ISSN 0972-1584

24 • No. 2 • 2006

Journal of the Indian Society of Coastal Agricultural Research

ISCAR

Advancement in Research on Coastal Agriculture

Publication of
Indian Society of Coastal Agricultural Research
www.iscar.org

ISSN 0972-1584

Journal
of
THE INDIAN SOCIETY OF COASTAL AGRICULTURAL RESEARCH

Volume 24 | July - December 2006 | Number 2

Papers Presented

on

State-of-art technologies for higher production in aquaculture and animal husbandry including integrated farming system

Mangroves, forests, agroforestry and ecological security

Integrated farming with resource recycling and extension initiatives for sustainable economy

and

Natural disasters vis-a-vis stability of coastal ecosystem

at the

National Seminar
on
"Strategies for Improved Farming and Ecological Security of Coastal Region"

Thiruvananthapuram, Kerala, 21-24 December, 2005

INDIAN SOCIETY OF COASTAL AGRICULTURAL RESEARCH

Regn. No. T/40093 of 1982-83

Subscription Rates

		India and SAARC Countries	Other Countries*
Individual Annual Members			
Admission fee	:	Rs. 30.00	US$ 5.00
Annual Subscription	:	Rs. 120.00	US$ 35.00 per annum
Individual Life Members	:	Rs. 1200.00	US$ 350.00
Institutions & Libraries (Annual)	:	Rs. 800.00	US$ 85.00 per annum
Institutions & Libraries (Life)	:	Rs. 8000.00	US$ 1450.00

Subscriptions should be sent to the Hony. Secretary, Indian Society of Coastal Agricultural Research, Central Soil Salinity Research Institute, Regional Research Station, P.O. Canning Town - 743 329, Dist. South 24 Parganas, West Bengal, India.

*All publications are sent by surface mail. If the publications are required by **"Air Mail"** then an additional amount of US$ 10.00 is to be paid.

Acknowledgement

The Indian Society of Coastal Agricultural Research (ISCAR) is grateful to the Indian Council of Agricultural Research (ICAR), New Delhi for recognizing the contribution of ISCAR for disseminating the research findings on the various aspects of Coastal Agriculture through the journal (Journal of the Indian Society of Coastal Agricultural Research) published by the Society. The Society is highly indebted to ICAR for providing necessary financial assistances for publication of the Journal.

Organisers of ISCAR National Seminar held at Thiruvananthapuram, Kerala from 21-24 December, 2005

Indian Society of Coastal Agricultural Research, Canning Town

Central Research Institute for Jute & Allied Fibres, Barrackpore

Central Tuber Crops Research Institute, Thiruvananthapuram

Sponsors for ISCAR National Seminar held at Thiruvananthapuram, Kerala from 21–24 December, 2005

- **Indian Council of Agricultural Research, New Delhi**
- **Ministry of Rural Development, Govt. of India**
- **Dept. of Science & Technology, Govt. of India**
- **Council of Scientific & Industrial Research, New Delhi**
- **Indian Society of Root Crops, Thiruvananthapuram**
- **State Bank of Travancore, Thiruvananthapuram**

Information to Authors

It is requested that in future all articles submitted for publication in **'Journal of the Indian Society of Coastal Agricultural Research'** or for presentation in its **Seminars** must be typed in **MS-Word 97** or later versions with Times New Roman Script in 12 pt. Font size, in double space on A-4 size paper, with at least 1.5 inch margin on the left side and one inch margin on all other sides.

Two hard copies of the manuscript along with a CD or 1.44 MB (3.5") floppy disk must be sent for consideration. Further the same may also be sent by e-mail as an attachment (Word document) to iscar@rediffmail.com, iscar.c@gmail.com

The author(s) are also requested to sent their e-mail address if any, for quick correspondence.

Our website : www.iscar.org.in

Appeal

Fresh drive has been initiated for membership for which a copy of membership form has been attached at the back of this issue. The person(s) interested may please multiply the copies for use of others.

ISSN 0972-1584

JOURNAL
OF
THE INDIAN SOCIETY OF COASTAL AGRICULTURAL RESEARCH

VOLUME 24 | JULY - DECEMBER 2006 | NUMBER 2

CONTENTS

Published by the Hony. Secretary, Indian Society of Coastal Agricultural Research Canning Town (743 329)
and Printed by Media, Kolkata - 700 029, Phone : 2223 5529

J. Indian Soc. Coastal agric. Res., 24(2), 229-240, 2006 **Presidential Address**

Improved Farming and Ecological Security in Coastal Region

J. S. P. YADAV[1]

President, Indian Society of Coastal Agricultural Research

An economically robust agriculture is the key to overall economic development and will continue to be the backbone of the Indian prosperity. Agriculture contributes about one-fourth of the national GDP and sustains livelihood of about two-thirds of the population. With the application of modern agricultural technology, India has moved from an era of chronic food shortages to food self sufficiency and even food export. Since independence, the productivity gains are nearly 3.3 times in food grains, 1.6 times in fruits, 2.1 times in vegetables, 5.6 times in fish, 1.8 times in milk, and 4.8 times in eggs.

In view of globalization of marketing and liberalization of economy, we have to take cognizance of the recent rapid advances in molecular breeding, genomics, biotechnological tools, cloning of Dolly, transgenic crops and other discoveries. Our information technology has to be upgraded to promote knowledge-based agriculture. Prudent conservation, utilization and management of resources and maintenance of high productivity are crucial to enhance and sustain the targeted tempo of growth in agricultural production to meet the increasing needs of the swelling population which is expected to become 1.4 billion by 2025 and 1.7 billion by 2050. Any ill-planned and indiscriminate use of the resources is bound to create serious decline in productivity, resulting in dreadful crisis. This poses a formidable challenge in view of practically no hope of sizeable expansion in the net cultivated area. One of the options for overcoming the situation is to extend the benefits of modern advances in science and technology to the hitherto low productivity areas such as coastal and rainfed regions.

Despite unique endowments suited to diversified and productive farming systems, the productivity growth rate in the coastal areas is lagging behind due to extremely fragile ecological situation. The Agenda 21 of Earth Summit of UNCED 1992 has stressed the need of development in the coastal areas. It is indeed gratifying to note that the Indian Council of Agricultural Research has realised the critical role of this agro-ecosystem in impacting agricultural production and socio-economic development of the country. The Council has lately launched a Mission Mode Project "Land Use Planning" under the World Bank funded programme of NATP, laying emphasis on different production systems in the coastal areas relating to agri-horti production, livestock production and fish production with the chief objective of upgrading the agricultural productivity of these areas.

Coastal ecosystem

Coastal ecosystem includes estuaries and coastal waters and lands located at the lower end of drainage basins, where stream and river systems meet the sea and are mixed by tides. It can consist of rocky cliff, sandy beaches or mudflats besides river or estuary. The coastal ecosystem includes saline, brackish and fresh waters, as well as coastlines and the transition of lands from terrestrial to marine influences and vice versa.

Around the world, nearly 1 billion people live along the 312,000 km long coastline. The coastal areas provide livelihood security for millions of people by supporting roughly 60% of world's population. About 40% of world's population lives within 60 km of coastline. Amongst 18 countries (Table 1), Canada, Japan, Australia, Norway, USA, China, U.K., Mexico and India have coastline greater than 8,000 km in each. Canada has the longest coastline. In the remaining 9 countries the length of coastline varies from 2,289 to 7,600 km. The narrow coastal stretches are under immense pressure today. Most fertile agricultural lands are found near the coast, and the industries also prefer to be located close to the coast for easy discharge of their effluents. Peninsular India is bound by sea water on three sides: the Bay of Bengal in the East, the Arabian sea in the West and the Indian Ocean in the South. The Indian coastline runs to around 8,129 km distributed among nine coastal states (West Bengal, Orissa, Andhra Pradesh and Tamil Nadu in the east

[1] Present address: B 14, Indian Agricultural Research Institute, Pusa Campus, New Delhi - 110 012

coast, and Gujarat, Maharashtra, Karnataka, Kerala and Goa in the west coast), two groups of islands (Andaman & Nicobar and Lakshadweep), and two union territories (Pondicherry and Daman & Diu). The coastal belt comprises of a wide range of ecosystems extending from sandy beaches and mangroves to coral reefs and rocky areas.

Table 1. *Length of coastline in some countries*

Country	Coastline (km)	Country	Coastline (km)
Canada	243,791	Italy	7,600
Japan	29,751	Brazil	7,491
Australia	25,760	Turkey	7,200
Norway	21,925	Spain	4,964
USA	19,924	France	3,427
China	14,500	Thailand	3,219
UK	12,429	Sweden	3,218
Mexico	9,330	South Africa	2,798
India	8,129	Germany	2,289

The coastal ecosystem is highly fragile and vulnerable to natural hazards, sea level rise and anthropogenic activities. Coastal belt has been located in the east as well as in the west. The east coast is lowlying with lagoons, marshes, beaches and deltas rich in mangrove forests, whereas the western coastline has a wide continental shelf and is marked by backwaters and mud flats. In general, the following constraints affect the productivity in the coastal areas.

Constraints

- Influence of tidal waves and periodical inundation of soil by tidal water
- Shallow water table enriched with salts contributing to increase in soil salinity during winter and summer months
- Heavy rainfall (except in some parts of Gujarat) and cyclonic weather
- Poor surface and subsurface drainage conditions
- Lack of good quality irrigation water during dry period in certain areas
- Agriculturally poor lands and monocropping in some parts
- Undeveloped irrigation
- Seawater intrusion in aquifers
- Threat from environmental and man-made pressures
- Toxicity of certain elements in soil and water

Soil resources

Soil is a dynamic, living, non-renewable resource whose healthy condition is vital to the production of both food and fibre and also to the global balance and ecosystem function (Doran *et al.*, 1996). The quality and health of soils determine agricultural sustainability (Acton and Gregorich, 1995), environmental quality (Pierzynski *et al.*, 1994), and as a consequence, plant, animal and human health (Haberern, 1992). Soils of coastal areas are generally deep to very deep having coarse sandy to fine loamy texture, non-calcareous to calcareous, poor to rich in organic, slightly to moderately saline, and highly acidic to alkaline. In many coastal areas uncontrolled extraction of ground water has resulted in intrusion of seawater and development of high salinity. Important physical and chemical properties of coastal soils of India are given in Table 2 (Velayutham *et al.*, 1998). Some details in respect of (1) coastal saline soils, (2) acid sulphate soils, and (3) coastal sand dunes follow:

Coastal saline soils

Out of 49 million hectare area under the salt affected soils in the south and southeast Asia, about 27 million hectares (55%) are within coastal areas. In India, the salinity status in saline soils varies widely from ECe 0.5 dSm^{-1} in monsoon to 50 dSm^{-1} in summer. Mostly NaCl followed by Na_2SO_4 are the dominant soluble salts, with abundance of soluble cations in the order Na>Mg>Ca>K with chloride as the predominant anion, and bicarbonate in traces. The soils are, in general, free of sodicity problem except in a few pockets in the south and west coast.

Table 2. *Physical and chemical properties of coastal soils of India*

State	AESR No.	pH(1:2.5)	EC(dSm^{-1})	O.C. (%)	CEC {cmol(P$^+$) kg^{-1}}	B.S. (%)
West Bengal	15.1	6.3-7.4	1.5-9.8	0.15-0.52	19.4-22.7	70-80
	18.5	6.5-7.6	4.1-35.0	0.3-0.78	6.6-10.6	74-82
Orrisa	18.4	6.7-7.4	—	0.10-0.22	12.8-13.4	75-85
	18.5	4.5-6.3	—	Tr.-0.20	33.8-55.5	49-69
Andhra Pradesh	18.3	8.0-8.4	4.6-27.0	0.9-1.1	2-6	-
Tamil Nadu	18.1	5.1-6.1	—	0.06-0.09	4.0-6.6	89-100
Kerala	19.3	2.4-3.2	—	9.2-19.9	26.4-58.0	8-57
	19.3	5.1-5.6	—	0.3-2.6	3.9-7.6	48-58
Karnataka	19.3	3.9-5.7	—	0.07-1.23	0.7-4.6	29-89
Maharashtra	19.3	6.6-7.0	—	0.4-0.7	20.8-28.0	40-45
Goa	19.1	5.4-5.9	—	0.28-0.60	0.5-7.8	48-69
Gujarat	2.2	8.2-8.7	0.20-6.50	0.18-1.10	1.3-3.7	—
	5.3	7.7-8.0	0.46-3.20	0.13-0.15	12.26-19.26	—
Lakshadweep	20.2	8.5-9.1	0.1-0.2	0.11-0.77	0.4-1.5	100

Acid sulphate soils

Acid sulphate soils contain sulfides (mainly pyrites, which become very acid when sulfides are oxidized to sulphates on drying; and usually have a pH below 4 in water. Acid sulphate soils cover large areas of temperate lands. In India, presence of acid sulphate soils has been reported in the lowlying coastal areas of Kerala, Andaman and Nicobar islands, and recently in the coastal areas of Sundarbans, West Bengal (Bandyopadhyay and Maji, 1995). Acidification of these soils is caused by a combination of abiotic and microbial oxidation of pyrites (FeS_2).

Many plants appear to be able to tolerate relatively large concentrations of H^+, although work using solution cultures indicates some root injury at low pH. It is probable, however, that Al and Mn toxicity is more important than that due to H^+. In acid sulphate soils, phosphate deficiency is widespread and also there are deficiencies of Ca and K; whereas the levels of exchangeable Mg may be high.

Coastal sand dunes

Coastal sand dunes are deficient in plant nutrients due to extensive leaching which occurs during their formation, transport and deposition. Dune fertilization is a useful management tool for improving the establishment and growth of new plants. If fertilization of sand dunes with urea is contemplated as a management tool, it may be prudent to apply a nitrification inhibitor such as N-serve in order to minimize NO_3^--N losses. On the debit side, such a combination might enhance NH_4^+-N volatilization, thereby necessitating the addition of urease as well as nitrification inhibitor.

Water resources

Water is the most crucial input, which must be developed, conserved and used judiciously. The ultimate irrigation potential in the country is tentatively estimated at 139.89 million hectare (M ha) comprising 58.46 M ha through Major and Medium irrigation projects and 81.43 M ha from minor irrigation, which the country is expected to achieve by 2010 (Brij Kishore, 2002). An action plan is needed for coastal ecosystem separately keeping in view the objective of optimal and sustainable development and management of water resources of the country as envisaged in the National Water Policy 2002 document. The strategy for research has to focus on augmentation of available water resources and their optimal utilization without sacrificing on its quality, with active participation of all the stakeholders. All available water resources (surface as well as ground) have to be managed in an integrated and synergic manner. The National Water Policy 2002 further envisages that the drainage system should form an integral part of water management.

Coastal ecosystem occurs in the vicinity of creeks, rivers, deltas, lowlying lands, estuaries, and is characterized by high salinity of groundwater, besides paucity of good quality water in the post-monsoon season. It poses serious problems and challenges to cultivation. The entire area is almost monocropped,

rice being the major crop. Though these areas receive good rainfall ranging from 1000 to 4000 mm during monsoon, there is virtually no source of irrigation to the crop except the rainwater. The paucity of good quality irrigation water, besides building up the salinity in soil and groundwater, is always a limitation for taking second post-monsoon crop. The nature and extent of the problems vary from region to region, but in most of the places the coastal ecosystem presents a unique problem of water management. In view of the peculiar characteristics and problems of coastal ecosystem appropriate strategies for integrated water management merit serious consideration.

Biologically productive ecosystem

The coastal regions constitute one of the most biologically productive environments endowed with a wide diversity of physiographical features including mountain ranges of varying slopes and valleys, altitude, climatic variation, rainfall pattern with spatial and seasonal changes, soil types, quality and quantity of available water and other related aspects. Because of these endowments the coastal areas have the distinction of rich biodiversity of many flora and fauna. Beside biologically diversified production system, Kerala state, in particular, has the common practice of multi-tiered high density cultivation, as a result of which almost every piece of land is exploited to its full capability. The system contributes immensely to the socioeconomic upliftment of the local people as reflected in highest literacy rate, per capita income and employment opportunities, etc.

Some details relating to diverse marine and coastal habitats (Ayyappan and Modayil, 2005) reveal that the Indian Ocean accounts for 29% of global oceans, 13% of marine organic carbon synthesis, 10% of capture fisheries, 30% of coral reefs and 10% of mangroves. India has 246 estuaries draining into a hinterland greater than 200 km^2 besides coastal lagoons and backwaters. Out of a total of 22,000 species of fish, about 4,000 are found in the Indian Ocean, of which 1800 species are from the coastal areas. The coastal ecosystem provides important services viz., breeding ground for many fish species, storing and recycling of nutrients, regulating water balance, protecting land against erosion from storms and waves, filtering pollutants, regulating climate and oxygen supply. Nevertheless, the anthroponegic degradation including over-exploitation, pollution, sand mining, tourism, and natural disasters including climate change, weather aberrations, storms and cyclones, etc. cause tremendous damage to the habitat conditions as well as productivity levels. Therefore, restoration, rehabilitation, conservation, protection and judicious management of the biological asset of the coastal ecosystem are concerns of major importance.

Cropping systems

Rice is the major crop in coastal ecosystem. During the last 50 years, while the rice area in India has increased only by one and half times from 30 million hectares to about 45 million hectares, the rice production has increased more than four times from 22 million tons to 90 million tons and the productivity has increased three times from 700 kg ha^{-1} to 2000 kg ha^{-1}. It is estimated that the rice demand will be 100 million tons in 2010 and 140 million tons in 2025. Rice research has to be geared up to surmount the technological challenges in breaking the genetic yield barriers, improving input use efficiency, and finally in developing environmentally acceptable strategies for alleviating losses due to pests and diseases (Mishra, 2004).

New tools in rice research to meet challenges of WTO regime

Hybrid Rice: In the immediate future, hybrid rice is the practically feasible and adoptable technology for enhancement of rice production and productivity. Hybrids have recorded 15-20 percent higher yield than the highest yielding inbred varieties in the farmer's fields. However, its suitability under varied agro-climatic conditions and weather adversities in coastal ecosystem is yet to be rigorously tested.

Genetic transformation in rice: It is another tool that promises to revolutionize rice improvement programme in India. The most important advantage of transgenic technology is the capacity to mobilize useful genes from non-rice gene pool to rice with least disruption to rice genome. Transgenic rice with resistance to insect pests and pathogenic viruses, fungi and bacteria have been developed and are being tested under limited field evaluation in India (Mishra, 2004).

Crop diversification

Diversification of agriculture has been acknowledged to give better returns to generate additional employment for rural masses and to conserve natural resources. Diversification to horticultural crops has

been found to be the best option as these crops not only meet the above requirements but also are adapted to a wide range of climate, produce higher biomass than field crops per unit area, are more remunerative for replacing subsistence farming, and thus, alleviate poverty particularly in rainfed, coastal, dry land, hilly and arid ecosystem. The emphasis should be mainly on production, protection and post-harvest management of horticultural crops. India contributes 10-13 percent of the total world production of fruits and vegetables occupying second place in the world. The area under flower crops has also been increasing and protected cultivation of cut flower has been established (Chaddha, 2004). Coastal ecosystem has wide scope and warrants special attention.

In case of tropical root crops, the annual production in the country is to the tune of 170 million metric tonnes, roughly equivalent, in caloric content, to 50 million metric tonnes of grain. While cereals are grown on superior lands with irrigation or better moisture, roots and tubers are predominantly grown in the upland or rainfed areas, mainly by resource poor small and marginal farmers. However, there is an urgent need to improve the productivity of these crops since they are related to food security. Hence, it is desirable to integrate production of various tuber crops with the major cropping systems in vogue in the coastal areas.

Out of 109 spices listed by the ISO, only 63 are grown in the country. Commercial cultivation is limited to about a dozen of spices which attained importance in the internal and international markets. India is the largest producer, consumer and exporter of spices in the world. The international spice scenario depicts a quantum leap over the past decade to more than 4.5 million tonnes, valued at US $ 1,500 million. India's share of the world spices trade is estimated as 45-50 percent by volume and 25 percent by value. The present annual production of spices in the country is 3.0 million tonnes from over 2.5 million hectares. The Lion's share (90%) of the spices produced in India is absorbed in the domestic market and only 10 percent is exported to over 150 countries. About 8.5 percent of India's export earnings from agricultural and allied products come from spices which constitute 1.24 percent of the total export earnings during 1999-2000 (Peter and Nybe, 2002). Since the spices occupy a prominent place in the production system in the coastal tracts, intensified research to exploit the full potential of these crops in compatible diversified cropping in the coastal environment is needed.

Integrated nutrient management in horticulture and plantation crops with inclusion of leguminuous crops as cover cropping in perennial plantations, and incorporating them in the fields will help improve soil fertility, thereby supplementing the fertilizer needs; and reducing cost of production. Organic farming has immense potential and needs to be validated through intensive research.

Post-harvest technologies

The need to reduce post-harvest losses by proper pre-and post-harvest handling, proper packaging, and creating suitable infrastructure e.g., cold storages for fruits and vegetables, cold chain transport, and other technologies cannot be overemphasized. Use of pre-cooling units, controlled/modified atmosphere/ refrigerated containers, particularly for transport by sea will go a long way in enhancing the self life of fruits and vegetables, and reducing transport losses.

Agro-techniques have been developed in all major crops suitable for different regions. These include high-density plantations in banana, pineapple, citrus, mango and apple, and high production technology in several crops e.g. pineapple, black pepper and cardamom. Use of F_1 hybrids of vegetable needs to be promoted (Chaddha, 2004). Here again, inspite of specific need, practically very little work progress has been made in the coastal ecosystem to develop suitable agro-techniques for storage and transport of fruits, vegetables and flowers, thereby depriving the farmers of due benefits.

Quality improvement

In the post-liberalization period, the main thrust needs to be on low cost technologies for improving the quality of various horticultural and other crops, to make our produce qualitatively competitive in the world market. At present, various products in India do not conform to the standards prescribed by major importing countries. Therefore, popularization of improved agro-techniques, use of INM, IPM, growth regulators, organic inputs, biopesticides, and cultivation of specific varieties for table and processing purposes for export needs emphasis. Several plant growth regulators are commercially employed in promoting both production and quality improvement of horticultural crops (Chaddha, 2004) and hence, adoption of such technologies will benefit the coastal areas from the international trade.

Forests including mangroves and agroforestry

Forests occur predominantly on the hill slopes though many plantations also constitute an important part of coastal ecology. The forest coverage in the Andaman & Nicobar Islands is as high as nearly 88% of the total land area. Indiscriminate denudation of forests on the sloping lands accelerates runoff, sediment movement, nutrient loss, and hydrological degradation which is conspicuous in the Western Ghats. The mangrove forests are usually found in the littoral regions in the tropics, in the estuaries of rivers, in creeks and lagoons, and in low mud flats along the sea coast where soil is silty loam or stiff clay depending upon the salinity status and vicinity to the tidal influence. These forests are developed mainly within the zone inundated daily by the high and low tides, and stop sharply beyond the influence of salt water. The mangrove species are mostly evergreen with thick leathery leaves which minimize the transpiration loss under the physiologically xerophytic condition in such swamps and tidal habitats impregnated with salinity. The dense impenetrable growth together with extensive network of numerous stilt roots as in case of *Rhizophorus mucronata* and the knee root of *Burguiera gymmerhiza* protect the trees against the tidal action and washing away of soil, as the roots hold the silt and also facilitate deposition of silt brought by the tides. The profuse growth of breathing aerial roots called pneumatophores above the ground in the presence of numerous lanticals on the root surface as in *Avicennia officinalis* and *Sommeratia apetala* are source of adequate aeration. The mangrove wetlands provide a variety of protective and productive services to the coastal communities. Specifically, the mangroves serve as (i) protective function against tidal action, (ii) soil conservation, (iii) economic products, (iv) source of fodder timber, poles, tanning bark, fuelwood, charcoal, (v) promotion of cottage industries, (vi) breeding ground for prawns, fish, crabs and mollusks, etc.

In India, the mangrove forests occur along both east and west coasts as also in islands in a total area of 4482 sq km (roughly 0.45 M ha) accounting for 0.14% of the geographical area of the country and about 5% of world's mangroves. The data on mangrove forests in different districts of various coastal states/UTs (Table 3, Forest Survey of India, 2001) reveal that the delta of the Ganga-Brahmaputra river system carries the largest single patch of magroves in the world in Sundarbans of West Bengal (2081 km^2) together with Bangladesh. This is followed by Gujarat (911 km^2), A&N (789 km^2), AP (333 km^2), Orissa (219 km^2) and Maharashtra (118 km^2). Among the districts, 24-Pagranas South tops the list. It is reported that 35 mangorve areas in the country have been identified for intensive conservation and management because of their defensive vital role to mitigate the damage.

Table 3. Extent of mangrove forest in the states/UTs (in sq km)

States/UTs	Districts	Total
Andhra Pradesh	Godawari East (194), Krishna (91), Guntur (47), Prakasam (1)	333
Goa	North Goa (4), South Goa (1)	5
Gujarat	Bharuch (28), Bhavnagar (16), Jamnagar (142), Kutchchh (706), Surat (13), Nawsari (2), Porbandar (1), Rajkot (1), Ahmedabad (2)	911
Karnataka	Kanada Dakhshina (2)	2
Maharashtra	Mumbai City (1), Mumbai (26), Raigarh (34), Ratnagiri (9), Thane (47), Sindhudurg (1)	118
Orissa	Baleshwar (3), Bhadrak (19), Jagatsinghpur (5), Kendrapara (192)	219
Pondicherry	Yanam (1)	1
Tamil Nadu	Chidambaranar (1), Caddalore (7), Nagapattinam (10), Ramnathapuram (1), Thanjavur (4)	23
West Bengal	Midnapur (8), 24 Parganas North (27), 24 Parganas South (2046)	2081
A&N Islands	Andamans (772), Nicobars (17)	789
Total		**4482**

( ) figures in km^2

The single greatest threat to mangroves worldwide is shrimp farming, which requires clearing of mangroves to build ponds. Once the mangroves are ripped out, the coast is rendered unstable and many creatures lose their habitat. Fish catches decline and ecosystems are knocked out of balance. In addition to the loss of biodiversity, the destruction of mangrove areas also means the loss of access for the local

coastal communities to their only source of income. Thirty percent of the shrimp and prawns produced worldwide came from aquaculture in 2001, and the share continues to grow as the demand for shrimp increases. About 35 percent of mangroves worldwide have been lost in the last 20 years.

In terms of agroforestry the common systems practised in India are agri-silviculture (crops + trees), agri- horticulture (crops + fruit trees), agri-horti-silviculture (crops + fruit trees + multipurpose trees), silvipasture (trees + pasture + animals), hortipasture (fruit trees + pasture + animals) and homestead agroforestry (multiple combinations of various components). Some of these agroforestry systems offer promising opportunities in the coastal areas.

Integrated farming system

For sound and sustained socioeconomic progress, the small farmers such as those in Kerala state having average holding size of 0.27 ha (smallest in any state of India) have to adopt a production system which provides not only cereals but also fruits, vegetables, milk, egg, fish, fodder, fuel, fibre as well as more income from value addition options to ensure regular flow of goods, services, and employment. The various components of the system have to be mutually synergic, complementary and efficient through recycling of the by-products like organic wastes/residues, thereby rendering the system more remunerative and environmentally safe.

Under the World Bank funded NATP, the Indian Council of Agricultural Research has identified coastal agro-ecosystem as one of the five major agro-ecosystems with the chief objective of enhancing efficiency, relevance and responsiveness of the system under the location-specific biophysical and socioeconomic environment for integrated agricultural growth. A coconut-based integrated farming comprising coconut, banana, pepper, mulberry, fodder grass, dairy, poultry and fishery was developed and validated at CPCRI Kasaragod in Kerala. The output from the system consisted of 23,535 coconuts, 11,445 litres milk, 645 kg broiler birds, 173 kg fish, 17 kg silkworm cocoon, 3,477 quail eggs and 87 kg banana with a net return of Rs. 73,142 in a year. Besides, the nutrient management through recycling of organic wastes/residues from different components was more efficient in this system. In Lakshadweep, coconut-based farming including papaya, poultry, turmeric, ginger, beetroot, radish and onion could help provide vegetable production in the island which otherwise depends on the mainland for vegetables (CPCRI, 2005).

Intercropping of juvenile phase of oil palm with crops like maize, tobacco, chillies, ridged gourd, bhindi, banana, colocasia and Niper grass yielded encouraging results under West Godavari conditions, whereas intercropping with banana, spider lily and turmeric was found promising in Gujarat. Under the upland rainfed condition of village Chenkal, intercropping of coconut with ginger (variety Varada) tried by CTCRI, Thiruvananthapuram (Kerala) under the Institute-Village Linkage Programme (IVLP) gave a net return of Rs. 105,940 per ha against only Rs. 16,990 per ha under coconut cultivation without any intercrop. At Bhubaneswar, integration of fisheries and plantation crops with traditional monoculture of rice raised the farm income from Rs. 4166 to Rs. 69,275 per ha per annum (Samra, 2005). Thus, the integrated intercropping farming systems have vast potential for improving the livelihood of the farming community with more efficient and ecofriendly resource utilization.

The Central Institute of Fisheries Technology, Cochin with the financial support from DST, New Delhi has launched a project on "Action research on community-based coastal zone management with specific involvement of women". Attempt will be made to develop micro-level model to address the problems relating to fishing methods, sustainable aquaculture, coastal erosion and degradation of natural resources, waste disposal, and alternative livelihood. The outcome of the project is expected to improve livelihood of women whose role in the coastal areas is of major significance (ICAR Reporter, Oct-Dec., 2004).

Fish production

Indian fisheries has made a long leap of over eight fold increase in production from 0.75 MT in 1950-51 to 6.2 MT in 2002-03 (GOI, 2004) in the last about five decades. This achievement has not only contributed immensely to the animal protein deficit of the country but has also played an important role in global trade. Compared to the marine sector the country has made higher growth in inland sector, with production of over 3.1 million tonnes and occupies second position in the world next only to China.

Presence of rich and diverse inland water resources in the form of 29,000 km of rivers, 0.3 m ha of estuaries, 0.19 m ha of backwaters and lagoons, 0.2 m ha of floodpain wetlands, and 0.72 m ha of upland lakes, besides 3.15 m ha of man-made reservoirs and 0.12 million km of canal, has been the pride of the country. Considering the increasing gap between demand and supply of fish, and stagnation of production from the sea and inland open water resources, the inland fisheries development in India must depend mainly on aquaculture and culture-based fisheries in reservoirs and floodplain wetlands (Jana and Sena, 2004).

The proposed inter-river basin linkage might have both positive and negative impact on overall fish production in the coastal areas by augmenting area under water bodies in the former case, and deterioration of water quality and ecology in the downstream estuaries, delta, etc. in the latter case. A recent study by CMFRI, Cochin reveals adverse effect caused by changes in chemistry and quality on the fisheries in estuaries (NAAS, 2004). Relatively, marine conservation and its biodiversity have received less attention as compared to terrestrial conservation. The Orissa Marine Fisheries Regulation Act (OMFRA) prohibits all trawlers from fishing 5 km of sea shore, but the act is not followed in practice, as the fisherfolk fish even in nearshore areas. A huge quantity of wastewaters including municipal sewage water and industrial effluents impregnated with toxic metals and other harmful substances find their way into the coastal areas through different rivers. In the eastern part of Kolkata city, a large number of sewage-fed fisheries are located where high accumulation of Cd, Pb and Cr in fish muscle and brain is reported, which is a source of health hazard. Heavy metal pollution in Ganga river water adversely affects the aquatic fauna including fish in the industrial coastal belt.

Land disposal or release of untreated wastewaters into the water bodies affects the quality of different water bodies and consequently aquatic productivity including marine production. In a programme of wastewater treatment through stabilization ponds followed by use of pond effluent for fish production, wherein slow flowing sewage gets diluted with rainwater, high concentration of nutrients promotes phytoplankton plant-based organisms, production of which serves as fish food chain. In Kolkata alone, wastewater is used in 3200 ha of pond to produce 5-7 $t^{-1}ha^{-1}yr^{-1}$ fish (Minhas and Samra, 2004). Therefore, the need for improvement of environment and food chain through adoption of appropriate techniques for higher fish production in such coastal areas subjected to water pollution is quite obvious. Mumbai generates about 2,800 million litres of sewage daily. The 'marine outfall', which is basically a conduit, disposes sewage after partial treatment roughly 3 km inside the sea through a pipeline running along the seabed. The sewage network comprises 41 satellite pumping stations and 7 major pumping stations. Earlier, untreated sewage was dumped into it affecting marine fish life, but after establishment of this facility, marine fish life has improved.

Livestock management

Livestock sector is a prominent sector among agriculture and allied activities in India. In 1997-98, livestock alone contributed to 25 percent of the total value of agriculture GDP. This has increased gradually from 14 percent in 1980-81. The annual rate of growth in GDP from livestock and agriculture in these years were 7.3 percent and 3.1 percent, respectively. Dairy sector ranks first among the individual agriculture commodities in terms of total value of production. The value of milk output and its products is 70,000 crore rupees and that of dairy industry as a whole is 1,05,000 crore rupees (Kadirvel, 2004).

Dairy

Dairy farming is visualized by the farmers in the country as part of an integrated agricultural system where dairy and agriculture complement each other. We have to look forward to the 21st century, its challenges and opportunities. Some 70 million farmers maintaining a milch herd of 108 million heads of cattle (64 million cows and 44 million buffaloes) make this possible. Buffalo contributes largest to the milk pool with about 46.5 million tonnes (55 percent), followed by indigenous cows, with 18.3 million tonnes (24 percent), and crossbred cows, with 13.5 million tonnes (16 percent), and goats contributing 4.2 million tonnes (5 percent).

Dairy development in India has been acclaimed world over as one of the modern India's most accomplished developmental programmes. Productivity performance of dairy industry across the country has registered an annual growth of 17.1 percent with highest market share of 23.5 percent for Maharashtra followed by Gujarat (17.2 percent). The contribution in value addition from the manufacture of dairy products is only 5.4 percent of gross output against 12.1 percent achieved in the food processing sector. The legendary Amul, the ANAND pattern of dairy cooperatives started in 1946 in the district of Kheda in

Gujarat. During 1959-60, the Government started Intensive Cattle Development Project (ICDP) that focused on providing artificial insemination and veterinary services to the milk producers through planned development of the dairy sector was initiated with the launching of the first five-year plan in 1951. The policies and programmes during the first three five-year plans were inadequate to boost milk production and therefore, milk output continued to be stagnant.

Subsequently, milk production in rural milk sheds through milk producers' cooperatives and movement of processed milk to urban demand centres became the main focus of government policy for dairy development. The much needed linkage between producers and the consumers had been established, thereby resulting in white revolution. Policy linkage involved pricing structure, procurement and marketing system, breeding, cattle feed, disease control and veterinary services. The launching of technology mission by the government of India in 1987 is another major milestone for dairy development in the country (Kadirvel, 2004).

Trends in milk production

Milk production in the country witnessed very slow growth between 1950-51 and 1970-71 from 17 m t to just 22 m t. But thereafter, the production increased to 31.6 m t in 1980-81, 53.9 m t in 1990-91, and reached a milestone of 80.8 m t in 2000-01. With 84.8 m t of production in 2001-02, India ranks first in the world milk production (GOI, 2004).

Impact of WTO agreement

Indian dairy sector has achieved remarkable progress during the last two-and-half decades, when the export and import of dairy products were restricted through various measures. However, the situation is changing very fast when Indian dairy sector is moving towards open economy environment of liberalization due to commitments made at the WTO as well as domestic economic reforms. In the early 1990s, the Government of India introduced major trade policy reforms, which favoured increasing privatization and liberalization of all sectors of the economy.

Future policies

A survey conducted by Economic Times reveals that Indian consumers are moving towards value added rich diets like milk and milk products compared to cereals, pulses, vegetables, fruits, meat and fish. It is estimated that the present consumption of 64.1 MT of milk and milk products may witness a growth of 159 percent reaching a level of 165.8 MT in 2020. The nutritional and economic demand for dairy products may escalate further due to the increasing awareness among the people about the nutritional qualities of dairy products, increase in per capita income and rapid urbanization. The planners and policy makers in Government and industry may concentrate on the options for fine-tuning the dairy production, processing industry and trade to meet both domestic and global demand. Low productivity is an important constraint in dairying, and hence, intensified efforts should be focused on cross breeding programmes, to produce high yielding cows/buffaloes (Kadirvel, 2004). There is tremendous scope for improvement in productivity in the coastal ecosystem having hot and humid climate. The productivity is particularly low here on account of poor animal health and lack of fodder. Following are the recommendations:

- Artificial breeding of animals be given due importance.
- Artificial breeding of animals be given due importance.
- Ensure creation of disease free zones in milk-shed areas to boost production of quality milk. Enact laws for control of infectious diseases of animals, disease surveillance, drug and vaccine quality enforcement.
- Ensure collaborative research on clinical studies, epidemiological surveillance for contaminants like metals, pesticide residue, aflatoxin and drug residues.
- Stringent quality control – The ISO 9000 series and HACCP (Hazard Analysis and Critical Control Point) norms should be strictly adhered by entrepreneurs/corporate bodies, which plan for exports. An autonomous body like Quality Council of India should be established to monitor the quality standards.
- The common land property resources owned by the village local administration should be exclusively used for pasture/fodder development, since non-availability of adequate feed and fodder seems to be one of the prime constraints faced by the dairy farmers.
- Owing to the success of cooperative system of milk production and marketing, more number of farmers should be brought into cooperative sector – this structure should be strengthened. The Operation Flood should be introduced in non-Operation Flood areas also. Marketing infrastructure should be strengthened. Refrigerated trucks, chilling centres and processing centres should be given encouragement with an eye on export quality.

Cyclones and *tsunami* occurrence

The fragile coastal ecosystem is highly prone to disasters such as cyclones and hurricanes. The cyclones over the warm tropical oceans cause huge loss of lives and damage to the property, primarily in coastal areas. Approximately, on an average, 80-100 tropical cyclones occur globally in a year. Average annual damage has been estimated at about US $ 1500 million, and over the past 30 years or so the average annual death toll has been about 15000. In a recent example from India in 1999, the supercyclone in the Bay of Bengal took a record toll of nearly 15,000 lives of human population and half a million of bovine population, apart from a near total loss of agricultural crops and other properties in ten coastal districts in South Orissa. In 1998, the heavy storm took toll of more than 1000 people besides colossal loss of property in the coastal region of Saurashtra. In the same year, severe erosion due to strong sea waves resulted in tremendous damage to the buildings, roads, vegetation and human lives especially of the fishermen in the coastal belt of Karnataka. Other notable examples of extensive cyclonic damage in the past were those in Andhra Pradesh and Tamil Nadu in 1930, 1940, 1943, 1962, 1977, 1979 and 1990, and that in West Bengal in 1981. Extensive areas in Bangladesh suffer due to cyclonic damage almost every year.

The unprecedented recent horrible occurrence of *tsunami* on December 26, 2004 engulfed the coastal areas of Indonesia, Sumatra, Thailand, Myanmar, Sri Lanka, Maldives and India, and is reported to have a toll of roughly 1,50,000-2,00,000 people, rendered thousands of families homeless, and damaged enormous movable and immovable properties. In addition, it also caused serious damage to the coastal ecological resources. The poor people were the first to be affected most and were the last to recover. In India, the onslaught of severe tidal waves upto 40 ft high at a speed of roughly 450 km per hour due to *tsunami* in the sea coast of Andaman and Nicobal islands and in eastern coast of Tamil Nadu and Pondicherry caused more alarming loss of life, crops, buildings and other properties.

A study was undertaken by ISRO through satellite mapping at the initiative of the Ministry of Environment and Forests, GOI to assess the colossal damage caused by *tsunami* in A & N Islands. The report revealed extensive depletion of forests, large scale erosion of coral reefs, destruction of marine life, and vanishing of several important beaches including some famous tourist spots. In Nicobar group of islands 12,224 ha of forest cover was lost. Even some of mangrove trees failed to resist the forceful ravages of gushing tidal waves. The report clearly indicates that rehabilitation of the badly damaged coastal ecosystem will take many years. In this context, collection of accurate scientific data on changes in important soil characteristics as well as on salinity and other harmful effects in water bodies like ponds, lakes, open walls and groundwater will help immensely in developing suitable strategies to rehabilitate the already affected areas and also to avoid recurrence of devastating effects in future.

The coral reefs and mangroves provide the barrier between the sea and human habitation and therefore in accordance with the Coastal Regulation Zone guidelines of 1991 no developmental work is allowed upto 300 m from the high tide line for the protection of coral reefs and mangroves, but in practice the guidelines are hardly followed in the name of development. *tsunami* waves in the lowlying areas occupied by settlements in Nagapattinam and Cuddalore caused greater loss of life and property than in the areas having dense belt of mangrove. Therefore, conservation and rejuvenation of these natural buffers as green belt to minimize the destructive impact of the tidal waves are of paramount importance.

Apart from the mangrove wetlands, coastal shelterbelt plantations, mainly casuarinas, were raised by the Forest Department of State Governments with support of centrally sponsored schemes (CSS) and funding agencies like Japan Bank for International Cooperation (BIC) in order to mitigate the adverse impact of storms and cyclones in the coastal areas. The coastal communities, both fishing and farming, raise coconut, palm and cashew plantations along the coastal areas, particularly in between their village and sea for both productive and protective services.

The government of India is planning to set up a statutory body as 'Natural Disaster Management Authority' and is also considering the possibility of constructing a high wall all along the seashore, though some reservations from ecological considerations are expressed in certain quarters. It is also planned to establish an accurate forecast system relating to *tsunami* disaster by 2007. The United Nations is expected to help in setting up a *tsunami* early warning network for the Indian Ocean similar to that for Pacific Ocean. Japan has one of the world's most advanced warning systems, using supercomputer linked by satellite to an array of seismic, pressure and tidal sensors to help forecasting about the size of waves approaching the coastline.

A deep water fish with red tail locally known as "araraival' reported to measure about 12 cm when fully grown, surfaces during 'upwelling' – a phenomenon of water at the bottom 'coming up'. This was observed by the fishermen of Pondicherry about 2 months before occurrence of *tsunami* disaster on December 26, 2004. A detailed scientific investigation to validate the appearance of the red tail fish as a signal regarding occurrence of *tsunami* may be one of the cost-effective options.

The major programme in this area should be the establishment of bio-shields along the coast involving plantations of mangroves in suitable areas along with casuarina, bamboo and other appropriate coastal plants including economically important tree species such as cashew, coconut, etc. The eco-restoration pogramme should also involve the promotion of joint mangrove forest management and the raising of community nurseries of suitable bio-shield plants. This programme may be envisaged with an objective of blending ecological security of the coastal ecosystems with livelihood security of coastal communities in a mutually reinforcing manner. The global warming caused by emission of green house gases is also projected to threaten the livelihood of the lowlying coastal belts, which deserves appropriate attention to mitigate the problem through proper proactive planning well in advance.

I believe, the brainstorming session scheduled in the seminar on this very serious issue will throw new light on the present status and various management options.

The entire nation and particularly those living in the coastal areas of the country look forward to all of us for more effective and scientifically sound recommendations to alleviate poverty vis-à-vis improved socioeconomic standards of the poor farming community in the coastal areas. I expect very meaningful and successful outcome emanating from the deliberations during these three days.

The Indian Society of Coastal Agricultural Research since its inception in 1983 has brought home vividly the various potentials and constraints of the coastal regions through scientific deliberations held during the last seven national seminars in different coastal states and also through publication of latest research findings in its journal. The Society has now received recognition nationwide through the active support and cooperation from all members. Further, in the international arena also problems related to coastal ecosystem have become an issue of great concern in view of the colossal damage to lives and properties taking place almost as a ritual each year in different parts of the globe and special attention required to be given for improved productivity on account of soil and climatic constraints in these areas different from those in the inland areas. In this context we feel the Society may perform a very important role to discuss these issues on an international platform. We propose to organize an International Seminar in India under the aegis of Indian Society of Coastal Agricultural Research possibly in early 2008, which may be the most befitting way to celebrate silver jubilee of the Society, for which we have to work very hard with active support and cooperation from each one of you.

Coming back to this seminar, I particularly express my profound thankfulness to Dr. Edison, Director CTCRI and his dedicated team for their relentless hard work and willing excellent cooperation in organizing this seminar. I also thank all the participants for their active participation which would be the main input base for the discussion. On behalf of the Society I also wish to record my sincere gratitude to ICAR, Department of Land Resources (Ministry of Rural Development), CSIR and DST for their generosity in sponsoring this national seminar.

Kerala is a land of the God, blessed with extremely rich natural biodiversities, cultural heritage, and warm sense of hospitality which are widely acclaimed. I am sure that all of you will have enjoyable and fruitful stay here.

In the end, I wish you all a very happy Christmas and a prosperous 2006.

Thank you.

REFERENCES

Acton, D. F. and Gregorich, L. J. (1995). *The Health of Our Soils: Toward Sustainable Agriculture in Canada, Agric.* Agri-Food Can., Ottwa.

Ayyappan, S. and Modayil, M. (2005). Indian marine biodiversity. *NAAS News* **5**(2): 10-12.

Bandyopadhyay, B. K. and Maji, B. (1995). Nature of acid soil of Sundarban delta and suitability of classifying them as acid sulphate or potential acid sulphate soils. *Journal of Indian Society of Soil Science* **43**: 103-107.

Brij Kishore, B.H. (2002). Agricultural development in India: is it still a long way from promise to prosperity? *Indira Gandhi Memorial Lecture*, I.G.A.U., Raipur.

Chaddha, K.L. (2004). Diversifying strategies. *The Hindu Survey of Indian Agriculture* 2004, pp. 119-121.

CPCRI (2005). *Annual Report* 2004-05, Central Plantation Crops Research Institute, Kasargod, Kerala.

CWC (2003). *Water Profile of Selected Countries*, Water Planning & Projects Wing, Government of India.

Doran, J. W., Sorrantonio, M. and Liebig, M. (1996). Soil health and sustainability. *Advances in Agronomy* **56,** pp. 1-54, Academic Press, San Diego.

Forest Survey of India (2001). *State of Forest Report,* Ministry of Environment and Forests, Dehradun.

GOI (2004). *Agricultural Statistics at a Glance,* Department of Agriculture and Cooperation, Ministry of Agriculture.

Haberern, J. (1992). Viewpoint: a soil health index. *Journal Soil Water Conservation* **47**: 6.

Jana, R.K. and Sena, R.K. (2004). Overwhelming growth. *The Hindu Survey of Indian Agriculture* 2004, pp. 110-113.

Kadirvel, R. (2004). Towards open economy. *The Hindu Survey of Indian Agriculture* 2004, pp. 101-103.

Minhas, P.S. and Samra, J.S. (2004). *Wastewater Use in Peri-Urban Agriculture: Impact and Opportunities.* Tech. Bull. No. **2/2001**, Central Soil Salinity Research Institute, Karnal. 74p.

Mishra, B. (2004). Exploring new opportunities. *The Hindu Survey of Indian Agriculture* 2004, pp. 22-31.

NAAS (2004). *Impact of Inter River Basin Linkages on Fisheries,* Alpha Lithographics Inc., New Delhi. 7p.

Peter, K.V. and Nybe, E.V. (2002). Dominating global markets. *The Hindu Survey of Indian Agriculture* 2002, pp. 87-95.

Pierzynski, G. M., Sins, J. T. and Vance, G.F. (1994). *Soils and Environmental Quality,* Lewis Publishers, Boca Raton, FL.

Samra, J.S. (2005). Natural resource management issues in 21st century. *Indian Society of Soil Science Newsletter* **18**.

Velayutham, M., Sarkar, D., Reddy R. S., Natarajan, A., Shiva Prasad, C. R., Challa, O., Harindranath, C. S., Shyampura, R. L., Sharma, J. P. and Bhattacharya, T. (1998). Soil resources and their potentials in coastal areas of India. Proceedings 5th National Seminar *Frontiers of Research and its Application in Coastal Agriculture,* held at Gujarat Agricultural University, Navsari, Gujarat, 16-20 Sep, 1998. Indian Society of Coastal Agricultural Research, CSSRI, RRS, Canning Town, West Bengal.

State-of-art technologies for higher production in aquaculture and animal husbandry including integrated farming system

J. Indian Soc. Coastal agric. Res., 24(2), 241-246, 2006

Status and Environmental Impact of Shrimp Aquaculture in East Godavari District, Andhra Pradesh

M. MURALIDHAR, B.P. GUPTA and P. RAVICHANDRAN

Central Institute of Brackishwater Aquaculture
75, Santhome High Road, R.A. Puram, Chennai - 600 028, Tamil Nadu

In India area under shrimp culture and production increased by 234% and 325%, respectively from 1990-91 to 2002-03. A comparison on status of shrimp farming between 1999 and 2004 was made and studies were conducted on water and soil quality from different sources, their effect on soil salinisation to assess the impact of shrimp culture on the environment in East Godavari District, Andhra Pradesh. During 2004 the shrimp culture was in 18 *mandals* compared to 13 *mandals* in 1999. The number of farmers and area under shrimp culture has increased from 4814 and 6207.2 ha, respectively in 1999 to 10479 and 9252.82 ha, respectively during 2004. About 92.6 percent of farmers are having less than 2 ha area under shrimp farming during 2004 compared to 82.2 percent in 1999, reflecting the increase in number of marginal farmers. Shrimp farmers were practising improved/modified extensive farming of tiger shrimp with stocking density of 4-10 nos. of post-larvae per sq m. No adverse social or economic impacts have been reported by the local population excepting conversion of rice fields into shrimp farms in a few cases. The pollution indicators like ammonia N and chemical oxygen demand were well within the permissible limits indicating no adverse impact in the external source water. The electrical conductivity values of soil ranged between 1.0 and 1.89 dS m^{-1} in various agricultural fields adjacent to shrimp farms indicating that the soil salinity was not affected by the shrimp farming activities in the areas surveyed.

(***Key words:*** *Shrimp aquaculture, Water and soil quality, Environmental impacts)*

Scientific shrimp farming in India developed as an off-shoot of the traditional filtration system and has been given the "Extreme Focus" status among the fisheries development programmes of the country. The potential area for aquaculture is estimated around 1.2 m ha. Shrimp culture area and production increased from 65,100 ha and 35,500 m tons, respectively during 1990-91 to 1,52,080 ha and 1,15,320 m tons, respectively during 2002-03. The contribution of cultured shrimp production to the total shrimp production in the country increased from 56.9 % during 1990-91 to 79.1 % during 2002-03. Early 90s witnessed a quantum jump in the development of shrimp farming without much control or planning. Shrimp contribution to total seafood export was 29% out of 4,67,297 tonnes contributing 67% earnings of US$ 1425 million in 2003 (Anon., 2004). Among the coastal states Andhra Pradesh occupies vanguard position by contributing more than half of the shrimp farming area and production. Development of shrimp farming in Andhra Pradesh was at a phenomenal rate during the years 1990-1996. In 1990, a total of 6000 ha was under shrimp farming which rose to 88,290 ha during 1997-98 and presently it hass declined to 53,246 ha.

Commercial shrimp culture has gained global attention not only on account of the role it played in strengthening the economy of a country but also by the sudden collapse the industry registered in certain countries. The issues related to aquaculture and environment belongs to two broad categories; impact of aquaculture on environment and impact of environment on aquaculture. Aquaculture utilises the resources and causes slight environmental changes. Many reviews lead to the conclusion that aquaculture had both positive and negative impacts, but occasionally negative impacts have received wide publicity (Lee and Wickins, 1992, Csavas, 1994). Unfortunately, the issue of salinisation because of shrimp farms has been, blown out of proportion without any substantiating data. Most of these issues are site specific and are localised in nature. The present status of shrimp farming was compared with 1999 data and the environmental impacts of shrimp farming are discussed in the present paper.

MATERIALS AND METHODS

Study area

East Godavari district is situated on the North East of Andhra Pradesh at 16° 30′ and 18° 20′ northen latitude and 81° 30′ and 82° 36′ of eastern

longitude. The district is bounded on the north by Visakhapatnam district and the State of Orissa, on the east by Bay of Bengal, on the south by West Godavari District, and on the west by Khammam district. The map of the district along with the boundaries is given in Fig. 1.The district has an area of 10807 sq km, with a population of 49,01,420 (2001 census). There are about 59 *mandals* in the district. It is a major rice producing State with 52% of the total area of the district under rice cultivation.

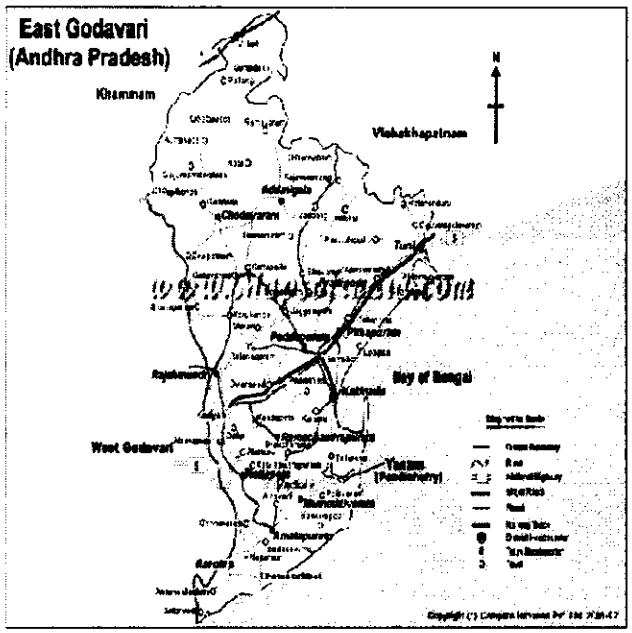


Fig. 1. Map showing the location of East Godavari districts and its boundaries

The *mandal*-wise area details on shrimp farming, farm size distribution and the location and extent of farming area with reference to coastal regulation zone were collected from the State Fisheries Department and the present status of shrimp farming in the district was compared with 1999 data. Thirty shrimp farms were chosen in 8 *mandals* for the detailed study regarding the cultural practices. Water and soil samples from the farm, source creek, irrigation canal and the bore were collected to study the environmental impacts. The samples were analysed for various parameters following the standard methods (Piper, 1966; Jackson, 1967, Strickland and Parsons, 1972, APHA, 1989).

Soil salinisation studies

The associated villages around the shrimp farms were selected randomly to assess the impact of the shrimp farming on salinisation of land, if any. Soil samples were collected from the adjoining paddy fields in triplicate at a distance of 50, 100, 250 and 500 m away from the farms in a straight line and analysed for pH and electrical conductivity in 1:2.5 soil-water suspension.

RESULTS AND DISCUSSION

Status of shrimp farming

East Godavari district ranks third as of now with respect to shrimp farming area compared to fourth position during 1999. Shrimp farms were located in 18 *mandals* in two fisheries divisions, viz. Kakinada and Amalapuram compared to 13 coastal *mandals* in two fisheries divisions, i.e. Kakinada and Rajahmundry division during 1999. The mandal-wise details of shrimp farms during 1999 and 2004 are presented in Table 1 and the farm size distribution and location and extent of coastal farms in relation to CRZ in the district are presented in Tables 2 and 3.

There was a tremendous increase in the area over the last five years. The district has developed about 10085.17 ha of actually brackishwater area into shrimp ponds compared to 7800.55 ha during 1999 (Table 1). Uppalaguptam *mandal* followed by the Tallarevu *mandal* had maximum shrimp farming area in the district. The percentage of actually developed area for the shrimp culture in the district has increased form 79.36 in 1999 to 91.75 in 2004 (Fig.2). About 82.23% are small farmers having less than 2 ha of water spread area in 1999 compared to 92.6 % in 2004 (Table 2). As per the CRZ rules out of 10085.17 ha area developed, 7242.95 ha area was developed within CRZ and 2842.22 ha area outside CRZ (Table 3).

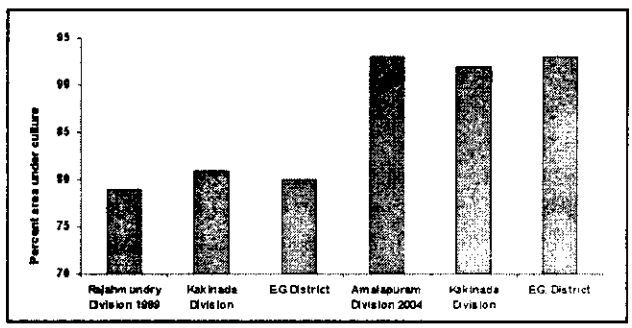


Fig. 2. The percentage of developed area under shrimp culture in East Godavari district

Farming practices

Shrimp farmers of this area are practising improved/modified extensive farming of tiger shrimp with stocking density of 4-10 nos. post larval per m^2.

Table 1. *Shrimp farming area details in East Godavari district during 1999 and 2004*

Mandal	1999			2004		
	No. of farmers	Potential area (ha)	Area under culture (ha)	No. of farmers	Potential area (ha)	Area under culture (ha)
	Kakinada Division			**Kakinada Division**		
Tallarevu	961	2335.6	1905.2	1684	2280.74	2018.55
Kajuluru	14	85.06	56.71	295	308.76	308.76
Karapa	46	138.88	101.71	225	222.30	207.62
Kakinada rural	10	27.44	18.34	10	27.5	27.5
U. Kothapalli	122	155.55	125.24	142	261.03	261.03
Thondangi	-	-	-	8	13.85	13.85
Total	1153	2742.53	2207.18	2364	3114.18	2837.11
	Rajahmundry Division			**Amalapuram Divisioin**		
Sakhinetipalli	516	656.08	524	769	324.76	324.76
Malikipuram	247	254.2	190.09	938	479.53	479.52
Razole	38	51.3	38	453	173.05	172.96
Mamidikuduru	310	375.54	313.75	984	469.77	442.08
Allavaram	738	1094.41	782.09	1465	1175.50	1174.60
Uppalaguptam	1079	1482.02	1244.3	1858	2713.45	2713.40
Katrenikona	513	616.09	493.32	552	745.07	497.05
I. Polavaram	220	528.38	414.43	508	536.03	358.31
Amalapuram	-	-	-	47	40.20	40.20
Inivilli	-	-	-	7	5.80	5.80
P.Gannavaram	-	-	-	101	37.76	35.96
Mummidivaram	-	-	-	433	270.07	170.87
Total	**3657**	**5058.02**	**4000.02**	**8115**	**6970.99**	**6415.51**
Total for the district	**4814**	**7800.55**	**6207.2**	**10479**	**10085.17**	**9522.82**

Table 2. *Farm size distribution in East Godavari district during 1999 and 2004*

Year	Farm < 2 ha		Farm 2-5 ha		Farm > 5 ha		Total	
	No.	WSA (ha)	No.	WSA (ha)	No.	WSA (ha)	No.	WSA (ha)
1999	3959	3530.95	737	1339.59	118	1350.56	4814	6221.10
2004	8750	6434.65	650	2324.2	54	493.97	9454	9552.8

Table 3. *Details of shrimp farming area (ha) as per the CRZ rules in East Godavari district during 2004*

	Actual BW area developed into ponds			Actual BW area under culture		
	Amalapuram	Kakinada	Total	Amalapuram	Kakinada	Total
Within CRZ	6627.99	614.96	7242.95	6095.51	452.77	6548.28
Outside CRZ	343	2499.22	2842.22	320.00	2384.54	2704.54
Total	6970.99	3114.18	10085.17	6415.51	2837.31	9252.82

They were raising two crops, one in summer (Feb-Mar. to Jun-July) and the other in winter (Sep-Oct. to Dec.-Jan). They were of the view that the former was successful and the latter was uncertain due to heavy rain, severe cyclone, non-availability of required salinity and outbreak of disease. Interestingly during summer farmers of this area mixed godavari canal irrigation water with creek water for culture and in winter the former was mixed with borewell water (20-25 ppt) to lower the water salinity to 10-15 ppt which they felt optimum for shrimp culture. All the farmers followed similar pond preparation procedures. Most of the farmers tested the quality of the seed before buying them. Most of

the farmers reported that disease menace particularly white spot virus and poor seed quality were the major constraints in 1999, whereas during 2004, low market rate of shrimp and poor seed quality were the major constraints. Labourers from local villages were engaged. The production varied across the farms from 0.8 to 2 tonnes per ha per crop of 30 g size *Penaeus monodon* in 120-150 days, during summer. The successful winter crop yield was 0.5 to 1 t ha^{-1} but it was uncertain.

Environmental impacts

Aquaculture being a biological production activity, the interaction of inputs such as shrimp seed, feed etc. with the ambient water resulted in growth and production of shrimp and changed water quality (Gupta *et al.*, 2001).

Water quality

The average water quality condition of creeks, borewell, irrigation canal and river and shrimp ponds are given in Tables 4, 5, 6, and 7, respectively. The water quality characteristics of the pond and creek revealed that that there was no serious nutrient loading in the creek water. The salinity levels in the creek were low in most of the cases and the farmers were using saline water from the borewell to raise the salinity levels. Wherever the salinity of the creek was higher, water from irrigation canal was used to reduce the salinity. Borewell waters registered high values of total ammonia nitrogen (TAN), nitrite N (NO_2 - N) and chemical oxygen demand (COD) than those in the creek, irrigation canal and river waters. The pH, salinity, TAN, NO_2 - N and COD values ranged from 6.97-7.29, 2-24 ppt, 0.007-0.138 ppm, 0.007-0.023 ppm and 8.7-96.5 ppm in creeks; 6.97-7.05, 17-32 ppt, 0.059-2.539 ppm, 0.012-0.588 ppm and 68.7-112.1 ppm in bore wells and 6.74-8.13, 5-23 ppt, 0.011-0.197 ppm, 0.015-0.187 ppm and 5-67.5 ppm in pond waters, respectively.

The pollution indicators like ammonia-N and chemical oxygen demand (COD) were well within the

Table 4. *Water quality characteristics of creeks in different pond clusters in East Godavari district*

Site	pH	Salinity (ppt)	Total NH_3-N (ppm)	NO_2-N (ppm)	Phosphate (ppm)	Total phosphorus (ppm)	Alkalinity (ppm)	COD (ppm)
Pathirajaram	7.27	4	0.035	0.007	0.036	0.046	162.4	10.1
G. Mollapalem	7.09	24	0.095	0.018	0.016	0.042	152.4	84.9
N. Kothapalli	7.32	3	0.126	0.019	0.042	0.073	172.8	6.7
Katrikona	7.10	6	0.037	0.008	0.016	0.062	160.8	40.3
Bodasakuru	7.21	3	0.091	0.015	0.019	0.054	168.4	2.6
Ponamanda	7.10	3	0.054	0.023	0.021	0.042	198.8	55.9
Korangi village	7.29	8	0.040	0.023	0.028	0.044	144.4	15.9
Korangi creek drain	7.16	2	0.138	0.022	0.009	0.064	165.2	8.7
Ramanaleapeta	6.97	18	0.007	0.012	0.016	0.053	161.6	96.5

Table 5. *Water quality characteristics of borewells in the study area*

Site	pH	Salinity (ppt)	Total NH_3-N (ppm)	NO_2-N (ppm)	Phosphate (ppm)	Total phosphorus (ppm)	Alkalinity (ppm)	COD (ppm)
Yeduralenka	6.97	32	0.059	0.588	0.028	0.088	219.6	91.8
Uppudi	7.05	20	0.70	0.012	0.011	0.021	324.8	68.7
Lutukuru	7.02	17	2.539	0.548	0.041	0.079	308.8	112.1

Table 6. *Water quality in the irrigation canal and river*

	pH	Salinity (ppt)	Total NH_3-N (ppm)	NO_2-N (ppm)	Phosphate (ppm)	Total phosphorus (ppm)	Alkalinity (ppm)	COD (ppm)
Vainatha river	7.14	25	0.032	0.023	0.065	0.070	134.8	77.4
Uppudi irrigation canal	7.44	4	0.126	0.015	0.037	0.123	245.2	34.2

Table 7. *Water quality in ponds from different villages in East Godavari district*

Site	pH	Salinity (ppt)	Total NH_3-N (ppm)	NO_2-N (ppm)	Phosphate (ppm)	Total phosphorus (ppm)	Alkalinity (ppm)	COD (ppm)
Yedurulanka	6.74	10	0.041	0.187	0.011	0.095	108.4	27.2
Pathirajaram	6.93	13	0.032	0.016	0.004	0.064	117.2	39.8
Pathirajaram	6.92	10	0.14	0.018	0.037	0.045	143.6	41.9
Bodasukuru	7.12	17	0.089	0.015	0.058	0.089	138.4	59.8
Lutukuru	6.96	23	0.109	0.017	0.075	0.094	103.6	65.7
Korangi	7.77	5	0.063	0.022	0.018	0.048	179.6	15
Lakshmipathipuram	7.52	15	0.087	0.018	0.056	0.07	169.2	63
Ramanaleapeta	7.05	20	0.034	0.018	0.037	0.062	149.6	67.5
G. Mollapalem	6.93	15	0.131	0.015	0.043	0.019	129.6	49.6

Table 8. *Soil quality in creek, shrimp ponds and agricultural fields near to shrimp farms*

Parameter	Creek	Shrimp ponds	Agrl. fields near to shrimp farm
pH	7.34 - 8.33	7.53 - 8.75	6.75 - 7.52
Electrical conductivity (dS/m)	0.83 - 4.08	0.58 - 5.95	1.06 - 1.89
Organic carbon (%)	0.555 - 1.722	0.258 - 1.311	1.218 - 1.593

permissible limits (MoEF, 1993) indicating no adverse impact in the external source water. In most of the cases, the creek acted as the intake as well as outlet, thereby increasing risk of cumulative loading of nutrients, but due to the improved traditional system of culture practiced reduced the possible pollution load was reduced.

