



**जननायक चन्द्रशेखर विश्वविद्यालय, बलिया-277001 (उ.प्र.)**  
**Jananayak Chandrashekhar University, Ballia-277001 (U. P.)**



## **FACULTY OF AGRICULTURE**

**COURSE STRUCTURE FOR**

**M.Sc.(Fisheries)**

**AQUACULTURE**

**UNDER SEMESTER SYSTEM**

**ACADEMIC SESSION -2020-21**



**M.Sc. (Fisheries) AQUACULTURE**

**FACULTY OF AGRICULTURE**

**SEMESTER SYSTEM**

# **FACULTY OF AGRICULTURE**

## **M.Sc. (Fisheries)-AQUACULTURE**

### **SEMESTER SYSTEM**

The Country-level exercise undertaken by the ICAR aims to address certain concerns with respect to acceptability, transferability of the knowledge and skills and employability of the postgraduates receiving Agricultural Education in the Country. The overall aim is to infuse quality, excellence and relevance in Agricultural Education.

The proposed curricula and syllabi are utilitarian, futuristic, incorporate modern science and cutting-edge technologies, lay emphasis on experiential learning, and would equip students to become entrepreneurs as well as professionals.

At present, besides the Central Institute of Fisheries education (CIFE), Mumbai which is a Deemed University, postgraduate education in the Discipline of Fisheries Science is offered by 10 Fisheries Colleges in the country.

The Curricula and Syllabi in the Broad Subject Matter Area (BSMA) of Fisheries Science were reviewed by a Committee (BSMAC) and a total of 14 Courses for the M.F.Sc. and 11 Courses for the Ph.D. programmes were identified. Their salient features are as follows:

- Aquaculture as a specialization is taught by all the Institutes offering postgraduate programme in Fisheries, in view of its importance in terms of contribution to fish production and employment generation.
- After studying the courses offered under Aquaculture by various Colleges and CIFE, a synthesis was made taking into consideration the level of exposure required for the students at Masters and Doctoral levels and in keeping with current knowledge and future needs.
- Courses on culture of finfish and shellfish in fresh, brackish and marine waters are included, besides ornamental fish culture.
- Courses on nutrition, seed production, health management, biotechnology and genetics have also been included.

## **FACULTY OF AGRICULTURE**

### **M.Sc. (Fisheries) AQUACULTURE**

#### **COURSE STRUCTURE**

<b>SEMESTER FIRST</b>	<b>MM.:400</b>
Paper 101 SUSTAINABLE AQUACULTURE	MM.:75
Paper 102 SOIL AND WATER QUALITY MANAGEMENT IN AQUACULTURE	MM.:75

Paper 103 NUTRITION AND FEED TECHNOLOGY	MM.:75
Paper 104 STATISTICAL METHODS	MM.:75
Paper 105 LIBRARY AND INFORMATION SERVICES (Non Gradial)	MM.:75
Practical for all	MM.:100
<b>SEMESTER SECOND</b>	<b>MM.:400</b>
Paper 201 AQUATIC ANIMAL HEALTH MANAGEMENT	MM.:75
Paper 202 SEED PRODUCTION AND HATCHERY MANAGEMENT OF FINFISHES	MM.:75
Paper 203 SEED PRODUCTION AND HATCHERY MANAGEMENT OF SHELLFISHES	MM.:75
Paper 204 APPLIED GENETICS IN AQUACULTURE	MM.:75
Paper 205 TECHNICAL WRITING AND COMMUNICATIONS SKILLS (Non Gradial)	MM.:100
Practical for all	MM.:100
<b>SEMESTER THIRD</b>	<b>MM.:400</b>
Paper 301 NON-FOOD AQUACULTURE	MM.:75
Paper 302 COASTAL AQUACULTURE	MM.:75
Paper 303 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (e-Course) (Non Gradial)	MM.:75
Paper 304 BASIC CONCEPTS IN LABORATORY TECHNIQUES (Non Gradial)	MM.:75
Paper 305 FRESHWATER AQUACULTURE	MM.:75
Paper 306 RESEARCH METHODOLOGY	MM.:75
Practical for all	MM.:100
<b>SEMESTER FORTH</b>	<b>MM.:400</b>
Paper 401 LARVAL NUTRITION AND CULTURE OF FOOD ORGANISMS	MM.:75
Paper 402 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (e- Course) (Non Gradial)	MM.:75
Paper 403 DISASTER MANAGEMENT (e-Course) (Non Gradial)	MM.:75
Paper 404 AQUACULTURE ENGINEERING	MM.:75
Paper 405 MASTER'S SEMINAR	MM.:75

Paper 406 Thesis for MASTER'S RESEARCH

MM.:125

Viva vice of thesis of Master Research

MM.:50

## PROPOSED REGULATION

Semesters/Papers <b>SEMESTER I</b>	Title of the papers	Theory		Practical	
		Max. Marks	Min. Marks	Max. Marks	Mini. marks
Paper 101	(Theory Paper)	75	25	-	
Paper 102	(Theory Paper)	75	25	-	
Paper 103	(Theory Paper)	75	25	-	
Paper 104	(Theory Paper)	75	25	-	
Paper 105	(Theory Paper) Non Gradial	75	25	-	
	<b>PRACTICAL FOR ALL</b>			100	33
<b>Total aggregate of First Semester is 36%</b>		Max. Marks – 400 Min.Marks – 144			
<b>SEMESTER II</b>					
Paper 201	(Theory Paper)	75	25	-	
Paper 202	(Theory Paper)	75	25	-	-
Paper 203	(Theory Paper)	75	25	-	-
Paper 204	(Theory Paper)	75	25	-	-
Paper 205	(Theory Paper) Non Gradial	75	25	-	-
	<b>PRACTICAL FOR ALL</b>	-	-	100	33
<b>Total aggregate of First Semester is 36%</b>		<b>Max. Marks – 400</b> <b>Min. Marks – 144</b>			
<b>SEMESTER III</b>					
Paper 301	(Theory Paper)	75	25	-	-
Paper 302	(Theory Paper)	75	25	-	-
Paper 303	(Theory Paper) Non Gradial	75	25	-	-
Paper 304	(Theory Paper) Non Gradial	75	25	-	-
Paper 305	(Theory Paper)	75	25	-	-
Paper 306	(Theory Paper)	75	25	-	-
	<b>PRACTICAL FOR ALL</b>	-	-	100	33
<b>Total aggregate of First Semester is 36%</b>		<b>Max. Marks – 400</b> <b>Min. Marks – 144</b>			
<b>SEMESTER IV</b>					
Paper 401	(Theory Paper)	75	25	-	-
Paper 402	(Theory Paper) Non Gradial	75	25		
Paper 403	(Theory Paper) Non Gradial	75	25		
Paper 404	(Theory Paper)	75	25		

Paper 405	Master Seminar	-	75	25
Paper 406	THESIS WORK FOR RESEARCH		125	42
	VIVA-VOCE OF THESIS WORK FOR RESEARCH		50	17
<b>Total aggregate of First Semester is 36%</b>		<b>Max. Marks – 400</b>		
		<b>Min. Marks – 144</b>		

**Consolidate Performa for allotments of all semester are as follows-**

First Semester	400	144
Second Semester	400	144
Third Semester	400	144
Fourth Semester	400	144
Grand Total	1600	576

**Note-**

1. The research work may be initiated in any of II or III semester but the thesis shall be submitted at the end of IV semester.
2. The evaluation of seminar presentation shall be done by the departmental committee which shall be constituted by the Head of Department /Principal of College.
3. The Non Gradual course marks are not included in total marks but students should be pass in that course.
4. The thesis evaluation and viva-voce shall be made by the external and internal examiner.
5. The minimum passing marks of every paper shall be 33 % in theory and practical separately and total aggregate of the semester shall be 36 % minimum.

