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Fisheries

India is one of the largest fish producing countries in the world and shares 7.58% to the global production.

Contributing 1.24% to India's Gross Value Added (GVA) and 7.28% (2018-19) to the agricultural GVA, fisheries and aquaculture continue to be an important source of food, nutrition, income and livelihood to millions of people. (As per NFDB website)

The marine fisheries potential is estimated at 5.31 million tons as against present production of 4.17 million tons during 2018-19.

Resources		
Coastline	8118 kms	
Exclusive Economic Zone	2.02 million sq. km	
Continental Shelf	0.530 million sq. km	
Rivers and Canals	1,95,210 km	
Reservoirs	3.150 million ha	
Ponds and Tanks	2.414 million ha	
Flood Plains lakes and derelict waters	0.798 million ha	
Brackishwaters	1.240 million ha	
Estuaries	0.290 million ha	





Types of fishes

Based on the structure of their mouths and the types of skeletons

- a. Agnatha these are jawless fishes.
 - They do not have pairs of fins like most fish. Instead, the mouths of these fishes have structures for scraping, stabbing, and sucking.
 - Hagfishes and lampreys are the only living kinds of jawless fishes.
- b. **Chondrichthyes:** These are cartilaginous fishes that have skeletons primarily composed of cartilage. They have jaws. Ex: **sharks**, **rays**, **skates**, **and sawfish**
- c. **Osteichthyes**: popularly referred to as the bony fish, that have skeletons primarily composed of bone tissue. Ex ocean sunfish, blue marlin, black marlin.

Based on migratory nature:

- Anadromous fish migratory fish that live in salt water but breed in fresh water.
 Ex salmon ,sturgeons ,herrings
- Catadromous fish migratory fish that live in fresh water but breed in salt water.
 Ex: Eels
- Amphidromous fish migratory fish that live in both fresh and salt water, independent of breeding. Ex bigmouth sleeper, mountain mullet, river goby, torrentfish,
- Potamodromous fish migratory fish that move within fresh water only. Ex sicklefin redhorse, lake sturgeon, robust redhorse, flathead catfish
- Oceanodromous fish migratory fish that move within salt water only. Ex: black grouper,
 mutton snapper, goliath grouper.





Fisheries can be further categorised into

Capture fisheries:

- It is exploitation of aquatic organisms without stocking the seed. Recruitment of the species occur naturally. This is carried out in the sea, rivers, reservoirs, etc.
- Fish yield decreases gradually in capture fisheries due to indiscriminate catching of fish including brooders and juveniles.
- Overfishing destroys the fish stocks.
- Pollution and environmental factors also influence the fish yield. The catches include both desirable and undesirable varieties.

Culture fisheries

- It is the cultivation of selected fishes in confined areas with utmost care to get maximum yield.
- The seed is stocked, nursed and reared in confined waters, then the crop is harvested.
- Culture fisheries is conducted in freshwater, brackish water and sea waters.
- With the development and expansion of new culture systems, farming of a wide variety of aquatic organisms like prawns, crabs, molluscs, frogs, sea weeds, etc. have come under culture fisheries.
- Due to the culture of a variety of aquatic organisms, culture fisheries has been termed as aquaculture.

Inland Fisheries

Around 70% of India's fish production comes from inland waters, of which nearly 65% comes from aquaculture.





• Out of the total inland aquaculture production, Indian Major Carps are the most cultured freshwater fish followed by Exotic Carps, Minor Carps, Catfish and Trout

Inland Water Resources of India

Warmwater Resources	Extent
Rivers & Canals (km)	1,95,210
Tanks & Ponds (lakh ha)	24.14
Reservoirs (lakh ha)	31.50
Floodplain / Derelict Water Bodies (lakh ha)	8-12
Brackishwater (lakh ha)	12.40
Saline / Alkaline affected areas (lakh ha)	12.00
Coldwater Resources	
Rivers (km)	8,253
Natural Lakes (ha)	21,900
Reservoirs (ha)	29,700

The Inland Fisheries of India may be classified as:

- Lacustrine Fisheries (Lakes and Reservoirs)
- Riverine Fisheries (Rivers and Streams)
- Estuarine Fisheries (Estuaries and Backwaters)
- Floodplain and Wetland Fisheries
- Coldwater Fisheries
- Ornamental Fisheries
- Sport Fisheries
- Culture Fisheries (Aquaculture

Freshwater species

Carps

• Carps form the mainstay of aquaculture practices in India, contributing over 85% of the total aquaculture production.