Soil quality

The pH and organic carbon content in creek and pond soil ranged from 7.34-8.33 and 0.56-1.72 % and 7.53-8.75 and 0.258-1.809%, respectively (Table 8).

Soil salinisation

The soil quality of the agricultural lands located adjacent to the shrimp farms were tested for salinity. The electrical conductivity in various agricultural fields ranged between 1.06 to 1.89 dS m^{-1} (Table 8), which indicated that the shrimp farming activities in the areas surveyed does not affect the soil salinity. Agricultural fields were located very close to the shrimp farms and the creeks and there was no complaint from the agriculturists regarding the shrimp farming activities. Practically there was no soil salinisation even at a distance of 50 m away from the farm except in four villages out of 14 villages studied in Nellore District and Tamil Nadu (Muralidhar et al., 2000). NEERI's study also reported that salinity of the soil did not change at a distance of about 25 m (Chandran, 1998). In Cuddalore district of Tamil Nadu, during a study period of 18 months, the soil beyond 250 m was suitable for agriculture as the EC values ranged from 1.1 to 3.9 dS m^{-1} (Gupta *et al.*, 2002).

Conversion of agricultural land

In East Godavari district, conversion of agricultural fields into shrimp farms was reported in a few case. It was found that rice fields had been converted as shrimp farms due to the highly profitable nature of shrimp farming Recently conversion of shrimp farms back to paddy fields has been observed in some of the places.

CONCLUSION

Shrimp aquaculture has contributed significantly to employment generation and infrastructure development for the welfare of the coastal community and development in the district. Shrimp farming is continued in East Godavari District although with some constraints. The mixing of borewell and creek waters with fresh irrigation water, use of extensive and intensive feeds during the yearly and later period of culture, and shrimp + coconut + paddy farming system are the unique features of shrimp farming being practised in this district. There are no adverse impacts on the environment due to shrimp farming and in many places the positive impacts have outweighed the negative impacts, if any, like conversion of

agricultural lands into shrimp farms and others. The type and scale of any environmental change will depend on the method of culture, the level of production, and characteristics of the coastal area. Unless the pollution load in pond wastewater exceeds the assimilative capacity/carrying capacity of a water body that is seldom known (Muralidhar *et al.*, 2004), adverse environmental changes will not occur.

REFERENCES

Anon. (2004). In *Business Line*, 22 January, 2004.

APHA (1989). *Standard Methods for the Estimation of Water and Wastewater*, 7th Edn, American Public Health Association, Washington D.C., USA. 1430p.

Chandran, K.K. (1998). Myths & facts: Environment, ecology and aquaculture. *Fishing Chimes* **18**(6): 29-34.

Csavas, I. (1994). Important aspects in the success of shrimp farming. *World Aquaculture* **25**(1): 34-56.

Gupta, B.P., Krishnani, K.K., Joseph, K.O., Muralidhar, M., Ali, S.A. and Gopal, C. (2001). Soil & water characteristics and growth of *Penaeus monodon* fed with formulated feed in experimental tanks. *Indian Journal of Fisheries* **48**(4): 345-351.

Gupta, B.P., Krishnani, K. K., Joseph, K.O., Muralidhar, M., Nagavel, A. and Parimala, V. (2002). Studies on the effect of shrimp farming on adjacent agricultural land and underground water in Cuddalore District of Tamil Nadu. *Applied Fisheries & Aquaculture* **II**(1): 47-50.

Jackson, M.L. (1967). *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi. 498p.

Lee,D'OC. and Wickins, J.F. (1992). *Crustacean Farming*. Blackwell Scientific Publication, Oxford. 392p.

MoEF (1993). *Notification–General Standards for Discharge of Environmental Pollutants*, Part **A** – *Effluents*, Ministry of Environment and Forests, Govt of India, May, 1993.

Muralidhar, M., Gupta, B.P., Joseph, K.O. and Krishnani, K.K. (2000). Impact of brackishwater shrimp farming on surrounding coastal soil and water. Proceedings National Seminar *Coastal Zone 2000*, held at Hyderabad, 26 -27 Feb. 2p.

Muralidhar, M., Gupta, B.P., Ravichandran, P., Pillai, S.M., Sarada, C. and Mathew Abraham (2004). Significance of assessment of carrying capacity of source water body for shrimp farming. Proceedings National Symposium *Disease problems in Aquaculture: Challenges, Approaches and Management*, pp. 59, held at Mumbai, 6-7 Feb, 2004.

Piper, C.S. (1966). *Soil and Plant Analysis*. Hans Publishers, Bombay, 368p.

Strickland, J.D.H. and. Parsons, T.R. (1972). *A Practical Hand Book of Seawater Analysis*. Bulletin Fishery Research Board, Canada **167**. 310p.

J. Indian Soc. Coastal agric. Res., 24(2), 247-249, 2006

Environmental Impact of Brackishwater Aquaculture in Pichavaram, Tamil Nadu

M. JAYANTHI[1], S. RAMACHANDRAN, P. NILA REKHA[1] and M. MURALIDHAR[1]

Institute for Ocean Management, Anna University
Chennai - 400 025, Tamil Nadu

and

[1]Central Institute of Brackishwater Aquaculture, 75, Santhome High Road
Chennai - 400 028, Tamil Nadu

Shrimp aquaculture has been developed from 65,100 ha in 1990 to 1,54,600 ha in 2004 with increase in production by 217%. This fast rate of development of shrimp culture has invited many environmental issues like changes in water quality in nearby water bodies and conversion of agricultural lands to aquaculture. The development is still expected because our potential area for shrimp aquaculture is 1.2 million ha. Pichavaram has unique mangrove ecosystem and shrimp culture has been developed in the last decades in this area. To assess the impact of aquaculture water quality, samples were collected and analysed from shrimp farms and also from the creek nearby aquafarms and away from aquafarms. Shrimp farmers are practising improved traditional farming with stocking density of 50,000 -1 lakh ha^{-1}. No adverse impacts have been reported except conversion of rice fields into shrimp farms. The water quality parameters are well within the permissible limits indicating no adverse impact in the source water.

***(Key words :** Aquaculture, Water quality assessment, Agriculture land conversion, Impact, Mangroves)*

Aquaculture has traditionally been practised in India in both freshwater and coastal saline waters from time immemorial. These were characteristically low input and low pr :duction systems depending on wild seed collection and stocking in natural ponds, or impounding seed in large water bodies without any further management measures. During the last two decades, aquaculture has been transformed into a commercial activity of high profit sector and production and area under culture was increased from 65,100 ha and 35,500 MT in 1990 to 1,54,600 ha and 1,12,780 MT in 2004, respectively.

Due to high profit, economic viability, low labour requirement, suitable soil and environmental conditions and encouraging market for products, shrimp aquaculture industry has expanded in very short duration and occupied around 80 % of total shrimp production. However, its impressive growth has also often been accompanied by significant failures, which made it as a high risk activity. In many cases, problems have arisen because of a lack of understanding of the aquatic environment and the use of unreliable means for resource assessment, rather than production technology problems.

Known for its unique mangrove ecosystem, Pichavaram has an estuarine type of mangrove. Many aquaculture farms have been developed recently and further developemnt is also expected considering the high profit margin compared to agriculture. Fastest rate of development of shrimp aquaculture has emphasized the need for more effective controls on the quality of water discharged into the environment. Approximately 10% of the feed is dissolved and 15% remains uneaten. The remaining 75% is ingested, but 50% is excreted as metabolic waste, producing large amounts of gaseous, dissolved and particulate waste. If the discharge water is enriched with nutrients, it causes the eutrophication in the receiving water body and also leads to self-pollution of aquaculture ponds.

Since mangroves serve as a nursery and breeding ground for many reef organisms and their intricate root systems provide shelter for many marine and terrestrial animals, small changes in water quality will have a big impact on environment. So, the study was carried out to assess the impact of aquaculture on environment in Pichavaram,

MATERIALS AND METHODS

The area under different land use class was analyzed and the percentage of each class was calculated. The discharge water from twenty aquaculture farms were collected during winter (September to December) and summer (March to June) every month to assess quality of the water discharged into creek. Simultaneously, the samples

were also collected from creek at five places nearer to aquaculture farms and away from aquaculture farms. The samples were analyzed for pH, salinity, dissolved oxygen, nitrite, nitrate, and phosphorus using standard methods (APHA, 1995).

RESULTS AND DISCUSSION

Shrimp aquaculture is growing in very fast rate (Fig.1) and our potential area for aquaculture is 1.2 million ha. The area and production under aquaculture increased by 134%, and 217%, respectively between 1990 and 2004. Aquaculture in Pichavaram started after 1980's and occupied 5.01% of area (Fig.2). Shrimp farmers are practising improved traditional farming with stocking density of 50,000 -1 lakh ha^{-1}. Agriculture is the major activity and 42.29% of the land is under agriculture. Since environmental issues have been raised over the development of aquaculture further development should go with proper planning and anticipated negative impacts should be prevented.

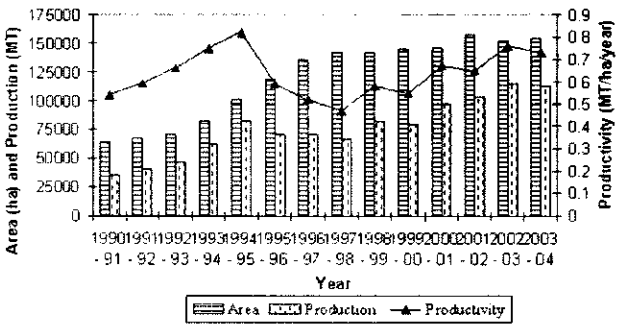


Fig. 1. Development of shrimp culture in India

Conversion of agricultural lands

Conversion of agricultural lands was one of the issues raised over the development of aquaculture. In Pichavaram, most of the farms have been converted from agricultural fields. High profit and good water scarcity were the two main reasons

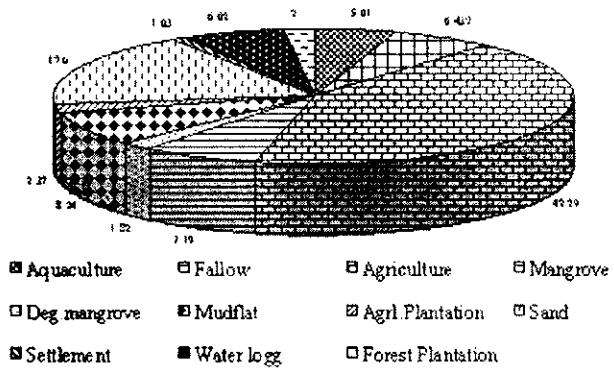


Fig. 2. Land use pattern

according to local people. The farmer's perception differs from the environmental considerations. As per the opinion of the farmer, agriculture is not profitable now and they may be able to get 5-10 times higher return in aquaculture compared to agricultural activity.

Assessment of water quality

It can be seen that pH was ranging from 8.03-8.04 in summer and 7.34-7.52 in monsoon periods in farm ponds and the creek water pH was little less (7.35-7.88) than farm pond water (Table 1). The discharged water salinity was 30.16-37.85 ppt in summer which reduced to 16.15-25.36 ppt in winter season. It was also observed that the DO concentration was more in monsoon period and less in summer period because of more salinity and high temperature in summer. Earlier studies by Boyd (1990) also revealed the similar variations, whereas Chattopadhyay (1998) observed highest dissolved oxygen in the pond water treated with fertilizers during July inspite of salinity level being highest in that time. The dissolved oxygen (DO) values were little high in farm ponds than creek water and this may be due to the aeration systems provided in the farms. The nitrite and nitrate values did not differ

Table 1. *Water quality in discharged water from shrimp farms and in creek*

Parameters	Summer			Winter			Standards for shrimp farm water discharged into creek
	Discharge water	Creek water near shrimp farms	Creek water away from shrimp farms	Discharge water	Creek water near shrimp farms	Creek water away from shrimp farms	
pH	8.03-8.04	7.35 -7.42	7.30-7.34	7.34-7.52	7.81-7.88	7.70-7.80	6.0-8.5
Salinity (ppt)	30.16-37.85	22.0 -25.52	20-22.12	16.15-25.36	6.72 -7.82	6.55-7.72	-
DO (mg/l)	3.92-4.02	3.05-3.12	2.98-3.10	5.94-6.28	4. 34 -4. 58	4.04-4.50	<3
Nitrite (mg/l)	0.007-0.009	0.004 - 0.006	0.003-0.006	0.008-0.009	0.012 -0.014	0.010-0.015	0.5
Nitrate (mg/l)	0.16-0.23	0.064 -0.097	0.060-0.091	0.17-0.23	0.121 -0.131	0.124-0.129	3.0
Total P (mg/l)	0.039-0.051	0.009-0.015	0.008-0.014	0.044-0.055	0.008 -0.021	0.007-0.010	2.0

much in winter and summer seasons. The total phosphorus values were high in winter than summer in creek and discharged water. None of the parameters have exceeded the standards (Table 1) prescribed by the Ministry of Agriculture for shrimp pond water discharged into creek

CONCLUSION

Shrimp culture has brought significant changes in utilization of uncultivable lands and alternate ones wherever the fresh water scarcity persists. There are no adverse impacts on the environment due to shrimp farming apart from the conversion of agricultural lands. In the agricultural lands converted to aquaculture, most of the agriculture farms were abandoned few years before the start of aquaculture. This development has not affected the water quality characteristics of creek in Pichavaram. Considering the future development, the drainage canal networking with the community based waste water treatment facility is suggested to prevent the future negative impacts.

REFERENCES

APHA (American Public Health Association) (1995). *Standard Methods for the Examination of Water and Waste Water*, 19th Edn, APHA, Washington.

Boyd, C.E. (1990). *Water Quality in Ponds for Aquaculture*, Alabama Agricultural Experiment Station, Auburn University, Alabama, USA. 482p.

Chattopadhyay, G.N. (1998). In *Chemical Analysis of Fish Pond Soil and Water*, pp.110-122, Daya Publishing House, New Delhi.

J. Indian Soc. Coastal agric. Res., 24(2), 250-253, 2006

Growth and Survival of *Macrobrachium Rosenbergii* (Giant Freshwater Prawn) under Monoculture Practice in Sindhudurg District of Maharashtra

P. E. SHINGARE[1], N. H. SAWANT[2], B. P. BHOSALE[3] and S.G. BELSARE[3]

Agricultural Research Station, Dr. B.S. Konkan Agricultural University, Mulde
Dist. Sindhudurg – 416 520, Maharashtra

There is a growing awareness among the fish farmers of Western and vidarbha region of Maharashtra to undertake the culture of *Macrobrachium rosenbergii* (Giant freshwater prawn) in freshwater earthen ponds. The culture experiments were conducted using *M. rosenbergii* seed in Sindhudurg district of Konkan region of Maharashtra to assess the productivity and to standardize the culture technique for *M. rosenbergii* in the region. The prawns were harvested after 170 days of culture period. The survival and average growth of prawn in pond 1, 2 & 3 were in the range of 33.02% to 36.97% and 31.49 g to 35.55 g, respectively at the time of harvesting. The feed conversion ratio was in the range of 1: 3.5 to 1: 4.5. The production of these three ponds was in the range of 520.120 to 620.380 kg ha^{-1}.

(Key words: *Giant freshwater prawn, Monoculture practice, Growth & survival, Feed conversion ratio, Harvest)*

Macrobrachium rosenbergii (Giant freshwater prawn) is the largest growing species of freshwater prawns and is preferred for culture due to its fast growth rate, high nutritional value, hardy nature, easy acceptability of supplementary feed, high monetary value and ready demand in domestic as well as in export market. Considering its distinguished features, there is a wide scope to popularize the culture technique of this species. In Maharashtra, about 182.57 hactare area is under prawn farming and out of which 57.61 hactare area belongs to Bhandara District (Raje, 1997). This reveals the emergent awareness for the culture of *M. rosenbergii* among the farmers of Vidharbha region of Maharashtra State. In Sindhudurg District, about 500 ha water spread area comes under minor irrigation tanks and village ponds, however there is little attention towards freshwater prawn farming in this region.

In South Konkan region, adults occur in all rivers but in very small quantity, mainly during monsoon season and occasionally during remaining period of the year (Sankoli and Shenoy, 1994). This region has laterite type of soil with high percolation rate, low moisture holding capacity, low fertility and acidic nature. If this available area is properly utilized for at least one crop of freshwater prawn in year, it can yield large quantities of this high-priced export commodity. It was therefore decided to undertake culture experiment in Sindhudurg district to assess the productivity and to standardize the suitable culture method. The details of culture experiment conducted are presented in the text.

MATERIALS AND MEHTODS

The study was conducted in three earthen rainfed ponds using stocking density of prawn seed @ 50,000 nos ha^{-1} (Sandifer *et al.*, 1982 Cohen *et al.*, 1983) besides usual stocking density @ 30,000 nos ha^{-1} (Shirgur *et at.*, 1988). The hatchery-bred juveniles of *M. rosenbergii* were obtained from M.B.R.S. Ratnagiri in the month of December and were stocked in earthen ponds with different water spread area at Agricultural Research Station, Mulde. The experimental duration was reduced to short period of 170 days due to rapid fall in water level. The prawns were fed @ 5 to 10% of body weight using artificial pelleted feed (Mathew *et al.*, 1990). The raw cattle dung, urea and single superphosphate were applied as manure for the mass production of zooplankton before starting of studies. The artificial feed was commonly available and relatively inexpensive with ingredients, viz. soya floor, rice bran and wheat floor which were applied

[1] Present address : Kharland Research Station, Panvel, Raigad – 410 206, Maharashtra
[2] Present address: College of Fisheries, Shirgaon, Ratnagiri – 415 629, Maharashtra
[3] Present address: Marine Biological Research Station, Pethkilla, Ratnagiri – 415 612, Maharashtra

Table 1. *Experimental site features and input details*

Particulars		Pond 1	Pond 2	Pond 3
Water spread area		196 m^2	185 m^2	172 m^2
Mean water depth		1.00 m	1.00 m	1.00 m
Source of water		Rainfed	Rainfed	Rainfed
Source of seed		Hatchery bred (M.B.R.S)	Hatchery bred (M.B.R.S)	Hatchery bred (M.B.R.S)
Duration of experiment		170 days	170 days	170 days
Initial average length (mm)		17.20 ± 0 .30	15.84 ± 0 .30	16.04 ± 0.30
Initial average weight (g)		0.029 ± 0.6	0.027 ± 0.6	0.028 ± 0.6
Number of seed stocked				
a) Per pond (Nos.)		980	925	860
b) Per hactare (Nos.)		50000	50000	50000
Initial biomass of the seed				
a) Per pond (g)		28.42	24.97	24.08
b) Per hactare (g)		1450	1350	1400
Feed used		Supplementary feed in the form of pellets	Supplementary feed in the form of pellets	Supplementary feed in the form of pellets
Feed quantity used(kg)				
a) Per pond		40.50	40.50	40.50
b) Per hactare		2066.330	2066.330	2066.330
Total quantity of fertilizer used (kg)				
a) Per pond	i) RCD	100.00	100.00	100.00
	ii) SSP	5.00	5.00	5.00
	iii) Urea	5.00	5.00	5.00
	Total	**110.00**	**110.00**	**110.00**
b) Per hactare	i) RCD	5000.0	5000.0	5000.0
	ii) SSP	250.0	250.0	250.0
	iii) Urea	250.0	250.0	250.0
	Total	**5500.0**	**5500.0**	**5500.0**

in pelleted form (composition: protein - 38.4%, fat - 12.8%, ash - 10.5% and moisture - 8.3%). The supplementary feed in measured quantity was given twice a day. The detailed features of the study area and input details are given in Table 1. The initial length, weight, number of seed stocked, initial biomass of seed etc. were recorded. The pH, dissolved oxygen, temperature etc. were recorded at the interval of 15 days (Table 2) by adopting standard procedure for maintaining good water quality (APHA, 1985).

The sampling for growth from all the three ponds was undertaken at the interval of 30 days by using cast net and drags net. After 170 days of experimental period, all the three ponds were dewatered and prawns were collected. The data pertaining to length-weight, percentage survival, total prawn biomass harvested, net gain in biomass and actual feed conversion ratio were recorded.

RESULTS AND DISCUSSION

The results upon harvesting at the end of 170 days culture duration are shown in Table 3. Under experimental study, prawns were grown with

Table 2. *Water properties of the experimental pond*

Particular	Pond 1	Pond 2	Pond 3
pH	6.5 - 6.8 (6.6)	6.5 - 6.8 (6.6)	6.5 - 6.8 (6.6)
DO (mg/lit)	5.8 - 8.0 (6.75)	5.6 - 8.4 (6.78)	5.6 - 8.0 (6.74)
Temperature (°C)	24.4 - 30.6 (27.56)	24.4 - 30.6 (27.56)	24.4 - 30.6 (27.56)

Table 3. *Results of* M.rosenbergii *harvest*

Particulars	Pond 1	Pond 2	Pond 3
Culture duration (days)	170	170	170
Number harvested			
a) Per pond	347	342	284
b) Per hactare	17700	18485	16510
Survival %	35.4	36.97	33.02
Final length (mm)	151.8 ± 0.30	152.0 ± 0.40	150.8 ± 0.50
Final weight (g)	32.197 ± 2.46	33.558 ± 5.15	31.498 ± 6.95
Prawn biomass weight			
a) Per pond (kg)	11.144	11.477	8.964
b) Per hactare (kg)	570.00	620.38	520.12
Net gain biomass			
a) Per pond (kg)	11.144	11.477	8.921
b) Per hactare(kg)	568.57	620.38	518.66
Feed conversion ratio (FCR)	1 : 3.63	1 : 3.53	1 : 4.53
Gross income / ha from sale of prawn @ Rs. 150 /- per kg	85000 /-	93057 /-	78018/-
Expenditure on inputs per hactare in Rs.			
a) Cost of seed @ Rs. 600 /1000 nos.	30000/-	30000/-	30000/-
b) Cost of feed @ Rs. 9/kg	18900/-	18900/-	18900/-
c) Cost of fertilizer			
i) RCD @ Rs.1/kg	5000/-	5000/-	5000/-
ii) SSP @ Rs. 3/kg	750/-	750/-	750/-
iii) Urea @ Rs.3/kg	750/-	750/-	750/-
Sub Total	**6500/-**	**6500/-**	**6500/-**
d) Labour cost for 200 man days @ Rs. 25 / day	5000/-	5000/-	5000/-
Total Expenditure (Rs.)	60400/-	60400/-	60400/-
Net income / hectare (Rs.)	**25100/-**	**32657/-**	**17614/-**

constant feed input and at specified stocking density. The average growth of prawn in pond 1,2 and 3 was 32.19 g, 33.55 g and 31.49 g, respectively. The growth reported by other research workers was 26 g in 115 days (Mathew *et al.*,1993), 30 g in 180 days (Durairaj *et al.*,1992) and 33 to 160 g in 9–10 months (Raje and Joshi.,1992). These growth rates are comparable to growth reported under present experiment. In India, production of freshwater prawn from monoculture was reported in the range of 280 –700 kg ha^{-1} in 6 months (Subramanyam, 1984) and 535 –3125 kg ha^{-1} in 10 months with an average growth rate of 1678 kg ha^{-1} (Raje and Joshi, 1992). The average production of 808 kg ha^{-1} in 153 days has been reported (Mathew *et al.*, 1993). The average survival has been reported to be 24.4% (Parameshwaram *et al.*, 1992), 33–43% (Raje and Joshi,1992). The survival rate of 35.40%, 36.97% and 33.02% for pond 1, 2 & 3, respectively with PL stocking, as reported in this study, was better even when compared with the data reported earlier. The feed conversion ratio (FCR) under low cost input was 1: 3.63, 1: 3.53 and 1: 4.53 in pond 1, 2 and 3, respectively. The feed conversion ratio earlier reported are 1.66 to 2.33 (Smith and Sandifer, 1980), 4.7 (Sebastian *et al.*,1992) and 12.49 (Parameshwaran *et al.*, 1992).

Physicochemical factors in regards to temperature indicated the range of 24.4 to 30.6° C. The pH varied in the range of 6.5 to 6.8 which was slightly acidic in nature, where as the dissolved oxygen varied in the range of 5.6 to 8.4 mg l^{-1} (Table 2). The main observation of present study was that prawns were able to withstand pH as low as 6.5. The low pH was due to acidic soil of this region. The data revealed maximum growth rate and percentage survival in pond no 2 followed by pond no 1 and 3. Further, it was observed that feed conversion ratio was also found minimum in pond no 2, while it was maximum in pond no 3. The poor survival and growth of the prawns may be due to presence of weed fishes like Barbs, Danios, Puntius, Rasbora, etc. as well as carnivorous fishes like Eels, magur, Murrel, etc.suggesting that there was competition

with weed fishes and predation by predatory fishes. The result showed that growth rate and survival percentage can be increased by avoiding entry of weed fishes and carnivorous fishes so as to utilize the supplementary feed by prawns (Shingare *et al.*, 1995).

The production of *M. rosenbergii* under monoculture practice depending upon natural trophic level was thus 136.5 kg per hectare, while under 100% supplementary feeding with 199 days culture duration maximum production was 334.3 kg per hectare (Shirgur *et al.*, 1988, Vasudevappa, *et al.*, 1998). Hence, it can be concluded from the above results that monoculture of prawn with stocking density of 50,000 nos per hectare using locally available artificial feed is feasible. The total gross income on hectare basis varied from Rs. 78018.00 to Rs. 85000.00 as per the current prices of prawn in the market. Therefore, the net income per hectare under this type of culture was in the range of Rs. 17614.00 to Rs. 25100.00 for a period of 170 days.

In conclusion, this type of monoculture showed that the overall production of pond can be doubled if input of supplementary feed is proportionately increased and culture duration is prolonged up to 10 months by releasing the seed of *M. rosenbergii* immediately after monsoon season.

REFERENCES

APHA (1985). *Standard Methods for the Examination of Water and Wastewater*, 16th Edn, Americian Public Health Association, DC. 1134p.

Cohen, D., Ravanar, Z., Rapport, V. and Ariell, Y. (1983). The production of freshwater prawn *M. rosenbergii* (Deman) in Israel. *Bamidgeh* **35**(2): 31-37.

Durairaj, G., Chandrasekaran and Umamaheswary, R. (1992). Experimental culture of giant freshwater prawn in Tamilnadu. In *Freshwater Prawn*, E.G. Sailas (ed.), pp. 249-256, Kerala Agricultural University, Trissur.

Mathew, P.M., Sebastion, M.J., Thampy, O.M. and Nair, C.M. (1990). Observations on the culture of Giant freshwater prawn, *M. rosenbergi* in pokkali fields. In *Aquaculture*, P.C. Thomas (ed.), pp. 36-41.

Mathew, P.M., Sebastion, M.J., Thampy, O.M. and Nair, C.M. (1993). Preliminary observations on the culture of Gaint freshwater prawn, *M. rosenbergi* in pokkali fields. Proceedings *Second Indian Fishery Forum*.

Parameswaran, S., Manbodh, M. and Hawabhay, K. (1992). Aquaculture of freshwater prawn, *M. rosenbergii* (De Man) in Mauritius. In *Freshwater Prawn*, E.G. Sailas (ed.), pp.10–12, Kerala Agricultural University, Trissur.

Raje, P.C. and Joshi, V.P. (1992). Multilocational grow out trials of *M. rosenbrgii* in western Maharastra. In *Freshwater Prawn*, E.G. Sailas (ed.), pp.180-182, Kerala Agricultural University, Trissur.

Raje, P.C. (1997). Status of freshwater prawn farming in Maharashtra. Proceedings Workshop *Freshwater Prawn Farming*, pp. 1-4, held at College of Fisheries, Ratnagiri (Maharashtra), 23 Mar, 1997.

Sandifer, P.A., Theodore, I.J. and Smith. (1982). *Gaint Prawn Farming*, M.B. New (ed.), Elsevier Scientific Publishing Company, New York. 170p.

Sankoli, K.N. and Shenoy Shankuntala (1994). Status of freshwater prawn farming in Konkan (Maharashtra). Proceedings Workshop *Freshwater Prawn Farming in India*, 17–18 Mar, 1994. Spl. Pub. **10**. 113p.

Sebastian, M.J., Nair Mohankumar, C. and Thampy, D.M. (1992). Culture of *M. rosenbergii* in homestead ponds. In *Freshwater Prawn*, E.G. Sailas (ed.), pp.200-205, Kerala Agricultural University, Trissur.

Shingare, P.E., Shirgur, G.A., Singh, R.K. and Mehata, V.B. (1995). Assessment of polyculture of gaint freshwater prawn (*M. rosenbergi)* with *O. mossambicus* and carps. Proceedings National Seminar *Challenge and Opportunities of Research and Development in Coastal Agriculture*, held at Bhubaneswar, Orissa, 4-7 Dec, 1995. Indian Society of Coastal Agricultural Research, Canning Town, West Bengal.

Shirgur, G.A., Chavan, J. B., Indulkar S.T. and Siddiqui, S.Q. (1988). Extensive pond culture of freshwater prawn *M. rosenbergii*, pp. 429-438. Proceedings National Seminar *Aquaculture Production*, held at New Delhi.

Smith, T.I.J. and Sandifer, P.A. (1980). Influence of three stocking strategies on the production of prawn, *M. rosenbergii* from ponds in South Carolina, U.S.A. Proceedings.Symposium *Coastal Aquaculture*, held at Cochin, 12–18 Jan, 1980.

Subramanyam, M. (1984). Experimental pond culture of giant freshwater prawn, *M. rosenbrgii*. Proceedings Seminar *Aquaculture*, pp. 57–68, held at CIFRI, Cuttack.

Vasudevppa, Swamy Vijaykumara, C., Mohire, K.V. and Kumari, N. B. (1998). Culture of gaint freshwater prawn *M. rosenbergii*- A case study. In *Current and Emerging Trends in Aquaculture*, P.C. Thomas (ed.), pp. 69–73.

J. Indian Soc. Coastal agric. Res., 24(2), 254-257, 2006

Surface Dugout Pond: Boon for Coastal Integrated Farming System in Maharashtra

J. H. DONGALE, S. S. DHANE, P. E. SHINGARE and S. J. MESHRAM

Khar Land Research Station, Dr. B.S. Konkan Krishi Vidyapeeth
Panvel - 410 206, Dist. Raigad, Maharashtra

Maharashtra is having 4.03 lakh hectare of saline soil, out of which 64,465 hectare is situated in Konkan region called as coastal saline soil. In Konkan, the annual rainfall ranges from 2500 to 4000 mm. Surface dugout farm pond showed the advantage of desalinization of an area upto a radial distance of 27 m by periodical pumping of saline water into the drain. The periodical pumping, intensity and distribution of rainfall were the major factors governing the leaching and recharging process. These soils are fertile in nature, however, due to lack of freshwater sources, it is monocropped having only rice in *kharif* season. Therefore, surface dugout pond technology acts as good source of irrigation to meet freshwater demand during dry spell period of *kharif* and *rabi* hot weather season. Water depth of 1.0 to 1.5 m for 7 – 8 months allows growing fishes like Indian major carps, *Lates calcarifer*, *Cyprinus carpio*, *Macrobrachium rosenbergii*, etc. to generate additional income. Further this water can be utilized for growing horticulture crops like coconut and vegetables on *bunds* with protective irrigation in coastal saline soils.

*(**Key words:** Integrated farming system, Surface dugout pond, Rainfall analysis, Konkan soil)*

The coastal saline soils, locally called "Khar Lands" in Konkan, are the problematic soils of the region. The repeated ingress of saline creek water as well as upward rise of salts due to low ground water table during hot season make these soils unsuitable for cropping. The average EC of the soils during pre-monsoon period is 25 dS m^{-1}. Na^+ and Cl^- are the dominant ions on exchange complex. The heavy texture of the soil reduces the hydraulic conductivity and infiltration rate which impedes the drainage. The soils are adequate in available nutrients. However, their productivity is affected by high salt content (Anon., 1992).

The Maharashtra State has 720 km of coastal length with fifty four creeks. It comprises the districts of Thane, Raigad, Ratnagiri and Sindhudurg. It is having total area of 65,465 ha out of which is 80% in Thane and Raigad district (Anon., 1990).

Thane and Raigad district come under VRN Zone of non-lateritic type of soils. These land are having infiltration rate 7.84 to 8.71 cm d^{-1} and hydraulic conductivity 0.62 to 1.05 cm d^{-1} in the low range. Clay percentage in this soil is 45% showing better water holding capacity which helps in storage of water in pond for about 8 to 9 months.

The paper presents the scope for creating additional surface water resource in dugout pond based on climatic data, and its use for integrated farming system in coastal saline soil areas.

Rainfall plays an important role in the cropping system of Khar Lands. The rainfall data of last 27 years were analyzed yearwise, seasonwise, monthly, weekly and daily. It is observed that average rainfall is 2854.21 mm with 86.68 rainy days. Highest rainfall of 4320 mm was observed in the year 1990 over 105 days and lowest rainfall of 2050 mm was observed in the year 1986 over 70 days. The average rainfall during *kharif* was observed to be 2683.93 mm, in *rabi* 151.37 mm and in summer 18.7 mm. In *kharif* higher percentage of rainfall occurred which is 94.03% as compared to 5.32% in *rabi* and 0.85% in summer. Maximum rainfall occurred in the month of July 1010.7 mm followed by August 730.75 mm. Thus assured period of rainfall is helpful for the storing the water in surface dugout pond.

Weekly analyzed rainfall data showed that 23rd to 39th meteorological weeks are having annual rainfall of 52.98 to 295.05 mm. In these weeks total rainfall was 2638.85 mm (92.45%) 29th week showed highest rainfall and 38th week showed lowest rainfall. In the 25 to 34th weeks there was lot of scope to harness the water for pond.

Analysis of dry spells

From the above rainfall data it is clear that these areas are having maximum rainfall. Inspite of such heavy rainfall, occurrence of dry spells is common and has significance in the management of coastal soils. The maximum dry spells are 13, 17 and 31 days, which occurred in the months of August,

September and October, respectively. Due to occurrence of dry spell the salinity of land increases, damaging the rice crop.

Prediction of 50% dry spells occurred for 8, 3, 2 and 6 days in the month of June, July, August and September respectively. Weekly dry spells were observed in the 23rd, 35th and 38th week, which were more than 40%.

In the Khar Land there is no source of water for irrigation during *rabi* season. The brackish groundwater of coastal saline soils is a constant source of soil salinity. The critical depth of mineralized ground water was found to be 407±15 cm at Panvel (Sahu *et al.*, 1982). The ground water table rose to 0.17 m in the month of September and dropped from October onward. The water table depth and it's salinity were measured through observation wells installed at Pargaon (Mehta, 1991). It reached the average depth of 1.74 m in the month of May. To stop this cycle of salinity, it is essential to bring the land under cultivation during *rabi* season. But due to lack of irrigation facilities it becomes difficult to take second crop during *rabi* season.

To overcome the above problems of Khar Land and to fit for second crop surface dugout pond was the best solution (Sahu *et.al.* 1981). This stored water will be utilized for the agriculture, horticulture and aquaculture.

Construction of surface dugout pond

The depth of pond should be 1 to 1.5 m deep below ground level. It is observed that width of *bund* should be 3 m. This *bund* can be utilized for the growing of horticulture and vegetable crops. To overcome the problem of seepage it is better to strengthen the inside slope with stone or bricks. *Bund* height above ground level should be 1 to 1.5 m, so that it doesn't gets flooded during rainy season, which will also serve as a protection of incoming water from outside. It should be in a rectangular shape with minimum 0.1 ha water spread area. *Bund* slope should be 1.5:1 to 2:1.

Water quality in surface dugout pond

The studies conducted on water quality depth at Panvel showed that the initial salinity of 0.20 ha pond started decreasing after the construction of pond, data are presented in Table1.

The above saline data on salinity of water of surface dugout pond indicated that the same decreased continuously however, its suitability for irrigation purpose throughout the year was observed from 5th year onward.

Table 1. *Salinity of 0.20 ha pond (1.5 m depth) at Panvel*

Year	Salinity (ppt) in the month of April	Water depth (m) in the month of April
1993-94	14.5	1.2
1994-95	9.2	1.0
1995-96	6.5	1.1
1996-97	6.2	1.0
1997-98	4.5	1.0
1998-99	2.5	1.0
1999-2000	1.0	1.0

Chemical properties of water

The chemical properties of water also plays an important role in aquaculture and irrigation. The studies conducted on chemical properties of water at different levels of pond at Panvel are presented in Table 2.

The above data clearly indicate that pH does not have much difference at the depth of pond water. Whereas EC, calcium and magnesium of water increased as per the depth of pond. Also the chlorides, sulphate and carbonate concentrations increased as the depth of pond water increased. From the above data it is clear that the surface dugout pond should be excavated upto 1.5 m below the ground level and raised to the *bund* height 1 to 1.5 m above ground level. The water stored in such pond acts as a good water source for irrigation and aquaculture.

Benefits of surface dugout pond

Surface dugout farm pond showed added advantage of reclaiming an area upto a radial distance of 27 m by periodical pumping of saline water into drain and flushing it out (Chavan *et.al.*,1985).

The stored water will be utilized for nursery of rice if dry spell occurs in *kharif* season and also for the critical growing stages of rice if required. The stored water can be used for growing other crops with protective irrigation during *rabi* season.

The pond *bund* will be utilized for the growing horticultural crops like coconut and vegetable crop like ladies finger.

The stored pond water is also used for aquaculture activity. Studies on growth of euryhaline species, fresh water fishes and prawn were carried

Table 2. *Chemical properties of pond water at different water depths*

Pond No.	Water depth (m)	Month	pH	EC dsm^{-1}	Ca^{++} mel^{-1}	Ca^{++} + mg^{++} mel^{-1}	Cl me^{-1}	HCO_3^- mel^{-1}	SO_4^- mel^{-1}
1)	2.75	Dec.	7.4	0.68	1.58	2.25	5.0	1.6	1.2
		Jan.	7.4	0.72	1.60	2.30	6.0	1.8	1.4
		Feb.	7.7	0.86	1.25	1.80	8.0	2.0	1.5
		Mar.	7.5	0.86	0.40	1.20	7.0	4.0	1.7
		Apr.	7.9	1.35	0.60	1.60	10.0	6.0	1.6
		May.	8.0	1.60	0.80	2.80	16.0	8.0	1.8
2)	2.00	Dec.	7.4	0.93	0.92	2.65	9.0	1.7	1.8
		Jan.	7.3	0.98	1.00	2.85	10.0	1.8	2.0
		Feb.	7.5	1.02	0.86	2.10	12.0	4.0	2.0
		Mar.	7.7	1.07	0.65	1.20	16.0	4.0	2.1
		Apr.	7.6	1.63	0.80	1.40	17.0	4.0	1.9
		May	7.8	2.34	1.10	2.70	18.-0	6.0	2.2
3)	3.00	Dec.	7.4	8.20	6.50	18.00	170.0	1.7	2.1
		Jan.	7.3	9.10	7.40	20.00	180.0	1.8	2.3
		Feb.	7.7	9.88	7.40	30.00	222.0	6.0	2.4
		Mar.	7.4	13.72	9.00	36.60	282.0	6.0	2.2
		Apr.	7.6	16.64	10.00	62.00	406.0	6.0	2.5
		May	7.3	34.84	11.90	125.0	776.0	9.8	2.9

Table 3. *Species suitable for culture in surface dugout pond*

Species	Culture duration (month)	Weight range (kg)	Yield kg/ha
Sea bass (*Lates calcarifer*)	8-9	0.5-0.7	500-700
Tilapia (*O.mossambicus*)	8-9	0.1 to 0.2	300-500
Indian Major carp + *Cyprinus carpio* + Grass carp	8-9	0.5 to 1.5	1000-1200
IMC + sea bass + Tilapia	8-9	0.5 to 1.5	1200-1500
Freshwater prawn (*M. rosenbergii*)	8-9	50-60 gm	600-1000
Brackish water prawn (*P. monodon*)	5-6	40-48	400-520
Nursery rearing of IMC seed	1	0.327 gm	50-60% survival
Nursary rearing of C. *carpio*	1	0.407 gm	40-50% survival

out since the last 15 years. Sea bass (*Lates calcarifer*) culture is fairly wide spread in the coastal area of the Raigad and Thane districts, and thus ranks second after Indian Major Carps. When tilapia was used as forage fish growth, a range from 450-700 g in eight months was observed in case of sea bass. Under the combination of sea bass, Indian major carps and tilapia, the production was in the average range of 1200 – 1500 kg ha^{-1} in seven months culture period. (Shingare *et al.*, 2002).

With the technique of phased fertilization, the fresh water prawn *M. rosenbergii* grew to an average weight of 50 g in 8-9 months, while the tiger prawn, *P. monodon* grew to weight range of 42 to 48 g in 5-6 months (Shirgur *et al.*, 1986).

The results revealed that there is a vast potential for the culture of above fish and prawn species in the surface dugout ponds.

If nursery ponds are constructed near the area of surface dugout ponds, it is possible to take the nursery rearing of Indian Major Carp and *C. Carpio* during rainy season with survival percentage of 50 to 60.

Many trials of different varieties of fishes and prawn were undertaken in surface dugout pond at Panvel locations (Table 3).

REFERENCES

Anon. (1990). Report, *Present Status of Khar Land Development*, Government of Maharashtra.

Anon. (1992). *Coastal Saline Soils of Maharashtra.* Research Bulletin **5**, Konkan Krishi Vidyapeeth, Dapoli.

Chavan, K.N., Patil, S.P. and Kadrekar, S.B. (1985). Leaching and recharging of salts in coastal saline soils of Pargaon (Panvel). *Journal of Indian Society of Coastal Agricultural Research* **3**(2): 71-76.

Mehta, V.B. (1991). Seasonal fluctuations in level and salinity of ground water in coastal salt affected soils of Maharashtra. *Journal of Maharashtra Agricultural University* **16**(1): 99.

Sahu, R.K., Chavan, K.N. and Kadrekar, S.B. (1981). Some hydrological observations of coastal saline soils of Konkan. Proceedings 2nd Conference *Problems and Management of Coastal Saline Soils*, pp. 199-207, held at Bombay. C.S.S.R.I. Canning Town (W.B.).

Sahu, R.K., Chavan, K.N. and Kadrekar, S.B. (1982). Ground water characteristics of coastal saline soils of Maharashtra. *Current Agriculture* **6**(3-4): 1-4.

Shingare, P.E., Shirgur, G.A., Singh, R.K. and Mehta, V.B. (2002), Assessement of polyculture trial of Giant Freshwater prawn (*M. rosenbergii*) with Tilapia (*O. mossambicus*) and carp in the pons of Aquafarmer of Raigad district (MS). Proceedings 2nd Congress *Indian Fishery Science*, held at Bhopal, 23-25 Oct, 2002.

Shirgur, G.A., Singh, R.K. and Chavan, J.B. (1986). On the prospects of pond production of seed of *M. rosenbergii* and culture trials besides *P. monodon* and carps common phased fertilization. Proceedings National Seminar *Perspective in Hydrobiology*, pp.69-74, held at Ujjain, 8-10 Feb, 1986.

J. Indian Soc. Coastal agric. Res., 24(2), 258-260, 2006

Studies on Growth and Survival of *Cyprinus carpio* Fry upto Advanced Fingerlings in the Rainfed Ponds

P. E. SHINGARE[1], N. H. SAWANT[2], B. P. BHOSALE[3] and S. G. BELSARE[2]

Agricultural Research Station, Dr. B.S. Konkan Agricultural University, Mulde
Dist. Sindhudurg – 416 520, Maharashtra

Among the three varieties of exotic carps *Cyprinus carpio* var communis is in great demand and farmers prefer it for paddy-cum-fish culture, both monoculture and composite, in ponds. A few trials on seed rearing under different agroclimatic conditions were undertaken in north Konkan zone. Experiment was undertaken on rearing of *Cyprinus carpio* seed upto advanced fingerling size to assess the growth and survival using inexpensive artificial feed and fertilizer under rainfed conditions. The experiment was conducted at Agricultural Research Station, Mulde in small rainfed ponds measuring 200m² area by stocking the advanced fry at the rate of 10 lakh per ha against the normal rate of 5 lakh per ha for rainfed ponds. After rearing the fry for 30 days, the advanced fingerlings measuring 60 to 90 mm and 4.20 to 12.24 g were harvested. The conversion ratio of fish biomass to feed (FCR) varied from 1: 1.20 to 1: 1.56. The survival percentage varied from 77.92 to 84.20 %. The seeds were able to withstand water pH as low as 6.5. About 84 % of large size fingerlings with mean total length of 78.8 mm were obtained. The results indicated that there was even growth of large size fingerlings with better survival percentage under application of inexpensive artificial feed and fertilizers. It was further concluded that size obtained under this study was suitable for paddy-cum-fish culture.

(***Key words:*** *Fingerlings, Growth & survival, Supplementary feed, Soil & water properties)*

The preliminary studies on fry to fingerling rearing using live feed and artificial feed have been made by several research workers (Charlon and Bergot, 1984, Dabrowski *et al.*, 1978, Jeychandran and Raj, 1976, 1977, Lakshaman, 1966, Szlaminska and Przybyl, 1986). In Maharashtra, few trials were undertaken in laboratory and field to standardize the technique of spawn to fry and fry to fingerling rearing by using variable techniques of feeding in Nortth Konkan zone (Shirgur, 1986, Shirgur and Shingare, 1989, Shirgur *et al.*, 1988). However, no such trials were conducted in Shindhudurg distict. This district has laterite type of soil with high percolation rate, low moisture holding capacity, low fertility and acidic soil pH. Due to stocking of undersized seed, growth and survival were very poor in the ponds. To increase survival percentage and production of fish in small and medium irrigation tanks, it was necessary to stock good number of advanced fingerlings.

However, there was confusion regarding optimum size of fingerlings to be stocked in reservoirs. All these measures were taken in order to reduce the mortality and to enhance fish production. This zone receives around 3000-3500 mm rains during monsoon. Hence there is a scope to develop inland fisheries to enhance fish production. However, a fish seed farm has not been well established in this district. The seed is transported from nearby districts.

The main objective of the experiment was to assess the growth and survival by rearing upto advanced fingerling stage using natural live feed and artificial feed in rainfed ponds results of which are discussed herein.

MATERIALS AND METHODS

The experiment was conducted in small earthen ponds measuring 200 m² area each by stocking the advanced fry @ 10 lakh per ha for 30 days besides normal stocking rate of 5 lakhs per ha (Shirgur and Shingare, 1989). The commonly available and inexpensive feed and fertilizer were provided for day-to-day metabolic activities and enhancing zooplankton biomass (Rao et al., 1987, Shirgur, 1986). The facilities of areation and water exchange were not provided. The initial length weight, biomass of seed, number stocked etc were recorded. The raw cattle dung, urea and single superphosphate were applied at the rate of 3000 kg, 50 kg and 50 kg per

[1]Present address: Kharland Research Station, Panvel, Raigad – 410 206, Maharashtra
[2]Present address: College of Fisheries, Shirgaon, Ratnagiri- 415 629, Maharashtra.
[3] Present address: Marine Biological Research Station, Pethkilla, Ratnagiri- 415 612, Maharashtra

ha respectively. The artificial feed with ingredients, viz. soyafloor, rice bran and wheat floor were applied in pelleted form @ 5% body weight (composition: protein-38.7%, fat-12.6%, ash-10.8% and moisture-8.6%) to the three ponds at the rate of 2700 kg, 2650 kg and 3000 kg per ha, respectively. After rearing for 30 days, the advanced fingerlings of size 60 to 92 mm and 4.20 to 12.24 g were harvested. Sampling for growth from all the three ponds was done by using drag net. The data regarding final length-weight, percentage of survival, numbers harvested, food conversion ratio, etc. were recorded at the end of experiment.

The daily observations on pH, dissolved oxygen and temperature were recorded by adopting standard procedure to monitor water quality (Strickland and Parson, 1972, APHA, 1985).

RESULTS AND DISCUSSION

After 30 days of rearing of fry their growth in pond No.1, 2 and 3 was in the range of 60 to 90 mm (4.20–11.15 g), 65 to 90 mm (5.24–12.04 g) and 60 to 92 mm (5.24–11.24 g), respectively (Table 1). The survival percentage in three ponds was 79.67%, 84.20% and 77.92% respectively. The final total biomass of seed in these ponds was in the range of 108.246 kg to 128.648 kg (Table 1). Under low input of organic and inorganic substances, the feed conversion ratio was in the range of 1: 1.34 to 1: 1.74.

It was important that the seeds were able to withstand water pH as low as 6.5. The length-weight-wise growth rate and progressive percentage increase were minimum during second fortnight in all the ponds. The weight-wise growth of seed after 30 days was 500% more than the initial weight. After 30 days rearing period, the percentage of large size 75 to 92 mm with mean size of 78.8 mm was 60% in pond 1, 72% in pond 2 and 84% in pond 3 (Table 1). It revealed that maximum number of large sized fingerlings in the range of 75-92 mm with mean total length of 78.8 mm was obtained.

Considerable studies have been made regarding fry to fingerling rearing by the earlier workers using natural and artificial feed (Charlon and Bergot, 1984, Dabrowski *et al.*,1978, Jeyachandran and Raj, 1976, 1977, Lakshmanan, 1966, Szlaminska and Przybyl, 1986). A preliminary study on rearing of carp fingerlings was also done to achieve better survival and quality seed (Lashamanan, 1968, Randhir *et al.*, 1988, Singh, 1988, Tripathi and Khan, 1988). Comparative work considering the digestive physiology during fry to adult stages (Ranade and Kewalramani, 1986) has indicated that carps showed high rate of proteolytic enzyme activities in their guts indicating thereby necessity of rich proteinaceous diet during fry to fingerling phase. Keshvappa and Devraj (1990) also reported the possibility of using deoiled silk worm pupa and

Table 1. *Details of experiments in different ponds at Agricultural Research Station, Mulde, Dist. Sindhudurg*

Particular	Pond 1	Pond 2	Pond 3
Initial length range and average (mm)	42 - 63	42 - 64	40 - 62
	(49.7)	(49.4)	(49.8)
	± 0.12	± 0.13	± 0.13
Initial weight range and average (g)	1.0 - 4.58	1.04 - 4.24	1.02 - 4.26
	(2.07)	(1.97)	(1.92)
	± 0.20	± 0.18	± 0.19
Numbers stocked @ 10 lakh / ha	20000	20000	20000
Initial biomass of seed (kg)	41.540	39.560	38.540
Final length range and average (mm)	60 - 90	65 - 90	60 - 92
	(74.2)	(76.7)	(76.4)
	± 0.21	± 0.20	± 0.19
Final weight range and average (g)	4.20 - 11.15	5.24 - 12.04	5.24 -11.24
	(6.79)	(7.64)	(7.29)
	± 0.23	± 0.21	± 0.20
Number harvested	15935	16839	15583
Percentage survival	79.67	84.20	77.92
Total biomass of seed (kg)	108.246	128.684	113.740
Percentage of large size seed (75 - 92 mm)	60	72	84

earthworm meal as alternative protein source in the diet of carp fry.

It was observed from the results and work done by earlier scientist that under stocking density of 10 lakh fry per ha, the growth (length and weight) and survival percentage was better in all the three ponds. The size recorded was suitable for stocking the medium and large irrigation tanks. Further it was recorded that optimum growth upto advanced fingerling size was possible in rainfed ponds by applying inexpensive supplementary feed and fertilizers. There was even growth of large sized fingerlings (75–92 mm) which was very essential for stocking in the reservoirs to raise the overall growth and survival percentage. The studies reported have given very useful information regarding rearing of seed upto advanced fingerling size in the soil having low fertility and acidic nature (pH 6.5) under rainfed condition.

REFERENCES

APHA (1985). *Standard Methods for the Examination of Water and Wastewater*, 16th Edn., American Public Health Association, Washington, D. C. 1134p.

Charlon, N. and Bergot, P. (1984). Rearing system for feeding fish larvae on dry diets, trial with carp (*Cyprinus carpio* L.). *Journal of Inland Fishery Society of India* **XV**: 24-28.

Dabrowski, K., Dabrowski, H. and Grudniewski, Cz. (1978). A study of the feeding of common carp larvae with artificial food. *Aquaculture* **13**: 57-64.

Jeyachandran and Raj Samuel Paul (1976). Experiments with artificial feed on *Cyprinus carpio* fingerlings. *Journal of Inland Fishery Society of India* **VIII**.

Jeyachandran and Raj Samuel Paul (1977). Formulation of pelleted feeds and feeding trials with comon carp. *Journal of Inland Fishery Society of India* **IX**: 42- 52.

Keshavappa, G.Y. and Devaraj, K.V. (1990). Evaluation of three animal meals as protein source in the diet of common carp fry. Proceedings *Second Indian Fisheries Forum*, pp.1-3, 27-31 May, 1990.

Lakshmanan, M.A.V. (1966). Study on new artificial feed for carp fry. *FAO Fish Report* **44**(3): 373-387.

Lakshmanan, M.A.V. (1968). Preliminary study on the rearing of carp fingerlings. *Indian Journal of Fishery* **15**(1&2): 40-52.

Ranade, S.S. and Kewalramani, H.G. (1966). Studies on the rate of food passage in the intestine of carps. *FAO Fish Report* **44**(3): III/E - 2.

Randhir, M., Gupta, S.D. and Reddy, P.V.G.K. (1988). Economics of carp seed production. Proceedings National Workshop *Carp Seed Production Technology*, pp. 63, held at Eluru.

Rao Prabhakar, Radhakrishna, G.Y. and Rao Sambasiva (1987). Plankton productivity in fish nurseries with different fertilizers. Proceedings National Seminar *Freshwater Aquaculture in India*, pp. 54, held at Nagarjunagar.

Roop Singh, T.K. (1988). In *Status of Fish Seed Production in Andhra Pradesh*, pp. 34-37.

Shirgur, G.A. (1986). A note as further revised schedule of phased manuring in fish nurseries. *Fishery Bulletin* **IX**(1): 77-78.

Shirgur, G.A., Shingare, P.E. and Vipradas, K.C. (1988). On optimum rearing of common carp (*Cyprinus carpo*) fry into fingerlings. Proceedings National Symposium *Aquaculture Production*, 18-19 Nov, 1988.

Shirgur, G.A. and Shingare, P.E. (1989). On optimum culture parameters for rearing the fingerlings of major carps from fry stage. *Fishery Bulletin* **XIII** (2).

Strickland, J.D.H. and Parsons, T.R. (1972). *A Practical Handbook of Seawater Analysis*. Fisheries Research Board of Canada, Ottawa, Bulletin **167**, 2nd Edn.

Szlaminska, M. and Przybyl, A. (1986). Feeding of carp (*Cyprinus carpio*) larvae with an artificial dry food, living zooplankton and mixed food. *Aquaculture* **54**(1&2): 77-82.

Tripathi, S.D. and Khan, H.A. (1988). Carp seed production technology. Proceedings National Workshop *Carp Seed Production Technology*, pp. 8-9, held at Eluru.

J. Indian Soc. Coastal agric. Res., 24(2), 261-263, 2006

Fish Fauna of Pawashi Irrigation Tank in Sindhudurg, Maharashtra - A Case Study

B. P. BHOSALE[1], P. E. SHINGARE[2], N. H. SAWANT[3] and S.G. BELSARE[1]

[1]Marine Biological Research Station, Pethkilla, Ratnagiri – 415 612, Maharashtra

[2]Kharland Research Station, Panvel, Raigad – 410 206, Maharashtra

and

[3]College of Fisheries, Shirgaon, Ratnagiri – 415 629, Maharashtra

Sindhudurg district of South Maharashtra is characterised by thick laterite soil, heavy rainfall of an average of 3000-3500 mm, high humidity, ample sunshine and numerous water resources including the ones like perennial water tanks, viz. Pawashi minor irrigation tank. The fish fauna of this tank includes introduced Indian major carps, several varieties of commercially important fishes like Tilapia, Etroplus, Magur, Ompak, Channa and other fishes like Puntius, Danio, *Labeo kawrus*, Gagata, Monopterus, Ambasis, Chiramenu, Garra, glassogobius, Crab (*Metopegograpsus* spp.) and gait freshwater prawn (*Macrobrachium rosenbergii* spp.). In order to utilize the available fish fauna of Pawashi irrigation tank of Sindhudurg region for better economic returns, the following technologies could be made use of for developing location-specific packages and their subsequent transfer to the actual users. These are: (1) optimum utilization of tanks of the region through stocking of advanced fingerlings for culture of carps, (2) commercial harvesting the fish fauna from the reservoir or tanks at the right time, i.e. immediately after or during the first rain shower in monsoon by using the nylon gill net, (3) scientific management and fishery enhancement programs to increase the average fish production, (4) adoption of pen and cage culture techniques of aquaculture for effective utilization of water bodies of the region, and (5) utilization of other available freshwater aquaculture technologies such as freshwater prawn farming, pearl culture, etc.

***(Key words:** Reservoir, Irrigation tank, Fish fauna)*

Maharashtra is having 1,19,515 ha small, 39181 ha large and 1,15054 ha medium reservoir area (Sagunan, 1995). Pawashi tank in Sindhudurg district of Maharashtra comes under the category of small irrigation tank. The study of fish fauna of Pawashi minor irrigation tank was undertaken during 1992 to 1998 to assess the percentage contribution of fish fauna and their commercial significance in this region which has been discussed in this paper.

MATERIALS AND METHODS

Pawashi minor irrigation tank constructed on Bell river (local nala) of Pawashi village near Mumbai - Goa highway and geographically situated on longitude 70°-42′ and longitude 16°-2′. Total water spread area of tank is 10.49 km^2 and maximum depth of water is 27 metre. The catchment area of the tank basin recieves on an average annual rainfall 75 % of which occurs during south-west monsoon. Earthen *bund* of length 435 m, top width of 4 m and maximum height of 17.5 meter was constructed on the lower side. Wasteweir of clear overfall type of length 55 m was constructed at the lower reaches of tank to control overflow of the excess water during heavy mansoon. However, one nylon net of one inch mesh size of length 65 x 6m acted as close barrier just 8-10 m behind of the wasteweir to avoid escape of fishes during excess water flow.

Different locations were selected in the tank area for collection of fish fauna in each netting operation. Gill net, caste and drag net of nylon and monofilament type were used for collection of fishes. One wooden *dingi* of 3.5 m x 1.5 m was used for netting operation. Fish catch and percentage contributions were estimated immediately. A part of the catch was preserved in the 5% formalin for identification.

RESULTS AND DISCUSSIONS

A large varieties of freshwater fishes were found in Pawashi minor irrigation tank in Sindhudurg district. The average fish production of this tank was estimated at 12.5 kg year^{-1} ha^{-1} during the study period. Fish representatives of 5 orders, 14 families, 24 genera and 28 species with two species of crustaceans were so far collected from the Pawashi tank. Commercially important species alone were included in this study. From this stand point, Indian major carps, namely catla (*Catla catla*), rohu (*Labeo*

rohita) and mrigal (*Cirrhinus mrigala*) were the introduced species and contributed as much as 60% of the catches. The exotic varieties of carps, viz. Silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngdon idella*) and common carp (*Cyprinus carpio*) became important components of species mix in composite fish culture operations in the area. However, these exotic carps enjoyed a subdued market status in the nearby region as compared to Indian major carps.

The air-breathing fishes such as magur (*Clarius batrachus*) and ompak (*Ompak bimaculatus*) are of special significance in this region as they have a high nutritive and therapeutic value. One species of murrel or snakehead (*Channa marulius*) was commonly encountered in this area which belonged to the category of air-breathing fishes and also attracted consumers. These fishes collectively contributed as much as 10 to 15% of the catch in Pawashi tank. The catch of Cichlid species, namely *Oreochromis mossambicus* and Etroplus (*Etroplus suratensis*) were also captured during fishing of Pawashi tank. Tilapia species and Etropus are of considerable commercial significance. These fishes collectively account for about 20% of fish landing in the Pawashi tank. The air breathing fishes, especially magur (*Clarius batrachus*), singhi (*Heteropneustes fossilis*) and kabai (*Anabas tetudineus*) are of special significance in that region. These fishes thrive in highly euthrophicated swampy and derelict waters of the district. Four species (*Channa marulius*, *C. striatus*, *C. punctatus* and *C. gachua*) were commonly encountered but they did not attract consumers as magur, singhi and kabai. Featherbacks (*Notopterus chitala* and *N. notopterus*) are also air breathing fishes. Of the two species,

Table 1. *Checklist of fish fauna of Pawashi irrigation tank*

Sr. No.	Scientific name	Local Marathi name
1	*Catla catla* (Hamilton – Buchanan)	Catla, Tanvar
2	*Cirrhinus mrigala* (Hamilton – Buchanan)	Mrigal, Mirya, Tamar
3	*Cyprinus carpio* (Linnaeus)	Tamar
4	*Labeo kawrus* (Sykes)	Tamar
5	*Labeo rohita (Hamilton – Buchanan)*	Rohu, Tambada masa, Tamar
6	*Puntius amphibius* (Valenciennes)	Bhondgi / Khavli
7	*Puntius narayani* (Hora)	Khawali
8	*Puntius sarana spilurues* (Gunther)	Khawali
9	*Puntius sarana subnasutus* (Valenciennes)	Khawali
10	*Hypophthalmichthys molitrix* (Valenciennes)	Chavada masa
11	*Garra gotyla gotyla* (Gray)	Shingcha,- mallya, Malva
12	*Danio malabaricus* (Jordon)	Danio
13	*Porluciosoma daniconius* (Hamilton – Buchanan)	Dandakai
14	*Ompak bimaculatus* (Bloch)	Mooni, Valatai
15	*Gagata gagata* (Hamilton – Buchan)	Shingati
16	*Clarius batrachus* (Linnaeus)	Thigur
17	Xenenthodon cancila *(Hamilton – Buchanan)*	Kutsa, Tikali, Tol
18	*Monopterus(Amplipnous) indicus* (Silas & Dawson)	Kodai
19	*Aplocheilus lineatus* (Voencienues)	Piku, Chandaka
20	Ambassis gymnocephalus *(Lacepede)*	-
21	*Etroplus suratensis* (Bloch)	Kalunder
22	*Oreochromis mossambica* (Peters)	Tilapia
23	*Chiramenu fluviatus* (Rao)	-
24	*Glassogobius biocellatus*	Kharchi
25	*Channa marulius* (Hamilton – Buchanan)	Murrel
26	*Mastacembalus armatus* (Lacepede)	Vam, Kadai
27	*Macrobrachium rosenbergii* (Deman)	Shivad
28	*Metopograpsus maculatus* (Milne - Edwards)	Khekada, Chimburi

however *N. chitala,* localy called bhunna is considerd as a delicacy and enjoy good consumer preference. These fishes collectivelly contributed nearly upto 15-20 to the market arrival of fishes in the area.

Other species of fishes include Puntius, Danio, *Labio kawrus*, Gagata, Monopterus, Ambasis, Chiramenu, Garra and Glassogobius, etc. Large species of tengra included *M. seenghala* alone. Ompak binaculatus, locally called banspatta is also a catfish of considerable commercial significance. These fishes collectively accounted for about 15 percentage of the fish landing in the area. Other species of fishes included suha (*Gadusia chapra*), gaincha (*Mastacembellus spp.*), mara, etc.

Macrobrachium rosenbergii (Gaint fresh water prawn) generally came into the cast net hauls with miscellaneous fishes in Pawashi tank, while one crab species of *Metopegograpsus maculatus* appeared in shallow water areas. Harrison *et al.* (1986) reported a low cost effective trap for use in sampling of aquatic fauna. Several varieties of small prawns and crabs found in Darbhanga district area were treated as a delicacy. Prawns, as by-catch, come into the cast net hauls of miscellaneous fishes from ponds, pools and ditches, while crabs appeared red in shallow water bodies, especially paddy fields. The details of fish fauna of Pawashi irrigation tank are given in Table 1.

REFERENCES

Harrison T.D., Ramm, A.E.L. and Cerff, E.C. (1986). A low cost effective trap for use in sampling aquatic fauna. *Journal of Aquaculture* **58**(1-2): 145-149.

