hrs.

- After that hatchlings are transfer to the nursery pond when the young fry starts feeding and proper care should be given to avoid the mortality rate of fry.

Conclusion: ……?

PRACTICAL NO.14

Design of Trout Raceway

Objective(s):

- To acquire the knowledge about the design of trout raceway culture.
- To know the method of stocking trout species in raceway culture.

Theory:

A raceway, also known as a flow-through system, is an artificial channel used in aquaculture to culture aquatic organisms. Raceway systems are among the earliest methods used for inland aquaculture. A raceway usually consists of rectangular basins or canals constructed of concrete and equipped with an inlet and outlet. A continuous water flow-through is maintained to provide the required level of water quality, which allows animals to be cultured at higher densities within the raceway

Freshwater species such as trout, catfish, and tilapia are commonly cultured in raceways. Stocking densities for raceways are usually higher than for other culture systems. Densities of 10 to 15 fish per cubic foot are not unusual for raceway systems. These high densities have distinct disadvantages including: more rapid disease spread less reaction time when problems occur, and large volumes of effluent with dilute fish wastes.

Source: *www.google.com.np/search?q=raceway+culture*

Fig.14: Raceway culture

Advantages of raceways can include:

- Higher stocking densities.
- Improved water quality
- Reduced manpower
- Ease of feeding
- Ease of grading
- Ease of harvest
- Precise disease treatments
- Collection of fish wastes
- Less off-flavor

Selection of site for raceway culture

The most important factor to consider when selecting a site for a raceway farm is the water supply. Water sources for raceway aquaculture operations are usually streams, springs, reservoirs or deep wells. Trout do best in spring water because it keeps a constant temperature, while catfish need a strong flow, about 80 litres per second for every 0.4 hectares of raceway. A backup water supply should be positioned so, if the water supply or pump fails, it can flow by gravity into the start of the raceway.

Size

A raceway is most often a rectangular canal with a water current flowing from a supply end to an exit end. The length to width ratio is important in raceways. To prevent the fish stock from swimming in circular movements, which would cause debris to build up in the center, a length to width ratio of at least six to one is recommended. If the width is too large this could result in a feeble current speed which is not desirable. The length of a raceway unit is usually constrained by the water quality or by how much stock a unit can hold for ease of management. The average depth of a raceway for fin fish, such as rainbow trout, is about one meter. This means each section in a raceway should be about 30 m long and 2.5–3 m wide. The landscape should slope to one or two percent, so the flow through the system can be maintained by gravity. The raceway should not be curved, so the flow will be uniform.

Water flow:

The water flow rate in a raceway system needs to be sufficiently high to meet the respiratory (dissolved oxygen) requirements for the species concerned and to flush out metabolic wastes, especially ammonia. In a well-designed system, the existing water in the raceway is largely replaced by new water when the same volume of new water enters the raceway. Self-cleaning can sometimes be achieved if the fish stocks density is sufficiently high and the water level is sufficiently low. For example, if trout are stocked at 20 kilograms per cubic meter, they can keep the raceway unit clean by their swimming movements, preventing waste solids from settling to the raceway floor.

Maximum load/capacity in raceway culture:

The maximum load of organisms that can be cultured in a raceway system depends on the species, and particularly on the size of the species. For trout, stocking rates of 30 to 50 kg/m^3 are normal at the end of a rearing cycle. The total volume required for a raceway is calculated by dividing the total amount of fish in kg by the desired stocking rate in kg per $m^{3.}$

Feeding:

In most raceway aquaculture feed needs to be supplied. The composition of the feed, and the amount and time of feeding needs to be adjusted to the specific species. This can be optimized to reduce costs and minimize the amount of waste.

Material Required:

- Measuring Tape
- Paper
- Pencil
- Scale
- Pegs
- Plastic rope
- Plastic sheet
- Thermometer
- pH meter

Procedure:

- Take all the required material for designing of raceway culture.

- Identify a suitable site for raceway culture.
- Draw a sketch of design of raceway culture according to place and site.
- Measure all the parameter (physical & chemical) according to requirement for growing trout species.
- After that measure a land in rectangular shape for raceway culture.
- Proper layout should be carried out with the help of measuring tape, pegs, plastic rope.

Conclusion: ……?

PRACTICAL NO.15

Differentiate Between Disease and Healthy Fish

Objective(s):

- To be able to identify the healthy and disease fish species.
- To be able to differentiate the healthy and disease fish species.