- The carps which are native to the Indus-Ganges River Systems/ Indo-Gangetic Plains of
 India are referred to as the Gangetic Carps / Indian Major Carps (IMC), comprising of
 Catla, Rohu and Mrigal that contribute 60% of total Carps production.
- The carps that were introduced from other countries are referred to as Exotic Carps such as Silver Carp, Grass Carp and Common Carp.

Fish Name	Picture
Indian Major Carps	
Catla Catla catla	
Rohu Labeo rohita	
Mrigal Cirrhinus mrigala	
Minor Carps	
Reba Cirrhinus reba	
Bata Labeo bata	





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Fringe-lipped Carp Labeo fimbriatus	
Calbasu	
Labeo calbasu	
Pengba	
Osteobrama belangeri	
Exotic Carps	
Common Carp	W.
Cyprinus carpio	
Amur Common Carp	_
Cyprinus carpio	
Grass Carp	
Ctenopharyngodon idella	
Silver Carp	_
Hypophthalmichthys molitrix	





Catfish

- Catfish can generally be found in faster-flowing rivers and streams, some catfish species
 have adapted to living in shallow salt-water environments while other catfish species live
 their lives in caves underground.
- Most catfish are **bottom feeders as they are negatively buoyant** (which means that they usually sink rather than float due to a reduced gas bladder and a heavy,bony head).
- The air-breathing catfishes such as Magur and Singhi inhabit shallow waters, withstand low
 oxygen conditions and are referred to as "live fishes"; they are marketed live and fetch
 higher price.

Fish Name	Picture
Magur/ Walking Catfish Clarias magur	
[formerly known as C. batrachus]	de la
Singhi/ Stinging Catfish Heteropneustes fossilis	
Giant River-Catfish, Sperata seenghala	
[formerly Mystus seenghala / Aorichthys seenghala]	
Freshwater Shark Wallago attu	
Pabda Catfish Ompok pabda	
Sutchi/ Striped Catfish (Exotic) Pangasianodon hypophthalmus	





Featherbacks

- Featherbacks are **adapted to flowing conditions** and widely distributed in deep and clear waters in the rivers, beels, reservoirs and ponds.
- The Bronze Featherback is reported to enter brackish water.
- They are carnivorous and predatory fish and feed on aquatic insects, molluscs, shrimps
 and small fishes and take insects and tender roots of aquatic plants during early stages of
 life.

Snakeheads

- The snakeheads are members of the freshwater Perciformes fish family Channidae, native to parts of Africa and Asia.
- They inhabit swampy waters and their gills are adapted to breathe air. They can survive out of water for up to four days, provided they are wet.

Snakeheads	
Fish Name	Picture
Striped Murrel / Snakehead Channa striata	THE PROPERTY OF
Spotted Murrel / Snakehead Channa punctata	
Flower Murrel / Bullseye Snakehead Channa marulius	
Dwarf Murrel / Snakehead Channa gachua	





Coldwater Fishes

- Coldwater fishes occupy an important place amongst the freshwater fishes of India.
- The cold-water fisheries deal with fisheries activity in water where temperature of water ranges from 5 to 20 degrees centigrade.
- The gills of cold water fish are greatly reduced and the gill opening are smaller in size for adaptation to cold temperatures.
- Important coldwater fishes of India are Mahseers such as Tor putitora, T. tor, T. khudree, T. mosal, Snow Trout such as Schizothorax richardsonii and Schizothoraichthys esocinus,
 Mountain Trout such as Barilius vagra, B. bendelisis, other fish such as Glyptothorax sp.,
 Garra sp.