J. Indian Soc. Coastal agric. Res., 24(2), 264-266, 2006

Studies on Effect of *Lactobacillus acidophilus*, a Feed Probiotic on Growth of Seed of *Labeo rohita*

P. E. SHINGARE, S. J. MISHRA, R. K. SINGH[1], J. H. DONGALE and S. S. DHANE

Khar Land Research Station, Dr. B.S. Konkan Krishi Vidyapeeth
Panvel – 410 206, Raigad, Maharashtra

The manipulation of feed could be done by using feed with probiotic or ingredient mix for better utilization of nutrient, which ultimately helps in improvement of growth, survival and resistance to diseases. The experiment was conducted in triplicate to observe the effect of *Lactobacillus acidophilus* on growth of seed of *L. rohita*. The seeds size range 2.49 (± 6.07) – 2.69 (± 6.58) cm was fed with five different dosages of *L. acidophilus* at the rate of 2, 4, 6, 8 and 10 g per kg of laboratory made feed and compared with the control, i.e. without probiotic. The water parameters recorded were in the favourable range. Out of five treatments, the dose at the rate of 6 g per kg has shown significantly highest growth. The growth was found lower for dose of 8 g per kg and 10 g per kg of feed.

***(Key words:** Feed probiotic, Seed growth & survival of L. rohita)*

Probiotics may be single or mixed cultures of selected strains of bacterial which have varied beneficial effects. The use of antibiotics and chemothera-peutants indiscriminately to overcome the disease problem in aquaculture may result in the accumulation of residues and development of resistant strains of bacteria. Therefore, the use of biological or probiotic feed additives is the only alternative. Now-a-days many commercial feed probiotics are available for livestock feed. However, the use of probiotics in aquaculture feed is under development and studies conducted have shown the vast scope in improving the growth of fishes and prawns by use of feed probiotics. The beneficial effects of probiotic microorganisms are well known in veterinary medicine and target species are domestic animals (Fuller, 9189, Sissions, 1989). Ghosh *et al.* (2002) noted the potential of bacterial flora for use as a probiotic.

MATERIALS AND METHODS

The experiment was conducted in laboratory at Khar Land Research Station, Panvel, District Raigar (Maharashtra). The plastic troughs of 30 litre capacity were used. The *Lactobacillus acidophilus* was used as feed probiotic. The doses of *L. acidophilus* were @ 2, 4, 6, 8 and 10 g per kg of feed. The control tank was without application of probiotics. The supplementary feed was given at the rate of 10% of body weight. Total 20 numbers of *Labeo rohita* fry were introduced with initial average weight of 218 g and length of 2.59 cm. The experiment was conducted for 60 days period in triplicate. The feed ingredient composition and proximate composition of feed on dry basis are given in the Table 1. The physicochemical parameters such as temperature, dissolved oxygen, free carbon dioxide, pH, total alkalinity and total hardness were estimated by using standard methods (APHA 1989) and presented in the Table 2. Formulated diet was analysed for proximate composition (AOAC, 1990).

RESULTS AND DISCUSSION

Results of present studies (Table 3) indicated that there was better growth in all five treatments, such as 2, 4, 6, 8 and 10 g of probiotic *L. acidophilus* per kg of feed over the control. However, the lengthwise (4.55 ± 0.01 cm) and weightwise (0.991 ± g) growth were significantly higher ($p<0.05$) in the treatment of 6 g feed probiotic per kg of feed compared to other treatments. The growth was lowest (3.76 ± 0.02 cm, 0.629 ± 3.68 g) in control (without probiotic). The growth was also found lower for dose of 8 g per kg (4.38 ± 0.01 cm, 0.892 ± 0.01 g) and 10 g per kg of feed (4.33 ± 0.015 cm, 0.866 ± 5.58 g).

[1]Present address: TMBRS, Mumbai

Table 1. *Experimental details and feed treatments with composition*

Experimental details

Plastic but volume	30 litres
Replication	Triplicate
Treatment	5 no.
Control	1 no.
No. of rohu fry in each tank	20
Probiotic used	*Lactobacillus acidophilus*
Dosages	2 g, 4 g, 6 g, 8 g & 10 g/kg

Feed treatments

Dose (g/kg)	Tub number
2	1, 2, 3
4	4, 5, 6
6	7, 8, 9
8	10, 11, 12
10	13, 14, 15
Control	16, 17, 18

Feed ingredients

Ingredients	% composition
Deoiled cake of groundnut	22.90
Wheat flour	31.28
Soyabean meal	22.91
Fish Meal	22.91
	100.00

Proximate composition of feed on dry weight basis

Component	Percentage
Crude protein	42.75
Crude lipid	6.79
Ash	8.92
Moisture	3.50
Dry matter	96.50
Carbohydrate	41.54

Feeding rate - 10% of body weight
Experimental period - Two months
Initial length weight details:
(a) Initial average length (cm) - 2.59
(b) Initial average weight (g) - 0.218

Table 2. *Physicochemical properties of water*

Parameter	Range
Temperature (°C)	26.5-28.5
Dissolved oxygen (ppm)	4.0-4.8
pH	7.52-7.98
Total alkalinity (mg/l)	130-155
Total hardness (mg/l)	25-45

The percentage gain in length and weight after 60 days in the treatment of 6 h feed probiotic per kg of feed was 186% and 77.3%, respectively, which were higher than any other treatments. The final lengthwise growth was increased considerably from 165 to 186% in the treatment of 2, 4, 6 g probiotic per kg of feed, while it was reduced from 178 to 116% in treatments of 8 and 10 g of probiotic per kg of feed and control. The same trend was observed in case of weightwise gain (Table 3).

The incorporation of probiotic in feed has long tradition in animal husbandry (Stavric and Komegay, 1995) but use in aquaculture is very rare. The stains of Bacillus sp. used in feed for terrestrial animals have telluric origins. They are not autochthonous in gastrointestinal tract but may be active during intestinal transit (Gaurnier-chateau *et al.*, 1994). The beneficial role of bacterial enzymes on fish growth have been discussed by Ghosh *et al.* (2001). The strain, *L. acidophilus* used in the present studies might have induced growth in rohu by producing essential nutrients not present in the formulated diet. Further, it might have improved digestion by supplying digestive enzymes to the fish. The effect of lactic acid bacterial in the feed on the growth and survival of fry of Atlantic cod (*Godus*

Table 3. *Growth and survival of rohu seed with different doses of probiotic*

Days	2 g/kg		4 g/kg		6 g/kg		8 g/kg		10 g/kg		Control	
	L	W	L	W	L	W	L	W	L	W	L	W
0	2.49 ±6.07	0.420 ±2.50	2.60 ±8.44	0.96 ±1.56	2.69 ±6.58	0.218 ±1.61	2.60 ±7.24	0.234 ±2.23	2.59 ±0.86	0.245 ±1.63	2.60 ±8.04	0.196 ±1.65
15	3.29 ±0.01	0.398 ±3.07	3.27 ±0.01	0.331 ±4.41	**3.53**[1] ±0.01	**0.605**[1] ±5.19	3.34 ±0.01	0.524 ±6.57	3.31 ±0.01	0.439 ±4.12	2.95 ±0.01	0.268 ±3.09
30	3.44 ±0.07	0.509 ±5.35	**3.95**[1] ±0.01	0.674 ±7.67	3.91 ±0.01	**0.709**[1] ±6.05	3.86 ±0.07	0.675 ±5.88	3.75 ±0.01	0.584 ±0.03	3.37 ±0.01	0.397 ±4.79
45	3.79 ±0.01	0.607 ±6.29	4.22 ±0.01	7.15 ±4.88	**4.32**[1] ±0.01	**0.865**[1] ±0.01	4.24 ±0.01	0.780 ±9.19	4.03 ±0.01	0.711 ±4.81	3.61 ±0.01	0.530 ±3.87
60	4.14 ±0.01	0.686 ±6.33	4.31 ±0.01	0.802 ±5.38	**4.55**[1] ±0.01	**0.991**[1] ±0.01	4.38 ±0.01	0.892 ±0.01	4.31 ±0.01	0.866 ±5.58	3.76 ±0.01	0.629 ±3.68
% gain	165	46.6	171	60.6	186	77.3	178	65.8	172	62.1	116	43.3
Survival[1]	100	100	100	100	100	100	100	100	100	100	100	100

[1] Survival at 5% level of significance; L, length (cm); W, weight (g)

morhua) has been studied by Gildberg *et al.* (1977). Sharma and Kumar (1998) showed the positive impact of microbial population on the growth of *Cirrhinus mrigala*. Mohanty *et al.* (1996) observed better efficiency in growth and survival of *Labeo rohita* spwan, when treated with bacterial concentrative, vitamin C and minerals.

Thus, the present study showed that *Lactobacillus acidophilus* bacterial may be used as a supplement in formulated diet for *Labo rohita* seed for better utilization of nutrients.

REFERENCES

AOAC (1990). In *Association of Official Analytical Chemists (AOAC)*, 15th Edn, Vol. 1, W. Horwitz (ed.), Official Analytical Chemists, Washington.

APHA (1989). *Standard Methods for the Examination of Water* and Waste Water. American Public Health Association, 17th Edn, Washington, D.C.1452p.

Fuller, R. (1989). Probiotics in Mean and Animals. *Journal of Applied Bacteriology* **66**: 365-378.

Ghosh, K., Chakraberty, K., Sen, S.K. and Ray, A.K. (2001). Effects of thermostable bacterial 2 - amylase on growth and feed utilization in rohu, *Labeo rohita* (Hamilton), fingerlings. *Israeli Journal of Aquaculture Bamidgeh* **53**(3-4): 101-109.

Ghosh, K., Sen, S.K. and Ray, A.K. (2002). A characterization of bacilli isolated from gut of rohu, *Labeo rohita*, fingerlings and its significance in digestics. *Journal of Applied Aquaculture* **12**(3): 33-42.

Gildeberg, A., Mikkelsen, H., Sandaker, E and Ringo, E. (1977). Probiotic effect of tolactic acid bacteria in the feed as growth and survival of fry of Atlantic cad (*Godus morhua*). *Hydrobiologia* **352**: 279-285.

Gournier-Chateau, N. Larpent, J.P., Castellanes, I. and Larpent, J.L. (1994). In *Les probiotiques on Alimentation Animale et Humaine Technique at Documentation Layoisier*, Paris. 192p.

Mohanty, S.N., Swain, S.K. and Tripathi, S.D. (1996). Rearing of catla (*Catla catla* Ham.). spawn on formulated diet. *Journal of Aquaculture Tropics* **11**: 253-258.

Sharma, O.P. and Kumar, A. (1998). Growth of fingerlings of *Cirhinus mrigala* (Ham.) in waters fertilized with fishmin. *Fishing Chimes* **18**(5): 15-16.

Sissons, J.W. (1989). Potential of probiotic organisms to prevent diarrhea and promote digestion in farm animals: A review. *Journal of Science &. Food Agriculture* **49**: 1-13.

Stavric and Komegay, T. (1995). In *Microbial Probiotics for Pigs and Poultry*, pp. 205-231.

J. Indian Soc. Coastal agric. Res., 24(2), 267-268, 2006

Studies on Effect of Different Levels of Protein on the Absorption Efficiency in *Heteropenestus Fossils*

S. J. MESHRAM, P. E. SHINGARE, R. K. SINGH, J. H. DONAGLE and S. S. DHANE

Khar Land Research Station, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli
Panvel, Dist. Raigad – 410 206, Maharashtra

Being air breathing fish the *Heteropnestus fossils* is cultured in some village ponds in traditional way. However, there is not much attention paid on artificial feed containing fish meal which is the main protein source and should be cost effective. Concentration of dietary ingredients has an important effect on absorption efficiency. The experiment was conducted in laboratory for 30 days to study the absorption efficiency of *H. fossils* at different protein levels in the diet. The fishes were fed with four different protein levels, such as 20%, 30%, 40% and 50%. The results showed that absorption efficiency of *H. fossils* is associated with increase in the protein concentration. It was significantly highest (89.89+0.08%) at the protein level of 40% followed by 87.40% (+0.29) at 30% protein level and 86.71% (0.02%) at 50% protein level. It was lowest (84.63+0.39%) at 20% protein level in the diet.

(***Key words:*** Heteropenestus *fossils, Protein absorption efficiency)*

The culture of *H. fossils* can be possible in derelict and sewage water. Some of the village ponds with high vegetation grow this fish in their ponds in traditional way. Not much work has been done on the artificial feed in relation to *H. fossils*. For artificial feed fish meal is a main protein source which is cost effective. Therefore in order to prepare economical based feed it should have good absorption efficiency.

Absorption is a useful measure of metabolism and growth because it indicates the energy potentially available from energy consumed. Therefore the present experiment was conducted to know the protein absorption efficiency in *H. fossils*, which is a measure of metabolism and growth.

MATERIALS AND METHODS

The experiment was conducted in laboratory of Khar Land Research Station, Panvel in 60 x 30 x 30 cm glass aquaria for one month. The seeds were collected naturally from the village ponds. After collection it was acclimatized to laboratory conditions before using for experimental purpose. Four artificial feeds having protein percentages of 20, 30, 40 and 50% were prepared. Experimental fishes were slowly acclimatized to artificial feed and thereafter fed completely on artificial feed during experimental period. Tanks were siphoned out to collect the feaces and then nitrogen was estimated. Proximate composition was done on dry weight basis following standard methods.

RESULTS AND DISCUSSION

Feed consumptions of experimental fishes during experimental period are shown in Table 1. The average length was found to be 8.94± cm. From the data it is clear that fishes fed with protein rich diet of 39.02% showed significant absorption

Table 1. *Composition of different feed ingredients (on dry weight basis)*

Feed ingredients	Protein %			
	20	30	40	50
Fish meal (g)	15	30	45	60
Starch(g)	62	47	32	17
Chromic oxide (g)	01	01	01	01
Gelatin (g)	10	10	10	10
Cod liver oil (g)	9	09	09	09
Vitamin (g)	3	03	03	03
Crude protein (%)	18.98	29.39	39.02	48.92
Carbohydrate (%)	68.78	54.10	36.52	24.18

Table 2. *Consumption and absorption of protein by* H. fossils *fed with different feeds*

Percentage of protein in feed (%)	Protein in diet (%)	Weight of fish (g)	Food consumed (g)	Nitrogen consumed as protein (g)	Nitrogen in feaces as protein (g)	Nitrogen absorbed as protein (g)	Absorption efficiency (%)
20	18.98	15.79	100.86	19.14	2.93	16.20	84.63
		±0.35	±0.18	±0.12	±0.01	±0.05	±0.39
30	29.39	15.61	105.95	31.13	3.92	27.21	87.40
		±0.34	±0.20	±0.03	±0.01	±0.03	±0.29
40	39.02	15.27	104.04	49.59	4.10	36.49	89.89*
		±0.31	±0.23	±0.02	±0.03	±0.03	±0.18
50	48.92	15.20	102.95	50.36	6.69	43.67	86.71
		±0.36	±0.28	±0.02	±0.01	±0.04	±0.02

* Significant at p=0.05

efficiency as compared to (Table 2) those recorded under 20% protein level (84.63%) and 30% protein level (87.40%). Muros *et al.* (2003) studied the effect of feeding pattern of *Sparus aurata* and observed better efficiency with experimental diets containing 45% protein level. Madrid (1994) reported that the same diet offered at different times of the day is assimilated differently.

CONCLUSION

The absorption efficiency of *H. fossils* is associated with the increase in the protein concentration upto 39.02%, beyond which the protein efficiency falls significantly.

REFERENCES

Madrid, J.A. (1994). Effect of demand feeding on protein assimilation. *Aqua Review*: 52-53.

Muros, M.J., Corchete, V., Suarez, M.D., Cardenete, G., Gomez-Milan, E. and Higuera, M. De la (2003). Effect of feeding method and protein source on *Sparus aurata* feeding pattern. *Aquaculture* **224**: 89-103.

J. Indian Soc. Coastal agric. Res., 24(2), 269-271, 2006

Identification and Assessment of Nutrient Availability in Backyard System of Poultry Farming

S. K. SAHOO, B. K. PANDA, S. C. GIRI and M. K. PADHI

Regional Centre, Central Avian Research Institute
Jokalundi, (in front of Kalinga Studio), Bhubaneswar – 751 003, Orissa

A study was conducted to study the system of rearing poultry in backyard, type of feed ingredients available, feeding pattern of birds, crop contents and blood biological value of field birds. For this study 30 farmers from three villages were taken. It was revealed that in backyard sector most of the care and management of poultry birds were taken by women members of the family. The people have special preference towards colour birds. The average flock size was 5-10 birds per family. On analysis of crop contents it was revealed that they were deficient in protein and energy. A wide variation was observed in both physical and chemical composition of the crop contents. Normal values were observed in SGOT, SGPT, total cholesterol, calcium and phosphorous besides higher value of glucose.

(***Key words:*** *Backyard poultry, Nutrient availability, Crop contents*)

The poultry sector in India mainly consists of two components, i.e. commercial and backyard poultry. Commercial poultry sectors mostly depend upon pure exotic lines, whereas the backyard sector mostly consists of different indigenous varieties of chickens. The rural people practised backyard poultry farming from time immemorial. Recently more emphasis has been given towards backyard poultry farming as a means of nutritional security to rural people through organic farming. The farmers usually rear the birds by allowing them to scavenge in the field with little or no supplementation. The birds grow by taking the feed materials available to them, which varies from season to season, place to place, and also the number of birds reared in the specific area at a point of time. The feed materials available in the scavenging system are limited with low in quality. The scavenging feed resource base can be assessed by examining the feed in the crop at different times, of day to determine how much is household waste, how much is from supplementary feed, and how much is from the environment (Roberts and Gunaratne, 1992, Roberts, 1995).

The population of backyard chicks in village grows till the scavenging feed resource base is exhausted. The low crude protein in the scavenging feed is inadequate for chicks and growers. Mostly the weaker chicks and growers die of starvation where there is competition for scavenging feed. Growth and survival rate of the chicks usually improve if they are provided with preferential access to household waste supplemented with protein. Supplementation of small quantity of animal protein improve the growth and production of such birds because it provides essential amino acids (Roberts *et al.*,1994). Farmers who take little care of their birds with little supplementation of available feed ingredients find better performance than those who rear in the free range system without any supplementation. Horst (1991) reported 12-20% increased hen day production with better plane of nutrition. Cresswell and Gunawan (1982) reported 40% increased egg production when Indonesian village birds were provided with excellent nutrition in pens. Rangnekar and Rangnekar (1996) have reported that there was a need for critical study on nutritional status of backyard poultry.

MATERIALS AND METHODS

Three villages in the vicinity of the Bhubaneswar city were selected for this experiment. A total of 30 respondents were selected for this study to survey the pattern of keeping poultry birds, number of birds per family, type of birds, feed ingredients available and feeding pattern of the birds. Observing the birds while scavenging identified the feed ingredients consumed by the birds from the environment by preference. The feed samples were collected from the farmer's house and also from the environment. The blood samples were collected from the field birds to study different blood parameters in the serum samples. The blood parameters like Serum Glutamate Oxaloacetate Transaminase (SGOT) and Serum Glutamate Pyruvet Transaminase (SGPT), glucose, total protein, total cholesterol, calcium (Ca) and Phosphorus (P) were determined by using

standard diagnostic kit manufactured by Bayer Diagnostic India Ltd., Baroda-390 019, Gujarat. Three birds from each village were sacrificed to study the crop contents in the evening before housing the birds. The crop contents were examined physically to identify the individual feed ingredients consumed by the birds. The pulverized feed samples collected from the field and the crop contents were analyzed for the proximate principles like Dry Matter (DM), Organic Matter (OM), Crude Protein (CP), Crude Fibre (CF) and Ether Extract (EE) as per AOAC (1990) and Gross Energy (GE) content by 1425 Oxygen Bomb Semi-micro Calorimeter (Parr Scientific Equipments). Data collected during the investigation were subjected to statistical analysis as per Snedecor and Cochran (1989).

RESULTS AND DISCUSSIONS

The results of survey conducted in the villages about the status of backyard poultry are given in Table 1. It was revealed that the backyard poultry production system was practised in the rural areas by most of the farm families below poverty line with a small number of stocks ranging from 5-10 birds per family. The farmers have special preference for dual purpose colour birds, which fetched a moderate return in terms of meat and egg. The female and children in the families looked after the poultry flocks as the male members usually went out for fieldwork. The birds were allowed to graze in the nearby areas with a constant watch on them to save them from theft or predators. Occasionally the birds were called with a typical voice and feed ingredients available with them. By this way they nourish the birds and also keep constant watch on them. It was also observed that the kitchen waste is gathered in a pot and placed in a particular place so that the birds can easily take it.

The feed ingredients identified in the crop contents are given in Table 2. From this table it was revealed that along with various feed ingredients, the birds consumed several non-feed ingredients like stone, sand, hair, rubber tubes, etc. The composition of crop contents is given in Table 3. A wide variation in composition of crop contents was observed among the birds. The average CP content was 9.94±0.66%, which falls between 7.6–11.8% as reported by Gunaratne *et al.* (1993). The GE value of the crop contents were lower which might have been due to higher levels of ash in crop contents. The blood parameters like SGOT, SGPT, Glucose, Total

Table 1. *Survey of farm families rearing poultry birds in backyard system*

Particular	Observation
Status of farmers	Small, marginal and landless labourer
Category	SC / ST, Muslims
No. of birds per family	5-10
System of rearing	Semi-intensive
Type of birds	*Deshi*, sometimes improved varieties
Members of family looking after birds	Mostly women

Table 2. *Feedstuff identified from the crop contents of scavenging chickens*

Particular	Ingredient
Cereals	Paddy, wheat
Legumes	Black gram, green gram, arhar
Byproducts	Rice polish, wheat bran, suji
Kitchen waste	Boiled rice, vegetable coverings, fish scale and bones, left over food materials, Bread pieces
Insects	Red and black ant, millipodes, maggots, bittle worms, larvae
Metazoans	Earth worms, snail, oyster
Green vegetations	Tender parts of different grasses, herbs, weeds
Inert substances	Stones, sand, rubber tube, hair

Table 3. *Composition of crop contents of scavenging chickens*

Particular	Average Value	Range
DM %	35.42±2.38	25.76 - 45.95
OM %	75.56±4.65	57.63 - 95.04
CP %	9.94±0.66	8.67 - 13.86
CF %	5.46±0.61	3.98 - 6.92
EE %	1.72±0.33	0.39 - 3.06
Total Ash %	24.44±4.65	4.96 - 42.37
Acid Insoluble Ash %	20.14±4.99	3.67 - 30.37
GE (k cal /g)	3389.87±244.45	2679.89- 4201.89

Table 4. *Different blood parameters of the birds in the backyard system*

Particular	Average Value	Range
SGOT (*u*/L)	160.66±4.48	142.99 - 174.52
SGPT (*u*/L)	15.89±0.94	13.32 - 19.96
Protein (g/dl)	4.10±0.32	3.13 - 5.58
Glucose (mg/dl)	240.16±6.40	231.37 - 252.94
Cholesterol (mg/dl)	318.27±17.37	233.72 - 370.93
Calcium (mg/dl)	7.97±0.75	5.13 - 10.88
Phosphorus (mg/dl)	2.01±0.25	1.75 - 2.95

Cholesterol, Ca & P determined in the blood of field birds were well within the normal value as reported by Kaneko *et al.* (1997), except the serum glucose level which was higher than the normal value (Table 4). This might have been due to variable period of collection, as the bloods were collected in the evening and by that time the crop was filled with feed materials. These normal blood values indicate that the birds consumed sufficient nutrients from the backyard.

It was concluded that further study is required to assess the production potential of dual purpose birds in the backyard system of rearing.

REFERENCES

AOAC (1990). *Official Method of Analysis*, 15th Edn, Association of Official Analytical Chemists, Washington D.C.

Cresswell, D.C. and Gunawan, B. (1982). *Indigenous Chicken in Indonesia: Production and Characteristics in an Improved Environment*, Report No. **2**: 9-14, Research Institute for Animal Production , Bogor, Indonesia.

Gunaratne, S.P., Chandrasiri, A.N.D., Hemlatha, W.A.P. and Roberts, J.A. (1993). Feed resource base for scavenging village chickens in Sri Lanka. *Tropical Animal Health and Production* **25**: 249-257.

Horst, P. (1991). Native fowl as a reservoir for genome and major genes with direct and indirect effects on productive adoptability and their potential for tropically oriented breeding plan - A review. *Animal Research and Development* **33**: 93-101.

Kaneko, J.A., Harvey, J.W. and Bruss, M.L. (1997). *Clinical Biochemistry of Domestic Animals*, 5th Edn, Academic Press, California, USA.

Rangnekar, D. and Rangnekar, S. (1996). Traditional Poultry production system - A need for fresh look from rural development perspective. Proceedings *20th World Poultry Congress*, Vol. **III**, pp. 405-405, held at New Delhi.

Roberts, J.A. and Gunaratne, S.P. (1992). The scavenging feed resource base for village chickens in a developing country. Proceedings *19th World Poultry Congress* **1**, pp. 20-24, held at Amstedam.

Roberts, J.A., Gunaratne, S.P., Wikramaratne, S.H.G. and Chandrasiri, A.D.N. (1994). The benefits from use of creep feeder for scavenging chickens in villages. Proceedings *7th AAAP Animal Science Congress*, Vol. **II**, pp. 69-70, held at Bali, Indonesia.

Roberts, J.A. (1995). Assessing the scavenging feed resource base for sustainable smallholders poultry development. Proceedings ANRPD Workshop *Sustainable Rural Poultry Production in Africa*, pp. 40-52, held at Addis Ababa, Ethiopia.

Snedecor, G.W. and Cochran, W.G. (1989). *Statistical Methods*, Oxford and IBH Publishing Company, Kolkata.

J. Indian Soc. Coastal agric. Res., 24(2), 272-275, 2006

Growth and Production Performance of Rhode Island Red Chicken in Orissa

M. K. PADHI, B. K.PANDA, S. C. GIRI and S. K. SAHOO

Regional Centre, Central Avian Research Institute
Jokalundi, Bhubaneswar – 751 003, Orissa

Rhode Island Red (RIR) chicks were reared under deep litter system of management. Growth and production performance of the birds were recorded. The body weight (g) at 4,6,8, and 20th week of age in male, female and combined sex were 232±4.17, 203±3.13, 214±2.66; 429±7.36, 378±5.89, 397±4.86; 679±10.93, 576±7.89, 614±7.16 and 2216±31.78, 1725±20.57, 1892±24.69 g, respectively. Significant difference (p<0.05) for body weight was observed between different sexes except at 2nd week. Body weight of the female at 40th week of age was 1850±2.94 g. The hatchability % on total egg set was 65.78%. First egg of the flock was obtained at 124 day and 50 % hen housed egg production was recorded at 150 day. Peak hen housed production was obtained at 181 day. Egg production of the bird on hen housed basis was 89.38 eggs upto 40th week of age, whereas hen day production per bird upto 40th week of age was 93.90 eggs. Hen housed and hen day production % of the flock at 40th week of age were 53.90 and 63.95 %, respectively. Average egg weight at 40th week of age was 52.28±0.36 g. Mortality % of the flock from 0-8 and 18-40 week of age were 7.82 and 11 %, respectively.

(Key words: *Body weight, Egg production, Egg weight, Hatchability, Mortality)*

Poultry production in the country has made a significant achievement in its journey from backyard poultry to a dynamic and viable industry within the last three decades. India to day ranks 4th in the world egg production. However the per capita availability of 34 eggs is lagging far behind the recommendation by ICMR of 180 eggs per year. So there is need for further improvement in poultry production, mostly in backyard sector in the country. In Orissa more than 70 % of the poultry population are of indigenous types whose growth and production potential are low (Padhi and Panda, 2002). Many people prefer brown or tinted eggs than white egg shell due to their similarity to the *desi* egg appearance. So there is a demand for brown/ tinted egg in the rural and urban market. Rhode Island Red (RIR) which lays brown/tinted egg is a dual purpose bird which can be used both for meat and egg production. The performance of RIR are reported by some authors (Kataria *et al.*, 2003, Anon., 2004, Panda *et al.*, 2004). In the present study the growth and production performance of RIR were recorded under deep litter system of management in Orissa.

MATERIALS AND METHODS

A total of 450 fertile eggs of RIR selected flock kept at the Regional Centre, Central Avian Research Institute, Izatnagar were collected for hatching. Chicks hatched at 22nd day of incubation were wing banded and kept for brooding under deep litter system. Standard feeding practices were followed and starter feed was given from 0 to 8 week of age, and grower feed from 8-16 week of age. Individual body weights were recorded at 2nd, 4th, 6th, 8th and 20th week of age in a top pan balance. Extra males and weakling females were discarded for sale at 8 week of age. Standard management practices were followed. Male and female are reared separately from 8th week onward. The females selected were provided with layer feed from 16th week onwards. A total of 118 females were kept for egg production study in deep litter system. Daily egg production was recorded from first egg of the flock to 40th week of age. Egg and body weight at 40th week were recorded. Hatchability % was calculated on total egg set basis. Mortality records were kept daily and mortality % was calculated from 0-8 week, 8-18 week and 18-40 week of age. Hen housed egg production % and hen housed egg production per bird were calculated for each week of egg production from 18th week of age as per the standard formulae. Similarly, hen day production % and hen day production per bird were calculated for each week from 18 to 40 week of age. Data were subjected to analysis of variance (Snedecor and Cochran, 1989).

RESULTS AND DISCUSSION

Hatchability: The hatchability % on total egg set basis was found to be 65.78 % in RIR breeds. The result

are in agreement with Anon. (2004) and better than the report of Kataria *et al.* (2003). The hatchability % showed the adaptability of the birds to Orissa climate.

Body weights: The body weights recorded at different week of age in male, female and combined sex are presented in Table 1. From the perusal of the data significant difference ($p<0.05$) for body weight was observed between different sexes for 4th, 6th, 8th and 20th week of age. However, no significant difference was observed at 2nd week of age between the sexes. So the sexual dimorphism between male and female were observed at 4th week of age. In female 20th week body weight was 1725±20.57 g which was higher than the reports available (Sharma *et al.*, 1992, Kumar *et al.*, 2002, Panda *et al.*, 2004). This may be due to better growth rate of the birds during the study. In case of male the 20th week body weight was 2216±31.78 g indicating the suitability of the birds for meat purpose. The extra male can be used for meat purpose due to their higher growth. The 40th week body weight of the female was found to be 1850±20.94 which is in agreement with the reports of Sharma *et al.* (1992) and higher than the reports of Hazary *et al.* (1991). However, in most of the reported results the birds were kept in cages and in the present case the hens were kept in deep litter system.

Age of the flock for different production parameters: Since the birds were kept under deep litter system as a flock/group the flock production performance was recorded. Age at first egg of the flock was recorded at 124 day of age, whereas 5% hen housed egg production was recorded at 126 day of age. Hen housed egg production % was 50% at 150 day age of the flock. This result is in agreement with the reports of Hazary *et al.* (1991), Sharma *et al.* (1992) and Kumar *et al.* (2002). However these reports are from cage system of rearing and in the present study the flock average was taken under deep litter system of management. It is assumed that at 50% hen housed egg production all the hens laid their first egg and are sexually mature. Age at peak production on the basis of hen housed was observed at 181 day of age.

Table 1. *Body weight of RIR at different ages in different sexes*

Age in week	Male (88)	Female (150)	Combined sex (238)
2nd wk B.wt. (g)	87±1.54	84±1.10	85±0.91
4th wk B.wt. (g)	232±4.17[a]	203±3.13[c]	214±2.66[b]
6th wk B.wt (g)	429±7.36[a]	378±5.89[c]	397±4.86[b]
8th wk B.wt. (g)	679±10.93[a]	576±7.89[c]	614±7.16[b]
20th wk B.wt(g)	2216±31.78 (60)	1725±20.57 (118)	1892±24.69[b] (178)

Means bearing different superscript in a row differ significantly ($p<0.05$).
Values in parenthesis for 20 week body weight showed number of observation.

Table 2. *Hen housed (HH) production performance at different week of age*

Age in week	Hen housed production per bird	Progressive hen housed production per bird	% of lay	Age in week	Hen housed production per bird	Progressive hen housed production per bird	% of lay
18	0.07	0.07	0.97	30	4.79	45.14	68.40
19	0.67	0.74	9.56	31	4.80	49.93	68.52
20	1.77	2.51	25.30	32	5.03	54.96	71.79
21	2.37	4.88	33.90	33	5.03	59.99	71.79
22	3.43	8.31	49.03	34	4.76	64.75	68.04
23	3.86	12.17	55.09	35	3.86	68.61	55.21
24	4.53	16.70	64.65	36	4.15	72.76	59.32
25	4.68	21.37	66.83	37	4.39	77.15	62.71
26	4.72	26.09	67.43	38	4.11	81.26	58.72
27	4.88	30.97	69.73	39	4.09	85.35	58.48
28	4.75	35.73	67.92	40	3.98	89.34	56.90
29	4.62	40.35	65.98				

Table3. *Hen day (HD) production performance at different week of age*

Age in week	Hen housed production per bird	Progressive hen housed production per bird	% of lay	Age in week	Hen day production per bird	Progressive hen day production per bird	% of lay
18	0.07	0.07	0.97	30	5.00	45.63	71.43
19	0.67	0.74	9.56	31	5.09	50.72	72.63
20	1.77	2.51	25.30	32	5.34	56.06	76.32
21	2.37	4.88	33.90	33	5.34	61.40	76.32
22	3.43	8.31	49.03	34	5.06	66.46	72.33
23	3.86	12.17	55.09	35	4.27	70.73	60.96
24	4.53	16.70	64.65	36	4.62	75.35	66.04
25	4.68	21.37	66.83	37	4.89	80.24	69.81
26	4.72	26.09	67.43	38	4.58	84.82	65.45
27	4.88	30.97	69.73	39	4.60	89.42	65.71
28	4.86	35.83	69.43	40	4.48	93.90	63.95
29	4.79	40.63	68.47				

Egg production: The hen housed and hen day egg productions of the flock are presented in Tables 2 and 3, respectively. From the results it is evident that more than 60% hen housed egg production was obtained from 24 to 34 week of age. However, in case of hen day egg production where mortality was taken into consideration more than 60% production was observed from 24 to 40 week of age. The average hen housed egg production from 20 to 40 week of age was found to be 60.27% which is in agreement with the reports of Swain *et al.* (2005). Hen housed egg production per bird upto 40th week of age was 89.34, whereas hen day egg production per bird was 93.90 eggs. The results are in agreement with the reports of Kataria *et al.* (2002), Swain *et al.* (2005) and better than the reports of Hazary *et al.* (1991) and Sharma *et al.* (1992). However, it is to be noted that all the reports are in cage system of rearing where individual hen egg production was recorded for calculation of average egg production and in the present study hen housed and hen day egg production are presented. The results showed that the birds can be useful for brown/tinted egg production as well as for higher growth.

Egg weight: Average egg weight of the flock measured at 40th week of age was found to be 52.28±0.36 g which is in agreements with the reports available in the literature (Sharma *et al.*, 1992, Kataria *et al.*, 2003).

Mortality %: The mortality % calculated for combined sex from 0-8 week and 8-18 week of age were 7.825 and 3.57 %, respectively. The mortality % from 18 to 40 week of age was 11% in female. The mortality % in combined sex are comparable to the report of Panda *et al.* (2004).

From the results it is evident that the RIR performed comparable or better for some traits. So this breed of chicken can be reared successfully for tinted/brown egg production in Orissa. The birds may be useful for backyard poultry production as a dual purpose bird for its better growth, higher egg production and tinted/brown egg shell colour as well as colour plumage.

REFERENCES

Anon. (2004). Comparative performance of RIR pure strain. In *Annual Report*, 2003-04, pp.26, Central Avian Research Institute.

Hazary, R.C., Johari, D.C., Kataria, M.C. and Mohapatra, S.C. (1991). Evaluation of response to selection for egg mass in Rhode Island Red flock 2. Correlated response. *Indian Journal of Poultry Science* **26**(2): 71-76.

Kataria, M.C., Nath, M., Singh, B.P., Singh, D.P., Gopal Ram, Dash, B.B. (2002). Improvement of poultry for egg production. In *Annual Report*, CARI, 2001-02, pp.5-7.

Kataria, M.C., Padhi, M.K., Singh, B.P., Nath Mintu, Singh, D.P. Gopal Ram and Sharma, D. (2003). Improvement of poultry for egg production. In *Annual Report*, CARI, 2002-03, pp.15-16.

Kumar, A., Sharma, R.K., Singh Harpal, Singh, C.V. and Singh, B. (2002). Genetic studies on some economic traits of Rhode Island Red. *Indian Journal of Poultry Science* **37**(1): 31-34.

Padhi, M.K. and Panda, B.K. (2002). Status of indigenous fowl in Orissa. Proceedings National Workshop *Characterization and Conservation of Indigenous Poultry Germplasm*, pp.119-126, held at Port Blair, 26-27 Feb, 2002.

Panda, B.K., Padhi, M.K., Sahoo, S.K. (2004). Comparative growth and performance studies of exotic breeds in the intensive and extensive system of rearing at Orissa state. *Indian Journal of Poultry Science* **39**(3): 285-288.

Sharma, D., Johari, D.C., Kataria, M.C. and Singh, D.P. (1992). Combining ability analysis for egg production traits of light and heavy breed crosses of egg type chicken. *Indian Journal of Poultry Science* **27**:183-187.

Snedecor, G.W. and Cochran, W.G. (1989). *Statistical Methods*, 9th Edn, Iowa State University Press, Ames, Iowa.

Swain, B.K., Sundaram, R.N.S. and Chakurkar, E.B. (2005). Effect of feeding supplemental calcium from different source on the performance of Rhode Island Red laying hens. *Indian Journal of Poultry Science* **40**(1): 79-82.

J. Indian Soc. Coastal agric. Res., 24(2), 276-277, 2006

Indigenous Ethno Veterinary Practices for Animal Husbandry under Coastal Villages of Sundarbans

C. KARPAGAM, D. BURMAN., B. K. BANDYOPADYAY and A. R. BAL

Central Soil Salinity Research Institute
Regional Research Station, Canning Town – 743 229, West Bengal

To control and manage the various animal diseases, farmers in Sundarbans area are practising various indigenous as well as various Modern Veterinary Drug (MVD). The Indigenous Technical Knowledge in animal husbandry under this coastal area is little documented. In the regime of IPR, it is of paramount importance to document any innovations or new knowledge. Keeping these things in mind a study has been undertaken during 2004-2005 in the six selected coastal villages of Sundarbans to identify and document the various indigenous animal disease management practices of farmers. This paper reveals that various animal diseases, like diarrhoea, food and mouth diseases, arthritis, etc. has been treated indigenously with various locally available material mainly with various plant parts.

(***Key words:*** *Animal husbandry, Indigenous, Ethno veterinary).*

Various animal diseases are traditionally treated by using indigenous practices in many parts in India including coastal areas. Since the coastal area of Sundarbans in West Bengal comes under tropical and humid climate, the health condition of the farm animals are usually seriously affected by various diseases and the productivity of farm animal declines over a period of time. Keeping the above said background in mind, a study has been undertaken with the objective to identify and document the indigenous animal practices of farmers in the coastal village of Sundarbans.

MATERIALS AND METHODS

By using multistage random sampling method, district, sub division and block has been selected. From the selected Canning 1 block, 6 villages had been selected. From each one of the selected villages, 10 key informants have been selected based on snow ball technique and thus totally 60 farmers were constituted for the present study.

Prior to data collection, a baseline survey was undertaken. Based on the baseline survey a semi-structured interview schedule was formulated and the survey was undertaken in the project site. The collected information were compiled and analyzed.

RESULTS AND DISCUSSION

ITK for food and mouth disease (FMD)

The common symptom of this disease is development of characteristics bubbles in mouth and claws. Most of the farmers did not treat their animals with Modern Veterinary Drugs (MVD) like FMD vaccination. Patra *et al.* (2003) also reported that vaccination is a precautionary measure and is not highly accepted by rural farmers due to high cost, lack of awareness and by other reasons.

Most of the farmers in the study area have been treating their animal by local practices that oral feeding of paste made of *Bash* (Bamboo), leaf and semi-ripened *sapheda* (Sapota) fruit. In the same vein, the paste made of *Bash* leaf and *Dumur* (Fig) leaves has also been an effective control measure. Apart from these; paste made of *Tetul* (Tamarind) leaf and *Golmairch* (Black Pepper) seed were also an effective local control measure for the same disease. Among all the ingredients *Bash* leaf was an important ingredient to treat the disease and the practicability and applicability of this practice is also very simple.

Tobacco leaf dust for mites control in cattle

Red batches over the skin, hair coat become rough, severe scratching and development of foul smell are some of the common symptoms in cattle due to mites attack. Paste made of tobacco leaf dust and *Choon* (Lime) was applied externally in the skin. Farmers opines that the smell from the tobacco leaf dust kept away the cattle from mites attack.

ITK for easy delivery in cow

Most of the time delivery in cow becomes more difficult due to various reasons. A commonly found local practice that makes the delivery become very easy is mixture of *Durbghas* (*Cynodon dactylon*) leaf,

Table1. *Indigenous practices for various animal diseases*

Disease/Problem	ITK practised
Cattle fever	Oral feeding of paste made of 50 g *adha* (Ginger) rhizome and 15-20 *Golmirch* (Pepper).
Arthritis / Joint pain (*panchima*)	External application of paste made of 100g of Arjuna tree bark, 50 g of ginger and 50g of *Masoor* (lentil) leaf.
Sounbaighana in poultry	Paste made of one green *lanka* (Green chilli) with 5 drops of mustard oil. After this treatment the birds are not allowed to feed anything for the whole day.
Stomach related problems in cow	Paste made of 2g of *jumko* root, 5g *adha* (ginger), 21 numbers *Golmirch* (black pepper) was fed to the affected animal.

Kata notae (*Amaranthus sp*) root, rice washed water and molasses which is fed to the pregnant cow during pre-delivery time.

ITK for *Gala Phola* control in cow

The common symptom of *Gala Phola* (*Hemorrhagic septicemia*, HS) diseases are sudden rise in temperature, swelling in jaw followed by difficult in respiration, and swelling in neck and perennial region. Most of the farmers in the study area are not treated their animal with HS vaccine due to their unawareness, careless and paucity of money. At farmers' level, common local practice has been followed to treat HS disease that the juice prepared from *Deshi sheem* (local beans) was warmed and applied externally in the affected portion. After applying of the juice the swelling has been found to be reduced to a significant level.

ITK for sleeping sickness in poultry

Due to this, eggs become too small, productivity of the birds were reduced. A commonly practised local treatment for this disease is that juice made up from *Dhutra* (Datura methal) seed was given as oral feeding to the affected birds. In the same vein juice from *Tetul* (Tamarind) leaf has also been used to treat the same disease in the study area.

Apart from the above discussed problem and treatments some commonly available disease and their local practices were given in the Table 1.

REFERENCES

Patra, N.K., Majhi, K., Basu, D. and Mazumder, G. (2003). Identification and documentation of traditional knowledge based medicine of tribal people. *Journal of Interacadamica* **7**(2): 202-205.

J. Indian Soc. Coastal agric. Res., 24(2), 278-281, 2006

Integrated Fish Culture with Piggery in Different Districts of Meghalaya - An Enterprising Approach for Economic Benefit of Tribal Community

N. M. CHAKRABARTY, N. K. DAS, P. P. CHAKRABARTI and S. C. MONDAL

Regional Research Centre, Central Institute of Freshwater Aquaculture
A-5 (Phase – III), Santalpara, Kalyani, West Bengal

Integration of fish farming with livestock has always taken deeper roots and extensively practised in China and Thailand where the technology has been successfully implemented with a great degree of sophistication. In India raising of pig is fruitfully combined with fish culture by siting pigsties on pond embankment so that the wastes are directly drained into the pond. Pig dung acts as excellent fertilizer for fish pond and fishes directly feed on them. The expenditure of the fish culture is drastically reduced, since pig dung is utilised both as feed and fertilizer. The return is highly profitable. With the idea in mind and considering the scope of integration of pig and fish farming in different districts of Meghalaya, where pig rearing is a way of life of rural people, a number of trials were made in 16 beneficiary ponds, having the water spread on 0.10-0.20 ha area located at 7 different districts. Indigenous but upgraded piglets suitable for raising were procured and installed in pigsties/ pig houses constructed by using bamboo/ wooden structure with asbestos roofs. In October-November 2003, initially 3 piglets had been stocked per 0.10 ha @ 30 nos/ha with an average weight range of 7.0-10.0 kg comprising 2 females and 1 male. Pigs were fed with pig mash @ average 0.8 kg per pig per day in addition to grass and green fooder. Pig mash were prepared by mixing various ingredients available locally, fortified with vitamins and minerals, etc. As per the availability of fish fingerlings, depending upon the altitudinal variation, three different types of culture were practised. The initial stocking size of carp fingerlings varied over the range of 8.0-15.0 cm per 10.0-20.0 g and the combined stocking density of 12000 nos. ha^{-1} were maintained uniformly in all ponds. No supplementary feed was required in this system as fishes fed directly on pig excreata containing 70% digestible food for fishes. On harvest, the high range of fish production of 4800 kg $ha^{-1}yr^{-1}$ to 8400 kg $ha^{-1}yr^{-1}$ was obtained from the culture of 6 species of carps from Garo hills (East, West and South Garo hills), followed by the production range of 2120 kg $ha^{-1}yr^{-1}$ to 5000 kg $ha^{-1}yr^{-1}$ from 3 species of carp culture at East and West Khasi and Jayantia hills. The range of production of pigs was between 200-390 kg in a year from different pig-cum-fish culture units. The variable costs and the return function of the system have been worked out and it is evident that the investment level of Rs. 29060/- assures a return of Rs. 51300/- and the percentage of profit on variable cost worked out to be 76.53%. The initial inputs, expenditure and estimated profit from a unit of 0.1 ha pond after one year culture is furnished.

***(Key words:** Integrated fish-pig culture, Economic appraisal, Tribal community)*

The sustained research efforts were made by several workers to develop low cost farming system based on the principles of productive utilization of farm waste that has resulted in development of integrated farming system involving fish culture with piggery. The excreata of pigs were recycled in polyculture fish ponds which resulted in increased production of high grade of animal protein at low cost. A mass demonstration on integrated fish-cum-pig farming was conducted by many in different districts of Meghalaya where pig rearing is a way of life for the rural people. The proposed system on fish-cum-pig farming is the effective and possible way to help economically small and marginal farmers who can go a long way in increasing the animal protein production and generating employment for the people of the hilly state.

MATERIAL AND METHODS

A total of 16 beneficiaries having water area ranging from 0.10 – 0.20 ha located at 7 different districts of the state of Meghalaya were selected for fish-cum-pig culture demonstration. For providing good housing with accommodation incorporating all essential requirements necessary for pigs, pig houses were constructed on the pond embankments facing the pond to facilitate the drainage of pig dung directly to the pond for all 16 ponds under the demonstration programme. Pigsties having cemented floor with side walls made of locally available ingredients such as bamboo, mat and roofs made of asbestos materials were constructed. The size of each pig house was 10 x 8 x 5 ft for facilitating free movement and up-keeping of health. Indigenous

but upgraded piglets procured from the animal husbandry department were installed in the pig house. Pigs were fed with commercial pig mash, @ 0.8kg per pig per day in addition to grass and green fodders provided regularly to them.

Stocking of pigs

Initially 3 piglets per 0.01 ha (@ 30 nos. per ha.) have been stocked comprising 2 females and 1 male. The piglets were reared for six months when they matured and attained the weight of 60-70 kg per pig. About 5 nos. of piglets were obtained from each female on mating. The parental stock was ready for sale and out of the new stock of the piglets (10 nos. from 2 females), 7 nos. were sold out retaining the 3 nos. required for continuation of the culture system.

The quantity of pig dung going to pond decreased after 6 months when first lot of pigs was disposed off and a fresh lot of piglets was brought to the pig sties. This did not affect the fish growth as the organic load in the pond by that time was sufficient to tide over for the next few months when fresh piglets grown and quantity of pig dung produced increased.

Stocking of fish

As per the availability of fish fingerlings, depending upon the altitudinal variation, three different types of culture were adopted:

A. 3-species culture - silver carp (SC) + common carp (CC) + grass carp (GC) (highest altitude zone)
B. 4-species culture - catla + SC + CC + GC (mid. altitudinal zone)
C. 6-species culture - catla + rohu + mrigal + SC + GC + CC (lowest altitude zone)

The initial stocking size of carp fingerlings varied from the range of 8.0-15.0 cm per 10.0-20.0 g and the combined stocking density of 12000 nos. ha^{-1} were maintained uniformly in all ponds. Keeping in view the size attained, prevailing market rate, demand of carps in local market, partial harvesting of the table sized fish was done, and the stock was replenished with the same number of fingerlings depending upon the availability of fish seed. The details of fingerlings stocked are furnished in Table 1.

Table 1. *The details of stocking of livestock and fish fingerlings*

Initiation (Months)	Type of culture	No of ponds utilised and location	Stocking density of fingerlings (no/ha)	Stocking size (length in cm/g)	Stocking no. of piglets (no/ha)	Weight of piglets (kg)
October - November, 2003	**3-species culture**	7 ponds (East Khasi hills-2, West Khasi hills-3 & Jaintia hills-2)	12,000	8.0-10.0 /10.0-15.0	30.0	7.0-9.0
	S.C-40					
	CC-40					
	GC-20					
	4- species culture	3 ponds (Ri-Bhoi)	12,000	10.0-15.0 /15.0-20.0	30.0	7.0-10.0
	C-15					
	SC-25					
	CC-40					
	GC-20					
	6- species culture	6 ponds (East, West, & South Garo Hills -2 nos. each)	12,000	10.0-15.0 /15.0-20.0	30.0	7.0 -9.0
	C-25					
	R-20					
	M-10					
	SC-10					
	CC-25					
	GC-10					

C – Catla, R – Rohu, M- Mrigal, GC – Grass carp, SC- Silver carp, CC – Common carp

RESULTS AND DISCUSSION

The details of livestock and fish production are furnished in Table 2.

Reports are available on trials on effect of liquefied swain manure to fish ponds which affects primary production and yield of fish stock at different rates (Teichest *et al.*, 1990). In earlier experiments by Hickling (1968) and Huet (1972), manure was applied in a single large dose at the beginning of culture season, but in a later

Table 2. *Production of fish and pig on harvest*

District	Pond size (ha)	Culture System	Production of fish (kg/ha/yr)	Production of pig (kg/yr)
East Khasi Hills	0.1	3 species of carp & pig	3600	305
	0.1	3 species of carp & pig	2160	390
West Khasi Hills	0.1	3 species of carp & pig	2120	380
	0.1	3 species of carp & pig	2310	390
	0.2	3 species of carp & pig	2600	280
Jaintia Hills	0.15	3 species of carp & pig	5000	360
	0.1	3 species of carp & pig	3000	271
Ri-bhoi	0.1	4 species of carp & pig	2330	260
	0.15	4 species of carp & pig	1846	295
East Garo Hills	0.2	6 species of carp & pig	4800	390
	0.13	6 species of carp & pig	3400	200
West Garo Hills	0.15	6 species of carp & pig	Not harvested	Not harvested
	0.15	6 species of carp & pig	and sold	and sold
	0.20	6 species of carp & pig		
South Garo Hills	0.1	6 species of carp & pig	8400	350
	0.1	6 species of carp & pig	not available	380

Table 3. *Initial inputs for 0.10 ha pond (unit area) under pig-cum-fish culture demonstration at Meghalaya*

A. Expenditure

Sl. No	Item	Rate (Rs.)	Amount (Rs.)
1.	Construction of 1 pig site (10x8x5 ft)	-	10,000.00
2.	Purchase of 3 piglets	Rs. 900 each	2,700.00
3.	Purchase of pig feed (0.8 kg/pig/day) 876 kg/3 pigs/yr(292 kg/pig/yr)	10/kg	8,760.00
4.	Renovation of ponds	-	1,000.00
5.	Stocking component; Carps fingerlings 5 to 6 species 1200 nos.(@ 12,000/ha)	Rs. 3 / fingerling	3,600.00
6.	Lime, 100 kg/year (1000 kg/ha/yr)	6/kg	600.00
7.	Prophylactic measure	-	400.00
8.	Periodic raking, sampling & harvesting	-	2000.00
		Total	**29060.00**

B. Expected profit after 12 months of culture

1.	**Sale of fish**	**Rs. 500 kg/yr (1000 nos of 500 g each)**	**@Rs. 40/kg**	**Rs. 20000**
2.	Sale of pigs after 6 months	180 kg pig meat (3 pigs x 60 kg/pc)	@ Rs. 50/kg	Rs. 9000
3.	Sale of piglets	7 nos.	@ Rs. 950/pc	Rs. 6650
4.	Sale of pigs after 6 months	180 kg pig met (3 pigs x 60 kg/pc)	@ Rs. 50/kg	Rs. 9000
			TOTAL	**Rs. 44650**

C. Gross Profit : B – A = Rs. 15590

Percentage of profit on variable cost = 76.53 %

experiment the rate and frequency of manure application to ponds were increased during growing season (Hopkins *et al.*, 1981). This practice was reasonable as fish required more nutrients with the increase in biomass. In the present demonstration initial application of pig manure stimulated primary production and early fish growth while subsequent fertilization through regular application of pig dung helped to maintain optimum primary production required for fish growth. The organic carbon load resulting from the application of raw and fresh pig manure enhanced phytosynthetic activity due to the growth of phytoplankton, which maintained high natural fish food resources, all these finally resulting in increased fish growth and production. The organic carbon was converted to fish *via* both algae and detrital food chain through zooplankton and zoobenthos, which were consumed by fish. Besides providing protein rich food at low cost the system proved to be an effective method of waste disposal and waste utilization. The additional advantage of fish-cum-pig culture was that the fish utilised the feed spilled by pig and the excreta which were rich in nutrients for fish, no additional land was required for piggery operation as pigsties were constructed on the pond embankment, and the pond provided much more needed water for washing of pigsties and piglets. It resulted in high production of animal protein per unit area and ensured high profit with lower investment. The variable cost and return function of the system have been worked out for 0.1 ha pond (Table 3). It is evident that the investment of Rs. 29060 assured a return of Rs. 51300 and the percentage of profit on variable cost worked out to be 76.53%.

REFERENCES

Hickling, C.F. (1968). *The Farming of Fish*, Pergemon Press, NewYork.

Hopkin, K.D., Cruz, E.M., Hopkin, M.L. and Chong, K.C. (1981). Optimum manure loading rates in tropical freshwater fish ponds receiving untreated piggery wastes. Report *The ICLARM - CLSV Integrated Animal Fish Farming Project, Poultry-Fish and Pig-Fish Trails*, International Centre for Leaving Aquatic Resource Management, Manila, The Philippines.

Huet, M. (1972). *Text Book of Fish Culture*, Fishing News Books, Farnham, Great Britain.

Teichert, D. R., Behrends, L. I. and Smitherman, R.O. (1990). Effect of manuring regime and stocking rate on primary production and yield of tilapia using liquid swine manure. *Aquaculture* **88**: 61-68.

Mangroves, forests, agroforestry and ecological security

J. Indian Soc. Coastal agric. Res., 24(2), 283-284, 2006

Ecological Peril in Coastal Regions - An Overview

D. KUMARA CHARYULU[1], H. DEEPTHI[2] and S. NARASIMHAM[3]

[1&3]College of Agriculture, Rajendranagar, Hyderabad – 500 030, A.P.

and

[2]ICRISAT, Patancheru, A.P.

Out of the total landmass of about 3.28 million sq km, nearly 0.15 million sq km of coastal land-belt (considering 25 km landward distance) girdles three sides of the country's sea front. The seabed up to the territorial limit covers about 0.13 million sq km. India has a coastline of about 7,500 km and 2.02 million sq km of Exclusive Economic Zone. About 47 percent of the population lives in the coastal states. The coast also has some of the largest and most dense urban agglomerations such as Mumbai, Kolkata, Chennai, Kochi and Visakhapatnam. About 60 percent of the labour force in the coastal region is occupied in agriculture. Several thousands of plant species are endemic to our country and they have so far not been reported from anywhere else in the world. The biological diversity of our country is so rich that it may play a very important and crucial role in future for the survival of entire mankind if it is conserved and used with utmost care. With the view of the high importance of ecological security in coastal regions the present paper is an attempt to recall the Government for reinforce and implement more stringent laws to protect and preserve the ecological balance in coastal regions for sustainable long viable future. The paper also briefly highlights some of the serious perils in coastal regions which needs immediate attention to correct them.

(***Key words:*** *Ecology, Mangrove destruction, Tourism development, Shrimp aquaculture, Sand mining, Deforestation)*

Yet, India has signed and ratified various international conventions and agreements on environment and related issues and it has been implementing them effectively. India is among the countries which are in the vanguard of environmental protection. India has environmental standards for products and processes, has environmental impact assessment, and has introduced environmental audit as an eco-labelling scheme. India believes that environmentally harmful processes should be stopped and that over-exploitation of non-renewable resources should be controlled. Even after making several efforts, India could not succeed in protecting the coastal ecological security in a significant way. They have often not proved very effective in regulating competing interests and addressing conflicts concerning natural resources and the environment because they act only when violations have become too obvious to ignore. It was due to the lack of committed political will from the government leading to serious perils which resulted in ecological imbalance in the coastal region. We should not blame the government alone, but it is also because of lack of awareness, faster urbanization and development and poor planning. The identified some of the serious perils are as follows.

Direct Physical Alteration and Destruction of Habitats (PADH) is now viewed as the most important threat to the coastal environment. It is estimated that 80 percent of the pollutants load in the coastal regions originates from land-based activities. The major threats to the health, productivity and biodiversity of the marine environment result from human activities in coastal areas as well as in the hinterland. Environmental degradation is often the result of the convergence of factors such as a limited resource base, an accelerating rate of economic and demographic growth, inadequate knowledge of resource management, and poor enforcement of regulations. Normally, with the convergence of commercial activities in urban centres, traditional activities get squeezed out of existence which results in more dense populations in nearby places for better employment and livelihood options. In the case of physical alterations and destruction of habitats, the driving force is the poorly planned and rapid social and economic development in coastal areas, which in turn results from such increasing pressures like population, urbanization and industrialization, maritime transport and tourism. Recent studies developed an index of potential threats to coastal

ecosystems due to development related activities which has shown that more than half of the world's coasts are under 'moderate' or 'high' threat from development.

Destruction of mangroves: In India, the area under mangroves is about 4,900 sq km constituting about 7 percent of the world's mangroves and about 8 percent of India's coastline. The Sundarbans are the world's largest contiguous mangroves spread across India and Bangladesh. The Sundarbans Biosphere Reserve (SBR) was established in 1989 covering an area of 9630 sq km, but SBR has only 4246 sq km under reserved forest, the rest being inhabited. Destruction of mangroves can affect a variety of activities like fisheries breeding areas and nurseries for many commercially important fish, molluscs and crustaceans, and also may result in increase coastal erosion because of the absence of sediment-trapping mangrove roots. etc.

Major activities leading to PADH

Tourism development

Tourism is one of the fastest growing industries in the world. Statistics from the World Tourism Organization (WTO) indicates that the industry has grown at a very accelerated pace over the latter half of the past century. Projections for continued growth make it an important sector of the world economy. While coasts are increasingly the preferred destinations of tourists, coastal tourism is an attractive choice for small coastal countries and islands with limited development options. There are a number of problems associated with the rapid and unplanned development of coastal tourism. They are like destruction of mangroves, coral reefs, habitats of shore birds and turtles, etc. as components of fragile coastal infrastructure leading to environmental degradation. It is also leads to displacement of traditional culture and loss of skills.

Shrimp aquaculture

Export oriented shrimp aquaculture grew rapidly in the 1980s, fueled by the growing demand for seafood in wealthy countries, with simultaneous depletion of wild ocean shrimp stocks. Cash strapped economics was attracted with the possibility to earn large amount of foreign exchange in a short time frame.

The indiscriminate exploitation of fishery resources and unregulated use of nets of small mesh size for the collection of tiger prawn seeds have resulted however in biodiversity losses.

Sand mining

Sand is essential for beach and shoreline protection as wave action is dissipated by the presence of sand. When sand is mined close to the shoreline, wave action attempts to replace the lost material by taking sand from the beach or some other source resulting in erosion. It is necessary to prohibit large scale sand mining from the active beach area.

Ports

An important activity that can have significant effect on coastal environment is the construction and operation of ports and harbours. While there are some natural harbours, in many places artificial harbours have been constructed because of the demand by trade. Protection of the port and the vessels berthed in them may require the construction of breakwaters, groynes, etc., which may disturb the natural current patterns and sediment deposition patterns, causing erosion or accretion.

New threats to forests

Life in the hills is hard; the huge time and effort involved in the critical activities of collecting water, fodder and fuelwood and the viability and productivity of hill agriculture are directly linked to the status of local natural resources like forests. Ill-conceived, lopsided policies and projects degrade or destroy the natural resources on which people are directly dependent.

J. Indian Soc. Coastal agric. Res., 24(2), 285-287, 2006

Adaptability of Mangroves in Shrimp Farm Discharge Water

P. NILA REKHA and M. JAYANTHI

Central Institute of Brackishwater Aquaculture
75, Santhome High Road, R.A. Puram, Chennai - 600 028, Tamil Nadu

In brackishwater aquaculture, discharge water is generated either from water exchange to maintain water quality in ponds or during the harvest of a crop. The treatment of the aquaculture effluent is expensive because of the large volume of dilute effluent. In fact the wastewater enriched with nutrients is a resource, and exploitation of nutrient sources from wastewater is an appropriate strategy. In case of low saline aquaculture effluent, it can be used for the irrigation of salt tolerant field crops, whereas the brackishwater aquaculture effluents require most salt tolerant field crops. In this context mangrove proves may be an appropriate solution. However the adaptability of the mangroves in shrimp farm discharge water needs to be ascertained. Hence a preliminary pot culture experiment was conducted to assess the adaptability of mangrove species (rhizophora) under different types of soils prevailing in coastal areas, viz. sandy loam, loamy sand and clay loam. The seedlings were irrigated with wastewater collected from the shrimp pond. The biometric parameters, viz. height (cm), number of lateral branches and leaves and surface area of the leaves of the seedlings were monitored weekly for three months. The changes in the soil quality were assessed. The study revealed that there was not much variation in biometric parameters among the three soils. Review on mangroves as biofilters has also been enumerated.

*(**Key words:** Shrimp pond, Effluent discharge water, Mangroves)*

In brackishwater aquaculture discharge water is generated either from water exchange to maintain water quality in ponds or during the harvest of a crop. Intensive shrimp aquaculture systems rely on high protein feed pellets to produce high rates of growth, but a large proportion of the pellets are not assimilated by the shrimps. Approximately 10% of the feed is dissolved and 15% remains unused. The remaining 75% is ingested, but 50% is excreted as metabolic waste, producing large amounts of gaseous, dissolved and particulate waste. The dissolved nutrients and organic material in shrimp ponds stimulate rapid growth of bacteria, phytoplankton and zooplankton. Though all these nutrients and organic wastes are biodegradable, the discharge water if enriched with nutrients, may cause the eutrophication of the receiving water body. Moreover, it may also lead to the self pollution of aquaculture ponds, i.e. the pond effluent is fed back through the farm intake and associated with disease and low quality-aquaculture products (Sakthivel, 2001). Although aqua-culturists are moving towards systems where the discharge of wastewater is minimized and treatment methodologies developed, the problem of the disposal of the discharge water continues to challenge the brackishwater aquaculture. In case of low saline aquaculture effluent, it can be used for the irrigation for salt tolerant field crops (Macintosh and Fitzsimmons, 2003), whereas the brackish water aquaculture effluents require a most salt tolerant field crop. In this context mangrove proves to be an appropriate solution.

Mangroves have multipurpose uses. They provide important economic benefits to coastal communities including the production of charcoal, firewood and construction materials for local fisheries and as well as for coastline protection. Mangroves can tolerate upto varyin gdegrees of salinity and it plays a vital role in breeding and nursery phases of many riverine and marine organisms of commercial value. Hence the environmentalist highlights the importance of mangroves in coastal areas. Deforestation of mangroves is caused by conversion to agriculture, salt ponds, industrial uses, urbanization or mining activity and also due to shrimp farms in many countries and it is associated with decline in shrimp seed densities, saltwater intrusion and accelerated coastal erosion (Rao and Ravichandran, 2001). In fact, most of the mangrove rehabilitation programme is for the cyclone protection, erosion control rather than wastewater treatment.

MATERIALS AND METHODS

Mangroves seedlings were collected and planted in pots of different soils, viz. sandy loam, loamy sand and clay loom. The seedlings were irrigated with wastewater collected from the shrimp pond. The

initial water characteristics were monitored for various water quality parameters, viz. pH, salinity, turbidity TAN, nitrite nitrogen and total phosphorous. The biometric parameters, viz. height (cm), number of lateral branches and, leaves and surface area of the leaves of the seedlings were monitored weekly for three months. The height of each individual was measured from the stem base to the nodes of the last leaves. The changes in the soil quality were assessed. The collected data were analyzed statistically.