Theory:

Fishes are the first successful class of the chordates. They are aquatic cold blooded vertebrates which breathe by means of pharyngeal gills, propelling and balancing themselves by means of fins. A healthy fish may be define as those fish which can prefer their normal activities such as movement in water, feeding behavior, and their normal metabolic activities which helps them to attain their normal growth and development. Fish are generally grown in aquatic environment and they feed on food available in the pond ecosystem and sometimes additional feed. Fish can perform their normal activities in the own way but sometime due to change in aquatic environment helps to create many abnormalities due to many factors. Such factors include abiotic factor and biotic factor. Abiotic factor includes any environmental cause such as Asphyxiation. Similarly, biotic factor includes different microorganism such as fungal (water mould**)**, bacterial (Tail rot or fin rot**)** and virus (Lymphocystis). So, that it is essential to identify healthy and disease fish in a pond eco system which helps to grow fish in a normal condition. Similarly, differentiation of healthy and disease fish helps to overcome the disease spread in the pond ecosystem that helps to minimize the cost of production and enhance economic growth in fish farming.

Table: 6 Different between healthy and disease fish

Healthy Fish	Disease Fish
Fish are active and normal.	Fish becomes restless or abnormal.
Maintain its balance and position in the pond water.	Loss of balance and fish is unable to maintain its position in the column of water.
Fish tends to stay in its normal position in the pond.	Fish tends to lie on its side either resting at the bottom or floating at the surface.
Gills are normal red in color.	Gills appear pale.
Fish have a normal eye.	Bloody and bulging eye
Normal size of abdomen.	Swelling the abdomen
Tail and fins do well its function in normal condition.	Tail and fins do not seem to function normally with vigor
Scale, fins, gill and scale looks attractive and shining.	Erosion of scale, fins, gill lamellae or part of skin.
Feeding in normal condition without any disturbance.	Slowly down or complete stoppage of feeding.

Material Required:

- Healthy and disease fish
- Bucket
- Water
- Plastic sheet
- Knife
- Forceps
- Needle

Procedure:

- Take all the required material for differentiating healthy and disease fish.

- Allow a regular monitoring the activities of fish in the pond in a frequent interval.
- Take both a healthy and disease fish.
- Keep them in the clean plastic sheet after washing with clean water.
- After that compare both the healthy and disease fish in the different parameter.
- Compare both the fish in term of different fish organs such as scale, gills, fins, tail etc.
- Record the information obtains from the observation.

Conclusion: ……?

PRACTICAL NO.16

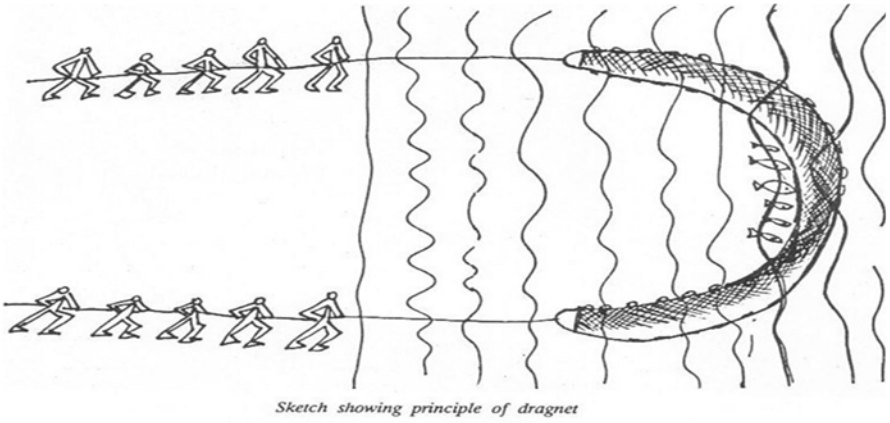
Preparation of Drag Net

Objective(s):

- To be able to identify the drag net.
- To be able to know the method drag net preparation.

Theory:

Drag net is one of the most common used net in fish farms. This net is shaped like a wall of enormous length. The upper margin of the net is supported by a strong rope (head rope) and is lined with float line. The lower margin is the foot rope and is provided with sinkers, to keep net in position. Two ends of the net slowly dragged by two parties of fishermen. A variety of livings in the mid water and near bottom are caught.



Source: *www.google.com.np/search?q=drag+net*

Fig.15: Drag net

Material Required:

- Plastic rope
- Plastic net
- Knife

Procedure:

- Take all the required material for preparation of drag net.
- Adjust the length and width of net required for dragnet.
- Cut appropriate size and length of plastic rope to keep in upper and lower part of net for handlings.
- Keep both the net and rope in a right place then tie them to adjust in a place.
- After that the net is ready to harvest the fish in the pond.

Conclusion:……?

PRACTICAL NO.17

Harvesting of Fish by Using Different Methods

Objectives(s):

- To be able to familiar with different harvesting methods.
- To be able to know the technique of harvesting in the fish pond.