## **M.Sc. (Fisheries) Aquaculture**

### **SEMETER WISE DETAILS OF SYLLABUS**

#### **SEMESTER FIRST**

**MM.:400**

Paper 101 SUSTAINABLE AQUACULTURE

MM.:75

#### UNIT I

Present scenario and problems: Trends in global and Indian aquaculture; different farming systems; intensive systems and constraints - environmental degradation and disease outbreaks. Sustainability and development: Systems approach and its application in aquaculture with special reference to resource-poor systems; Role of aquatic resources in food and nutrition; Aquatic resource and livelihood systems.

#### UNIT II

Environmental issues: Exotic species introduction; escapement; contamination of indigenous gene pool; salinization of soil and water; environmental impact; over exploitation of wild stocks; mangrove deforestation. Economic viability: export vs. domestic marketing, value addition.

### UNIT III

Socio-economic issues: Conflicts over water and land use; conflicts of interest between aqua farmers and fishermen; resistance from local public; anti-dumping duties. Strategies for sustainability: Sustainability concept; food security; biosecurity; organic farming; integrated farming; responsible aquaculture; rotational aquaculture; bioremediation; role of biotechnology, traceability.

### UNIT IV

Application of renewable energy in aquaculture - solar energy, wind, and tidal energy, Seed certification, Sustainable use of antibiotics. Guiding principles to sustainable aquaculture development: Coastal Aquaculture Guidelines Source Book, FAO Code of Conduct for Responsible Fisheries; Holmenskollen Guidelines for Sustainable Aquaculture.

#### Practical

Visit to conventional aquafarm to see the management of used water; Survey on environmental impact nearby aquaculture farms; Setting model for sustainable aquaculture (organic farm, integrated farm); Applications of remote sensing and GIS (geographical information system); Economic evaluation of aquaculture practices.

#### Suggested Readings

- Bardach JE. 1997. Sustainable Aquaculture. John Willey & Sons.
- Bardach JE, Rhyther JH & Mc. Larney WO. 1972. Aquaculture Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons.
- Beets WC. 1990. Raising and Sustaining Productivity of Small-Holder Farming Systems in the Tropics. Agbe Publ.
- Edwards P, Little DC & Demaine H. (Eds.). 2002. Rural Aquaculture. CABI. FAO 2001. Planning and Management for Sustainable Coastal Aquaculture Development. FAO.
- Imai T. 1978. Aquaculture in Shallow Seas. Progress in Shallow Sea Culture. Amerind Publ. James PM. 1983. Handbook of Mariculture. Vol. I. Crustacean Aquaculture. CRC Press. Leung P, Lee CS & O'Bryen JP. (Eds.). 2007. Species and System Selection for Sustainable Aquaculture. Blackwell Publ. Midlen & Redding TA. 1998. Environmental Management for Aquaculture. Chapman & Hall. Selvamani BR & Mahadevan RK. 2008. Aquaculture, Trends and Issues. Campus Books International.

Paper 102 SOIL AND WATER QUALITY MANAGEMENT IN AQUACULTURE MM.:75

### UNIT I

Soil and water interaction: Physical and chemical properties of soil and water, Productivity vs nutrient quality and quantity of soil and water; aquatic microorganisms and their role in carbon, nitrogen, phosphorus and sulphur cycles and impact on aquatic habitats and species.

## UNIT II

Soil and water quality monitoring: soil and water quality standards; soil and water quality monitoring and management.

## UNIT III

Fertilizers and manures: Different kinds of fertilizers and manures, fertilizer grade, source, rate and frequency of application, Biofertilizers, Use of treated sewage for pond fertilization, Ecological changes taking place after fertilizing, Primary production, degradation of molecules in aquatic environment, Utilization of bioactive compounds by microorganisms.

## UNIT IV

Soil and water quality management: Cat clay/pyrite soil, seepage, water treatment, water filtration devices, aeration, chlorination, ozonation and UV radiation, Algal bloom control, eutrophication, Aquatic weed management, Waste water treatment practices, Water quality management in hatcheries, Waste discharge standards, Role of microorganisms in fish production, fish health and fish safety; Microbial load and algal blooms.

### Practical

Equipment used in soil and water analysis; Soil sampling, determination of soil moisture and bulk density; pond filling, analyses of mud acidity and soil texture; Measurements of temperature, pH, conductivity, salinity, transparency, turbidity and solids; Analyses of dissolved oxygen, alkalinity and hardness, phosphorus, nitrogen; Estimation of primary productivity and 15 chlorophyll; Application of fertilizers and pond liming; Analysis of toxic elements; Microbial techniques; Visit to effluent treatment plant; Design and operation of biological filters.

### Suggested Readings

Adhikari S &Chatterjee DK. 2008.Management of Tropical Freshwater Ponds.Daya Publ. APHA, AWWA, WPCF. 1998. Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, D. C.

Boyd, C. E. and Tucker, C. S. 1992.Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.

Boyd CE. 1979. Water Quality in Warm Water Fish Ponds. Auburn University.ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR.

Parsons TR, Maita Y &Lalli CM. 1984.A Manual of Chemical and Biological Methods for Seawater Analysis.Pergamon Press.

Rajagopalsamy CBT & Ramadhas V. 2002. Nutrient Dynamics in Freshwater Fish Culture System. Daya Publ. Sharma LL, Sharma SK, Saini VP & Sharma BK. (Eds.). 2008. Management of Freshwater Ecosystems. Agrotech Publ. Academy.

## Paper 103 NUTRITION AND FEED TECHNOLOGY

MM.:75

### UNIT I

Fish nutrition: Principles of fish nutrition and terminologies, nutritional requirements of cultivable finfish and shellfish: larvae, juveniles and adults. Feed Resources: Nutritional value of feed ingredients and live feed, Contribution from natural food to nutrient requirements of fish, Feed additives (attractants, growth stimulants and probiotics and binders), and Feed resources assessment.

