What do you mean about aquaculture, fisheries, pisciculture and mariculture?

1. **Aquaculture / Aquafarming:**

   i. Aquaculture is the 'farming and husbandry of economically important **aquatic plants and animals** under controlled conditions'.
   ii. It is related to culture, capture, preservation, transport and marketing of aquatic organisms on fresh water, brackish water or sea water.
   iii. **Aquaculture**, also known as **aquafarming**, is the farming of aquatic organisms such as fish, crustaceans, molluscs and aquatic plants.
   iv. Aquaculture involves cultivating freshwater and saltwater populations under controlled conditions, and can be contrasted with commercial fishing, which is the harvesting of wild fish.

2. **Fisheries:**

   The scientific process by which **aquatic animals** not only fishes but also some other economically important aquatic animals (prawns, crabs, sharks, rays, various mollusks, dolphin, whale etc) are cultured, captured, preservation, transport and marketing are collectively called fisheries.

3. **Pisciculture:**

   The scientific process by which **only** economically important edible and marketable **fishes** are reared for breeding, culture, capture, preservation, transport and marketing are collectively called as pisciculture.

4. **Mariculture :**

   The scientific process of **culture of marine animals** like pearl oyster, edible mussels, lobster, marine crabs, milk fish, eels, sea cucumber, turtles, sponges etc. is called mariculture.

Distinguish between aquaculture, fisheries and pisciculture.

Aquaculture	**Fisheries**	**Pisciculture**
Aquatic plants and **aquatic animals** are cultured.	**Only aquatic animals** are cultured.	**Only fishes** are reared.
The rearing organisms are algae, phytoplankton, prawns, crabs, sharks, rays, various mollusks, dolphin, whale etc.	The rearing organisms are prawns, crabs, sharks, rays, various mollusks, dolphin, whale etc.	The rearing fishes are ruhu, catla, mrigel, exotic carps etc.
Eg. Pearl culture, weed culture	e.g, pearl culture, carp culture, prawn culture	Eg. Carp culture, joel fish culture

Salient features of aquaculture (Advantages of aquaculture over agriculture):

1. **Aquaculture** is a **three dimensional cultural system**, while **agriculture** is a **two dimensional cultural system**. Therefore, as a three dimensional cultural system the available environment of aquaculture is much greater than agricultural environment.

2. Stocking density in aquaculture is higher than agricultural field.

3. Aquaculture gives efficient means of recycling agricultural and domestic wastes, in order to help protect our environment.

4. In aquaculture, there is scope for **integrated fish farming with agriculture and animal husbandry** like paddy cum fish culture, duck cum fish culture, pig cum fish culture etc. It is known to be more profitable than agriculture alone.

5. There is maximum scope for exploitation and manipulation. Here, we can manipulate or upgrade the environment 15 times keeping the carrying capacity fixed.

   e.g., **in case of prawn**

Extensive	Semi intensive	Intensive	Super intensive
2-3 no / m^2	5-8 no / m^2	25-30 no / m^2	100 no / m^2

6. High-valued and commercially important items (such as lobsters, prawn, ornamental fishes etc) are produced through aquaculture than can earn good foreign exchange.

7. In aquaculture, there is maximum scope for employment generation.

8. In aquaculture, there is high feed conversion efficiency. Generally if 1.9 kg feed is supplied, we may get 1 kg fish flesh. While in case of beef it is 3:1 and in poultry it is 2:1.

9. From the point of view of human nutrition, the fish food is not only easily digestible but is also rich in essential amino acids. The unique poly unsaturated fatty acid (namely eicosapentaenoic acid) of fish is known to reduce cholesterol level of blood and save human beings from coronary diseases.

Types of Aquaculture / Aquafarming

A. Depending on the variations in salinity, aquaculture could be broadly divided into 4 types which again sub divided into many types.