Theory:

Farmed fish can be harvested in several ways & several methods according to needs, situation & pond condition. These methods are;

A. Harvesting by draining the pond

B. Using the basket trap

C. Using the hooks & baits

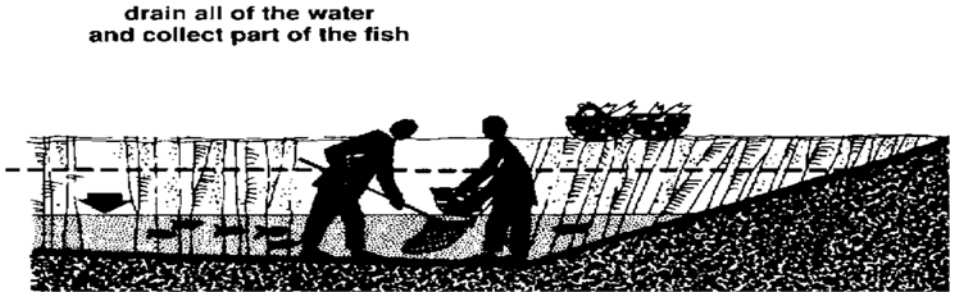
D. Using cast net

E.Poisoning

F.Looping

A. Harvesting by draining the pond

This method of harvesting is the simplest & most effective. Water is let out of the pond by opening the lowering pipes at the outlet. As the water level drops & the water moves towards the deeper end of the pond, the fish drift with it. Finally, all the fish collects at the outlet & is collected by hand or with a net.



Source: *www.google.com.np/search?q=drain+pond*

Fig.16: Drain pond

B. Using bucket trap

The baskets are important in harvesting small ponds where the farmer cannot afford the more expensive gear. The basket is made from twigs, cane or climbing plants. The trap is left in a stream in a fixed position. Several elongated conical bamboo traps of approximately 1.5 m in length and 0.25 m in circumference are used in the hills of Nepal. Their size varies from place to place. They are used in very fast waters.

Source: *www.google.com.np/search?q=basket*

Fig.17: Basket

C. Using Hooks

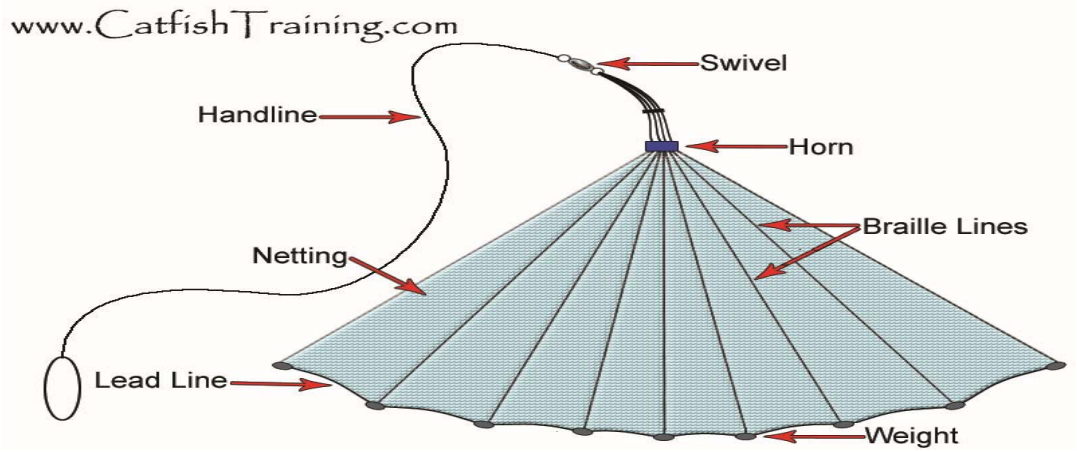
The hook for the line is usually made from the metal of an umbrella. The hooks are attached to the line. Bait is small pieces of fish, earthworms, bread or flour or fish fry. A single man may operate several rods at the same time.

Source: *www.google.com.np/search?q=Hook+line*

Fig.18: Hook & line

D. Cast net

A cast net is a net made like an umbrella. It is tied on a rope. It opens out when cast over the ponds. As it sinks deep into the pond the mouth is closed, trapping whatever fish that will be in the water space enclosed.



Source: *www.google.com.np/search?q=cast+net*

Fig.18: Cast net

E. Poisoning:

Leaves of Sapium insigne, Agave Americana are crushed and thrown in the water. Bark and roots of Dalbergia stipulacea are also used for poisoning fish. The crushed leaves and fruits of Adhatoda vasica and Randia dumentorum are commonly used in ditches for catching fish. Pithecallobium bigeminum is also used for fish catching. These are common plants in the Terai. Edgeworthia gardneria, Polygonum flacidum, P. hydropiper, Ficus pumila and Acacia pennata are also used as fish poison. More recently, pesticides such as Aldrin, Thiodine, BHC, Malathion, and DDT have also been used.