### UNIT II

Nutritional biochemistry: Classification, nutrient quality and evaluation of proteins, lipids and carbohydrates. Nutritional bioenergetics: Fish as an open thermodynamic system, Energy requirement of fishes, protein to energy ratio, digestible energy, nitrogen balance index, protein sparing effect, high energy feeds, isocaloric diets, Optimal foraging theory, Mathematical modeling of ingestion, Metabolic rate, Energy budgets, Energetic efficiency of fish production.

### UNIT III

Role of nutrients: amino acids, fatty acids, proteins, lipids, carbohydrates, vitamins and minerals. Nutritional physiology: Digestion, accretions and nutrient flow, Factors affecting digestibility. UNIT VI Nutritional pathology: Antinutritional factors and antimetabolites, microbial toxins, methods of elimination, nutrient deficiency and symptoms.

### UNIT IV

Feed Manufacture: Feed formulation and processing, On-farm feed manufacture, Commercial feed manufacture, Feed storage. UNIT IX Feeding Practices: Supplementary feed—theory and practice, Complete diet - theory and practice, Feeding methods and scheduling, ration size, feed performance and economics.

#### Practical

Formulation and preparation of a balanced fish feed; Feeding trials; Proximate analysis- moisture, crude protein, crude lipid, ash, acid insoluble ash content of feed; Estimation of crude fibre, nitrogen free extract, calcium and phosphorus content of feed; Estimation of protein and lipid quality; Determination of gross energy content of feed and feed ingredients; Determination of the digestibility of feed using markers; Estimation of FCR from feeding trials and preparation of feeding table; Estimation of growth parameters from feeding trials; Analysis of mycotoxins from feed



ingredients/feed; Gut content analysis to study artificial and natural food intake. Visit to feed manufacturing units.

### Suggested Readings

- ADCP (Aquaculture Development and Co-ordination Programme). 1980. Fish Feed Technology. ADCP/REP/80/11.FAO.
- Cyrino EP & Bureau D & Kapoor BG. 2008. Feeding and Digestive Functions in Fishes. Science Publ.
- D' Abramo LR, Conklin DE & Akiyama DM. 1977. Crustacean Nutrition: Advances in Aquaculture. Vol. VI. World Aquaculture Society, Baton Rouge.
- De Silva SS & Anderson TA. 1995. Fish Nutrition in Aquaculture. Chapman & Hall Aquaculture Series. Elena M. 2003. Nutrition, Physiology and Metabolism in Crustaceans. Science Publishers.
- Guillame J, Kaushik S, Bergot P & Metallier R. 2001. Nutrition and Feeding of Fish and Crustaceans. Springer Praxis Publ.
- Halver J & Hardy RW. 2002. Fish Nutrition. Academic Press. Halver JE & Tiews KT. 1979. Finfish Nutrition and Fishfeed Technology. Vols. I, II
- Heenemann, Berlin. Hertrampf JW & Pascual FP. 2000. Handbook on Ingredients for Aquaculture Feeds. Kluwer.
- Houlihan D, Boujard T & Jobling M. 2001. Food Intake in Fish. Blackwell. Lavens P & Sorgeloos P. 1996. Manual on the Production and Use of Live Food for Aquaculture. FAO Fisheries Tech. Paper 361, FAO.
- Lovell RT. 1998. Nutrition and Feeding of Fishes. Chapman & Hall. New MB. 1987. Feed and Feeding of Fish and Shrimp. A Manual on the Preparation and Preservation of Compound Feeds for Shrimp and Fish in Aquaculture.
- FAO – ADCP/REP/87/26.17 NRC (National Research Council). 1993. Nutrient Requirements of Fish. National Academy Press, Washington.
- Ojha JS. 2005. Aquaculture Nutrition and Biochemistry. Daya Publ. AQC

Paper 104 STATISTICAL METHODS

MM.:75

### UNIT I

Sampling distribution for mean and proportion, standard error, confidence interval for mean and proportion; Test of hypothesis: type I and type II errors, level of significance, tests based on Z, t,  $X^2$  and F distribution.

### UNIT II

Properties of estimators: unbiasedness, efficiency, sufficiency and consistency. Simple correlation and regression, Spearman's rank correlation.

### UNIT III

Basic concepts of sampling techniques: simple random, stratified, systematic, cluster and two stage sampling and their applications in fisheries.

## UNIT IV

Analysis of variance: one way and two way classification; Non-parametric test, advantages and disadvantages over parametric tests; Run test and Sign test.

### Practical

Tests of hypothesis based on Z, t, X<sup>2</sup> and F; Simple correlation and regression, Rank correlation; Analysis of variance: one way and two way; Simple random, stratified, systematic, cluster and two stage sampling; Sign test, Run test; Hands on experience in using the statistical software packages MS Excel, Systat and SPSS in data analysis and interpretation.

### Suggested Readings

Biradar RS. 2002. Course Manual on Fisheries Statistics. 2nd Ed. CIFE, Mumbai.

Keller G. 2001. Applied Statistics with Microsoft Excel. Duxbury. Kothari CR. 1998. Research Methodology. 2nd Ed.

Wishwa Prahashan, Levin RL & Rubin DS. 1983. Statistics for Management. Prentice-Hall of India.

Panse VG & Sukhatme PV. 1978. Statistical Methods for Agricultural Workers. ICAR.

Siegel S & Castellan NJ. Jr. 1988. Non Parametric Statistical Methods. John Wiley & Sons.

## Paper 105 LIBRARY AND INFORMATION SERVICES (Non Gradiual) MM.:75

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search. Practical Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; eresources access methods.

## SEMESTER SECOND MM.:400

## Paper 201 AQUATIC ANIMAL HEALTH MANAGEMENT MM.:75

### UNIT I

Basics of fish and shellfish health management: Host-pathogen-environment relationship, Management of culture systems, Environmental stress. Parasitic and mycotic diseases: General characteristics, Epizootiology, Diagnosis, Life cycle, Prevention and treatment.

## UNIT II

Defence system in fish and shellfish: Defence systems in fish, innate and acquired immunity, inflammation response to diseases. Antibody and cell mediated immunity in fish and shellfish. Non-infectious Diseases: Nutritional diseases, water, soil, environmental parameters and their effects on fish health. Disease in hatcheries and growout systems.

## UNIT III

Infectious bacterial and viral diseases: General characteristics, Epizootiology, Diagnosis, Prevention and treatment. UNIT VI Techniques in health management: Microbiological, haematological, histopathological, immunological and molecular techniques. Disease surveillance and reporting.

## UNIT IV

Disease control and management: Environment management, chemotherapeutic agents, host management, prophylaxis- vaccines, adjuvants, immunostimulants and probiotics. Use and abuse of antibiotics and chemicals in health management. Fish health and quarantine systems. Seed certification, SPF and SPR stocks - development and applications.

## Practical

General procedures for disease diagnosis; Taxonomy and identification of fish parasites; Sampling, preparation of media and culture of pathogenic bacteria; Techniques for bacterial classification; Histological techniques for disease diagnosis; Molecular and immunological techniques; Biochemical tests; PCR; ELISA; Agglutination test; Challenge tests; Purification of virus; Stress related study of fish and shellfish; Disease treatments.