Picture

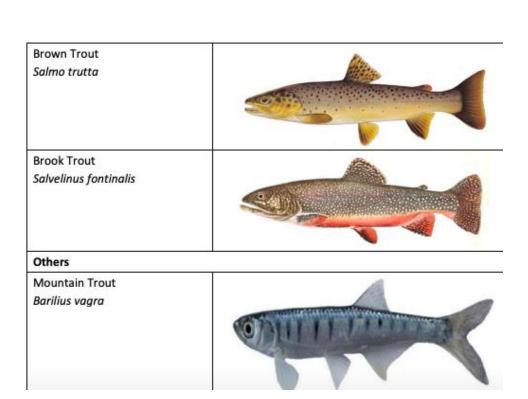








		Rainbow Trout
A. S.		Oncorhynchus mykiss
	The second second second second	
	Many to the same of the same o	







Brackish water species:

- India has around 1.2 million ha brackishwater resources comprising of estuaries (deltaic river mouths), coastal lagoons, lakes, backwaters, tidal creeks, canals, mudflats, mangrove plants, etc
- The most commonly cultured fish are Mullets, Milkfish, Seabass, Pompano, Grouper, etc.

Marine Fisheries:

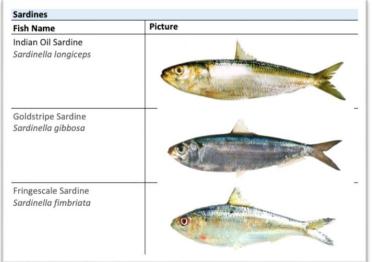
The important Marine Fisheries can be grouped into the following categories:

- 1. Surface-water Fish (Pelagic): Sardines, Anchovies, Ribbonfish, Mackerel, Seerfish, Tuna, etc.
- 2. Mid-water Fish (Pelagic): Bombay Duck, Cobia, Silver Bellies, Horse Mackerel, etc.
- 3. Bottom-water Fish (Demersal): Perches, Catfish, Pomfrets, Flatfish, Eels, etc

Sardines

- Sardines are one of the two most important commercial pelagic schooling fishes in India (the other being Mackerel).
- The Indian Oil Sardine is one of the most regionally limited species of Sardinella and can be

found in the northern regions of the Indian Ocean





Anchovies

- Anchovies are small fish having greenish-blue reflections due to a silver-coloured longitudinal stripe that runs from the head to base of caudal (tail) fin.
- They are found in scattered areas throughout the world's oceans, but are concentrated in temperate waters, and are rare or absent in very cold or very warm seas.
- Anchovies contributes around 6% to the total pelagic fish landings of India

Anchovies	
Fish Name	Picture
Indian Anchovy Stolephorus indicus	
Goldspotted Grenadier Anchovy Coilia dussumieri	
Malbar Anchovy Thryssa malabarica	

Mackerels

- Mackerel is a common name applied to a number of different species of schooling epipelagic fish of the family Scombridae.
- They are found in both temperate and tropical seas, mostly living along the coast or offshore in the oceanic environment.
- Mackerels found in Indian waters are the Indian Mackerel (Rastrelliger kanagurta) and the
 Indian Chub Mackerel (Scomber indicus).





Tunas

- Tunas (family Scombridae) are among the largest, most specialized and commercially important of all fishes.
- They are found in temperate and tropical oceans around the world and account for a major proportion of the world fishery production.
- Tunas are unique among fishes because they possess body temperature several degrees
 higher than the ambient waters and have high metabolic rate that enables them to exhibit
 extraordinary growth rate.
- Around 19% of the global tuna catches are from the Indian Ocean. The waters of Andaman
 Islands are known to have the world's richest stocks of Tunas
- Tunas commonly found in Indian waters are Little Tunny (Euthynnus affinis), Frigate Tuna
 (Auxis thazard), Oriental Bonito (Sarda orientalis), Yellowfin Tuna (Thunnus albacares),
 Bigeye Tuna (Thunnus obesus), Skipjack Tuna (Katsuwonus pelamis), etc.

On the basis of intensity of input and stocking density aquaculture is categorised as follows.

Extensive fish farming system

- It is the least managed form of fish farming, in which little care is taken.
- This system involves large ponds measuring 1 to 5 ha in area with stocking density limited to only less than 5000 fishes/ha.
- No supplemental feeding or fertilisation is provided. Fish depends only on natural foods.
- Yield is poor (500 to 2 ton/ha), and survival is low.
- The labour and investment costs are low, and this system results in minimum income.

Semi-intensive fish farming system





- Semi-intensive fish culture system is more prevalent and involves rather small ponds (0.5 to 1 hectare in an area) with higher stocking density (10000 to 15000 fish/ha).
- In this system, care is taken to develop natural foods by fertilisation with/without supplemental feeding.
- However, the major food source is natural food.
- Yield is moderate (3 to 10 ton/ha), and survival is high.