RESULTS AND DISCUSSION

The discharge water from aquaculture pond has been collected and the characteristics were studied as given in Table 1. On comparison with the guidelines issued by the Ministry of Agriculture, it could be observed that all the parameters were within the permissible limits. The total suspended soil ranged from 35-42 mg l^{-1}. The ammonical nitrogen ranges from 1.1 to 1.8 mg l^{-1}. The nitrite nitrogen ranged between 0.045 to 0.013 mg l^{-1}. Similarly the phosphate ranged between 0.224 to 0.344 mg l^{-1}.

The biometric parameters observed, viz. the height and the no. of leaves of the mangrove seedlings are given in Fig. 1 and Fig. 2. It could be observed from the Fig.1 that the height of the seedlings was more in clay loam. The statistical analysis revealed that there was no significant variation with respect to height among the three soils, whereas the growth of the number of leaves was significantly different in sandy loam when compared with loamy sand and clay loam. The changes in the soil characteristics were given in Table 2. The soil analysis revealed that the soil pH and EC increased. The increase in soil pH and EC was due to continuous application of the discharge water which was saline. The organic carbon also increased slightly. The presence of higher concentration of suspended and dissolved solids contributed to the build-up of organic matter.

Mangroves grow well on silty clay soils which are prevalent along the coastline. Research in Ranaong on the Andaman sea coast of Southern Thailand has shown that mangroves could be planted successfully in shrimp waste sludge, dumped into holding areas in the intertidal zone around the shrimp farm (Macintosh, 1996).

It has been suggested earlier that mangroves, grasses and other hydrophonic system can filter the nutrients in wastewater. Besides their nutrient sripping capabilities, mangrove also trap suspended sediments (SS) to a great extent. Earlier research

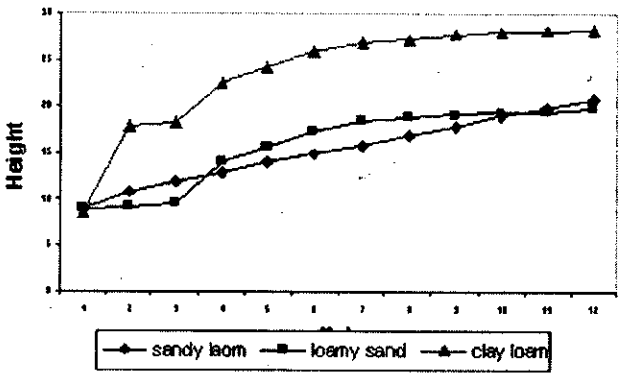


Fig. 1. Height of the seedlings in different soils

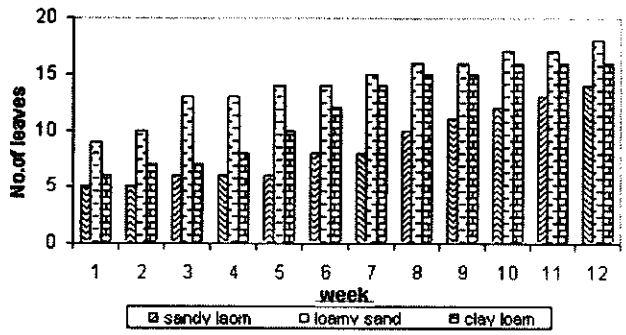


Fig. 2. No. of leaves of the mangrove seedlings in different soils

Table 1. *Characteristics of the shrimp pond discharge water*

Parameter	Shrimp pond waste water	Standards for the aquaculture pond wastewater discharged into		General standards
		Coastal marine waters	Creek	Marine coastal areas
pH	8.3-8.7	6.0-8.5	6.0-8.5	5.5-9.0
Salinity (ppt)	36-39	-	-	-
Suspended solids (mg/l)	35 – 42	100	100	100
T. Ammonia N (mg/l)	1.1- 1.8	1.0	0.5	5
Nitrite N (mg/l)	0.045 to 0.13	-	-	-
Phosphorus (mg/l)	0.224 to 0.344	2.0	2.0	-

Table 2. *Soil characteristics*

Parameter	Initial soil characteristics			Soil characteristics after three months		
Texture	**Sandy loam**	**Loamy sand**	**Clay loam**	**Sandy loam**	**Loamy sand**	**Clay loam**
Soil pH	8.3	7.9	8.4	9.41	9.06	9.47
EC (dS/m)	40.15	150.24	225.3	44.02	183.5	285.6
OC (%)	0.23	0.25	0.34	0.23	0.28	0.42

shows that heavy metals can also be absorbed by mangroves (Tam and Wong, 1995). Though many researchers have advocated the role of mangroves as biofilters (Kutty, 2001) only very few works on the effectiveness of mangroves as biofilters have been done in India.

REFERENCES

Kutty, M.N. (2001). Diversification of aquaculture. Proceedings National Seminar *Sustainable Fisheries for Nutritional Security*, T.J. Pandian (ed.), pp. 189-212, National Academy of Agricultural Sciences, New Delhi.

Macintosh, D.J. (1996). Mangroves and coastal aquaculture; doing something positive for the environment. *Aquaculture Asia* **1**(2): 3-8.

Macintosh, D.J. and Fitzsimmons, K. (2003). Characterization of effluent from an inland low salinity shrimp farm what contribution could this water make if used for irrigation. *Aquacultural Engineering* **27**: 147-156.

Rao, G.R.M. and Ravichandran, P. (2001). Sustainable brackishwater auaculture. Proceedings National Seminar *Sustainable Fisheries for Nutritional Security*, T.J. Pandian (ed.), pp. 134-152, National Academy of Agricultural Sciences, New Delhi.

Sakthivel (2001). Challenging tasks for sustainable fisheries development in the millennium 2000. Proceedings National Seminar *Sustainable Fisheries for Nutritional Security*, T.J. Pandian (ed.), pp. 6-18, National Academy of Agricultural Sciences, New Delhi.

Tam, N.F.Y. and Wong, Y.S. (1995). Mangrove soils as sinks for wastewater-borne pollutants. *Hydrobiologia* **295**: 231-241.

Integrated farming with resource recycling and extension initiatives for sustainable economy

J. Indian Soc. Coastal agric. Res., 24(2), 289-294, 2006 **Invited Paper**

Model for Poverty Alleviation in Coastal Agro-ecosystem

S. ARULRAJ, C. V. SAIRAM and C. THAMBAN

Central Plantation Crops Research Institute, Kasaragod - 671 124, Kerala

Implementation of the poverty alleviation project through a large number of activities taken up by Central Plantation Crop Research Institute, Kasaragod, Kerala under IPGRI sponsored project on "Developing sustainable coconut-based income generating technologies in poor rural communities in India" proved the importance of organizing coconut farmers at grass root level by forming a Community Based Organisation (CBO) for planning and implementing interventions for enhancing their income and standard of living. Capacity building of farmers through training and Front Line Demonstrations were effective in bringing the desirable changes in the attitude of coconut growers towards adoption of improved technologies to enhance income from coconut farming. The concept of microcredit could be effectively employed for enabling members of CBO to take up need based interventions in their coconut gardens. Collaboration with other Government /Non-Government agencies were found quite useful for developing marketing infrastructure to ensure the success of all the income generating activities initiated by the CBO. The experience highlighted the relevance of appropriate technologies related to intercropping and product diversification for the reduction of poverty among coconut growers in the community. From the study it could be inferred that coconut farmers could augment their farm based income through community nursery, adoption of coconut based farming systems and production of high value coconut products through community based organization alongwith microcredit system approach.

(Key words: *Coconut based farming, Microcredit system, Community based organization, Product diversification for value addition, Women empowerment, Poverty alleviation)*

Rural development means improvement in the well being of the people living in rural space. If the improvement happens for the people who lack capabilities to meet the basic needs, rural development would encompass poverty alleviation. Traditionally poverty is viewed as pronounced deprivation in well-being. Agriculture generates wage employment for the landless households, as farmers hire labour for conducting farm operations and hence agricultural growth indirectly contributes to the growth of income of landless households and helps them to come above the poverty line.

In the coconut sector, its cultivation in the country is mainly in the hands of small and marginal farmers in the coastal agro-ecosystem. More than 90% of the coconut holdings are of less than 0.40 ha in size. In Kerala, it is basically a homestead crop having profound influence on the socioeconomic security of 2.50 million farmhouseholds. The average size of holding devoted to coconut farming is as small as 0.25 ha and over 90 percent of the holdings (accounting for 60 percent of the total area under the crop) are in the category of marginal holdings not capable of generating adequate income for the dependent households. Similarly in the East coast region, marginal (<1.0 ha) and small farmers (1.0 – 2.0 ha) predominate coconut farming, accounting for about 95% of the coconut community.

Research work carried out by the CPCRI, SAUs and other organizations have resulted in the identification of a substantial number of technologies for improving the production and productivity of coconut. But studies have shown that there still exists a gap between the productivity level of coconut at Research Stations and the yield level realized in farmers' gardens. The national average of coconut productivity is >7000 nuts ha^{-1} $year^{-1}$, while that of the best managed garden is 27,300 nuts ha^{-1} $year^{-1}$. It has been demonstrated that an increase in yield by four folds can be achieved by adopting proper cultivation practices for coconut as compared to the poor managed palms. Besides, lack of adoption of appropriate mixed cropping and mixed farming practices and the very low level of product diversification are leading to greater reliance on the returns from coconut only. There is a great scope for enhancing the production, productivity and returns from coconut cultivation through the adoption of scientific practices.

Central Plantation Crops Research Institute implemented an IPGRI sponsored project (with financial assistance from Asian Development Bank) entitled "Developing sustainable coconut-based income generating technologies in poor rural communities in India". India is one among the eight participating countries in this novel extension

project for "Poverty reduction through the use of new coconut technologies". CPCRI implemented the project during 2002-04 in Ariyankuppam and Pallikkara communities representing East coast and West coast regions in India. The three-pronged strategy for the project included i) growing suitable inter/mixed crops in coconut gardens and integrating animal husbandry and other subsidiary enterprises with coconut farming, ii) cultivating high yielding cultivars of coconut to enhance the yield and income, and iii) promote the diversification of coconut products. The special feature of the project was that the participants were to pay for the critical inputs, i.e. nothing was offered to the participants free of cost. Microcredit was provided to the Community Based Organisation members for introducing the interventions on intercropping in coconut gardens, livestock and fodder production activities and production and marketing of high value products.

METHODOLOGIES

The methodology in the project included several tasks such as sensitization of the project objectives among the coconut farmers, formation of Community Based Organization (CBO), formation of the Executive Committee of the CBO, creation of microcredit system, rapport building measures among the community members as well as various research, extension and development agencies, conducting training programmes about the project as well as various production, protection and processing aspects of coconut, formulation of an yearly action plan and its implementation, monitoring the action plan and dissemination of the success to other coconut farmers, extension and development agencies.

Group approach: Under the project, individual farmers were encouraged to form common-interest groups in undertaking similar income generating activities, which promoted social cohesiveness and group unity. It goes without saying that infrastructure, machinery, equipment and other physical facilities are important in a technology based poverty reduction project such as this. Under the project, the physical capital of the communities was enhanced by introducing simple, inexpensive, village level machinery and equipment to process coconut into high value, marketable products. This was a strategy adopted by the project to ensure that successful technologies would easily be replicated, adapted and expanded by the communities themselves at minimal cost but with maximum benefit to its constituents, even when the project ended.

Microcredit system: One of the main reasons why small scale coconut farmers remain poor is because they have very limited access to financial resources to diversify and invest in higher return, high value income generating activities or enterprises. Most of the coconut farmers are marginalized with less land and collateral to obtain loans and are considered non-bankable by formal lending institutions. Although the project provided funds to the communities, these were mostly in the form of revolving funds for microcredit that the CBO used to loan out to members which were repaid at nominal interest. With this principle in mind, the CBOs were encouraged to develop their own microcredit lending system, which would make their revolving fund grow. The establishment of these microcredit systems provided the 'non-bankable' farmers access to capital which they used to finance their various coconut based income generating activities. Such a system would ensure that farmers have continuous access to the needed financial resources to further expand their activities and at the same time catalyze the fiscal growth of the CBO to serve more poor members.

Project framework: For each community, the detailed project frame included-

a. Establishment and strengthening of CBO to manage the project at the community level. Special emphasis was made on the design of the CBO to ensure broad access and participation of several categories of stakeholders, including women;
b. establishment of a microcredit system and provision of initial revolving fund;
c. market surveys to identify marketable products and development of market channels to make such markets sustainable;
d. development and implementation of farmers' and women's action plans for income generating activities;
e. development of training manuals on income generating technologies and the development of instruments for analysis and promotion of viable technologies;
f. development of community managed income generating coconut seedling nurseries and the documentation, enhancement and conservation of selected and promising local and introduced coconut varieties;

g. draining of coconut farmers, women and village level entrepreneurs on income-generating technologies;

h. production and marketing of high value products from the coconut's kernel, husk, shell, wood, water and leaves;

i. introduction of: (i) coconut based intercropping technologies for enhancing incomes and food security; and (ii) livestock and fodder production to boost total farm productivity and nutrition; and

j. promoting the use of research results through field days and the replication and adoption of resulting viable development interventions by national governments, development organizations and NGOs.

Activities: The following activities were undertaken to achieve target outputs-

i. Conduct a community resource inventory,

ii. establish and strengthen a Community Based Organization (CBO) and develop a CBO Mission, Vision and Goals per project site,

iii. conduct a baseline socioeconomic and baseline food security and nutrition survey,

iv. establish a sustainable microcredit system and a CBO revolving fund,

v. conduct market surveys to identify marketable products,

vi. conduct pre-feasibility study to identify profitable marketable products,

vii. conduct training on CBO and microcredit management and on production of identified marketable and profitable products,

viii. develop a farmers' action plan and a women's action plan,

ix. develop a business plan for each item in the action plan,

x. integrate the project action plans into the village/town development plan,

xi. conduct production and marketing trials on production of high-value coconut products,

xii. development of catalogues of coconut food recipes and other village level delicious food recipes,

xiii. development of catalogues of high value products from coconut,

xiv. introduce intercropping interventions of cash and food security crops,

xv. introduce poultry and livestock/fodder production interventions,

xvi. conduct diversity fair, characterize farmers' coconut varieties and develop a catalogue,

xvii. establish a community-managed nursery per project site,

xviii. monitor survival of planted seedlings,

xix. conduct farmers' field days at least 1-2 times per year,

xx. document and publish success stories in each project site

RESULTS AND DISCUSSION

Situation analysis

Under a DFID funded project, a survey of ten poor coconut communities, which might form the ground for launching poverty alleviation programmes, was conducted. Using primary and secondary data, ten strategically located coconut growing communities representing the major coconut growing regions in India were identified. For each of the ten identified coconut growing

Table 1. *Socioeconomic data of selected project sites*

Sl. No	Location of the community	Average farm size (ha)	Average farm income (US$)	Education level	Socio-economic status	Farmers practising intercropping (%)	Farmers raising livestock (%)
1.	Andhra Pradesh	0.93	91.42	Secondary	Poor	62.00	35
2.	Goa	1.96	289.79	Secondary	Poor	10.00	33
3.	Karnataka	0.42	229.96	Primary	Poor	56.00	45
4.	Karnataka	1.70	213.70	Primary	Poor	27.00	93
5.	Kerala	0.21	68.45	Secondary	Poor	88.00	53
6.	Kerala	0.75	130.60	Primary	Poor	15.00	40
7.	Kerala	0.88	151.28	Primary	Poor	5	63
8.	Orissa	2.53	147.60	Primary	Poor	0.00	89
9.	Pondicherry	0.40	228.60	Primary	Poor	22.00	23
10.	Tamil Nadu	0.69	368.23	Primary	Poor	0.00	87

communities (with 100 coconut farmers per community as sample size), poverty situation was defined. Constraints, opportunities and technological interventions needed for poverty reduction were described. A brief summary of the details of the selected communities is presented in the Table 1.

Outcome

Community Based Organization (CBO)

Community Based Organisations (CBO) consisting of 320 members in Ariyankuppam site and 472 members in Pallikkara site were organized to implement the project interventions and operate the microcredit system. The study proved that sustainable coconut based income generating technologies can be successfully implemented through group approach. In Ariyankuppam, the CBO called "Aryiankuppam Commune Coconut Farmers Association" (ACCFA) was established and registered as a society in the Office of The Registrar of Industries, Pondicherry". An entry fee of Rs.50/- per participant was collected and the amount was added to the seed money. The office bearers of the Executive Committee were selected through consensus approach and the Executive Committee has 10 members including a women. A person was appointed on contract basis for managing the day to day functions of the CBO and for assisting the CBO executive. Similarly, a CBO was organized at Pallikkara also.

Community nurseries

Production and marketing of elite planting materials of coconut through community nursery was recorded to be technically feasible and economically viable for coconut farmers in the study area. For example, at Ariyankuppam, community nursery for the production of elite coconut planting materials was raised in three different locations of the site. During the period 2003-04, 1800 seedlings were sold @ Rs.13 and revenue of Rs.23400 was earned by ACCFA. After meeting the cost of production of Rs. 8 per seedling, the CBO realized a net profit of Rs.9000/-.

Improving coconut productivity

Efforts were taken to popularise the available coconut crop management technologies for improving the yield levels of existing coconut gardens. Special emphasis was given on the introduction of integrated nutrient management technologies which included coirpith composting and vermicomposting technologies, integrated pest management strategies for the control of rhinoceros beetle, leaf eating caterpillar and red palm weevil. Special emphasis was given on the management of stem bleeding disease in Aryiankuppam community.

Increasing income through intercrops

Results obtained from the intercropping interventions indicated that the coconut farmers could profitably cultivate intercrops such as brinjal, tomato, snake gourd, chillies, banana, elephant foot yam, tapioca, groundnut and fodder grass in the East coast and crops such as brinjal, chillies, banana, elephant foot yam, tapioca, ginger, turmeric, colocasia and fodder grass in the West coast. Mixed cropping in coconut garden with black pepper is economically viable in the West coast. In places where rainfall is not well distributed, irrigation may be necessary during summer months. However, these crops are to be adequately and separately manured in addition to the manures applied to the coconut palms. At Ariyankuppam, intercropping interventions were conducted for crops such as tapioca, groundnut, bajra, napier grass, rice, ragi etc. The realized profit varied between Rs. 5640 per ha in the case of tapioca to Rs. 32220 per ha in the case of bajra napier grass.

Increasing income through non-crop enterprises

The present study confirmed that the farming system involving diverse cropping models and enterprises, such as dairying, poultry rearing, pisciculture, apiculture etc. depending on the edaphic and climatic conditions that could ensure multiple sources of income, nutritious food of plant and animal origin and additional on-farm employment. It could also create opportunities for gainful employment to the women members of the participating households and facilitate efficient resource conservation. In Ariyankuppam, microcredit was extended to animal husbandry components which yielded a net profit of Rs. 3360 in the case of layers and Rs. 13235 in the case of broilers. Similar encouraging results were obtained in Pallikkara also.

Product diversification and value addition enterprises

Central Plantation Crops Research Institute has developed many technologies for value addition in coconut through product diversification. Production and marketing of such high value products from coconut provide opportunities to enhance income and employment opportunities especially to socio-economically disadvantaged rural women. The

success story of self help groups in the production and marketing of coconut chips, coconut burfy and snow ball tender nut clearly indicated the scope for income enhancement utilizing technologies of value addition in coconut. At Ariyankuppam, the following enterprises are in operation:

Interventions	Justification for the selection	Progress
1. *Copra* and oil production	Good domestic demand for the oil and the oil cake obtained will be used by the members as cattle feed	*Copra* is produced by the members. CBO collects the *copra* and then after crushing, oil & cake are sold out to the members or in the domestic market
2. Chips production	Since the nearby town is one of the famous tourism places, more scope is expected.	Chips are produced by the CBO on contract basis by using the members of CBO and marketed by CBO
3. Sale of tender coconut and snow ball tender coconut	Since the nearby town is one of the famous tourism places, more scope is expected.	Tender coconut is purchased and the snow ball tender nut is produced by the CBO on contract basis by the members of CBO and marketed by CBO
4. Coir yarn	Fibre produced by CBO will have good market in the area	Fibre is sold out to the members of CBO. After yarn production, it is collected by CBO for marketing in the nearby areas.
5. Handicrafts from coconut shell	Large quantity of shell available in the *copra* and chips making places is to be used effectively.	Shell is collected by CBO and various handicrafts are produced and marketed by CBO locally.
6. Collection of shell from the *copra* producing farmers and marketing to the existing shell flour unit	Large quantity of shell available in the *copra* and chips making places is to be used effectively.	Excess shell available is marketed to the existing shell flour unit
7. Vermicompost from coconut garden waste	Large demand exists for the compost. Large quantity of waste materials available from other cropping systems also are to be used.	Farmers are encouraged to put vermicomposting unit in their gardens. CBO collects the excess compost for marketing.
8. Coir pith compost by fungi	Large demand exists for the compost. Large quantity of waste materials available from other cropping systems are also to be used.	Farmers are encouraged to put coirpith composting units in their garden. CBO collects the excess compost for marketing.
9. Leaf plaiting	Large demand exists for the coconut leaf plaits. Large quantity of leaves which are now being used as fuel by the farmers. The expected returns through the sale of leaf plaits is Rs. 300 ha^{-1}.	Farmers are encouraged to prepare leaf plaits. CBO collects the final product for marketing.

Women empowerment

One of the major objectives of the IPGRI sponsored project was to increase the income of resource poor coconut farmers and socioeconomically disadvantaged rural women through the production of high value products from the coconut kernel, husk, shell, water, wood and leaves.

Major avenues for job for the women labourers in the coconut community include *beedi* rolling, laterite quarrying, construction works, etc. Number

of women agricultural labourers is on the decline, mostly because of the low wages and shift to sectors like construction works and laterite quarrying. The involvement of women in the coconut farm families is confined to agricultural operations such as transporting and application of manures and fertilizers, *copra* drying, transporting the harvested nuts, management and milking of cattle where mixed farming is followed, and other minor activities. It was assessed that there is immense scope for introducing interventions related to the promotion of women's groups for processing of high value coconut products at the farm household and community level. Hence a women's action plan was formulated under the project with emphasis on preparation of value added coconut products. Accordingly, a group of women representing the self help group, viz. Sree Durga Kudumbasree unit, Koottakkani has started for the production of coconut chips and coconut burfy.

All the members of the group attended the Entrepreneurship Development Programme on 'Value addition in Coconut' organised by CPCRI under the project for women at Pallikkara village. They acquired knowledge and skill for the production of coconut kernel based food products, preparation of coconut candies, production of coconut chips, etc. by attending the training programme. Besides the above topics, the concept and practices of entrepreneurship development, appropriate strategies for effective functioning of Self Help Groups, credit facilities for Self Help Groups and group approach for microlevel interventions on product diversification in coconut were also covered in the training programme.

Microcredit system through Community Based Organisation (CBO)

Before the implementation of IPGRI sponsored project on poverty reduction, the coconut farmers in various communities had faced the problem of getting quick agricultural loans for their investment. In those situations, they were mostly depending upon the private moneylenders, who have charged enormous interest rates for these loans. Hence the coconut farmers were put into difficulties for raising capital for their investments. By the establishment of a microcredit system through Community Based Organizations, a new dimension of Rural Finance for agriculture and allied enterprises was created, which was very well appreciated by the coconut farmers.

The strategies envisaged in the project were implemented through Community Based Organisation of coconut growers in the selected communities. The microcredit operations as well as the group based value addition enterprises were the major activities undertaken by the CBO. At Pallikkara, to implement the interventions, a Community Based Organization (CBO) was formed and christened as "Pallikkara Community Coconut Development Centre (PCCDC)".

Based on the criteria for assessing the effective functioning of CBO, it was found that the Pallikkara Community Coconut Development Centre, the local coconut farmers' organisation, has been successful in streamlining its activities to achieve the objectives.

The most characteristic feature of this microcredit system was that more than 98 percent of the members, who have availed the credit for the adoption of various intercropping/animal husbandry interventions, repaid their loan amount with a marginal interest rate of 2 percent per annum and these funds were ploughed back for carrying out other activities of the society.

Effective linkages established

For the effective implementation of various interventions at various stages of project implementation, linkages were established with the following agencies, primarily to avail the services offered by these organizations for the benefit of the farming community:

- State department of Agriculture
- State government sponsored poverty alleviation project
- Service Co-operative Banks
- Panchayat Raj Institutions (PRI's)
- State Department of Animal Husbandry
- State Dairy Development Department
- Non Governmental Organizations (NGO,s)
- State Agricultural University
- National Bank of Agriculture and Rural Development (NABARD)

Replication of results

Efforts were made to replicate this project in more number of communities in different parts of the country through the following approaches.

1. Give wide publicity for the results obtained from the project to encourage other institutions including NGOs to take up similar efforts.
2. Discuss with the Government of Pondicherry and the Government of Kerala and other State Governments about the impact of the project and encourage them to launch similar ventures in the State.
3. Discuss with Coconut Development Board to encourage them to initiate similar ventures in different states as a Plan Activity under the XIth Five Year Plan.

J. Indian Soc. Coastal agric. Res., 24(2), 295-298, 2006

Extension Methodology for Sustainable Coastal Aquaculture

M. KUMARAN, S. RAJA, M. ALAGAPPAN, D. D. VIMALA, C. SARADA, V. S. CHANDRASEKARAN and N. KALAIMANI

Central Institute of Brackishwater Aquaculture,
75, Santhome High Road, Chennai - 600 028

Effectiveness of the extension services are greatly influenced by the extension methodologies and strategy employed by the extension personnel in convincing their clients to adopt the innovations. The present study carried out along the east coast of Tamil Nadu and Andhra Pradesh with fishery extension personnel revealed that farm visit, farmers meetings, on-off campus trainings, exhibitions, etc. were the extension methodologies adopted by fishery extension personnel. However, their frequencies were observed to be very low. Investments in extension per se and capcity building of fishery extension personnel on alternative extension methodologies should be given top priority. Moreover planning and infrastructure strengthening in fisheries extension are of immediate concern. Organization for aquafarmers for group action, employment of participatory extension methodologies combined with ICT and mass media could be an extension strategy to promote sustainable growth and development of coastal aquaculture.

***(Key words:** Acquaculture extension, Capacity building, Manpower planning)*

Extension is an applied behavioural science, the knowledge of which is applied to bring about desirable changes in human behaviour usually through various strategies and programmes of changes and by applying latest scientific technological innovations. The Bangkok Declaration and Strategy on aquaculture development (NACA/ FAO 2000) emphasized that investments in research, extension and training would lead to the development of aquaculture systems, effectively managed according to best available practices integrated with surrounding ecosystems. Investments in extension may certainly be attribute to the rapid development of aquaculture and China is an example of this contributing 68% of Asian aquaculture production (Wang 2001, World Bank 1998). Successful introduction of technological change in aquaculture depends on effective communication and extension. These constraints are particularly acute in developing countries (Jagger and Ponder, 2001), where institutions and infrastructure to promote dissemination of information are lacking. Nonetheless, the development and dissemination of inexpensive sustainable technologies to assist aquaculturists are crucial. Transfer of aquaculture technology requires a sustained long term effort working directly with farmers through the development of an efficient extension system (Engle and Stone, 1989).

Extension and developmental efforts in the fisheries sector could improve the socioeconomic conditions of fish farmers particularly the shrimp farmers through gain in knowledge, increased production and favourable attitudes (Krishna, 1986). In India, coastal aquaculture with an enormous potential untapped in coastal (1.2 million ha) and inland saline soils of north and northwest parts of the country (about 8 million ha) could contribute for augmenting its fisheries production. However, presently coastal aquaculture is confined with tiger shrimp culture (*Peneaus monodon*) which is being practised in 1, 54,600 ha with a production of 1,12,780 metric tonnes for national productivity of 730 kg ha^{-1} $annum^{-1}$ (Table 1). Shrimp is a major foreign exchange earner which accounted for about 29% of the fisheries export (in terms of volume) and about 66% in terms of value. Effectiveness of the extension services is greatly influenced by the extension methodologies employed by the extension personnel and the techniques used by him in convincing their clients to adopt the innovations. Aquaculture, being a technically loaded enterprise, needs novel methods of information delivery. With this background the present investigation was taken up to study the extension methodology employed, extension materials used, frequency, subject matter covered, and follow-up undertaken.

METHODOLOGIES

This investigation was conducted along the east coast in Tamil Nadu and Andhra Pradesh States of India where shrimp aquaculture is being actively practised. A sample of 30 extension personnel, fifteen personnel each of the Department of Fisheries

Table 1. *Statewise details of shrimp production during the year, 2003-04*

State	Potential area available (ha)	Area developed (ha)	Area under culture (ha)	Production (MT)	Productivity (Mt/ha/yr)
West Bengal	405000	50405	49925	29714	0.60
Orissa	31600	12880	12116	12390	1.02
Andhra Pradesh	150000	79270	69638	53124	0.76
Tamil Nadu	56800	5416	3214	6070	1.89
Kerala	65000	16323	14029	6461	0.46
Karnataka	8000	3435	3085	1830	0.59
Goa	18500	1001	963	700	0.73
Maharashtra	80000	1056	615	981	1.60
Gujarat	376000	1537	1013	1510	1.49
Total	**1190900**	**171320**	**154600**	**112780**	**0.73**

of each of the above States working in the coastal regions, was drawn using simple random sampling procedure. A structured interview schedule pre-tested with similar personnel elsewhere and personal observation were used for data collection. Ten independent variables, viz. age, education, experience, training attended, roles of performance, frequency of contact, resource appraisal, collaboratory work, targets, information behavior and awareness of good management practices were included to know the attributes of extension personnel and their extent of influence on the extension methodology employed. The dependent variable 'extension methodology' employed was studied and measured based on a summated rating procedure developed for the study, which includes extension methodology employed, frequency and follow-up undertaken. The data collected were processed with descriptive, correlation and regression statistics using SPSS package to interpret the findings.

RESULTS AND DISCUSSION

Attributes of the extension personnel

Personal attributes of the respondents were studied to have a better understanding of their profile and presented in the Table 2.

Around fifty percent (47%) of the respondents were aged less than 40 years and the other half (53%) aged above 40 years. This aptly indicated the lack of recruitment of young professionals from the fisheries research and academic institutions to the DOF like extension personnel in the recent past. More than half of the respondents (53%) were post-graduates or diploma holders. Majority of them (80%) had less than three years of field experience in coastal shrimp farming. However, majority of them had undergone trainings and among them about thirty percent had training either on shrimp or scampi (freshwater prawn) culture. Majority of them

Table 2. *Attributes of fishery extension personnel*

Attribute	% Response (N=25)
Age	
< 40 years	44.00
> 40 years	56.00
Education	
Graduation	52.00
Above graduation	48.00
Experience in costal aquaculture	
< 3 years	84.00
> 3 years	16.00
Extension approach	
Group contact	72.00
Personal contact	28.00
Frequency of contact	
Once a month	40.00
Occasional	60.00
Willingness to work with private extension	
Yes	84.00
NO	16.00
Communication of field problems to research (Through head office)	68.00
Nativity	
Rural	56.00
Urban	44.00
Technical information source	
Department R& D & Training Centre	56.00
Training	
Attended	84.00
Needed	60.00

(73%) followed group contact extension method to meet aquafarmers and group meetings were conducted at different places of their jurisdiction depending on the field situation. Most of them (83%) expressed willingness to work with private extension personnel of aquafeed companies since the latter had regular contact with the farmers. Majority of them (70%) reported their field problems to their head offices and in turn the same were communicated to the research wing of the department for solutions. They were of the perception that the farmers had followed their technical advice. Departmental training centre was their prime information source for majority (57%) of the respondents. Majority of them (60%) wanted training in extension methodologies, human relations management and subject matter.

Extension methodologies employed

Extension and technology transfer *per se* have been the responsibility of the State Departments. The Fish Farmers development Agency (FFDAs) and Brackishwater Fish Farmers Development Agency (BFDAs) with district level jurisdiction have been the important machinery for promotion of aquaculture. Extension methods, materials used, their frequency, subject matter covered and follow-up undertaken by the extension personnel are given in Table 3.

Farm visit to the aquafarms once a week for a direct personal contact was the prime extension methodology adopted for majority of the respondents (60%). Personal phone calls, pamphlets and printed manuals in local lingua were the extension materials used during farm visits. Information on Good Management Practices was shared with their clients and such interactions were reinforced during the following visit. 'Farmers meets' up to two meetings per month in different locations of their jurisdiction was the next preferred extension method employed as reported by more than half (57%) of the respondents. Lectures, printed farm publications, etc. complemented the farmers meetings. Aspects discussed during such meetings were followed up during their next visits. Off-campus training programmes were used as extension methodology by forty percent of the respondents. Printed manuals on local language, posters, pamphlets, etc were the extension materials used. Major topics covered were, viz. disease prevention & management, water quality management, feed management, probiotics culture, etc. Follow-up to this programme was done during the next visit or meeting.

Nearly one-third of the respondents reported that demonstration on diversification of aquaculture species like crab culture, antibiotics free culture, good management practices of shrimp culture was one of their extension methodologies. On-campus trainings, exhibitions, writing through mass media,

Table 3. *Extension methodology employed by DoF extension personnel*

Method	% response (N=30)	Extension materials used	Frequency	Topics covered	Follow-up
Farm visit	60.00	Phone calls, pamphlets	Weekly	Good Management Practices – especially on disease management, awareness creation on banned antibiotics, etc.	During next visit or meeting
Farmers meets	57.00	Lecture pamphlets	Monthly twice	On Good Management Practices – problems encountered by the farmers.	During next visit or meeting
Training (off-campus)	40.00	Printed manuals on local language, posters, pamphlets, etc.	Throughout the culture	Diseases prevention & management, water quality management, feed management, probiotics culture, etc.	During next visit or meeting
Demonstration	33.00	Printed literature on local language	Once in two years	Diversification – crab culture, good management practices	During next visit or meeting
Training (on-campus), viz. exhibition, workshop, writing through mass media etc.	20.00	Posters, manuals/ books, specimens	Yearly once	On good management practices - selection of quality seed	During field visits or meetings

etc. were the other extension methods used by one-fifth of the respondents (20%) to influence the farmers to adopt their advice. Farm publications, specimens, mass media, etc. were used extensively during these events. All these programmes were followed up during their regular farm contacts.

It is understood that farm visit, farmers meets, demonstration, training, exhibition, workshop, etc. were the extension methodologies used by the extension personnel. However, personal contact with farmers, which is cornerstone of extension, is absolutely lacking. Further, the above programmes were organized at different locations with a different audience, where the follow-up and reinforcement of information were totally ignored. This could be because of lack of adequate manpower and orientation of extension personnel with extension per se and extension education. Extension infrastructure, transport and provision of extension equipments at extension centers are very important for an effective extension service. Hence, substantiative investments in extension per se and capacity building of extension personnel on extension education and methodologies should be urgently addressed. Moreover extension campaigns for awareness building, organizing farmers for collective action and use of such groups as nodal points for extension, employemtn of farmer participatory methods like PRA, PLA, etc. combined with ICT and mass media could be pragmatic extension strategy for the coastal fishery fishery extension personnel. A dynamic extension mechanism for information delivery and feedback and a strong linkage with research system are to be evolved at State level. Packages of practices in the form of fishery extension officer, dairy or crop production guide should be prepared and supplied to the extension personnel to facilitate their work.

Regression analysis of attributes with Extension Methodology Employed

The nature of influence, the attributes of extension personnel had during their linkage with R&D institutions were studied by a regression analysis and the results are reported in Table 4. About 86% (R^2=0.858) of variation in extension methodology used was influenced by the attributes of extension personnel. Among the twelve variables taken for analysis, roles regarding performance and awareness of Good Management Practices of shrimp aquaculture were found to have significant influence at 5% level. Proper perception of the role as change agent to facilitate the end users to adopt proper management practices could have helped the extension personnel in choosing an effective extension methodologies or their combination. The knowledge on the good management practices of shrimp or scampi farming would facilitate the extension personnel in employing appropriate extension methodology and help in planning a strategy to reach, convince and motivate the end users.

Table 4. *Regression analyses of attributes with extension methodology adopted*

Attribute	Regression coefficient	
	B	SEm±
Age	0.173	0.126
Education	-1.682	0.865
Experience	-0.004	0.130
Training attended	-1.378	0.859
Role performance	1.132*	0.270
Frequency contact	2.605	1.265
Resource appraisal	0.346	0.558
Collaboratory work	3.351	2.998
Targets	0.431	0.365
Information behavior	-0.0003	0.063
Linkage	0.144	0.082
Awareness	0.146*	0.034
	R^2 = 0.858	

*Significant at 5% level

ACKNOWLEDGEMENT

The authors are grateful to the Indian Council of Agricultural Research for the funding the project.

REFERENCES

Engle, C.R. and Stone, N.M.. (1989). *A Review of Extension Methodologies in Aquaculture*, Aquaculture Development and Coordination Programme, FAO, Rome. 65p.

Jagger, P. and Ponder, J. (2001). Issues for aquaculture in East Africa: The case of Uganda, *Naga. The ICLARM Quarterly* **24**(1-2): 42-51.

Krishna. S. (1986). Prawn farming: A study on the attitude and awareness of farmers. *Indian Journal of Extension Education* **XXI**(1&2): 74-76.

NACA/FAO. (2000). *Aquaculture Development Beyond 2000: The Bangkok Declaration and Strategy*, NACA/FAO, Rome.

Wang.Y. (2001). China P.R.1: A review of national aquaculture development. In *Aquaculture in the Third Millennium*. Technical Proceedings Conference *Aquaculture in the Third Millennium*, Bangkok, Thailand.

World Bank. (1998). *Subsisdies in World Fisheries: A Re-examination*. World Bank Technical Paper **406**, Washington D.C.

J. Indian Soc. Coastal agric. Res., 24(2), 299-301, 2006

Extension of Jute Agriculture in Sundarbans Biosphere for Conservation of Biodiversity and Coastal Zone Security

A. BANDYOPADHYAY, A. K. MAHAPATRA and A. K. JANA

Central Research Institute for Jute and Allied Fibres
Barrackpore - 700 120, West Bengal

One hundred fifty-four Islands on the estuarine mouth of the river Ganga constitute Sundarbans Biosphere Reserve (SBR) in south coast of West Bengal. Fifty Islands are under mangrove forest cover and rest fifty-four are reclaimed for agriculture and general habitation. This tidal forest is highly productive and considered as biodiversity rich area. Over-exploitation of natural resource by surrounding people is a great concern, which necessitates to take up effective measures for biodiversity conservation and coastal zone security against storm, oceanic surges and other devastations as well. Though forestry, pisciculture and epiculture have got some success, agriculture still tops the list to generate employment. Both success and failure have been witnessed in trial and error method of several new crops. Introduction of jute with feasibility studies is an attempt towards more employment generation, as well as, a step against deforestation of mangrove forest for firewood, thus, tightening coastal security against natural calamities.

(Key words: *Biosphere reserve in Sundarbans, Exploitation of natural resources, Alternative agriculture)*

India, the seventh largest country of the world, with her 45,000 plant species and 81,000 fauna, is considered as a major centre of origin and diversity of more than 20 agricultural crops. It has coastal line of about 7500 km with varied precipitation, which constitute rich landscape diversity. About 2700 plant species are endemic and Eastern Himalaya, Western Ghats and mangrove rich coastal Sundarbanss are well known for endemic and plant diversity. For the sustenance of rich biodiversity, Government of India designated 12 biosphere reservers to protect the natural ecosystem (Sanjappa, 2001). Sundarbans Biosphere Reserve (SBR) was one of them declared on 29 March, 1989. An international programme like Man and Biosphere programme of United Nations Educational, Scientific and Cultural Organisation (UNESCO) was launched in 1971 that gave emphasis on *in-situ* conservation of biological diversity in reserves and including Plant Genetic Resources (PGR) (Skouri and Robertson, 1995). FAO, UNEP, IUCN and UNESCO are the major patrons of Biosphere Reserve Programme for conservation of natural resources and sustainable development.

Under National Agricultural Technology Project on 'Sustainable Management of Plant Biodervisity (PGR)' three special exploration missions to Sundarbans were conducted for collection of PGR of different agri-horticultural crops in last two years. Observations on status of biodiversity made during these visits is discussed. Based on the observation and experiment on jute, introduction of jute and mesta are suggested for some Islands in Sundarbans as an aid towards sustainable development, biodiversity conservation and coastal zone security.

MATERIALS AND METHODS

Features of Sundarbans Biosphere Reserve (SBR)

SBR (latitude $21^0 32'$ and $22^0 40'$ N and longitude $88^0 05'$ E and 89^0 E) covering an area of 9630 sq km consists of 104 Islands at the estuarine mouth of the river Ganga and lies at coastal West Bengal facing Bay of Bengal in the south. North-west boundary is demarcated by Dampier-Hodges Line (named after the surveyors) which extends from Kulpi (Kakdwip) in South 24-Parganas district to Basirhat in North 24-Parganas district. Out of 104 Islands, 50 are under forest cover and rest 54 are reclaimed for human habitation. There are altogether 19 administrative blocks under two districts. These are Hingalganj, Hasnabad, Haroa, Sandeshkhali-I, Sandeshkhali-II and Minakha in North 24-Parganas and rest 13 blocks of South 24-Parganas are Canning-I, Canning-II, Basanti, Gosaba, Patharpratima, Kakdwip, Sagar, Kulti, Mathurapur-I, Mathurapur-II, Jaynagar-I and Jaynagar-II.

In this ecosystem, mangrove trees and shrubs growing at sea-land interface zone are regularly

inundated twice by saline tidal waves. Mangrove plants and associated fauna have developed special salinity resistant mechanism for their existence in this environment. Since there is no clear definition for mangrove plants the total number of species in mangroves differs like 48 (Tomlinson, 1986), 33 (Naskar, 1996), while Banerjee (2001) stated that SBR harbours 62 mangrove species of which 6-7 species are endemic. Besides mangroves plants, huge number of algae, bacteria and other microorganisms enrich the biodiversity. This unique and fragile ecosystem supports many other life-forms representing terrestrial, aquatic and avian fauna through a definite food chain. Mangrove vegetation of this coast comprising of 60 percent of Indian mangrove vegetation forms the largest nursery of fish and shellfishes and therefore, are responsible for coastal fishery for the whole of eastern India. In animal, there are about 1586 species including mammals, birds, reptiles and protozoa groups (Das and Nandi, 2001). Like all other biosphere reserves of the world, 9630 sq km of total SBR area is divided into three zones, namely Core area, Buffer zone and Transition area.

1. Core area: Sundarbans National Park is situated in the core area of about 1692 sq km serves as tiger and mangroves reserve.
2. Buffer zone: It lies next to core area having 4264 sq km of reserve forest where 3 wild life sanctuaries, viz. Sajnekhali, Lothian Island and Holiday Island are situated.
3. Transition area: This is next to the buffer zone and outermost part of SBR, having an area of 3674 sq km. This is the dynamic zone of cooperation with local communities where emphasis is given on intensive agriculture, pisciculture, settlement, managed forest, areas of recreation as well as on experiment with alternative sustainable use of resource development and for conservation of this ecosystem for eastern coastal zone of India as a whole.

Agroclimatic condition

In summer, temperature hardly exceeds 38 ^{0}C in May and June. Most of the annual precipitation is received during June to October. High humidity prevails all through the year. Cyclonic storms occur sometimes in April and are frequent during monsoon and rainfall in July-August. Tidal water height ranges from 0.96 to 5.8 meters (Sanyal, 1996). Soils of upper deltaic plain are loamy in texture and neutral to slight alkaline while in lower delta acidic to alkaline (pH 5.0-8.0) with fine texture. Soils of marshes are also fine textured with acidic to neutral in reaction.

Experiment on alternative agriculture

Total fourteen germplasm accessions, two of *Corchorus olitorius* and twelve of *Corchorus capsularis* after collection from SBR, were primarily evaluated for their fibre yield and yield contributing characters at the experimental farm of Central Research Institute for Jute and Allied Fibres (CRIJAF) at Barrackpore. Data were collected and expressed on mean value of five randomly harvested plants, which included plant height, stem diameter (basal, middle and top), number of nodes, dry fibre and stick weight per plant.

RESULTS AND DISCUSSION

It was observed from the study on alternative agriculture at CRIJAF that in *C. capsularis* (white jute) fibre yield was low, except in two accessions where, the fibre yield per plant was slightly lower than existing cultivars, viz. 8.4 g (SBC 1/68) and 8.2 g (SBC 2/13). In one accession of *Corchorus olitorius*, fibre yield was recorded as 17.8 g per plant, which was higher than the existing varieties. Of course, this was a preliminary data but it indicated the possibility of jute cultivation in Sagar and Patharpratima Islands where mangrove forest was reclaimed long back for agriculture, and salinity was very less. Yadav *et al.* (1978) also stated that except a few, most of cultivated areas of Sundarbans turned non-saline during *kharif* season. So jute can be well suited in this coastal zone. In this regard, allied fibre, HC mesta (kenaf) is more tolerant to salinity and therefore, can also be tried for cultivation. Moreover, it can act as a supportive crop for betelvine cultivation, which has come up recently as prime cash crop of Sagar Island. Most of the farmers cultivate betelvine here, for which about 300 truck load of jute stick are brought to this Island annually from distant districts of West Bengal by road and river transport. Cost of jute sticks varies from Rupees fifty to sixty per bundle of 300 sticks. Mahapatra (1999), in his earlier study on SBR, also proposed for probable introduction of jute in Sagar Island.

Our experience on jute agriculture in the following areas indicates its probable cultivation in Sagar and adjacent Islands of SBR.

Data on jute production in Northern Transition Zone of SBR

Places in North SBR	Area under cultivation (ha)	Production of fibre (q/ha)
Hingalganj	150	19.8
Hasnabad	475	19.8
Haroa	300	25.2
Sandeshkhali-I	40	18.0
Sandeshkhali-II	20	18.0
Minakha	47	18.0

Earlier sugar beet, cotton, sunflower, chilli and watermelon were introduced for cultivation. Except chilli and watermelon other crops are not cultivated at present due to some reason or other.

A good number of PGR of jute, mesta and other crops were thus collected from Sagar Island of Sundarbans and conserved in National Gene Bank in New Delhi. In addition PGR of Jute and other Allied Fibre Crops were also conserved in Mid-term Gene Bank of CRIJAF for their further use. Experiments on these germplasm, as expressed earlier, for their feasibility as a cultivated crop while grown under proper agronomic practices had already shown promise. Our experience on jute and H.C.mesta cultivation in Northern transition zone of SBR was encouraging. Similarly, from recent studies, it might be resolved that jute and mesta cultivation is possible in Sagar and adjacent Islands lying in the western part of SBR. Moreover, with the availability of jute stick, a good source of fuel, deforestation at an alarming rate due to firewood collection will be checked. Stress on this ecosystem due to anthropogenic pressure could be overcome through development of intensive agriculture and thus, introduction of new suitable crop like jute is the need of the hour.

CONCLUSION

By engaging more and more jobless rural poor in alternative agriculture throughout the year, their dependence on the natural resources of this coastal ecosystem will be reduced. Restoration of this highly productive ecosystem to cater for a larger area was very much necessary for people of this biosphere reserve.

ACKNOWLEDGEMENT

Authors are grateful to the National Director, NATP-PB for funding.

REFERENCES

Banerjee, L.K. (2001). Status of endangered plant species in Sundarbans Biosphere Reserve. Proceedings Workshop *Sundarbans Day*, held at Kolkata, 3rd Jun, 2001. SBR & Zilla Parisad, 24-Parganas (South).

Das, A.K. and Nandi, N.C. (2001). Endangered and threatened animals of Sundarbans Biosphere Reserve. Proceedings Workshop *Sundarbans Day*, held at Kolkata, 3rd Jun, 2001. SBR & Zilla Parisad, 24-Parganas (South).

Mahapatra, A.K. (1999) Sundarbans biosphere reserve – its perspective. In *Sundarbans Mangal*, Guha Bakshi, *et al.* (eds.), pp. 386-399, Naya Prakash, Calcutta.

Naskar, K.R. (1996). Status of mangroves in Sundarbans in the perspectives of India and World Mangal. Proceedings Willium Roxburgh Memorial Seminar *Sundarbans Mangal*, pp. 19-65, held at Calcutta, 8-10 Nov. Calcutta Wild Life Society.

Sanjappa, M. (2001). In *State of the Art Report, Sundarbans Biosphere Reserve*, Botanical Survey of India, Kolkata. 1p.

Sanyal, P. (1996). Sundarbans, the largest mangrove diversity on globe. Proceedings William Roxburgh Seminar *Sundarbans Mangal*, held at Calcutta, 8-10 Nov. Calcutta Wild Life Society.

Skouri, M. and Robertson, J. (1995). Success in UNESCO biosphere reserve network in Mediterranean will impact biodiversity conservation plans. *Biodiversity* **II** (1&2): 39-40.

Tomlinson, P.B. (1986). *The Botany of Mangroves*, Cambridge University Press, London, New York. 414p.

Yadav, J.S.P., Bandyopadhyay, A.K. and Rao, K.V.G.K. (1978). *Management of Coastal Saline Soil of Sundarbans*, Bulletin **7**, CSSRI, Karnal.

J. Indian Soc. Coastal agric. Res., 24(2), 302-305, 2006

Technological Interventions for Women Empowerment in Coastal Agro-ecosystem

S. RAMANATHAN and M. ANATHARAMAN

Central Tuber Crops Research Institute
Sreekariyam, Thiruvananthapuram - 695 017, Kerala

Women play a vital, but silent role in agricultural development especially in the developing countries like India. Of late, great attention has been paid towards developing gender specific technologies aimed at improving the status of women, the invisible workers, in terms of reducing drudgery, increasing employment generation and enhancing income levels. Majority of the farm families in Kerala belonged to small and marginal farmers and landless labourers category and farm women were observed to contribute much towards the family income working as agricultural labourers and engaging themselves in off-farm avocations. Technological assessments were done to delineate appropriate technologies under the institution - Village Linkage programme of coastal agro-ecosystem operated at Chenkal village in Neyyatinkara *Taluk*, Thiruvanathapuram District, Kerala by the Central Tuber Crops Research Institute. Keeping the problem-cause relationship of farm women as the base, technological interventions such as backyard poverty, turkey rearing, goat rearing, mushroom cultivation, etc. were introduced and assessed for improving the contribution of farm women. The detailed socioeconomic assessment of these interventions revealed additional employment generation to the tune of 45-50 labour days from backyard poverty, turkey and goat rearing and around 100 days from mushroom cultivation. Similarly these interventions enabled the farm women to generate a net income of Rs 1365 per head (poultry Rs 140 per bird per year; turkey Rs. 225 per bird; goat Rs. 600 per goat, and mushroom Rs. 400 per person from 100 beds). The experience in the technological assessment for women empowerment to make them self reliant is discussed in this paper.

(***Key words:*** *Technological intervention, Women empowerment, Coastal agro-ecosystem, IVLP)*

Women constitute the invisible work force and contribute towards rural and family economy. They play a crucial role in food production producing more than half of the world's food (FAO 1986). However, it is often observed that woman remain invisible, their presence not counted, their contribution to agriculture remains unaccounted and their priorities and problems remain unattended. In this context it is worthy to mention that the Indian National Policy for the Empowerment of Women, in 2001, stressed the need to main stream "Gender Perspectives" in the process of development and envisaged women specific interventions where there are currently gaps in policies and programmes. Experience in the past had indicated that if women rather than men are targeted with resources, the end result is that welfare benefits will accrue directly to them and their children (Buvinic and Gupta, 1997). Women accounts for more than 76 percent of marginal workers and about 16 percent of main workers. Amongst the main workers, more women seemed to belong to the category of agricultural labourers. In Kerala about 79 percent of the female work force is absorbed in agriculture sector and female agriculture labourer constituted about 47 percent of total work force (Census of India, 1981). Creation of gainfull employment in and around the homestead is perhaps the most essential requirement to raise the income levels of farm women so as to empower them.

In this context, different strategies are required which encompass advocacy, access to resources, capacity building and organizational issues. When the Institution - Village Linkage Programme (IVLP) came into operation under the coastal agro-ecosystem during 1999 at the Central Tuber Crops Research Institute (CTCRI) the agro-ecosystem analysis of the adopted village Chenkal in Thiruvananthapuram district, Kerala indicated that the agricultural labourers, particularly women constituted nearly 60 percent of the households belonging to scheduled castes and most backward classes. Based on problem-cause relationship, various technological interventions were contemplated and implemented for increasing the income of these farm women. The present investigation was conducted under IVLP with the objectives of assessment of the performance of improved breeds of poultry, goat, turkey rearing and mushroom cultivation, and empowering the farm

women through increased income and employment generation through these technological interventions.

MATERIALS AND METHODS

The study was taken up amongst the farm women beneficiaries of IVLP of CTCRI operated at Chenkal village. The selected beneficiaries were supplied with improved breeds of poultry, goat, turkey and mushroom. About 160 farm women were given improved poultry breeds, namely Kadakkanath, Nicobari and Nakedneck. Likewise turkey birds of 6-8 week age were supplied to 75 farm women. The improved goat breed "Malabari" was distributed to 30 farm women. Two women Self Help Groups consisting of 25 members each were given the critical inputs for mushroom cultivation, *viz.* spawn of variety - Co1 and Florida of *Pleurotus* sp. These technological interventions were supported with appropriate hands-on training in backyard poultry rearing, goat rearing, turkey rearing and mushroom cultivation involving the resources personnel available in other organizations like Kerala Agricultural University, Dept. of Animal Husbandry, Kerala State, etc. Detailed socioeconomic assessment of these technological interventions were carried out amongst the 315 beneficiaries through personal interview and focused group discussion.

RESULTS AND DISCUSSION

Backyard poultry

The assessment of the performance of improved backyard poultry breeds vis-à-vis the local breed was carried out amongst the 160 farm women who where supplied with these birds. The comparative performance of these breeds is presented in Table 1. A perusal of the data clearly indicates the superior performance of Nicobari breed as compared to others with an annual egg production of 210 per bird. While Nakedneck produced 200 eggs and Kadakkanath, 190 eggs, the local breed could produce only 170 eggs. Compared to high mortality rate (>50 percent) of the local and Nakedneck, Nikobari and Kadakkanath exhibited low (< 25 percent) mortality. Similarly, these two breeds had medium tolerance /resistance to diseases. In tune with highest egg production Nicobari gave the maximum net return of the 165 per bird with a benefit-cost ratio of 1.45:1. Pramanik and Rai (2004) also observed from their IVLP experience that the farmers of Andaman and Nicobar Islands too rated improved Nicobari breed as the best suited for backyard with an annual egg production of 137 per bird. In addition, they observed Nicobari to possess very less broodiness (10-15 days) compared to *Desi* birds. Thus, backyard poultry has emerged as a strong potential as an income generating activity amongst the rural poor, especially farm women. Therefore, the performance assessment and careful selection of right kind of breed suited to the specific locality is a key to success in backyard poultry. While Sivakumar *et al.* (2005) and CIBA (2005) identified Nandanam breed of chicken as best suited to Kancheepuram and Chennai region, Tamil Nadu, Vanaraja breed was assessed to be performing better under East Godavari belt of Andhra Pradesh (CTRI, 2005) and Gramalakshmi and Gramasree as appropriate breeds for Central Kerala condition (KAU, 2005). All these pointed to the fact that backyard poultry was a beneficial avocation to boost the income and empower farm women. It is also noteworthy to mention that the technoeconomic analysis of poultry production with technological innovations comprising rearing of hybrid strains of poultry for egg production, scientific method of housing, management and disease control resulted in a profit of Rs. 11880 and generated 300 man days of employment from a poultry unit of 1000 layers (ICAR, 1988).

Table 1. *Comparative performance of improved breeds of backyard poultry*

Performance indicator	Local	Kadakkanath	Nicobari	Nakedneck
Mortality	High (>50%)	Low (<25%)	Low (<25%)	High (>50%)
Tolerance/resistance to diseases	Low	Medium	Medium	Low
Weight gained in 10 months (kg/bird)	1.35	1.20	1.85	1.40
Annual egg production (no./bird)	170	190	210	200
Cost of rearing (Rs./bird)	320	360	360	360
Gross returns (Rs./bird)	425	475	525	500
Net returns (Rs./bird)	105	115	165	140
Benefit : Cost ratio	1.32:1	1.31:1	1.45:1	1.38:1

Turkey rearing

Turkey rearing was assessed to be another profitable enterprise for farm women. The turkey birds of 6-8 weeks age with an average body weight of 1 kg supplied to 75 women beneficiaries gained a body weight of 6 kg at 5-6 month stage. By selling the turkey meat @ Rs. 125/- per kg, they earned a gross return of Rs. 875/- and a net return of Rs. 225/- per bird. Good taste of meat, high market price, less disease incidence, etc. were perceived as the positive aspects of turkey rearing, whereas, high cost of chicks, need for big cagé, indiscriminate eating of greenery by the turkey birds in and around the homestead, etc. were expressed as the negative aspects. Nevertheless, rearing of Beltsville small white turkey under backyard system resulted in higher body weight and higher revenue to farm women under the IVLP of Livestock Research Station (TANUVAS) at Kattupakkam (Sivakumar *et al.*, 2005).

Goat rearing

The performance of improved breed of goat Malabari was assessed under IVLP village condition by 30 farm women as beneficiaries and the details of the parameters assessed are given in Table 2. Though both the local breed as well as Malabari had high survival percentage (>90 percent), Malabari had higher percentage of goats conceived (83%) and delivered (85%), when compared to the local. This breed also gave a marginally higher milk yield (0.25 lit per goat per day) than the local. By way of selling milk and kids, the farm women realized an additional income of Rs. 600/- from goat rearing. ICAR (1988) also observed that the enterprises suitable for women might be goat and /or sheep rearing (with 25 cross breed goat or sheep and one ram) which generated 240 man days of employment with an annual profit of Rs. 2380/-.

Backyard poultry, turkey rearing and goat raring put together enabled the farm women to earn a net income of Rs. 965/- per head and generated around 45-50 man days of employment.

Table 2. *Comparative performance of Malabari breed of goat under homestead*

Performance indicators	Local	Malabari
Survival (%)	90	93
Goats conceived (%)	44	83
Goats delivered	64	85
Average milk production (litre/goat/day)	0.50	0.75

Mushroom cultivation

Mushroom cultivation is relatively a new technological intervention assessed under IVLP for effective utilization of leisure time of farm women. Under TAR-IVLP at Chenkal village, two mushroom units were established which were solely managed by the members of two women Self Help Groups. They were given hands on training on various aspects of mushroom cultivation and critical inputs like mushroom spawn, etc. were supplied under the programme. The farm women cultivated two varieties of *Pleurotus* sp. namely Col and Florida. On an average they produced 100 kg mushroom from 100 beds at a production cost of Rs. 30/- per kg and earned a net profit of Rs. 6000/-. Preparation and sale of value added products from mushroom like pickles, cutlet, pakoda, etc. also generated additional income. The farm women had gainful employment of 100 labour days through mushroom cultivation. Agro-ecosystem Directorate (Coastal) (2005) indicated that mushroom cultivation was assessed as a profitable enterprise for empowerment of farm women under the IVLP at CTCRI, CPCRI and CSSRI.

REFERENCES

Agro-ecosystem Directorate (Coastal) (2005). Genesis, Assessment, Refinement and Success. Report (TAR-IVLP, 1999-2004), *National Agricultural Technology Project*, CTCRI, Thiruvananthapuram.

Buvinic and Gupta, G.R. (1997). Female headed households and female maintained families. Are they worth targeting to reduce poverty in developing countries? *Economic Development and Cultural Change* **45**(2).

Census of India (1981). *District Census Hand Book*, Series **10**, Thiruvananthapuram, Kerala.

CIBA (2005). Institution-Village Linkage Programme for Technology Assessment and Refinement in Coastal Agro-ecosystem of Thiruvallur District of Tamil Nadu. Final Report *National Agricultural Technology Project*, CIBA, Chennai.

CTRI (2005). Final Report *Technology Assessment and Refinement through Institution-Village Linkage Programme in Krishna-Godavari Agro-climatic Zone of the Coastal Agro-ecosystem*. CTRI, Rajahmundry.

FAO (1986). Women are farmers too. *News Release*, February, 1986, FAO, Rome.

ICAR (1988). Future research strategy and linkage with development systems. Proceedings International Conference *Appropriate Agricultural Technologies for Farm Women*, held at New Delhi, 30 Nov to 6 Dec, 1988.

KAU (2005). Project Report, *Technology Assessment and Refinement through Institution-Village Linkage Programme (TAR-IVLP)*, KAU, Regional Agricultural Research Station, Pattambi.

Pramanik, S.C. and Rai, R.B. (2004). Putting the last first. Report, *Participatory Assessment and Transfer of Agricultural Technology in Bay Islands*, CARI, Port Blair.

Sivakumar, T., Velmurugan, K., Perasirian, V. and Akila, N. (2005). Successful farming practices through refined technologies (1999-2005). Report, *TAR-IVLP (NATP) North Eastern Zone of Coastal Agro-ecosystem of Kancheepuram District, Tamil Nadu*, Livestock Research Station, Kattupakkam

J. Indian Soc. Coastal agric. Res., 24(2), 306-309, 2006

Empowering Fisherwomen in Coastal Sectors - A Strategy for Improving Farming

B. SHANTHI[1] and M. JAYANTHI[2]

[1]Avinashilingam Institute for Home Science and Higher Education for Women
Coimbatore – 641 043, Tamil Nadu

and

[2]Central Institute of Brackish Water Aquaculture
75, Santhome High Road, R.A.Puram
Chennai – 600 028, Tamil Nadu

Women in fishing communities contribute a great deal to the fishing economy. Technological changes in traditional activities often displace women workers. Low literacy, coupled with lack of training resulting in low level of skills and displacement due to technology, reduce women's participation in economic pursuits. All these lead to the resulting unequal status of women. Empowerment is an active process enabling women to realize their full identity and power in all spheres of life and build up their capacities to become partners in the process of development. This paper attempts to define the action research aimed at empowering the fisherwomen which was a maiden experiment with fisherwomen employing a set of PRA techniques for situation analysis based on which capacity building attempts were made. This study revealed the contribution of women in fisheries development, examined their living conditions, identified their needs and problems as well as explored the solutions on their own. If the fisherwomen are motivated to continue their collective efforts, the Integrated Fishing System perceived by them would be realized over a period.

*(**Key words:** Fisherwomen, Capacity building, Integrated system of fishing, Perspective plan)*

Tamil Nadu having the second longest coastline of about 1000 km ranks seventh in fish production in India and has a rich potential for the development of marine fisheries (Sarguna, 1998). Nearly one lakh fishermen are engaged in active fishing spreading over 422 fishing villages in the State. The capital of the State, Chennai alone has 44 fishing villages, called 'kuppams'.

Fishing is normally a male preserve. However, the post-harvest fish product development in the small scale fishing sector is mostly women dominated. Much of the skilled labour in post-harvest enterprises is provided by the womenfolk. The role of women in the subsidiary activities of fishing is considerable along the Tamil Nadu coast. About 70 percent of the persons participating in marketing activities at the landing centers are women. Fish marketing forms the greatest single source of income for women.

However, fisherwomen as any other women in agriculture, are not in the mainstream, but remain marginalized. Their labour and contribution are not reflected in the census or in surveys of the fishing communities. Many of their needs remain undocumented, underestimated and ignored. Fisherwomen are often caught in a deprivation trap of powerlessness, vulnerability, physical weakness, poverty and marginalization and reflect the Indian scenario characterized by these oppressive conditions of women (Sathiadas and Panikar, 1989, Rajendran, 1992, Herzl, 1993 and Mazumdar, 1984).

Technology opens the doors to modernization. However, technological changes in traditional activities often displace women workers. Low literacy, coupled with lack of training resulting in low level of skills and displacement, reduce women's participation in economic pursuits. All these lead to the resulting unequal status of women. Increasingly in the past few years the notion of participation as an exercise of empowering women has gained wide support. Empowerment is an active process, enabling women to realize their full identity and power and build up their capacities to become partners in the process of development (Devadas, 1997).

There is a growing realization that it is necessary to understand and appreciate the traditional technologies and the resource endowments of people so as to make programmes more effective. This research is a maiden experiment with fisherwomen employing a set of PRA techniques for situation analysis based on which capacity building attempts were made. This action research was taken up with

the specific objectives to study the profile of fisherwomen, take efforts for empowerment of the fisherwomen with special thrust on awareness generation, and evaluate the outcomes of the efforts in quantitative and qualitative dimensions.

