TOR TAMBORDEIS EMPURAO SARAWAK RIVER KING BREEDING PROJECT 2024

[Report by] Jan ling | Rainmaker Information System Sdn Bhd

Paul Yeo is an IT engineer who has 30 years' experience in the IcT arena and developed an explorative hobby for nature for fish breeding especially Borneo's breed like the Tor Tambordei species in Sarawak.

Completed a sponsored Proof of concept (PoC) amounted to Rm 180,000 by the only breeding farm in Sarawak with Aquaculture Sector MyGAP Certification Scheme.

myGAP MALAYSIA

Borneo Empurao Farm, Serian Kuching. The farm is currently breeding using his methodology and has been providing sustainably to contracted government sector.

Due to the limitation of space, he has ended the research and breeding programme in search of larger investment to continue his venture and breeding ambition to replenish the breed to Sarawak River and to grow aquaculture for our food consumption.

Being a trailblazer, is what this project is all about.

This report is directed to investor who wants to build an Empurao farm based on the breeder successful breeding experiment in the past.

Disclaimer clause

The breeder is not selling any patented methods to empower a cash cow model, nor a success guaranteed business solution to any investor.

The breeder is specialised in breeding activity mainly:

1. Design of a fish farm
2. Incorporate IoT to minimised human resource, enhance monitoring by data analytics to help owner make informed decisions.
3. Biological laboratory preparation for fish breeding
4. Breeding processes and training
5. Respond to ad hoc needs to ensure the health of the fish.

The breeder is not responsible for any fatality rates incurred naturally or due to natural disasters, workforce error, diseases as all natural calamities may incurred at any time despite closed monitoring protocol imposed.

The breeder is not responsible to sales and marketing and channel of any publicity which is under the revenue centre. This is mainly because sales activities is affected by many uncontrollable factors involving other expertise which the management can research into that further, but the breeder is not hesitate to contribute in any way to provide such information just as the breeder started off the journey of breeding the is based on demand existing in the market.

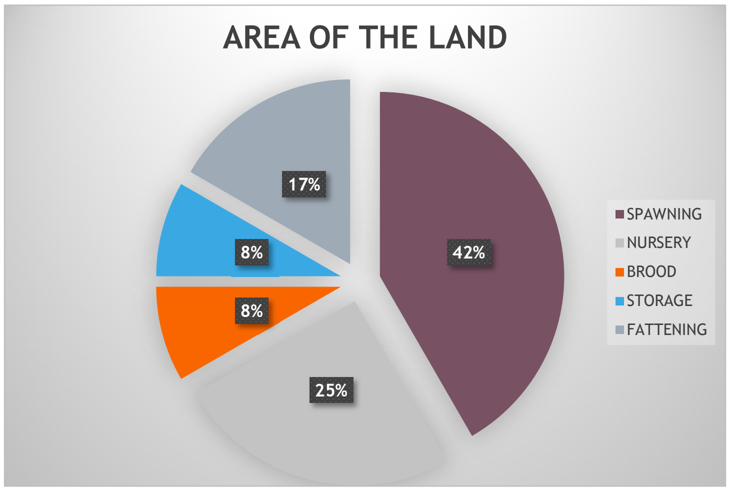
Therefore, the charges for the breeder like that of an consultation fee is based on these activities which is between 5 to 10% of the whole process of activities involved in setting up a farm.

Retaining the breeder as a consultant for running and training staff is viable which can be discussed further.

Before we dive into the excitement of creating a budget of building the farm, we first need to understand the basic of ponds type in aquaculture for each stage of growth like that of raising a human being from infant to a child, who is ready to be on its own and then allocated this ratio of land planning for each activity.

The four categories are:

1. spawning ponds for the production of eggs and small fry;
2. nursery ponds for the production of larger juveniles;
3. brood ponds for broodstock rearing;
4. storage ponds for holding fish temporarily, often prior to marketing;
5. fattening ponds, for the production of food fish;



we have these core activities determined we go into specific details of supplementary activities like feeds production administration of ICT, biological anesthesia, isolation, Laboratories, freezing room and distribution.

We try to be as clear and mediocre as possible for each activity so until the development has been mature, some activity can be combined or redundant just so as the learning curve has improved over time due to increased proficiency.

The author is opinioned that, this project should adopt activity-based budgeting.

After selecting the sites that is suitable in size, water quality, soil quality, distance to port, workforce, infrastructure and amenities;

The Master budget should be based upon the number of broodstock available and how many is in addition for the time to come? The fertility rate expected from the breeder expectation in the next breeding seasons which will fill up the ponds. If you can sort out these questions, then a budget can be formed realistically.

From these two assumptions, how big is a land suitable according to the ratio of the activity's selected to be developed? How much budget in RM do you have? Is it resilient? How big is your land? Where? And what features is going to affect your monetary budget for all five activities and sub activities deviations of 30%.

MORE INFORMATION FROM THE AUTHOR

JAN@RIS: before u draft the budget. simple question. How much do you plan to give and time u have to breakeven? then we work down up.

JAN@RIS: we are confident. we always have been. but as u see, if Feng Sui gets in a way. keep having high mortality, no reason found, just so if everyone works hard, then, this is clueless.

JAN@RIS: fish natural fatality rate is more than mammals like cats which I have been in the business before.

JAN@RIS: mammals are 50%, like engineered cats

fish in pond is higher. be prepared to lose. and the system is How we bounce back and recoup. A system that incorporate resilience that's the key point of success.

JAN@RIS: Any Size is profitable. Management just need to balance that activity-based budgeting. Justify each process. the main five Process has no room for negotiation, is based on size. Simple as that, a breeder is not afraid to present his idea but rightfully be, cannot guarantee.

The site is everything. A site with abrupt water will need expensive water treatment and RAS or even solar water need to be done standby. We don't even encourage any investor to go into it if you are new to breeding and don't have a piece of land that can be improvised creatively

JAN@RIS: Datuk Yong is the owner of the farm, thats his whole life in side. he is planning to retire inside.

JAN@RIS: his main activity is government grant research and development tourism and leaving a legacy to Sarawak

JAN@RIS: not a cash cow

JAN@RIS: Cultivating at optimum is the best choice for this breed.

JAN@RIS: my farm ok.... with Brocken milo-tin i can breed with low mortality, because the strength of my farm is its clean water and its nature environment, that ensure a 70% success rate. if i don't over-populates and over- breeding them

JAN@RIS: you children don't even have a 70% passing rates all the time. but my farm has. small scale. optimum.

JAN@RIS: My character some how contributes breeding success up to 80% because I ensure proper handling to be soft and delicate to avoid shock for my broodstocks. Moreover, i can speak to my own brood stock and know each of their named i need to tag???? tagging makes them uncomfortable.

JAN@RIS: Investors need to have the mind of a fish- lover themselves just like when u first get into a business and starting to see risk as controllable and not something to be afraid off.

Can a biologist breed? yes. but he may not like fish. and he may like to do genetic sequencing based on fixed structure and pass up homework

can a ICT manager breed. yes. as a hobby is directed by self-motivation and he will take the extra mile to care and do more than a biologist

JAN@RIS: knowledge wise- the gap of a popper documenting of genetic sequencing which in history is not important to any fish farmers. Because the purpose is to identify and analyse genetic variant to determined its breed like pure or mix breed. Is more to research and breed preservation purposes.

JAN@RIS: but the breeding process can be recorded scientifically which will fall under biological lab handle by government sectors outsources of internal trained staff.

JAN@RIS: Ris is focusing on these Five (5) process, but it is majorly all it takes to operate the farm smoothly:-

1. Design of a fish farm
2. Incorporate IoT to minimised human resource, enhance monitoring by data analytics to help owner make informed decisions.
3. Biological laboratory preparation for fish breeding
4. Breeding processes and training
5. Respond to ad hoc needs to ensure the health of the fish.

JAN@RIS: until your land selection and have a topography and a layout then budget, you will knows better than me.

JAN@RIS: know immediately how much to budget in detail the pond base on all your pond constructions then designing ICT. we will draft based on the design.

JAN@RIS: The fund don't come from us so we will always choose the best brand and system.

JAN@RIS: if u cannot see a suitable land , then I suggest you go to Batang ai, we can use floating methods. Save all the budget on land preparation. Just float.

“Bacteriological analysis revealed that 86%, 35% and 8% of water samples exceeded the normal range for total coliform count, total E. coli count and faecal streptococci count respectively, which may be due to neglected pond management. Therefore, it is necessary to protect the environment near the fish ponds from weeds and pollutants. The micro-organisms can enter fish ponds passively through rainfall, weeds and wind. Before stocking, it is better to examine the water samples for water quality to provide the optimum environment for fish culture, as the increase or decrease in physio-chemical and bacteriological parameters could act as predisposing factors and results in infection in fish” We have to ensure the system is able to guarantee the capability of preventing this.

JAN@RIS: High turbidity and Fish grills

High turbidity of water can decrease fish productivity, as it will reduce light penetration into the water and thus oxygen production by the water plants. Dissolved suspended solids will also clog filters and injure fish gills.

That's our job

JAN@RIS: There too much to do. We can't guarantee the irrigation and construction can handle the climate change

JAN@RIS: Temperature

JAN@RIS: Handling the water quality is the core of breeding.

JAN@RIS: My farm. I don't have to think on all this.

JAN@RIS: When u breed, 1 by 1 (water quality chart) it means something. U will remember when your fish died of grill injury.

The Pharma Innovation Journal http://www.thepharmajournal.com

Table1: Comparison of water quality parameters of samples with standard values

Parameters	Normal range	Minimum	Maximum	Mean ±SE	POV
Temperature (°C)	20 to 30	23.9	33.2	26.58±0.214	7%
pH	6.5 to 9	4.9	11.6	7.26±0.105	24%
Turbidity (NTU)	20 to 30	0.13	90	12.9±1.538	9%
DO (ppm)	>5	3.6	9.1	6.9±0.101	2%
Salinity (ppt)	< 2	0.01	0.74	0.079±0.01	0%
Conductivity (µS/cm)	30 to 5,000	38.2	747	143.57± 13.607	0%
TDS (ppm)	400	12.6	440	72.16±7.167	1%
Total hardness (ppm)	75-150	25	250	67±3.808	3%
Fluoride (ppm)	<1.5	0	0.5	0.44±0.016	0%
Chloride (ppm)	60	10	100	31.4±13.47	4%
Nitrate (ppm)	0-100	45	100	86.8± 2.36	0%
Ammonia (ppm)	<0.2	0	1.5	0.3± 0.043	38%

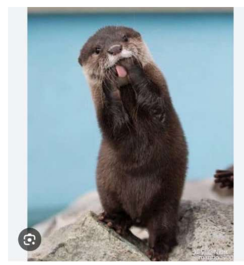
*POV – Percentage of variation from normal range

Table 2. Season wise comparison of water samples using analysis of variance (ANOVA)

Parameters	Winter	Summer	South west monsoon	North-east monsoon	P value	Level of significance
Temperature (°C)	25.25 ± 0.10	27.73± 0.54^{a}	25.96±0.13^{ab}	27.39± 0.51^{a}	0.003	**
Turbidity (NTU)	21.69 ± 3.63^{a}	9.13±1.78^{b}	11.25 ±2.4^{b}	9.54± 3.53^{b}	0.001	**
pH	7.43 ± 0.16^{ab}	8.01± 0.29^{a}	6.70± 0.12^{b}	6.92 ±0.09^{b}	0	**
Salinity (ppt)	0.38 ± 0^{ab}	0.72± 0.02^{a}	0.12± 0.02^{bc}	0.07± 0.01^{c}	0	**
Conductivity(µS/cm)	112.86 ±11.21^{ab}	95.90 ±13.15^{b}	221.10±41.65^{a}	144.43± 25.23^{a}	0.02	*
TDS (ppm)	57.99 ± 6.80^{ab}	43.45± 4.64^{b}	110.99 ±21.69^{a}	78.03± 14.21^{a}	0.002	**
DO (ppm)	6.75 ± 0.17^{ab}	7.50 ±0.22^{a}	6.58±0.21^{b}	6.76± 0.14^{ab}	0.015	*
Total Hardness (ppm)	73.0 ± 8.40	71.0 ±8.5	63.0± 8.79	61.0 ±3.84	0.446	Ns
Fluoride (ppm)	0.46 ± 0.27	0.44 ±0.03	0.40± 0.04	0.46 ±0.02	0.522	Ns
Chloride(ppm)	36.0 ± 2.76	30.4 ±2.54	29.6 ±3.67	29.60 ±2.61	0.081	Ns
Ammonia (ppm)	0.26 ± 0.77	0.20 ±0.06	0.34± 0.09	0.40 ±0.10	0.615	Ns
Nitrate(ppm)	100.0 ± 0^{a}	95.6± 3.04^{a}	64.80 ±5.38^{b}	86.8± 4.79^{a}	0	**
Total coliform (MPN/100mL)	748.68 ± 113.63^{a}	661.59± 122.02^{ab}	491.86± 120.36^{b}	375.40± 92.22^{b}	0.032	*
E. coli (MPN/ 100mL)	196.25 ±61.72	204.31± 73.10	137.74 ±52.55	73.85± 28.35	0.678	Ns
Faecal streptococci count (MPN/100mL)	44.49 ± 20.31^{a}	6.99± 2.18^{b}	31.31± 11.18^{a}	28.56± 10.39^{a}	0.015	*

Means having different letters having superscript differ significantly, * & **- significant at 1% and 5% level of significance respectively, ns- non significant (p value >0.05 is non-significant)

U will know what is turbidity. All these u hope u know as much and do as much. Only proper data analytics can tell you something.



JAN@RIS: The farm which we conducted PoC was attacked by this fella. This kills all the fish. It shows we need to also incorporate more surveillance and sensor in entry point to deter entry.

Turbidity is a measure of the level of particles such as sediment, plankton, or organic by-products, in a body of water. I told u is a cycle. Paul can handle this. To build a natural and a balance environment to improve fertility. No one understand yet. This fish eats plankton and so on, I am referring to turbidity.

TURBIDITY

TURBIDITY

TURBIDITY

not just turbidity....

JAN@RIS: The learning curve is real.

It will lead u back to nature. the other species will take care of plankton...for u.

U can sleep at night...

JAN@RIS: Is it because u are not good enough? No. Don't sleep and go away. As long as it breath u stay with them. Like my cats. FIP another F. If u have 1million broodstock. U can't sleep. I sleep with my cats. if the system is not automated or allows control remotely, it does not help to free up your manpower. So it's call mortality rates.

Switzerland is cold and full developed for aquaculture mortality rates 25% Singapore. hot and dirty water.

JAN@RIS: So it's call mortality rates. Switzerland is cold and full developed for aquaculture mortality rates 25%

JAN@RIS: We can do 50 /50, improved to 25% like Switzerland.

Switzerland 24% Malaysia 50% Singapore 70%

BIOSECURITY TO ADDRESS MORTALITY RATE

Among the challenges faced by Singapore's fledgling aquaculture sector is the high fish stock mortality rate, with some traditional farms in Singapore reporting a rate as high as 70 per cent, which Dr Koh called a "very high number".