Intensive fish farming system

- An intensive fish farming system is the well-managed form of fish farming, in which all attempts are made to achieve maximum production of fish from a minimum quantity of water.
- This system involves small ponds/tanks/raceways with very high stocking density (10-50 fish/m3 of water).
- Fish are fed wholly formulated feed.
- Proper management is undertaken to control water quality by use of aerators and nutrition by use of highly nutritious feed.
- The yield obtained ranges from 15 to 100 ton/ha or more.
- Although the cost of investment is high, the return from the yield of fish exceeds to ensure the profit.

Integrated aquaculture system

Fish farming with agriculture

In the fish integrated agriculture system, fish culture is integrated with agricultural crops such as rice, banana and coconut, thereby producing fish and agricultural crops. Agriculture based integrated systems include rice-fish integration, horticulture-fish system, mushroom-fish system, Seri-fish system.





Post-harvest fisheries

Post-harvest fisheries is defined as what culminates into activities, processes, and steps
after harvesting, handling, processing, distributing, marketing, and consumption.

Handling

- ✓ The quality of fish depends on how it is handled from the time it is taken out from the water until it reaches the kitchen.
- ✓ Fish landed is usually subjected to rough handling treatments.

Cardinal Rules in Handling Fresh Fish

1. Cleanliness throughout the fish handling chain.

2. Care:

- ✓ Sorting out of fish properly before packing.
- ✓ protect them from heat and other elements while on deck
- ✓ Drain fish before icing

3. Cooling:

Temperature is the most important single factor affecting the quality of fish.

- plenty of ice to be used.
- Fish is cooled more quickly when ice cold water is poured on them while spoils easily when allowed to stay in stagnant water, blood or slime.
- Store fish in ice as quickly as possible. Make sure the fish room is always kept clean.

Transportation:

- Fresh fish transported to far distances must be packed with ice to ensure freshness when they reach the consumers.
- arrange the fish and ice alternately in the container to maintain chilling temperature.
- It is attained with the ratio of 1 kg of ice to 2 kg of fish.





- The more sophisticated method of the transportation is the refrigerated truck or Insulated
 Van.
- The latest practice of transporting live marketable fish.

Processing:

- Fish spoils very quickly within 12 hours after being harvested. This due to the high ambient temperature that is ideal for bacterial growth.
- To prevent contamination of the fish, proper hygiene must be ensured.
- Contamination can come from people, soil, dust, sewage, surface water, manure, or spoiled foods.
- Poorly cleaned equipment, domestic animals, pets, vermin or unhygienically slaughtered animals can also be the cause.
- To prevent spoilage of the harvested fish, either the bacteria present in them must be killed or their growth must be suppressed.

Different methods exist to suppress bacterial growth:

Curing

- The traditional methods of processing fish by salting, drying, smoking pickling etc. are collectively known as Curing. Curing is the oldest method of fish preservation.
- Though produced in coastal areas, cured fish is usually consumed in the interior markets and hilly areas. This is the cheapest method of preservation also, since no expensive method or technology is used.
- About 20 % of the fish caught annually is used for curing in India. It is also an important form of export.

Salting:





- fish and salt are alternately placed in the tank and wooden planks are over put down on the top and weighed down.
- The salt draws out the water in the fish and the weight placed keeps it under pressure. The fish is kept in this condition for 24-48 hours.
- After this the fish is taken out, washed in brine solution to remove adhering salt and drained

Drying:

- There are basically two methods of drying fish. The common one is by utilising the natural heat available from the sun. This is known as sun drying.
- The other is by using artificial means like mechanical driers for removal of moisture from the fish
- Quality and nutritional value are reasonable if storage is good.

Smoking

- Smoking is usually done in a kiln or a room, which is specially prepared for it.
- The source of smoke is wood or sawdust or coconut husk, depending on the particular flavour required.
- The fish that is salted and partially dried is used for smoking.
- Smoking can be cold or hot. If the temperature is below 35 °C, it is cold and when 70 to 80°C it is hot.
- The preserving effect of smoking on fishery products is attributed to a combination of surface drying, salting and deposition of phenolic and other anti microbial constituents of smoke on the fish

Fermentation:

- This method is often inexpensive, but the fish taste and odour are radically changed.
- Storage life varies depending on the product.
- Nutritional value is often high.