## Suggested Readings

Aline W. 1980. Fish Diseases. Springer Verlag.

Andrews C, Excell A & Carrington N. 1988. The Manual of Fish Health. Salamander Books. Austin B & Austin DA. 1987. Bacterial Fish Pathogens (Diseases in Farm and Wild).

Ellis Harward. 18 Felix S, Riji John K, Prince Jeyaseelan MJ & Sundararaj V. 2001. Fish Disease Diagnosis and Health Management. Fisheries College and Research Institute, T.N. Veterinary and Animal Sciences University.

Thoothukkudi. Inglis V, Roberts RJ & Bromage NR. 1993. Bacterial Diseases of Fish. Blackwell. Iwama G & Nakanishi T. (Eds.). 1996. The Fish Immune System - Organism, Pathogen and Environment. Academic Press. Roberts RJ. 2001. Fish Pathology. 3rd Ed. WB Saunders. Schaperclaus W. 1986. Fish Diseases. Vols. I, II. Oxonian Press.

Shankar KM & Mohan CV. 2002. Fish and Shellfish Health Management. UNESCO Publ. Sindermann CJ. 1990. Principal Diseases of Marine Fish and Shellfish. Vols. I, II. 2nd Ed. Academic Press.

Walker P & Subasinghe RP. (Eds.). 2005. DNA Based Molecular Diagnostic Techniques: Research Needs for Standardization and Validation of the Detection of Aquatic Animal Pathogens and Diseases.

FAO Publ. Wedmeyer G, Meyer FP & Smith L. 1999. Environmental Stress and Fish Diseases. Narendra Publ. House.

## Paper 202 SEED PRODUCTION AND HATCHERY OF FINFISHES

MM.:75

### UNIT I

Introduction: History, constraints and current status of natural seed collection and hatchery seed production. Reproductive biology: Physiology and morphology; Molecular and physiological basis of reproduction, Overview of current developments in reproductive biology.

### UNIT II

Gamete maturation and development: Spermatogenesis and oogenesis, Hormonal pathways and mode of control. Environmental and endocrine control of reproduction: Reproductive cycles, Seasonality (Photoperiod, change in water quality and quantity, temperature, lunar cycle, etc.), Environmental and exogenous hormonal stimuli.

### UNIT III

Induced spawning: Methods of natural and artificial fertilization, GnRH and Linpe models, evaluation of milt and egg, cryopreservation technique, use of different synthetic hormones and analogues for induced spawning, Egg staging, Stripping and fertilization. Hatchery technology for different species: Indian major and minor carps, Exotic carps, Catfishes, Tilapia, Masheer, Trout, etc. Marine fish seed production: Seabass, milkfish, mullets, sea breams, rabbitfish, grouper, yellowtail, eel, cobia, etc.

### UNIT IV

Hatchery design and management: Criteria for site selection of hatchery and nursery, Design and function of incubators, Jar hatchery, Chinese hatchery and other hatchery systems- design and operation, hatchery protocols, larval rearing stages, rearing technology, packaging and transport of seed. Seed supply in aquaculture: Relationship between fry supply and grow-out, Macro-planning of fry production to stimulate grow-out, Marketing and economics of fish seed.

### Practical

Study of gonadal development in carps and other cultivable finfishes; Identification of carp and catfish seed; Collection and identification of cultivable brackishwater finfish seed; Packing and transportation of cultivable finfish seed; Induced breeding of fishes through various inducing agents; Evaluation of carp milt and egg; Design and operation of Chinese hatchery; Preparation of brood and larval feed for different cultivable finfish; Rearing of carp spawn and fry; Visit to different finfish hatcheries.

### Suggested Readings

FAO. 1992. Manual of Seed Production of Carps. FAO Publ.  
ICAR. 2006. Hand Book of Fisheries and Aquaculture. ICAR.  
Jhingran VG & Pullin RSV. 1985. Hatchery Manual for the Common, Chinese and Indian Major Carps. ICLARM, Philippines.  
Jhingran VG. 1991. Fish and Fisheries of India. Hindustan Publ. Landau M. 1992. Introduction to Aquaculture. John Wiley & Sons.  
Mcvey JP. 1983. Handbook of Mariculture. CRC Press.  
Pillay TVR & Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell. Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.  
Thomas PC, Rath SC & Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ.

## Paper 203 SEED PRODUCTION AND HATCHERY MANAGEMENT OF SHELLFISHESMM.:75

### UNIT I

Introduction: Current status; problems and prospects. Seed resources: Site selection and techniques of collection; identification and segregation of shellfish seed.

### UNIT II

Reproductive biology: Gonad anatomy, endocrinology and reproductive mechanisms in prawns, shrimps, crabs, lobsters, mussels, oysters, scallops and clams; age at first maturity; factors affecting maturation and spawning. 20

### UNIT III

Broodstock: availability; improvement; nutritional requirements; transport; captive rearing and maturation; induced spawning; physical and chemical inducing agents; physiology and techniques of eyestalk ablation. Seed production: Seed production of commercially important prawns, shrimps, crabs, lobsters, mussels, edible oysters, pearl oyster, scallops, clams and sea cucumber.

### UNIT IV

Hatchery technology and management: Site selection and facilities required; culture and use of different live feed in shellfish hatcheries; larval diseases and their management; different chemicals and drugs used; water quality and feed management; Hatchery standards and biosecurity; sanitary and phytosanitary (SPS) measures; better management practices (BMPs); packaging and transport of seed. Economics of seed production

### Practical

Layout and design of prawn and shrimp hatcheries; Study of gonad development in different cultivable crustaceans and molluscs; Collection and identification of shellfish seed; Packing and

transportation of shellfish seed; Eyestalk ablation technique; Identification of larval stages of shrimp, prawn, crab, mussel and oyster; Culture techniques of microalgae and other live feed used in shellfish hatcheries; Artemia hatching technique; Visit to different shellfish hatcheries; Economic analysis of shellfish hatcheries.

#### Suggested

Readings CMFRI Bulletin. 1987. National Seminar on Shellfish Resources and Farming. FAO. 2007. Manual for Operating a Small Scale Recirculation Freshwater Prawn Hatchery. ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR. Jhingran VG. 1991. Fish and Fisheries of India. Hindustan Publ. Corp. Landau M. 1992. Introduction to Aquaculture. John Wiley & Sons. Mcvey JP. 1983. Handbook of Mariculture. CRC Press. Pillay TVR & Kutty MN. 2005. Aquaculture - Principles and Practices. Blackwell. Thomas PC, Rath SC & Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ. House.

Paper 204 APPLIED GENETICS IN AQUACULTURE

MM.:75

#### UNIT I

Introduction: Origin and advancement in genetics; physical basis of heredity; genetic correlation, domestication and local adaptation. Chromosome manipulation: Ploidy induction methods - triploidy and tetraploidy, advantages and disadvantages of polyploids, androgenesis and gynogenesis.