JAN@RIS: Two business sector1) fish breeding 2) fish food that's the protein sources

JAN@RIS: The fish food production itself sustains the main operating cost of the fish breeding.

JAN@RIS: Fish food production is the supplementary core business capability. Now. Sarawak has none. Relying on imports.

JAN@RIS: Instead of buying feed gred we need to raise our own feed gred.

JAN@RIS: And worms.

JAN@RIS: that's all.

JAN@RIS: those are the Q AND A answered

Preparation and construction of such ponds and their associated structures

KNOWLEDGE Resources: FAO

1. GENERAL BACKGROUND

1.0 Introduction

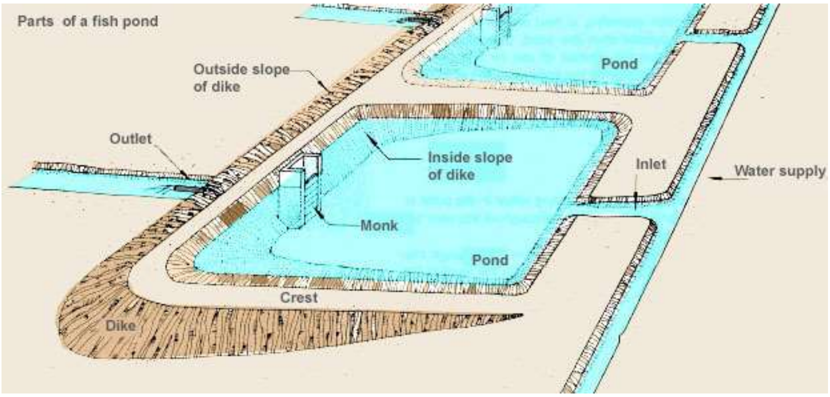
1. A large part of the world's fish culture production relies on the use of freshwater ponds which hold and exchange water, receive fertilizer or feed, and allow for holding, rearing and harvesting of fish. **The proper preparation and construction of such ponds and their associated structures are essential for successful fish farming.** Good ponds should be inexpensive to construct, easy to maintain and efficient in allowing good water and fish management.

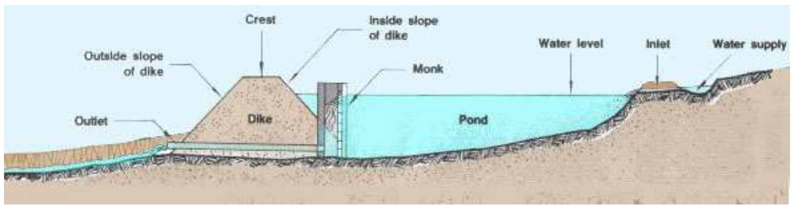
2. The purpose of this manual on Simple Methods for Aquaculture (**Pond construction for freshwater fish culture**, FAO Training Series) is to provide the basic knowledge needed to build good, efficient and reliable pond systems. This manual should ideally be used together with earlier manuals on Simple Methods for Aquaculture (**Water for freshwater fish culture**, FAO Training Series, **4; Soil and freshwater fish culture**, FAO Training Series, **6; Topography for freshwater fish culture,** FAO Training Series, **16**). The next manual in this series will deal with pond and fish management (**Management for freshwater fish culture,** FAO Training Series, **21**).

1.1 Features of a fish pond

1. Although there are many kinds of fish ponds, the following are the main features and structures associated with them in general:

- **pond walls or dikes,** which hold in the water;
- **pipes or channels,** which carry water into or away from the ponds;
- **water controls,** which control the level of water, the flow of water through the pond, or both;
- **tracks and roadways** along the pond wall, for access to the pond;
- **harvesting facilities** and other equipment for the management of water and fish.





Note: in this manual, a fish pond is defined as an artificial structure used for the farming of fish. It is filled with fresh water, is fairly shallow and is usually non-flowing. Tidal ponds, reservoirs, storage tanks, raceways and fish farm tanks are not included.

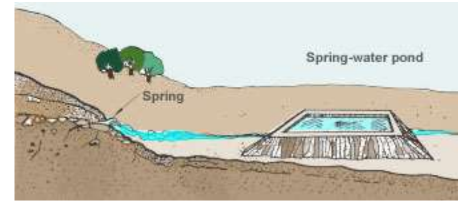
1.2 Different kinds of pond

1. Freshwater fish ponds differ according to their source of water, the way in which water can be drained from the pond, the material and method used for construction and the method of use for fish farming. Their characteristics are usually defined by the features of the landscape in which they are built. Ponds can be described as follows.

According to the water source

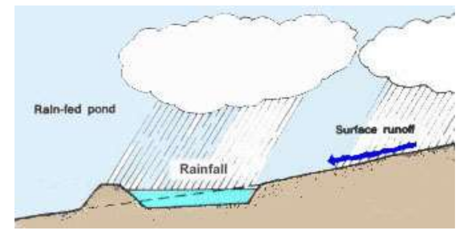
2. Ponds can be fed by **groundwater:**

(a) **Spring-water ponds** are supplied from a spring either in the pond or very close to it. The water supply may vary throughout the year but the quality of the water is usually constant.

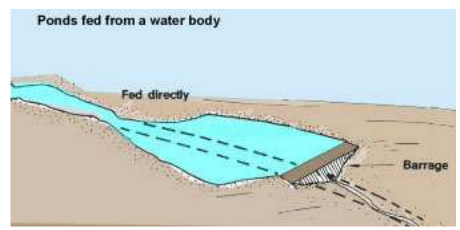


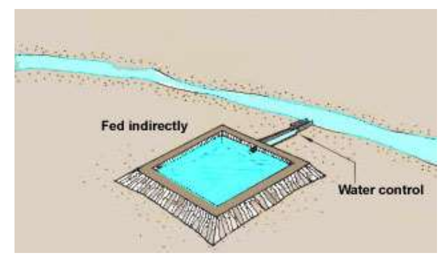
(b) **Seepage ponds** are supplied from the water-table by seepage into the pond. The water level in the pond will vary with the level of the water-table.

3. **Rain-fed ponds** are supplied from rainfall and surface runoff. No water is supplied during the dry season. These ponds are often small depressions in impermeable soil, with a dike built at the lower side to retain more water.

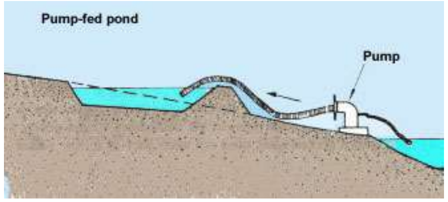


4. **Ponds can be fed from a water body** such as a stream, a lake, a reservoir or an irrigation canal. These may be **fed directly** (e.g. **barrage ponds**), by water running straight out from the water body to the ponds, or **indirectly** (e.g. **diversion ponds**), by water entering a channel from which controlled amounts can be fed to the ponds.





5. **Pump-fed ponds** are normally higher than the water level and can be supplied from a well, spring, lake, reservoir or irrigation canal, by pumping.

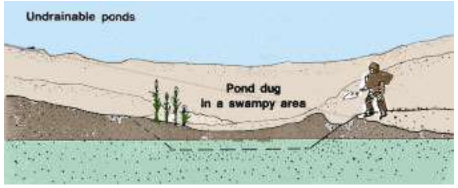


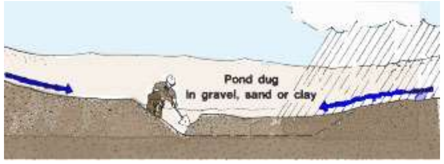
According to the means of drainage

6. **Undrainable ponds** cannot be drained by **gravity***. They are generally fed by **groundwater** and/or **surface runoff**, and their water level may vary seasonally. Such ponds have two main origins.

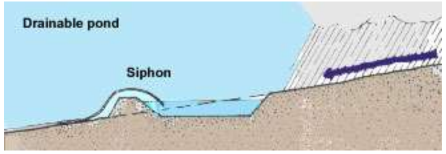
(a) They may be dug in swampy areas where there is no source of water other than groundwater.

(b) They may result from the extraction of soil materials such as gravel, sand or clay.

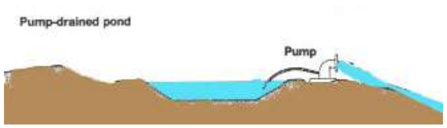




7. **Drainable ponds** are set higher than the level to which the water is drained and can easily be drained by **gravity***. They are generally fed by surface water such as **runoff***, a spring or stream, or are pump-fed.

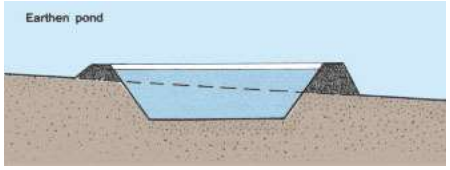


8. **Pump-drained ponds** may be drainable by gravity to a certain level, and then the water has to be pumped out. Other ponds, similar to undrainable ponds, must be pumped out completely. These ponds are only used where groundwater does not seep back in to any extent.



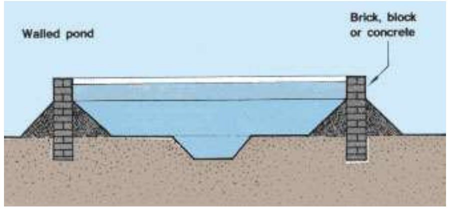
According to the construction materials

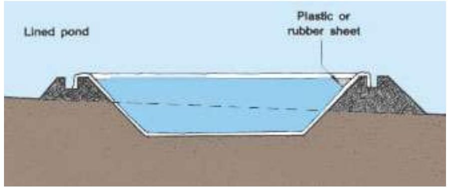
9. **Earthen ponds** are entirely constructed from soil materials. They are the most common, and you will learn primarily about these ponds in this manual.



10. **Walled ponds** are usually surrounded by blocks, brick or concrete walls. Sometimes wooden planking or corrugated metal is used.

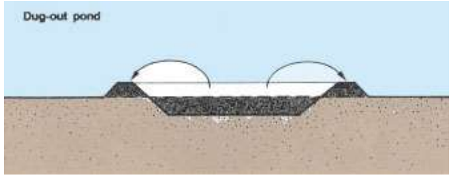
11. **Lined ponds** are earthen ponds lined with an impervious material such as a plastic or rubber sheet.



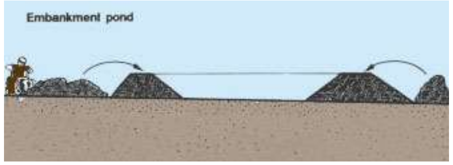


According to the construction method

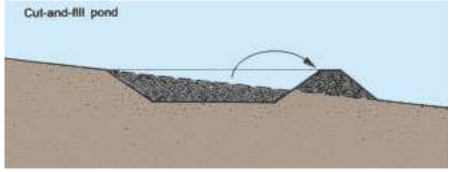
12. **Dug-out ponds** are constructed by excavating soil from an area to form a hole which is then filled with water. They are usually undrainable and fed by rainfall, surface runoff* or groundwater.



13. **Embankment ponds** are formed without excavation by building one or more dikes above ground level to impound water. They are usually drainable and fed by **gravity*** flow of water or by pumping.



14. **Cut-and-fill ponds** are built by a mix of excavation and embankment on sloping ground. They are usually drainable, and water, which is impounded within the dikes, is fed by gravity or by pumping.



According to the use of the pond

15. There may be different types of pond on a fish farm, each used for a specific purpose:

- **spawning ponds** for the production of eggs and small fry;
- **nursery ponds** for the production of larger juveniles;
- **brood ponds** for broodstock rearing;
- **storage ponds** for holding fish temporarily, often prior to marketing;
- **fattening ponds**, for the production of food fish;
- integrated ponds which have crops, animals or other fish ponds around them to supply waste materials to the pond as feed or fertilizer;
- wintering ponds for holding fish during the cold season.

1.3 Three basic pond types

1. As you have just learned, there are many types of pond. As shown in **Table 1**, they can be conveniently grouped into three basic types depending on the way the pond fits in with the features of the local landscape.

TABLE 1
Basic types of freshwater ponds

BASIC TYPE OF POND (subtypes, see Section 17)	MAIN WATER SUPPLY: Groundwater – Seepage	Groundwater – Spring	Surface water – Rainfall and surface run-off	Water body – Direct	Water body – Indirect	Pumped – Various sources	DRAINING – Undrain-able	DRAINING – Drain-able	DRAINING – Pumped	CONSTRUCTION METHOD – Dug-out	CONSTRUCTION METHOD – Embank-ment	CONSTRUCTION METHOD – Cut-and fill
SUNKEN POND single water supply any combination of supply	●	●	●		●		●		○	●	○	○ sloping ground
BARRAGE POND without diversion canal with diversion canal in series		○	●	●	●		○	●	○		● dam	
DIVERSION POND in series in parallel			○		●	●		●	○		● flat ground	● sloping ground

● Most common
○ Less common

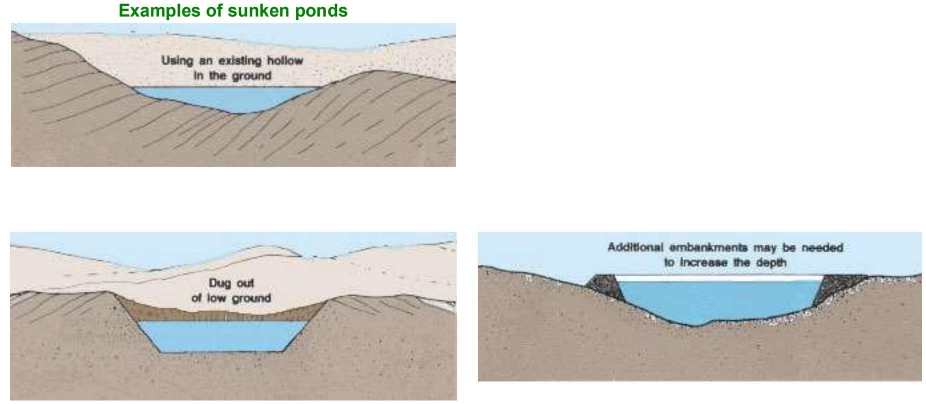
Sunken pond

2. The pond floor is generally below the level of the surrounding land.

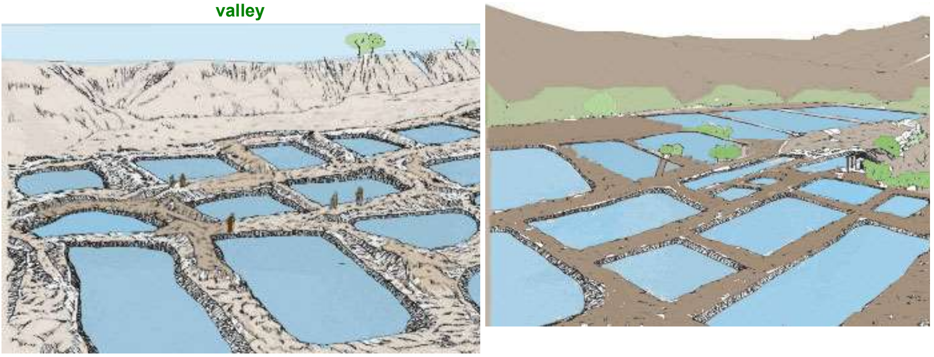
3. The pond is directly fed by groundwater, rainfall and/or surface runoff. It can be but is not normally supplemented by pumping.