METHODOLOGIES

This study was carried out in Mattaankuppam, located at 'Kannaki Beach', Triplicane, Chennai, the capital of Tamil Nadu. Semi-structured interviews and PRA methods was adopted to study the profile of 100 fisherfolk. Based on the profile of the fisherfolk, capacity building efforts were made in terms of technology transfer and exposure to educational inputs.

RESULTS AND DISCUSSION

Profile of fisherwomen

Women played a major role in pre-preparation and post-harvest fishing activities. Fisherwomen's work schedule began from 3.00 A.M., when their husbands left for fishing. The work schedule ended up at around 11.00 P.M.

Matrix scoring exercise was done to elicit information related to motivating and facilitating factors for participation in fishing activity. Interactions and deliberations by the fisherfolk were marked using beads of different colors and chalk pieces. Raising of the standard of living was the factor given the highest score (80%), followed by 'economic independence' (50%).

Motivating Factors

S. No.	Factors	Scores
1.	To raise the standard of living	* * * * * * * *
2.	Economic Independence	* * * * *
3.	To occupy time usefully	* * *
4.	Dislike household work	*

One * = represents 10 % score

Among the facilitating factors, 'fishing being a traditional activity' was given the highest score (100 percent) followed by 'need to help husband/father/son' (80 percent) and 'satisfaction in looking after own business' (40 percent).

The fish processing activity was found to be the exclusive domain of women. Fisherwomen were engaged also in drying the trash fish and waste from fish for poultry feed or glass factories and a few were occupied in packaging, transporting and trading.

Facilitating Factors

S. No.	Factors	Scores
1.	Fishing being a traditional activity	* * * * * * * * * *
2.	Need to help husband father/son/others	* * * * * * * *
3.	Satisfaction in looking after own business	* * * *
4.	Technology and labour saving devices available	* * *
5.	Family size is small	* *
6.	Encouragement from family members	*

One * = represents 10 % score

The major activities carried out by the fisherfolk was fish drying and preservation. The constraints in drying and salt-curing expressed by the fisherwomen were:

- Non-availability of drying equipment leading to drying on unhygienic platforms.
- Lack of areas available to put up permanent drying structures
- Low price for their products owing to poor quality.

The fisherwomen played a major role in the decision making related to both fishing and household activities either singly or jointly with their men. The maximum time consuming activity was fishing, followed by cooking food. The least time was reported to be spent on 'sleep' since they normally go to bed very late and woke up very early in the morning. Women never participated in fishing. Twenty-five families from the middle income and high income groups used labour saving devices to ease their household chores.

Impact of the capacity building efforts

The PRA exercises brought to light the socio-economic conditions of the fisherfolk under study and revealed the need to build up the capacity of the fisherwomen to promote their quality of living. The capacity building efforts included education on appropriate technologies and exposure to developmental inputs.

Demonstration of appropriate technologies: The constraint faced in drying fish, expressed by the fisherwomen, prompted the researcher to design low cost portable dryers which would ensure hygienic and faster drying. Two dryers, a bamboo dryer and

a solar dryer, were designed, for drying 2 kg of fish at a time. Demonstrations and field trials were conducted for the benefit of the fisherwomen. In addition training programmes were conducted on hygienic handling of fish and fish food recipes. The trials were made by the fisherwomen and the advantages of the new dryers were understood by them.

Awareness about programmes and welfare measures: Frequent contacts with the Extension Officer of the Directorate of Fisheries, Government of Tamil Nadu enabled the fisherwomen, men and youth to become aware of the programmes and welfare measures. Twenty fisherwomen got sanction to receive the aluminum containers used for transporting fish.

Vocational skill training and entrepreneurship development: EXNORA groups facilitated 45 fisherwomen to get training on Entrepreneurial skills to manage micro-enterprises. Twenty educated youth (10 boys and 10 girls) could get vocational skill training in basic computer programmes. After getting training on making sea shell fancy articles, five youth were absorbed in the production unit by the trainer himself. After attending the demonstration on fish pickle making, five women initiated pickle making on a commercial basis on a small scale. An association by name "Kannaki EXNORA Sakthi" was registered with 35 women members.

Preparing a perspective plan for an integrated system of fishing: Against the backdrop of the PRA exercises done earlier, the fisherwomen made a SWOT analysis and identified their own strength (S), weakness (W), opportunities (O) as well as threats (T) and envisaged an integrated fishing system. The women perceived a number of interlinked activities related to fish sales, fish waste utilization and setting up auxiliary enterprises.

A perspective plan for Integrated Fishing System is shown in Fig. 1.

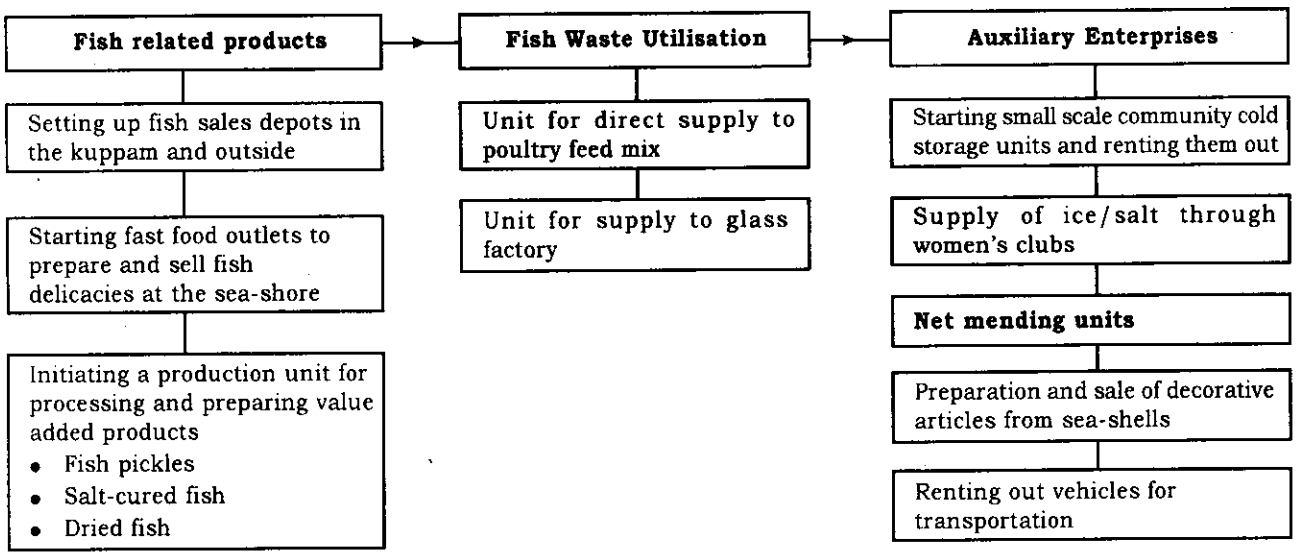


Fig. 1. Perspective plan for an Integrated Fishing System

Preparation of perspective plan for Integrated System of Fishing

The SWOT analysis helped the fisherwomen to reason out systematically and analytically the important facts related to strength, opportunities and threats.

Strengths	Weakness
• Indigenous knowledge and technology • Tenacity and capacity to put in hard work • Understanding of market trends • Ability to withstand crisis during lean periods. • Willingness to take risks	• Poor communication skills owing to illiteracy, poverty, etc., • Lack of technical skills to produce value added food products from fish • lack of infrastructural facilities for transportation, provision of ice and salt, drying or storing fish. • Inadequate credit/marketing support

Opportunities	Threats
• Infrastructural facilities being promoted by government • Access to programmes of Government for promoting fisheries • Exposure to media and educational facilities • Vocational skill training programmes for unemployed youth	• Interference of launches during catamaran fishing • Weather forecast such as cyclones and depression in the sea adversely affecting fishing leading to risks. • As their dwelling area belongs to the temple trust property of 'Parthasarathi Swamigal Temple', there is always a Threat to vacate the land.

The SWOT analysis done by the representatives of the fisherwomen revealed the following:

CONCLUSION

This study has established the credibility of PRA as a tool for applied research in social sciences. This exercise enabled the fisherwomen to examine their living conditions, identify needs and problems as well as explore solutions on their own. If Mattaankuppam people continue their collective efforts, the Integrated Fishing System perceived by them would be realised over a period.

REFERENCES

Sarguna, M. (1998). An appraisal of coastal fisheries in Tamil Nadu (1991-96). *M. Phil. Thesis*, Department of Geography, Queen Mary's College, Chennai.

Sathiadas, R. and Panikar, K.K. (1989). Socio-economic status of marine fishermen along Madras coast. Report *Marine Fisheries Information Service*, pp. 13-14, Cochin.

Rajendran, I. (1992). Marine fish marketing in Tamil Nadu. Report *BOBP Post-Harvest Fisheries Project*, pp. 12-15, ODA.

Herzl, T. (1993). Women in fisheries. *Social Welfare* **XL**(6): 27-30.

Mazumdar, V. (1984). In *Women in Focus–A Community in Search of Equal Roles*, pp. 7-8, Sangam Books, Hyderabad.

Devadas Rajammal, P. (1997). Empowerment of women through education in science and technology. Paper, Australian Joint Regional Conference *GASAT and IOSTE*, Curtin University of Technology, Perth, 5-8 Dec 1997. 89p.

J. Indian Soc. Coastal agric. Res., 24(2), 310-311, 2006

National Agricultural Extension Policy Framework - Scope and Prospects for Coastal Agro-ecosystem

C. KARPAGAM, B. K. BANDYOPADYAY, D. BURMAN and A. R. BAL

Central Soil Salinity Research Institute
Regional Research Station, Canning Town - 743 329, West Bengal

The Framework of National Agricultural Extension Policy provides reforms and suggestion to alleviate the poverty through agricultural development in this changing global environment. This paper attempts to study the broad areas / issues and clause in the National Agricultural Extension Policy and analyze the various scope and prospects for all areas in general and the coastal area of West Bengal in particular.

(Key words: *National Agricultural Extension Policy, Framework, Scope, Coastal area)*

The Union cabinet of India has approved the National Agricultural Policy on July 25th, 2000. Of this, the generation and transfer of technology form a major thrust area and the reforms in agricultural extension will be implemented through a unique policy framework called the National Agricultural Extension Policy (NAEP). This framework policy mainly concentrates in ten thrust area to reinvent and re-coil the existing extension system in India. This paper discusses the various thrust areas as well as various clauses under each area and analyze the scope and prospects for all areas in general and the coastal area of West Bengal in particular.

Policy reforms

Under this thrust area there were many clauses such as farming system approach, multi-agency extension service, promotion of farmer participatory approach, etc. As far as Farming System approach is concerned, coastal West Bengal has lot of potential in fish farming sector. The average aquaculture productivity in West Bengal is only 250-500 kg ha^{-1} when compared to the productivity of Andhra Pradesh and Tamil Nadu which is 1-2 t ha^{-1}. In this background the farming system approach with more emphasis on fishery may be a potential area to be tapped.

Under the agro-ecosystem component of NATP, 13 TAR-IVLP projects have been completed in various parts of coastal area in India. In West Bengal two projects had been undertaken; one in south 24 Parganas and the other one in Midnapore district. Based on this experience the project may be extended to other coastal districts too to encourage the farmers' participation.

Institutional restructuring

In this head, eight clauses have been highlighted. District level Agricultural Technology Management Agency (ATMA) model, Strategic Research and Extension Plan (SREP) through PRA, upgrading the extension staff, strengthening Research-Extension-Farmer linkage, group approach for extension are some of the important reforms under the institutional restructuring component.

The present extension model in West Bengal is exemplary for democratic decentralization. A recent innovative approach ATMA has been introduced in 28 districts in 7 states. The experience of those states has been taken in to account to introduce ATMA model in the coastal district of West Bengal on pilot basis.

Another important institutional restructuring reform is the group approach for extension. West Bengal is famous for its rural youth clubs, those village clubs consist of mainly the farmers as its members. So these clubs can be converted to farmer's interest group or self help group (SHG) with the initiative of local NGOs or other developmental institutes.

Management reforms

This reform mainly deals with the centre state co-operation in agricultural extension management and also the alternative extension system arrangement such as para-professional based private extension, NGO based extension service and contracting out extension service.

Unlike Madhya Pradesh and Uttar Pradesh the para extension professional concept has not been well developed in West Bengal. Utilizing the potential of para-extension professional in least developed coastal districts may be an effective alternative extension approach as for West Bengal.

Improving Research-Extension-Farmer Linkage

This reform mainly dealing with the aspects such as direct interface between farmer and

scientist, activating existing interface mechanism and priority setting based on SREP. As per direct interface between farmers and scientists is concern Punjab agricultural university has achieved significant success, However, Punjab is a small state and what is applicable in Punjab may not be possible in large state like West Bengal. But this can be pilot -tested in the coastal districts of West Bengal by the centre or state level agricultural organizations which are working in that coastal area. For improving the interface between the Research-extension; the liaison unit concept may also be introduced in the coastal area.

Capacity building of extension functionaries

It is mainly deals with HRD component. All national and state level agricultural organization situated in the coastal districts of West Bengal can be networked with state headquarters, SAU, MANAGE, NAARM and other training institutes to formulate a separate strategic training programme for the coastal agro-eco-system extension personnel.

Empowerment of farmers

Participation of farmers in any extension programe is the first way to attain the empowerment. An example of a case of successful farmer empowerment is seen in Sathyamangalam flower market, wherein marketing, price structure is entirely controlled by farmers and a direct transaction exists between farmers and buyers. In the same way, farmers in the coastal area of West Bengal have scope in fish marketing. Other successful approaches like Farmers Sandy (Ryuthu Bazaar in Punjab and Andhra Pradesh, Ulazhavar sandhai in Tamil Nadu) and e-choupal may also be tried in coastal area of West Bengal to enhance the empowerment of farmers.

Mainstreaming of women in agriculture

This reform deals with two aspects of women in agriculture, one is about farm women and another one is women extension workers. A study conducted in the coastal area of Sundarbans shows that participation of women in agricultural operation is very low. For example, participation of women in activities like raising nursery and transplanting in paddy cultivation is only 22%. But this case might be different in state like Tamil Nadu or Andhra Pradesh. A FAO study shows that in West Bengal participation of women in small scale fisheries is very limited. The potential of women in coastal area can be brought into agriculture as well as fishery activities by expanding the women workforce in the field of agricultural extension services.

Use of Information Technology

The proposed framework policy for National Agricultural Extension has been given emphasis through IT application. It is a fact that IT is getting paramount importance during the last one decade, but in general the benefit from IT revolution has so far reached more to urban areas than to rural areas.

The use of Information shops on the lines recommended by M.S. Swaminathan should be established through out the country, rather than existing in few isolated pockets. The ultimate aim of this policy related to IT is that to promote private information shops / kiosks, franchised out to private sector especially unemployed rural educated youth should be employed in the manner of PCOs or STD shops. In this context, various IT enabled services can be started in coastal areas of West Bengal with the participation of private as well as NGOs.

Financial sustainability and resource mobilization

This reform deals with the subjects such as cost-cutting mechanism for extension services, efficient use of available resources, privatization of agro services towards realistic cost recovery of agro services, etc.

The coastal agro-ecosystem is unique and mostly it operates under CDR agriculture and it is mainly consists of small and marginal farmers, therefore promoting the private extension alone may not be a good option. Public funded extension should continue to play a predominant role and wherever feasible, co-operative and contract farming can be promoted. For effective cost cutting mechanism, encouragement of NGOs and other corporate sector involvement may also be taken into account wherever possible.

Changing role of Government

As far as the coastal ecosystem of West Bengal is concern enhancing competition through Agri-Clinics and Agri-Business center may pave an effective way to tap the potential of young entrepreneur to prepare business plan, conduct market survey, and other needed help. Strengthening farmers association is another important area for the government to concentrate. In this context the changing role of government may be an effective facilitator rather than a service provider.

J. Indian Soc. Coastal agric. Res., 24(2), 312-314, 2006

Agro-ecosystem Analysis of a Village in Coastal Areas of Sundarbans through Participatory Approach

S. K. JHA[1], C. R. BISWAS[1], B. MAJI[1] and B. K. BANDYOPADHYAY

Central Soil Salinity Research Institute, Regional Research Station, Canning Town, South-24 Parganas – 743 329, West Bengal

The coastal areas of Sundarbans form a typical ecosystem with low productivity due to a variety of constraints, technical, socioeconomical and infrastructural in nature, which warrant special attention. Therefore, for increasing the productivity in a sustained manner, participatory approach was followed by applying Participatory Rural Appraisal (PRA) tools, viz. agro-ecosystem mapping, transect walk, problem analysis under the top-down approach. The problems were identified through transect walk and critical analysis of the problems. The study suggested the possibilities of improving the condition through appropriate use of opportunities available. The study was conducted in two hamlets of one village in the coastal areas of Sundarbans under South-24 Parganas district of West Bengal.

(Key words: *Land utilization pattern, Enterprises, Production systems)*

Participatory Rural Appraisal (PRA) emphasizes farmers' participation in technology assessment. It involves farmers in determining directions for technological innovations. Such information are critical in planning on-farm research programmes where decisions about the types of farmers' involvement are integral to research design and the management of on-farm trials. This is an interdisciplinary approach where the opportunity for learning interdisciplinary research achievements is available. The scientists working in such programmes facilitate the process of appraisal, and the farmers do the appraisal themselves in the form of self drawn pictures and diagrams (Mettrick and Wessel, 1986, Conway, 1987). Objectives of this study, undertaken in Sundarbans region of West Bengal included understanding the farming system and identifying system problems and solutions thereof through participatory data collection procedures.

MATERIALS AND METHODS

The present study was conducted in two hamlets, viz. Bodo Dumki and Chhoto Dumki of a village called Dumki, located in Canning Block of South 24-Parganas district of West Bengal. Climate is subtropical with high humidity (80-95 %). Maximum temperature is about 32°c during the month of May and minimum is 21°c during January. Rainfall is high (1768 mm annually), of which 80 % occurs during June to September. Rainfall during rest of the months is erratic and irregular.

The system tools and methods were used for identifying the indigenous natural resource types, relationships and key decision making systems in the village. As the study was completely participatory and interdisciplinary in nature, the following methods and procedures were used to invoke participation and data collection.

Agro-ecosystem mapping

The farmers themselves identified resources and locations, their utility and decision making systems. They drew a map on the ground and later translated into the drawing sheet. The farmers discussed various decision making system while constructing the maps, and other useful information about the village was also collected while preparing the agro-ecosystem map.

Village transect

Three transect walks through the village were conducted along with villagers and discussions during the walk helped to identify indigenous natural resource types, elements of systems (Conway 1985, Mettrick, 1993) to find contrast in various niches and reasons of contrast.

RESULTS AND DISCUSSION

Agro-ecology

The village Dumki lies in the coastal areas of Sundarbans, which is the biggest delta in the world, and possesses important coastal agro-ecological features. Out of the 429 farm households, 70% were

[1]Present address: Central Research Institute For Jute And Allied Fibres, Barrackpore - 700 120, West Bengal

engaged in agricultural or allied activities, while 2% were engaged in service, 3% in business and the rest 25% as daily paid labourers (DPL). Out of this 429 farm households, 3.26% were in high, 14% in medium, 28% in low and 54.74% in very low income group.

Land utilization pattern

The village is having 835 acres as total cultivable area. Land holdings of the farmers are mostly low or marginal without proper water control facility. There were about 37 families in the village without any cultivable land, and they were living in the *khas* lands of PWD, Govt. of West Bengal. On an average, more than 85% of the total cultivated area was found to be monocropped having an average yield potential of the rainfed rice as low than 1.75 t ha^{-1}. Under second crop hardly 15% area was available. Irrigation was not well developed in the village and the main sources of irrigation are ditches, ponds, canal and some shallow tubewells. Various soil types exhibited in the village determined the land use pattern. The soil types ranged from silty clay loam in the high land to silty clay in medium and lowland. Vegetable crops grown were pumpkin, chilli, potato while plantation crops were coconut, mango, sapota.

Enterprises

From the enterprise map prepared by the villagers, agriculture (70%) came as the main occupation of the villagers followed by daily paid labour (25%) due to lack of alternate sources of income. There were only four husking machines, eight tailoring machines and three *chikan jari* units, the work load and income of which were limited. Some families were having cows as source of milk and fuel; some had goats, sheep, poultry birds and ducks but as no-investment enterprises. In Chhoto Dumki, pigs are reared for meat purpose but at a very small scale. Fish, in general, was found as common enterprise and sold in the local market after meeting their family requirement.

System properties

Crop production system

The village is monocropped with rice during *kharif* season. Out of 835 acres of land 818 acres were occupied by rice. Very small area was cultivated with vegetables in uplands. During *rabi*, 85-90% of the area was kept as fallow, while on 6% area different types of vegetables on 4% area of boro rice

The cropping intensity (C.I.) of the village was 200% only in 10-20% of the area while for the rest area it was only 10%. Scope for increasing the cropping intensity was limited mainly due to lack of irrigation water and short and mild spell of winter limiting the choice of *rabi* crops.

Table 1. *Village transect : Dumki, District South-24 Parganas (WB)*

	Upland	Medium land	Low land
Soil type	Silty clay-loam	Silty clay	Silty clay
Land use	Houses, cattle-shed, crops, fallow	Houses, cattle-shed, cultivation, fallow	Cultivation, ponds, canal, fallow
Soil characteristics	Brownish red, gravel, low	Brownish gray, loam	Black fine
Water retention	—	Water retentive	Water retentive
Field crops	—	Rice	Rice
Vegetables crops	Potato, pumpkin, chilli	Potato, pumpkin, bhindi	—
Plantation crops	Coconut, palm sapota, arecanut	Palm, date palm, coconut,	—
Fodder	Crop residues	Crop residues	Crop residues
Trees	Babool, neem, ber	Guava, date palm, ber, ficus spp.	—
Water source	Hand pump, pond	Hand pump, pond, canal	Pond, canal, ditches
Weeds	*Cyperus rotundus* *Echinochloa colonum*	*Chenopodium album* *Setaria glauca*	*Chara* spp.
Livestock	Cow, goat, poultry, duck	Cow, duck, goat, sheep	Pigs, sheep, goat
Problems	Low productivity of vegetables	Low productivity of rice, less cropped areas	Low productivity of rice less productive animals
Opportunities	Increase the scope of irrigation, Selection of suitable HYV and cropping pattern	Increase the scope of irrigation, introduction of less water requiring crops, animal production	Introduction of HYV of rice and paddy-cum-fish farming, increase *boro* rice

Livestock production system

Among the animals, cows, goats, sheep, pigs, etc. dominated the population, while some farmers maintained small population of poultry birds and ducks for additional income. Various diseases like foot and mouth disease, haemorrhagic septicemia were the major ones which mainly occurred during March-April. The problem in livestock production system was productivity and infertility of animals. Goats were susceptible to diseases during August-December, while poultry birds and ducks were prone to diseases in November- March. Disease infestation in case of fishes and pigs were observed during October to February. Disease infestation particularly in fishes some times caused colossal damage financially to the fish farmers.

Transect walk map

This was undertaken thoroughly along with a group of villagers. Information on land, soil, vegetation, crops and cropping pattern were collected through discussion and visual observations at site (Table 1).

Scope of irrigation could be increased so that *rabi* (*boro*) crops could be taken up by the farmers in the area. In addition to this, the productivity can be increased simply through introduction of suitable HYV of rice as well as other crops and introduce suitable cropping pattern. Introduction of less water requiring crops could be another aspect of utilizing the resources available. Successful introduction as well as implementation of paddy-cum-fish and good breed of livestock can augment the income of the farmers as well.

REFERENCES

Conway, G.R. (1985). Agro-ecosystem analysis. *Agricultural Administration* **20**: 31-55.

Conway, G.R. (1987). The properties of agro-ecosystems. *Agricultural Systems* **24**: 95-117.

Hoque, M. Z. (1984). *Cropping Systems in Asia: On Farm Research and Management*, IRRI, Los Banos, Phillipines.

Mettrick, H. and Wessel, M. (1986). ***Farming System Research as an Analytical Framework and a Tool for Training,*** Bulletin **23**, ICRA, Wageningen, The Netherlands.

Mettrick, H. (1993). *Development Oriented Research in Agriculture*, ICRA, Wageningen, The Netherlands.

J. Indian Soc. Coastal agric. Res., 24(2), 315-319, 2006

Integrated Restructuring of Homesteads through Farmer Participatory Approach - A Case Study from Central Kerala

M. JOY JOHN JACOB and S. REGEENA

Cropping Systems Research Centre, Kerala Agricultural University
Karamana, Thiruvananthapuram - 695 002, Kerala

A two year study was undertaken as part of the National Agricultural Technology Project entitled 'Analysis and Development of Homestead Farms of Kerala - A farmer Participatory Approach' to restructure an existing homestead in an integrated manner through planned interventions into a sustainable unit. Technical interventions suggested after on-farm discussions with the farmer and considering his resources, preferences and constraints were increasing cropping intensity by adding new crops, introducing trees, integrating poultry as subsidiary source of income, promoting biomass generation and recycling of farm waste, correcting the farmers' practice with respect to nutrient management and plant protection and promoting integrated approaches for nutrient and pest management. The technical interventions and restructuring resulted in higher cropping intensity, improved soil fertility, biomass production and labour generation. Interventions like inclusion of intercrops and improved and scientific management practices made the system more productive. Technologies that reduced the cost of cultivation and increased the profitability made the system economically viable. Besides these qualities, the restructured system provided nutritional security to the farm family.

*(**Key words:** Homesteads, Integration, Restructuring, Soil fertility, Nutritional security)*

Integrated land use practices are becoming increasingly important for the small and marginal farmers. In Kerala, the small and marginal homesteads constitute over 90 percent of the total operational holdings of Kerala. Homesteads/Home gardens of Kerala epitomize an intense agroforestry system in which plants, animals and men co-exist in a mutually symbiotic manner. Jacob (1997) defined home garden as a functional and self sustaining farm unit which consists of a conglomeration of crops and multipurpose trees, planted arbitrarily, with or without animals/poultry /apiculture, owned and primarily managed by the dwelling farm family, with the objectives of satisfying the basic family needs (food, fuel, timber) and producing marketable surplus for the purchase of non-producible items.

Homestead farming has the advantage of being based largely on local and accessible resources. However, selection and management of enterprises in the home garden is mostly unscientific and based on farmer's perception and experience. Jose and Shanmugaratnam (1993) opined that recent trends in agrarian structure and the high market orientation exert pressure on the home garden and its sustainability is under threat. Unless the management is directed in the right path, there is imminent danger to the system's sustainability. In the past few years, attempts to improve farming in homesteads have been through a piece meal approach. The crops/enterprises and its management aspects have been singled out and development projects formulated. Improvement of this traditional but complex farming system can be achieved only through a whole-farm or systems approach. Hence, an attempt was made as part of the National Agricultural Technology Project entitled 'Analysis and Development of Homestead Farms of Kerala-A Farmer Participatory Approach' to restructure existing homesteads in an integrated manner through planned interventions into sustainable units.

MATERIALS AND METHODS

The two year on-farm study was undertaken in the Thrissur Districts of the Central Zone of Kerala during 2002-2004. During a preliminary survey conducted, the tree-crop-livestock combination and socioeconomic aspects of the homestead, the willingness and suggestions of the farmer for restructuring and improving the homestead were ascertained. A multidisciplinary team of scientists along with the Agricultural Officer of the panchayat visited the farmers' field thoroughly analyzed the existing situation, discussed with the farmer (on-farm), and finalized interventions to restructure and develop the homestead. The homestead of Mr.Thomas of Thekkumkara *panchayat*, Thrissur

Table 1. *Impact of restructuring and technical interventions in the homestead over a period of two years*

Total area: 100 cents Home & Permanent structures: 6 cents Net cropped area: 94 cents

Enterprise	**Number**		**Area (cents)**		**Yield * (FW in kg)**		**Produce***				**Recyclable biomass** (FW in kg)	
							Consumed		Marketed			
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Banana	28	100	2.198	7.85	200	900	100	300	100	600	500	1500
Cassava	100	200	2.5	5	80	600	80	200	0	400	15	40
Elephant yam	0	250	0	6.25	0	400	0	150	0	250	0	80
Colocasia	200	200	5	5	200	400	80	100	120	300	40	80
Bhindi	-	-	0	1	0	25	0	25	0	0	0	5
Cowpea	-	-	0.5	1	10	30	10	30	0	0	2	5
Amaranthus	-	-	0.5	1	8	20	8	20	0	0	1	4
Brinjal	-	-	0	1	0	40	0	40	0	0	0	8
Coconut	60	60	94	94	1500	2500	350	350	1150	2150	2500	4000
Arecanut	0	200	0	28.62	0	0	0	0	0	0	0	0
Pepper	40	150	3.14	11.8	50	80	2	3	48	77	10	15
Cashew	4	4	1.96	2	30	12	5	2	25	10	50	25
Jack	5	10	4.8	9.61	0	0	0	0	0	0	0	0
Mango	1	1	1.6	1.6	20	20	20	20	0	0	0	0
Ailanthus	4	5	0.31	0.4	0	0	0	0	0	0	0	0
M. peltata	25	25	1.96	2	0	0	0	0	0	0	0	150
Sapota	0	5	0	1.57	0	0	0	0	0	0	0	0
Nutmeg	0	10	0	4.9	0	0	0	0	0	0	0	0
Clove	0	10	0	4.9	0	0	0	0	0	0	0	0
All Spice	0	2	0	1	0	0	0	0	0	0	0	0
Gooseberry	0	4	0	0.31	0	0	0	0	0	0	0	0
Vanilla	0	40	0	6	0	0	0	0	0	0	0	0
Poultry	0	20	0	0	0	3360	0	500	0	2860	0	0
Total			118.5	196.8							3118	5912
Cropping Intensity (%)		**126**	**209.4**									

* Coconut and egg in nos; FW: Fresh weight

Table 2. *Impact of restructuring and technical interventions in the homestead over a period of two years*

Enterprise	Number		Male labour (days)				Female labour (days)				Expenditure (Rs.)		Gross return (Rs.)		Net return (Rs.)	
			Hired		Family		Hired		Family							
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Banana	28	100	4	6	2	4	0.5	0	0	0	945	2370	1200	7200	255	4830
Cassava	100	200	2	8	1	6	0.5	0	0	0	200	1000	375	2400	175	1400
Elephant yam	0	250	0	3	0	2	0	3	0	2	0	1370	0	3000	0	1630
Colocasia	200	200	5	3	4	2	5	2	3	1	900	1000	2000	2400	1100	1400
Bhindi	-	-	0	1	1	0	0	0	0	0	0	100	0	250	0	150
Cowpea	-	-	0.5	1	0.5	1	0	0	0	0	100	100	200	300	100	200
Amaranthus	-	-	0.5	1	0.5	1	0	0	0	0	75	100	175	240	100	140
Brinjal	-	-	0.5	1	0.5	1	0	0	0	0	0	100	0	480	0	380
Coconut	60	60	7	16	4	10	7	8	3	4	2700	6890	4400	13825	1700	6935
Arecanut	0	200	0	10	0	6	0	4	0	2	0	3400	0	0	0	-3400
Pepper	40	150	3	4	2	3	3	2	3	10	1400	2325	3000	4960	1600	2635
Cashew	4	4	0	0	0	0	0	0	0	0	300	0	1200	500	900	500
Jack	5	10	0	0	0	0	0	0	0	0	0	0	0	100	0	100
Mango	1	1	0	0	0	0	0	0	0	0	0	0	100	100	100	100
Ailanthus	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M. peltata	25	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sapota	0	5	0	1	0	1	0	0	0	0	0	150	0	0	0	-150
Nutmeg	0	10	0	0.5	0	0.5	0	0	0	0	0	200	0	0	0	-200
Clove	0	10	0	0.5	0	0.5	0	0	0	0	0	200	0	0	0	-200
All Spice	0	2	0	0	0	0	0	0	0	0	0	50	0	0	0	-50
Gooseberry	0	4	0	0	0	0	0	0	0	0	0	50	0	0	0	-50
Vanilla	0	40	0	2	0	2	0	1	0	1	0	600	0	0	0	-600
Poultry	0	20	0	0	0	10	0	0	0	10	0	700	0	5800	0	5100
Total			22.5	58	15.5	50	16	20	9	30	6620	20705	12650	41555	6030	20850

with a size of 0.4 ha (100 cents) was one among the several homesteads selected for restructuring. The net area available for cropping after excluding the areas occupied by house, well and other permanent structures was 0.376 ha (94 cents). The technical interventions suggested included increasing cropping intensity by adding new crops, introducing trees, integrating poultry as subsidiary source of income, promoting biomass generation and recycling of farm waste, correcting the farmers' practice with respect to nutrient management and plant protection and promoting integrated approaches for nutrient and pest management. The homestead, thus restructured, was monitored for two years for the changes in cropping intensity, soil fertility, biomass production, labour generation, marketing and consumption patterns and economics.

RESULTS AND DISCUSSION

The crops, trees and livestock met the diverse requirements of the farm family. The various enterprises, besides increasing the production from the farm, resulted in better utilization of family, generated more biomass and income. The details of the situation in the homestead before (pre) and after interventions (post) are furnished in Tables 1 & 2. The homestead model evolved by restructuring and introduction of technical interventions exhibited a high degree of interaction and integration among the various enterprises and with the farm family, which contributed to the sustainability of the model. Planting of new crops and trees in the vacant interspaces and unutilized areas resulted in more efficient use of the available land resources and resulted in increasing the cropping intensity from the earlier 126 % to 209 %. The interventions and newly introduced enterprises were also very effective in enhancing the utilization of family, labour, especially female. Planting of the entire newly introduced pepper vines was undertaken by the farmer's wife over a period of time in the pits taken by the male labourers and the farmer. The poultry component, besides being remunerative, served in generating employment for the farm family. The amount of produce marketed and consumed by the farm family also increased. The newly introduced components, especially banana, augmented the biomass that could be recycled and added as organic manure. The coconut wastes generated were more effectively recycled in the system. Coconut husk that was earlier sold was used for moisture conservation.

The soil fertility status improved progressively over the study period (Table 3). The higher organic carbon and nutrient status in the homestead soil may be due to the integrated nutrient management through addition of organic manures, recycling of crop residues and soil-test based fertilization. The nutritional security offered by the tree-crop-livestock mix in the homestead to the farm family which comprised of two adults and two children was worked out and compared with the minimum requirements prescribed by the Indian Medical Association (Table 4). It was found that the availability of protein, carbohydrate, fat and energy from the components in the restructured homestead was well above that required for the farm family, thus revealing the nutritionally security offered by the homestead.

Table 3. *Changes in soil fertility in the homestead during the study period*

Period	pH	Organic carbon (%)	Av. P (kg/ha)	Av .K (kg/ha)
Before intervention	5.6	0.88	34	100
6 months after	5.9	1.05	34	175
1 year after	5.6	1.02	48.64	304
2 years after	5.2	1.18	45.00	307

Table 4. *Nutritional balance sheet of the homestead*

For a family of 1 man + 1 woman + 2 children (below 15 years)

	Annual	
	Requirement	Availability
Protein (kg)	86.50	91.280
Fat (kg)	30.66	350.520
Carbohydrate (kg)	-	850.23
Energy (K cal)	3474800	6905571

The interventions like inclusion of intercrops and improved and scientific management practices made the system more productive. Adoption of Integrated Nutrient Management with a thrust on soil-test and need based fertilization, Integrated Pest Management with priority for use of biocontrol agents, inclusion of multipurpose trees, especially nitrogen fixing trees, contributed to protection of natural resources. Inclusion of diverse and subsidiary enterprises has led to stability of the system. Technologies that reduced the cost of cultivation and increased the profitability made the system economically viable. The multiple enterprises in the home garden reduced the risk of adverse effects from pests, weather, and economic factors. This results in a higher level of stability.

Home gardens can be improved, provided it is based on sufficient understanding and sound principles. Detailed analysis of plant associations in the home garden could provide a better knowledge of the ecological and economic compatibility of different plant species. This could lead to new planting patterns based on a selection of species and varieties in terms of such variables as nutrient content in the produce and market demand, as well as light tolerance and root structure. Such improved designs, however, need to retain the combination of perennial trees with annuals. Perennials require less labour for their care and hence are more affordable to poorer people.

Improvement of home gardens is not only hampered by the lack of research but it also requires a reorientation of existing extension services. Extension work focuses mainly on single crops instead of using the integrated approach needed for such complex and diverse systems.

ACKNOWLEDGEMENT

The research was conducted under National Agricultural Technology Project on homestead farming at Kerala Agricultural University. The authors are thankful to the NATP, ICAR for providing grant for the research work.

REFERENCES

Jacob, J. (1997). Structure analysis and system dynamics of agroforestry home gardens of Southern Kerala. *Ph. D. Thesis*, College of Agriculture, Agricultural University, Kerala.

Jose, D. and Shanmugaratnam, N. (1993). Traditional home gardens of Kerala: A sustainable human ecosystem. *Agroforestry Systems* **24**: 203-213.

J. Indian Soc. Coastal agric. Res., 24(2), 320-321, 2006

Farmers Participatory Assessment of Biological Control Measures in Rice Based Coastal Agro-ecosystem

K. PONNUSAMY, M. JAYANTHI and M. KUMURAN

Central Institute of Brackishwater Aquaculture
75, Santhome High Road, Chennai - 700 028, Tamil Nadu

A farmer's participatory field study was undertaken on the use of biological agents, viz. *Pseudomonas fluourescens* and *Trichogramma japonicum* in the coastal agro-ecosystem of Tiruvallur district of Tamilnadu. It has created an awareness among farmers that *P. fluorescens* was effective in the management of grain discolouration and *T. japoricum* in the management of stem borer.

(***Key words:*** *Participatory rural appraisal, Biological control in rice, Grain discolouration, Stem borer)*

The two most important pest problems of rice cultivation in the coastal agro-ecosystem of Tiruvallur district of Tamilnadu are grain discolouration (a complex disease due to fungal and bacterial infection) and stem borer due to *Scipophaga incertules*. Farmers in this area either resort to indiscriminate use of pesticides or never apply any pesticides even when the pests seriously affect the crop. Venkateswaralu (1992) made an assessment of the potentialities for increase in rice production under different ecosystem in the eastern belt and came to the conclusion that through improved agronomic and other crop management practices, the yield could be improved. Chattopadhyay (1993) stated that in order to achieve the desired results and to evolve appropriate technology for an area, on-farm trials are to be conducted involving farmers. The participatory farmers will be allowed to manage the trials themselves in their own way in collaboration with researchers and extension agencies. Farmers prefer this type of experimentation because it fosters immediate and observable feedback on potentially useful technologies (Ohlmer and Borechmer *et al.*, 1998). In the above background, a study was undertaken to manage the problems of grain discolouration and stem borer under farmers participatory field trials.

MATERIALS AND METHODS

The grain discolouration and stem borer incidence were assessed as major problems in rice cultivation by the farmers through Participatory Rural Appraisal (PRA) techniques. The study on assessment of efficiency of various measures in controlling grain discolouration in rice and assessment of the efficiency of the biological agent, viz. *Trichogramma japonicum* for control of rice stem borer were conducted in fields of 30 and 50 farmers, respectively under the project entitled 'Institution Village Linkage Programme for Technology Assessment and Refinement in the Coastal Agro-Ecosystem of Tiruvallur district of Tamilnadu'. This project was implemented at Kattur village, 50 km north of Chennai.

The study was conducted during August 2001 to January 2002 (Samba season). The size of the treatment plot was 2000sq m. The weather was moderately warm with rains received between October to December. The soil was moderately drained clay loam with a pH of 7.4, low in nitrogen, medium in phosphorus, and high in potassium.

The following treatments were given:

Treatment	Dosage	Time of application
T_1 Carbendazim	250 g ha^{-1}	45 and 55 DAT
T_2 Neem oil 3%	500 ml ha^{-1}	45 and 55 DAT
T_3 *Pseudomonas fluourescens*	1 kg ha^{-1}	45 and 55 DAT
T_4 *Trichogramma japoricum*	5 cc ha^{-1}	20,27,34 and 41 DAT

No insecticides were applied to the plots released with Trichogramma parasites, DAT – Date of transplanting

Carbendazim and neem oil were obtained from the market. The biocontrol agents, viz. P. *fluourescens and T. japonicum* were obtained from Sun Agro Biosystem Pvt. Ltd.[1], Chennai. All the plots were monitored by scientists and farmers for natural enemies, pests, pest infections, crop management practices and yields.

RESULTS AND DISCUSSION

The results of both technological interventions are discussed below:

Assessment of efficiency of various measures in controlling of grain discolouration in rice

After harvest 1000 grains were selected at random from each treated plot and number of discoloured grains were counted. From this percentage of discoloured grains was calculated and intensity of damage was graded as below.

[1]Does not suggest preference for the product

Table 1. *Effect of treatment in grain discolouration*

Observation	Farmers practice	Treatment		
		Carbendazim	Neem oil	*Pseudomonas fluourescens*
Intensity of infection	High	Low	Low	Low
Weight of 1000 grains (in g)	15.4	15.8	15.6	15.5
Grain yield (kg/ha)	3719	4180	4080	4010
Straw yield (kg/ha)	4830	5420	5320	5350
Cost of production (Rs/ha)	10840	11145	20945	22040
Gross return (Rs/ha)	27531	30951	30270	29640
Net return (Rs/ha)	16691	19806	19325	18600
Benefit-Cost ratio	2.53	2.77	2.77	2.68

- 50 percent discoloured grain – High incidence
- 10 percent discoloured grain – Low incidence

The weight of the 1000 grains and the total plot yield of straw and grain were determined. The results are given in Table1.

It could be observed from Table 1 that the percent infestation was high in farmers practice resulting in reduction of grain and straw yield. Even though the treatments of carbendazim, neem oil and *P. fluourescens* are at par with each other, the application of P. *fluourescens* can be recommended, since it was not only useful in the management of grain discolouration, but also for the control of other major diseases of rice such as blast, helminthosporium leaf spots, bacterial leaf blight and sheath blight (Nandakumar *et al.*, 2000, 2001, Vidyasekaran *et al.*, 1997).

Assessment of efficiency of *Trichogramma japonicum* in controlling stem borer incidence

Plants affected by stem borer were counted in each plot released with parasite from 2nd release onward to harvest. From this percent incidence was calculated. After harvest, weight of 1000 grains were recorded. Further, weights of straw and grain yield were measured. The results are given in Table 2.

It could be seem from Table 2 that the incidence of stem borer in the parasite released plot remained below the economic threshold level, resulting in higher straw and grain yield. Hence it can be concluded that the release of *T. japonicum* @ 5 cc ha^{-1} for four times at weekly intervals can effectively control the stem borer problem in rice.

CONCLUSION

The farmers who participated in the programme got the awareness about this new concept in pest management and gained the practical knowledge of using *P. fluourescens* and *T. japonicum*. It can be concluded that technological innovations should be linked closely with what farmers are already doing, thereby reducing the cost of dissemination and ensuring the appropriateness of the technology.

Table 2. *Effect of* Trichogramma japonicum *on control of stem borer in rice*

Observation	Farmers practice	Parasite released plot
Incidence of white ear (Stem borer attack)	> 2 percent	< 2 percent
Weight of 1000 grains (in g)	15.2	15.4
Grain yield (kg/ha)	3850	4125
Straw yield (kg/ha)	5230	5450
Cost of production (Rs/ha)	10420	10330
Gross return (Rs/ha)	28500	30495
Net return (Rs/ha)	18080	20165
Benefit-Cost ratio	2.73	2.95

ACKNOWLEDGEMENT

This project was supported by Indian Council of Agricultural Research under National Agricultural Technology Project fund.

REFERENCES

Chattopadhyay, S.B. (1993). *Technology Generation: Role of Farmers, Extension Agents and Scientist in Extension Strategy for Agricultural Development in 21st Century*, Samanta (ed.), Mittal Publication, New Delhi.

Nandakumar, R., Babu, S., Viswanathan, R., Raguchander, T. and Samiyappan, R. (2001). Reduction of systematic resistant in rice against sheath blight disease *Pseudomonas fluourescens*. *Soil Biology & Biochemistry* **33**: 603-612.

Ohlmer, B. K. and Brechmer (1998). Understanding farmers' decision making process and improving managerial assistance. *Agricultural Economics* **18**: 273-290.

Venkateswaralu, B. (1992) East merits more attention. *The Hindu Survey of Indian Agriculture*, pp. 24-27, Chennai, India.

Vidhyasekaran, P., Sethuraman, K., Rajappan, K. and Vasumathi, K. (1997). Power formulation of *Pseudomonas fluourescens* for control rice blast. *Plant Pathology* **46**: 291-297.

J. Indian Soc. Coastal agric. Res., 24(2), 322-325, 2006

Problem Identification and Intervention Selection through PLA Approach in Sundarbans

S. K. JHA[1], B. MAJI[1], C. R. BISWAS[1] and B. K. BANDYOPADHYAY

Central Soil Salinity Research Institute, Regional Research Station
Canning Town, South-24 Parganas- 743 329, West Bengal

Sundarbans presently exists only at the smallest South-eastern corner of West Bengal. For increasing the productivity, identification of problems and its remedial measures were sought through participatory approach followed by applying some Participatory Learning and Action (PLA) tools, viz. problem-cause analysis techniques with bottom-up approach. Critical analysis of the diagrams indicated the actual causes, either primary, secondary or even tertiary, responsible under a particular situation. The study has been done in two hamlets of one village, namely Dumki.

(Key words: *Socioeconomic condition, PLA tools, Microfarming situations, Problem identification, Problem prioritization & ranking, Problem-cause analysis diagram, Technological intervention)*

Sundarbans is situated between 21-35' and 22-40' North latitude and between 88-05' and 89-00' Eastern longitude at an altitude of 0-3 m above MSL. It covers an area of 0.9630 M ha, out of which, about 0.5366 M ha is under cultivation and habitation and the rest 0.4264 M ha is under reserve mangrove forest. It is the biggest delta of the world with mangrove forest. Apart from the mainland, the region also consists of 102 delta islands, of which, 54 are under habitation and the rest 48 are under mangrove forest vegetation (Anon., 1999). For Sundarbans, the extreme poverty provokes the people for over-exploitation of its natural resources, i.e. plants, animals, water and land without any consideration for regeneration and preservation. As a result, the ecological balance in the region is deteriorating at a very fast rate. Thus, to keep the ecology unaffected by further human interference, agriculture in the area should be developed and made a profitable livelihood means. For increasing the productivity, identification of problems and its remedial measures were sought through participatory approach followed by applying some Participatory Learning and Action (PLA) tools, viz. problem-cause analysis techniques with bottom-up approach. This is presented in details in this paper.

METHODOLOGIES

PLA is a family of approaches, methods and behaviours to enable poor people express and analyse the realities of their lives and conditions, and themselves to plan, monitor, and evaluate their actions. The common theme to different approaches followed was the full participation of people in the processes of learning about their needs and opportunities, and in the action required to address them. The study was conducted in two hamlets comprising of over 500 farming families in the village Dumki under Canning P.S. representing socio-economically and demographically a typical village of Sundarbasn.

RESULTS AND DISCUSSION

Occupational status

The village survey conducted by the authors using PLA tools on the socioeconomic conditions of the people of Sundarbans indicated that about 70% of the people were directly or indirectly dependent on agriculture. Besides, about 25% of the people were daily paid labourers and were indirectly dependent on agriculture, about 5% were dependent on other sources of income, viz. services (2%) and business (3%) (Anon.,1999) . Land-holdings of most of the farmers were low or marginal with complex, diverse and risk prone (CDR) agriculture. Productivity of crops and animals was very low due to various constraints which were technical, socioeconomical and infrastructural in nature. Majority of the people were below the poverty line and lived with extreme uncertainties. A good number of families are unable to provide even two major meals to their children throughout the year, while many others lived under debt throughout the life. The average family size of the area was found to be 7.01 members while the average size of holding was

[1]Present address: Central Research Institue For Jute And Allied Fibres, Barrackpore-700 120 West Bengal

as meagre as 0.76 acre (Jha *et al.*, 2003). The economic condition of the farmers could be clearly gauged from the fact that they had to feed seven mouths from less than one acre.

A very large number of men and women folk did not have more than three months employment in a year. At present, the area did not show any immediate prospect for industrialization.

Microfarming situations and problem identification

During the transect walk of the village, along with the villagers, different microfarming situations were identified based on the various soil and water characteristics and related biophysical factors of the area. Considering the characteristics of different microfarming situations along with their cropping systems, problems and production systems were also identified by the farmers and the scientist-facilitators. After necessary discussion, interaction and triangulation these were thus categorized described below (Table 1).

All the farming situations belong to Complex, Diverse and Risk Prone (CDR) class within Small Production System (SPS). Problems of the above microfarming situations were identified on the basis of problem-cause analysis involving the farmers. The problems identified against each of the microfarming situations are given below.

The problems, thus identified on the basis of importance to the farmers for each microfarming situation, were prioritized through matrix ranking based on their extent, importance, severity and frequency. The foremost part of the exercise was to identify the priority of the listed problems through matrix ranking. After ranking, the problems were designated with a specific number as per priority in action.

Problem analysis for finalization of intervention points

Agro-ecosystem analysis helped to carry out problem analysis. The problems in the system were identified, analysed (Mettrick,1993) and ranked on the basis of various criteria identified by the farmers and the intensity of yield loss (Sabarathnam and Vennila,1996). There was an in-depth analysis of the top most problem in the form of problem-cause analysis diagram constructed after focused group discussion with key stakeholders.

Table 1. *Identification of problems according to microfarming situations and their matrix ranking*

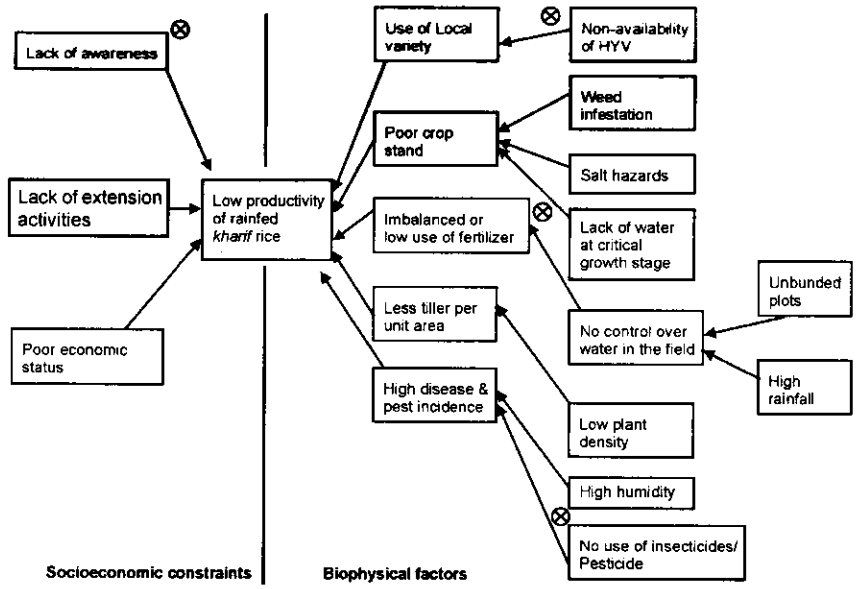
Microfarming situation	Problems identified	Extent	Importance	Severity	Frequency	Rank
MFS-1	Low productivity of rice	00000	00000	00000	00000	I
Rainfed upland						
MFS-2	Low productivity of potato	000	0000	0000	000	III
Irrigated upland	Low productivity of vegetables (gourd, hindi, chilli, pinach, knol-khol, brinjal, etc.)	0000	000	00	000	V
MFS-3	Low productivity of rice	00000	00000	00000	00000	I
Rainfed medium land						
MFS-4	Low productivity of rice	00	000	00	000	VII
Partially irrigated medium land	Low productivity of potato	00	000	00	00	VIII
	Low productivity of vegetables (gourd, bhindi, chilli, pinach, knol-khol, brinjal, etc.)	000	000	00	000	VI
MFS-5	Low productivity of rice	000	0000	00000	0000	II
Rainfed low land						
MFS-6	Low productivity of rice	00	00	000	000	VII
Partially irrigated low land	Low productivity of cow milk	00	000	000	00	VII
Allied enterprises	Low productivity of fish	0000	00	000	0000	VIII
	Low productivity of pig meat	00	000	00	00	IV
	Low productivity of coconut	00	00	00	00	IX
Food & economic security	Additional and essential		00000000 Essential			

While analyzing the system properties various researchable problems were identified on the basis of problem-cause analysis involving the farmers. The problems, thus identified on the basis of importance to the farmers were ranked in order of their importance which are as follows:

1. Low productivity of rice.
2. Low productivity of potato.
3. Low productivity of vegetables.
4. Low productivity of cow milk.
5. Low productivity of pig meat.
6. Low productivity of coconut.

All the identified problems were subjected to problem-cause analysis to pin-point the intervention points for action. Critical analysis of the diagrams indicated the actual causes, either primary, secondary or even tertiary, responsible under a particular situation which, again, may be of biophysical or socioeconomical in nature. The details of the analysis for identification of intervention points through causal diagram have been presented hereunder [Fig. 1(a)]. The low yield of vegetable crops was analysed and presented below in Fig. 1(b) (including the types of interventions required to deal with such problems/ causes).

(a) Rainfed *kharif* rice



(b) Vegetables

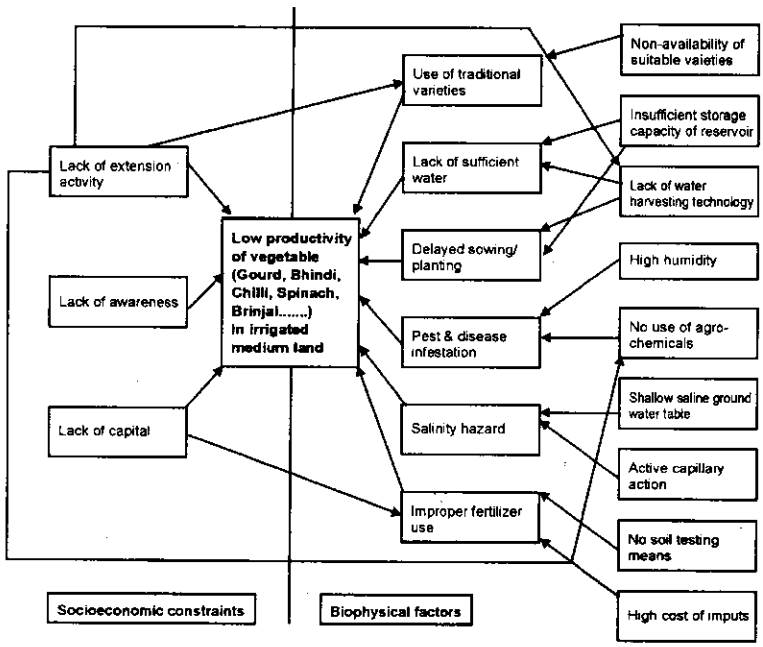


Fig. 1. Problem-cause diagram for low productivity of crops
Most important intervention points are marked with asterisk in the diagram.

DISCUSSION

Out of the total cultivated area about 90 % was cultivated with rice during *kharif*. Soil was silty clay in texture. Water level reached upto 15-30 cm range. Analysis of data revealed low yield of rice under kharif season due to various biophysical and socioeconomic factors [Fig. 1(a)]. Through further investigation, the probable reasons of prime importance, found were :

1. Use of traditional varieties
2. Poor crop stand
3. Less plant population per unit area.
4. Excessive weed infestation
5. Imbalanced use of fertilizers
6. Non-use of insecticides.
7. Poor soil health

The secondary reasons for the problems were :

1. Non-availability of HYV seeds
2. Improper plant density
3. Nutrient deficiency
4. Undulating field surface

The various socioeconomic constraints of prime importance were :

1. Lack of awareness
2. Poor extension linkage
3. Poor economic condition of the farmers

For increasing the productivity of rice, the following intervention points were thus suggested, which can be taken up on a priority basis.

1. Introduction of the latest HYV suitable for the area
2. Need to introduce balanced use of fertilizers
3. Need to introduce and popularize the use of indigenous low-cost method for weed control
4. Proper use of insecticides and fungicides to check insects, pests and diseases for a healthy crop
5. Increase awareness amongst the farmers about recommended package of practices for rice cultivation

CONCLUSION

The participatory approach in planning and conducting the demonstrations was to help to motivate the farmers for adopting the new technologies. The approach in conducting the demonstration was very much positive from the farmers' side, as they felt involved. The bottom-up approach in planning and conducting the demonstration proved better as it created a sense of belongingness among the farmers. This approach led to the selection of the right intervention points and critical inputs for better transfer of technology for the betterment of the farmers.

ACKNOWLEDGEMENT

We acknowledge our sincere thanks to the Director (NATP) for providing financial help to carry out this study and completion of this work. Further, we also appreciate the help and cooperation rendered by the farmers of Dumki village.

REFERENCES

Anon. (1999-2003). In *Annual Report*, Central Soil Salinity Research Institute, Karnal, Haryana.

Jha, S.K., Bandyopadhyay, B.K, Maji, B. and Tripathi, S. (2003). Socio-economic profile of typical coastal village of Sundarbans. *Journal of Indian Society of Coastal Agricutural. Research* **21**(2): 45-48.

Mettrick, H. (1993). *Development Oriented Research in Agriculture*, ICRA, Wageningen, The Netherlands.

Sabarathnam, V.E. and Vennila, S. (1996). Estimation of technological needs and identification of problems of farmers for formulation of research and extension programmes in Agricultural Entomology. *Experimental Agriculture* **32**: 87-90.

J. Indian Soc. Coastal agric. Res., 24(2), 326-329, 2006

Adoption of Cassava Production Technologies by Farmers of Coastal Districts of Kerala

T. SRINIVAS, M. ANANTHARAMAN and T. SIJU

Central Tuber Crops Research Institute
Sreekariyam, Thiruvananthapuram - 695 017, Kerala

Cassava production technologies in terms of recommended package of practices are available since long. The extent of adoption of these practices by the cassava growers is of much help in understanding the influence of these practices on the yield of cassava. An attempt is made in this paper to understand the extent of adoption of cassava production technologies in the selected coastal districts of Kerala. The overall adoption level by the farmers will be measured using the adoption quotient (AQ) formula. Three districts, viz. Thiruvananthapuram, Kollam and Malappuram were selected as they were the top three coastal districts having larger cassava areas in Kerala. Data were collected using a structured interview schedule. Average Adoption Quotient for the three districts was worked out to be 57.43 %. Recommended practices like land preparation, sett length, sett making, planting method and storage of planting material were adopted correctly by all the farmers while very few farmers were adopting the technologies like high yielding varieties, spacing, fertilizers, organic manures, retaining two shoots per plant, and cassava mosaic disease management, etc.

(Key words: Cassava, Production technologies, Adoption quotient)

The end uses of cassava saw a sea change with the production of many value-added products, such as starch, sago etc. Indonesia, Thailand and India are the major countries growing cassava in Asia. India acquires significance in the global cassava scenario due to its highest productivity in the world (27.91 t ha^{-1}). It is cultivated in an area of 0.24 million ha producing 6.7 million tones.

Although it is cultivated in India in 13 states, it is concentrated in the Southern peninsular region of the country and to certain extent in North-east region of the country. The crop is concentrated owing to the favourable climate and efficient utilization commercially in the Southern states of Kerala, Tamil Nadu and Andhra Pradesh. Among the Southern states, Kerala stands first in cassava area (45%) in the country. Maximum production goes for human consumption in Kerala.

Though the consumption of cassava has reduced over years in the State, its importance as a secondary staple still exists. Area and production of cassava show a declining trend over years in the state but productivity shows considerable increase. The increasing trend in yield is due to adoption of various improved cassava production technologies by the farmers. The study of extent of adoption of these technologies by the farmers is of much help in understanding the role of these technologies on the yield of cassava. An attempt is made in this paper to understand the extent of adoption of improved cassava production technologies in the selected coastal districts of Kerala.

MATERIALS AND METHODS

Among the nine coastal districts of Kerala, three districts, viz. Thiruvananthapuram, Kollam, and Malappuram were selected as they were the top three coastal districts having larger areas under cassava cultivation in the State.

Two blocks having larger area under cassava were selected from each of these three districts. From each selected block two villages were selected randomly. Thus a total of 12 villages were selected. Ten cassava growers were randomly selected from each of the selected villages, thus making the total sample size to 120.

Central Tuber Crops Research Institute recommended the package of practices for cassava cultivation in both low land and upland conditions during seventies. Weightages were assigned to these selected technologies based on opinion survey conducted among the scientists of Central Tuber Crops Research Institute (CTCRI) involved in cassava research. Weightages assigned to cassava production technologies based on the opinion survey were furnished in Table 1.

J. Indian Soc. Coastal agric. Res., 24(2), 326-329, 2006

Adoption of Cassava Production Technologies by Farmers of Coastal Districts of Kerala

T. SRINIVAS, M. ANANTHARAMAN and T. SIJU

Central Tuber Crops Research Institute
Sreekariyam, Thiruvananthapuram - 695 017, Kerala

Cassava production technologies in terms of recommended package of practices are available since long. The extent of adoption of these practices by the cassava growers is of much help in understanding the influence of these practices on the yield of cassava. An attempt is made in this paper to understand the extent of adoption of cassava production technologies in the selected coastal districts of Kerala. The overall adoption level by the farmers will be measured using the adoption quotient (AQ) formula. Three districts, viz. Thiruvananthapuram, Kollam and Malappuram were selected as they were the top three coastal districts having larger cassava areas in Kerala. Data were collected using a structured interview schedule. Average Adoption Quotient for the three districts was worked out to be 57.43 %. Recommended practices like land preparation, sett length, sett making, planting method and storage of planting material were adopted correctly by all the farmers while very few farmers were adopting the technologies like high yielding varieties, spacing, fertilizers, organic manures, retaining two shoots per plant, and cassava mosaic disease management, etc.

(Key words: Cassava, Production technologies, Adoption quotient)

The end uses of cassava saw a sea change with the production of many value-added products, such as starch, sago etc. Indonesia, Thailand and India are the major countries growing cassava in Asia. India acquires significance in the global cassava scenario due to its highest productivity in the world (27.91 t ha^{-1}). It is cultivated in an area of 0.24 million ha producing 6.7 million tones.

Although it is cultivated in India in 13 states, it is concentrated in the Southern peninsular region of the country and to certain extent in North-east region of the country. The crop is concentrated owing to the favourable climate and efficient utilization commercially in the Southern states of Kerala, Tamil Nadu and Andhra Pradesh. Among the Southern states, Kerala stands first in cassava area (45%) in the country. Maximum production goes for human consumption in Kerala.

Though the consumption of cassava has reduced over years in the State, its importance as a secondary staple still exists. Area and production of cassava show a declining trend over years in the state but productivity shows considerable increase. The increasing trend in yield is due to adoption of various improved cassava production technologies by the farmers. The study of extent of adoption of these technologies by the farmers is of much help in understanding the role of these technologies on the yield of cassava. An attempt is made in this paper to understand the extent of adoption of improved cassava production technologies in the selected coastal districts of Kerala.

MATERIALS AND METHODS

Among the nine coastal districts of Kerala, three districts, viz. Thiruvananthapuram, Kollam, and Malappuram were selected as they were the top three coastal districts having larger areas under cassava cultivation in the State.

Two blocks having larger area under cassava were selected from each of these three districts. From each selected block two villages were selected randomly. Thus a total of 12 villages were selected. Ten cassava growers were randomly selected from each of the selected villages, thus making the total sample size to 120.

Central Tuber Crops Research Institute recommended the package of practices for cassava cultivation in both low land and upland conditions during seventies. Weightages were assigned to these selected technologies based on opinion survey conducted among the scientists of Central Tuber Crops Research Institute (CTCRI) involved in cassava research. Weightages assigned to cassava production technologies based on the opinion survey were furnished in Table 1.

Table 1. *Selected cassava production technologies along with their weightage*

Sl. No	Name of the Technology	Weightage
1	Variety	3.53
2	Land preparation	2.87
3	Sett making	2.73
4	Sett length	1.93
5	Planting method	2.20
6	Spacing	3.67
7	Retaining two shoots per plant	2.27
8	Application of organic manures	3.27
9	Application of N fertilizers	2.93
10	Application of P_2O_5 fertilizers	2.60
11	Application of K_2O fertilizers	3.13
12	CMD management	2.33
13	Storage of planting material	2.47

All the sample farmers were personally interviewed using a well structured pre-tested interview schedule for collecting information regarding adoption of various improved cassava production technologies like cultivation of improved/ high yielding varieties, land preparation, sett making, sett length, planting method, spacing, retaining two shoots per plant, application of organic manures, application N, P, K nutrients, adoption of Cassava Mosaic Disease (CMD) management practices, and storage of planting materials. Data were compiled and analysed using tabular and percentage analysis.

