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# **SELECTION METHODS AND BREEDING PLANS**

Dr. Amrutha Gopan  
Assistant Professor  
School of Fisheries  
Centurion University of Technology and Management  
Odisha

Centurion University of Technology and Management  
Odisha



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## NEED FOR GENETIC VARIATION

- Genetic variation provides the raw material for selection.
- Without additive genetic variance there can be no response to selection.
- Rare alleles in a population may not be of value to aquaculture today but may be tomorrow. For e.g. in conferring resistance to an outbreak of new disease.



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- Once alleles are lost from a population, they cannot be recovered without addition of new material.
- Genetically variable populations are thought to have higher levels of developmental stability and fitness.
- Inbreeding depression is prevented.



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## DESIGN OF BREEDING PROGRAMMES

A large breeding programme involves a single **nucleus breeding centre** where the selective breeding is carried out with **multiplier stations** which concentrate on large scale fry production without having to be concerned about broodstock management or selective breeding.



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# SPECIES TRANSFORMER

- **Cross** breeding between two individuals to develop new progeny.
- This is based on a male, having high quality of quantitative characters and its proportion in the new hybrid become higher from generation to generation.
- Heterosis effect can be observed.
- Effect of heterosis appears in the first hybrid generation and decrease gradually in the second and subsequent generations.



## Input for quality seed production - healthy brood fish

- 1) Collection of different strains of a fish species from various sources of origin.
- 2) Fish seeds produced from different strains are marked and reared to the size of fingerling.
- 3) Detail study is conducted on FCR, growth, quantitative and qualitative characters etc., before rearing as brood fish.

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- ## GUIDELINES FOR SELECTION OF BROODFISH
1. Selection of Fast growing fishes.
  2. Selecting young brood fish fed with nutritious diets for spawning to ensure better quality of seeds.
  3. Avoiding breeding of small sized (both age and weight) brood fish.
  4. Avoiding inbreeding and cross breeding.
  5. Exchange of brood stock, ideas, technologies, etc ., between hatcheries.



1. Establishment of a live gene bank at least for the Indian Major Carps to supply pure strains.

2. Training the fish seed producers, hatchery operators on appropriate technologies concerning selective breeding, brood stock management, etc.

3. Initiating participatory research with farmer, hatchery operators on induced breeding, selective breeding, line crossing, hybridization, nursery management, transportation, etc.





# INTRASPECIFIC CROSSBREEDING

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- It increases growth of aquaculture species.
- Variable levels of crossbreds showing heterosis for growth rate have been obtained in the channel catfish; rainbow trout; common carp and the Pacific oyster.
- Heterosis was also found in survival, disease resistance and reproductive traits.



# CROSSBREEDING IN COMMON CARP

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- Crossbreds exhibiting heterosis are the basis for the carp culture industries in Israel, Vietnam, China and Hungary.
- The crossbreds' growth rate and other qualitative traits give 20% better performance than the parental lines and other control strains.



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# CROSSBREEDING IN CATFISHES

- Cultured in the southeastern states of the USA.
- Produces an increase of 55 percent and 22 percent in growth rate.
- Cross-breeds of different strains of European catfish, *Silurus glanis*, have adaptability under warm water holding conditions and mixed diet feeding regimes.



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# TYPES OF SELECTION PROGRAMMES

I. Individual or mass selection

II. Family selection

- Between-family selection
- Within family selection
- Combined selection



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# I INDIVIDUAL OR MASS SELECTION

➤ Simplest form.

- The best individuals are selected from a population on the basis of their own 'phenotypic value' compared to the population means.
- The top 10 to 15% individual are selected.
- After selection, the young brood fishes are kept under optimal conditions before choosing the most appropriate female and male individuals for hatchery operation.



- At least 50 pairs of fish should be selected in each generation and contribute to the next generation.

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- The genetic gains may be 5-10% per generation.
- Tilapia farmers conduct selection by culling smaller fish in the breeding stock and propagating only large individuals.
- Mass selection is done when breeding space is limited.



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# LIMITATIONS IN INDIVIDUAL SELECTION

- Applied only to traits that have relatively high  $h^2$ '  
S.
- Selection of simply the largest individuals in a population
- Choose individuals from a few families which are larger than average for environmental rather than genetic reasons.
- In small hatchery populations this could result in rapid inbreeding.



1) **Between-family selection**  
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## II. FAMILY SELECTION

### 1) **Between-family selection**

➤ The families showing good phenotypic value are selected.

➤ When between-family selection is used relatively few families are saved.

➤ This retroactively lowers  $N_e$  of the previous generation to a very small number.





## 2) Within family selection

- Family is considered a sub-population and best individual from within family are selected or culled based on their relation to their family mean.
- Efficient method.
- Selection is favoured for traits with lower heritabilities or where the trait cannot be measured on the live animal e.g. meat quality, fat content.



### 3 Combined selection

➤ Within family selection and between families selection are combined in a single program where best individuals of the best families can be bred together.

➤ Advantage – exploitation of additive genetic variation between and within the families to have a better selection response.

➤ Used when the main differences are within rather than between families.



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# PROGENY TESTING

- It is a breeding programme that deciphers a parent's genotype by determining its offspring's phenotypes.
- Once the genotypes of the dominant parents are deciphered, selection is used to save the homozygotes and cull the heterozygotes, which will eliminate all copies of the recessive allele, fix the dominant allele, and produce a true-breeding population.



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## SELECTION FOR MORE THAN ONE PHENOTYPE

- This is the easiest, most efficient programme.
- For improving more than one phenotype;
  - tandem selection,
  - independent culling,
  - selection index.



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## TANDEM SELECTION

- A two-step selective breeding programme designed to first improve one phenotype, and after begin a second selective breeding programme to improve another phenotype.
- It takes so long to try and improve two phenotypes using this back-to-back procedure.



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# INDEPENDENT CULLING

- Easiest selective breeding programme used to improve two or three phenotypes.
- Selection is done simultaneously for two or more phenotypes by establishing cut-off values for each phenotype independent of the other(s), and each fish must reach or exceed all cut-off values in order to be saved.
- A fish which fails one cut-off value is culled.



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# SELECTION INDEX

- Used to improve two or more phenotypes.
- More sophisticated and more expensive than independent culling.
- Used by aquaculturists who work at research stations.
- Needed only if three or more phenotypes will be improved simultaneously.



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# DIALLEL CROSS

- All parents are crossed to make hybrids in all possible combinations.
- Aims at establishing a foundation population for genetic improvement.





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