4. The sunken pond is undrainable or only partially drainable, having been built either as a **dug-out pond** or to make use of an **existing hollow** or depression in the ground, sometimes with **additional embankments** to increase depth.

Examples of sunken ponds



Examples of sunken ponds built on the bottom of a valley



Barrage pond

5. They are created in the bottom of a valley by building a **dam** across the lower end of the valley. They may be built in a series down the valley.

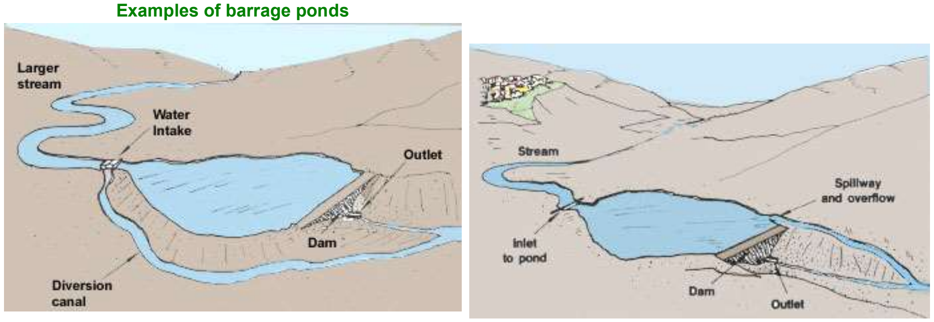
6. The barrage pond is drainable through the old river bed.

7. If large floods are present, the excess water is normally diverted around one side of the pond to keep the level in the pond constant. A **diversion canal** is built for this purpose; the pond water supply is then controlled through a structure called the **water intake.**

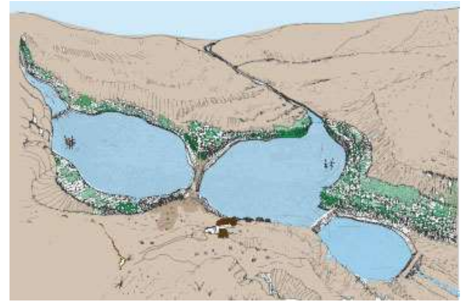
8. Directly fed from a nearby spring, stream or reservoir, the water enters the pond at a point called the **inlet** and it flows out at a point called the **outlet.**

9. To protect the dike from floods, a **spillway** should be built.

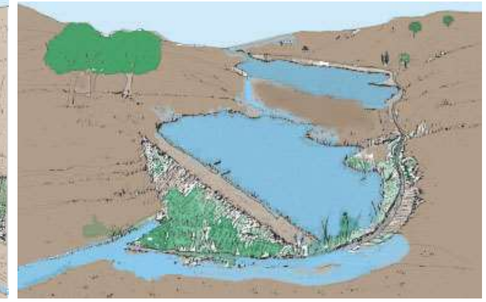
Examples of barrage ponds



Barrage ponds in a V-shaped valley, with no diversion canal



Barrage ponds in series with diversion canal



Diversion pond

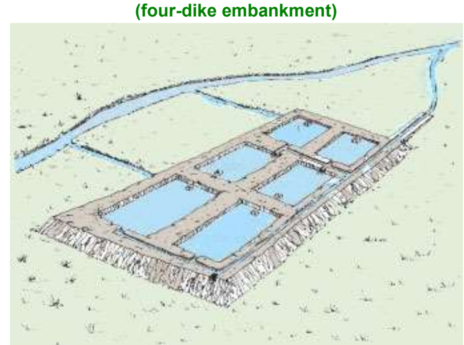
10. The diversion pond is fed indirectly by gravity or by pumping through a diversion canal (which becomes the **main feeder canal**), from a spring, stream, lake or reservoir. The water flow is controlled through a water intake. There is an inlet and an outlet for each pond.

11. The diversion pond can be constructed:

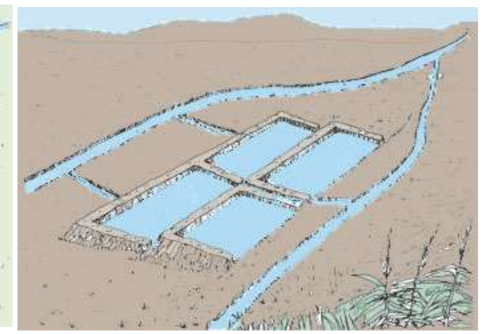
- either on sloping ground as a cut-and-fill pond;
- or on flat ground as a four-dike embankment pond sometimes called a **paddy pond.**

12. It is usually drainable through a drainage canal.

Diversion or paddy ponds built on flat ground (four-dike embankment)



Cut-and-fill diversion ponds built on sloping ground



1.4 Advantages and disadvantages of these types of pond

1. The advantages and disadvantages of the three basic types of pond that have just been defined are summarized in Table 2. It is important to remember the following points.

2. Better control of the water supply means easier management of the pond, e.g. when fertilizing the water and feeding the fish.

3. Better drainage also means easier management of the pond, e.g. when completely harvesting the farmed fish and when preparing and drying the pond bottom.

4. A regular shape and the correct size makes a pond easier to manage and more adaptable for particular purposes.

5. The choice of a particular type of pond will largely depend on the kind of water supply available and on the existing topography of the site selected (see Sections 1.6 to 1.8).

6. When you have a choice of several types of pond, you should give:

- highest priority to **diversion ponds** fed by gravity;
- lowest priority to **barrage ponds** in flooding areas requiring large diversion canals.

7. A barrage pond without a diversion canal should preferably be constructed only:

- to be supplied by local surface runoff and/or springs;
- across a stream with a small and regular water flow;
- below a reservoir where it will be supplied by a controlled water flow.

8. Unless pumping is very cheap, you should not rely on it for filling or draining ponds. Do not use it where there is excessive seepage into or out of a pond.

TABLE 2
Advantages and disadvantages of the three basic types of pond

Type	*Advantages*	*Disadvantages*
Sunken pond	No need for dikes except for flood protection No water body to supply water Little skill required for construction	Water level can greatly vary seasonally Requires more work to excavate Undrainable; uncontrolled water supply, unle pumped; pumping may be expensive Low natural productivity of groundwater Pond management difficult
Barrage pond*	Simple to design for small streams Construction costs relatively low unless there are flood defence problems Natural productivity can be high, according to quality of water supply	Dike needs to be carefully anchored Need for a spillway and its drainage canal No control of incoming water supply (quantity, quality, wild fish) Cannot be completely drained except when incoming water supply dries out Pond management difficult (fertilization, feeding) as water supply is variable Irregular shape and size
Diversion pond**	Easy control of water supply Good pond management possible Construction costs higher on flat ground Can be completely drained Regular pond shape and size possible	Construction costs higher than barrage ponc Natural productivity lower, especially if built infertile soil Construction requires good topographical surveys and detailed staking out

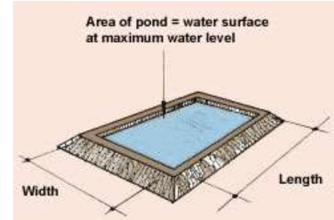
* If the barrage pond is built with a diversion canal, some of the disadvantages may be eliminated (controlled water supply, no spillway, c drainage, easier pond management), but construction costs can greatly increase if the diversion of a large water flow has to be planned
** Relative advantages will vary according to the arrangement of the ponds (see Section 16), either in series (pond management is more diffic parallel (both water supply and drainage are independent, which simplifies management).

1.5 The physical characteristics of fish ponds

1. Fish ponds are characterized by their **size, shape and water depth.**

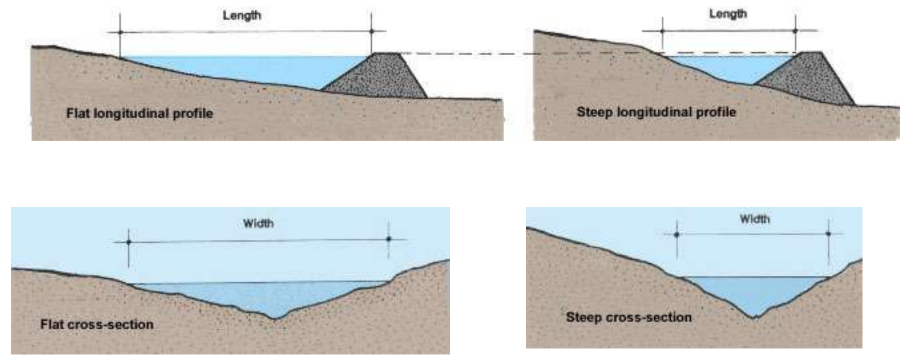
Size of fish ponds

2. The size of a fish pond is measured by its **water surface area** when the pond is full of water.



3. The size of a barrage pond depends directly on the height of the dike built across the valley and on the topography of the valley. The length and width can be found from the longitudinal profile and from the cross- sectional profiles of the valley (see Sections 9.5 and 9.6, **Topography**).

The size of a barrage pond depends on the height of the dam



4. The individual size of sunken ponds and diversion ponds can be decided upon by the farmer, considering the following factors.

(a) **Use**: a spawning pond is smaller than a nursery pond, which is in turn smaller than a fattening pond.
(b) **Quantity of fish to be produced:** a subsistence pond is smaller than a small-scale commercial pond, which is in turn smaller than a large-scale commercial pond.
(c) **Level of management:** an intensive pond is smaller than a semi-intensive pond, which is in turn smaller than an extensive pond.
(d) **Availability of resources:** there is no point in making large ponds if there are not enough resources such as water, seed fish, fertilizers and/or feed to supply them.
(e) **Size of the harvests and local market demand:** large ponds, even if only partially harvested, may supply too much fish for local market demands.

Size of fattening ponds under semi-intensive management* in Africa

Type of pond	Area (m^2)
Subsistence ponds	100-400

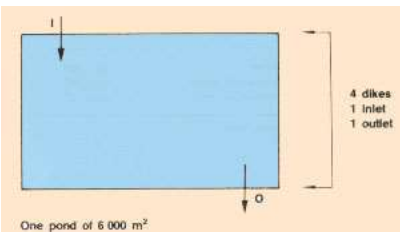
Small-scale commercial ponds	400-1000
Large-scale commercial ponds	1000-5000

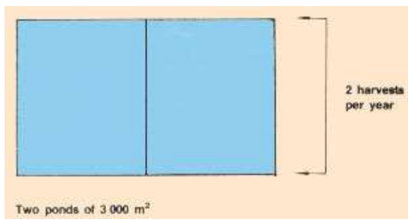
* Fertilization and some feeding

Resource availability and pond size

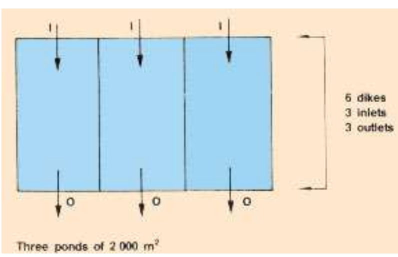
	Small pond	**Large pond**
Water	Small quantity; rapid filling/draining	Large quantity; slow filling/draining
Fish seed	Small number	Large number
Fertilizer/feed	Small amount	Large amount
Fish marketing	Small harvest Local markets	Large harvest Town markets

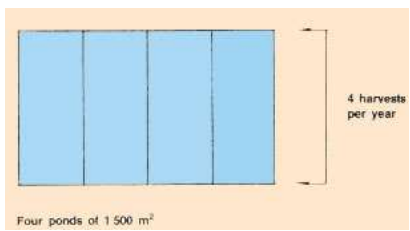
Note: when designing a fish farm with several fattening ponds, consider also that the **construction costs decrease as pond size increases,** and that the flexibility of **management improves as the number of ponds increases.**





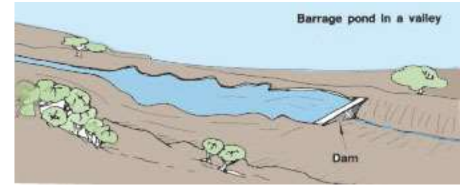
I = Inlet O=Outlet





Shape of fish ponds

5. A fish pond may have any shape, as shown by barrage ponds whose shape depends exclusively on the topography of the valleys in which they are built.

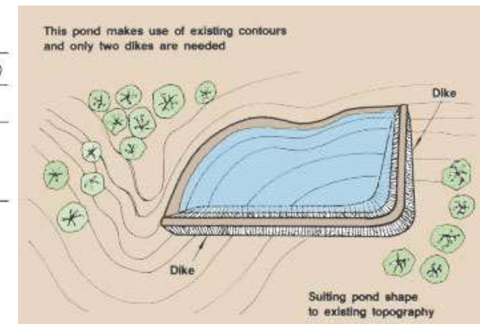


6. Generally, however, sunken ponds and diversion ponds are designed with a **regular shape**, either square or rectangular. For the same pond size, the total dike length regularly increases as the pond shape gradually deviates from square and becomes more elongated. At the same time the construction costs increase.

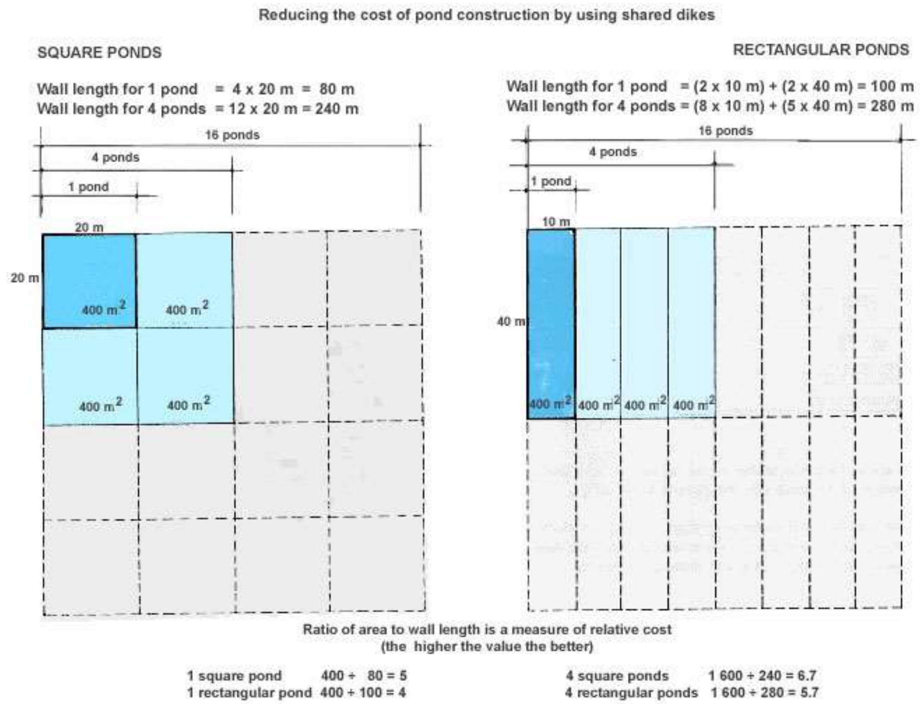
7. There are some cases where it may be simpler and cheaper to match the shape of the pond with the existing topography, (see paragraph 13).