#### UNIT II

Sex determination: Sex differentiation and sex reversal in fishes, sex control and its role in aquaculture. Selection: Scope, application and methods of selection, marker assisted selection- biochemical and molecular markers. Molecular tools for stock differentiation for selection.

#### UNIT III

Hybridization: Heterosis, hybrid vigour, introgression. Inbreeding: Methods of estimation, inbreeding depression and consequences, measures to reduce inbreeding in hatcheries. Conservation genetics: Genetic resources of India and conservation, endangered species, cryopreservation of fish gametes.

#### UNIT IV

Cytogenetics: Importance and karyotyping. Fish breeding: History and advancement of fish breeding, mode of reproduction, basic breeding methods and breeding programmes and goals. Genetic management strategies: Environmental impacts, Lessons from the green revolution, Bioprospecting, GMOs and their detection.

#### Practical

Estimation of gene and genotype frequencies; Exercises on HardyWeinberg equation; Estimation of inbreeding coefficient; Protocol of androgenesis and gynogenesis; Protocol of cryopreservation of milt; Karyotypic studies; Isolation of DNA from fish blood.

### Suggested Readings

Carvalho GR & Pitcher TJ. (Eds.). 1995. Molecular Genetics in Fisheries. Chapman & Hall. Falconer DS & Mackay. 1996. Introduction to Quantitative Genetics. 4th Ed. Longman. Kanakaraj P. 2001. A Text Book on Animal Genetics. International Book Distributing Co. Nair PR. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publ. Padhi BK & Mandal RK. 2000. Applied Fish Genetics. Fishing Chimes. Pandian TJ, Strüssmann CA & Marian MP. 2005. Fish Genetics and Aquaculture Biotechnology. Science Publ. Purdom CE. 1993. Genetics and Fish Breeding. Chapman & Hall. Reddy PVGK. 2005. Genetic Resources of Indian Major Carps. FAO Publ. Reddy PVGK, Ayyappan S, Thampy DM & Krishna G. 2005. Text book of Fish Genetics and Biotechnology. ICAR. Ryman N & Utter F. (Eds.). 1988. Population Genetics and Fishery Management. Washington Sea Grant Programmes, USA. Tave D. 1996. Genetics for Fish Hatchery Managers. 2nd Ed. AVI Publ. Thorpe JE, Gall GAE, Lannan JE & Nash CE. (Eds.). 1995. Conservation of Fish and Shellfish Resources, Managing Diversity.

### Paper 205 TECHNICAL WRITING AND COMMUNICATIONS SKILLS (Non Gradial) MM.:75(Practical)

To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

### Practical

Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article. Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

### Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.

Collins' Cobuild English Dictionary. 1995. Harper Collins.  
Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.  
James HS. 1994. Handbook for Technical Writing. NTC Business Books. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.  
Mohan K. 2005. Speaking English Effectively. MacMillan India. Richard WS. 1969. Technical Writing. Barnes & Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.  
Abhishek. Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.  
Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

### **SEMESTER THIRD**

**MM.:400**

Paper 301 NON-FOOD AQUACULTURE

MM.:75

#### UNIT I

Aquarium fish trade: Present status; potential; major exporting and importing countries; species-wise contribution of freshwater and marine fishes; contribution of culture and capture; marketing strategies; anesthetics, packing and transportation. Breeding techniques: Reproductive biology, captive breeding and rearing of freshwater, brackishwater, marine ornamental fishes and invertebrates.

#### UNIT II

Aquarium keeping: Design and construction of tanks; species-wise tank size requirement; heating, lighting, aeration and filtration arrangements; decorations used; common aquarium plants and their propagation; Feed, health and water quality management; prophylaxis; quarantine. Value addition: Colour enhancement; genetic manipulation and production of new strains; hybrids; acclimatization strategies for marine ornamental fish to freshwater.

#### UNIT III

Pearl Production: Overview of pearl trade, pearl oysters and mussels of commercial importance; anatomy, biology and seed production, techniques of implantation, method of rearing and harvesting of pearl, Mable pearl production, processing and quality evaluation of pearls, pearl production by tissue culture.

#### UNIT IV

Bait fish culture: Scope and importance, bait fish species (minnows, silver heads, etc.), farming practices. Ornamental aquatic plants: Propagation methods, nutrient and environmental requirement, cropping methods, packing and transport.

Practical



Identification of common freshwater aquarium fishes and breeding trials of selected freshwater fishes; Identification of common brackish water and marine aquarium fishes; Aquarium fabrication, setting and maintenance; Preparation of powdered and pelleted feed for ornamental fishes; Visit to ornamental fish farms; Study of bacterial, viral, fungal diseases of ornamental fishes and their control; Prophylactic and quarantine measures; Nuclei implantation in pearl oyster; Identification of ornamental aquatic plants.

### Suggested Readings

Axelrod HR & Vorderwinkler W. 1978. Encyclopaedia of Tropical Fishes. TFH Publ. Axelrod HR & Sweeney ME. 1992. The Fascination of Breeding Aquarium Fishes. TFH Publ. Axelrod HR. 1967. Breeding Aquarium Fishes. TFH Publ. ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR. Mills D. 1981. Aquarium Fishes. Kingfisher Books. Sanford G & Crow R. 1991. The Manual of Tank Busters. Salamander Books. Saxena A. (Ed.). 2003. Aquarium Management. Daya Publ. Spotte S. 1979. Fish and Invertebrate Culture. John Wiley & Sons. Thabrow De WV. 1981. Popular Aquarium Plants. Thornbill Press.

## Paper 302 COASTAL AQUACULTURE

MM.:75

### UNIT I

Introduction: An overview of the status of coastal aquaculture; Present trend and scope in India. Different farming systems: Cage and pen culture – type, site selection, construction, specifications for different species; Raft and rack culture – site selection, design and construction.

### UNIT II

Important cultivable finfishes: Distribution, biology, seed collection, nursery rearing, culture techniques, problems and prospects (seabass, milkfish, mullets, pearlspot, sea breams, rabbitfish, grouper, yellowtail, eel, cobia, salmon, flatfish).

### UNIT III

Culture of marine molluscs and echinoderms: Present status and scope in India, Species cultured (mussels, oysters, pearl oysters, scallops, clams, cockles, abalones, sea cucumber) distribution, biology, practices followed in India, farming methods - off-bottom and on-bottom culture; Problems and prospects.

### UNIT IV

Culture of crustaceans: Shrimp farming: systems of farming – extensive, semi-intensive and intensive; site selection, infrastructure requirement, design and construction of culture systems, pond preparation, stocking, feed and water quality management, disease prevention and treatment;

harvesting and handling; freshwater farming of tiger shrimp, shrimp farming in undrainable ponds, low and zero water exchange systems; Mud crab fattening, production of soft-shell crabs; Lobster culture; Crayfish culture. Seaweed culture: Major seaweed species of commercial importance; methods of culture; farming of agar, algin, carrageenan yielding species; emerging trends in their farming in open seas; Integration with other farming systems.