F. Looping:

Looping, locally called `paso', is practised in the Trisuli (Rajbanshi, 1976) and Sun Koshi rivers. The loop is made from a nylon thread. A single line may support 3-5 loops. The size of loop regulates the size of catch. A coloured lead weight functions

as bait. Live bait such as fish, shrimp, earthworms, stonefly and may fly larvae are also used in looping in the Trisuli and Sun Koshi. When a fish detects the slowly moving coloured lead it mistakes it for insect larva, approaches the lead and enters into the loop where it gets stuck by its dorsal and pectoral fins. Fish are looped in the afternoon and evening, when fish up to 6 kg may be captured. Paso is used from September to April, when the stream water is clear and cold and the fish start their upstream migration. This method captures Schizothorax (asla), Labeo angra (Thailand) and some other fish.

Material required:

- Spade
- Pipe
- Hooks
- Cast net
- Bucket
- Hooks
- Poison
- Looping

Procedure:

- Take all the required material for harvesting of fish**.**
- Select the place to harvest the fish either it is pond, river or lake.
- Select appropriate net, hooks, bucket or any other material for fish harvesting.
- Then try to install or use appropriate instrument used for fish harvest.
- Finally, harvesting operation should be carried out and collect the fish species.

Conclusion: …….?

PRACTICAL NO.18

Packaging of Fish in for Transportation up to the Market

Objective(s):

- To be able to know the method of packaging fish for transportation up to the market.
- To know the technic of fish packaging for transportation.

Theory:

Fish farming is generally carried out for the economic development of grower. The success of fish farming starts from fry or fingerling rearing to maturity level. After attaining the marketable size fish should be harvest and sold in the market. Fish should be handled hygienically and chilled from the time of capture or harvesting until they are packed. Whole fish and fillets should be kept in ice while waiting processing and smoke products should be held in a chill room at 0^0c ideally and air blast chiller should be provided in a processing line, either before or after the packaging machine since the fish may warm significantly during the packaging operation. Layering of products within a pack should be avoided. A single filler or portion is more fully exposed to the action of the gases. Layering is unavoidable when packing sliced smoked products salmon, but the products doesn't gain the full benefits of the modified atmosphere. Wet fish products that are likely to exude can be laid on a pad of absorbent paper inside the pack. Pack with faulty seals can be detected by pressing dam with the hands, faulty packer will collapse. Packed should be clearly labeled according to existing regulations and should be marks with a sell by a consumed by date. Generally packing of fish can be done by following methods,

- Modified atmosphere packaging
- Vacuum packaging
- Active packaging

1) Modified atmosphere packaging

In this method fish are enclosure in gas-barrier materials, in which the gaseous

environment has been, extends the shelf-life & retard the deterioration of fish product under refrigeration.

2) Vacuum packaging

- It is used for long term storage of dry foods & the shelf life.
- It has good barrier properties towards oxygen & water & can be easy sealed.
- Air is removed under vacuum & the package is sealed.
- The products kept under a lower o_2 atmosphere with less than 1% inhibiting the growth of aerobic spoilage microorganisms, particularly Pseudomonas spp, & Aeromonads spp.
- Vacuum packaging could prevent oxidative rancidity & improve organoleptic quality of fish.
- Vacuum packaging effectively extends the shelf life of fishery products by maintaining their odor & flavor.

***Source**: www.google.com.np/search?q=fish+vacuum+packaging*

Fig.19: Vacuum packaging

3) Active packaging

- It is a technique used for extending the shelf life of fish by addition of active agents heat absorb or release a compound in the gas phase.
- Compounds in packaging include co_2, o_2, water vapour or volaties.
- Active agent can be useful in a package such as oxygen or carbon dioxide scavengers, moisture absorber & oxygen or carbon dioxide emitter.
- Active packaging systems have also been studied, in which specific bioactive substances are combined with the packaging material or within the package resulting in the retardation of the microbial growth & lipid oxidation.

- It was the reported that the use of carbon dioxide emitters in fish can control the G/P ratio & volume reduction compared with traditional MAP.

Material Required:

- Refrigeration
- oxygen or carbon dioxide scavengers
- moisture absorber & oxygen or carbon dioxide emitter
- Plastic sheet
- Scissor
- Water

Procedure:

- Take a required material for packaging of fish.
- Select a harvested fish species for packaging.
- Wash with clean water to remove the soil and other dirty material attached in the fish body parts.
- After that select a appropriate or suitable measure of packaging for fish transportation.
- Packaging of fish depends upon the distance of market.
- Follow all the precaution measure to avoid the contamination.
- Finally, after packaging the fish is ready for transportation to the market.

Conclusion: ……..?

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