Different shapes for a pond of 100 m²

Pond shape	*Width (m)*	*Length (m)*	*Length of dikes (m)*
Square	10	10	20 + 20 = 40
Rectangle	7	14.3	14 + 28.6 = 42.6
	5	20	10 + 40 = 50
	2	50	4 + 100 = 104



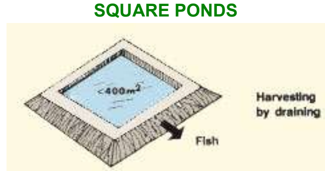
8. You will also find that rectangular ponds are not so much more expensive if you can build a group of them, with **shared walls.**



When square ponds are preferable

9. Because they are cheaper to build, **square ponds** are particularly useful as smaller ponds (up to 400 m^2), which you plan to harvest by draining.

SQUARE PONDS

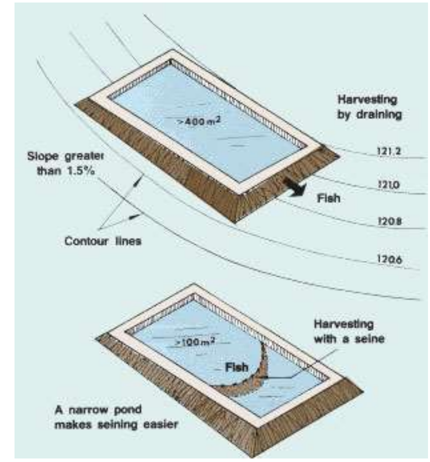


When rectangular ponds are preferable

10. You should prefer **rectangular ponds** whenever:

- you build ponds larger than 400 m^2 on land with a slope greater than 1.5 percent (see Section 1.7, paragraph 3);
- you build ponds larger than 100 m^2 and you plan to harvest your fish by seining.

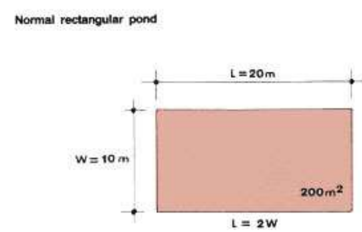
RECTANGULAR PONDS

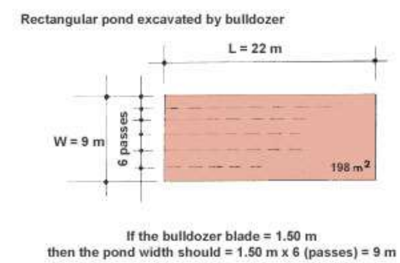


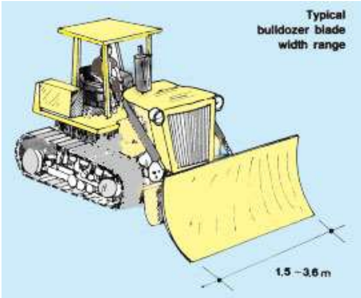
Selecting a rectangular shape

11. In general, rectangular ponds are about twice as long (**L**) as they are wide (**W**); but if you build your ponds with a bulldozer, it is cheaper to select a pond width which is a multiple of the blade width of the bulldozer.

Note: it is best to use a **standard width** for ponds that are meant for the same use. This will enable you to use standardized seine nets when harvesting them.

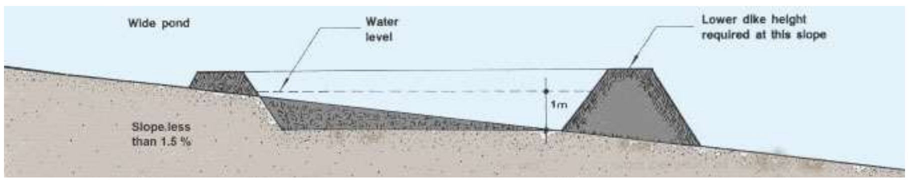


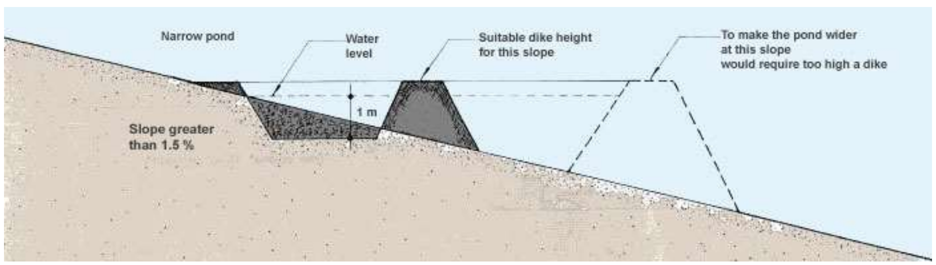




Type of pond	
Spawning	Width 1
Nursery 1	Width 2
Nursery 2	Width 3
Fattening	Width 4

12. Where the ground slope is greater than 1.5 percent (see Section 1.7), the ponds are best built with the longer sides running across the slope, with the width of the ponds limited accordingly, so that the downhill dike does not need to be too high, and so that the earth built up as walls balances the earth dug out. As the slope increases, the ponds should become narrower. You should avoid building dikes higher than three metres.





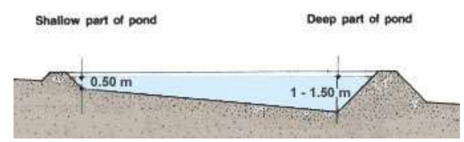
Selecting ponds shaped to the topography

13. You should select ponds shaped to fit the local topography whenever:

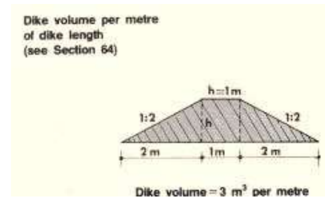
- you need to use every part of the available area;
- shaping the pond this way entails good cost savings, for example by using existing earth banks or slopes;
- a regular pond shape is not too important.

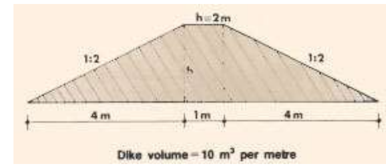
Water depth in fish ponds

14. Except in some barrage ponds built on streams with steep longitudinal (downhill) profiles, **fish ponds are generally shallow**. Their maximum water depth does not normally exceed 1.50 m. Their shallowest area should be at least 0.50 m deep to limit the growth of aquatic plants. The water depth in small rural ponds normally varies from 0.50 m (shallow area) to 1 m at the most (deep area).



15. Deeper ponds are much more expensive to build, because the volume of the dikes increases rapidly as you make ponds deeper.





16. Sometimes it is necessary, however, to use deeper ponds:

- **in dry regions** where you need to store water through the dry season to make sure there is enough for the fish;
- **in cold regions** where it may be necessary to provide the fish with a refuge in deeper, warmer waters during cold weather.

Note: during the cold season, it is sometimes better to keep the main ponds dry and to hold the fish in smaller, deeper wintering ponds. In such cases, the main ponds can be designed more cheaply. They will also warm up more quickly than deep ponds in spring.

Characteristics of shallow and deep ponds

Shallow ponds	Deep ponds
Water warms up rapidly	Deep water warmer in cold season
Great fluctuations of temperature	Water temperature more stable
Greater danger from predatory birds	Less natural food available
Greater growth of water plants	Difficult to seine in deep water
Smaller dikes needed	Strong, high dikes needed

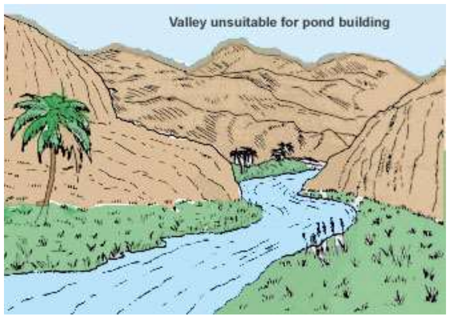
1.6 How to select the pond to suit local topography

1. In the previous manual of this series (see Section 8.2, **Topography**), you learned how to make a cross- section profile of a valley. From the general shape of this profile, you can already decide upon the type of pond which could be built:

- if the valley is deep, steep and narrow, do not build ponds;
- if the valley bottom is 50 to 100 m wide, barrage ponds might be appropriate;
- if the valley bottom is more than 100 m wide, diversion ponds could be built.

2. A more detailed study should confirm your choice, based on the longitudinal profile and on the cross-section profile of the valley. Select the type of ponds to build:

- either according to **the shape** of the valley and its profiles **(see Table 3);**
- or according to **the slope** of the longitudinal profile (downhill) and the cross-section profile of the valley **(see Table 4).**



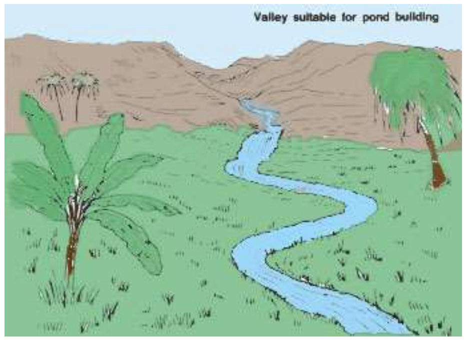
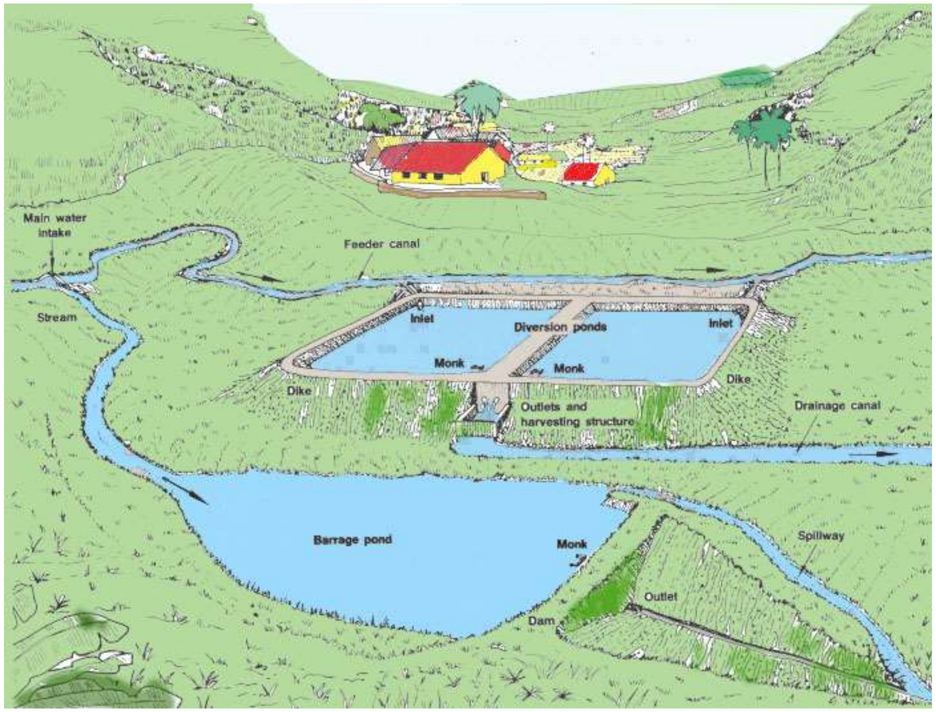


TABLE 3
Selection of pond type according to shape of valley

Type of pond	Shape of Valley cross-section profile: V	Rounded V	Centrally truncated V	Laterally truncated V
Shunken pond	—	Whenever groundwater (spring or seepage) or runoff is available		
Barrage pond	If longitudinal profile of valley has slope less than 5%	—	—	If longitudinal profile has slope less than 5% and cross-section profile has slope 5-10%
Diversion pond: cut-and-fill type	—	Where cross-section profile has slope less than 5%	Where cross-section profile has slope 0.05-5%	
Diversion pond: paddy type	—	—	Where cross-section profile has slope less than 0.5%	

TABLE 4
Selection of pond type according to valley slope

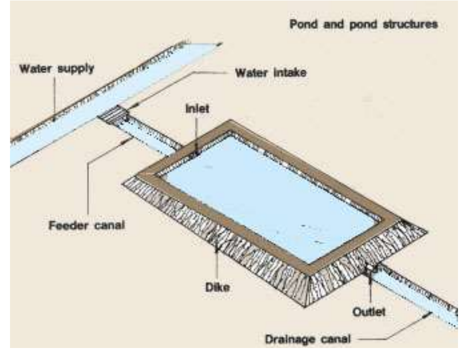
Valley longitudinal profile (downhill)	Valley cross-sectional profile	Possible type of pond
Slope greater than 5%	Slope greater than 5%	None
	Slope less than 5%	Diversion pond Sunken pond
Slope less than 5%	Slope 5-10%	Barrage pond Sunken pond
	Slope less than 5%	Diversion pond Paddy pond Sunken pond

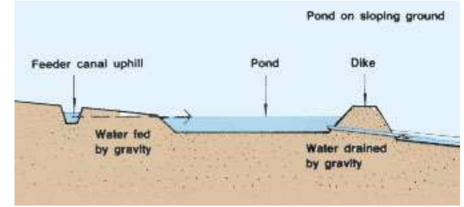


1.7 Laying out fish ponds

1. You have already learned (see Section 1.2) that several structures may be required for the good functioning of your fish ponds, particularly if you plan to have several of them in production. In the next part, you will learn how to build various structures, but right now it is important to understand the different possibilities which exist for the layout of your ponds and their structures.

2. It will always be easier to lay out your ponds if the land you select slopes slightly and if you can supply water along its highest contour line, i.e. at the top end of the site.