#### Practical

Identification of cultivable marine and brackishwater finfish and shellfish; Identification of cultivable seaweeds; Designing of different farming systems – cages, pens, rafts and racks; Visit to coastal aquafarms. 24

#### Suggested Readings

- Bardach EJ, Rhyther JH & McLarney WO. 1972. Aquaculture the Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons. FAO. 2001. Planning and Management for Sustainable Coastal Aquaculture Development. FAO Publ.
- Gilbert B. 1990. Aquaculture. Vol. II. Ellis Horwood. ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR.
- Pillay TVR. 1990. Aquaculture, Principles and Practices. Fishing News Books.
- Pillay TVR & Kutty MN. 2005. Aquaculture: Principles and Practices. 2nd Ed. Blackwell.
- Shepherd J & Bromage N. 1990. Intensive Fish Farming. B.S.P. Professional Books.

#### Paper 303 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (e-Course)(Non Gradial) **MM.:75**

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material 290 transfer agreements, Research collaboration Agreement, License Agreement.

#### Suggested Readings

- Erbisch FH & Maredia K. 1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy.

McGraw-Hill. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.

Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.

Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.

Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

## Paper 304 BASIC CONCEPTS IN LABORATORY TECHNIQUES(Non Gradual)MM.:75 (Practical)

### Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vascupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

### Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

## Paper 305 FRESHWATER AQUACULTURE

MM.:75

### UNIT I

Introduction: Present status, problems and scope of fish and prawn farming in global and Indian perspective. Aquaculture systems: Extensive, semi-intensive and intensive culture of fish, Pen and cage culture in lentic and lotic water bodies, polyculture, composite fish culture.

### UNIT II

Fish farming: Nursery and grow-out, pond preparation, stocking, feeding and water quality management in the farming of major and minor carps, magur, singhi, murrels, tilapia, pangasius, freshwater turtle, etc.; Stunted seed production and culture practice.

### UNIT III

Freshwater prawn farming: Monoculture practice of prawn in ponds, allmale culture and its advantages, polyculture with carps, prawn farming in inland saline soils. Nursery rearing, sex segregation, pond preparation, stocking, feeding and water quality management, disease prevention and treatment; harvesting and handling.

### UNIT IV

Integrated farming systems: Design, farming practices, constraints and economics of IFS of fish with paddy, cattle, pig, poultry, duck, rabbit, etc. Wastewater-fed aquaculture: Water treatment methods, species selection, culture practices, harvesting and depuration process. Economics of different fish farming systems.

#### Practical

Identification of commercially important cultivable fish and prawn species; Assessment of seed quality- stress test; Calculating carrying capacity of pond and stocking density; Check tray assessment and feed ration calculation; Sampling procedure and growth assessment; Lime and 25 fertilizer requirement calculations; Farm visits; Modeling of different culture systems.

#### Suggested Readings

- AAHRI. 1998. Health Management in Shrimp Ponds. Aquatic Animal Health Research Institute (AAHRI), Department of Fisheries, Thailand.
- Agarwal SC. 2008. A Handbook of Fish Farming. 2nd Ed. Narendra Publ. House.
- Beveridge MCM & Mc Andrew BJ. 2000. Tilapias: Biology and Exploitations. Kluwer.
- De Silva SS. (Ed.). 2001. Reservoir and Culture Based Fisheries: Biology and Management. ACAIR Proceedings. FAO. 2007. Manual on Freshwater Prawn Farming.
- Midlen & Redding TA. 1998. Environmental Management for Aquaculture. Kluwer.
- New MB. 2000. Freshwater Prawn Farming. CRC Publ.
- Pillay TVR. 1990. Aquaculture: Principles and Practices. Fishing News Books, Cambridge University Press, Cambridge.
- Venugopal S. 2005. Aquaculture. Pointer Publ. Welcomme RL. 2001. Inland Fisheries: Ecology and Management. Fishing News Books.

Paper 306 RESEARCH METHODOLOGY

MM.:75

### UNIT I

Elements of scientific method; Research - purpose, relevance and scope; Generalization and transferability of research data; Objectivity and value neutrality in scientific research; ethical dilemmas in research.

## UNIT II

Types of research - basic, applied, strategic, anticipatory and adaptive research; historical, descriptive and experimental research; Qualitative and quantitative research methods; Experimental and ex-post facto approaches, survey research, action research, participatory research, case study method, content analysis.

## UNIT III

Steps involved in research process; Identifying and defining researchable problems; Formulation of research objectives; Hypothesis - meaning, types, development of hypothesis and its testing; Constructs; Nature and type of variables; Types and levels of measurement; Types of reliability and validity and their measurement.

## UNIT IV

Methods of observation and data collection for biological and social sciences research; Selection of appropriate tools for analysis of biological and social sciences research data. Formats of research report - writing thesis/dissertation, research articles - abstracts, literature review, materials and methods, results and discussion, summary and references.

### Practical

Exercises on identification of a problem and formulation of research questions and hypothesis; use of data base systems and online resources; Preparing a mock synopsis / outline of research work; Exercises on case study research / developing case studies; Exercises on reliability and validity; Review and evaluation of research articles, books, theses and their presentation; Conduct of a mock research including designing a research programme, conducting experiment / field research, data collection, analysis, report writing and presentation; Writing a research article; Writing a winning research proposal.

### Suggested Readings

Kerlinger FN. 1983. Foundations of Behavioural Research. Surjeet Publ.

Kothari CR. 1998. Research Methodology. 2nd Ed. Vishwa Prahashan.

Kumar R. 1996. Research Methodology: a Step-by-Step Guide for Beginners. Sage Publ. Rossiter DG. 2003. Preparation for M.Sc. Thesis Research. ITC, Netherlands.

Walliman N. 2001. Your Research Project: a Step-by-Step Guide for the First Time Researcher. Sage Publ.

## **SEMESTER FOURTH**

**MM.:400**

## UNIT I

Larval nutrition: Larval stages, nutritional requirements of fish and shellfish larvae, quality requirements of larval feeds (particle size, digestibility), natural food and its importance in aquaculture, nutritional quality of commonly used fish food organisms.

## UNIT II

Fish food bioenrichment, biofilm/periphyton and its use, culture of single cell proteins and their nutritional quality, formulation and preparation of artificial feeds for larval rearing, microparticulate diets.

## UNIT III

Fish food organisms: Bacterioplankton, phytoplankton and zooplankton and their role in larval nutrition.

## UNIT III

Mass culture techniques: Methods of collection, maintenance and rearing of fish food organisms, Different media used in culture, Mass culture of fish food organisms and their application in hatcheries, culture of important microalgae, rotifers, artemia, cladocerans, copepods, oligochaetes, nematodes and insect larvae.