The adoption level of various cassava production technologies were measured using Adoption Quotient (A.Q) formula developed by Chattopadhyay (1963) modified to suit the farmer and the crop type. The modified formula is

$$\text{Adoption Quotient (AQ)} = \{\sum_{i=1}^{N} (e_i w_i / P_i) / \sum_{i=1}^{N} w_i\} 100$$

where, e_i = Extent of correct adoption of ith practice

P_i = Potential area for adoption of ith practice

w_i = Weightage given to i^{th} practice

N = Number of improved practices under consideration

RESULTS AND DISCUSSION

Post-sampling stratification of the selected farmers was done based on land holdings as Marginal farmers (<1ha), Small farmers (1-2ha), Semi-medium farmers (2-4ha), Medium farmers (4-10ha) and Large farmers (>10ha) for better understanding of adoption level of farmers of these groups. All the sample farmers were falling under marginal and small farmers categories only. None of the sample farmers were in the categories of semi-medium, medium and large farmers. The classification of the sample farmers is presented in Table 2.

Value of Adoption Quotient (AQ) of cassava farmers in the selected coastal districts were presented in Table 3. Adoption quotient of cassava

Table 2. *Classification sample cassava farmers in the selected coastal districts of Kerala*

State	Percentage of sample farmers in each category				
	Marginal farmers (<1ha)	Small farmers (1-2ha)	Semi-medium farmers (2-4ha)	Medium farmers (4-10ha)	Large farmers (>10ha)
Thiruvananthapuram	97.50	2.50	0	0	0
Kollam	100.00	0	0	0	0
Malappuram	100.00	0	0	0	0
Average	**99.17**	**0.83**	**0**	**0**	**0**

Table 3. *Adoption quotient of cassava farmers in selected coastal districts of Kerala*

District	Adoption Quotient					Overall adoption quotient
	Marginal farmers (<1ha)	Small farmers (1-2ha)	Semi-medium farmers (2-4ha)	Medium farmers (4-10ha)	Large farmers (>10ha)	
Thiruvananthapuram	58.60	63.05	0	0	0	58.71
Kollam	58.61	0	0	0	0	58.61
Malappuram	54.99	0	0	0	0	54.99
Average	**57.40**	**63.05**	**0**	**0**	**0**	**57.44**

Table 4. *Percentage of farmers adopting cassava production technologies as per recommendation in the selected coastal districts of Kerala*

District	Cassava production technologies under consideration								
	Variety	Land preparation	Sett making	Sett length	Planting method	Spacing	Retaining two shoots /plant	CMD management ment	Storage of planting material
Thiruvananthapuram	17.50	100.00	100.00	100.00	100.00	82.50	57.50	10.00	100.00
Kollam	5.00	100.00	100.00	100.00	100.00	100.00	60.00	10.00	100.00
Malappuram	0.00	100.00	100.00	100.00	100.00	32.50	100.00	10.00	100.00
Average	**7.50**	**100.00**	**100.00**	**100.00**	**100.00**	**71.67**	**72.50**	**10.00**	**100.00**

farmers in Thiruvananthapuram was estimated to be 58.71 which was the highest among the three districts. While in Kollam and Malappuram districts, it was estimated to be 58.61 and 54.99, respectively. The average AQ of the three districts was worked out to be 57.44.

Percentage of farmers adopting cassava production technologies as per recommendation in the selected coastal districts of Kerala are presented in Table 4. Among the cassava production technologies considered, all the respondents were correctly adopting technologies like land preparation, sett making, sett length, planting method and storage of planting materials in all the three selected districts.

Nearly 72 percent of the total respondents were correctly adopting technologies like recommended spacing and retaining two shoots per plant. In Malappuram only 32 percent of the respondents were following the recommended spacing. Only 57.50 and 60.00 percent of the respondents were retaining two shoots per plant in Thiruvananthapuram and Kollam districts, respectively. While in Malappuram district all the farmers were adopting this practice as per recommendation.

Only 10 percent of respondents in each district were following management practices for controlling cassava mosaic disease like using disease free planting materials, using some pesticides to control white flies, etc.

Most of the farmers were not using organic manure as recommended in all the three districts. Only 22.50 percent of farmers were correctly applying the organic manures as recommended.

Imbalanced use of fertilizers was observed in all the three districts. Most of the farmers were not applying the correct recommended dosage of N, P, K nutrients. On an average only 8.33 percent, 11.67 percent and 3.33 percent of the total farmers were following the correct dosage of N, P and K fertilizers respectively. This indicates that there is scope to increase the productivity of cassava in these coastal districts if farmers adopt these recommendations correctly.

CONCLUSION

The average AQ of the three coastal districts was worked out to be 57.44 which indicates that the overall adoption level of improved cassava production technologies in these districts is

farmers in Thiruvananthapuram was estimated to be 58.71 which was the highest among the three districts. While in Kollam and Malappuram districts, it was estimated to be 58.61 and 54.99, respectively. The average AQ of the three districts was worked out to be 57.44.

Percentage of farmers adopting cassava production technologies as per recommendation in the selected coastal districts of Kerala are presented in Table 4. Among the cassava production technologies considered, all the respondents were correctly adopting technologies like land preparation, sett making, sett length, planting method and storage of planting materials in all the three selected districts.

Nearly 72 percent of the total respondents were correctly adopting technologies like recommended spacing and retaining two shoots per plant. In Malappuram only 32 percent of the respondents were following the recommended spacing. Only 57.50 and 60.00 percent of the respondents were retaining two shoots per plant in Thiruvananthapuram and Kollam districts, respectively. While in Malappuram district all the farmers were adopting this practice as per recommendation.

Only 10 percent of respondents in each district were following management practices for controlling cassava mosaic disease like using disease free planting materials, using some pesticides to control white flies, etc.

Most of the farmers were not using organic manure as recommended in all the three districts. Only 22.50 percent of farmers were correctly applying the organic manures as recommended.

Imbalanced use of fertilizers was observed in all the three districts. Most of the farmers were not applying the correct recommended dosage of N, P, K nutrients. On an average only 8.33 percent, 11.67 percent and 3.33 percent of the total farmers were following the correct dosage of N, P and K fertilizers respectively. This indicates that there is scope to increase the productivity of cassava in these coastal districts if farmers adopt these recommendations correctly.

CONCLUSION

The average AQ of the three coastal districts was worked out to be 57.44 which indicates that the overall adoption level of improved cassava production technologies in these districts is

Table 4. *Percentage of farmers adopting cassava production technologies as per recommendation in the selected coastal districts of Kerala*

District	Cassava production technologies under consideration							
	Variety	Land preparation	Sett making	Sett length	Planting method	Spacing	Retaining two shoots /plant	CMD management ment	Storage of planting material
Thiruvananthapuram	17.50	100.00	100.00	100.00	100.00	82.50	57.50	10.00	100.00
Kollam	5.00	100.00	100.00	100.00	100.00	100.00	60.00	10.00	100.00
Malappuram	0.00	100.00	100.00	100.00	100.00	32.50	100.00	10.00	100.00
Average	**7.50**	**100.00**	**100.00**	**100.00**	**100.00**	**71.67**	**72.50**	**10.00**	**100.00**

reasonably good. Adoption level of improved technologies like cultivation of improved/high yielding varieties, application of recommended dose of N, P, K, application of organic manures and CMD management practices were very low in these selected coastal districts. Thus future extension activities need to concentrate on these areas so that adoption level of these cassava production technologies can be improved thereby yield of cassava can be enhanced considerably in these districts.

REFERENCES

Chattopadhyay, S.N. (1963). A study of some psychological correlates of adoption of innovations in farming. *Ph. D Thesis*, IARI, New Delhi.

J. Indian Soc. Coastal agric. Res., 24(2), 330-333, 2006

Research - Extension Linkage in Coastal Aquaculture

M. KUMARAN, M. ALAGAPPAN, S. RAJA, D. D.VIMALA, C. SARADA, V. S. CHANDRASEKARAN and N. KALAIMANI

Central Institute of Brackishwater Aquaculture (CIBA)
75, Santhome High Road, Chennai - 600 028, Tamil Nadu

An investigation carried out along the east coast of the country revealed that the fisheries extension personnel had moderate linkage with fisheries research institutions, NGOs to perform their function. However, a vibrant extension at State level and a mechanism for regular interaction, joint problem diagnosis, prioritization and implementation with above stakeholders need to be evolved and institutionalized for an effective research-extension linkage and sustainable growth and development of coastal aquaculture.

*(**Key words:** Research-extension linkage, Aquaculture, Extension personnel attributes)*

In India, coastal aquaculture has an enormous potential (1.2 million ha) for enhancing its fisheries production. However, presently, coastal aquaculture is confined with tiger shrimp culture (*Peneaus monodon*) which is being practiced in 1,54,600 ha with a production of 1, 12,780 metric tonnes with a national productivity of 730 kg ha^{-1} yr^{-1} (Table 1). Sustainable coastal aquaculture development is closely related with the development of the ability of the farmer's understanding and adoption of new technology. Thus, fisheries extension bridges the gap between fisheries research station and the farming community by establishing suitable learning situations at various levels that would create access and interaction between the technology evolvers and its end users (De *et al.*, 1999). Keeping the above as background the present study was undertaken to investigate the nature and extent of linkage exist between the extension and research subsystems of coastal aquaculture.

MATERIALS AND METHODS

This investigation was conducted along in coastal Tamil Nadu and Andhra Pradesh where shrimp aquaculture is being actively practised. A sample of 30 extension personnel, fifteen each from the Departments of Fisheries of the above States, working in the coastal regions was drawn using simple random sampling procedure. A structured interview schedule pre-tested with similar personnel elsewhere and personal observation were used for data collection. Ten personal attributes, viz. age, education, experience, training attended, performance, frequency of contact, resource appraisal, collaboratory work, targets, information behavior were included for the study. The dependent variable, viz. extent of linkage with the Fisheries R&D Institutions was studied and measured based on a summated rating procedure developed for the study, which included linkage with an agency, frequency of contact and perceived satisfaction of the respondent. The data collected were processed with descriptive, correlation and regression statistics using SPSS package to interpret the findings.

RESULTS AND DISCUSSION

Attributes of the extension personnel

Personal attributes of the respondents were studied to have a better understanding of their profile and presented in Table 2.

Around fifty percent (47%) of the respondents were aged less than 40 years and the other half (53%) aged above 40 years. This aptly indicates the lack of recruitment of young professionals from the fisheries research and academic institutions to the DoF as extension personnel in the recent past. More than half of the respondents (53%) were post graduates with biology as their main subject and the remaining (47%) were of graduates or diploma holders. Though the respondents had more than 15-28 years of experience in the department, majority of them (80%) had less than three years of field experience in coastal shrimp farming. However, majority of them had undergone trainings and among them about thirty percent had training either on shrimp or scampi (freshwater prawn) culture. Majority of them (73%) followed group contact extension method to meet aquafarmers and group meetings were conducted at different places in their

Table 1. *Statewise details of shrimp production during the year 2003-04*

State	Potential area available (ha)	Area developed (ha)	Area under culture (ha)	Production (MT)	Productivity (Mt/ha/yr)
West Bengal	405000	50405	49925	29714	0.60
Orissa	31600	12880	12116	12390	1.02
Andhra Pradesh	150000	79270	69638	53124	0.76
Tamil Nadu	56800	5416	3214	6070	1.89
Kerala	65000	16323	14029	6461	0.46
Karnataka	8000	3435	3085	1830	0.59
Goa	18500	1001	963	700	0.73
Maharashtra	80000	1056	615	981	1.60
Gujarat	376000	1537	1013	1510	1.49
Total	**1190900**	**171320**	**154600**	**112780**	**0.73**

(Source: MPEDA, 2004)

Table 2. *Attributes of extension personnel*

Attribute	% of Responses (N=30)
Age	
< 40 years	47.00
> 40 years	53.00
Education	
Graduation	53.00
Above Graduation	47.00
Experience in costal aquaculture	
< 3 years	80.00
> 3 years	20.00
Extension approach	
Group contact	73.00
Personal contact	27.00
Frequency of contact	
Once a month	40.00
Occasional	60.00
Willingness to work with private extension	
Yes	83.00
NO	17.00
Communication of field problems to research	
Through Head office	70.00
Nativity	
Rural	57.00
Urban	43.00
Technical information source	
Department R& D & Training centre	57.00
Training	
Attended	83.00
Needed	60.00

jurisdiction depending on the field situation. Most of them (83%) expressed willingness to work with private extension personnel of aquafeed companies since the latter had regular contacts with the farmers. Majority of them (70%) reported their field problems to their head offices and in turn the same were communicated to the research wing of the department for solutions. They were of the perception that the farmers had followed their technical advice. Departmental training centre was their prime information source for majority (57%) of the respondents. Majority of them (60%) wanted training in extension methodologies, human relations management and subject matter. Many respondents were of the view that since every aqua-extension officer has the jurisdiction of more than two to three *mandals* or *talukas* in addition to other work there should be an exclusive person for aquaculture in the department or this work can be given to a reliable NGO or qualified private extension personnel.

Linkage with fisheries R&D institutions

The nature and extent of linkage the respondents have with the fisheries R&D institutions are indicated in the Table 3. Linkage between the extension agencies and the fisheries R&D institutions is very vital for development of need based location specific technologies and holistic development of the sector. It may be seen from the Table 3 that majority of the respondents (67%) had link with Marine Products Export Development Authority (MPEDA) by participating in the meetings organized by the latter at frequent intervals. The MPEDA being the promoter of aquaculture offered several subsidy-oriented schemes and the DoF is the member of that subsidy committee. The respondents on behalf of their superiors participated in such meetings and interacted with MPEDA officials and exchanged information with them. Further, scheduled banks like, State Bank of India

Table 3. *Extension personnel linkage with R&D Institutions*

Institution	% of responses* (N=30)	Through	Frequency	Perception	Remarks
MPEDA	67.00	Farmers meetings, Guidelines, Subsidy/License, enquiry	Monthly	Satisfied	Need to be strengthened
FC & RI	47.00 & 40.00	Reference/ Technical information	Occasional	Satisfied	Need to be strengthened
Development Departments	33.00	AA License - Meetings	Monthly	Moderately satisfied	Need to be strengthened
Aquaculture Authority	27.00	Guidelines, Subsidy/License, policies, Regulations	Occasional	Satisfied	Need to be strengthened
NGOs	20.00	Meetings	Occasional	Satisfied	Need to be strengthened
Bankers	17.00	Farmers meetings	Occasional	Satisfied	Need to be strengthened

* Multiple responses

Table 4. *Regression analyses of attributes in linkage with R&D institutions*

Attributes	Regression co-efficient	
	B	SE(I) 5%
Age	-0.458	0.407
Education	7.954*	2.128
Experience	-0.006	0.411
Training attended	4.263	2.720
Role performance	-1.851	1.225
Frequency of contact	12.109*	3.053
Resource appraisal	-0.952	1.768
Collaboratory work	-8.568	9.624
Targets	-0.229	1.215
Information behaviour	1.433	0.811

*Significant at 5% level

and Canara Bank, etc. were offering credit assistance to aquafarmers on the basis of the projects prepared by MPEDA and DOF and through these programmes also they had close interactions. The respondents satisfied with the existing linkage and opined that linkage with MPEDA needs to be strengthened considering the role played by the both.

About half of the respondents had rapport with Fisheries Colleges (47%) and Research Institutions (40%) at occasional intervals through joint meetings and inviting technical experts from the above for their training programmes. Many respondents had attended training programmes conducted by ICAR institutes like Central Institute of Brackishwater Aquaculture (CIBA, Chennai) and Central Institute of Freshwater Aquaculture (CIFA, Bhuvaneswar). The respondents were satisfied with those programmes and felt that linkage with research institutions and fisheries colleges need to be strengthened on a regular basis for obtaining scientific research findings and to communicate field problems. The respondents had linkage with the aquaculture authority (27%) and NGOs (20%) working in aquaculture. The respondents were involved in approval of shrimp farms by the aquaculture authority and had frequent contact with it. Similarly, majority of respondents (33%) had linkage with development departments like Agriculture, Ground water board, Revenue department, etc. since they all are members of the district Committee for screening the applications of licenses submitted by the farmers and felt that linkage with developments is to be strengthened. Some NGOs working in coastal villages were involved in organizing Women Self Help groups for taking up fisheries activities like crab fattening, value addition of fishes, ornamental fish farming and training of farmers. The frequency of interaction with such NGOs was occasional and they were of the view that linkage with them needs to be improved.

It is observed that the organizational set up for fisheries extension in the Central as well as in State sector needs reorientation. Even the nominal setup existing at present differs from State to State depending upon the priorities assigned to fisheries development and resources available. However, a strong fisheries extension set up is an essential prerequisite for a dynamic and effective research-extension system. The linkage between the extension organizations of different States/UTs and between

Central and State fisheries departments are to be strengthened. Explicit linkage among the extension systems of the fisheries organizations of the Centre, State, UTs and SAUs and between extension and input supply agencies ought to be established at different levels to ensure prompt transfer of technology and efficient extension services to the end users. State Fisheries Extension system should support research institutions (RIs and SAUs) in providing comprehensive feedback information from the production systems for evaluation and use for further improvement, refinement and reinventions. Similar observations were made by CMFRI (1980), Kumaran *et al.* (2003).

Regression analysis of attributes in linkage with R&D institutions

The nature of influence, the attributes of extension personnel had with R&D institutions in linkage with was studied by a regression analysis and the results are reported in Table 4. Among the ten variables taken for analysis, education and frequency of contact with end users were found to have significant positive influence at 5% level with their extent of linkage with fisheries R&D institutions. Higher education facilitated for closer interaction with research and development institutions to acquire and update the technical knowledge of the extension personnel, hence it was positively influencing. Moreover, the frequent contact with the end users would definitely force the respondents to obtain appropriate and adequate information from the R&D institutions to communicate and convince the end users to adopt proper scientific management practices.

REFERENCES

CMFRI (1980). Seminar on fisheries extension. *Marine Fisheries Information Service*, Technical Extension Series No. **27**. 20p.

De, H.K., Saha, G.S. and Sahu, B.B. (1999). Problem identification using farmer participatory research tool. *Journal of Extension Education* **IV**(1&2): 36-40.

Kumaran, M., Chandrasekaran,V.S. and Kalaimani, N. (2003). Aquaculture extension - the neglected aspect in aquaculture development. *Fishing Chimes* **23**(6): 29-34.

Suliman, R.V. and Hall, A.J. (2004). *Towards Extension Plus: Opportunities and Challenges*, National Centre for Agricultural Economics and Policy Research, Policy Brief No.**17**.

Venkatesan, V. (1985). In *Policy and Institutional Issues in Improving Research- Extension Linkage in India in Research, Extension, Farmers: A Two-way Continuum for Agricultural Development*, Michael Cernea, M., John K. Coulter and John F.A.Russell (eds.), The World Bank, Washington, DC, USA.

J. Indian Soc. Coastal agric. Res., 24(2), 334-337, 2006

Communication Behaviour of Shrimp Farmers

D. DEBORAL VIMALA, M. KUMARAN and M. KRISHNAN

Central Institute of Brackishwater Aquaculture
75, Santhome High Road, R.A. Puram, Chennai – 600 028, Tamil Nadu

An effective two-way communication is the soul of extension education which *inter alia* strives to evoke desirable changes in the attitude and behaviour of both communicators and receivers. Possession of rich knowledge base is fundamental in making appropriate in-time decisions in shrimp farming, an input and risk loaded enterprise. An attempt has been made in this investigation conducted among the 34 proportionate randomly chosen shrimp farmers to examine their communication channels and information processing behaviour. Personal localite (Peers), personal cosmopolite (formal sources) and impersonal cosmopolite (mass media) were their order of preferred communication sources. Information received were processed with peers, stored in classified notebooks and shared with fellow farmers. Evolving and strengthening of extension networking systems, revamping the state fisheries extension systems with adequate extension skilled staff supported with required logistics, promotion and facilitation of farmers' fora at field level and optimal utilization mass media for aquaculture extension would help the end user well informed and take appropriate decisions.

(***Key words:*** *Communication behaviour & channels, Shrimp farming, Communication approach)*

Communication is the process of exchanging any information between the communicator and the audience. An effective two-way communication is the soul of extension education. Possession of rich knowledge base is fundamental in making appropriate in-time decisions in shrimp farming an input and risk loaded enterprise. Learning of new know-hows and do-hows ensure desired changes in the shrimp farmers knowledge, technology, skills and attitude. The modern communication medium has diversified streams, including research institutions, government extension agencies, other government organizations, input dealers, mass media, etc.(Malik *et al.*, 2000). The role of communication in affecting socioeconomic change cannot be over-emphasized- greater the number of information sought- higher the contact with the communication sources and wider is the adoption. Three kinds of resources are essential for rapid aquacultural progress, viz. capable scientists at work on the problem of the people, farmers who have confidence that science can help them, and a bridge of communication to link the duo. Singh and Sahay (1970) rightly pointed that, the investigator advances knowledge, the interpreter advances progress. It is frequently asserted that farmers' rich experience and accurate scientific knowledge enhance their capacity to manage shrimp farms efficiently. Knowledge on the farmers' communication sources and their information processing behaviour would help the extension system in devising proper communication strategies. With this background, this study was conducted with the objectives, viz. i) to examine the existing communication channels accessible to the farmers, and (ii) to study the information processing behaviour of the respondents.

MATERIALS AND METHODS

The present study was carried out in Ramanathapuram district of Tamil Nadu, which ranks second in area under shrimp culture in the State. A sample of 34 farmers was selected from five villages by means of proportionate random sampling method. The data have been collected through a well-structured interview schedule. Awareness and use of communication channels and information processing behaviour of the farmers were studied through the methodology devised by Deboral (1989) with slight modifications. Percentage analysis was used in categorization and interpretation of the data collected.

RESULTS AND DISCUSSION

Profile of the respondents

The personal profile of the respondents is presented in Table 1. It is seen from the data that most of the farmers belonged to middle age group and two-thirds were educated at collegiate level. The entrepreneurial urge of young age and high profit nature of this enterprise could have fascinated the educated people. Most of the farmers had other occupations in addition to shrimp farming and a farming experience of 10 years and above. The size

Table 1. *Profile of the respondents*

Variables	Response (%) N= 34
Age	
Young	3(8.82)
Middle	29(85.29)
Old	2(5.88)
Educational level	
Primary	-
Middle	-
High School	3(8.82)
Hr Sec	12(35.29)
Collegiate	19(55.88)
Occupational status	
Aquaculture + Agri	7(20.58)
Aquaculture +business	9(26.47)
Aquaculture alone	18(52.94)
Farm size	
Up to 2.00 ha	26(76.47)
2.01-4.00 ha	8 (23.52)
Farming experience	
Up to 5 years	5(14.70)
6-10 years	16(47.05)
> 10 years	13(38.23)
Social participation	
Low	4(11.76)
Medium	25(73.52)
High	5(14.70)
Economic motivation	
Low	-
Medium	2(5.88)
High	32(94.11)
Risk Orientation	
Low	-
Medium	3(8.82)
High	31(91.17)

of the farm holdings ranged from 1.0 ha - 4 ha. They had medium level of social participation. They had high level of economic motivation and risk orientation. The respondents adopted improved extensive shrimp farming system with a stocking density of 4-6 post-larvae (PL) per square metre.

Communication channels used

Farmers communicate with multiple sources of information to assess and enrich their knowledge base. Communication sources through which the farmers get information about production practices of shrimp culture have been classified into three categories as personal cosmopolite, personal localite and impersonal cosmopolite channels (Tables 2 & 3). Data indicate that personal-localite channels, viz. feed dealers (100%) and fellow farmers (85%) were the primary communication channels used for receiving information regarding production practices of shrimp culture. They were the source of information for all the technical matters viz. purchase of quality hatchery seeds, stocking of PCR tested seeds, fertilizer application, feeds and feeding, soil and water quality management, discharge of water, and disease management aspects. The feed dealers visited ponds regularly and at times of farmer's request offered required technical assistance. However, the farmers felt that the information provided them are mainly to market their products not for helping the farmers. Their supply of inputs on credit, easy and timely accessibility outweighed their intentions and competence. Absence of an effective fisheries extension network with Department of Fisheries gave them the monopoly. Many farmers had employed full time technicians and unskilled permanent labourers to manage routine farm operations as reported by Kumaran *et al.* (2003). The shrimp farmers association established in Ramanathapuram district is active only during adverse times like disease outbreak, water scarcity, etc. However, fellow farmers were kept informed about date of stocking, drainage discharge into canals and creeks. This was because of their previous negative experiences.

Table 2. *Communication channels of shrimp farmers*

Communication channels	Response (%) N= 34
Personal-cosmopolite channels	
Fisheries college and Research Institute, Thoothukudi	8 (23.52)
Scientists of CMFRI, Mandapam	10 (29.41)
Officials of Department of Fisheries	5 (14.70)
Personal-localite channels	
Progressive farmers	11 (32.35)
Friends /relatives/Neighbours	29 (85.29)
Feed consultants	34 (100.00)
Impersonal-cosmopolite channels	
Radio	2 (5.88)
Television	2 (5.88)
Newspapers	21 (61.76)
Aquacultural magazines	4 (11.76)
Aquacultural exhibitions	2 (5.88)

Multiple responses (Numbers in parentheses indicate percentage)

Table 3. *Approach of communication channels for shrimp farming practices*

SL. No	Shrimp farming practices	Personal -cosmopolite N=34 (%)		Personal -localite N=34 (%)		Impersonal-cosmopolite N=34 (%)	
1	Purchase of hatchery seeds	2	5.88	32	94.11	-	-
2	Stocking of PCR tested seeds	2	5.88	32	94.11	1	2.94
3	Fertilizer application	1	2.94	16	47.05	-	-
4	Feeds and feeding	3	8.82	34	100.00	-	-
5	Water management practices	2	5.88	29	85.29	-	-
6	Soil management practices	1	2.94	4	11.76	-	-
7	Discharge of water	-	-	34	100.00	-	-
8	Disease diagnosis and management	7	20.58	32	94.11	1	2.94
9	Marketing	-	-	27	79.41	-	-
10	Hiring labourers	-	-	17	50.00	-	-
11	License and subsidies	32	94.11	-	-	-	-
12	Application of probiotics	4	11.76	31	91.17	1	2.94

Multiple responses (Numbers in parentheses indicate percentage to total)

Impersonal cosmopolite channels like mass media (Radio, TV and print), CMFRI, Mandapam and Fisheries College, Thoothukudi through farm publications were the second important communication sources (Table 2). However, the farmers were of the view that their frequency of contact was rare.

The personal–cosmopolite channels ranked the third important communication source (Table 2). It was reported that although shrimp farmers were aware of the State extension agencies, the latter seldom visited the farmers. However, almost all shrimp farmers relied on the State Fisheries Department for obtaining license and subsidies. Inadequate extension staff, orientation and heavy populist works thrusted on them carried away their time.

Information processing behaviour of respondents

The information processing behaviour of respondents was studied under three headings, viz. information evaluation, information storage and information transfer. From Table 4 it is seen that majority (44%) of respondents assessed the information from fellow farmers (21%) and hardly three 3 percent accepted without any evaluation. Most of the respondents (85%) stored the information by maintaining classified note books and memorizing (35%). The received information was shared with fellow farmers in farmers meetings (26%).

Table 4. *Information processing methods*

Information processing methods	Response (%) N= 34
Information Evaluation	
a. Discussion with officials in the State Department in Aquaculture	5(14.70)
b. Judging in the light of climatic condition	-
c. Judging in the light of socio-economic condition	2(5.88)
d. Discussion with other farmers	15(44.11)
e. Acceptance without reservation	1(2.94)
f. Weighing in the light of past experience	7 (20.58)
Information storage	
a. By maintaining classified note books	29 (85.29)
b. By memorizing	12 (35.29)
c. By conveying to family members and asking them to remember	-
Information transfer	
a. Giving radio/TV talk	-
b. Writing in newspapers	-
c. Speaking in local meetings	4 (11.76)
d. Conveying to other members at farm or at home	9 (26.47)
e. By demonstration	-
f. Lending aquacultural magazines to others	2 (5.88)

Multiple responses (Numbers in parentheses indicate percentage to total)

Implications of the study

- The study showed that it was the high time that formal fisheries extension networking system has to be systematically evolved and strengthened with adequate qualified personnel recruitment, capacity building in extension basics, approaches and methodologies with sufficient budgetary and other logistics support. This would clip the monopoly of the input dealers.
- The effectiveness of mass media-facilitated extension has been proved in agricultural sciences. However, its utilization in fisheries was inadequate. Hence, it should be optimally exploited for fisheries extension.
- Promotion and facilitation of farmers fora at field level ensured effective information exchange among the fellow farmers and check communication and time lag.

REFERENCES

Kumaran, M., Kalaimani, N., Ponnusamy, K., Chandrasekaran, V.S. and Vimala, D. Deboral (2003). A case of informal shrimp farmers association and its role in sustainable shrimp farming in Tamil Nadu, India. *Aquaculture Asia* **VIII**(2): 10-12.

Singh, I.B. and Sahay, B.N. (1970). *Communication Behaviour and Social Change*. Bookhive Publishers and Booksellers, 26/18, East Patel Nagar, New Delhi.

Singh Malik, Karwasra, D.P.S.N. and Rai, K.N. (2000). Sources of information on improved crop production technology and its valuation in Haryana. *Indian Journal of Agricultural Economics* **55**(3-4): 521-527.

J. Indian Soc. Coastal agric. Res., 24(2), 338-340, 2006

Shrimp Seed - A Critical Problem Faced by Shrimp Farmers - A Cross Sectional Analysis

D. DEBORAL VIMALA[1], S. RAMACHANDRAN[2], P. S. SWATHILEKSHMI[3] and M. KUMARAN[4]

[1&4] Central Institute of Brackishwater Aquaculture, Chennai - 600 028, Tamil Nadu

[2]Anna University, Chennai - 600 025, Tamil Nadu

and

[3]Central Marine Fisheries Research Institute, Chennai - 600 028, Tamil Nadu

Seed is a major input in shrimp farming and all the farmers and entrepreneurs depend on hatchery seeds. For expansion of brackishwater shrimp farming, a regular and steady supply of quality shrimp seeds in large quantities at a given time for stocking is essential. Hatcheries are the source for the supply of quality hatchery seeds and stocking wild seeds is banned. Presently, in Tamil Nadu there are 68 shrimp hatcheries with a production capacity of 3000 million post-larvae. The survey was carried out in Nagapattinam and Thanjavur in two districts of Tamil Nadu. A sample of 300 shrimp farmers was interviewed randomly for the study. This paper presents the problems pertaining to shrimp seed encountered by the farmers and suggestions to overcome the same. The problems encountered by the farmers in both districts were lack of assurance on quality seeds, non-existence of government agency for regulating the price of seeds, high cost of seeds, non-availability of seeds from research institutes, inadequate supply of hatchery seeds, mortality of seeds during transportation, mixed seeds and deceptive method of counting the seeds. Suggestions given by them to overcome the problems were that the government research institutes should set up some more hatcheries and virus free Nauplius should be supplied to the farmers, assurance about seed quality from research institute and production of improved broodstock from government research laboratories. Since without a healthy broodstock shrimp farmers cannot hope to get quality seed, PCR was suggested as a sensitive diagnostic tool for detecting viral infection but due to various gaps in training this tool has not been used with consistent results.

*(**Key words:** Shrimp seeds, Broodstock, Quality control, Diagnostic tool, Supply and role of agencies)*

Globally, shrimp farming has been a significant agro-based economic activity since the early 1970s. Shrimp farming in India has been undergoing rapid technological transformation and it has gained extensive popularity. Seed is a major input in shrimp farming and all the farmers and entrepreneurs depend on hatchery seeds. For expansion of brackishwater shrimp farming, a regular and steady supply of quality shrimp seeds in large quantities at a given time for stocking is essential. To meet this requirement, to the extent possible, shrimp seeds are produced in the hatcheries and supplied to the farms. Hatcheries are the source for the supply of quality hatchery seeds and stocking wild seeds is banned. Presently, in Tamil Nadu there are 68 shrimp hatcheries with a production capacity of 3000 million post-larvae. Though about 55 species of shrimp are available in India, only 11 of them are considered suitable for culture. Among 11 species *Penaeus monodon* is widely cultured in the study area. This paper presents the problems encountered by the farmers pertaining to shrimp seed and suggestions to overcome the same.

MATERIALS AND METHODS

The investigation was carried out in Nagapattinam and Thanjavur in the two districts of Tamil Nadu. The brackishwater area available area in Nagapattinam, Thiruvarur and Thanjavur districts is 31,400 ha and the potential area readily available is 6292 ha. Total area under culture in Nagapattinam district is 1294.18 with water spread area of 989.93 as against 198.44 ha in Thanjavur district with water spread area of 139.69 ha (Anon, 2003). There were only 4 hatcheries functioning in and around Nagapattinam district and there were no hatcheries in Thanjavur. So, the farmers in both the districts totally depended on the hatcheries in and around Chennai. A sample of 300 shrimp farmers was interviewed randomly for the study. The respondents were asked open-ended question to elicit important problems faced by them. They were also asked to suggest measures which in their opinion would help solving the problems faced.

RESULTS AND DISCUSSION

From Table 1 it could be observed that lack of assurance of quality seeds was reported by 80.67

percent of respondents in Thanjavur and 62.67 percent in Nagapattinam district. Many shrimp farmers in the study area reported frequent outbreak of viral diseases, which necessitated them to check the quality of seeds. Farmers normally selected healthy PL's based on physical appearance. But for quality assurance in recent years, modern biotechnological method like Polymerase Chain Reaction (PCR) is preferred which could detect the presence of small viruses. So they subjected the seeds to PCR tests. Farmers stated that the cost for checking the quality of seeds was high. While the farmers preferred PCR tests, the manipulation of seeds from some of the hatcheries was inevitable and they said the technical workers were mainly responsible for this malpractice.

Secondly non-existence of Government agencies for regulating the price of seeds was reported by 48.00 percent of the respondents in Nagapattinam and 42.66 percent in Thanjavur. The hatchery seeds were sold at exorbitant prices. So far the Government agencies have not taken keen steps to regulate the price and make the hatchery authorities sell the seeds at reasonable cost.

The third major problem was high cost of seeds encountered by 45.33 percent of the respondents in Nagapattinam and 32.00 percent in Thanjavur district. It resulted in skyrocketing of prices and black marketing. There was no regulation over cost and supply. The farmers requested the government agency to come forward and take interest in their welfare by regulating the prices of shrimp seeds at reasonable cost for the benefit of the farming community. Due to the scarcity of hatchery seeds, the wild seeds were also sold at exorbitant prices. Some of the respondents did not perceive the high cost of seeds as a problem because they were convinced that the high cost of seeds was compensated by high returns from shrimp farming.

Another seed oriented problem identified in the study area was non-availability of seeds from research institute as reported by 46.67 percent of the total respondents. They felt that promotional agencies should make sincere attempt to produce hatchery seeds for the farming community. Inadequate supply of hatchery produced seeds at appropriate time was a problem perceived by 26.00 percent of respondents in Nagapattinam and about 19.33 percent in Thanjavur. Some of the respondents informed that the same problem was very severe during the year 1994. It was also reported by some that the price of the wild seeds had gone up to Rs 200-250 per 1000 during 1993 and to about Rs 500-750 per 1000 numbers during 1994. Inspite of the problem of inadequate supply of hatchery seeds, they had to forgo the culture and were not able to take up the culture at a particular time.

Table 1. *Problems pertaining to shrimp seed*

Types of problems	Nagapattinam n=150	Thanjavur n=150	Total n=300*
Lack of assurance on quality seeds	94 (62.67)	121 (80.67)	215 (71.67)
Non-existence of government agency for regulating the price of seeds	72 (48.00)	64 (42.67)	136 (45.33)
High cost of seeds	68 (45.33)	48 (32.00)	116 (38.67)
Non-availability of seeds from research institutes	65 (43.33)	75 (50.00)	140 (46.67)
Inadequate supply of hatchery seeds	39 (26.00)	29 (19.33)	68 (22.67)
Mortality of seeds during transportation	25 (16.67)	32 (21.33)	57 (19.00)
Mixed seeds	17 (11.33)	19 (12.67)	36 (12.00)
Deceptive method of counting the seeds	11 (7.33)	5 (3.33)	16 (5.33)

* Multiple responses (Figures in parentheses indicate percentage to total)

Table 2. *Suggestions pertaining to shrimp seed*

List of suggestions	Nagapattinam n=150	Thanjavur n=150	Total N=300*
Government research institutes should set up some more hatcheries and virus free Nauplius should be supplied to the private hatcheries	90 (60.00)	117 (78.00)	207 (69.00)
Assurance about seed quality from research Institute	58 (38.67)	72 (48.00)	130 (43.33)
Production of improved broodstock from government research laboratories	54 (36.00)	71 (47.33)	125 (41.67)

* Multiple responses (Figures in parentheses indicate percentage to total)

About 16.67 percent of respondents from Nagapattinam and 21.33 percent from Thanjavur reported that the seed transportation from hatcheries to several farming areas was time consuming and stressful. Prolonged transportation of seed often packed in poor quality cardboard boxes caused stress rendering them weak and susceptible to disease by the time they arrived at the farming site for stocking.

Some 14.00 percent of the respondents in Nagapattinam and 12.67 percent in Thanjavur reported that certain hatcheries had supplied seeds of mixed ages. Out of the total respondents only about 5.33 percent of the respondents encountered the deceptive method of counting the seeds as one of the problem. As there was heavy demand for shrimp seeds during 1994, some of the hatcheries were reported to indulge in the malpractice. The farmers could not insist on proper counting of seeds because of heavy demand for shrimp seeds. Similar findings such as shortage of quality seeds were reported by Gopinathan and Deboral (1995), high cost of seeds by Sakthivel (1997) and Lekshmi (2004), inadequate supply of seeds by Anon. (1992), Rao (1997) and deceptive method of counting the seeds by Chand (1992). The suggestions given by the respondents who faced this problem are discussed below and the pooled data are presented in Table 2.

About 78.00 percent of respondents in Thanjavur and 60.00 percent in Nagapattinam suggested that the shortage of seed should be overcome and that modernized/ improved seed production should be taken up in the private sector. Further, to the supply of quality seed, a directory of seed producers/ suppliers/ rearers has to be prepared at the district level by the Brackishwater Fish Farmers Development Agency and Marine Products Export Development Authority and supplied to the farmers.

Farmer's experiences have shown that stocks whose samples give negative results in PCR test sometimes turn out to be WSSV positive. If government PCR is made to function properly, more number of farmers will be benefited by viral free shrimps.

Thus setting up of accrediting bodies with quality control labels like Agmark as in agriculture may be followed for aquacultural inputs (Lekshmi, 2004). Attempts should be made to set up government shrimp hatcheries of required capacity to meet the seed requirements of the farmers of both the districts. For this, the project cost for such hatchery may be high, a part of which may be financed by the farmers, entrepreneurs, seafood processors/exporters.

REFERENCES

Anon. (1992). Indian fishery statistics at a glance. *Seafood Export Journal* **24**: 31-32.

Anon. (2003). *Auqaculture Authority News*, pp. 14-16 June 2003.

Chand, B.K. (1992) Shrimp farming in Orissa: Past, present and future. *Fishing Chimes* **12**(8): 35-38.

Gopinathan, K. and Deboral Vimala, D. (1995). Transfer of technology and extension systems in shrimp farming. Proceedings National Workshop *Transfer of Technology for Sustainable Shrimp Farming*, pp. 142-145.

Lekshmi Swathi (2004). In *Computer Simulation Modeling for Prediction of Diffusion and Decision Support in Shrimp Farming.*

Rao, G.R.M. (1997). Coastal Aquaculture in India. Proceedings Workshop *Environment Impact Assessment of Aquaculture Enterprises*, pp. 32-38, held at Chennai.

Sakthivel, M. (1995). Indian aqua and marine trade fair 94. *Fishing Chimes* **10**.68 p.

J. Indian Soc. Coastal agric. Res., 24(2), 341-343, 2006

The Impact of TAR/IVLP in a Coastal Village of Sundarbans in West Bengal

A. B. MANDAL, C. KARPAGAM, B. K. BANDYOPADHYAY, A. R. BAL, S. K. DUTT, K. K. MAHANTA, and S. K. TRIPATHI

Central Soil Salinity Research Institute
Regional Research Station, Canning, P.O. Canning Town
Dist. 24-Parganas (South) – 743 329, West Bengal

The technology assessment and refinement through Institute-Village Linkage Programme (TAR-IVLP) was launched since 1999 under the NATP in the village Dumki in the Sundarbans area of West Bengal by CSSRI, Canning. The village Dumki is highly constrained economically and physically. The area is mainly agriculture based with more than 95% people depending directly on complex diverse and risk (CDR) prone farming for the livelihood. The farmers are mainly small and marginal (43%) and a good number are agricultural labourers (54%) with minor holdings. The project for development of the whole village was drawn taking into consideration the biophysical and socioeconomic factors of the village. Thus sixteen technological interventions related to diverse enterprise, viz. agriculture, animal husbandry, poultry, duckery, goatery, mushroom, etc. were undertaken. Some training programmes were arranged regularly to impart necessary know-how. Health camps were arranged for the domestic animals and birds for achieving good health and production. After 5 years of work in the village (1999 to 2005) the economic gains achieved annually were for small and marginal farming families 43% (having 0.2 to 0.4 ha of land): Rs.14307; for agricultural labourers 54% (with minor holdings of 0.06 ha): Rs.4,467.00; and for well-to-do farming families 3% (with more than 0.40 ha land + business/ service). Incomes from cattles, goats, sheep, poultry, ducks and mushroom, etc. were not considered in the annual income shown above. All these practices could be managed by the housewives keeping the male members free to earn from outside.

***(Key words:** Technology assessment & refinement, Income generation, Minor holding, Small or medium holding, Well-to-do farmers)*

The Technology Assessment and Refinement through Institution-Village-Linkage Programme (TAR/IVLP) for economy generation basic to agriculture and allied aspects at Dumki village in the coastal Sundarbans was launched since 1999 under the NATP (ICAR) by CSSRI, Regional Research Station, Canning.

The project site Dumki comprising two hamlets, Chhota and Bara Dumki is very constrained economically and physically, being mainly agriculture- based with more than 95% people depending directly on complex, diverse and risk-prone (CDR) small farming for the livelihood. The per capita holding being low, the small farmers and marginal farmers having up to 0.25 ha land comprise 43% and the families with minor holding or no holding of own but owning some land (0.06 to 0.12 ha) from the Govt by *patta*, form about 54%. The remaining about 3% families with service or business and some land are quite affluent.

The entire area is monocropped with rainfed low yielding (15-20 q ha^{-1}) traditional rice varieties under variable waterlogged situation in *kharif* season.

MATERIALS AND METHODS

After survey of the village on existing socioeconomic and biophysical factors the project for economy development for the whole village was designed utilizing the skills and capabilities of the farmers through participation and decision making.

Considering the pros and cons of the various technologies suitable for the coastal rural village of Dumki, 16 technological intervention related to diverse enterprises, viz. agriculture, animal husbandry, poultry, duckery, goatery, piggery, mushroom cultivation, etc. were undertaken. Though the cultural practices were not unknown to the farmers but for imparting up-to-date knowledge some training with the experts on the aspects were arranged before taking up the activities. A multi-disciplinary team of experts working in the rural Institutes dealing with economy generating enterprises were formed to supervise and execute the interventions sincerely. Apart from practising the interventions directly for economic gain some interaventions oriented to health issues of the domestic animals and birds were taken.

Table 1. *The main interventions allotted to the farmers (1999-2005)*

Season	Interventions	Beneficiaries per year	Total No. of beneficiaries
Kharif	*Kharif* rice- polyculture of fish in the	30 – 60	300
	ponds paddy-cum-fish	30 – 120	480
		30 – 60	210
Rabi	Salt tolerant HYV rice and vegetables	30	150
		30 – 60	240
		30	180
Others	Mushroom culture	20	120
Miscellaneous	Animal health camps for vaccination, deworming of animals, ducks and poultry birds	Most of the birds and animals treated annually	-

To assess the prevailing agricultural and socioeconomic conditions of the area and the problems faced by the farmers, Participatory Rural Appraisal techniques (PRA) were followed. Based upon PRA analysis various problems were identified and in consideration of those problems suitable technological interventions (16) of various diverse enterprises, viz. agriculture, animal husbandry, horticulture and fishery were decided to be introduced in the project site. The technological interventions followed/practised in the village during 1999 to 2005 are given in Table 1. Farm families in the village were grouped into four well-defined categories (Table 2) and the economic impact of the technological interventions in each one of the categories was analyzed based upon the economic gain they received from the interventions (Table 3).

Miscellaneous Animal health camps for vaccination, deworming of animals, ducks and poultry birds Most of the birds and animals treated annually.

RESULTS AND DISCUSION

The area being monocropped with *kharif* paddy giving a poor yield of 15-20 q ha^{-1} in general, the introduction of optimum dose of fertilizer has shown a mean grain yield of 39.25 q ha^{-1}, against farmers yield of 30 q ha^{-1}. The net income was Rs. 14,565 ha^{-1}, which was more than farmers practice (9735/-) by 49.6%.

From the practice of paddy-cum-fish in lowlands in *kharif* the net income received was Rs.40,924/- which was more than 3 times received from the farmers practice (9735/-), i.e. 320% gain. Mandal *et al.* (2004) reported the performance due to intervention of paddy-cum-fish, as well as polyculture of fish in the village which highlighted the gains. The polyculture of Indian major crops in the farmers domestic ponds generated a net income of Rs. 96, 806/- ha against the farmers' practice of Rs. 68, 272/-, i.e. a net gain of 41.80%.

The salt tolerant paddy and HYV of paddy in *rabi* gave a net income of Rs. 10, 556/- and 8414/- per ha, respectively against that of the farmers' getting Rs. 3182/- per ha, i.e. a gain of 232 and 164%, respectively. Similarly, vegetables in *rabi* (in the paddy fields, after *kharif* harvest) produced a net income of Rs. 39180 per ha against the farmers practice of Rs. 22,967, i.e. a net gain of 71%.

The mushroom culture using straw was quite enterprising. A start in small scale, say 3 units at a time and four times a year could yield 24 kg, which at a price of Rs.40/- per kg could give a net income of Rs. 960/- per year.

The women in the village are almost without earning beyond the household. The practices of the intervention have offered them enough job and sufficient earning scope. Health camps taking care of the animals and domestic birds have enhanced production of eggs, meat and milk, which improved the economy of the farm families.

Table 2. *Wellbeing ranking of the farm families (429) of Dumki village (before TAR/IVLP)*

Classes of families	No. of families	% of families
Minor holding		
Having 0.06 to 0.12 ha mostly given by the Govt. as *patta*	231	53.85
Small and marginal		
Having 0.2 to 0.4 ha of land	124	28.90
Having at least 0.4 ha of land	60	13.99
Well-to-do		
Having more than 0.4 ha land + Business/service	14	3.26

Table 3. *Annual income of the farmers*

A. Annual income of the minor holding category (0.06 to 0.12 ha)

Season	Interventions	Net Income (Rs)
Kharif	Polyculture of fish (0.03 ha)	3227
	Vegetable	Additional income
Rabi	Vegetable (0.03 ha)	1240
	Mushroom	960
Income from cattle, goats, ship, pigs, poultry, ducks, etc.		Additional income
	Total	**5427**

B. Annual Income of small/marginal category (0.2 to 0.4 ha)

Season	Intervention	Net income (Rs.)
Kharif	Polyculture of fish (0.06 ha)	6454
	Paddy-cum-fish (0.06 ha)	2728
	kharif paddy (0.12 ha)	1942
	Some *kharif* vegetables	Additional
Rabi (& Summer)	Salt tolerant /HYV paddy (0.06 ha)	704
	Vegetable (0.06 ha)	2479
	Mushroom	960
	Total	**15267**

Mandal and Bandyopadhyay (2003) have highlighted the technological practices introduced to the farmers of the Dumki village and indicated about the gain. The economic status of the farm families in the Dumki village was quite poor. About 54% families possess minor holding or no holding of own who have been given 0.06 to 0.12 ha of land by the Govt. as *patta* and about 29% families have 0.02 to 0.5 ha of land, which do not suit for taking any big venture for production enhancement.

The results showed that the capability of the farmers for improving their income were quite satisfactory.

They can further improve their economy by utilizing the land and ponds, etc. by practising the interventions demonstrated in the village.

The farmers under minor holding category being mainly the daily laboures are most vulnerable and their income remains at Rs. 5427/- per year which does not include the income received from animals, ducks and poultry, etc.

Similarly, the small or marginal category of farmers considered to be middle class and their anmal income was Rs.15267/-. They have cattle, goats, sheep and ducks and poultry, managed by themselves which will further add to the income above.

REFERENCES

Mandal, A.B. and Bandyopadhyay, B.K. (2003). *Krishi Gabeshana Pratisthan O Chasider Joutha Prachesthay Sundarbans Dumki Gramonnayan–TAR/IVLP* (in Bengali) [Development of Dumki village of Sundarbans by joint efforts of the Research organizations and the farmers], A special publication in the occasion of the International Freshwater Year, 2003. 3p.

Mandal, A.B., Karpagam, C., Bandyopadhyay, B.K., Bal, A.R, Dutt, S.K., Mahanta, K.K. and Tripathi, S. (2004). Transfer of technology for fishery production system in Sundarbans under coastal agro-ecosystem. *Journal of Indian Society of Coastal Agricultural Research* **22**(1&2): 341–342.

Natural disasters vis-a-vis stability of coastal ecosystem

J. Indian Soc. Coastal agric. Res., 24(2), 345-350, 2006 **Invited Paper**

Impact of *Tsunami* on Coastal Agro-ecosystems of India and Strategies for Restoration

V. RAJAGOPAL

Director, Central Plantation Crops Research Institute
Kasaragod, Kerala 671 124

During January-February 2005, the Central Plantation Crops Research Institute, Kasaragod had conducted a study on the impact of *tsunami* on coastal agro-ecosystems and strategies for restoration in Tamil Nadu, Kerala, Pondicherry and Andhra Pradesh. In *tsunami* affected areas, salinisation, waterlogging, soil erosion and siltation were the major soil and water related problems. In Kerala, intrusion of seawater to a distance of about 500m caused severe damage to plants and animals. Arecanut, mango, jack, breadfruit, ficus, *anjili*, tamarind, banana and papaya were completely dried. In Tamil Nadu and Andhra Pradesh, crops like palmyrah, groundnut, paddy, cashew, etc. have dried due to *tsunami*. In general, coconut palms withstood the impact of gushing water and high salinity to survive the natural calamity. However, yellowing of outer whorls of leaves in older palms, button shedding, bunch buckling and uprooting of seedlings were observed in some places. Plants like *ailanthus* (*Thespesia populenea*), *punna*, pongamia, wild *badam*, etc. were tolerant to *tsunami* water and survived. Most of the poultry, duck and cows in the *tsunami* affected areas were perished.

A follow-up survey taken in Tamil Nadu and Kerala States during September-October 2005 indicated that a remarkable recovery was observed in the degree of salinisation and affected coconut palms. In few areas of Cuddalore and Nagappatinam districts of Tamil Nadu, community planting of coconut was carried out in remembrance of the deceased people.

***(Key words:** Tsunami, Coastal agro-ecosystem, Impact, Restoration)*

Tsunami, which struck the coastal areas of Indonesia, Sri Lanka, India and few other countries during December 26th had led to the loss of several thousands of lives and had destroyed the properties worth several million dollars. In India *tsunami* had hit the coastal areas of Tamil Nadu, Pondicherry, Kerala and Andaman and Nicobar islands causing deleterious effects on the coastal agro-ecosystems. In order to study the impact of *tsunami* on coastal agro-ecosystem of these states with special reference to palms and suggest suitable strategies for restoration, a multidisciplinary team of scientists from the Central Plantation Crops Research Institute (CPCRI) visited the affected areas during the last week of January, 2005. A re-survey was undertaken during October 2005 to assess the nature of impact and the degree of deleterious effects after the South-west monsoon. This paper highlights the observations made during the surveys and suggests strategies for restoration of *tsunami* affected areas.

Impact of *tsunami*

Tamil Nadu and Pondicherry

Soil and water: The water distribution network was partially damaged in some locations and completely destroyed elsewhere. This has caused considerable difficulties for the people not only in terms of drinking water, but also unsuitable for agricultural purposes.

Almost all of the bore or open wells available were salanized with salt water intrusion and a process of decontaminating wells was required urgently for drinking water purposes. As only rainwater could flush out the aquifers, one had to wait for the monsoon. All attempts were to be made for rainwater harvesting wherever possible.

In general, four types of problems were observed on soil and water near the coasts of *tsunami* affected areas, viz. a) Salinisation, b) Waterlogging, c) Soil erosion, and d) Siltation.

In Mamallapuram even though *tsunami* water front spread up to 500m landward, the irrigation wells in 1.5 km from seashore have become saline (EC 11.5 dSm^{-1}) due to seawater intrusion.

The details of analysis of soil samples collected from tsunami affected areas are presented in Table 1.

Flooding with seawater during and after the *tsunami* has turned normal soil into saline soils. The EC went up to 51.1 dSm^{-1}. The flooding of seawater by the tsunami waves has caused a deposition of

salts on the soils (salt encrustation). Open water bodies like ponds and lakes have become saline. Severe soil erosion has occurred in the landward slopping soil surfaces. In the extreme situations, entire root mat of trees were exposed. Sediment siltation was observed in the mouth of rivers. This led to top soil contamination and reduction of soil fertility.

Table 1. *Analysis of soil samples from* tsunami *affected areas of Tamil Nadu*

District/Location	pH	ECe (dS m^{-1})
Nagapattinam		
1. Naluvetahapatty Coast	7.5	51.1
2. Naluvetahapatty	8.7	25.2
3. Nochikuppam	7.2	11.7
4. Poompugar	7.5	5.38
Villupuram		
1. Kanakachettikulam	8.7	27.3
2. Samiyar madam	8.7	27.3
3. Kottakuppam(after leaching)	7.0	0.93
4. Kottakuppam	7.8	7.21
Kancheepuram		
1. Mamallapuram	7.5	48.8
Pondicherry		
1. Kalapet (water sample)	7.2	27.1
Kanyakumari		
1. Kolechel-Kottilpad	6.84	9.87

Plants: In extreme situations, the entire root mat was exposed in coconut gardens. This led to a) root drying, b) reduction in absorption, c) drying of palms, and d) subsequent yield loss.

In general, coconut withstood salinity. However, in heavy soils yellowing of lower leaves and button shedding from yielding palms was noticed where no irrigation or no post-*tsunami* management was followed. Coconut seedlings having yellow or orange petiole suffered maximum where as green tall seedlings in the same location had less injury due to salinity.

It was observed that even about 50 m away from the sea, juvenile coconut palms (i.e. one to three years of age) had tilted due to *tsunami* as they have more surface area (canopy) touching the *tsunami* waves

However, adult palms did not tilt and they withstood the impact of boats carried away by *tsunami* waves. Among the tree species palmyrah (*Borrassus flabelifer* L.) was severely affected by salinity and complete drying of foliage was noticed. Overflowing of *tsunami* waves through cashew canopy led to shedding of leaves and ultimate drying causing an economic loss to the extent of Rs.150-160 per tree.

The soil of *tsunami* affected areas at Colechel in Kanyakumari district is coastal sandy loam. In areas about 50 m away from the sea, coconut palms showed symptoms of drooping of leaves, drying of outer whorl and uprooting. This led to subsequent yield reduction and economic loss to the extent of Rs.250 to 300 per palm per year and might have had more adverse effects in long term. The details of damage occurred for coconut in different areas is given in Table 2.

Table 2. *Details of coconut trees affected by* tsunami *in Kanyakumari district, Tamil Nadu*

Details	Name of revenue village											Total
	Kanyakumari	Azhagappapuram	Thamaraikulam	Thengamputhur	Neendakarai-B	Manavalakuruchi	Colechal	Kadiyapattinam	Lakshmipuram	Keezhmidalam	Midalam	
Total area cultivated (ha)	342	615	440	538	1410	583	918	916	500	148	285	6695
area affected (ha)												
No.of palms affected	20	4	8.82	60	116	20.8	64.5	18.4	12	3.2	6.2	334.25
No.of farmers affected	3475	700	1544	10500	20356	3640	11287	3220	2100	525	1085	58432
Marginal	52	1	15	159	115	37	44	48	13	9	14	507
Small	2	—	2	86	154	14	36	7	5	3	-	309
Big	3	1	—	15	2	—	—	—	-	-	-	21
Total	57	2	17	260	271	51	80	55	18	12	14	837

Source: Office of the Jt. Director (Agri.), Nagercoil, Tamil Nadu

Table 3. *Impact of* tsunami *on lives and properties of coastal agro-ecosystems in Tamil Nadu and Pondicherry*

District affected	Population affected	Houses damaged	No. of lives lost	No. injured
Cuddalore	99704	15200	617	198
Kanyakumari	187650	31175	828	727
Nagapattinam	196184	39941	6065	1982
Others	501026	39866	500	585
Total	984564	126182	8010	3432

Source: Government of Tamil Nadu

Socioeconomic aspects: The overall impact of *tsunami* in terms of loss of human lives, properties, etc. are presented in Table 3. More than 80% of affected families were from the fishermen community and they grew coconut as a component in their homestead with minimum to moderate level of management. It is interesting to observe that some of the fisherman maintain community coconut garden in the seashore. In Naluvethapathy village of Nagapattanam district of Tamil Nadu, this was at a distance of 500 m from sea, *tsunami* entered up to 2 km into the land. However, the shelterbelts established with casuarina, coconut and portia tree (*Thespesia populnea*) have saved the entire village from the *tsunami* waves. The maximum level of damage for coconut was observed to be less than one percent. After *tsunami*, till relief measures reached, the people depended on coconut for drinking water and food.

Kerala

Soil and water: The coastal areas of the region affected by the *tsunami* present highly diversified human activities like multispecies cropping system, wetlands for prawn/crab culture, rope making from coconut fibre to mangrove and coastal strips used primarily for fishing. Coconut is the predominant crop cultivated in the coastal belt affected by *tsunami.*

Tsunami affected areas, in general, are a narrow strip of land between sea and back water. Soil along the affected areas of Kerala coast is littoral sand. This led to severe erosion of topsoil to a depth of about 30 cm exposing roots of coconut palms in some areas, whereas deposition of soil was noticed in certain other areas.

Exposed roots were showing symptoms of drying. This adversely affected absorption of water and nutrients leading to yield loss. In those areas where soil erosion was not observed, a plant species, viz. *Ipomea biloba* was present. It was informed that water from sea was deep brown in colour with foul smell and stagnated for two hours upto three days. In certain areas, the *tsunami* seawater got mixed up with backwater and intruded into the adjoining areas. Water collected from inundated area (both from open and bore well) showed very high salinity (up to 6195 ppm). The pH ranged from 6.55 to 8.82. The details are given in Table 4. In some areas, the receipt of a few summer showers has helped to reduce the high concentration of salt accumulated in soil and thereby helping the crops from persistent injury.

Table 4. *Analysis of soils in* tsunami *affected areas of Kerala*

District/Location	pH	ECe (dS m^{-1})
Kollam		
1. **Azhhekkal Ward III**	7.80	17.91
2. **Alappad Ward V**	5.76	18.44
3. **Azheekkal Ward VIII**	7.57	16.20
4. Azheekkal Ward III	7.98	18.33
Alappuzha 1.		
1. Valiyazheekkal Ward V	7.55	17.98
2. do	7.95	12.38
3. do	7.99	17.83
4. Pattanakkad	8.36	18.27
5. do (coconut basin)	7.98	17.98
6. Devikulangara (coconut basin)	7.98	18.33
Ernakulam		
1. Edavanakkd	7.14	18.47

Plants and animals: Intrusion of seawater to a distance of about 500 m caused severe damage to plants and animals. The details on damage to crops collected for different districts are given in Annexure Table 5-7. Arecanut, mango, *artocarpus heterophyllus* (Jack), *Artocarpus insisa* (Breadfruit), ficus, *Artocarpus hirsuta* (*anjili*), *tamarindus indica* (Tamarind), banana and papaya were completely dried. Coconut palms withstood the impact of gushing water and high salinity to survive the natural calamity. However, yellowing of outer whorls of leaves in older palms, button shedding, bunch buckling and uprooting of seedlings were observed

Table 5. *Details of area and crops affected by* tsunami *in Kollam district, Kerala*

Details	Name of *panchayat*						Total
	Alappad	Karuna-gapally	Clappana	KS Puram	Sakthi-kulangara	Panmana	
Area affected (ha)	735	5	5	12	5	7	769
Coconut-bearing nos.)	1000	—	40	—	30	8	1,078
Do-non-bearing (nos.)	35000	—	—	—	1550	14	36,564
Do-seedlings (nos.)	5000	—	150	300	—	—	5,450
Banana-yielding (nos.)	15000	1000	22000	1500	2000	400	41,900
Do- young plants (nos.)	20000	1500	3000	1000	5000	600	31,100
Arecanut (nos.)	10000	—	6000	1500	1000	—	18,500
Vegetables (ha)	5	2	3	—	—	3	13
Pepper (nos.)	—	—	1500	200	—	—	1,700
Tapioca (ha)	—	—	—	—	5.5	—	5.5
Other tuber crops (ha)	150	—	—	—	—	—	150
Timber trees (nos.)	1700	—	250	—	—	—	1,950
Mango tree (nos.)	15000	—	150	—	—	—	15,150
Paddy-salt water affected (ha)	—	—	3	—	—	—	3
Area affected by top soil erosion (ha)	560	—	—	—	—	—	560

Table 6. *Details of area and crops affected by* tsunami *in Alappuzha district, Kerala*

Details	Name of *panchayat*					Total
	Arattupuzha	Devikulangara	Kandalloor	Pattanakkad	Kuthi-yathode	
Area affected (ha)	122.13	39.63	4.84	5	50	221.6
Coconut-bearing (nos.)	523	15	2	165	—	705
Do-non-bearing (nos.)	1343	53	9	50	36	1,491
Do-seedlings (nos.)	7045	444	87	3302	—	1,0878
Banana-yielding (nos.)	5901	610	27	5110	500	1,2148
Do- young plants (nos.)	12936	2890	151	15437	800	32,214
Arecanut (nos.)	2926	1234	—	2150	—	6,310
Vegetables (ha)	1.25	0.6	—	—	2	2.85
Pepper (nos.)	78	68	—	—		146
Tapioca (ha)	—	—	—	—		—
Other tuber crops (ha)	2.8	1.35	—	—		3.35
Cashew (nos.)	343	68	1	91		503
Nutmeg (nos.)				3		3

in some places. Tilting of young coconut seedlings was also noticed in some places. Plants like *Thespesia populnea (poovarasu/seelanthy), Calophyllum inophyllum (punna), Pongamia glabra, Terminalia catappa (wild badam), Casuarina equisitifolia etc.* were tolerant to *tsunami* water and survived. Most of the poultry, duck and cows were perished.

Socioeconomic aspects: In Kollam and Alappuzha districts, arecanut was one among the crops, which was severely affected due to salinity, causing an average damage of Rs. 100-150 per palm per year. The development departments were required to take corrective measures through appropriate schemes for saving the affected palms and to compensate the loss incurred to the farmers. Similarly, the State Department of Animal Husbandry should have implemented proper schemes for restoring the livestock based activities in the affected villages.

Fisheries and agriculture in coastal areas have been severely hit by the *tsunami* waves. Almost the entire fishermen folk in the affected areas have lost

Table 7. *Details of area and crops affected by* tsunami *in Ernakulam district, Kerala*

Details	Total
Coconut bearing (nos.)	63
Do non-bearing (nos.)	200
Do-seedlings (nos.)	110
Arecanut-bearing (nos.)	2,500
Do-young plants (nos.)	2,000
Banana-yielding (nos.)	2,500
Do-young plants (nos.)	2,500
Vegetables (ha)	1 acre
Tapioca (nos.)	25 cents
Pepper (nos.)	200
Nutmeg (nos.)	32
Cashew (nos.)	16
Cocoa (nos.)	2

their fishing boats, nets and other gadgets for fishing etc. Relief efforts must ensure that local farmers and fishermen folk hit by the *tsunami* receive all sorts of assistance needed to meet their food needs and restart farming and fishing at the earliest possible time.

Andhra Pradesh

Soil and water: In *tsunami* affected areas in Andhra Pradesh, it was noticed that though the seawater entered 0.5 to 1 km inside the coast line, it had minimum impact in those areas where casuarina plantations were present as compared to higher level damage observed in other areas. In those areas near the back waters, the impact of *tsunami* was such that the *bunds* were cut and soil erosion hastened the coconut uprooting on the *bund* areas. The local people reported increase in the levels of backwater as compared to pre-*tsunami* levels. The raised levels were existent till date. In Odelarevu village located in the mouth of the river Godavari in the East Godavari district, sedimentation of silt was observed. The details of analysis of soil samples from different areas are presented in Table 8.