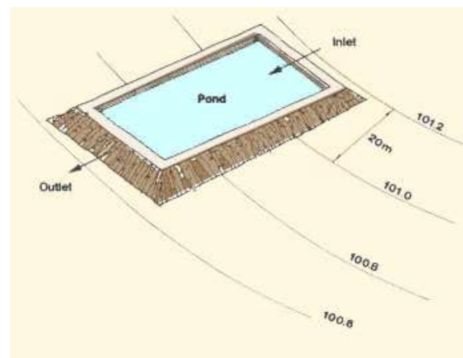


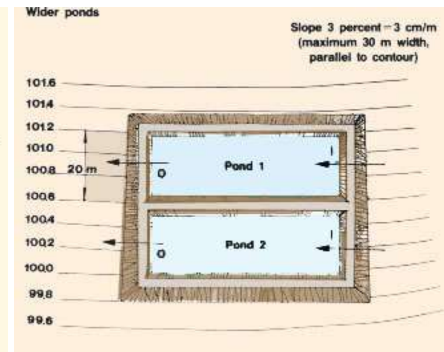


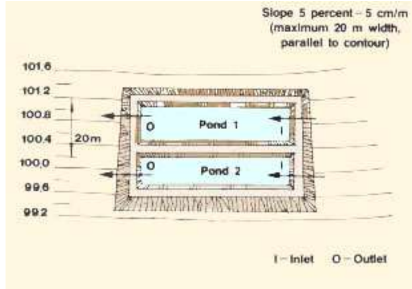
Ponds on a slope

3. If diversion ponds are built on a slope, their orientation should vary according to the angle of slope so that there is a minimum amount of earthwork:

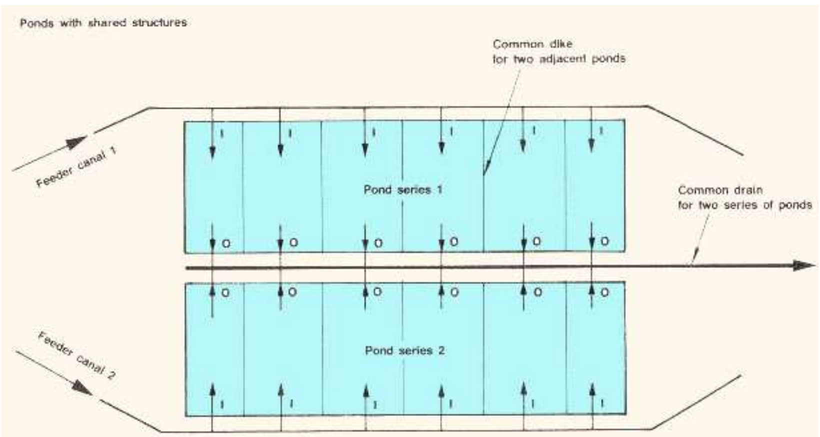
- **slope 0.5-1.5 percent:** the length of rectangular ponds should be perpendicular to the contour lines*, i.e. the ponds should run downhill so that the floor of the pond will follow the natural slope, and no excavation will be needed to make the deeper part of the ponds;
- **slope greater than 1.5 percent:** the length of rectangular ponds should be parallel to the **contour fines***, i.e. the ponds run perpendicular to the slope. You would make the ponds narrower as the slope increases (see Section 1.5, paragraph 12).







4. If there is more than one pond, you should try to share structures such as dikes, feeder canals or drains. To reduce costs, keep the length of the canals and drains as short as possible.

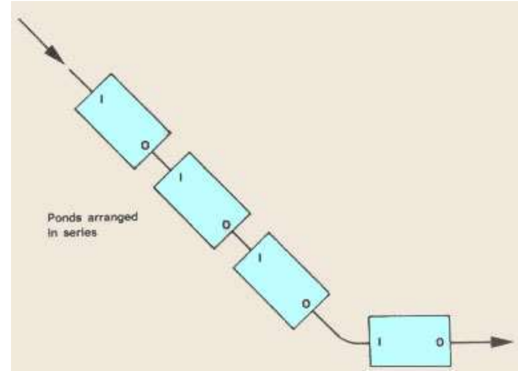


I = Inlet O = Outlet

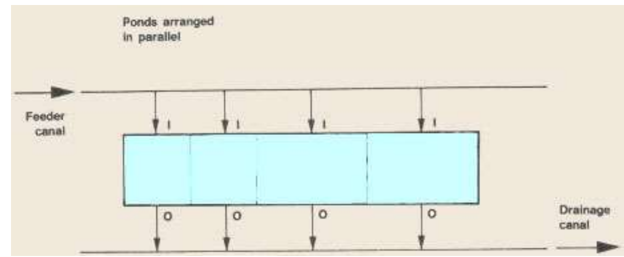
Layout of ponds

5. Lay out your fish ponds in one of the following ways.

(a) **In series:** ponds depend on each other for their water supply, the water running from the upper ponds to the lower ponds.

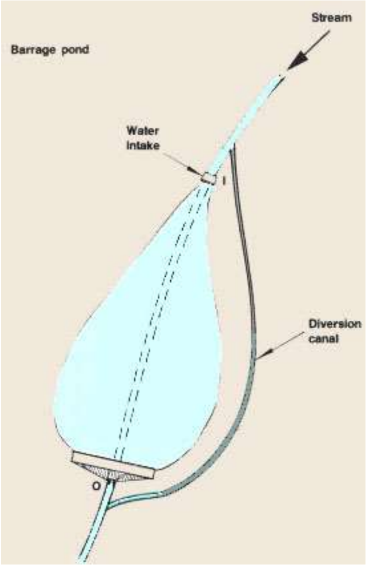


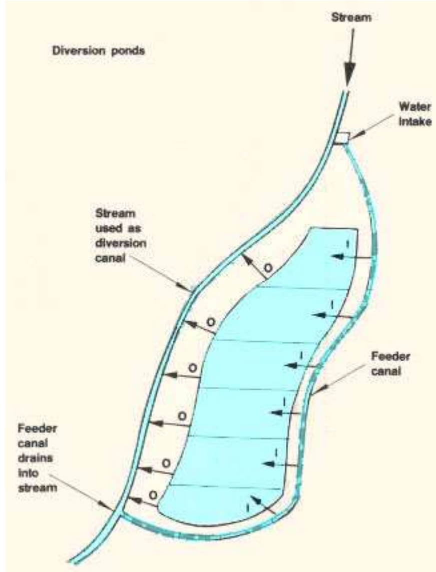
(b) **In parallel:** ponds are independent from each other, each pond being supplied directly from the feeder canal. Water has not been used after passing through another pond. This layout is to be preferred.



6. It is always best to provide **a means of diverting excess water**. In the case of barrage ponds, a diversion canal can carry the water around the pond to a point downstream from the barrage. For diversion ponds, the excess water is simply allowed to flow in the natural stream bed instead of in the feeder canal.

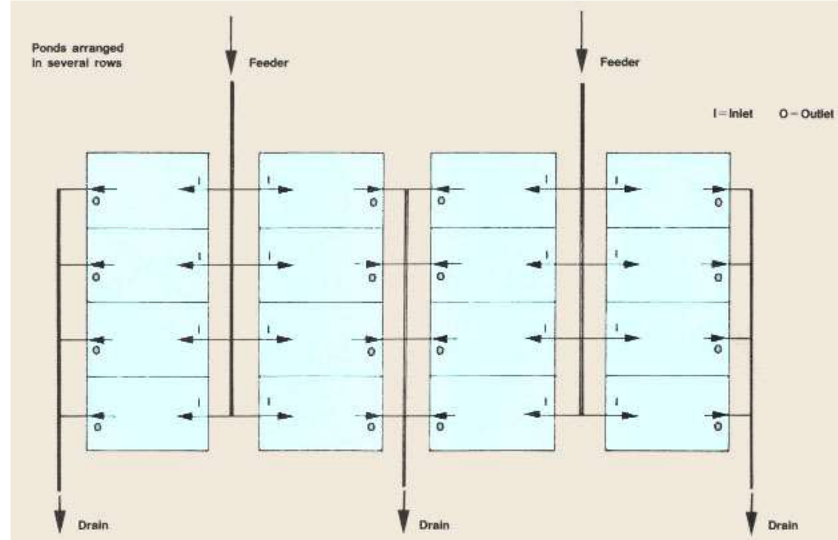
7. All feeder canals should end in a drain, so that any excess water in the canal can be discharged away from the ponds.



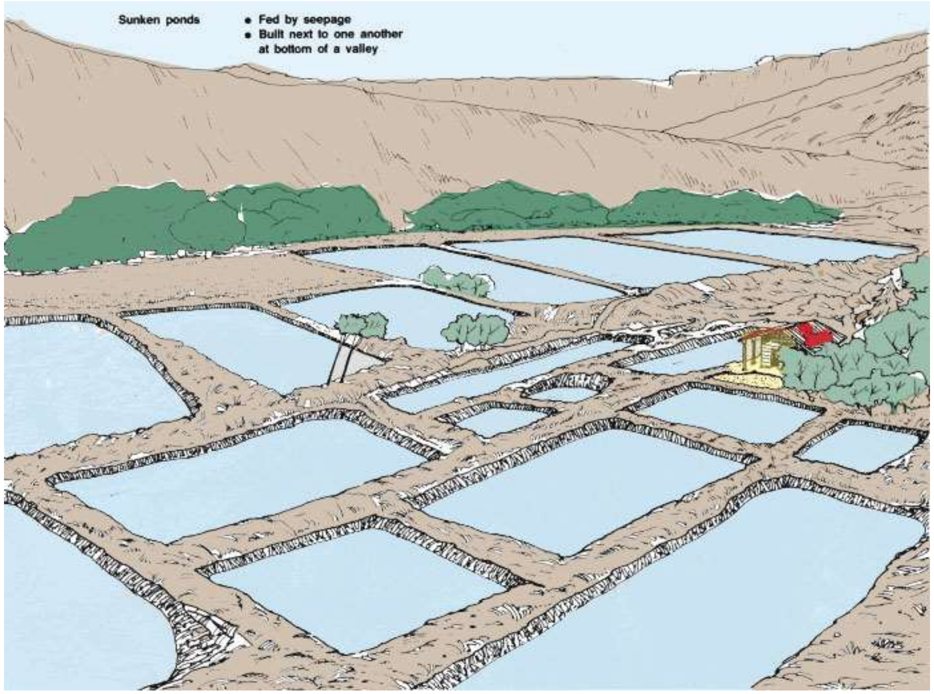


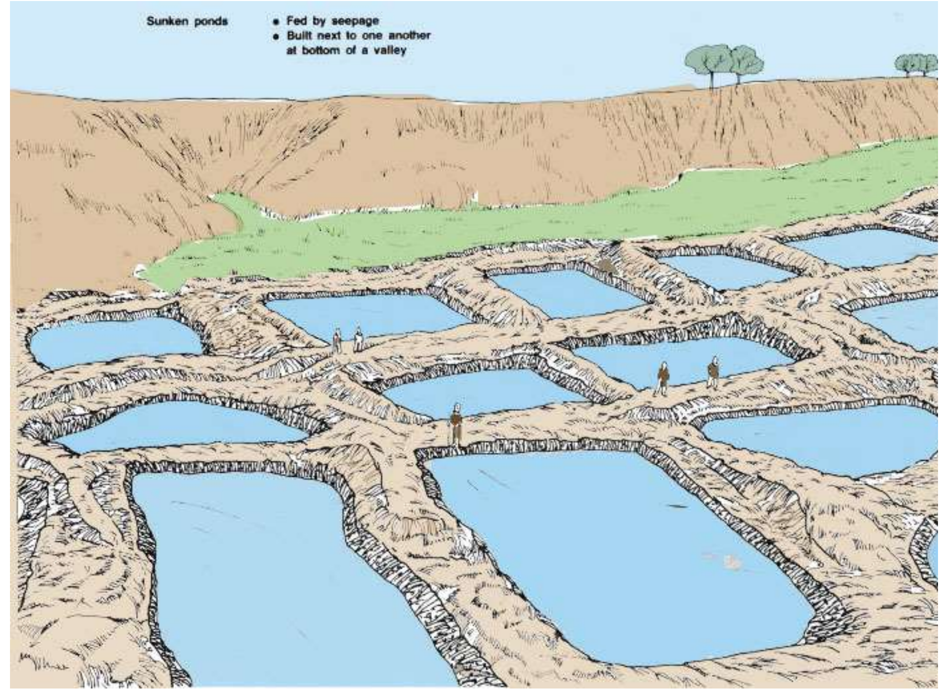
I = Inlet O = Outlet

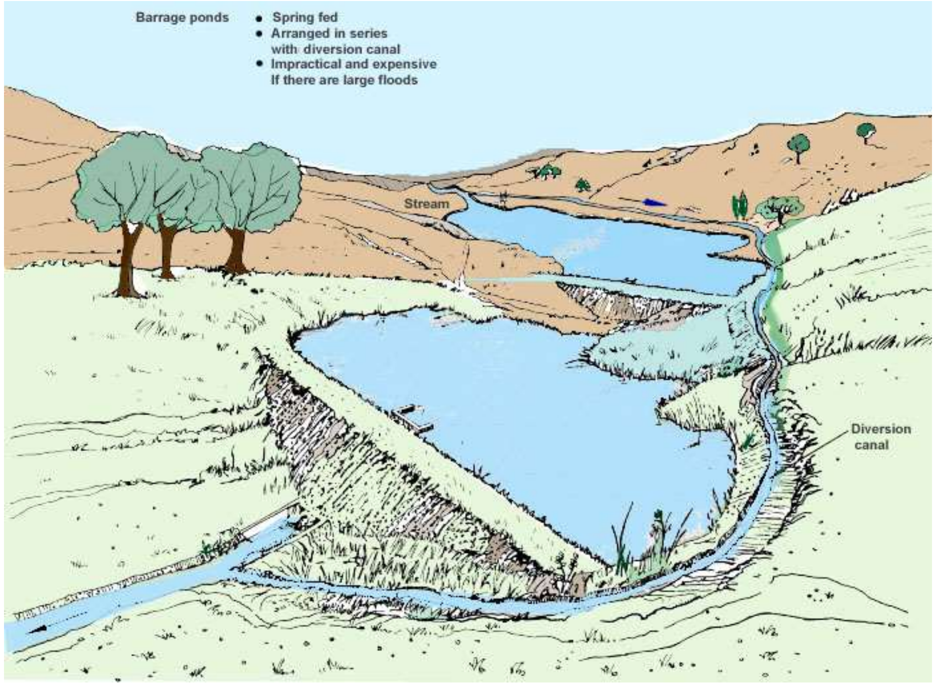
8. With **several rows of ponds**, it is always best to arrange feeder and drainage canals to serve a row of ponds on both sides of the canals.

