

जननायकचन्द्रशेखर विश्वविद्यालय, बलिया-277001 (उ.प्र.)  
JananayakChandrashekhar University, Ballia-277001 (U.P.)

**FACULTY OF SCIENCE**

**COURSE STRUCTURE FOR**

**M.Sc. (Fisheries)**

**Applied AQUACULTURE**

**UNDER SEMESTER SYSTEM ACADEMIC SESSION -2020-21**

**M.Sc. AQUACULTURE**

**FACULTY OF SCIENCE SEMESTER SYSTEM**

Faculty of Science

M.Sc.(Fisheries) Applied Aquaculture

**Semester System**

**Introduction**

M.Sc. Aquaculture is a master level course. Duration of this course is 2 years and is divided into 4- semesters its also known as aqua-farming. It is career oriented in nature and provides many job opportunities for the candidates after its successful completion. This course refers to the study of Biodiversity, Fish Nutrition, Fish diseases, Aquatic Toxicology. Immunology and endocrinology.

M.Sc. Aquaculture has the job opportunity in the field of Oceanographer, Onshore Seafood Processor, Seafood Factory Supervisor. Seafood Processor, Seafood Supervisor. Farm Supervisor, Farm Worker. Fishery Officer, Fishing Skipper, Marine Biologist, Marine Engineer.

It is a postgraduate course in Aquatic Science. In this course, students learn about aquaculture and the farming of aquatic organisms such as fish, molluscs, crustaceans and aquatic plants. It includes the study of Biodiversity. Aquatic Toxicology, Fish Diseases, Fish Nutrition and Immunology. The students conduct investigations on varied aspects of frogs, fish and mice as experiment models.

**Eligibility Criteria**

**The basic eligibility criteria for pursuing M.Sc Aquaculture course is a pass degree in Bachelor's with Fisheries / Zoology as one of the subjects and from a recognized college or university.** The student will

be admitted on the basis of their performance in the admission test conducted by the university The duration of M.Sc Aquaculture course is of 2 years which opens many career opportunities after passing this course. This course is job orienting in nature.

### **SEMESTER FIRST**

MM:400

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**

### **SEMESTER SECOND**

MM:400

Paper 201 AQUATIC ANIMAL HEALTH MANAGEMENT MM-75

Paper 202 SEED PRODUCTION AND HATCHERY MANAGEMENT OF FINFISHES MM.75

Paper 201 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 Gradual) MM 100

**Practical for all MM 100**

### **SEMESTER THIRD**

MM:400

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**

### **SEMESTER FORTH**

MM: 400

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 Seminar

MM:75

Paper406 Thesis for MASTERS RESEARCH

MM: 125

**Viva vice of thesis of Master Research**

**MM:50**

**NOTE:**

**Each Semester maximum marks 400**

**Each Semester minimum marks 144**

1. The research work may be initiated in any of it 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 (Applied Aquaculture)**

**SEMESTER WISE DETAILS OF SYLLABUS**

**SEMESTER FIRST M.M. 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 resource-poor systems; Role of aquatic resources in food and nutrition; Aquatic resource a livelihood systems.

UNIT II

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

### UNIT III

Socio-economic issue Conflicts over water and land use, conflicts of interest between aqua farmers and fisherman resistance from local public, anti-dumping duties. Strategies for Sustainability, Sustainability concept food security, biosecurity; organic farming integrated farming, responsible aquaculture, rotational aquaculture bioremediation rule 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, Home-schooling Guidelines for Sustainable Aquaculture.

#### **Practical**

Visit to conventional aqua farm to see the management of used water: Survey on environ 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**

Bandach JE 1997, Sustainable Aquaculture. John Wiley & Sons

Bardach JE. 1997. Sustainable Aquaculture. John Wiley & Sons

Bardach JE, Rhyther JH & Mc Lamey 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.

Paper102 SOIL AND WATER QUALITY MANAGEMENT IN AQUACULTURE MM:75

### UNIT I

Soil and water interaction: Physics 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 measuring and management

### UNIT III

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

### UNIT IV

Soil and water quality management: Cat clay/pyrite soil, seepage, water treatment, water filtration devices, aeration, chlorination, ozonization 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 . Application of fertilizers and pond lining. Analysis of toxic elements: Microbial techniques: Visit to effluent treatment plant. Design and operation of biological fitters.

#### **Suggested Readings**

Adhikari S & Chatterjee DK 2008 Management of Tropical Freshwater Ponds Daya Publ.

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

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

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

Shamis LL. Shams SK, Saini V P& Sharma BK (Eds). 2008 Management of Freshwater Ecosystem AgrotechPubl Academy.