Fresh water aquaculture (<0.5% salinity)	**Brackish water aquaculture** (<0.5% - 30% salinity)	**Mariculture** (30% - 35% salinity)	**Metahaline culture** (>35% salinity)
Earthen ponds (mono, poly, joel fish culture) Raceways Sewage fed ponds Temple tanks Irrigation tanks Reciculation system Ornamental fish Larvivorous fish Coldwater fish Moriculture Integrated farming (pig-cum fish, duck-cum-fish, poultry-cum fish, paddy-cum-fish culture etc)	On-bottom Racks Rafts Tidal ponds Pens Cages	Floating cage Rafts & cage Racks Poles Longline On-bottom Nylon webbing Artificial reef	Salty ponds
e.g., carp culture, jeolfish culture.	e.g., milk fish, lates, mugil, prawn, mussel culture etc.	e.g., prawn culture, lobster culture, fish culture etc.	E.g., culture of brine shrimp.

1. **Fresh-water aquaculture:** The culture of organisms in fresh water having less than 0.5% salinity is called freshwater aquaculture.
2. **Brackish-water aquaculture:** The culture of organisms in brackish water having a salinity range between <0.5% - 30% is called brackish water aquaculture.
3. **Mariculture:** The culture of marine organisms in sea water having 30-35% salinity is called mariculture.
4. **Metahaline culture:** The culture of marine organisms in sea water having more than 35% salinity is called metahaline culture.

B. Depending on motive of farming, based on economic and commercial considerations, this culture may be classified as-

1. **Extensive fish culture:**
   i. Extensive system of culture is usually done by stocking seeds on the basis of natural carrying capacity and is characterized by low inputs and maximum utilization of natural food resources available in culturable space.
   ii. Her**e litt**le care is taken with regard to its improvement. So, it is the leas**t managed fish farming.**
   iii. **Here, the yield is modest and the expenditure is less** as it is raised on natural food.
   iv. **L**arge ponds, beels etc for fish culture are brought under this culture.

2. **Intensive fish culture:**
   i. It is usually done by stocking seeds above the natutal carrying capacity and is involved higher stocking densities and high inputs.
   ii. Here effect**ive care is taken to achieve maximum production of fish from a minimum quantity of water.**
   iii. **It is the best managed form of fish f**arming and fishes are **fed on art**ificial food in addition to natural feed. Here the yieldis very high (over **6000 kg/ha/yea**r).
   iv. Although the cost of investment is high, the ear**ning from this culture far** exceeds the cost, so as to ensure high profit.

3. **Semi-intensive fish culture:**
   i. As intensive culture possesses certain hazards, for which a culture between the first two is generally plasticized and called semi-intensive culture.
   ii. Here certain amount of management is required and the net profit is in between the above two.

Comparative account of different types of shrimp farming

Parameters	Extensive/ Traditional	Modified extensive	Semi-intensive	Intensive	Super-intensive
Stocking is done on	Natural productivity level	Natural productivity level	Slightly above the natural productivity level	More or highly above the natural productivity level	Higher the natural productivity level
Pond size	Indefinite	1-2 ha	<=1 ha	0.2-0.4 ha	0.05 -0.1ha
Shape	Irregular	Rectangular	Square	Square	circular
Stocking density (nos/m^2)	1-2	3-7	8-15	50-100	>100

Water depth (m)	0.5-1.2	0.8-1.5	0.8-1.5	0.8-1.5	0.8-1.5
Seed source	Wild	Wild / Hatchery	Hatchery	Hatchery	Hatchery
Aeration	Not required	Very less, if needed	2HP	8-12 HP	Continuous
Feed use	Natural	Formulated	Pelleted	Pelleted	Pelleted
Water exchange	Erratic	10% per day	25-40% per day	>= 50% per day	100% per day
Crops/year	1	2	2	Batch-wise	Batch-wise
Production (kg/crop/yr)	300-500	1000-2000	3000-6000	15000	25000

Characteristics	Extensive aquaculture	Intensive aquaculture
Inputs	Low	High
Self-sufficiency	Closed system	Open system
Waste	Useful-recycled	Hazards
No of spp	Several	One
Energy input	Low	High
Markets	Near to farm	Far away from farm
Economy	Subsistence	Capital intensive

C. Depending on special operational techniques, fish culture practices may be classified as-

1. **Cage culture:**
   Rearing of fin-fishes and shellfishes in cages made by synthetic float and nylon meshes either in flowing river or in a big impoundment is called cage culture. The cage is supported by a rigid frame work made by bamboo, wood, metal Joel fishes respond well to cage culture practices.
2. **Pen culture:**
   Culture of fin-fishes and shellfishes in small fenced enclosure along the margin of water sheds of which sides are covered by bamboo matting, netting or screening is called pen culture.