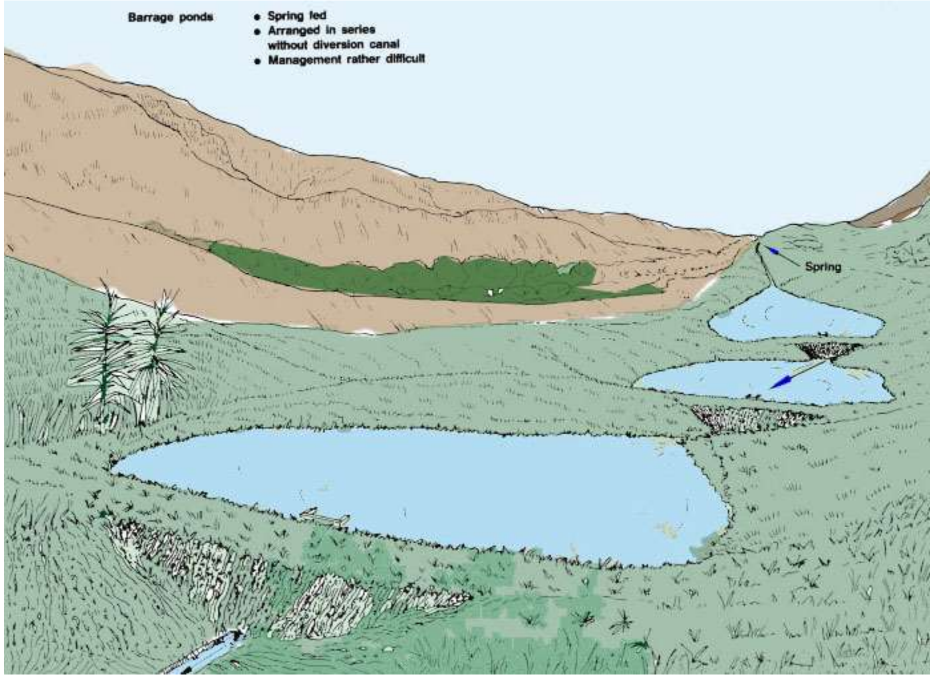


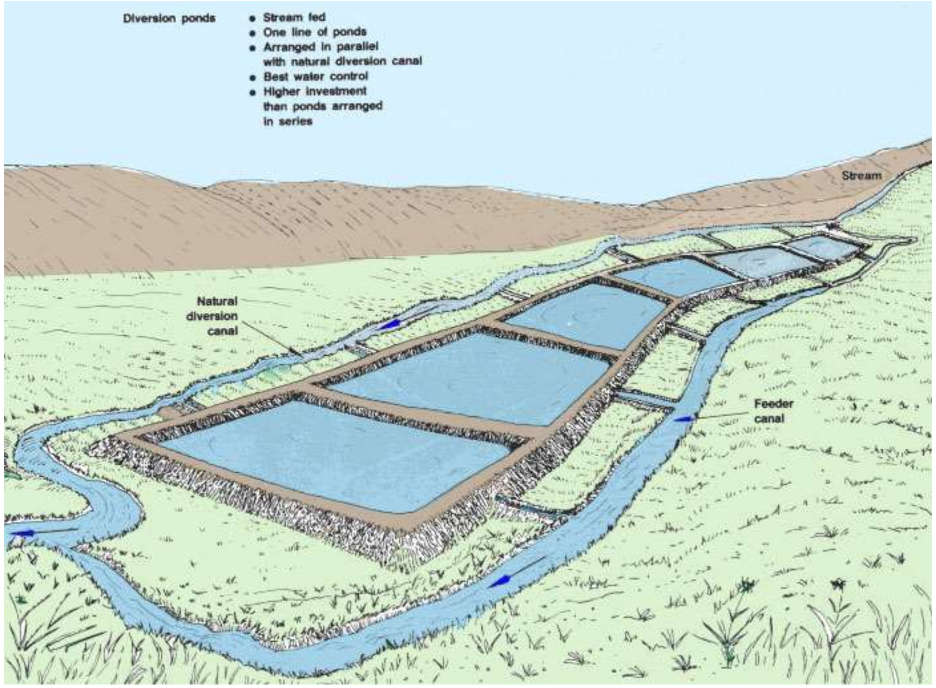
Note: below are a number of examples showing the layout of various kinds of fish ponds.

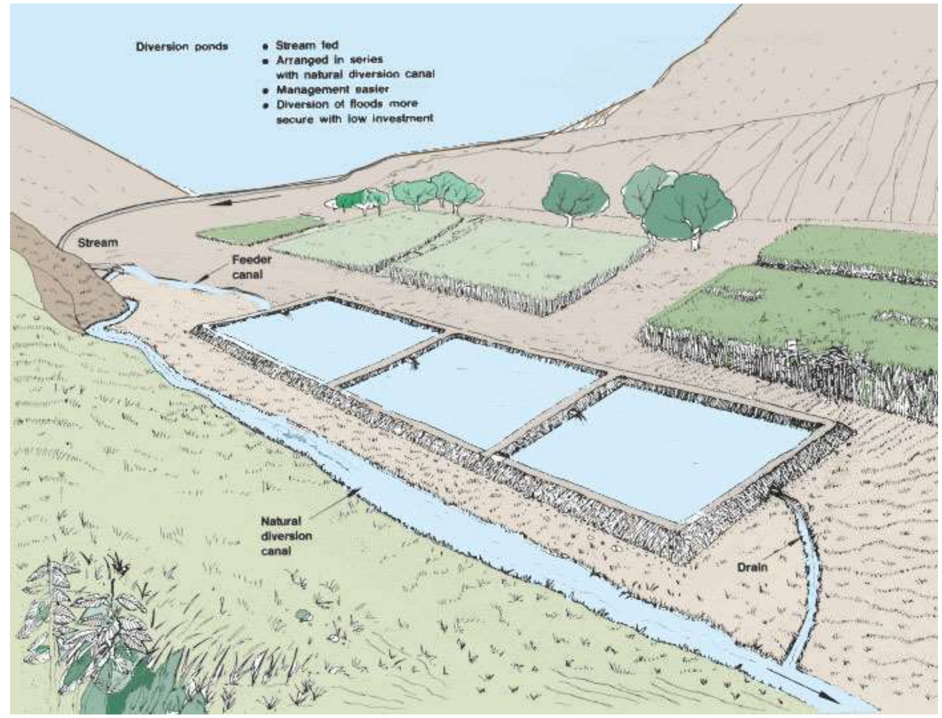

Sunken ponds
• Fed by seepage
• Built next to one another
at bottom of a valley

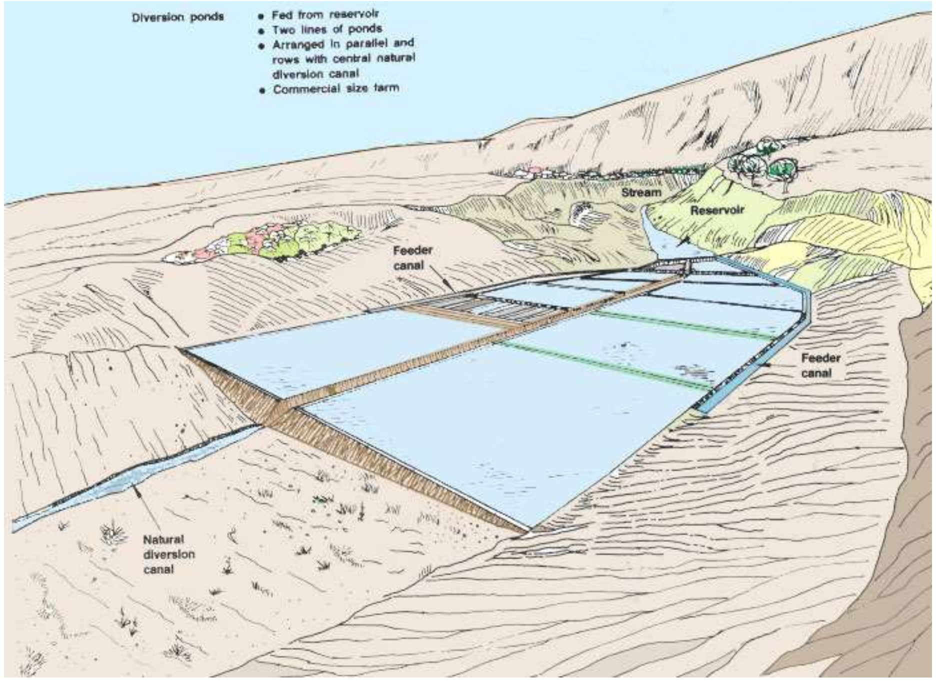

Sunken ponds
• Fed by seepage
• Built next to one another
at bottom of a valley


Barrage ponds
• Spring fed
• Arranged in series with diversion canal
• Impractical and expensive If there are large floods
Stream
Diversion canal

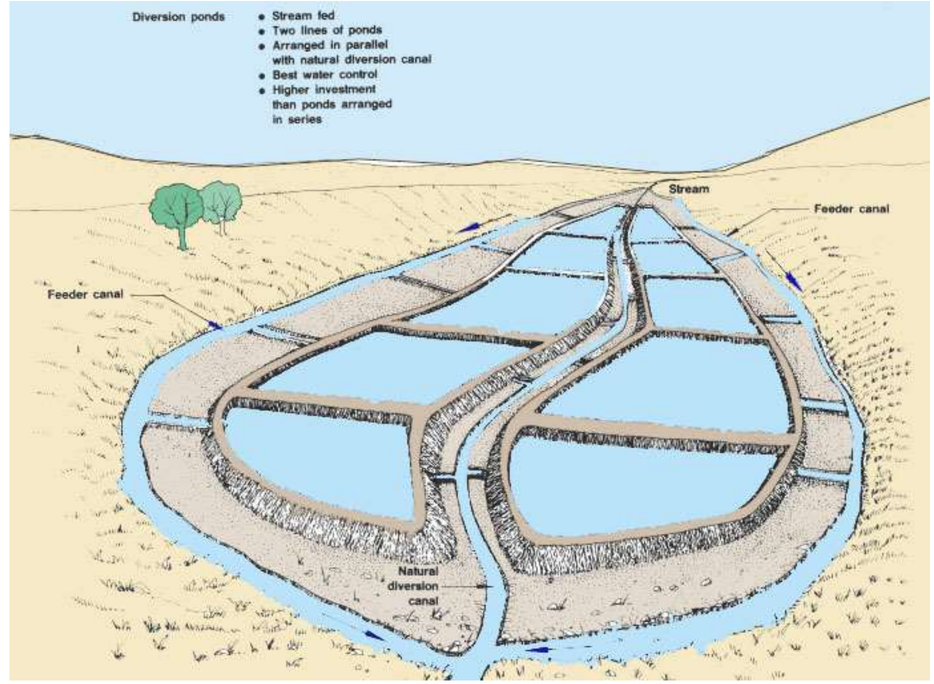

Barrage ponds
• Spring fed
• Arranged in series without diversion canal
• Management rather difficult
Spring


Diversion ponds
• Stream fed
• One line of ponds
• Arranged in parallel with natural diversion canal
• Best water control
• Higher investment than ponds arranged in series
Stream
Natural diversion canal
Feeder canal

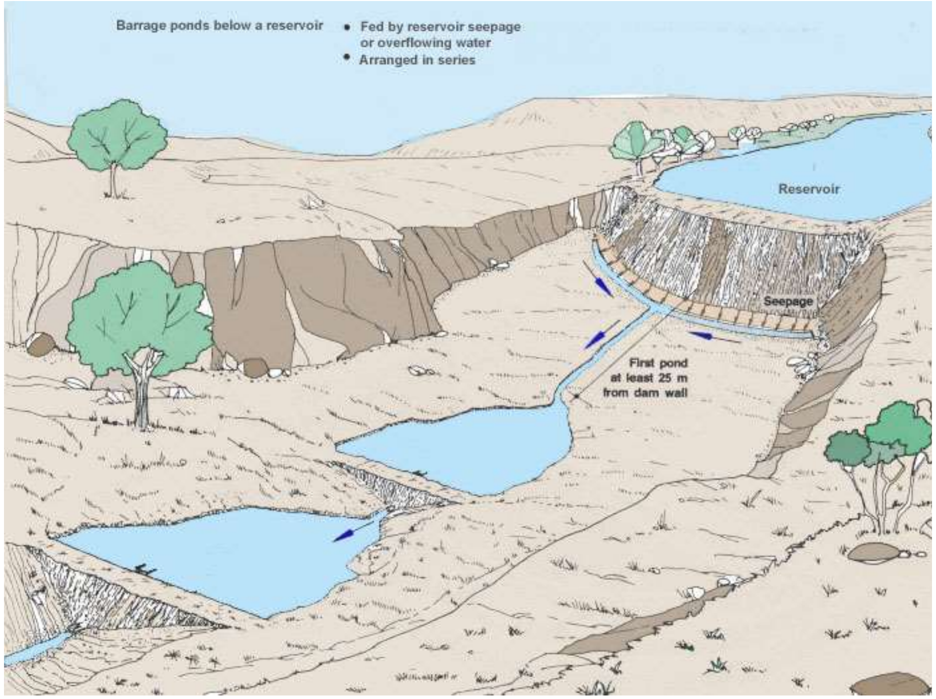

Diversion ponds
• Stream fed
• Arranged in series with natural diversion canal
• Management easier
• Diversion of floods more secure with low investment
Stream
Feeder canal
Natural diversion canal
Drain

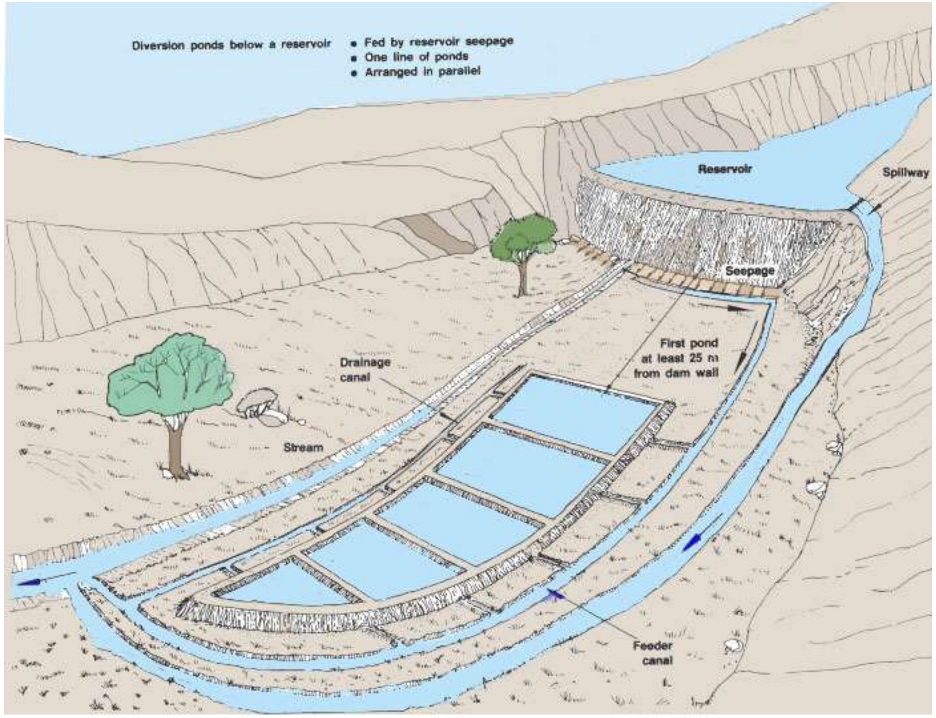


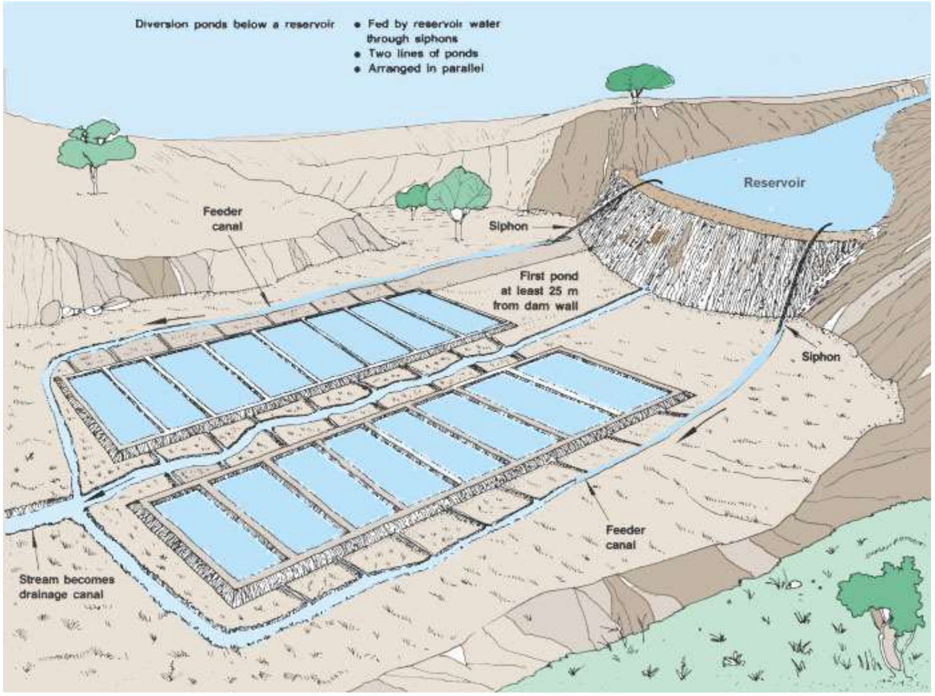
Diversion ponds
• Fed from reservoir
• Two lines of ponds
• Arranged in parallel and rows with central natural diversion canal
• Commercial size farm
Stream
Reservoir
Feeder canal
Feeder canal
Natural diversion canal