Plants and animals: The coconut plantations on the coast have started showing yellowing and scorching of leaves in lower and middle whorls. The seedlings of coconut showed symptoms of leaf scorching and drying. Coconuts on the *bunds* of backwater coasts were uprooted due to soil erosion caused by *tsunami* waters. More than 50% of the canopy in palmyrah palms has dried and palmyrah seedlings, cashew nut trees and jamun completely dried up due to seawater stagnation for seven days. Goats and poultry birds were lost at Chinnadainavari Lanka.

Table 8. *Analysis of soils in* tsunami *affected areas of Andhra Pradesh*

District/Location	pH	ECe (dSm^{-1})
West Godavari		
1. Odela	6.21	15.80
2. P. Rao garden area	6.34	2.60
3. do (coconut basin)	5.89	4.24
4. Odela	6.90	1.23
5. Garden 20m away	6.58	3.40
6. P. Rao garden	7.00	1.45
7. do - Unaffected area	6.51	0.90
East Godavari		
1. Chinnalanka unaffected	6.57	14.3
2. do - 500m away	6.99	16.85
3. do - 1 km away	6.79	18.73
4. do - 100m away (A)	7.70	16.94
5. do - 100m away (B)	7.33	17.43

Socioeconomic aspects: People in the affected areas were: 1) those depending on fishing and water transport (ferrying), 2) farmers whose plantations or homesteads were on the sea coast, and 3) those depending on fishing and salt making. Farmers incurred a loss of about Rs.500 per annum per cashew plant at Odalarevu due to complete drying of the trees. Each family engaged in salt making might have incurred loss of around Rs.25,000/-due to damage of salt making plots at Chinnadainavari Lanka.

Strategies for restoration: There is an urgent need for rehabilitation of agriculture and fisheries in the *tsunami* affected areas. Short term (<2 years), medium term (2-5 years) and long term (>5 years) measures were to be adopted for restoration. Immediate needs in the agricultural sector include supply of planting materials and other inputs, tools, small livestock and assistance in rehabilitating small scale infrastructure such as irrigation schemes, animal shelters, storage facilities and retail markets. It also required some consistent interventions to help farmers cleaning up agriculture fields to get rid of salt and sediments and restore fertility.

Re-survey details

A follow-up survey taken in Tamil Nadu and Kerala States during September-October 2005 indicated that a remarkable recovery was observed in the degree of salinisation and affected coconut palms. Providing irrigation once in three days and manuring had effectively controlled the post-*tsunami* effect on coconut at Kalapattu in Pondicherry. It was further inferred that coconut seedlings having yellow petiole affected maximum whereas those with green petioles in same location had less injury due to salinity.

In few areas of Cuddalore and Nagappatinam district of Tamil Nadu, community planting of coconut was carried out in remembrance of the deceased people. The people of Kameswaram village stated that coconut plantation along the sea coast saved their lives and properties from *tsunami*.

Among the tree species, palmyrah was affected severely by salinity. Palmyrah palms with 75 % and more of dried leaves (during February 2005) were found dead during the re-survey.

In Kerala at many places soil was applied in the basins of coconut palms, where root system was exposed due to erosion and in some places mounds were taken as a practice followed in sandy soil areas of Onattukara region. The fallen trees were removed and the leaned palms were straightened by proper supporting.

CONCLUSION

Tsunami affected coastal zones fall within a distance of 0.5 to 1.5 km and the level of damage differed from place to place, plantation to plantation, crop to crop. Arecanut, palmyrah, cashew nut and mango were the most sensitive plants as complete drying was noticed. Coconut was found to be relatively tolerant and plants such as *casuarina*, mangroves and *Thespesia populnea* were not affected due to seawater intrusion. Various short, medium and long term strategies are required to restore the *tsunami* destroyed ecosystem of coastal India.

J. Indian Soc. Coastal agric. Res., 24(2), 351-355, 2006 **Invited Paper**

Crop Rehabilitation and Management for Supercyclone Hit Coastal Areas of Orissa

D. P. SINHABABU, B. N. SINGH, B. K. MAITY[1], N. SARANGI[2], H. N. VERMA[3], H. PANDEY[4], B. K. PANDA[5], G. NAIK[6], S. K. NASKAR[7] and G. SATISH KUMAR[8]

Central Rice Research Institute, Cuttack - 753 006, Orissa, India

The supercyclone of October, 1999 ravaged all the eight coastal districts of Orissa resulting in almost complete damage of agro-ecosystem, besides immense loss of infrastructure and human lives. In order to reconstruct and improve the cyclone damaged farming sectors, a multidisciplinary and multi-institutional NATP project was taken up for four years in the worst affected 41 villages/hamlets covering 2,800 farm families of mostly marginal and small categories in two coastal districts of Orissa. Improved technologies on rice and rice based crops production, fruit and vegetable crops, tuber crops, plantation crops, agro-forestry, aquaculture, poultry farming, integrated farming system, short term cash crops and other avocations, water resource development and management, family nutrition and women empowerment were introduced and popularized through men and women farmers' participatory 20,500 demonstrations and on-farm trials in addition to 198 on-station and on-farm training and field days. The result revealed that introduction of improved technologies increased productivity of field crops by 20-150% including more than 100% increase in the major crop, rice because of mostly low soil salinity ($EC_{1:2}$, 0.2-1.6 dSm^{-1}) present during crop growth in the wet season because of high rainfall (around 1500 mm). Rice variety Annapurna, hybrid sunflower (var. KBSH-1, MSFH-17) and guava variety Sardar were found promising in saline condition. Improved crop management with INM, IPM and mechanization increased rice yield by 10-34%, substantially reduced pesticide use and improved efficiency of farm operations. The farm income was greatly raised with the technologies of composite fish culture, backyard poultry farming, mushroom cultivation and rice- fish diversified farming system. Family nutrition was improved through nutritional kitchen gardens. Development and management of farmers' participatory water resources supported crop production with 250% higher cropping intensity. The project had large impact, as it resulted in 10 to 100% adoption of improved varieties along with recommended management practice in the case of field crops, including 48% in wet season rainfed rice. The average annual family income increased by Rs. 6,754 (Rs 950 - 42,000) and employment by 34 man days (4-235 man days). Development of a 7 km long shelter belt plantation in the epicenter of the cyclone and large scale restructuring of the fruit trees, plantation crops and agro-forestry will help in protection of the ecosystem against cyclone.

(***Key words:*** *Supercyclone in Orrisa, Effect on crops, Agro-forestry, Aquaculture & poultry, Integrated farming system, Water resource management, Family nutrition, Women empowerment)*

The coastal agroecosystem in Orissa spread over about 1.7 million ha of field crops area is highly fragile due to several abiotic and biotic stresses which often cause poor productivity (around 1.3 t ha^{-1} for rice). The supercyclone of October, 1999 with a wind speed of 250 to 300 km h^{-1} associated with high (400 mm) rainfall ravaged all eight coastal districts resulting in almost complete damage of field crops in 1.7 m ha area, 90 million plants/trees, 2.2 million livestocks, besides loss of 10,000 human lives and a large number of houses and other infrastructures, leading to total monetary loss of about 6,000 crores (Sarkar, 2000). With the aim of restructuring and improving the cyclone-damaged agroecosystem as well as strengthening the economic status of the cyclone hit farm families, a multi-institutional and multidisciplinary project was taken up under National Agricultural Technology Project (NATP) for about four years in some worst cyclone affected coastal areas of Orissa.

MATERIALS AND METHODS

A NATP project on "Management of coastal agro-ecosystem affected by supercyclone in Orissa" was taken up during the period 2001-05 in supercyclone affected 41 villages/ hamlets under five *panchayats* in Ersama (cyclone epicentre) and Astarang blocks of Jagatsinghpur and Puri districts of Orissa. The

[1]Orissa University of Agriculture and Technology, Bhubaneswar, [2]Central Institute of Freshwater Aquaculture, Bhubaneswar, [3]Water Technology Centre for Eastern Region, Bhubaneswar, [4]National Research Centre for Women in Agriculture, Bhubaneswar, [5]Regional Research Station for CARI, Bhubaneswar, [6]Central Horticultural Experimental Station of IIHR, Bhubaneswar, [7]Regional Centre of CTCRI, Bhubaneswar and [8]Out Reach Centre of NRCG, Bhubaneswar

project covered 2,800 farm families. Improved technologies on rice and rice based crop production, fruit and vegetable crops, tuber crops, plantation crops, agro-forestry, aquaculture, poultry farming, rice-fish diversified farming system, short term cash crops and avocations (mushroom, apiculture, betel vine), water resource development and management, family nutrition and women empowerment were introduced and popularized in the project areas. Benchmark survey in the beginning and impact evaluation at the end of the project were conducted using standard procedures. In order to increase the productivity of major field crops, quality seeds of 60 tons of fourteen improved rice varieties, 89 tonnes of potato tubers of four improved varieties such as, Kufri chandramukhi, K. Sinduri, K. Ashoka, and K. Lalima, 22.5 tons stalks of sugar cane (cv. CO- 7805), 16.7 tonnes seed and 16 lakh planting materials of improved varieties of vegetables and tuber crops were distributed to the farm families. For rejuvenation of the damaged fruit plants, about 14,000 saplings of improved varieties of different fruit crops (mango, guava, papaya, and banana) were planted in the backyards and in fields. For restructuring the lost plantation, 24,000 seedling of different plantation crops (hybrid cashewnut, coconut var. Elite Sakhigopal, arecanut var. Mangala) and 87,832 agro-forestry saplings of mainly *Acacia mangium*, *A. auriculiformes Casuarina equisetifolia*, *Eucalyptus hybrid* and *Pongamia pinnata* (fuel and oil source) were planted in homestead areas, field *bunds*, community lands and in river *bund* near the epicentre of cyclone, involving almost all the farmers. To increase quality irrigation resources, 20 sub-surface water harvesting structures, especifically in saline areas, and 10 shallow tube wells were developed and managed with 20 irrigation pumps on farmers' participatory basis. Composite fish culture was introduced in 11 ha water area using six fresh water carp species (*Catla catla, Lebeo rohita, Cirrhinus mrigala, Cyprinus carpio, Hypopthalmichthys molitrix* and *Ctenopharyngodon idella*) and fresh water giant prawn (*Macrobrachium rosenbergii*). A self-recruiting fish, viz. *Puntius gonionotus* was introduced for sustainable aquaculture. Improved backyard poultry farming was introduced by providing 16,400 chicks of coloured dual purpose birds of mainly CARI Devendra, Vanraja and Grampriya breeds and 3,150 ducklings of Khaki Campbell breed to 2,300 small, marginal farmers and landless labourers. Total 132 nutritional kitchen gardens of 100 m^2 area each were developed, involving mainly the women farmers. Total 3000 in-house mushroom production units were created, involving 52 women Self Help Groups (SHGs) and 40 beehives were installed in backyards and in crop fields. Improved betel vine orchards of 60 units were developed. On-farm research was conducted for identifying salt tolerant field crops and on integrated crop management through INM, IPM and mechanization. The farmers including women farmers were trained on the improved technologies through 198 trainings and field days, 20,500 demonstrations and on-farm trials, besides 67 technical bulletins and leaflets published mostly in local language.

RESULTS AND DISCUSSION

The benchmark survey of the project sites revealed that around 92% of the houses, 90% of the plantation crops, 82% of animals, 98% of birds and 13% of human population were lost due to supercyclone, besides complete damage of field crops. The damage was more in Ersama site (epicentre) as compared to Astarang site. Around 85% of the farm families in these areas belonged to marginal and small categories and 12% were landless labourers. The need of maximum (75%) farm families was for animal components, followed by seeds and planting materials of various crops (65%), fertilizers (32%) and irrigation facilities (32%). The average annual rainfall in the target area was around 1500 mm, of which more than 80% was received during south-west monsoon (June-October). The inherent problems of the target areas were complex and diverse. Rice ecology was dominant, since rice is the main food crop in coastal Orissa. The target agro-ecosystem was mostly (85%) rainfed and largely inflicted with a number of abiotic stresses such as drought, flood, submergence, soil salinity and acidity. The soils were mostly acidic (pH 3.5-6.7) with varying degree of salinity. The soil salinity levels remained low during wet season because of sufficient washings due to high rainfall, while salinity built up (average soil $EC_{1:2}$ 4.5-11 $dSm^{-1}$and field water EC 0.3-8.2 dSm^{-1}) during dry season, with comparatively higher levels in Ersama site. The major insect pests were stemborer, caseworm and plant hopper for rice, shoot and fruitborer, thrips and cutworm for vegetable crops, and caterpillar and eriophyid mites for coconut. The important diseases were bacterial leaf blight, false smut and tungro for rice, blight and collar rot for potato, bacterial and phomopsis wilt, mosaic virus, anthracnose for vegetable crops, and ring spot disease, foot rot, panama wilt, Sigatoka, bacterial canker and die back for fruit crops. These problems

compelled the farmers to grow mostly a monocrop of traditional rice varieties, besides local varieties of pulses, vegetables and fruit crops in limited areas. The poultry and livestock breeds were largely traditional. Conventional fish culture was prevalent mainly in personal ponds. Based on the physical, biological and socioeconomic conditions in the target areas and considering the farmers' needs, suitable technological interventions were taken up.

Among the introduced rice varieties, Gayatri performed best (average grain yield 4.7 t ha^{-1}), followed by Savitri and Kanchan (4.5 t ha^{-1}) in rainfed lowlands under low soil salinity ($EC_{1.2}$ 0.2-1.6 dSm^{-1}). In relatively saline ($EC_{1.2}$, 0.5-3 dSm^{-1}) and waterlogged (water depth up to 60 cm) areas, salt tolerant rice variety Lunishree produced good grain yield (3.9 t ha^{-1}). Early maturing (90 days) rice variety Vandana introduced in the upland and medium lands performed very well (grain yield 4.1 t ha^{-1}) and was accepted by the farmers because of its harvest before the normal cyclone period. During post-cyclone period (dry season), rice variety Khandagiri was widely adopted followed by Naveen which produced comparable grain yield (5.0 t ha^{-1}) under early planting (by the 2nd week of January). Rice variety Annapurna was found promising (grain yield 3-4 t ha^{-1}) for growing in saline soils (EC 3-8 dSm^{-1}), while CSR 4 and Canning 7 rice varieties were found suitable in relatively less saline areas (EC 2-5 dSm^{-1}) during dry season. Integrated nutrient management (INM) in rice crop resulted in 21- 34% higher grain yield with dhaincha (*S. aculeata*) for green manuring during wet season. *Azolla* dual cropping with rice increased grain yield by about 10% and 20 % in the wet and dry season, respectively, besides a saving of 30 kg N ha^{-1} in the form of chemical fertilizer. Trials on integrated pest management (IPM) in rice crop, including use of light and pheromone traps, reduced the incidence of insect pests (stemborer) up to 50%, besides controlling diseases like rice tungro and false smut. Yadav (2004) reported 15-18% increase in rice grain yield in the case of conjunctive use of inorganic and organic fertilizer including green leaf manuring and emphasized the need of INM and IPM in coastal agro-ecosystem. Introduction of mechanization in rice farming increased the efficiency of field operations by three to fifteen times. Introduction of improved varieties along with management technologies increased the rice productivity by around 120% in the project areas (Fig.1). Singh *et al.* (2001) also reported higher productivity of rice with improved varieties in cyclone prone coastal Orissa.

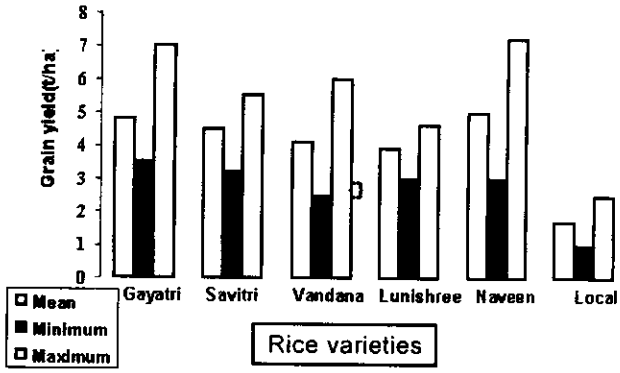


Fig. 1. Increase in rice productivity in the project areas due to adoption of improved varieties and management technologies

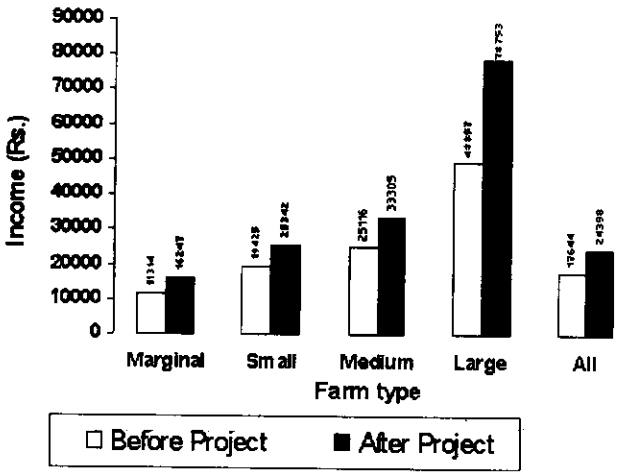


Fig. 2. Increase in farm income of different categories of farmers in project villages due to implementation of various activities

The rice based cropping system in the project areas was improved with the introduction and adoption of hybrid sunflower (particularly, var. MSFH-17) in medium land and shallow lowland rice fallow. The crop produced high average yield of 2.1 t ha^{-1}, and served as a source of edible oil. Sunflower (var. KBSH-1 and MSFH-17) crop was also found suitable for growing in saline soils ($EC_{1.2}$ 4-8 dSm^{-1}). Improved variety of greengram (PDM 54) yielded 1.1 of grain per ha in shallow lowland rice fallow. High yielding potato varieties, Kufri Chandramukhi and K. Sinduri were accepted by the farmers in rice fallow and homestead lands because of higher productivity (tuber yield 20-25t ha^{-1}), good taste and keeping quality. Around 200 farmers were motivated for seed production and proper storage of 15 tons seed tubers for the first time to support potato farming in the following season. Sesamum (var. Uma) recorded average yield of 0.75 t ha^{-1} in the residual fertility of potato crop. Among the six improved groundnut varieties tried after wet season rice crop and in home stead lands, Smruti performed the best

(pod yield, 1.7 t ha^{-1}) and produced around 100% higher yield over the popular variety AK 12 -24. Early sowing (first week of December) increased the pod yield by 30% to 100% as compared to sowing in the month of January. Improved sugarcane cultivation yielded on an average 63 t ha^{-1} and was accepted as a contingent food crop for cyclone.

Among the various improved varieties of fruit crops introduced in the project areas, guava variety Sardar was found promising (yield 10kg per year) for saline areas. Mango variety Amrapali recorded maximum survival of 64% (average survival of mango plants, 58%). Total 8 acres of mango orchards were established in project villages and the mean plant height and canopy spread after three years of planting were 1.47m and 1.46m, respectively. Among the different improved papaya varieties introduced, Pusa Dwarf produced the highest yield of 13 kg and 11.5kg per plant in the first and second year of age, respectively. Tissue-cultured Robusta variety of banana recorded high yield of 12 to 19 kg bunch per plant. Adoption of improved varieties of various vegetable crops (tomato, brinjal, bottlegourd, okra, French bean, Amaranthus) increased productivity by 1.4-6.6 t ha^{-1} over the traditional varieties. Raising of community nurseries for fruit and vegetable crops involving men and women SHGs of eight villages was successful and this activity would help in sustenance and further adoption of improved fruits and vegetables crops cultivation in the project sites and adjoining areas.

Adoption of improved tuber crop cultivation produced 125-140kg of sweet potato, 32-40 kg of colocasia, 52-55 kg of yam, 55-60 kg of elephant footyam, 45-50kg of yam bean, 250-300 kg of cassava per family. Among the five improved sweet potato verities introduced, Samrat outyielded (30 t ha^{-1}) other varieties. The increase in area of improved varieties of various tuber crops, (cassava, sweet potato, greater yam , Elephant footyam, colocasia, yam bean) ranged from 10 to 100% in Astarang site and 6 to 100% in Ersama site with 26% higher adoption in the Astarang area, because of less soil salinity in case of the latter. Among these crops, yam bean followed by elephant footyam and colocasia (in Astarang site) had highest adoption in both the sites because of higher benefit-cost ratio. The benefit-cost ratio in these crops ranged in between 1.2 to 3.

Among the plantation crops, coconut plants registered the highest survival (80%) followed by hybrid cashewnut and arecanut. Large scale agro-forestry plantation in homestead lands and field *bunds* recorded good survival and growth of the trees. Among the trees, *E. hybrid* and *A. mangium* attained maximum height (4.68 - 4.7m) and collar girth (18.3 -23.2 cm) after two years followed by *C. equisetifolia.*

Rice-fish diversified farming system with integration of various components (rice, pulses, oil seeds, horticultural crops, agro-forestry, fish, prawn, birds, etc.) was introduced in 8 rainfed waterlogged lowland farms (1.1-2.0 acres each) for improving the total farm productivity and income. This technology not only increased the net income by around fifteen times (Rs 44,500 per ha) over the traditional practice of rice cultivation but also helped in considerable additional employment generation (110 man days). The income is comparable with the reports under on-station rice- fish diversified farming technology for rainfed lowland areas (Sinhababu, 2001).

Creation of water resources (subsurface water harvesting structures and shallow tubewells) and their management with farmers' participatory approach increased the cropping intensity by about 250% due to increase in area of quality irrigation by around five times. Water productivity in those structures ranged from Rs 9 to Rs 48 m^{-3} due to higher cropping intensity and fish culture. This intervention increased farm income with a higher benefit-cost ratio of 1.4 to 2.3. A survey conducted from these groups revealed that farmers generated their own funds for the maintenance of water resources.

The productivity of fish under composite fish culture was higher (5.0 t ha^{-1}) in individual backyard ponds as compared to *Panchyat* ponds (3.0 t ha^{-1}). Along with fish, fresh water export quality giant prawn also grew well (size 100g per year). A self-recruiting fish, *Puntius gonionotus* introduced with carp culture was found to adapt well (size 1.0 kg per year) in the area. Introduction of participatory fish seed rearing in village nurseries supported growth of fish culture. The fish productivity achieved in these project areas is comparable with the potential yield level under growout carp culture technology for farmers (ICAR, 2005).

In the backyard poultry farming, the survival of chicks and ducklings was 78% and 90%, respectively. The poultry birds attained an average weight of about 1.5 kg in 8-10 weeks and 2.5 -6. 5 kg after 24 -26 weeks, which was two to three times higher than the native birds raised on free range scavenging. The layer birds laid 180-200 eggs in a year. The beneficiaries earned a net profit of about Rs 350 per bird. Panda *et al.* (2004) also reported higher body weight and profit gain in the case of on-farm extensive farming as compared to on-station intensive farming of poultry birds. Ducks attained a body weight of 1.0 kg in 8 weeks and laid 13 eggs per month.

A survey on the nutritional status of 120 farm families at the start of the project revealed that more than 50% of women had their Body Mass Index (BMI) values less than the desired level (>18.5), which indicates poor nutritional status among the women. Malnutrition was also found prevalent among children of the age group in between 1 to 15 years, as indicated by their anthropometric measurements, general appearance, and deficiency symptoms of vitamin A, C and protein. Children were also found suffering from the diseases like angular stomatitis and oedema. In order to improve the nutrition of farm families, seasonal vegetables and fruit crops were grown throughout the year in the nutritional gardens with a production level of 43 kg $100m^{-2}$ in each season. These gardens brought diversification in vegetable cultivation in backyards, resulting in 30-50% increase in the productivity of vegetables. This activity increased access of small farm families, especially women to more varieties and quantity of vegetable crops. Skill development of women farmers in preparation of low-cost nutritious recipes (*Postik Khichri, Namkeen Dalia, Basan Palak, Chilla,* Sweet potato *Kheer* and *Gulab Jaman*) helped them to get comparatively balanced diet to their families. Besides, training of farm women on value addition of pulses (*Badi* making), fruit crops (jam, pickle) helped in income generation.

Demonstration and adoption of straw mushroom and oyster mushroom production units by 52 women self help groups (SHGs) was highly beneficial with an yield of 0.8-1.2 kg mushroom and income of Rs. 750-1,000 per bed within a short period of 15-25 days. Introduction of beehives and rejuvenation of betelvine orchards also generated high annual income of Rs. 550 per hive and up to Rs. 40,000 per orchard per year, respectively.

A 7 km long shelter bed plantation was done with quick growing species, viz. *C. equisetifolia, A. mangium, E. hybrid* and *P. pinnata* at the epicenter of super-cyclone for protection from cyclonic wind and tidal waves. Among the trees, *E. hybrid* attained the maximum height (4.7m) after two years followed by *A. mangium* (4.2m) and *C. equisetifolia* (4.1 m). While, *A. mangium* accumulated the highest collar girth of 19.0 cm after two years, followed by *E. hybrid* (16.2 cm) and *C. equisetifolia* (12.8 cm).

CONCLUSION

The impact of the project was large. Introduction and popularization of the improved crop production technologies increased the productivity of field crops in the range of 20-150%. The coverage of high yielding rainfed rice varieties increased to 48% in wet season due to substitution of local cultivars by 36%, while that of dry season rice enhanced by more than 100%. Adoption level in the case of other field crops ranged in between 10-100%. Creation of quality water resources supported higher cropping intensity in the project sites which were mostly rainfed. Adoption of improved tuber crop cultivation and nutritional kitchen gardens increased household food security. Introduction and popularization of other income generating enterprises, like backyard poultry and duck farming, fish culture, betelvine orchard, vegetables, mushroom cultivation, rice-fish farming greatly increased the farm income and opportunities for employment of farmers and landless labourers. Due to adoption of these enterprises, the average farm income increased by Rs 6,750 per family, including Rs 4,930 and Rs 5,920 for marginal and small farmers, respectively (Fig.2). The employment of the families also went up by 34 mandays on an average with a maximum of 235 mandays. Restructuring of the cyclone devastated plantation in the project sites by large scale planting of agroforestry and perennial fruit crops and creation of shelter belt plantation at the epicentre of the supercyclone will provide protection to the agroecosystem, besides supplying fruits, fuel and fibre wood.

REFERENCES

ICAR (2005). *Aquaculture Technologies for Farmers*, Indian Council of Agricultural Research, New Delhi. 104p.

Panda, B.K., Padhi, M.K. and Sahoo, S.K. (2004). Comparative growth and performance studies of exotic birds in the intensive and extensive system of rearing at Orissa state. *Indian Journal of Poultry Science* **39**(3): 258-288.

Sarkar, H.S. (2000). The supercyclone of 1999 and its aftermath. In *Orissa Review*, Oct 2000, pp. 4-12, Govt. of Orissa, India.

Singh, B., Sinhababu, D.P., Venugopalan, M., Saha Sanjoy, Rayudu, B.T. and Ghosh, A. (2001). Household food security by improving rice based farming system in cyclone prone coastal belt of Orissa. *Journal of Indian Society of Coastal Agricultural Research* **19**(1&2): 323-332.

Sinhababu, D.P. (2001). *Rice-fish Farming for Rainfed Lowlands Areas*, CRRI Technology Bulletin 8, Central Rice Research Institute, Cuttack, Orissa.

Yadav , J.S.P.(2004). Coastal Agricultural Research - Present Status and Future Perspective with Special Reference to Value Addition. *Journal of Indian Society of Coastal Agricultural Research* **22**(1&2): 1-8.

J. Indian Soc. Coastal agric. Res., 24(2), 356-358, 2006

Supercyclone -A Natural Disaster

ASHWANI KUMAR and N. SAHOO

Water Technology Centre for Eastern Region
Chandrasekharpur, Bhubaneswar – 751 023, Orissa

Orissa, situated in eastern coast of India has been recurrently suffering from floods, famines and cyclones. The greatest calamity that has affected the people of Orissa coast was supercyclone which has occurred on 29-30th October 1999. The wind velocity was 270 km to 300 km h^{-1} which remained stationary for more than 24 hours at Paradip. Maximum of 42.6 cm rainfall was received during two days. In total 9885 persons were killed and the total loss was around Rs. 3000 crores. The suggested remedial measures were both hardware and software. The hardware solutions were safe shelter, foreshore road, one-way sluice gate, community grain bank and community drinking water system. The software solutions were coastal plantation, kitchen yard plantation for food security and growing saline resistant paddy variety. These should be the vital physical aspects necessary for planning to reduce the cyclone and flood havoc in Orissa's coastal plains in future.

(Key words: *Supercyclone, Wind velocity, Safe shelter, Food security)*

Orissa, situated in eastern coast of India has been recurrently suffering from floods, famines and cyclones. The memory of great famine of 1865-66 (*Naank Durvikhya*), floods of 1955 (*Dalei ghai*) and cyclone of 1999 (supercyclone) still remain in the memory of the people. In this famine about a quarter of Orissa's population perished. Similar situation occurred in 1955 flood though casuality was more in coastal Orissa. Again the supercyclone that devastated coastal Orissa on 29-30th October 1999 has once again opened the lacerated wounds of the people, virtually crippled Orissa's economy, and destroyed its ecosystem.

Supercyclone: Origin and development

The supercyclone first originated like any other tropical cyclone as a depression over North Andaman Islands at about 12°0 N to 13°30' N latitude and 95°0'E longitude and centered at about 350 km to the NE of Port Blair. It intensified further due to upper air disturbances and moved north-westernwards, and centered at around 140°3' to 94° 0' E longitudes. Then it moved further NW and took the shape of a cyclone and centered at about 800 km to the SE of Paradeep. After that it intensified further and became a supercyclone when it moved in a N-W direction and centered at about 25 km to the South East of Paradeep at 19°54'-20°5' N and 86°35' E longitude. The landfall at Paradeep was on 29-30th October and remained stationery there for more than 24 hours during which wind velocity reached a maximum 270 km to 300 km per hour. This was unprecedented.

The result was devastating. Tidal wave of 2 storied buildings high rushed coastwards (5-7 m) into the Mahanadi delta and affected Jagatsinghpur, Kendrapada, Puri, Khurda and Cuttack districts. It partially damaged Keonjhar, Dhenkanal and Nayagarh district in the Mahanadi-Baitarani basins. This supercyclone caused terrible havoc in Bhubaneswar, the capital city and Cuttack the commercial capital of Orissa. The first cyclone warning was sounded by the MDI on the 26th October for which about 1,50,000 people however could be shifted to safer places.

Cyclonic rainfall

Cyclonic rainfall started from 29th October and ceased on 1st November 1999. On 29th October maximum rainfall was recorded at Akhuapada (12cm) followed by Kujang (6.5 cm). Rain became heavier on 30th when maximum of 42.6 cm was received at Bhubaneswar followed by Anandpur (39.6 cm). On 31st October, heavier shower was recorded at Hadhgad (46.8 cm) followed by Bhadrak (44.6 cm). On 1st November 1999 rainfall became less and a maximum of 13.97 cm was recorded at Suneidam followed by Akhuapada (9 cm). In all these four days the maximum rainfall was recorded at Akhuapada (95.5 cm) followed by Bhadrak (86.7 cm), Sunei Dam (78.42 cm), and Anandpur (72.38 cm), Astarang (60.0 cm) and Ersama (55.7 cm).

Cyclonic Damage

The supercyclone affected 97 Blocks in 12 coastal districts including city of Bhubaneswar and Cuttack and 28 other coastal towns. In these coastal

districts 1.30 crore people were affected. The cyclone affected districts were Khurda, Puri, Cuttack, Jagatsinghpur, Kendrapada, Dhenkanal and Nayagarh which were agriculturally very rich. Jajpur, Bhadrak, Keonjhr, Balasore and Mayurbhanj were affected by high floods and cyclone. In total 9,885 persons were killed, 40 were missing and 2507 were injured. Out of this in Jagatsinghpur district alone 8,119 people died due to cyclone. It also killed 3,15,886 cows and buffaloes, 3,16,372 minor animals (Goat, sheep, pigs), and 1,883,468 poultry. It damaged 1,650,086 habitats. The cyclones caused heavy damage to standing crops as 13 lakh hectare of *kharif* paddy, 2.5 lakh hectare of other crops, and 1.76 lakh ha of vegetable and fruit crops were damaged. The total agricultural loss was estimated to be Rs. 1733 crore. Electricity connections were damaged in 19,062 villages. In cyclones, 3 Universities, 19 Govt. colleges 81 Private colleges, 3425 High schools, 14901 Primary school were destroyed. In addition to the devastation the net result was that the entire education system collapsed and the total loss has been estimated at Rs.1024.21 crore. It washed away 12000 km of rural roads, damaged 1474 bridges and 7020 Govt. buildings of RD department. During the cyclone 25,889 fishing families, two fishing ports (Dhamara and Chandbali) 19 fishing *jetties* were damaged. The supercyclone damaged 9085 fishing boats and 22,143 fishing nets in the Orissa coasts and in the river estuaries. The floods caused 2005 breaches to the embankments, 8674 cracks in the canal embankment and damaged 454 buildings of Water Resource department. It also caused damages to 422 minor irrigation projects. Besides, 5636 lift irrigation points became defunct. This killer cyclone has also ravaged the world's largest botanical garden (RPRC) located on the outskirts of Bhubaneswar. The loss was estimated to be Rs 20 crore.

Submerged areas

Submerged areas due to floods and tides have been estimated from satellite imagery of October 28 October and 2 November. These areas remained submerged for next 2 weeks up to 14th November. By comparing satellite imagery of every third day, ORSAC released the submergence data. In all, five coastal districts were very badly affected while six adjoining districts were partially affected where 3,20,225 ha of dry land remained submerged from 29th October till 15th November. The percentage of submergence of dry land in worst affected districts were Kendrapara (48.3%), Bhadrak (41.9%), Jagatsinghpur (26.81%), and Jajpur (25.87%). Other affected districts included Balasore, Kendrapara, Dhenkanal, Khurda and Mayarbhanj. In all these districts 60 blocks were affected and 320,225 ha were submerged.

Pisciculture

The supercyclone has killed the prospect of pisciculture in the coastal plains of Orissa very severely. The 13 coastal districts normally supply 70% of total fish production of the State. Due to supercyclone about 100,000 fishermen families lost almost everything and 25000 fish cultivation pond have been completely destroyed. Orissa normally produces fish worth Rs. 700.00 crores annually and it was growing rapidly which has been seriously affected.

Remedial measure

The present supercyclone became very disastrous since the protective cover of the tidal forests known as "Little Sunderban" in the estuaries of Mahanadi, Brahmani, Baitarani and Devi rivers were deforested by human interference. The mangrove forest shrunk drastically by setting up of the Paradeep port complex and accompanied industrial complex in addition to illegal felling by the unauthorized settlers. The result was total loss of the dense mangrove forest. Hence both hardware and software measures have been suggested.

Hardware solutions

(a) Foreshore road

It would be worthwhile to construct a foreshore road from Palur on N.H.5 in the Ganjam coast upto Jaleswar on N.H.5 in the N.E. via Brahmagiri, Puri, Konark, Astarang, Paradeep, Rajnagar, Raigarh, Ghanteswar, and it will follow the old high level canal embankment upto Bhograi and then upto Jaleswar on N.H.5. This will facilitate tourism industry being a longest marine drive road. The proposed road should be 7 m high.

(b) One-way sluice gate

There should be sluice gates on all river crossings which could be closed at the time of cyclonic tidal waves to prevent salt water intrusion to the rich agricultural land and could be opened at other times to drain out the flood water. Construction of a foreshore road will not be enough without sluice gates.

(c) Safe shelter

The disaster shelter building should be constructed in every coastal village. The buildings

must be of cement and concrete on specially raised mounds. Specially all primary school buildings must be designed in this fashion so that villagers can take shelter inside at the time of emergency. The proposed reconstruction of the rural houses should also be cyclone/flood resistant by using modern technology.

(d) Community grain bank

Some of the public building like school, clubs, etc. are to be converted into three storied building with the third floor being used for grain storage.

(e) Community drinking water facility

Each village should have a hand pump in second floor of the shelter house fitting to the drinking water tubewell in the ground so that during disaster pure drinking water could be available.

Software solutions

(a) Coastal plantation

Coastal plantations of cashew and *Casurina equisifolia* plantation have been illegally cut eliminating the green cover and barrier for wind as tide breaker. Whatever remained thereafter was completely lost due to the cyclones. The urgent task before the government is to now plant cashew, casurina plants all along the Orissa coast starting from Palur in the S.W. up to Jaleswar at the N.E. in a three-four kilometer wide stretch on the sand dunes. In addition in the estuaries of the river mouths the tidal forests has to be restored by planting suitable mangrove trees. This forest will protect the fury of cyclones and rush of tides. Thus nature is to be restored to its pre-cyclonic condition. These trees will take about 5-10 years to grow.

(b) Kitchen yard plantation for food security

For food security, every family should have tuber crops like sweet potato in the kitchen garden. Coconut plantation can also be taken. Sugarcane is also another good crop which has survived during cyclone disaster and has become first energy crop to the affected persons. This should also be taken into the kitchen garden.

(c) Growing saline resistant paddy

Coastal areas (0-10 km from sea) should be cultivated with saline resistant high yielding variety of paddy like Lunishree, Sonamani, etc. instead of local paddy. In the event of cyclone and saline water intrusion the crop damage will be minimal.

These are some of the vital physical aspects of planning to reduce the cyclone and flood havoc in Orissa's coastal plains in future.

J. Indian Soc. Coastal agric. Res., 24(2), 359-363, 2006

Integrated Management of Water Resources in Post-cyclone Situation

N. SAHOO and S. K. JENA

Water Technology Centre for Eastern Region
Bhubaneswar - 751 023, Orissa

This study was undertaken in supercyclone ravaged area of Ersama and Astarang with objectives of studying the performance of microwater resource development through shallow tubewells and small subsurface water harvesting structures on participatory basis. Participation of the farmers by paying a portion of the cost of construction of water resources has provided them a kind of ownership rights. The irrigated area increased about five times resulting into increased cropping intensity. The positive impact was realized through the increase of the productivity and income. It was also inferred that location specific microwater resource development is the real answer for increasing irrigated area and productivity in coastal waterlogged area. The farmers' paying capacity must be increased from the system to make it more sustainable. Participation of farmers by paying 40% of the cost of construction of water resources gives them the ownership rights and they do not consider this as one of the government donations or work. That is why in the second year more number of farmers came forward (15 numbers) even to pay upto 67% of the cost of the subsurface water harvesting structure. Similar was the case of construction of very shallow tubewell at Astarang.

(***Key words:*** *Shallow tubewell, Small subsurface water harvesting structure, People's participation, Supercyclone)*

The last supercyclone in Orissa on 29th October 1999 caused considerable loss not only in human being but also in agriculture, environment as well as in economic fronts which require considerable attention to realise the resources and the production systems. Seawater at 10 m height had entered to the inland causing devastation of standing crop in fields. In view of above, it is essential to develop a comprehensive land and water management policy, which can contribute a quantum jump in agricultural productivity to bring the population of this area out of perpetual poverty. So this study was undertaken with objectives of evaluating the performance of microwater resource development through shallow tubewells and small subsurface water harvesting structures on participatory basis.

MATERIALS AND METHODS

Location of the study area

Five villages, viz. Saraba, Bad Bellary, Ambiki, Baghadihi, and Kankan which were worst affected by last supercyclone of 1999 were selected in this study and are situated in Ersama block of Jagatsinghpur district in Orissa State. Another cluster of 5 villages (Hiradeipur, Gudubani, Sundar, Manduki and Chakrapada) which were also affected by the supercyclone in Astarang block of Puri district were identified for this study. These clusters of villages are situated within a radius of 4 km and within 5 km from the sea coast. Khulo river is passing in this location but there was no lift irrigation point nor wells used for agricultural purpose.

The major land situations such as medium lands and lowlands are present in the study area. Rice is the main crop grown in these villages. Other crops are also grown according to their seasonal suitability. Temperature is moderate and humidity is high. Rain mostly starts from mid-June which reach its peak in August and September and end in 3rd week of October. In general, the land holdings of the farmers of these villagers are marginal to small (less than 2 ha). The villagers obtain their livelihood from agriculture, agro-based enterprises, service and business. Total number of families in these five villages at each site was around 680. Around 90% houses, 80-90% crops, domestic enterprises and livelihood severely affected due to recent cyclone. The description of both the study area is presented through Tables 1 and 2.

To alleviate the problems related to agriculture, different interventions, such as introduction of lift irrigation through small pumps, construction of small subsurface water harvesting structures (SSWHS), construction of tubewells, rainwater harvesting technology, soil amendments and rice-fish farming system were introduced and studied for a period of three years.

Table 1. *Description of study area in Ersama block of Jagatsinghpur district*

Parameter	Homestead	Rainfed lowland			Irrigated
		Shallow (0-30 cm)	Medium deep (0-50 cm)	Deep water (> 50 cm)	
Topography	Flat	Flat with bunded and un-*bunded*	Slight undulated	Depression	Flat
Soil type	Red alluvial	Red alluvial, sandy loam	Sandy loam, clay loam	Clayey	Alluvial
Soil reaction	-	-	-	Saline	-
Water table	Shallow-medium	Shallow-medium	Shallow	Shallow	Medium
Water source	Open well, tubewells	Rain	Rain	Rain	River, Canal, MIPs, LIPs.
Hydrology	Backyard ponds	Water stagnation upto 30 cm during rainy season	Water stagnation upto 50 cm during rainy season	Water stagnation upto 50-100 cm during rainy season	Lift irrigation, ponds, river, canal, etc.

Table 2. *Description of study area in Astarang block of Puri district*

Parameter	Homestead	Rainfed lowland			Irrigated
		Shallow (0-30 cm)	Medium deep (0-50 cm)	Deep water (> 50 cm)	
Topography	Flat	Slight undulated	Undulated but *bunded*	Depression	Flat
Soil type	Sandy loam	Sandy loam	Loam to clay loam	Clay loam	Alluvial
Soil reaction	-	-	-	Saline	-
Water table	Shallow (4-8 m)	Shallow (4-8 m)	Shallow (4-8m)	Shallow (4-8m)	Shallow (4-8m)
Water source	Tubewells and open wells	Rain	Rain	Rain	Canal, MIPs, LIPs,Tubewells
Hydrology	No standing water	Standing water upto 30 cm during rainy season	Standing water upto 50 cm during rainy season	Standing water than 50 cm during more rainy season	Lift irrigation, ponds, borewells, tubewells, river, canal etc.

Water resource development through SSWHS at Ersama site

Construction of tubewell at this site was not feasible due to salinity in groundwater. Success of big ponds needs integrated farming system in which fish, poultry and horticultural crops on the pond *bund* should be added in a big way (Samra *et al.*, 2003). Construction of small subsurface water harvesting structures (SSWHS) on participatory basis was the best option available for poor farmers. Keeping this in mind Water Technology Centre for Eastern Region, Bhubaneswar developed a design for SSWHS (excavated tank). In this system small subsurface water harvesting structure (excavated tank) was constructed with an inlet at a depth of 3-4 m or less to harvest surface water in rainy season and to harvest subsurface seepage water in *rabi* season after each pumping session.

Water resource development through shallow tube well at Astarang site

Very shallow tubewell with depth varying from 8 m to 17 m depending on the site condition were constructed for creating microwater resources. Four shallow tubewells were constructed for different groups of farmers on participatory basis in the 1st year of study (Sahoo *et al.*, 2004). The cost of one tubewell was Rs. 2476 only. The tubewells were of 7.5 cm diameter and dug upto 13 m depth. In order to make the programme sustainable, the group was mobilized to purchase kerosene operated 2 hp pump to be fitted to shallow tube well. Agreement was made with the user groupto share water among all the group members and to non-members on payment basis so that the maintenance could be done with fund generated by the group. In the 2nd

year, another four water user groups came forward to construct shallow tubewell with the same conditions. In the 3rd year even with 50% of the project support, two groups constructed similar shallow tubewell (project support was Rs. 1250 only).

RESULTS AND DISCUSSION

Performance of the SSWHS System

These structures provided water for raising paddy nursery in June and irrigated additional area during *rabi* as well as summer. It could also be used for aquaculture and water loving crops such as water chestnut. This system was proved to be very effective in providing assured irrigation. As the resource position of the farmers of the region was poor, they could not construct it on their own nor could government fully subsidize the programme. Hence a participatory approach with involvement of the farmers group was felt to bring out sustainable water resources development. In the first year the group paid 40 % of the project cost and in total seven groups were formed, whereas in the second year the subsidy was reduced from 60 % to 33 % and still 13 user groups were formed and went for the SSWHS, which reflected interest in the approach.

In the first year itself in June (*kharif* 2001) 8.8 ha paddy nursery was saved from early drought. The rotation was prepared for both *kharif* and *rabi* crops and accordingly farmers had taken the crops. The economics of the system are presented in the Tables 3 and 4.

While analyzing the performance of SSWHS, in the first cluster where groups had paid 40 % of the cost, fish income per cubic meter varied from Rs. 3.21 to Rs. 10.28 with an average of Rs. 7.36. Whereas, total income varied from Rs. 17.01 to Rs. 47.19 with an average of Rs. 30.37 per cubic meter. Cropping intensity varied from 150% to 245% depending on the capability of the group. Similarly benefit-cost (B:C) ratio also varied from 1.42 to 1.95.

Table 3. *Performance of SSWHS with 60:40 participatory basis*

Name of the Group	Fish income /m^3	Total Income/m^3	Total Income/cost of construction Rs.	B:C Ratio	Water productivity (Rs /m^3)	Crop intensity (%)
Group-I	8.60	47.19	3.42	1.95	31.59	245
Group-II	8.78	31.19	3.01	1.94	20.87	215
Group-III	10.28	32.78	1.96	1.55	20.49	150
Group-IV	3.21	26.54	1.96	1.89	17.71	186
Group-V	6.38	23.76	2.49	1.74	15.34	155
Group-VI	8.54	34.17	2.53	1.42	20.37	173
Group-VII	5.73	17.01	1.29	1.69	11.02	234

Table 4. *Performance of SSWHS with 33:67 participatory basis*

Name of the Group	Cost of irrigation /ha	Fish income /m^3	Total income /m^3	Total income/ cost of construction Rs.	Water productivity /m^3	B:C Ratio	Crop intensity (%)
Group-I	7767	9.18	46.98	3.26	31.34	1.93	192
Group-II	8043	8.70	44.63	3.36	30.03	1.98	210
Group-III	10368	9.01	40.26	2.76	29.55	2.61	184
Group-IV	3150	12.46	80.43	5.65	53.70	1.93	270
Group- V	7874	7.38	34.04	2.60	21.72	1.69	254
Group-VI	13976	8.48	24.59	1.96	17.30	2.22	185
Group-VII	14661	9.37	27.59	1.84	15.41	1.20	192
Group-VIII	3816	10.69	62.59	4.94	43.76	2.26	224
Group-IX	13038	8.93	26.38	1.66	15.54	1.35	173
Group-X	13530	7.78	26.44	2.04	15.90	1.44	181
Group-XI	15438	7.01	25.40	1.40	13.09	1.01	161
Group-XII	12823	6.66	24.33	1.74	14.90	1.49	160
Group-XIII	10298	5.76	15.85	1.12	9.00	1.21	145

Incase of water productivity, the variation was due to higher productivity in fish. Average water productivity from the system was Rs 19.57 per cubic meter.

In the second cluster where farmers paid 67 % of the project cost, the fish income went upto Rs12.46 per cubic meter of water. This was around 20% higher than that in the first cluster. On an average fish income per cubic meter capacity in second cluster increased by 16.44% more than in the first cluster. This might be due to more participation in the project by paying more than in the first cluster. Similar trend was also seen in case of total income, water productivity and cropping intensity. Average water productivity in second cluster was Rs. 23.94m^{-3} which was 22.33% more than the first cluster. B:C ratio also varied from 1.01 to as high as 2.61. This might be due to more interest in fish cultivation than in *kharif* and *rabi* cropping. Average total income also was 21.43% more than that in the first cluster. Ratio of total income to cost of construction varied from 1.12 to 5.65 whereas in the first cluster it varied from 1.29 to 3.42. Cropping intensity in both the system remained more or less same, i.e. only 12.5% higher in case of second cluster. Cost per ha of irrigation came to Rs.11752 ha^{-1} in case of first cluster, whereas in second cluster it was Rs.10367 ha^{-1}. The lower cost of irrigation in the second case was only due to their more participation, i.e. by paying 67% cost of the project. This has happened because they have irrigated more area with higher water use efficiency and low losses.

Performance of very shallow tubewell

The utility of shallow tubewells constructed at Astarang site was presented in Table 5. It was evident that benefit-cost ratio varied from 0.74 to 1.42 with an average of 1.04. Similarly, cropping intensity varied from 107% to 154% with an average of 132.7%. Water productivity was found to be very high in Ersama in subsurface water harvesting structure due to fish component. However, in Astarang it was low as water was used for crop only. It varied from Rs. 4.03m^{-3} to Rs. 5.55m^{-3} with an average of Rs. 4.84m^{-3} with an assumption that tubewell was working for 50% of days during *rabi* and summer with 8 hours of pumping per session.

Participation of the farmers by paying a portion of the cost of water resources developed has provided them a kind of ownership rights. The group of farmers cultivated different crops by irrigating them from the water resources created by them. The irrigated area increased about five times resulting into increased cropping intensity. The positive impact was realized through the increase of the productivity and income. It gives a new insight for further research and extension work to empower the weaker, socially and economically poor, small and marginal farmers to create their own assets by forming groups and to enhance the productivity of the complex, diverse risk prone farming system. It was also inferred that location specific microwater resource development is the real answer for increasing irrigated area and productivity in coastal

Table 5. *A brief account of very shallow tubewells created at Astarang site during 2001-04*

Name of the tubewell water user group with no. of participants	Area irrigated (ha)			Income (Rs.)				Cost of production (Rs.)	Benefit (Rs.)	B:C Ratio	Cropping Intensity (%)	Water productivity (Rs./m^3) (*rabi* + summer)
	Kharif	*Rabi*	Summer	*Kharif*	*Rabi*	Summer	Total income (Rs.)					
Chakradhapur (6)	3.0	1.0	0.5	42,000	60,000	20,000	1,22,000	50150	71850	1.42	150	5.24
Adikandapur Sasan-I (8)	2.0	1.0	0.3	27,500	56,175	10,350	94,025	41050	52,975	1.28	110	4.35
Adikandapur Sasan-II (16)	2.0	1.2	0.7	31,500	61,200	22,375	1,15,075	56321	58,754	1.04	130	5.47
Manduki (8)	1.8	0.8	0.6	23,475	46,310	21,371	91,156	52135	39,021	0.74	107	4.43
Patalda-I(7)	2.5	1.0	0.6	35,130	52,375	21,375	1,08,880	54370	54,510	0.99	137	4.83
Patalda-II(8)	3.0	0.9	0.7	40,050	54,010	22,110	1,16,170	57890	58,280	1.002	154	4.98
Baridi-I(8)	2.8	0.7	0.5	35,728	42,130	19,371	97,229	47316	49,913	1.04	133	4.03
Baridi-II(8)	2.4	1.0	0.6	34,130	56,130	20,380	1,10,640	55376	55,264	0.99	133	5.01
Hiradeipur (6)	2.6	0.8	0.8	35,314	46,375	23,109	1,04,798	54375	50,423	0.92	140	4.55
Timore (7)	2.0	1.1	0.9	31,781	60,430	24,340	1,16,551	58375	58,176	0.99	133	5.55

waterlogged area. Integrated farming system approach for each microwater resource proved to be more economical.

REFERENCES

Sahoo, N., James, B.K., Verma, H.N., Ghosh, S., Roy Chowdhury, S., Panda, D., Singh, R., Srivastava, R.C. and Tripathi, V.K. (2004). In *Comprehensive Participatory Water Resources Development and Management in Coastal Agro-eco System of Orissa Affected by Supercyclone*, WTCER Publication **20**, WTCER, Bhubaneswar, Orissa.

Samra, J.S., Sahoo, N., Roy Chowdhury, S., Mohanty Rajeev K., Jena, S.K. and Verma, H.N. (2003). In *Sustainable Integrated Farming System for Waterlogged Areas of Eastern India*, WTCER Research Bulletin **14**, WTCER, Bhubaneswar, Orissa.

J. Indian Soc. Coastal agric. Res., 24(2), 364-366, 2006

Natural Disaster: Plan for Mitigation

A. K. BANDYOPADHYAY

P.O & Vill. Adcconagar, Dist. Hooghly
Pin - 712 121, West Bengal

This paper discussed details of the steps taken by Government of India to mitigate natural disasters in the coastal area. The Tenth Five Year Plan document has a detailed chapter on disaster management. The Terms of Reference of the Twelfth Finance Commission is changed and mandated to look at the requirements for mitigation and prevention also. Ministry of Home Affairs has initiated National Disaster Risk Management Programme in 169 districts of 17 multi-hazard prone States and assistance is being provided to States to draw up disaster management plans at the Sate, District, Block/*Taluka* and Village levels. National Cyclone Mitigation Project has been drawn up in consultation with cyclone prone States. Hospital preparedness is crucial to any disaster system. In consultation with Medical Council of India, two committees have been constituted for preparation of curriculum for introduction of emergency health management in MBBS curriculum and preparation of in-service training of hospital managers and professionals. Disaster Management as a subject in social sciences has been introduced in the school curriculum for class VIII and IX by CBSE and the State Governments have been advised to take similar steps. Since flood, cyclone, etc. are major problems the farmers are facing every year in coastal area, they must adopt some measures to withstand the problems. ISCAR may have a full seminar to find out possible location specific ways and means to withstand such problems.

*(**Key words:** Disaster management, Flood, Cyclone, Plans for mitigation, Awareness)*

The Yokohama message of May 1994 stressed that disaster prevention, mitigation, preparedness and relief are four elements which nations should incorporate in their development plans and ensure efficient follow-up measures at the community, subregional, regional, national and international levels. Disaster prevention, mitigation and preparedness are better than disaster response as they contribute to lasting improvement in safety. The Government of India has adopted mitigation and prevention as essential components of their development strategy. The Tenth Five Year Plan document has a detailed chapter on Disaster Management. Each State is supposed to prepare a plan scheme for disaster mitigation in accordance with the approach outlined in the plan. In brief, mitigation is being institutionalized into developmental planning. The Government of India has issued guidelines that where there is a shelf of projects, projects addressing mitigation will be given a priority. It has also been mandated that each project in a hazard prone area will have disaster prevention/mitigation as a term of reference and the project document has to reflect as to how the project addresses that term of reference. The Terms of Reference of the Twelfth Finance Commission have been changed and the Finance Commission has been mandated to look at the requirements for mitigation and prevention apart from its existing mandate of looking at relief and rehabilitation. Natural disasters may be flood, cyclone, *tsunami*, earthquake, landslide and drought. In the coastal ecosystem, flood and cyclone are very common, and accordingly, future plans will be discussed on them only. *Tsunami* will be discussed in a separate paper.

Flood

Measures for flood mitigation were taken from 1950 onwards. As against the total of 40 million hectare prone to floods, area of about 15 million hectares has been protected by construction of embankments. A number of dams and barrages have been constructed. The State Governments have been assisted to take up mitigation programs like construction of raised platforms, etc. Embankments have also given rise to problems of drainage with heavy rainfall leading to waterlogging in areas outside the embankment. To evolve both short term and long term strategy for flood management/ erosion control, Government of India has recently constituted a Central Task Force under the Chairmanship of Chairman, Central Water Commission. The Task Force will examine cause of the problem of recurring floods and erosion in States and regions prone to flood and erosion; and suggest short term and long term measures.

Flood preparedness and response

In order to respond effectively to floods, Ministry of Home Affaires has initiated National Disaster Risk Management Program in all the flood-prone States. Assistance is being provided to the States to draw up disaster management plans at the State, District, Block/*Taluka* and Village levels. Awareness generation campaigns have been initiated to sensitize all the stakeholders on the need for flood preparedness and mitigation measures. Elected representatives and officials are being trained in flood disaster management under the programme. Bihar, Orissa, West Bengal, Assam and Uttar Pradesh are among the 17 multi-hazard prone States where this program is being implemented with UNDP, USAID and European Commission.

Cyclone

National cyclone mitigation project

A project for Cyclone Mitigation (estimated cost Rs.10500 million) has been drawn up in consultation with the cyclone prone States. This project envisages construction of cyclone shelters, coastal shelterbelt plantation an areas, which are prone to storm surges, strengthening of warning systems, training and education, etc. This project has also been given in-principle clearance by the Planning Commission.

Hospital preparedness and emergency health management in medical education

Hospital preparedness is crucial to any disaster system. Each hospital should have an emergency preparedness plan to deal with mass casualty incidents and the hospital administration/doctor trained for this emergency. The curriculum for medical doctors does not include hospital preparedness for emergencies. Therefore capacity building through in-service training of the current health managers and medical personnel in hospital preparedness for emergencies or mass casualty incident management is essential. At the same time, the future health managers must acquire these skills systematically through the inclusion of health emergency management in the undergraduate and postgraduate medical curricula. In consultation with Medical Council of India (MCI), two committees have been constituted for preparation of curriculum for introduction of emergency health management in MBBS curriculum, and preparation of in-service training of Hospital managers and professionals. Rajeev Gandhi University of Health Sciences, Karnataka has been identified as the lead national resource institution for the purpose.

Disaster risk management program

A Disaster Risk Management Program has been taken up in 169 districts in 17 multi-hazard prone States with the assistance from UNDP, USAID and European Union. Under this project, the States are being assisted to draw up State, district and Block level disaster management plans; and village disaster management plans are being developed in conjunction with the Panchayati Raj Institutions and disaster management teams consisting of village volunteers who are being trained in various preparedness and response functions such as search and rescue, first aid, relief coordination, shelter management, etc. Equipment needs for district and State Emergency Operation Centers have been identified by the State nodal agencies and equipments, are being provided to these EOCs.

Disaster Management Teams have been constituted in villages and are being imparted training in basic functions of first aid, rescue, evacuation and related issues. The thrust of the programme is to build-up capabilities of the community since the community is invariably the first responder. During the recent past, it has been experienced that the capacity building of the community has been very helpful even in normal situations when isolated instances of drowning, burns, etc. take place. With the creation of awareness generation on disaster mitigation, the community will be able to function as a well-knit unit in case of any emergency.

Awareness generation

Recognizing that awareness about vulnerabilities is *sine qua non* for inducing a mindset for disaster prevention, mitigation and preparedness, the Government has initiated a nation-wide awareness generation campaign as part of its overall disaster risk management strategy. In order to device an effective and holistic campaign, a steering committee for mass media campaign has been constituted at the national level with due representation of experts from diverse streams of communication.

Disaster awareness in school curriculum

Disaster management as a subject in social sciences has been introduced in the school curriculum for class VIII & IX. The Central Board of Secondary Education (CBSE), which has introduced the curriculum, runs a very large number of schools throughout the country and the course curriculum is invariably followed by the State Boards of

Flood preparedness and response

In order to respond effectively to floods, Ministry of Home Affaires has initiated National Disaster Risk Management Program in all the flood-prone States. Assistance is being provided to the States to draw up disaster management plans at the State, District, Block/*Taluka* and Village levels. Awareness generation campaigns have been initiated to sensitize all the stakeholders on the need for flood preparedness and mitigation measures. Elected representatives and officials are being trained in flood disaster management under the programme. Bihar, Orissa, West Bengal, Assam and Uttar Pradesh are among the 17 multi-hazard prone States where this program is being implemented with UNDP, USAID and European Commission.

Cyclone

National cyclone mitigation project

A project for Cyclone Mitigation (estimated cost Rs.10500 million) has been drawn up in consultation with the cyclone prone States. This project envisages construction of cyclone shelters, coastal shelterbelt plantation an areas, which are prone to storm surges, strengthening of warning systems, training and education, etc. This project has also been given in-principle clearance by the Planning Commission.

Hospital preparedness and emergency health management in medical education

Hospital preparedness is crucial to any disaster system. Each hospital should have an emergency preparedness plan to deal with mass casualty incidents and the hospital administration/doctor trained for this emergency. The curriculum for medical doctors does not include hospital preparedness for emergencies. Therefore capacity building through in-service training of the current health managers and medical personnel in hospital preparedness for emergencies or mass casualty incident management is essential. At the same time, the future health managers must acquire these skills systematically through the inclusion of health emergency management in the undergraduate and postgraduate medical curricula. In consultation with Medical Council of India (MCI), two committees have been constituted for preparation of curriculum for introduction of emergency health management in MBBS curriculum, and preparation of in-service training of Hospital managers and professionals. Rajeev Gandhi University of Health Sciences, Karnataka has been identified as the lead national resource institution for the purpose.

Disaster risk management program

A Disaster Risk Management Program has been taken up in 169 districts in 17 multi-hazard prone States with the assistance from UNDP, USAID and European Union. Under this project, the States are being assisted to draw up State, district and Block level disaster management plans; and village disaster management plans are being developed in conjunction with the Panchayati Raj Institutions and disaster management teams consisting of village volunteers who are being trained in various preparedness and response functions such as search and rescue, first aid, relief coordination, shelter management, etc. Equipment needs for district and State Emergency Operation Centers have been identified by the State nodal agencies and equipments, are being provided to these EOCs.

Disaster Management Teams have been constituted in villages and are being imparted training in basic functions of first aid, rescue, evacuation and related issues. The thrust of the programme is to build-up capabilities of the community since the community is invariably the first responder. During the recent past, it has been experienced that the capacity building of the community has been very helpful even in normal situations when isolated instances of drowning, burns, etc. take place. With the creation of awareness generation on disaster mitigation, the community will be able to function as a well-knit unit in case of any emergency.

Awareness generation

Recognizing that awareness about vulnerabilities is *sine qua non* for inducing a mindset for disaster prevention, mitigation and preparedness, the Government has initiated a nation-wide awareness generation campaign as part of its overall disaster risk management strategy. In order to device an effective and holistic campaign, a steering committee for mass media campaign has been constituted at the national level with due representation of experts from diverse streams of communication.

Disaster awareness in school curriculum

Disaster management as a subject in social sciences has been introduced in the school curriculum for class VIII & IX. The Central Board of Secondary Education (CBSE), which has introduced the curriculum, runs a very large number of schools throughout the country and the course curriculum is invariably followed by the State Boards of

Flood preparedness and response

In order to respond effectively to floods, Ministry of Home Affaires has initiated National Disaster Risk Management Program in all the flood-prone States. Assistance is being provided to the States to draw up disaster management plans at the State, District, Block/*Taluka* and Village levels. Awareness generation campaigns have been initiated to sensitize all the stakeholders on the need for flood preparedness and mitigation measures. Elected representatives and officials are being trained in flood disaster management under the programme. Bihar, Orissa, West Bengal, Assam and Uttar Pradesh are among the 17 multi-hazard prone States where this program is being implemented with UNDP, USAID and European Commission.

Cyclone

National cyclone mitigation project

A project for Cyclone Mitigation (estimated cost Rs.10500 million) has been drawn up in consultation with the cyclone prone States. This project envisages construction of cyclone shelters, coastal shelterbelt plantation an areas, which are prone to storm surges, strengthening of warning systems, training and education, etc. This project has also been given in-principle clearance by the Planning Commission.

Hospital preparedness and emergency health management in medical education

Hospital preparedness is crucial to any disaster system. Each hospital should have an emergency preparedness plan to deal with mass casualty incidents and the hospital administration/doctor trained for this emergency. The curriculum for medical doctors does not include hospital preparedness for emergencies. Therefore capacity building through in-service training of the current health managers and medical personnel in hospital preparedness for emergencies or mass casualty incident management is essential. At the same time, the future health managers must acquire these skills systematically through the inclusion of health emergency management in the undergraduate and postgraduate medical curricula. In consultation with Medical Council of India (MCI), two committees have been constituted for preparation of curriculum for introduction of emergency health management in MBBS curriculum, and preparation of in-service training of Hospital managers and professionals. Rajeev Gandhi University of Health Sciences, Karnataka has been identified as the lead national resource institution for the purpose.

Disaster risk management program

A Disaster Risk Management Program has been taken up in 169 districts in 17 multi-hazard prone States with the assistance from UNDP, USAID and European Union. Under this project, the States are being assisted to draw up State, district and Block level disaster management plans; and village disaster management plans are being developed in conjunction with the Panchayati Raj Institutions and disaster management teams consisting of village volunteers who are being trained in various preparedness and response functions such as search and rescue, first aid, relief coordination, shelter management, etc. Equipment needs for district and State Emergency Operation Centers have been identified by the State nodal agencies and equipments, are being provided to these EOCs.

Disaster Management Teams have been constituted in villages and are being imparted training in basic functions of first aid, rescue, evacuation and related issues. The thrust of the programme is to build-up capabilities of the community since the community is invariably the first responder. During the recent past, it has been experienced that the capacity building of the community has been very helpful even in normal situations when isolated instances of drowning, burns, etc. take place. With the creation of awareness generation on disaster mitigation, the community will be able to function as a well-knit unit in case of any emergency.