Fisheries Resources of India and Their Classification

What are fisheries?

The scientific process by which **aquatic animals** not only fishes but also some other economically important aquatic animals (prawns, crabs, sharks, rays, various mollusks, dolphin, whale etc) are cultured, captured, preservation, transport and marketing are collectively called fisheries.

Types of fisheries resources based on different habitat:

Fisheries

Inland Fisheries | **Marine Fisheries**

Fresh-water fisheries | Brackish water fisheries | Coastal fisheries | Offshore fisheries

Estuarine fishery | Fisheries in Bheries | Pelagic fisheries | Deep sea fisheries (Demersal)

Capture fishery | Culture fishery

Reverine Fisheries | Lake fisheries | Reservoir fisheries | Pond fishery

Major Carp Fishery | Joel fish fishery

Common culture | Composite culture

Inland fishery resources:

i. Except the seas and bays, the inland rivers, streams, canals, beels, lakes, ponds etc where fish cultivation is possible, together constitute inland fisheries areas.
ii. Inland fisheries are possible both in fresh water as well as brakish water.
iii. In India there are about 40, 54,000 acre inland water bodies of which 15, 75,000 acre are remain in unused condition.
iv. In India west Bengal occupies the 1st position in inland fishery.
v. India's inland fisheries resources are as diverse as they are plentiful, comprising rivers, floodplains, estuaries, mangroves, estuarine impoundments, lagoons, upland lakes, reservoirs and ponds. In India, inland fisheries is classified as follows: freshwater aquaculture, including the pond culture of carp; brackishwater aquaculture, involving mostly shrimp culture; and capture fisheries in rivers, estuaries, lakes, reservoirs, etc.

Inland Fisheries resources of India	
Resource	**Size**
Rivers and canals	173 287 km
Swamps and other wetlands	1 097 787 ha
Floodplain lakes	202 213 ha
Upland lakes	72 000 ha
Mangroves	356 500 ha
Estuaries	285 000 ha
Lagoons	190 500 ha
Reservoirs	3 153 366 ha
Freshwater ponds	2 254 000 ha
Brackishwater ponds	1 235 000 ha

A. <u>Fresh water inland fisheries:</u>

They are of following types-

Fresh water inland fisheries

1Capture fishery 2. Culture fishery

Reverine Fisheries Lake fisheries Reservoir fisheries Pond fishery

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Major Carp Fishery Joel fish fishery

Common culture Composite culture

1. Capture Fishery	**2. Culture Fishery**
It means harvesting the fishes from the natural inland water bodies where they are spontaneously produced.	It means to grow fish in smaller inland water bodies that can be manipulated by man.
Man has only to reap without having to sow, nature herself sowing the seed through self propagation	Man himself sowing the seed, reared and finally harvested when grown to table size.
Only exploration, exploitation, conservation and management is done.	Pre-stocking, stocking and post-stocking management is generally done.

e.g., lake, river, reservoir fishery.	e.g., pond fishery
China occupies the first position.	China occupies the first position.

1. Capture Fishery

a. Riverine fishery:

i. The five riverine systems and their tributaries form the main riverine system of fresh water of India.

ii. They are Ganga, Brahmaputra, northern Indus riverine system, eastern coastal riverine system (Mahanadi, Subranarekha, Godabari, Krishna, Kaveri etc) and western coastal riverine system (Narmada, Taptietc).

	Ganga riverine system	Brahmaputra Riverine system	Indus riverine system	Eastern coastal riverine system	Western coastal riverine system
Total length	8047 km	4023 km		6437 km	3380 km
Icthyofauna	All types of carp, mahasole, Hilsa, prawn etc.	Carps (chital), cat fishes (Tangra, aar, boal, magur etc)	Trout, carps, catfish etc	Carps, catfish, trout, murel, prawn etc.	Carp, catfish, murel, perch, prawn etc.

b. Lake fishery:

i. Lake is defined as a natural body of standing water occupying a basin and taking continuity with sea and where thermal stratification is prominent.

ii. The important lakes of India are Kodaicanal Lake, Otoe lake, yarkud lake, noinital lake, loktak lake, ular lake etc.

iii. The icthyofauna in lakes are common carps, tilapia, and hybrid fishes.