Diversion ponds
• Stream fed
• Two lines of ponds
• Arranged in parallel with natural diversion canal
• Best water control
• Higher investment than ponds arranged in series
Stream
Feeder canal
Feeder canal
Natural diversion canal


Barrage ponds below a reservoir
• Fed by reservoir seepage or overflowing water
• Arranged in series
Reservoir
Seepage
First pond at least 25 m from dam wall

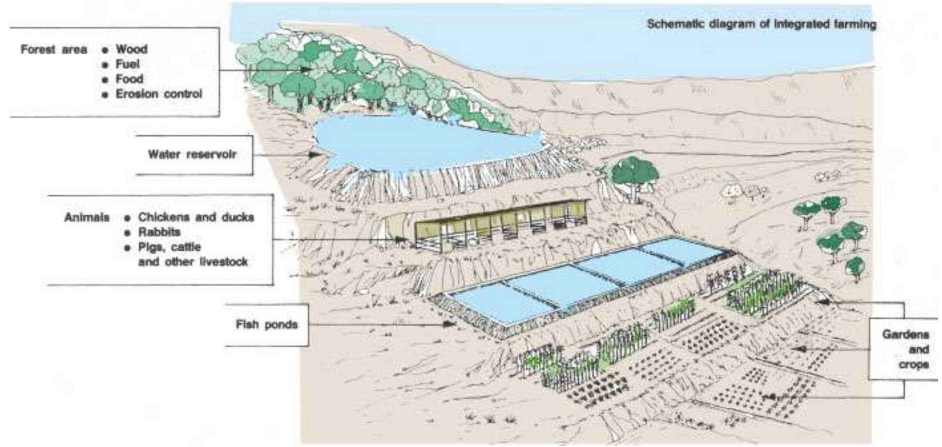

Diversion ponds below a reservoir
• Fed by reservoir seepage
• One line of ponds
• Arranged in parallel
Reservoir
Spillway
Seepage
First pond at least 25 m from dam wall
Drainage canal
Stream
Feeder canal



Integrated farming

9. The production of fish in ponds can easily be integrated with agricultural production, particularly on sloping ground.

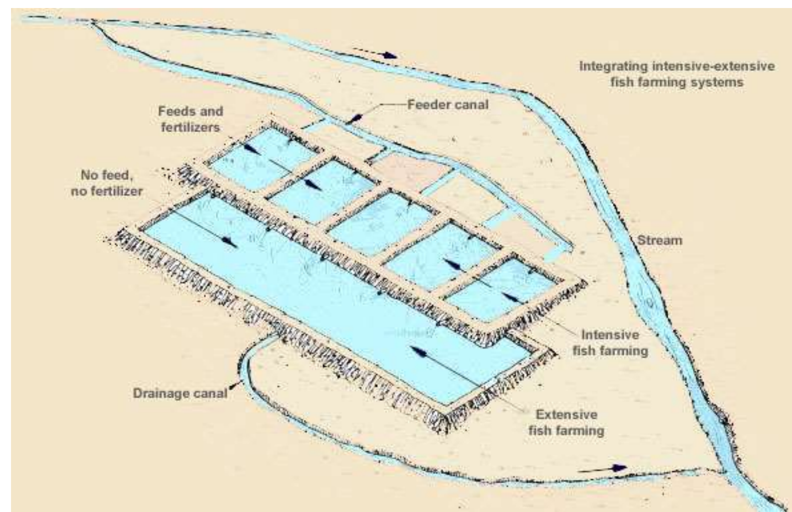
(a) On the slope itself, trees may produce wood, fuel and food. The forest cover will protect the soil well and control erosion (see Section 41, **Management**).
(b) A reservoir to store water during the dry season may be built and used for fish and agricultural production.
(c) At the lower end of the slope, fish ponds can be built.
(d) Various kinds of animals can be raised next to these ponds and can provide fertilizer for them (see Chapter 7, **Management**).
(e) Water from the ponds may be used for watering adjacent gardens and crops.
(f) Mud that accumulates on the bottom of the ponds can periodically be removed to fertilize surrounding crops.

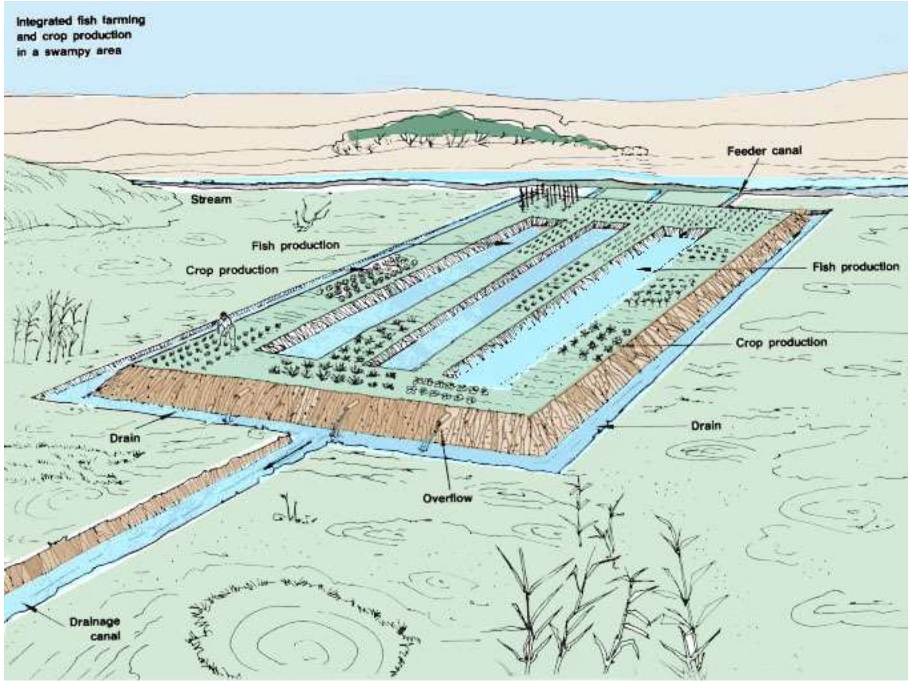


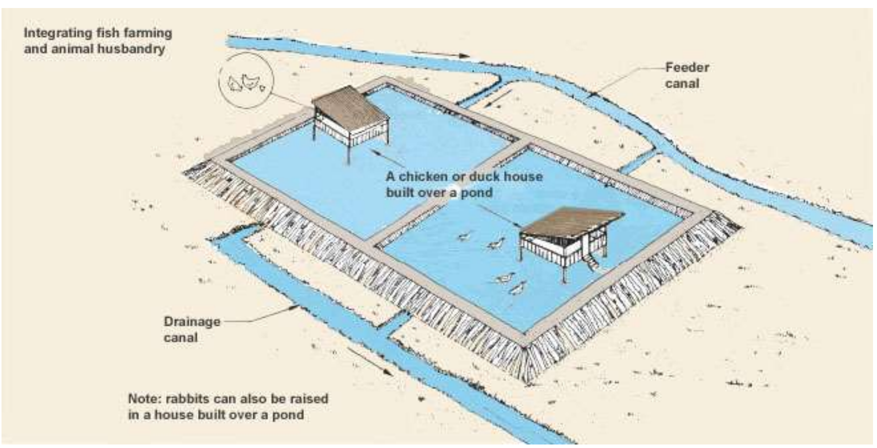
Integrated fish farming

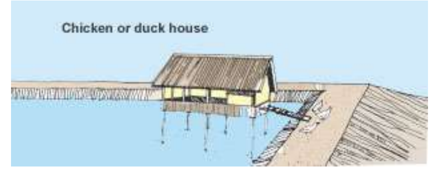
10. On your fish farm you may combine two production systems in two separate groups of ponds:

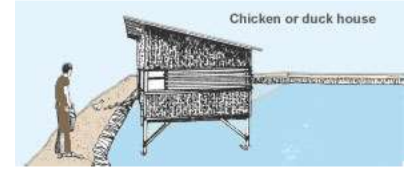
- an intensive system where fish are densely stocked and where their growth is sustained by adequate feeding, using fertilizers and feeds (see **Management**);
- an extensive system where fish are stocked at a lower density and where their growth relies only on the presence of natural food; the production of this natural food is enhanced by the rich water draining out of the intensive system into the extensive one.







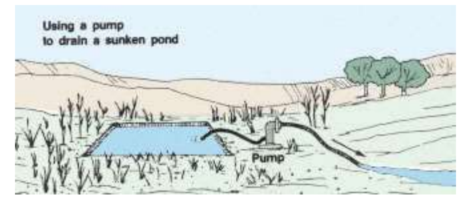




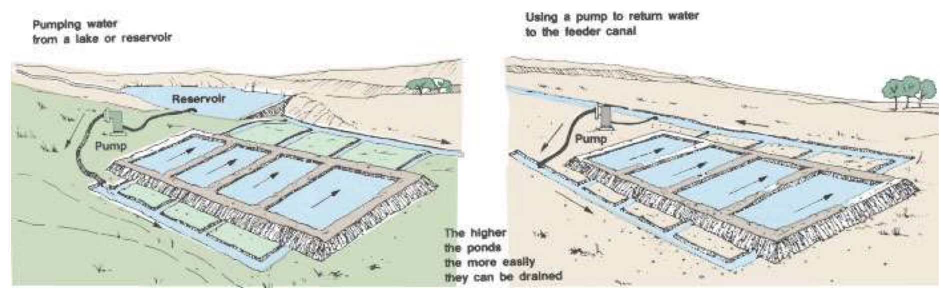
Using pumps

11. Pumping is not normally used in those layouts fed from streams or reservoirs but can be used for sunken ponds and sometimes to supply diversion ponds from a lake or reservoir. In times of severe water shortage, pumps can be used to recycle the waste water, drawn from the drainage canals and fed back to the feeder canals.

By using pumps where manual methods would be limited, you can sometimes take advantage of sites or plan your ponds more flexibly. However, using a pump involves additional costs, and re-using the waste water may cause problems to the fish. Recycling should only be considered in an emergency.

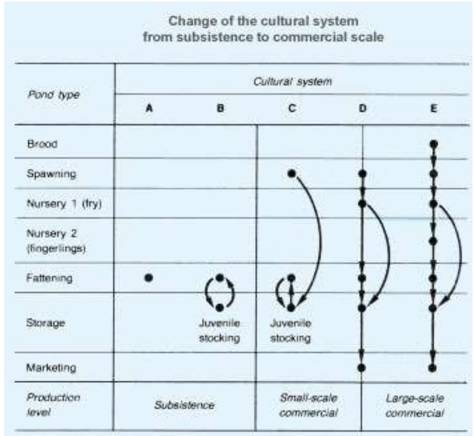


Note: In some cases drainage water may be returned to the supply



1.8 How to plan your fish farm

Considering its size and complexity



1. The size of a fish farm will vary according to the level of production you wish to reach. The greater the potential fish production, the greater the investment, and the greater the farm size. The number and size of ponds increase as the fish farm increases in scale. The culture system also becomes more complete, with special ponds for broodstock, fry and fingerlings, and storage, as well as the main ponds for producing food fish.

2. **Subsistence fish farmers** do not need more than one or two small ponds, which are used as fattening ponds and sometimes also as breeding/nursery ponds **(culture system A)**. This system can be improved by adding one or more small storage ponds to keep the harvested juveniles alive while the fattening pond is harvested, repaired and refilled with water **(culture system B)**.

3. **Small-scale commercial fish farms** usually add one or more spawning ponds and nursery ponds, making the farm independent as far as seeds are concerned **(culture systems C and D)**. Pond numbers and sizes slightly increase. One or more storage ponds can also be used for marketing.

4. **Large-scale commercial fish farms** may have the most complete range of fish-rearing facilities, including brood ponds and nursery ponds **(culture systems D and E)**. Pond numbers and sizes greatly increase.

5. As the fish-rearing facilities increase in size and become more complex, other facilities (the support infrastructure) also become important. These may include roads, power production and distribution, feeds production and storage, workshops, office/laboratory, hatchery, housing, etc.

6. The layout becomes more difficult to design as the fish farm grows in size and complexity. Remember, the design of large farms is best done by a specialized engineer. However, to lay out a smaller-scale farm, the following guidelines will be useful.

Laying out ponds according to their use

7. Ideally, the entire pond area should be visible from the main office/service building area at the centre of the farm. For very big farms, it may be necessary to group the ponds, each with its own small working centre.

8. Lay out the brood ponds, spawning ponds and storage ponds so that they are well protected against poaching, easily accessible by vehicle, easily drainable and well supplied with good quality water.

9. Lay out the nursery ponds between the spawning ponds and the fattening ponds. Provide easy access for at least a mini-tractor and its trailer.

10. Lay out the fattening ponds to allow good access for feeds, fertilizers and equipment as well as easy transfer of harvested fish to storage ponds or the outside market.

Laying out the access roads on your farm

11. To have better control over incoming and outgoing traffic, restrict access to the farm to one point only. It is sometimes preferable to group most of the service buildings near this access point.

12. Limit the canal crossings to the minimum.

13. Build road crossings on the feeder canals rather than on drainage canals, as these are usually narrower and easier to cross. This might require keeping the main access road along the higher side of the farm.