## Practical

Collection, identification and isolation of live food organisms using various techniques; Preparation of various culture media; Preparation and maintenance of stock microalgal culture; Preparation of artificial feed for rearing finfish and shellfish larvae; Mass culture of microalgae; Mass 26 culture of cladocerans, copepods and rotifers; Culture of Artemianauplii, infusoria – freshwater and marine; Culture of earthworms and chironomid larvae.

## Suggested Readings

CIFE. 1993. Training Manual on Culture of Live Food Organisms for AQUA Hatcheries. Central Institute of Fisheries Education, Versova, Mumbai.

Finn RN & Kapoor BG. 2008. Fish Larval Physiology. Science Publ.

Hagiwara A, Snell TW, Lubzens E & Tamaru CS. 1997. Live Food in Aquaculture. Proceedings of the Live Food and Marine Larviculture Symposium.

Kluwer.MPEDA. 1993. Handbook on Aqua Farming - Live Feed. Micro Algal Culture.MPEDA Publication.

Muthu MS. 1983. Culture of Live Feed Organisms. Tech. Paper 14. Summer Institute in Hatchery Production of Prawns Seeds. CMFRI, Cochin.

Ojha JS. 2005. Aquaculture Nutrition and Biochemistry. Daya Publ.

Santhanam R, Ramnathan M & Venkataramanujam. 1997. A Manual of Methods in Plankton. Fisheries College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Tuticorin.

Sorgeloos P & Pandian KS. 1984. Culture of Live Food Organisms with Special Reference to Artemia Culture. CMFRI Spl. Publ. No. 15.

Tonapi GT. 1980. Freshwater Animals of India. Oxford & IBH.

**Paper 402 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (e- Course) (Non Gradial) MM.:75**

**UNIT I**

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions.

**UNIT II**

Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

**UNIT III**

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

**UNIT IV**

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

**Suggested Readings**

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ. Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ. Singh K.. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

**Paper 403 DISASTER MANAGEMENT (e-Course) (Non Gradial) MM.:75**

## UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

## UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

## UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework.

## UNIT IV

Financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

### Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy.

Orient Blackswan.Hodgkinson PE & Stewart M. 1991.Coping with Catastrophe: A Handbook of Disaster Management.Routledge.

Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

## Paper 404 AQUACULTURE ENGINEERING

MM.:75

### UNIT I

Introduction: Technical components of farm designing, future trends in aquaculture engineering.

### UNIT II

Aquaculture facilities: Planning process, site selection and evaluation, design, components and construction of tanks, ponds, cages and hatcheries. Water intake and outlet: Pipe line, water flow and head loss, pumps.

### UNIT III



Water treatment: Equipment used for water treatment, filters, ultraviolet light, ozone, heating and cooling and other processes of disinfection. Aeration and oxygenation: Design and fabrication of aerators, oxygen injection system

#### UNIT IV

Recirculation and water use system: Definition, components and design. Feeding system: Different types of feeding equipment, feed control systems, dynamic feeding systems. Instrumentation and monitoring: Instruments for measuring water quality.

#### Practical

Visit to aqua farms; Contour survey and mappings; Evaluation of performance of seepage controlling devices; Designing of fresh and brackish water fin and shellfish farms; Designing of fresh and brackish water fin and shellfish hatcheries; Estimation of construction cost of FRP and cement hatchery units, inlets, outlets, sluice gate, monks, hatchery sheds, supply channel and drainage systems, gravitational flow; Design and construction of effluent treatment plant for hatchery; Evaluation of capacity of aeration devices.

#### Suggested Readings

Thomas L. 1995. Fundamentals of Aquacultural Engineering. Chapman & Hall.  
Wheaton FW. 1977. Aquacultural Engineering. John Wiley & Sons.  
Ivar LO. 2007. Aquaculture Engineering. Daya Publ. House.

#### **Paper 405 Seminar**

**MM.:75**

#### **Paper 405 Master Research (Thesis work for Research)**

**MM.:125**

Adverse effects of chemical fertilizer, application, Alternative protein sources, Antibiotic residues in the culture, systems; Aquaculture in inland salt affected areas , • Automated live food production systems, Bioactive compounds and Bioremediation , Bioenrichment of live food, Biofertilizers in pond productivity  
Breeding and rearing of indigenous, brackish water and marine, ornamental fishes, Breeding performance of different, stocks of brood, Cage and pen culture for marine, finfish, Carbon-nitrogen ratio in pond productivity, Cell lines and stem cell culture, Conservation of endangered species, Control of bioluminescent bacteria (LB) in aquaculture systems, Control of Cyanobacteria through nutrient manipulation, ryopreservation of gametes and embryos , Culture of live feed for larval rearing, Study of nutrient dynamics in ponds.

#### **VIVA VOCE OF THESIS**

**MM.:50**

#### **List of Journals**

- Animal Feed Sciences and Technology
- Animal Nutrition and Feed Technology
- Annals of Nutrition and Metabolism
- Annual Review of Nutrition

- Annual Review of Physiology
- Applied Aquaculture
- Applied Engineering in Agriculture
- Applied Fisheries and Aquaculture
- Aquacultural Engineering
- Aquaculture
- Aquaculture and Fisheries Management
- Aquaculture Asia
- Aquaculture Economics and Management
- Aquaculture International
- Aquaculture Nutrition
- Aquaculture Research
- Asian Fisheries Science
- Asian Journal of Microbiology Biotechnology Environmental Science
- Chromosoma
- Comparative Biochemistry and Physiology
- Diseases of Aquatic Organisms
- Fish and Shellfish Immunology
- Fish Physiology and Biochemistry
- Fisheries Research
- Fisheries Science
- Fishing Chimes
- Genetics
- Heredity
- Hydrobiologia
- Indian Journal of Animal Nutrition
- Indian journal of Environmental Health
- Israeli Journal of Aquaculture – Bamidgah
- Journal of Animal Breeding and Genetics
- Journal of Animal Genetics
- Journal of Applied Aquaculture
- Journal of Aquaculture and Aquatic Science
- Journal of Aquaculture in the Tropics
- Journal of Biotechnology
- Journal of Environmental Research
- Journal of Fish Diseases
- Journal of Ichthyology
- Limnology and Oceanography
- Pesticides Research
- Theoretical and Applied Genetics
- Toxic Environmental Chemistry
- Tropical Aquaculture
- Tropical Aquarium
- Tropical Science
- World Aquaculture
- Yojana

## **Minimum Standards for Establishing College of Fisheries**

**1. Degree Nomenclature:** M.F.Sc (Bachelor of Fisheries Science)

**2. Eligibility Criteria:**

**3. Medium of Instruction:** English

**4. Minimum Intake :** 20 students per year

**5. Departments**

1) Department of Aquaculture (AQ)