Floodplain lakes

i. India has more than 200000ha of floodplain lakes (locally called *mans, chaurs, beels, jheels,* and *pats*), especially in the States of Assam, Bihar, and West Bengal.

Distribution of floodplain lakes in India		
State	**River basin**	**Area** *(ha)*
Arunachal Pradesh	Kameng, Subansiri, Siang, Dibang, Lohit, Dihing and Tirap	2500
Assam	Brahmaputra and Barak	100000
Bihar	Gandak and Kosi	40000
Manipur	Iral, Imphal and Thoubal	16500
Meghalaya	Someswari and Jinjiram	213
Tripura	Gumti	500
West Bengal	Hooghly and Matlah (Ganga)	42500
Total		**202213**

ii. The current yield of floodplain wetlands is not precisely known. Nonetheless, important scientific studies have been made on the limnology and productivity of these ecosystems and a production potential ranging from 1000 to 2000 kg/ha/yr has been estimated. They also provide the ideal location for pen and cage culture operations. Pen culture of major carp has indicated a production potential of up to 4 t/ha in six months according to the results obtained in a *man* in the Gandak basin. The rearing of *Clarias batrachus* and *Heteropneustes fossilis* in a weed-choked Assam *beel*, over a period of 90 days in 2 km^2 cages, obtained production results ranging from 0.190 kg to 4.8 kg.

c. <u>Reservoir fishery:</u>

i. A reservoir is defined as a large expanse of impounded water artificially created by putting cross a stream of an earthen, stone or concrete bundth or dam.

ii. The important reservoirs are Nagarjun sagar in AP, Osman sagar in AP, Panchet, mithon, murakhi in Bihar, perier, noayer in Kerala, konsaboti, DVC in W.B.

iii. The icthyofauna in reservoirs are ruhu, catla, calbose, silver carp etc.

B. Brackish water inland fisheries

a. Bheries (brakish water pond):

i. When ponds are more than 200 acres and water depth is 6-7ft, it is known as bheries.
ii. chilka lake (OR), Pulikot lake (TN) etc are examples of brakish water lakes.
iii. Icthyofauna are lates, persay, topsey, pramfred, ribbon fish etc.

b. Estuary:

i. An estuary is a semi enclosed coastal body of water that has free connection with open sea and is strongly affected by tidal action and in which sea water is usually measurably diluted with fresh water from land drainage.
ii. River mouths, coastal bays, tidal marshes etc are examples of estuary.
iii. The common estuary in India are Hooghly matla estuary (WB), Mahanadi estuary(Orrissa), Godabari & Krishna estuary (AP), Kaveri estuary (TN), Narmada & Trapti estuaries (MH).
iv. Icthyofauna of estuary are divided into two types-
Resident species: Mugil parsia, M. tade, Lates calcarifer, Polynemus indicus, Pama pama etc.

Migratory species: Hilsa sp., Polynemus sp., Liza sp., Pangasius sp.,

2. Culture Fishery:

Pond Fishery:

i. It is a standing water bodies in which circulation of water is slow and usually of vertical type.
ii. It has no water current, minimum land water interchange, less evenly distributed oxygen.
iii. It has littoral zone, limnetic zone and profundal zone.
iv. Icthyofauna in pond fishery are carps, silver carp, grass carps, etc.

4 Reservoir fisheries

In India, reservoirs are considered the prime resource as regards capture fisheries and extensive aquaculture. The rivers, estuaries and other natural water bodies are threatened by increasing environmental degradation. With the great emphasis on conservation, there

is little scope for a substantial increase in yields. The reservoirs, which already cover 3 millionha of surface area, are a growing resource with enormous potential for yield augmentation. The available estimates made by various agencies are conflicting and inaccurate. The most recent study (Sugunan, 1995) estimated the combined surface area of all reservoirs, irrespective of size, as 3135366 ha. Enumeration of the medium and large reservoirs in India is a relatively easy task as there are fewer of them and the details are readily available from the irrigation, power and public works authorities. However, compilation of data on small reservoirs is a tedious task as they are ubiquitous and too numerous to count.

Definition and classification

The major irrigation tanks have an average size water bodies which retain water year wise are considered as reservoirs.