Storage

Chilled storage

- The objective of chilling is to cool the fish as quickly as possible to as low a temperature as
 possible without freezing.
- Chilling **cannot prevent the spoilage togethe**r but in general, the colder the fish, the greater the reduction in bacterial and enzyme activity.
- The important chilling methods of fish and fish products at non-freezing temperature are:
 - Iced storage.
 - Chilled seawater (CSW) storage.
 - Chilled freshwater (CFW) storage.
 - Mechanically Refrigerated seawater (RSW) storage.
 - Cold air storage.

Freezing

- Water accounts for 75-80% of the weight in most of the fish. the freezing begins in the fish
 usually at a temperature of -1 to -2oC
- Freezing methods are broadly classified into
 - Freezing in air: Fish, packaged or otherwise, placed in aluminum trays, is kept on shelves made of pipes or coils through which the refrigerant is circulated.
 - o **Indirect contact freezing :** Indirect contact freezing can be defined as freezing a product by keeping it in contact with a metal surface which is cooled by some refrigerant.
 - Immersion freezing: freezing is achieved by immersion in, or spraying with, a refrigerant
 that remains liquid throughout the process. Refrigerated aqueous solutions of propylene
 glycol, glycerol, sodium chloride, calcium chloride and mixtures of sugars and salt can be
 used as medium for freezing.
 - Cryogenic freezing: In cryogenic freezing very rapid freezing is achieved by exposing the fish, unpacked or with a very thin package, to an extremely cool freezant undergoing a change of state





Canning

- Canning is a method of food preservation in which preservation is achieved by the destruction of micro-organisms by the application of heat.
- This is a fairly expensive method. Because, it is labour intensive and requires plenty of energy, water and equipment, such as tins or jars with lids, sterilisers and canning machines.
- Packaging is expensive. Storage is easy and possible for long periods (below 25 °C / 77 °F).
- Quality and nutritional value are good.
- The important operations involved in a canning process are :
 - ✓ Selection and preparation of raw material: Preparation of raw material include descaling, beheading, gutting, removal of fins, tail and cutting in to small pieces etc.
 - ✓ Pre-cooking / blanching: fish pieces are immersed in a salt solution. This process removes blood, slime, dirt, etc and gives firmness to the texture and imparts a salty taste to the product. It also reduces the bacterial population.
 - Hot blanching: For shell fish including shrimps and crabs, blanching process is done in boiling brine. During this process the shrimp meat gets their characteristic red colour, curls and shrinks in size permitting adequate filling in to cans.
 - ✓ Filling in to containers.
 - ✓ Addition of liquid medium: Brine is the most satisfactory liquid medium for most fattyfishes where as non- fatty fishes require special additives to improve their flavour and texture.
 - Oil, usually double refined and de-odourised vegetable oil, is the principal additive for many canned fish products

Tomato sauce is an important additive in mackerel, oyster and the like

✓ Exhausting: It is the process of removal of air from the contents and headspace of the can before it is seamed.







- Removes oxygen and eliminates the chances of can corrosion.
- o Ensures proper vacuum
- √ Seaming
- ✓ Heat Processing / Retorting: It is the most important operation in canning process. In heat processing/ the product is subjected to heat at a high temperature (say 110°C or above) to sufficient length of time to cause destruction of all pathogenic organisms and inactivate or destroy the micro-organisms causing.
- ✓ Cooling
- ✓ Drying, warehousing, labelling and casing

Biotechnology And Its Applications In Aquaculture And Fisheries

- The concept of biotechnology encompasses a wide range of procedures for modifying living organisms according to human purposes, going back to domestication of animals, cultivation of the plants, and "improvements" to these through breeding programs that employ artificial selection and hybridization.
- It involves the use of living systems and organisms such as bacteria or yeasts, or biological substances, such as enzymes, to perform specific industrial or manufacturing processes.
- Modern usage also includes Genetic engineering as well as cell and tissue culture technologies.