14. Provide access as near as possible to the harvesting area of the fish ponds. By grouping harvesting areas together, a single access point can serve several ponds.

15. Have good access on the farm itself to the main water control structures. Try to make sure they are all within the farm boundary.

16. Design access roads and their turning points according to the particular type of vehicle you plan to use on them: the narrower the road, the cheaper it is to build and maintain.

Laying out the canals on your farm

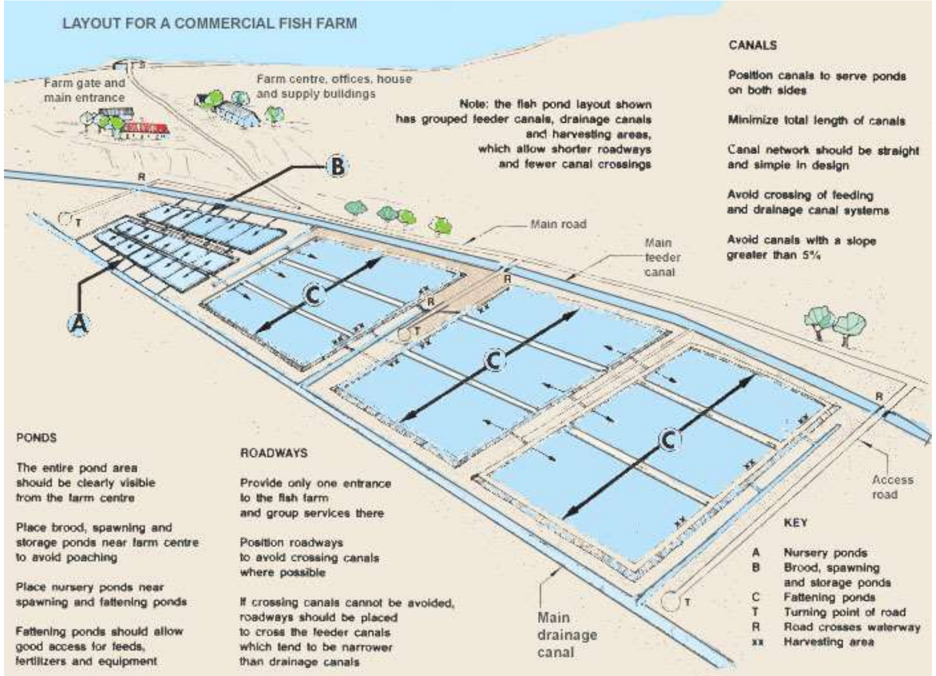
17. Try to make each canal serve ponds on both sides.

18. Try to minimize the total length of canals, unless it makes laying out the ponds too difficult or their construction too expensive.

19. Try to make canal networks reasonably straight and simple. Minimize the number of junctions.

20. Try to avoid drainage and feeder canals that have to cross each other.

21. Try to avoid canals that have to run down a slope steeper than 5 percent.



Level differences on your fish farm

22. When laying out your fish farm and, later, when designing your fish ponds, it is important that you clearly understand how the elevation of the various structures has to change progressively to ensure a **gravity*** water flow.

23. If you plan to have either **barrage ponds** or **diversion ponds** fed by gravity, remember:

(a) Water flows down from the highest to the lowest point.

(b) The water surface in a pond is always horizontal.

(c) The pond bottom should be above the water table at harvest.

(d) The bottom of the main water intake should be below the minimum level of the water source.

(e) The bottom of the feeder canal should be at or above the maximum pond water level.

(f) The pond inlet should be located at or above the maximum pond water level.

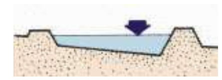
(g) The start of the pond outlet should be at the lowest point of the pond.

(h) The end of the pond outlet should be at or above the water level in the drain.

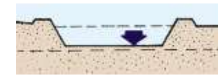
(i) The end of the drain should be at or above the maximum water level in the natural channel.

a Water flows down by gravity

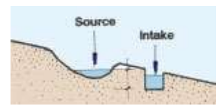
b Water surface horizontal



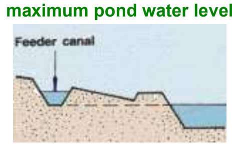
c Pond bottom above watertable a harvest



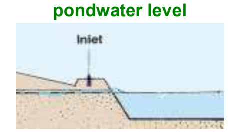
d Bottom of main water intake below water source



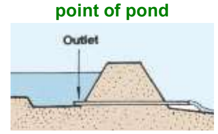
e Bottom of feeder canal at or above maximum pond water level



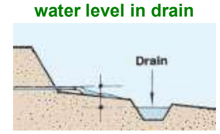
f Pond inlet at or above maximum pondwater level



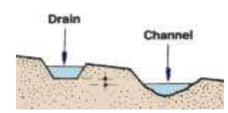
g Start pond outlet at lowest point of pond



h End of pond outlet at or above water level in drain



i End of drain at or above maximum channel water level



22. When laying out your fish farm and, later, when designing your fish ponds, it is important that you clearly understand how the elevation of the various structures has to change progressively to ensure a **gravity*** water flow.

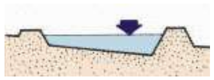
23. If you plan to have either **barrage ponds** or **diversion ponds** fed by gravity, remember:

(a) Water flows down from the highest to the lowest point.
(b) The water surface in a pond is always horizontal.
(c) The pond bottom should be above the water table at harvest.
(d) The bottom of the main water intake should be below the minimum level of the water source.

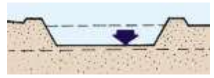
(e) The bottom of the feeder canal should be at or above the maximum pond water level.
(f) The pond inlet should be located at or above the maximum pond water level.
(g) The start of the pond outlet should be at the lowest point of the pond.
(h) The end of the pond outlet should be at or above the water level in the drain.
(i) The end of the drain should be at or above the maximum water level in the natural channel.

a Water flows down by gravity

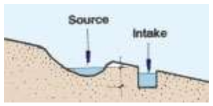
b Water surface horizontal



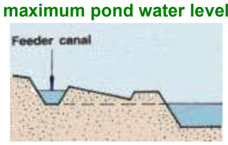
c Pond bottom above watertable a harvest



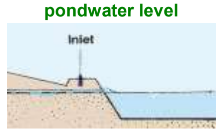
d Bottom of main water intake below water source



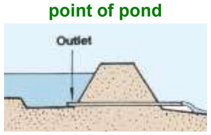
e Bottom of feeder canal at or above maximum pond water level



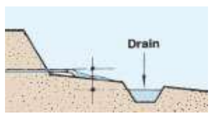
f Pond inlet at or above maximum pondwater level



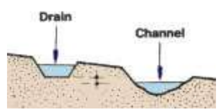
g Start pond outlet at lowest point of pond



h End of pond outlet at or above water level in drain



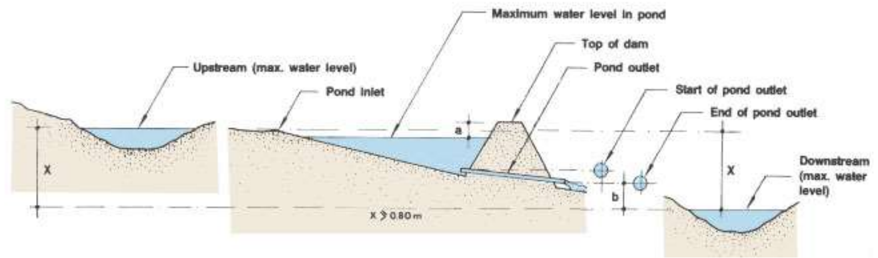
i End of drain at or above maximum channel water level



If you are building a barrage pond

24. In the case of a barrage pond fed directly by a small stream, it is easy to determine the difference in level (**X**) required between the **maximum water level upstream** and the **maximum water level downstream** from the pond that will provide enough depth of water in the barrage pond: X should be at least 0.80 m.

Barrage pond level differences

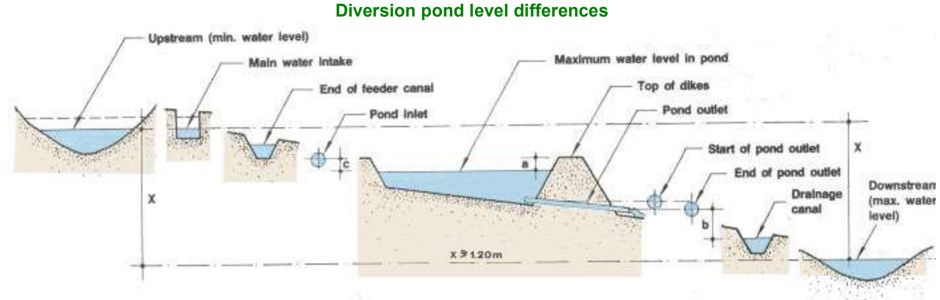


X = The difference in level required between the maximum water level upstream and the maximum water level downstream
a = The difference in level required between the top of the dam and the maximum water level in the pond (freeboard)
b = The difference in level required between the end of the pond outlet and the maximum water level downstream

If you are building a diversion pond

25. In the case of a diversion pond fed from a stream through a main water intake and a feeder canal, it is easy to determine the difference in level (**X**) required between **minimum water level at the main intake** and **maximum water level at the end of the drain: X** should be at least 1.20 m.

Diversion pond level differences

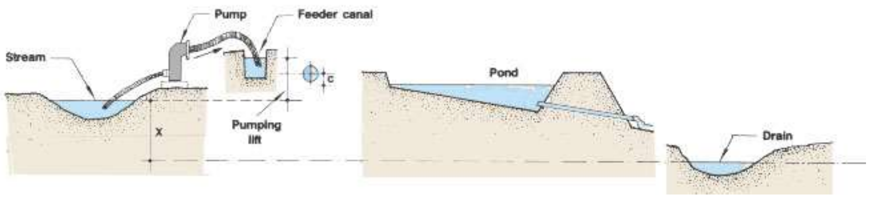


X = The difference in level required between the minimum water level at the main intake and the maximum water level at the end of the drainage canal
a = The difference in level required between the top of the dikes and the maximum water level in the pond
b = The difference in level required between the end of the pond outlet and the maximum water level in the drainage canal
c = The difference in level required between the pond inlet and the maximum water level in the pond

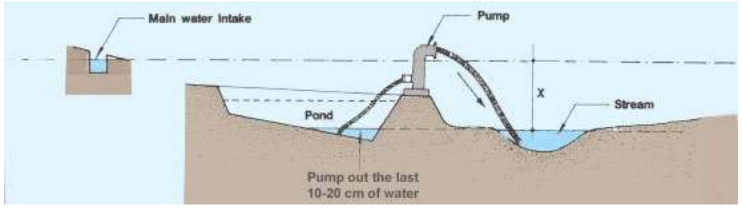
A pump might be necessary

26. If the topography of the site does not allow you to create these differences in level, and you can afford a pump, it is sometimes possible to pump water up from a stream into a feeder canal, or more often, to pump the last 10-20 cm of water out from a draining pond. In these cases, you can reduce the values of **x**, but you must be sure that the cost of pumping is acceptable.

Pond filling



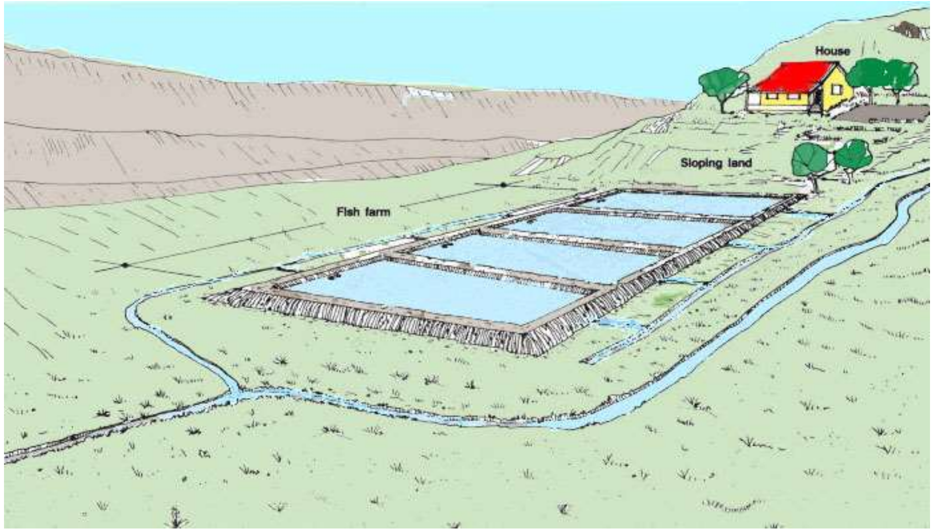
Pond draining



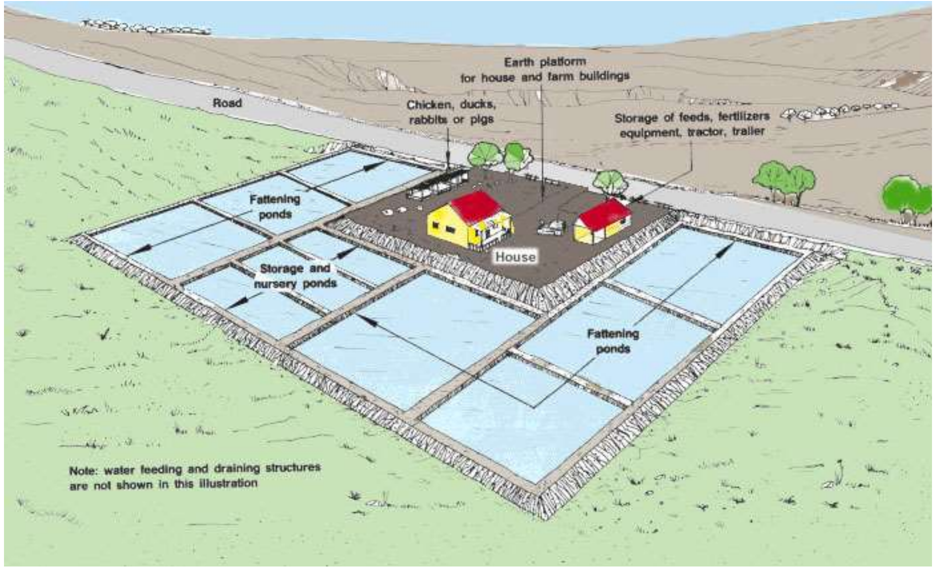
Living on your fish farm

27. It is always desirable that somebody lives on your fish farm next to your ponds, not only for security reasons but also to be able to manage the farm properly.

28. If the fish farm is built on sloping land, it is best to site the housing at a higher level, so that ponds can be observed from there.



29. If the fish farm is built on flat land, you may need to site the housing on a raised platform served by a road; such a platform could also be used for storage of equipment or feeds or fertilizers, and for small animal husbandry.



Which pond are we selecting for the species for these 5 activities?

1. SPAWNING ……………………………
2. BROOD ………………………………
3. NURSERY ………………………………
4. STORAGE ……………………………..
5. FATENNING………………………………