According to the records of the Government of India, reservoirs are generally classified as small (<1000 ha), medium (1000 to 5000 ha) and large (>5000 ha). All man-made impoundments, created by erecting a dam of any description in order to obstruct the surface flow of a river, stream or any water course, have been classified as reservoirs. However, water bodies of less than 10ha in area, being too small to be considered lakes, are excluded.

Surface area (ha) of reservoirs by states				
State	**Small**	**Medium**	**Large**	**Total**
Tamil Nadu	315 941	19 577	23 222	358 740
Karnataka	228 657	29 078	179 556	437 291
Madhya Pradesh	172 575	169 502	118 307	460 384
Andhra Pradesh	201 927	66 429	190 151	458 507
Maharashtra	119 515	39 181	115 054	273 750
Gujarat	84 124	57 748	144 358	286 230
Bihar	12 461	12 523	71 711	96 695
Orissa	66 047	12 748	119 403	198 198
Kerala	7 975	15 500	6 160	29 635
Uttar Pradesh	218 651	44 993	71 196	334 840
Rajasthan	54 231	49 827	49 386	153 444
Himachal	200	-	41 364	41 564

Pradesh				
Northeast	2 239	5 835	-	8 074
Haryana	282	-	-	282
West Bengal	732	4 600	10 400	15 732
Total	**1 485 557**	**527 541**	**1 140 268**	**3 153 366**

For purposes of clarity, the anomalies in nomenclature, especially as regards small reservoirs, can be ignored by simply classifying large (above 10 ha) irrigation tanks as reservoirs. According to this system of grouping, India has 19134 small reservoirs with a total water surface area of 1485557 ha. Similarly, 180 medium and 56 large reservoirs of the country have an area of 527541 and 1140268ha respectively. Thus, the country has 19370 reservoirs covering 3153366ha.

Fish production from reservoirs

A reliable estimate of fish production from Indian reservoirs is not available. Compared with the impressive volume of data on limnological aspects of reservoirs collected by individual researchers and various institutions, the estimates of fish catch remain grossly inadequate. Furthermore, the production data available are at times inaccurate and unreliable. Following are the main reasons for this deficiency:

- complications in the collection of data in some states because of the multiplicity of agencies owning fishing rights;
- widely dispersed and unorganized market channels, mostly controlled by unauthorized money lenders;
- an ineffective cooperative setup;
- diverse licensing/royalty/crop sharing systems practiced by different state governments; and
- inadequate and poorly trained workforce at the disposal of the states to collect catch data by following statistically sound sampling procedures.

Fish production in the small reservoirs of India			
State	**Number**	**Production**	**Yield**
		(ton)	*(kg/ha)*
Tamil Nadu	52	760	48.5
Uttar Pradesh	31	168	14.60
Andhra Pradesh	37	2224	188.0
Maharashtra	6	72	21.09

Rajasthan	78	970	46.43
Kerala	7	118	53.50
Bihar	25	22	3.91
Madhya Pradesh	2	24	47.26
Orissa	53	349	25.85
Total	**291**	4707	449.14
Average	**-**	**523**	**49.90**

Fish production figures of Andhra Pradesh as given by the State Department of Fisheries are the highest in the group, followed by Kerala, Tamil Nadu, Madhya Pradesh, Rajasthan and others ranging from 3.91 kg/ha (Bihar) to 188.0 kg/ha (Andhra Pradesh). On average, the 291 small reservoirs of India yield fish at the rate of 49.9 kg/ha. The average estimated yields of small, medium and large reservoirs are 49.9, 12.30 and 11.43kg/ha respectively. By applying the average yield of small reservoirs to their total surface area of 1485557 ha, their current production rate can be estimated at 74129 t. In the same way the production of medium and large reservoirs is estimated at 6488 and 13033t respectively.