Demand for fish is soaring worldwide and It appears unlikely, that the increasing demand can be met through increased natural harvest. There is international recognition that many of natural ocean and freshwater fisheries are being harvested to their limit. Aquaculture could help to meet





increasing demand, and biotechnology can make a great contribution to improve aquaculture yields

- The potential areas of biotechnology in aquaculture include the use of synthetic hormones in induced breeding, production of monosex, uniparental and polyploid population, molecular biology, transgenic fish, gene banking, improved feeds and health management and development of natural products from marine organisms
- Gonadotropin releasing hormone (GnRH) is the best available biotechnological tool for the induced breeding of fish. GnRH is the key regulator and central initiator of reproductive cascade in all vertebrates.
 - The technology offers an excellent opportunity for modifying or improving the genetic traits of commercially important fishers, mollusks and crustaceans for aquaculture.
 - The first transgenic fish was produced by Zhu et al. (1985) in China.
- resistance of fish to cold temperatures has been another subject of research in fish transgenics for the past several years.
 - Some marine teleost's (ray finned fishes) have high levels of serum antifreeze proteins
 (AFP) or glycoproteins (AFGP) which effectively reduce the freezing temperature by preventing ice-crystal growth.
- Chromosome sex manipulation techniques to induce polyploidy and uniparental chromosome inheritance have been applied extensively in cultured fish species.
 - Polyploidy individuals possess on or more additional chromosome sets for producing sterile fish for aquaculture and fisheries management.
 - o polyploidy can bestow long-term evolutionary flexibility
- Biotechnological tools such as gene probes and polymerase chain reaction (PCR) are showing
 great potential in the area of controlling diseases among fishes. Gene probes and PCR based
 diagnostic methods have developed for a number of pathogens affecting fish and shrimp.





Significant Highlights and Achievements by Deptt. Of Biotechnology (MoST)

- Whole genome sequencing of two commercially important Fish-Rohu (*Labeo rohita*) and
 Magur (*Clarias batrachus*) was completed.
- Triploidy was succesfully induced in rainbow trout (*Oncorhynchus mykiss*) which led to
 40- 46% hatching rate and 57-68% survival upto swim up fry stage.
- Seven potent antimicrobial peptides which showed activity against the septicemial pathogens *Aeromonas hydrophila* and *Pseudomonas aeruginosa* were isolated from marine actinomycetes. (Septicemia, or sepsis, is the clinical name for blood poisoning by bacteria)
- A total of 75 fish cell lines have been kept at National repository of fish cell lines
 (NRFC) for long term storage.
- Seven potent antimicrobial peptides which showed activity against the septicemial pathogens Aeromonas hydrophila and Pseudomonas aeruginosa were isolated from marine actinomycetes.
- A total of 75 fish cell lines have been kept at National repository of fish cell lines for long term storage.



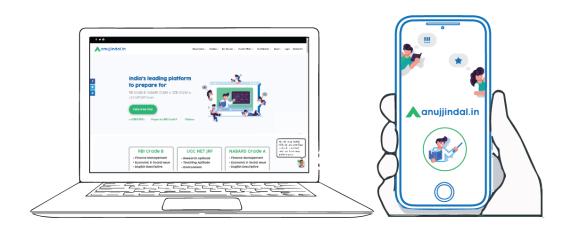


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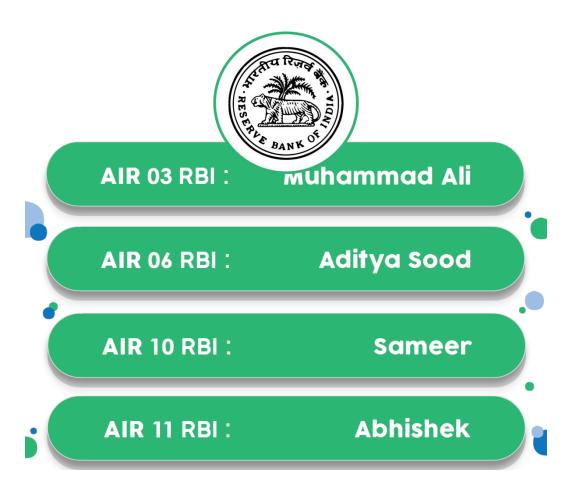








RBI



550+ Students cleared RBI Phase 1 300+ Students clear RBI Phase 2 48 Students got selected in RBI









SEBI



AIR 01 : Rajendra S

600+ Students cleared Phase 1

300+ Students cleared Phase 2

60+ Students selected in SEBI









NABARD



1100+ Students cleared Phase 1

250+ Students cleared Phase 2

30 Students selected in NABARD









UGC NET JRF



260+ Students selected in UGC NET JRF