### Paper 103 NUTRITION AND FEED TECHNOLOGY

MM 75

### UNIT I

Fish nutrition Principles of fish nutrition and terminologies, nutritional requirement 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 ( growth stimulants and probiotics and binders), and Food 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 IV

Feed Manufacture Feed formulation and processing. On-farm feed manufacture, Commercial feed manufacture. Feed storage

#### **Practical**

Formulation and preparation of a balanced fish feed Feeding trials, Proximate analysis-moisture,anide protein, crude lipid ash, acid insoluble ash content of feed, Estimation of crude fiber, nitrogen free extract, calcium and phosphorus content of feed. Estimation of protein and lipid quality. Determination of gross energy comment 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 (AI Development and Coordination Programme) 1980 Fish Feed Technology

Halver J& Hardy RW 2002. Fish Nutrition Academic Press

HalverJE&Tiews KT 1979 Finish Nutrition and Fish feed Technology Vols I, II

Heenemann, Berlin, HertrampfJW&Pascual FP. 2000 Handbook on Ingredients for Aquaculture Feeds. Kluwer

Houlihan D, BoujardT&Jobling M. 2001. Food Intake in Fish, Blackwell LavensP&Sorgeloos P. 1996

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 11 errors, level of significance, tests based on Z,t, X<sup>2</sup> 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 test Run test and Sign test

#### **Practical**

Tests of hypothesis based on Z, t.X2 und 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 is 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 Metodology 2nd Ed

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

Paper 105 LIBRARY AND INFORMATION SERVICES (Non Gradial)

### MM 75

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge sources, 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, CAB 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, eresourcesaccom 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

Defense system in fish and shellfish: Defense 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, sol, environmental parameters and their effects on dal health Disease in hatcheries and growout systems

#### UNIT III

Infectious bacterial and viral disease: General characteristics, Epizootiology, Diagnosis, Prevention and treatment a

#### 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. Send 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.1988 Fish Disease Springer Verlag

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

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

Paper 202 SEED PRODUCTION AND HATCHERY OF FINISHES MM75

#### UNIT I

Introduction History, constraints and current status of natural weed collection and hatchery seed production. Reproductive biology: Physiology and morphology: Molecular and physiological basis of production, 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 Liriodenine 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 system 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 brackish water 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 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

Paper 203 SEED PRODUCTION AND HATCHERY MANAGEMENT OF SHELLFISHES MM: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 mechanism in prawn, shrimps, crabs, lobsters, mussels, oysters, scallops and clams; age at first maturity, factors affecting maturation and spawning

## UNIT III

Brood stock 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 prawn shrimps crabs, lobsters, mussels, edible oysters, pearl oyster, scallops, clams and sea cucumber

## UNIT IV

Hatchery technology and management etion and facilities required, culture and use at 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 (BMP), 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, crab, mussels and oyster, Culture techniques of microalgae and other live feed used in shellfish hatcheries: Artemis 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 seed production of Shellfish. DayaPubl.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 vigor, introgression. Inbreeding Methods of estimation, inbreeding depression and consequences, measures to reduce inbreeding 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 deflection.

### **Practical**

Estimation of gene and genotype frequencies; Exercises on Hardy Weinberg 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 T1. (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 Chines

Pandian Tj, Striismann CA & Marian MMP 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.

Paper 205 TECHNICAL WRITING AND COMMUNICATIONS SKILLS (Non Gradiual)

MM-75

To equip the students/scholars with skills to write dissertation, 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 the speech, clauses, punctuation marks), Error analysis (Common error); 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.

## **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, anesthetic's, packing and transportation Breeding techniques: Reproductive biology, captive breeding and rearing of freshwater, brackish water, 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 &Sweenen 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

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, pearl spot, 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 brackish water finfish and shellfish; Identification of cultivable seaweeds; Designing of different farming systems - cages, pens, rafts and racks; Visit to coastal aquafarms.

#### **Suggested Readings**

Bardach EJ, Rhyther JH & McLaney 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 MANAGEMEN 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.

Paper 304 BASIC CONCEPTS IN LABORATORY TECHNIQUES(Non Gradiual)MM:75

### **Practical**

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccumets; 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, water bath, oil bath; 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.:750

### **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, all male 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 fertilizer requirement calculations; Farm visits; Modelling of different culture systems.

### **Suggested Readings**

Agarwal SC. 2008. A Handbook of Fish Farming 2nd Ed. Narendra Publ. House.

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 METHODOLOGYMM.: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 programmes, 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. VishwaPrakashan.

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

Paper 401 LARVAL NUTRITION AND CULTURE OF FISH FOOD ORGANISMS MM:75

#### 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 bio enrichment, biofilm/periphyton and its use, culture of single cell proteins and their nutritional quality, formulation and preparation of artificial feeds for larval rearing, micro particulate diets.

#### UNIT III

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

#### UNIT IV

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 micro algal culture; Preparation of artificial feed for rearing finfish and shellfish larvae; Mass culture of microalgae; Mass 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.

## Paper402 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 Centers partnership with NARS, role as a partner in the global agricultural search 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 Programmes, Intensive Agricultural District Programmes, Special group - Area Specific Programmes, Integrated Rural Development Programmes

(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 Gradiant) 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

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 SeminarMM.: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 ,Bio enrichment of live food, Bio fertilizers 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, cryopreservation of gametes and embryos, Culture of live feed for larval rearing.  
Study of nutrient dynamics in ponds.

VIVA VOCE OF THESIS

MM.:50qq

#### 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 -Bamidgeh

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