Fish species resources

The fish faunistic spectrum of India is very rich. More than 400 species of freshwater fish, many of which are economically important, have been identified in Indian rivers. The Gangetic system alone harbours at least 265 species of fish. One hundred and twenty-six species belonging to 26 families have been identified in the Brahmaputra system. The peninsular rivers have been reported to harbour at least 76 fish species. Despite the faunistic changes associated with impoundments, Indian reservoirs harbour a rich variety of fish species. On the basis of studies conducted so far, large reservoirs, on average, harbour 60 species of fish, of which at least 40 contribute to commercial fisheries. The fast growing Indo-Gangetic carp are among the most commercially important fish. More recently, a number of exotic species have contributed substantially to commercial fisheries. Following is a broad categorization of the species:

Indian major carp: *Labeo rohita, L. calbasu, L. fimbriatus, Cirrhinus mrigala, Catla catla*

Mahseer: *Tor tor, T. putitora, T. khudree, Acrossocheilus hexagonolepis*

Minor carp, snow trout and peninsular carp: *Cirrhinus cirrhosa, C. reba, Labeo kontius, L.bata, Puntius sarana, P. dubius, P. carnaticus, P. kolus, P. dobsoni, P. chagunio, Schizothorax plagiostomus, Thynnichthyes sandkhol, Osteobrama vigorsii*

Large catfish: *Aorichthys aor, A. seenghala, Wallago attu, Pangasius pangasius, Silonia silondia, S. childrenii*

Featherback: *Notopterus notopterus, N. chitala*

Air-breathing catfish: *Heteropneustes fossilis, Clarias batrachus*

Murrel: *Channa marulius, C. striatus, C. punctatus, C. gachua*

Weed fish: *Ambassis nama, Esomus danrica, Aspidoparia morar, Amblypharyngodon mola, Puntius sophore, P. ticto, Oxygaster bacaila, Laubuca laubuca, Barilius barila, B. bola, Osteobrama cotio, Gadusia chapra*

Exotic fish: *Oreochromis mossambicus, Hypophthalmichthys molitrix, Cyprinus carpio specularis, C. carpio communis, Gambusia affinis, Ctenopharyngodon idella.*

Most of the catfish, featherback, air-breathing fish, murrel and weed fish are distributed countrywide, while the distribution of major carp, minor carp and mahseer varies according to the river basins. Indian major carp are the main native ichthyofauna of the rivers of the Gangetic system. These rivers also harbour *Labeo bata*, *P. sarana*, *P. chagunio*, and *C. reba*. *Tor putitora*, *Labeo dero* and snow trout (*Schizothorax* spp.) are the dominant riverine fish fauna of Indus system. Mahseer, especially chocolate mahseer (*Acrosscheilus hexagonolepis*) are also found in the streams of all the major river systems of the country. Indigenous fish of the peninsular rivers include *Cirrhinus cirrhosa*, *C. reba*, *Labeo kontius*, *L. fimbriatus*, *P. dubius*, *P. sarana*, *P.carnaticus*, *P. kolus*, *P. dobsoni*, *T. tor*, *T. sandkhol* and *O. vigorsii.*

The three types of Indian major carp have been stocked extensively in reservoirs all over the country for many decades and, in many cases, they have established themselves in reservoirs which are far away from their original habitat. Sathanur reservoir in Tamil Nadu has a naturalized population of catla which constitute 80 to 90% of the total catch. This Gangetic carp has prevailed over indigenous fish fauna including *Labeo fimbriatus*, which made up 36% of the catch during the mid 1960s. Similarly, introductions of silver carp in Gobindsagar, common carp in Krishnarajasagar and tilapia (*Oreochromis mossambicus*) in Amaravathy are examples of man-induced changes in fish communities.

Impact of reservoir formation on the native ichthyofauna

The formation of reservoirs has particularly affected the following indigenous fish stocks:

- the mahseer, snow trout and *Labeo dero*, and *L. dyocheilus* of the Himalayan streams;
- the anadromous hilsa, catadromous eel, and freshwater prawn of all major river systems;

- *P. sarana*, *T. tor mahanadicus*, *T. mosal*, *L. fimbriatus*, *L. calbasu*, and *Rhinomugil corsula* of the Mahanadi river;
- *P. dobsoni*, *P. dubius*, *P. carnaticus*, *C. cirrhosa* and *Labeo kontius* of the Cauvery basin;
- *P. kolus*, *P. dubius*, *P. sarana*, *P. porcellus*, *L. fimbriatus*, *L. calbasu*, *L. pangusia* and *Tor kudree* of the Krishna river system; and
- the mahseer, eel and *Osteobrama belangiri* of the northeast.