**6. Faculty Requirements for Departments**

**Department Faculty Total      06**

**Professor                              01**

**Professor Associate                02**

**Assistant Professor                 03**

**7. Faculty Expertise**

**Department Faculty Expertise**

Aquaculture - Inland Aquaculture

-Freshwater Aquaculture

-Brackish water Aquaculture

-Mariculture

-Ornamental fish culture

-Cage Culture

-Culture of Fish Food organisms

-Aquaponics

- Finfish & shellfish breeding and seed production

-Brood stock and hatchery management

-Aquaculture Engineering

-Fish Farm Management

Fisheries Resource Management

**. Administrative and Supporting Staff for Departments**

**Department Assistant- 01**

**Attendant/Messenger- 02**

**Clerk Laboratory - 01**

**Laboratory Assistant Attendant - 04**

Total Aquaculture 1 2 1 4

**9. Manpower Requirements of Dean's Office**

**Manpower Number Dean 1**

**A. Establishment PA to Dean 1**

Administrative Officer 1

Superintendent 3

Steno 1

Assistant 3

Operator (Audio Visual) 1

Attendants/Messengers 4

Clerk (LDC) 4

Electrician 1

Plumber 1

Store Keeper 1

Security, Sanitation, transport and Landscaping To be outsourced as per therequirement

**B. Central Instrumentation Facilities**

Computer Assistant 1  
 Laboratory Technicians 2  
 Laboratory Assistant 1  
 Laboratory Attendant 3

**C. Library Staff**

**Manpower Number - Assistant Librarian 1**

Library Assistant 1  
 Clerk 1  
 Library attendant 2

**D. Instructional Fish Farm & Hatchery**

Farm Manager 1  
 Field Assistant 1  
 Laboratory Assistant 1  
 Field Attendant 2  
 Field Staff / Fishermen 20  
 Security (to be outsourced)

**E. Students Welfare**

Assistant Director (Students' Welfare) 1  
 Medical Officer 1  
 Assistant Professor (Physical Education for Boys and Girls) 1+1

**F. Hostel (Boys and Girls)**

Wardens 1+1  
 Assistant Wardens 1+1  
 Clerk (LDC) 2  
 Attendants 4  
 Security, Sanitation, Boarding and Landscaping To be outsourced

**10. Land Requirements**

Main building and hostels: 4 ha  
 Instructional Farm Area: 20 ha  
 Play grounds & other amenities: 2ha  
**Total: 26 ha**

**11. Floor Space Requirement**

**A. Central Facilities**

S. No.	Details	Number of Rooms	Dimensions (ft)
1.	Dean office	1	20 x 24
2.	PA room	1	20 x 12
3.	Committee room with video conferencing facility	1	20 x 48
4.	Administrative officer room	1	20 x 12
5.	Admin. Staff rooms	3	20x 36 each
6.	Examination cell	1	20 x 12
7.	Evaluation room	1	20 x 36
8.	Faculty room	1	20 x 12 each
9.	Placement cell	1	20 x 48
10.	Smart Lecture rooms	8	Seating capacity –50
11.	Auditorium (optional)	1	Seating capacity – 300
12.	Library/Book bank	1	30 x 72
13.	Examination hall (optional)	1	Seating capacity – 300
14.	Multipurpose room	1	20 x 36
15.	Laboratories	4	30 x 48 each / as per requirement
16.	Hostels	2	hostels UG and PG Boys, UG and PG Girls
17.	Generator shed	1	20 x 36

19. Toxic chemical waste storage/disposal Unit 1 20 x 24
20. Canteen 1 20 x 12 (kitchen) & 20 x 36(seating)
21. Toilets - 2 sets for each floor
22. Parking space As per requirement For college and hostels
23. Vehicles: Office car, Staff car/Jeep, Bus, Pick-up van

## **B. Departments**

### **S. No. Detail Number of rooms Dimensions (ft)**

1. Head of the Department 8 (one for every Department) 20 x 24 each
2. Administrative Staff 8 (one for every Department) 20 x 36 each
3. Faculty room 21 (as per faculty strength) 20 x 24 (3 rooms)  
20 x 12 (18 rooms)
4. Rooms for Research Scholars 8(one for every Department) 20 x 24 each
5. Committee room cum library 8 (one for every Department) 20 x 36 each
6. Smart Lecture cum seminar room 8 (one for every Department) Seating capacity – 50 each

## **12. Equipments Requirement**

### **A. Central Instrumentation Facility**

#### **S. No. Name of the Equipment Number**

- |   |   |   |
|---|---|---|
| 1 Cold room -200C                             | 1 |   |
| 2 -800 C freezer                              | 1 |   |
| 3 Chill room 40C                              |   | 1 |
| 4 High Speed Centrifuge                       |   | 1 |
| 5 HPLC,                                       |   | 1 |
| 6 GCMS  |   | 1 |
| 7 Gel doc system                              | 1 |   |
| 8 Real time PCR                               |   | 1 |
| 9 Research Vessel                             | 1 |   |
| 10 Ultra Centrifuge                           | 1 |   |
| 11 Programmable Freezer (Cryopreservation)    |   |   |
| 12 Water Purification Unit As per requirement |   |   |
| 13 Ice flaker                                 | 1 |   |
| 14 Freeze Dryer                               | 1 |   |
| 15 Atomic Absorption Spectrophotometer (AAS)  |   | 1 |
| 16 Automatic Tissue Processor                 |   | 1 |
| 17 Microtome                                  |   | 1 |
| 18 Inverted Microscope                        |   | 1 |
| 19 Generator                                  |   | 1 |

### **B. Instructional Farm Facilities**

- 1 Nursery ponds 20
- 2 Rearing Ponds 8
- 3 Stocking ponds 4
- 4 Brood stock ponds 4
- 5 Chinese Circular hatchery 1
- 6 Wetlab facilities As per requirement
- 7 Re-circulatory Systems 1

### **C. Departmental Laboratories**

#### **S. No. Name of the Equipment Total number**

- 1 -20°C Freezer 7
- 2 -80°C Freezer 3
- 3 Autoclaves 7
- 4 Biosafety Cabinet 3

- 5 Centrifuge 7
- 6 Refrigerated Centrifuge 7
- 7 Cryo-cans 6
- 8 Analytical balance 7
- 9 Stirrer 7
- 10 Spectrophotometer 7
- 11 Research Microscope 70
- 12 Micropipette set 7
- 13 Thermocycler 7
- 14 Waterbath (Digital) 7
- 15 Salino meter (Refracto meter) 6
- 16 Dissolved oxygen analyzer 2
- 17 Hot air oven 7
- 18 Kjeltex for protein estimation 1
- 19 Soxhlet for fat estimation 1
- 20 Muffle furnace 2
- 21 Microtome 1
- 22 Fish deboning machine 1
- 23 Fish drying & smoking kiln 1
- 24 Vacuum packing machine 1
- 25 Modified atmosphere packaging 1
- 26 pH meter 7
- 27 Computers 7
- 28 Incubator 7
- 29 Digital colony counter 3
- 30 Binocular Microscope 140
- 31 Bomb Calorimeter 1
- 32 Automatic Water Analyzer 2