Awareness generation

Recognizing that awareness about vulnerabilities is *sine qua non* for inducing a mindset for disaster prevention, mitigation and preparedness, the Government has initiated a nation-wide awareness generation campaign as part of its overall disaster risk management strategy. In order to device an effective and holistic campaign, a steering committee for mass media campaign has been constituted at the national level with due representation of experts from diverse streams of communication.

Disaster awareness in school curriculum

Disaster management as a subject in social sciences has been introduced in the school curriculum for class VIII & IX. The Central Board of Secondary Education (CBSE), which has introduced the curriculum, runs a very large number of schools throughout the country and the course curriculum is invariably followed by the State Boards of

Secondary Education. Teachers are being trained to teach disaster management syllabus for Class X and will be introduced in the course curriculum soon. The State Governments have been advised to take similar steps *vis-à-vis* their school boards.

Information, education and communication

In order to assist the Sate Governments in capacity and awareness generation activities and to learn from past experiences including sharing of best practices, the Ministry of Home Affairs has compiled/prepared a set of resource materials developed by various organizations/institutions to be replicated and disseminated by State Governments based on their vulnerabilities after translating it into the local languages. The voluminous material, which runs into about 10000 pages, has been divided into 4 broad sections in 7 volumes. These sections cover planning to cope with disasters; education and training; construction toolkit; and information, education and communication toolkit including multi-media resources on disaster mitigation and preparedness. Material and Strategies used by various States and international organizations, including tips on different hazards, have been incorporated along with multimedia CDs on disasters. The material has been disseminated to all the State Governments/UT Administrations with the request to have the relevant material, based on the vulnerability of each district, culled out, translated into local languages and disseminated widely down to the village level.

All the above mentioned statements clearly showed the plans and programme of the Govt. of India. Government identified Department of Agriculture and Cooperation (DAC) in the Agriculture Ministry as NODAL Department for all matters concerning natural calamities relief at the Center. DAC has set up a Control Room with full complement of staff for round the clock functioning with a Night Duty Cell where charter of duties of the Duty Officer clearly indicates control room responsibilities, details of actions to be taken on receiving first information, etc. In addition to National Crisis Management Committee (NCMC), Crisis Management Group (CMG), action to be taken after first warning, after second warning, and post-disaster measures, etc. are also identified.

Role of ISCAR

Since ISCAR is primarily a Society of Agricultural (including forestry, fishery and animal science) scientists, we can collect and collate information on mode of action of disasters on farming systems, including forestry, the intensity of damage of these systems, and what are the measures already developed by SAU, State, Departments, ICAR institutes as well as by the farmers themselves. Importance may be given on the experience of coastal farmers under such situation and what are the traditional ideas available.

Since flood, cyclone, etc. are major problems the farmers are facing every year, they must adopt some measures to withstand the problems. ISCAR may have a full seminar to find out possible location specific ways and means to mitigate such problems. A number of scientists may be identified from the entire coastal area who will collect information on the technologies developed on these problems and also the measures adopted by different farmers to sustain their livelihood during post-disaster period. They may give special thrust to generate short term and long term technologies to help the farmers. ISCAR may discuss on these technologies and measures and recommend location specific actions to be taken by the farmers. ISCAR may take time bound steps to generate such recommendations.

J. Indian Soc. Coastal agric. Res., 24(2), 367-369, 2006

Recent Floods in Konkan and Ecological Disasters: A Case Study

S. B. KADREKAR and C. V. BHAMBURE

Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli (M.S.)

The Konkan region is a narrow strip about 750 km in length and width ranging between 40-65 km lying on the western side of the State. It is sandwitched between Sahyandri ranges on the east and Arabian sea on the west. The region has 6 revenue districts, viz. Thane, Greater Mumbai, suburban Mumbai, Raigad, Ratnagiri and Sindhudurg. The topography is very rugged and undulating. The region receives about 95% of its total rainfall ranging between 3000 to 4500 mm from south-west monsoon. The parent material underlying the soil is basalt but in the extreme south it is a mixed material like granite, gneises, schists, etc. Due to the high rainfall and humidity, the soils in Sindhudurg, Ratnagiri and south portion of Raigad districts are lateritic while in the rest of Raigad district and Thane district those are medium in depth and black in colour. Out of the total geographical area of Konkan, 57 percent (17725 km^2) lies in runoff zone, 29 percent (8524 km^2) in recharge zone and only 14 percent (4038 km^2) in storage zone. The paper describes experiences due to recent floods in these soils.

(***Key words:*** *Flood drainage in Konkan, Climatic and soils characteristics, Drainage, Prediction, Master plan)*

The paper reviews the factors responsible for the recent floods in 2005 and the damages caused thereof, in Konkan region of Maharashtra. It was estimated that about 8-14 t of soils was lost per hectare from the areas having the protected sloppy land, and hundreds and thousands of tons of the fertilie layer of soil were lost, besides colossal loss of wealth and properties. A method of prediction of flood has also been suggested. The paper also suggests separately, for cities/towns and rural areas, some master plan, besides contingency plans, for protection of these lands against such floods.

Rainfall characteristics

In order to study the rainfall pattern and the frequency of heavy rains > 500 mm in a week, data recorded (Table 1) at the meteorological observatory, College Agriculture, Dapoli from 1972 to 2005 was used. The data revealed that monsoon commences usually in the first week of June and continues upto end of September. In the first week of July rainfall slightly decreases later on increases and continues till second week of August. The annual rainfall ranges from 2130.7 mm to 4921.9 mm. The maximum frequency of torrential rainfall above 500 mm per week occurs in late June and late July. The frequency was greater during June (6 to 7) than in the month of July (4) (Fig. 1). Such events of very heavy rains above 500 mm per week did not occur in the beginning of June (22nd meteorological week) or after September (36th meteorological week) during the period under study. Similarly, occurrence of heavy rains of this magnitude was very rare in the beginning of July as well as late August. Based on the analysis of rainfall for 34 years, it could be concluded that the second fortnight of June and July were vulnerable for flooding situations due to torrential rains especially along river banks and lowlying areas leading to devastation of crop and property.

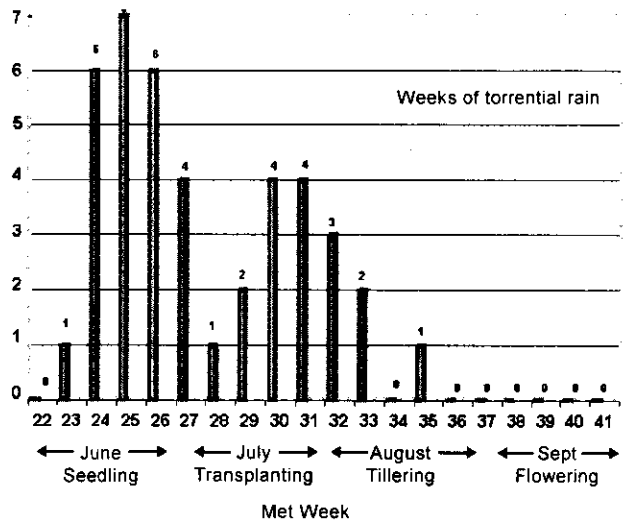


Fig. 1. Frequency distribution of rainfall (>500mm) during monsoon (1972-2005)

Drainage pattern

Soil physical characteristics and land features, individually or in combination, have great influence on the natural drainability of the area. Light soils of Ratnagiri and Sindhudurg districts have good intake and internal water transmission characteristics. Those are naturally well drained. The highly undulating topography coupled with high rainfall result in the

formation of network of streams which favour natural drainage from the area. Rice being the important crop of this region, can tolerate waterlogging for 2 to 3 days. Hence the problem of flooding in Konkan region even for 2 to 3 days goes unnoticed. However, this flooding ultimately scours the fertile top layer of soil from the runoff and recharge zone and deposit it in the lower storage zone and in the rivers.

Prediction of flooding

The question arises whether heavy floods in Konkan can be predicted? With the commencement of monsoon, water table in the soil profile starts rising slowly reaching almost upto 1 m below soil surface by the end of June, when the possibility of torrential showers is very high. Undulating topography of the region and high percolative soil strata particularly in Ratnagiri and Sindhudurg districts coupled with heavy surface as well as subsurface flow often contribute to peak flow on the surface and in the lowlying streams and rivers, resulting into floods. The peak rate of flow for the Konkan soil type can be worked out by rational formula (C.E. Ramser) as under :

$$Q = \frac{(CIA)}{360},$$

where,

Q = peak rate of runoff (Cubic meters per second)

I = intensity of rainfall (mm h^{-1})

A = watershed area, ha

C = runoff coefficient (dimensionless)

(values of C for different soil texture, slope and vegetation are given in Table 2)

As per the above rational formula and under above situation the entire rainfall goes as runoff, e.g. when the catchment area of 10,000 ha receives rain of 100, 200, 300, 400 and 500 mm in a day the peak runoff is equal to 115.74 $m^3 s^{-1}$, 231. 48 $m^3 s^{-1}$, 347.22 $m^3 s^{-1}$, 462.96 $m^3 s^{-1}$ and 578.78 $m^3 s^{-1}$, respectively. This shows that intensity of 200 mm d^{-1} in addition to base flow after saturation creates flooding conditions in the lowlying areas. This situation worsens during high tide period. Considering these peak flow rates and weeks of torrential rains (> 500 mm week), it appears that flood situation in the Konkan region is very common particularly during the period of late June and late July months, inspite of highly percolative sloppy terrain. In recent years, the flood situation is becoming more common due to heavy silting of rivers, soil disturbance, deforestation, etc. However, it is of great concern since it causes heavy crop losses, takes heavy toll of life, property and seriously affects communication.

Case studies

In the first fortnight of June 2005 there were no rains not only in Konkan but throughout Maharashtra State. As a result the sowing of *Kharif* crops was delayed. Later on, there were two spells of heavy rainfall, first between 25th to 27th meteorological week and later, from 29th to 33rd meteorological week. As a result, in Konkan, the transplating of rice was delayed. The 30th and 31st meteorological weeks were the wettest periods which received 623.7 (22-28 July) and 513.8 mm (29th July - 4th August)

a) *Mumbai and Suburban area*: A record rainfall of 944 mm was received within 18 hrs of 26th and 27th July. The exceptional rainfall coincided with high tide, and as a result large area in Mumbai and Thane urban area were under massive innundation. In Mumbai suburban area water reached a level of 8-10 ft high. Bandra – Andheri highway was like sea and ground floors and *Jhuggis/zopadpattis* were under water.

b) *Thane District*: All urban areas like Kalyan, Dombivli, Ambernath, Ulhasnagar, Bhivandi and Badalapur were under water. All rivers and *nalas* were overflowing and there were may breaches to the bridges as a result communication was disturbed.

c) *Raigad and Ratnagiri district* : Both Raigad and Ratnagiri districts had large areas under submergence. The towns which were severly affected were Panvel, Roha, Mahad, Mangaon from Raigad district and Khed, Chiplun, Sangmeshwar, Someshwar, Rajapur from Ratnagiri district. The heavy rainfall in these two districts also triggered landslides and deaths on large scale.

It has been one of the worst disasters in these areas in terms of human lives lost. Due to flooding rice crop in the coastal saline belt suffered loss due to continuous submergence. Near the banks of rivers in Mahad, Khed, Chiplun, Sangmeshwar *tehasils* the entire crop of rice suffered due to silting. The worst affected area was Mumbai where more than 15,321 cattles lost their lives, followed by Ratnagiri (3983), Raigad (2783) and Thane (1285).

It was estimated that about 8-14 t of soils was lost per hectare from unprotected sloppy land. Hundreds and thousands of tons of the fertile layer of soil were lost.

The damage due to such floods could be minimized if not completely eliminated. There should be overall master plan for the State and the region besides contingency plan for each district involving steps required to be taken before onset of monsoon.

A) In cities and towns:

Concerned departments in cities like Mumbai, should have:

- Premonsoon inspection of railway tracks, drains, rivers by respective department.
- Regular clearance of drains from silt, weeds. Restoring natural drainage blocked by roads, railway tracks.
- Regular maintenance of embankments of rivers, canals,
- Clearing storm water and sewerage drains.

B) In rural area :

In rural area of Konkan following actions need to be taken:

- Development of each river valley on integrated watershed management principles which include planting broad leaf forest trees and grass on more than 30% slopes with continuous counter trenching (CCT), planting rainfed horticultural crops like mango, cashew, *Kokam*, *Jambhul*, etc. between 10% to 30% slope with CCT, and annual food crops with proper *bunding* practices, terracing, etc. upto 10% slope.
- The soil conservation practices like CCT, *nalla* trainig, *nalla bunding*, farm ponds need to be constructed on large scale.
- Due to continuous silting for last several years the river beds have become shallow. Dredging to be done for removal of silt/sand to increase efficiency of water flow.

ACKNOWLEDGEMENT

Thanks are due to Dr. M. S. Mane, Agril. Engineer, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli for the help rendered in preparation of manuscript.

J. Indian Soc. Coastal agric. Res., 24(2), 370-374, 2006

Impact Assessment and Rehabilitation Strategies for *Tsunami* Affected Agricultural Lands of Andaman and Nicobar Islands

R. RAJA, S. GHOSHAL CHAUDHURI, T. P. SWARNAM, N. RAVISANKAR, V. JAYAKUMAR and SUDIPTA DAS

Central Agricultural Research Institute
Port Blair – 744 101, A&N Islands

Seawater ingression due to *Tsunami* waves has led to different situations affecting cultivation of the agricultural lands of A & N Islands, *viz.*, (1) seawater intruded to the cultivated land during *tsunami* and receded completely, (2) seawater intruded during high tide and receded during low tide, and (3) coastal areas had increasing depth of impounded seawater with high tide. So, the farmers of A & N Islands faced situations where they lost their farmland completely and or dealt with twin problems of soil salinity and sodicity, thus seriously hampering crop production. Soil samples were collected at periodical intervals in order to assess the changes occurring in soil physicochemical properties and to formulate rehabilitation strategies. The analytical results revealed that immediately after *tsunami*, the surface soil (0-15 cm) became saline sodic because of accumulation of soluble salts that increased soil EC and ESP immediately. Whereas, the subsurface soil (15–30 cm) turned saline because of increased EC alone. However, after onset of monsoon, the salts were leached down to the lower layers, and both surface and subsurface soils became saline sodic because of increased level of ESP and exchangeable Na though the EC values decreased.

(Key words: Tsunami *affected soils, Characterization, Rehabilitation)*

The massive earthquake of 9.2 magnitude on the Richter scale which hit Indonesia (of the west coast of the Northern Sumatra) on the morning of 26th December 2004 was the biggest in 40 years. This triggered massive *tsunami* waves, which created havoc and excessive devastation in terms of human lives and loss of infrastructures in coastal areas of Andaman and Nicobar Islands. The coastal areas of these Islands affected by the *tsunami* present had diversified cultivation practices from inland fresh water rice-based systems to mangroves and coastal strips used primarily for fishing. Seawater ingression due to *tsunami* waves led to the complete submergence of adjoining agricultural fields and other plantations and resulted not only in crop loss but also drastically changed the soil properties and rendered the soils salt affected. After *tsunami*, three different situations arose, viz., (1) seawater only intruded during tsunami and receded completely, (2) seawater intruded during high tide and receded during low tide, and (3) coastal areas had increasing depth of impounded seawater with high tide. So, the farmers of A & N Islands lost their farmland completely and or dealt with twin problems of soil salinity and sodicity. In saline soils, crop growth was hampered by salt accumulated in the root zone. Survey was undertaken at periodical intervals in order to assess the changes occurring in soil physicochemical properties, *viz.*, pH, electrical conductivity (EC), sodium absorption ratio (SAR), exchangeable sodium percentage (ESP), exchangeable cations (Na^+, K^+, Ca^{++} and Mg^{++}), anions (CO_3^{--}, HCO_3^- and Cl^-) and organic carbon content, and to formulate rehabilitation strategies.

MATERIALS AND METHODS

Soil samples were collected at periodical intervals in the *tsunami* affected areas of South Andaman, *viz.* Lalpahar, Craikabad, Mitha Khari and Guptapara from surface layer (0-15 cm) and subsurface layer (15-30 cm) in ten selected spots by making a transect walk across the slope under each of three different situations as discussed latter. The soil samples were air dried, powdered with wooden mallet and sieved through a 2 mm sieve. The sieved samples (< 2 mm) were analyzed for different physicochemical properties, *viz.* pH and EC, soluble sodium and potassium by using flame photometer, soluble calcium and magnesium by using atomic absorption spectrophotometer, organic carbon using standard methods (Page *et al.*, 1982) and soluble anions, i.e. CO_3^{--}, HCO_3^- and Cl^- (USSL Staff, 1954). Sodium adsorption ratio (SAR) and exchangeable sodium percentage (ESP) were derived (USSL Staff, 1954). The results were discussed here under.

RESULTS AND DISCUSSION

The *tsunami* affected agricultural lands from where the samples were collected falls under School line series (Guptapara), Tushnabad series (Mitha Khari) and Dhanikhari series (Lalpahar and Craikabad) *of A & N Islands*, and the pre-*tsunami* physicochemical characteristics of the same soil series are reproduced by Ganeshamurthy *et al.* (2002).

Pre-*tsunami* soil physicochemical characteristics

School line series

The soils were Tropofluvents formed from alluvial deposits and having topography of gentle sloping to nearly level flat plains. The soils were mainly used for cultivating rice, coconut and areca nut. The texture was sandy clay loam in nature with medium organic carbon content (0.55%) in the upper 25 cm. The soil reaction was acidic and the soil electrical conductivity (EC) was 0.32 and 0.04 dSm^{-1} at 0-15 and 15-30 cm depth, respectively, i.e. non-saline in nature. Exchangeable Ca + Mg content was 1.8 me 100 per g soil at 0-12 cm depth which increased to 3.3 me per 100 g soil at 55 cm depth. The exchangeable aluminum was very low (< 1%) and the available soil moisture was high (15.8%).

Dhanikhari series

The soils were Fluventic Sulfaquents with saline phase formed from alluvium from surrounding hills and marine deposits. The topography was flat and the soils were used for rice cultivation and shrimp farming. The soil texture was clay loam in nature with very high organic carbon content (4 %) in the upper 25 cm. The soil reaction was highly acidic and the soil electrical conductivity (EC) was 4.8 and 5 dSm^{-1} at 0-15 and 15-30 cm depth, respectively, i.e. moderately saline in nature. Exchangeable Ca + Mg content was 2.7 me per 100 g soil at 0-12 cm depth which increased to 3.9 me per 100 g soil at 24 cm depth and decreased further to 2.1 me per 100 g soil at 105 cm. The exchangeable aluminum was high and the available soil moisture was also high (19 %).

Tushnabad series

The soils were Umbric Fluventic haplaquepts formed from shales. The topography was slight to moderately sloping and the soils were used for cultivation of coconuts, arecanuts, spices, banana, papaya and vegetables. The soil texture was of clay loam in nature with high organic carbon content (1.5 %) in the upper 25 cm. The soil reaction was acidic and the soil electrical conductivity (EC) was 0.02 and 0.05 dSm^{-1} at 0-15 and 15-30 cm depth, respectively, i.e. non-saline in nature. Exchangeable Ca + Mg content was 14.5 me per 100 g soil at 0-23 cm depth which increased to 16.4 me per 100 g soil at 88 cm depth. The exchangeable aluminum was low (< 1%) and the available soil moisture was high (19 %).

Soil physicochemical characteristics immediately after *tsunami*

The analytical results of the soil samples of above said soil series collected immediately after *tsunami* and six months after *tsunami* has been given in Tables 1, 2 and 3. Under Situation 1, the pH of

Table 1. *Soil pH, EC and ESP of* tsunami *affected agricultural lands of A & N Islands*

Location	Situation	Soil pH (1: 2 soil: water)				EC (dSm^{-1})				ESP			
		(0-15 cm)		(15-30 cm)		(0-15cm)		(15-30cm)		(0-15cm)		(15-30cm)	
		ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2
Lalpad	I	6.5	5.9	6.7	6.1	11.9	4.8	5.4	4.1	27.2	26.5	12.9	19.9
Crikadabad		7.6	6.6	7.6	5.5	13.7	4.0	4.5	5.3	17.4	30.6	3.4	27.6
Mithakari		5.9	6.8	6.1	6.5	16.6	10.4	8.8	7.2	8.7	41.3	4.6	38.2
Guptapara		4.7	5.5	5.6	5.7	3.9	0.4	1.1	1.0	5.1	5.8	1.1	13.3
Lalpad	II	7.0	6.6	6.4	6.5	20.8	12.1	11.7	9.2	24.8	40.3	11.4	29.3
Crikadabad		7.5	6.4	7.5	4.8	20.3	4.2	8.2	5.1	25.3	25.2	7.0	25.3
Mithakari		5.8	6.3	5.6	5.8	23.2	11.2	14.5	10.3	18.7	16.2	13.5	19.4
Guptapara		4.8	5.0	5.1	5.1	12.6	1.2	4.2	1.4	17.3	14.4	6.8	14.7
Crikadabad	III	7.6	5.8	7.6	6.0	13.2	4.1	4.1	4.2	15.4	31.1	3.0	18.7
Mithakari		4.8	6.1	4.0	6.2	14.6	7.7	7.9	5.6	20.6	25.7	9.2	28.2
Guptapara		4.7	5.1	4.7	5.2	11.0	2.2	5.3	2.6	18.6	14.1	7.8	14.5

ST_1: Sampling Time 1 (Soil samples collected immediately after *tsunami*)

ST_2: Sampling Time 2 (Soil samples collected six months after *tsunami*)

Table 2. *Exchangeable cation concentratioin of* tsunami *affected agricultural lands of A & N Islands*

Location	Situation	Exchangeable Na (me/100g of soil)				Exchangeable Ca (me/ 100g of soil)				Exchangeable Mg (me/ 100g of soil)				Exchangeable K (me/ 100g of soil)			
		(0-15 cm)		(15-30 cm)		(0-15cm)		(15-30cm)		(0-15cm)		(15-30cm)		(0-15 cm)		(0-15 cm)	
		ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2
Lalpad	I	14.9	21.5	4.7	16.0	6.9	0.6	6.7	0.9	3.0	1.1	3.1	1.1	0.2	0.8	0.3	0.6
Crikadabad		18.3	21.0	4.0	26.0	12.0	0.4	13.6	0.5	2.4	1.0	1.8	0.9	0.7	1.2	0.3	1.2
Mithakari		25.1	48.8	11.1	38.3	4.1	0.6	5.8	1.5	2.4	1.0	2.4	1.0	1.0	1.8	0.5	1.3
Guptapara		3.8	0.5	2.1	0.5	0.2	0.5	0.1	0.8	0.8	0.8	0.7	0.6	0.1	0.5	0.1	0.5
Lalpad	II	39.9	67.8	12.2	41.5	4.6	0.9	4.7	1.4	2.7	1.0	2.8	1.0	2.5	2.0	0.5	1.3
Crikadabad		30.3	19.8	8.0	23.5	9.5	0.5	11.3	0.5	2.5	1.0	1.9	0.9	1.7	1.2	0.3	1.1
Mithakari		35.0	13.3	18.9	14.8	3.1	1.0	2.3	0.7	2.4	0.8	2.2	0.8	1.9	0.7	0.7	0.7
Guptapara		11.2	0.3	6.1	0.5	0.2	0.5	0.3	0.3	1.3	0.7	0.8	0.6	0.2	0.6	0.5	0.5
Crikadabad	III	12.9	23.0	4.0	15.0	8.0	0.7	10.5	0.7	1.8	1.0	1.3	1.0	0.7	1.3	0.1	0.9
Mithakari		19.6	15.3	7.8	15.0	0.1	0.5	0.2	0.1	2.0	0.8	1.5	0.5	0.7	0.8	0.1	0.6
Guptapara		10.8	0.3	5.9	0.4	0.1	0.4	0.2	0.3	1.3	0.7	1.0	0.5	0.2	0.5	0.1	0.4

Table 3. *Organic carbon and anion concentration of* tsunami *affected agricultural lands of A & N Islands*

Location	Situation	Organic carbon (%)				Carbonate (me/ 100g of soil)				Bicarbonate (me/ 100g of soil)				Chloride (me/ 100g of soil)			
		(0-15 cm)		(15-30 cm)		(0-15cm)		(15-30cm)		(0-15cm)		(15-30cm)		(0-15 cm)		(0-15 cm)	
		ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2	ST_1	ST_2
Lalpad	I	1.8	1.7	1.5	1.4	0.0	0.0	0.0	0.0	2.9	0.3	1.1	1.0	19.4	8.8	7.8	7.4
Crikadabad		1.4	1.6	0.9	1.3	0.6	0.0	0.0	0.0	6.1	0.6	1.8	0.7	19.2	6.8	5.4	9.2
Mithakari		2.1	2.2	1.3	1.7	0.0	0.0	0.0	0.0	0.9	1.5	0.7	1.1	21.4	18.8	11.0	15.2
Guptapara		0.5	0.6	0.3	0.4	0.0	0.0	0.0	0.0	0.7	0.4	0.7	0.3	4.4	0.8	1.2	1.8
Lalpad	II	2.0	2.1	1.7	1.7	0.4	0.0	0.0	0.0	4.0	1.2	1.5	0.6	40.8	24.8	25.0	15.8
Crikadabad		1.8	1.6	0.9	1.3	0.3	0.0	0.0	0.0	3.1	1.0	1.8	0.4	28.0	5.8	10.2	8.4
Mithakari		2.3	1.1	1.1	1.3	0.0	0.0	0.0	0.0	0.7	0.5	0.7	0.5	31.2	6.2	16.6	6.0
Guptapara		0.8	0.7	0.1	0.3	0.0	0.0	0.0	0.0	0.6	0.4	0.6	0.2	15.6	2.0	4.6	2.0
Crikadabad	III	1.1	2.6	0.8	1.3	0.0	0.0	0.0	0.0	1.5	0.9	1.0	0.6	15.4	8.4	5.0	6.0
Mithakari		1.2	0.9	0.7	0.9	0.0	0.0	0.0	0.0	0.8	0.7	0.5	0.6	20.8	5.8	9.0	6.0
Guptapara		1.2	1.0	1.4	1.2	0.0	0.0	0.0	0.0	0.7	0.5	0.5	0.3	14.8	3.2	6.2	3.0

ST_1 & ST_2 : Same as Table 1

surface soil (0-15 cm) varied between 4.7 and 7.6 and EC varied between 3.9 and 16.6 dSm^{-1}, which indicated that there were lot of changes in hydrogen ion concentration and soluble salt content in the same soil series between pre-*tsunami* and post-*tsunami* conditions. The results from surface soil sampling under Situation 1 also revealed that on the basis of SAR and ESP, the same soil series under different locations became saline to saline-sodic except in Guptapara which indicated that the impact of *tsunami* was negligible. But the subsurface soil (15-30 cm) of same soil series in the same location was having lesser amount of soluble salts. These trends clearly showed that where seawater intruded only during *tsunami* and receded completely thereafter could not affect the subsurface soil (15-30 cm).

Under Situations 2 and 3, the results revealed that irrespective of soil series and initial salinity level, the surface soil (0-15 cm) became saline-sodic with EC ranging from 11 to 23.2 dSm^{-1} and ESP ranging from 15.4 to 25.3. The increased level of soluble salt concentration in the subsurface resulted in soil salinity where the EC ranged from 4.1 to 14.5 dSm^{-1}. The reason for the surface soil becoming saline sodic may be attributed to the large volume of sodium and other soluble salts left on the surface soil due to frequent intrusion or permanent stagnation of seawater in the field. In case of subsurface soil, the increased level of salinity may be due to the percolation of soluble salts downward from the surface soil.

Soil physicochemical characteristics six months after *tsunami*

The analytical results revealed that six months after *tsunami*, irrespective of soil series and situations except in Guptapara, there has been appreciable increase in soil ESP and exchangeable Na levels with corresponding decrease in soil exchangeable Ca + Mg levels, especially in the subsurface soils. This turned the subsurface soils from saline to saline sodic soils, while the surface soils remained saline sodic. This was because, after onset of monsoon there had been heavy rainfall measuring 2000 mm up to the sampling period which might resulted in salts leaching down to the lower layers. Hence, both surface and subsurface soils became saline sodic because of increased level of ESP and exchangeable Na though the EC values decreased.

Though enough information on CO_3^{-}, HCO_3^{-} and Cl^{-} were not available for the pre-*tsunami* condition for the said soil series, the analytical results of post-*tsunami* soil samples revealed that there has been appreciable involvement of bicarbonate and chloride anions in surface and subsurface soils. It has also been observed that immediately after *tsunami*, the chloride content of surface soil increased ranging from 4.4 to 40.8 me per 100 g of soil. However, after availing high rainfall the chloride content decreased in the surface soils while the same increased in the subsurface soils.

Rehabilitation strategies

In Andamans, the agricultural lands under Situation 1 can easily be reclaimed considering the factors like higher annual rainfall (3500 mm), which can be effectively used for leaching out the accumulated salts and possibility of relatively better drainage. However, the areas under Situation 2 require construction of raised embankments along with sluice gates, which will regulate the ingress of seawater in these areas. It will restrict the entry of seawater into the field during high tide and will allow the drainage of rainwater from the field during low tide. In case of Situation 3, it has been envisaged that brackish water aquaculture would be an alternative livelihood pattern for the agricultural lands affected by *tsunami*.

Besides these, a set of agronomic management practices as enlisted below can also be followed for effective rehabilitation of salt affected soils.

- Selection and raising of salt tolerant crops like rice, sugarcane, sorghum, watermelon, castor, forage crops like karnal grass (*Diplachne fusca*) and para grass (*Brachiaria mutica*) and green manure crop like *Sesbania eculeata*.
- Selection of suitable crop rotation like rice-watermelon, rice-maize, rice-sorghum, rice-vegetables, rice-sugar beet and rice-forage crops
- Adoption of broad bed and furrow system of land manipulation in the affected areas to cope up with the problem of salinity and for increased profit
- Application of higher dose of farmyard manure and its incorporation in the field to improve the physical condition of the soil as well as the drainage
- Adoption of 25% higher seed rate than the recommended seed rate
- In case of rice, transplanting of aged seedling and increased number of seedlings (4-6) per hill
- Sowing the seeds in the furrows or at 2/3rd height from the top of the ridge

- For wide spaced crops like vegetables, adoption of pit system of planting by replacing the salt affected soil with mixture of normal soil and farmyard manure
- Adoption of frequent light irrigation
- Adoption of drip irrigation or pitcher irrigation for high value crops
- Application of higher dose of NPK than the recommended dose
- In case of rice, application of $ZnSo_4$ @ 25 kg ha^{-1} as basal dose
- Planting of trees/shrubs with higher evapotranspiration requirement, viz. *Eucalyptus sp.* and *Acacia auriculiformis* to act as a bio-pump in waterlogged areas
- Use of auger hole technique for planting tree species in salt affected areas

CONCLUSION

It may be concluded that intrusion of *Tsunami*-induced seawater in the agricultural lands of coastal areas in Andaman and Nicobar Islands has rendered the soils unfit for cultivation as such. Since, the quantum of sodium and other soluble salts left on the soil by *tsunami* waves vary among different situations, different set of reclamation strategies should be employed for rehabilitation of these areas.

REFERENCES

Ganeshmurthy, A.N., Dinesh, R., Ravisankar, N., Nair Anil and Ahlawat, S.P.S. (2002). *Land resources of Andaman and Nicobar Islands*, Central Agricultural Research Institute, Port Blair.

Page, A.L., Miller, R.H. and Keeney, D. R. (eds.) (1982). *Methods of Soil Analysis*, Part **II**, *Chemical and Microbiological Properties*, ASA, SSSA, Madison, Wisconsin, USA.

Somani, L.L. (1991). *Crop Production with Saline Water*, Agro Botanical, Vyas Nagar, India.

USSL Staff (1954). *Diagnosis and Improvement of Saline and Alkali Soils*, USDA Hand Book No. **60**. 147p.

J. Indian Soc. Coastal agric. Res., 24(2), 375-377, 2006

Impact of *Tsunami* on Soil Quality and Reclamation Strategies in the U.T. of Pondicherry

A.BASKAR, U.BAGAVATHI AMMAL, R.SANKAR, G. VEMBU and K.VALLIAMMAL

Department of Soil Science & Agricultural Chemistry
Pandit Jawaharlal Nehru College of Agriculture & Research Institute
Karaikal - 609 603, U.T. Pondicherry

An investigation was carried out in the *tsunami* affected areas of the Union Territory of Pondicherry to characterize the soils for developing site specific reclamation. Accordingly, a total number of 2762 soil samples were collected and analysed for EC, pH and gypsum requirement. The EC of the soils of Pondicherry ranged from 0.37 - 110.38 dS m^{-1} and that of the pH from 7.03 to 10.16. The gypsum requirement was found to be highly varying from 0.0 to 29.58 t ha^{-1}. In case of Karaikal region, the EC was found to range from 0.03 to 202.9 dS m^{-1} and the pH from 5.41 to 9.37. The gypsum requirement was found to vary from 0.0 to 16.51 t ha^{-1}. The results from the whole of U.T. of Pondicherry showed that around 26.21% of the *tsunami* affected soils were saline in nature, 30.59% sodic, 38.38% saline-sodic, while 4.82% were normal.

(***Key words:*** Tsunami *affected soils, Characterization, Reclamation)*

The *tsunami* differs from tidal wave in that the latter has got very low order energy since it originates due to gravitational forces (Ramakrishnan *et al.*, 2005). The recent hit *tsunami* on 26th December, 2004 has resulted in major damage both in terms of lives and properties and as such contaminated the soils by seawater flooding. The U.T. of Pondicherry lies on the east coast which has also been affected by the *tsunami* waves. Hence, an attempt was made to characterise the soils which were affected by *tsunami* and to develop site specific recommendations to restore the productivity of the soils.

MATERIALS AND METHODS

Immediately after the *tsunami* a preliminary survey was conducted to assess the actual impact under field conditions. It was seen that there were major differences in the impact of *tsunami* on agricultural lands due to the differences in soil texture, period of inundation, depth of standing water, distance from the sea, and the slope of the lands. Hence, it was decided to collect field to field soil samples to arrive at site specific recommendations. Accordingly, soil samples were collected from both Pondicherry and Karaikal regions (total 2762). The collected soil samples were air dried, sieved through 2mm sieve and analysed for EC, pH (Jackson,1973) and gypsum requirement (Schoonover, 1952). For determining the ECe (Electrical conductivity of the saturation paste extract) regression equations developed between ECe (USDA, 1954) and EC 2.5.

RESULTS AND DISCUSSION

The results of the analyses in the affected areas of the U.T. of Pondicherry had revealed that there were wide variations in the EC, pH and gypsum requirement. It was seen that in Pondicherry, the minimum ECe recorded was 0.37 dS m^{-1}, the maximum was 110.38 dS m^{-1}, the pH ranged from 7.03 to 10.16, and the gypsum requirement from nil to 29.58 t ha^{-1}. In Karaikal region the range was 0.03 to 202.9 dS m^{-1}, 5.41 to 9.37 and 0 to 16.51 t ha^{-1}, respectively for ECe, pH and gypsum requirement.

The detailed field to field soil analyses are presented in Table 1. It was seen that the EC of soils affected in Pondicherry region ranged from 0.37 to 110.38 dS m^{-1} and that of pH from 7.03 to 10.16. The gypsum requirement ranged from nil to 29.58 t ha^{-1}. In case of the Karaikal region, the EC was minimum (0.03 dS m^{-1}) in the Pattinacherry village and maximum (202.90 dS m^{-1}) in Poovam village. As regards pH it ranged from 5.41 to 9.37, and that of the gypsum requirement, from nil to 16.5 t ha^{-1}.

Based on the results, the soils were characterized as saline, sodic and saline-sodic. The results thus obtained are presented in Table 2, which revealed that in Pondicherry region 16.54 % of the samples were saline, 28.68% sodic, 43.01% saline-sodic and 11.76% normal. On the whole in the U.T. of Pondicherry, 724 fields (26.21%) were saline, 845 (30.59%) were sodic, 1060 (38.38%) were saline-sodic and 133 (4.82%) were normal (total 2762 fields).

Table 1. *Data on soil analyses in the* tsunami *affected areas of U.T. of Pondicherry*

Village	ECe (dS m^{-1})		pH		Gypsum requirement (t ha^{-1})	
	Min	Max	Min	Max	Min	Max
Pondicherry	0.37	110.38	7.03	10.16	0	29.58
Poovam	1.20	202.9	5.87	8.34	0	11.7
Pattinacherry	0.03	42.62	6.24	9.37	0	8.94
Keezhakasakudi	0.60	37.57	6.17	9.07	0	7.57
Kottucherry	0.92	81.63	5.84	8.94	0	16.5
Thiruvettakudy	0.73	145.73	5.41	9.17	0	16.51
Thalatheru	0.34	13.01	6.17	9.21	0	10.3
Neravy	0.98	69.70	6.75	8.84	0	8.26
Koil Pathu	0.60	3.16	6.41	8.80	0	1.38
Pattinum(N)	0.80	43.64	6.28	8.99	0	11.01
Pattinum(S)	0.07	155.19	6.28	8.99	0	8.94
Pattinum(M)	0.29	17.92	6.83	8.82	0	6.19
Vanjore(F)	0.65	178.51	5.83	8.65	0	5.50
Vanjore(T)	0.15	94.94	6.35	8.57	0	4.82

Table 2. *Classification of soils in* tsunami *affected areas in the U.T. of Pondicherry*

Village	Total samples	Saline		Sodic		Saline-sodic		Normal	
		No.	%	No.	%	No.	%	No.	%
Pondicherry	272	45	16.54	78	28.68	117	43.01	32	11.76
Poovam	94	27	28.7	55	58.5	12	12.8	-	-
Pattinacherry	151	30	19.9	63	41.7	56	37.1	1	0.6
Keezhakasakudi	113	56	49.5	24	21.2	32	28.3	1	0.1
Kottucherry	455	87	19.1	130	28.6	221	48.6	17	3.7
Thiruvettakudy	516	200	38.8	73	14.1	231	44.8	12	2.3
Thalatheru	242	7	2.9	185	76.4	31	12.8	19	7.9
Neravy	174	74	42.5	15	8.6	84	48.3	1	0.6
Koil Pathu	16	-	-	5	31.3	-	-	11	68.8
Pattinum(N)	211	34	16.1	102	48.34	71	33.6	3	1.4
Pattinum(S)	228	56	24.6	78	34.2	86	37.72	8	3.5
Pattinum(M)	115	19	16.5	14	12.17	59	51.30	23	20.0
Vanjore(F)	107	79	73.8	13	12.15	15	14.0	1	1.0
Vanjore(T)	68	9	13.2	10	14.7	45	66.18	4	5.9
Total	2762	724	26.21	845	30.59	1060	38.38	133	4.82

The results were communicated to the farmers along with the reclamation strategies specific for their fields. The strategies included either leaching with good quality water in case of saline soils or application of required quantities of gypsum combined with leaching in case of sodic and saline-sodic soils, respectively. The farmers were advised to dig trenches in their fields with due consideration to slope in their fields and raise *bund* upto about 15 to 30 cm. The farmers were also advised to puddle the field using good quality water. The standing water was allowed to seep through the soil profile, get collected in the trenches, and finally safely disposed off through drainage channel wherever possible. In case of sodic and saline-sodic soils, it was advised to apply the required quantities of gypsum and then puddle the field using power tillers. The leaching was continued as in the case of saline soil and the leachate was advised to be disposed off. In places where drainage facility was not present the farmers were advised to puddle the field, allow the standing water for 1-2 days, and then flush out the standing water through safe drainage disposal system.

Following additional features of damages caused due to *Tsunami* were also observed.

- The fields which were flooded with seawater but drained within hours
- The fields which were flooded with seawater but did not drain over periods resulting in infiltration of seawater into the soil profile
- Fields which were eroded at the top due to the impact of sea waves
- Fields which were deposited with coarser sand particles brought from the sand dunes on the coast lines
- Fields which were deposited with the marine sediments comprising of finer particles, namely silt and clay
- Fields which were deposited with sewage sludge especially near the river mouths

Extent and nature of damage due to *tsunami* were different depending on the above features observed in individual fields, and reclamation measures suggested accordingly.

ACKNOWLEDGEMENT

The authors express their sense gratitude to the Department of Agriculture, Government of Pondicherry for providing financial assistance in terms of a Research project for a period of three years.

REFERENCES

Jackson, M.L. (1973). *Soil Chemical Analysis*, Prentice Hall of India (Pvt.) Limited, New Delhi.

Ramakrishnan, D., Ganesh, S.K., Raja, V.K.M., Vinuchandran, R. and Jayaram, A. (2005). Trails of the killer *Tsunami*: a preliminary assessment using satellite remote sensing technique. *Current Science* **88**: 709-711.

Schoonover, W.R. (1952). *Examination of Soils for Alkali*, Extension Service, University of California, Berkelay, California.

USDA (1954). *Diagnosis and Improvement of Saline and Alkali Soils*, Agricultural Hand Book.**60**, United States Department of Agriculture, Oxford & IBH publishing Co, New Delhi.

J. Indian Soc. Coastal agric. Res., 24(2), 378-380, 2006

Tsunami Effect on Coastal Soil and Water

V. PETHAPERUMAL, C. SOUCIKALA and V. N. VARMA

Agriculture Department, Pondicherry - 605 009

During the last *tsunami* attack, heavy loss on human life, agricultural crops, soil and groundwater resource degradation and the ecological changes had occurred. In the soil, hyperacidity and salinity were developed and in the groundwater, the seawater intrusion took place. Larger acidic and free CO_2 and acid P contents observed might be due to the biogenic and hydrogenous organics and phosphorite mineral ion dissolution in the sea sediments which were the causative factors. The relative increase in Cl, SO_4 ionic constituents contributed to salinity. In the groundwater, some abrupt water levels rise and high salinity values were noted due to seawater intrusion. The agricultural crop damages were also heavy. The loss of human life and dwelling places were reported and hence the planning for ecological security against such disaster was needed. After a gap of 9 months the acidity decreased to normalcy but the soil and ground water salinity still persisted due to low potential monsoonic showers in these coastal areas.

(Key words: Tsunami, *Effect on soil & water)*

The world had observed the largest *tsunami* havoc in December, 2004. Over 1.5 lakh of estimated loss of life was occurred. The sea wavelengths were larger enough for advancing the water currents into the South Indian coastal areas. The pressurized sea water waves had possessed hyperacidity and salinity and higher energy flow to exhibit the bruitality on the coastal life.

The paper discusses the effects of *tsunami* on soil and water properties in Pondicherry and Tamil Nadu.

MATERIALS AND METHODS

Soil samples (104 nos.) were collected from the affected areas and analysed for pH, electrical conductivity, texture, available macronutrients and

Table 1. Tsunami *affected coastal soils (Jan. 2005)*

Village	EC (dS/m)		N kg/ac		P kg/ac		K kg/ac	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Panititoo	0.8	1.1	71	135	40	175	16	30
11samples	<1	1 to 3	Low	Medium	High	Very High	Low	Medium
	6	5	9	2	Nil	11	11	Nil
Ariyankup	Min:0.9	Max:10.8	Min:42	Max:132	Min:3.5	Max:80	Min:12	Max:180
69 samples	<1:(7), 1-3:(16), >3:(46)		Low:67	Med: 2	Low:4, Med:10, High:55		Low:50, Med:13, High:6	
Kalapeth	Min:0.12	Max:6.7	Min:52	Max:130	Min:7.9	Max:55	Min:14	Max:32
12 samples	<1 :(6) 1-3:(2), >3 : (4)	Low:11	Med:1	Med:1	High:11	Low:12	Med:Nil	
Thengatito	Min:1.4	Max:12.8	Min:66	Max:117	Min:1.25	Max:64	Min:35	Max:159
12 samples	1to3: (3)	>3: (9)	Low:12	Nil	Low:1; Med:2; High:9		Low:3; Med:6; High 3	

Table 2a. *Water soluble extracts of* tsunami *affected soil samples*

No.of samples	P kg/Ac	S ppm	Cl ppm
104	3 to 25	5 to 30	50 to 800

Table 2b. *Post-*tsunami *soil samples analyses*

No.	pH	E.C in dSm^{-1}	Soluble P kg/Ac
100	5 to 8.5	to 4	2 to 10

water soluble nutrients for P, Cl, SO_4. Twenty-five water samples were collected in Pondicherry and Tamilnadu areas where *tsunami* took place and they were analysed for pH and EC values.

RESULTS AND DISCUSSION

The results are presented Tables 1, 2(a,b), 3 & 4.

Effect of tsunami

The transported solute by *tsunami* action which may possess turbulent flow had affected the soil much. The solutes contained the suspended and dissolved solids. They were likely to be originated from the continental slope. Abrupt changes in the analytical values were noted, particularly very low pH, higher exchangeable P, low N and K values and also high salinity. Water soluble nutrient values, like Cl, SO_4, P were also relatively higher than the normal values. The suspended and colloidal solids might have been the causative factor for the exchangeable reactions and these solids probably infiltrated and remained at the top layer sediments itself to abstain from affecting the ground water quality. The water soluble salts had contacted the ground water layers by seawater intrusion and thus the salinity was developed.

The development of hyperacidity might have been due to the acidic CO_2 and higher acidic P. The oxidation zones of the organic matter laid on the continental slope and ocean floor. The seabed contained larger phosphorite hydrogenous sediments and nodules containing C and P especially in the continental slope. The driving force for the major Carbon release from the ocean sediments was the degradation of organic matter and the dissolution of $CaCO_3$. The route cause of the acidity initiation may not be fully ascertained with the present data.

*Post-*tsunami *effect*

After 9 months the change of the total soil acidity to normal pH was due to the hot summar heatwave to emit CO_2 by degassing and also this helped to decline P values. The soil and ground water salinity was still persisting and the farmers were expecting the north-east monsoon arrival to leach down the soil soluble salts. Immediately after

Table 3. *Water quality (EC umhos/cm) in Villupuram district during* tsunami *attack*

Location	Well depth (m)	Water Quality A. date	EC	B. date	EC	Dist. from coast (km)	Water level (m)
Marakanam Block							
K.Panikupam	50	7/04	310	30.12.04	250	0.2	2.9 to 3.30
Alapakkam	50	7/04	3050	"	1210	1	2.4 to 2.9
Ekyrkuppam	30	7/04	1010	"	1140	1	1.45to1.60
Nadukupam	56	7/04	670	"	1690	3	28.8 to 29.27
Kandadu	50	7/03	390	"	240	1.8	11.55 to12.3
Kilputupet	50	7/03	1240	"	1630	1	4.4 to 4.57
Vanur block							
T.chitrambalam	150	7/04	1050	"	1300	2.5	45.3 to 47.57
Kozuveri	100	7/04	600	"	1800	2	21.0 to 23.5
Nesal	150	7/04	640	"	1900	1.8	31.1 to 37.75
Kottakarai	150	7/04	280	"	580	1.2	4.68 to 5.33
EC							

Note: Well nos.2,4,6,7,8,9 and 10 were affected by *tsunami*

Table 4. *Water quality of cuddlore* Tsunami *affected areas*

Location	EC(μmhos/cm) 1/05	Distance	EC(μmhos/cm) 1/99	pH (1/05)
G.Upalavdi*	7280	2 km	4000	
Panchkupam	930	2 km	300	
Ayyampet*	1990	0.5 km	2440	
Parangipetai*	3000	2 km	1070	
Killai	170	1.5 km	1050	
Pinnathur	3800	3 km	2940	
Cuddalore*	3650	2 km	1100	
Periyakumati	1800	3 km		
Parangipetai*	5200	2 km	2450	
No.1 to 5: Open Wells and No.6 to 9: Tubewells of Cuddalore Sandstone aquifer)				
Pondicherry coast				
Panititoo estuary water*	4900	0.5	1800	7.1
Vambpet HP	1100		900	7.2
Utchimedu TW*	5900	1	1000	7.5
Nalavadu HP*	2200	1	600	7
Kalapeth HP 60'	900	0.2	300	6.2
Puthupet HP 45'	400	1.5	380	5.6
Puthupet BW 110'	400	1.2	390	5.9
Kazuveli TW 550'	300	2.5	300	7.4
Kalapeth BW 110'	500	1.5	490	7
P.Mudaliarchavady HP 65'*	2100	0.3	1000	5.8
Auroville	300	2	290	5.9
Bommayapalam BW 90'*	2300	0.4	600	6.5
C.Mudaliarchavady BW 70'	800	1	300	6.9
Thengaithittu HP 50'*	2800	0.5	900	6.8

Nos.15 to 18 & 20 lie in Uplands; All lie in the coastal belt of Pondicherry region

* Affected by *tsunami*

tsunami, the estuary load due to backwater was heavy and the ground waters in these pockets were still saline. Since Pondicherry coastal system was partially covered with the sand dunes, elevated beaches, estuaries, uplands and good drainage system, it showed minor threats. But on the contrary, the Karaikal coastal region was devoid of such geomorphological structures and hence the severity of the *tsunami* attack was more.

A well planned strategy for future protection against *tsunami* is suggested.

J. Indian Soc. Coastal agric. Res., 24(2), 381-385, 2006

Impact of *Tsunami* on the Coastal Vegetation of Boat Island, South Andaman

A. VENKATESH, C.B. PANDEY, N. KALA, N. RAVISANKAR, R.P. MEDHI and R.B. RAI

Central Agricultural Research Institute, Port Blair - 744 101, A&N Islands

A preliminary and rapid survey was made to asses the impact of *tsunami* on the coastal forest vegetation in Boat Island. The seawater intruded up to 120-180 m landward during *tsunami* and receded permanently. The damage to the vegetation particularly to the seedlings of koraiya and the poles jungli latov was more nearer to the coast. The mature trees were not affected. The soil pH increased closer to the coast i.e. at 0-20 m (8.8) distance and declined with distance to lowest to (6.7) at 160-180 m distance. Electrical conductivity also increased to 4.716 dSm^{-1} at 0-20 m and 0.347 dSm^{-1} at 160-180 m distance.

(***Key words:*** *Impact of* tsunami, *Coastal vegetation, Change in soil properties)*

Andaman and Nicobar Islands extend over 8,249 km^2 in the Bay of Bengal (Dutta *et al.*, 1985). These group of Islands are endowed with forest cover of about 86%. Out of this recorded forest area (7,171 sq. km), about 40% are under reserve forest and 60% under protected forest. The littoral beach forest occupies an area of 83.02 sq km and mangroves about 739.51 sq km.

The *tsunami* resulted due to an earthquake on the sea floor of the Indian Ocean (3.29°N, 95.77°E) at 6.20 A.M. IST, with a magnitude *M* 9.3 on 26th December 2004. This caused major disturbance to the coastal ecosystem of Andaman and Nicobar Islands besides decease of many human lives and buildings. The study on the effect of *tsunami* on the coastal vegetation was scanty. Keeping these in view, a preliminary and rapid survey was made to asses the impact of *tsunami* on the coastal forest vegetation and soil properties in Boat Island. This would give first hand information on ecological management and restoration of coastal belt.

MATERIALS AND METHODS

Boat Island is a part of Mahatma Gandhi Marine National Park in South Andaman, which was established initially in the year 1983. The survey was carried out in two sites (I) 11°32'24.2" N & 92° 33'26.1"E facing NW direction and (II) 11°31'35.1" N & 92° 33'21.4" E facing SW direction.

Six quadrates (20x20 m) were laid at site I at 20 m interval up to 120 m. Similarly, nine quadrates were laid at site II up to 180 m (distance upto which the seawater intruded). This happened because after this limit uplands (hilly) start. In each quadrate the total number of live and dead trees, poles, shrubs and seedlings were counted. Phytosociological study of the trees, i.e. frequency, density and important value index (IVI) were computed following Misra (1968). Importance value index was calculated by summing up relative frequency and relative density. Soil samples were collected from each quadrate at 5 places in 3 different depths, viz. 0-10 cm, 10-20 cm and 20-30 cm. The soils were air dried, sieved through a 2mm mesh. pH was determined in 1:2.5 soil to water suspension. Electrical conductivity was determined in the supernatant of 1:5 soil-water mixtures.

RESULTS AND DISCUSSION

It was observed that the seawater intruded up to 120-180m towards landside during *tsunami* and receded permanently. An elaborative list of species composition and its response to the *tsunami* with respect to the distance from the shore is given in Table 1. About 29 species were noticed in the littoral forests of Boat Island, of which were 24 trees, 4 climbers and one palm. The number of species increased while moving towards landside and the damage to the vegetation particularly seedlings of koraiya and the poles of jungli latov was more nearer to the coast, but the mature trees were not affected. This resulted in complete vanish of under storey vegetation in Boat Island. It also observed that the roots of sea mohwa were exposed due to seawater corrosion and subsequently it would fall down following frequent usurpation of seawater near the coast.

In site I, the density of *Sterculia rubiginosa* in sapling stage (887.5 ha^{-1}) was more followed by kadi lotov (125 ha^{-1}), *Manilkara littoralis* (66.7 ha^{-1}) and *Dipterocarpus* spp. (41.7 ha^{-1}). The higher frequency was observered for kadi lotov (83%), followed by

Table 1. *Species composition and its status after* tsunami *in Boat Island, South Andaman*

Botanical name	Common name	Habit	Status (nos.)			
			Site I		Site II	
			Live	Dead	Live	Dead
0-20m from seashore						
Manilkara littoralis	Sea mohwa	big tree	14	0	-	-
Pandanus tectorius	Pandanus	Palm	-	-	0	1
	Kadi latov	pole	1	39	-	-
	Cheli	tree	0	1	-	-
20-40m from seashore						
Ficus callosa	Bargath	tree	1	0	-	-
Hibiscus teliaceus	Kappas	tree	-	-	1	0
Lannea grandis	Nabbe	tree	1	0	-	-
Manilkara littoralis	Sea mohwa	big tree	2	0	-	-
Myristica irya	Jungli jaiphal	tree	2	0	-	-
Pandanus tectorius	Pandanus	plam	-	-	98	0
Syzygium claviflorum	Jungli jamun	pole	3	0	-	-
	Kadi latov	pole	1	56	-	-
	Cheli	tree	1	0	-	-
40-60m from seashore						
Alstonia spp.	Sathian	small tree	-	-	8	0
Bombax insigne	Jungli didu	pole	1	0	-	-
Guettarda speciosa	Sea coast teak	tree	-	-	1	0
Lannea grandis	Nabbe	pole	2	0	-	-
Manilkara littoralis	Sea mohwa	big tree	-	-	2	0
Myristica irya	Jungli jaiphal	tree	1	0		
Pandanus tectorius	Pandanus	palm	-	-	38	0
Pterocymbium tinctorium	Papitha	tree	2	0	-	-
Syzygium claviflorum	Jungli jamun	tree	2	0	-	-
	Kadi latov	pole	0	83	-	-
	Jungli kapok	tree	0	1	-	-
60-80m from seashore						
Alstonia spp.	Sathian	small tree	-	-	6	0
Celtis phillippensis	Jungli despathi	tree	2	0	-	-
Lannea grandis	Nabbe	tree	2	0	-	-
Manilkara littoralis	Sea mohwa	big tree	-	-	7	0
Myristica irya	Jungli jaiphal	tree	1	0	-	-
Pandanus tectorius	Pandanus	Palm	-	-	13	0
Plancheonella longipetiolatum	Lamba pathi	tree	1	0	-	-
Pterocymbium tinctorium	Papitha	tree	2	0	-	-
Tabenaemontana crispa	Koraiya	seedling	-	-	0	21
	Kadi latov	pole	5	18		

Contd.

Botanical name	Common name	Habit	Status (nos.)			
			Site I		Site II	
			Live	Dead	Live	Dead
80-100m from seashore						
Caryota mitis	Madi pathi	big tree	1	0	-	-
Daemonoops kurzianus	Sanga beth	climber	3	0	-	-
Diospyros crumenaata	Kala kendu	big tree	1	0	-	-
Manilkara littoralis	Sea mohwa	big tree	-	-	5	0
Parishia insignis	Red dhup	big tree	2	0	-	-
Plancheonella longipetiolatum	Lamba pathi	big tree	1	0	-	-
Saccharum elliptica	Chooi	small tree	1	0	-	-
Tabenaemontana crispa	Koraiya	shrub	-	-	62	0
Sterculia rubiginosa	Lal chilka	sapling	110	0	-	-
	Kadi latov	small tree	16	0	-	-
	Pathi beth	climber	2	0	-	-
100-120m from seashore						
Bombax insigne	Jungli didu	big tree	1	0	-	-
Calamus palustris	Malai beth	climber	1	0	-	-
Celtis phillippensis	Jungli despathi	big tree	1	0	-	-
Dipterocaspus spp.	Gurjan (Chota pathi)	big tree	10		-	-
Manilkara littoralis	Sea mohwa	big tree	-	-	4	0
Myristica irya	Jungli jaiphal	big tree	2	0	-	-
Sterculia rubiginosa	Lal chilka	sapling	103	0	-	-
Tabenaemontana crispa	Koraiya	shrub	-	-	100	0
	Daman	big tree	1	0	-	-
	Cheli	tree	1	0	-	-
	Pathi beth	climber	3	0	-	-
	Kadi latov	seedling	7	0	-	-
	Sabeth bael	climber	0	1	-	-
	Jungli beth	climber	1	0	-	-
120-140m from seashore						
Alstonia spp.	Sathian	small tree	-	-	6	0
Manilkara littoralis	Sea mohwa	big tree	-	-	2	0
Tabenaemontana crispa	Koraiya	seedling	-	-	88	5
	Kadi latov	small tree	-	-	6	0
140-160m from seashore						
Alstonia spp.	Sathian	small tree	-	-	4	0
Daemonoops kurzianus	Sanga beth	climber	-	-	9	0
Manilkara littoralis	Sea mohwa	big tree	-	-	5	0
Parishia insignis	Red dhup	small tree	-	-	1	0
Syzygium claviflorum	Jungli jamun	tree	-	-	10	0
Tabenaemontana crispa	Koraiya	seedling	-	-	88	0
	Daman	tree	-	-	4	0
	Kadi latov	small tree	-	-	2	0
160-180m from seashore						
Blachia andamanica	Hakshi	tree	-	-	2	0
Daemonoops kurzianus	Sanga beth	climber	-	-	8	0
Ficus lispida	Gullar	big tree	-	-	1	0
Pterocymbium tinctorium	Papitha	big tree	-	-	2	0
Syzygium claviflorum	Jungli jamun	tree	-	-	2	0
Tabenaemontana crispa	Koraiya	seedling	-	-	62	0
	Daman	small tree	-	-	2	0
	Kadi latov	small tree	-	-	3	0

Myristica irya (66%) and *Lannea grandis* (50%). The IVI shows more for kadi lotov (22.1) followed by *Myristica irya* (11.9) and *Manilkara littoralis* (10.1).

Different trend was observed in site II due to locational factors. The density was more for *Tabenaemontana crispa* seedlings (1111.1), followed by *Pandanus tectorius* (416.7), *Alstonia* spp. and *Daemonoops kurzianus* (41.6). *Manilkara littoralis* most frequently occurred (66%) which was followed by *Tabenaemontana crispa* and *Alstonia* spp.(55%). The frequency of *Pandanus tectorius* (44%) stood in the third place. Regarding the IVI, it was higher for *Tabenaemontana crispa* (75.5), followed by *Pandanus tectorius, Manilkara littoralis* and *Alstonia* spp. (34.5, 21.0 and 18.3, respectively) (Table 2).

The soil texture study revealed that the percent of sand was more (62.3-97.66 %) followed by silt (2.2-30.2%), clay (0.5-7.5%) and gravel (0-5.0%). The soil pH increased tremendously in places nearer to the coast, i.e. 0-20 m (8.8) and it gradually decreased to 6.7 in 160-180m. This evidenced that even after *tsunami* the seawater hit the coastal area during full moon and new moon day. The electrical conductivity also increased from 4.71 dSm^{-1} to 0-20m and 0.34 dSm^{-1} in the far end, i.e. 160-180 m (Table 3).

CONCLUSION

In order to safeguard the human life and protect the agricultural fields form natural disasters, viz. *tsunami* it is essential to rebuild the damaged biowall

Table 2. *Distribution pattern of species*

Sl. no.	Species name	Site I			Site II		
		Density (nos./ha)	Frequency (%)	IVI	Density (nos./ha)	Frequency (%)	IVI
1	*Alstonia spp.*	-	-	-	72.2	55	18.3
2	*Blachia andamanica*	-	-	-	5.5	11	3.2
3	*Bombax insigne*	8.3	33	5.7	-	-	-
4	*Calamus palustris*	4.2	16	2.7	-	-	-
5	*Caryota mitis*	4.2	16	2.7	-	-	-
6	*Celtis phillippensis*	12.5	33	6	-	-	-
7	Cheli	8.3	33	8.7	-	-	-
8	*Daemonoops kurzianus*	12.5	16	3.3	41.6	22	8
9	Daman	4.2	16	2.7	16.6	22	6.6
10	*Diospyros crumenaata*	4.2	16	2.7	-	-	-
11	*Dipterocaspus spp.*	41.7	16	5.5	-	-	-
12	*Ficus callosa*	4.2	16	2.7	-	-	-
13	*Ficus lispida*	-	-	-	2.8	11	3
14	*Guettarda speciosa*	-	-	-	2.8	11	3
15	*Hibiscus teliaceus*	-	-	-	2.7	11	3
16	Jungli beth	4.2	16	2.7	-	-	-
17	Kadi lotov	125	83	22.1	30.5	33	10.2
18	*Lannea grandis*	20.8	50	9.2	-	-	-
19	*Manilkara littoralis*	66.7	33	10.1	69.4	66	21
20	*Myristica irya*	25	66	11.9	-	-	-
21	*Pandanus tectorius*	-	-	-	416.7	44	34.4
22	*Parishia insignis*	8.3	16	3	2.8	11	3
23	Pathi beth	20.8	33	6.6	-	-	-
24	*Plancheonella longipetiolatum*	8.3	33	5.7	-	-	-
25	*Pterocymbium tinctorium*	16.6	33	6.3	5.5	11	3.2
26	*Saccharum elliptica*	4.2	16	2.7	-	-	-
27	*Sterculia rubiginosa*	887.5	33	5.7	-	-	-
28	*Syzygium claviflorum*	20.8	33	6.6	33.3	22	7.5
29	*Tabenaemontana crispa*	-	-	-	1111.1	55	75.5
	Total			200			200

Table 3. *Changes in soil pH and ECe after* tsunami *in the coastal area*

Distance from the seashore (m)	Soil depth (cm)						Mean	
	0-10		10-20		20-30			
	pH	ECe (dSm^{-1})	pH	ECe (dSm^{-1})	pH	ECe (dSm^{-1})	pH	ECe (dSm^{-1})
0-20	8.7	4.68	8.8	5.19	8.9	4.28	8.8	4.716
20-40	8.4	7.61	9.1	5.49	8.6	5.24	8.7	6.113
40-60	8.5	6.03	7.8	5.9	7.5	5.51	7.9	5.81
60-80	7.9	8.73	7.6	4.13	7.4	3.21	7.6	5.327
80-100	7.7	6.67	7.6	1.867	7.5	1.388	7.6	3.308
100-120	6.8	1.24	7.3	0.296	7.8	0.213	7.3	0.583
120-140	7.1	0.419	7.2	0.353	7.5	0.251	7.2	0.341
140-160	6.9	0.437	6.7	0.248	6.5	0.415	6.7	0.426
160-180	6.9	0.282	6.6	0.297	6.6	0.462	6.7	0.347

or create a new one. If the site is suitable for mangroves, it can be encouraged for the same. If the site is not suitable, bioshield can be developed through planting of the following tree species *Pandanus tectorius*, *Pandanus andanensium Manilkara littoralis*, *Hibiscus teliaceus*, *Lannea grandis*, *Morinda citrifolia*, *Syzygium claviflorum*, *Guettarda speciosa*, *Pongamia pinnata*, *Calophyllum inophyllum*, *Casuarina equisetifolia*, *Jatropha curcus*, *Gliricidia sepium*, *Bombax insigne*, *Myristica irya*, *Pterocymbium tinctorium*, *Bombax insigne*, *Blachia andamanica*, etc. The planting should be made in mixed cropping pattern. In the residential area of the coastal belt *jatropha* and *gliricidia* can be included for biofencing.

REFERENCES

Dutta, R., Tushar, R.S., Abbas Ahmed, R. and Rao, M.K.V. (1985). Plant used by Andaman arborigines in gathering rock bee honey. *Economic Botany* **39**: 130-138.

Misra, R. (1968). *Ecology Workbook*, Oxford and IBH Publishing Company, Calcutta.

J. Indian Soc. Coastal agric. Res., 24(2), 386-390, 2006

Has *Tsunami* Affected the Quality of Seawater and Backwaters? - Case Studies in and around Chennai, Tamil Nadu

M. MURALIDHAR, B. P GUPTA, R. SARASWATHY, ABEY VARAMPATH ABRAHAM and A. NAGAVEL

Central Institute of Brackishwater Aquaculture
75, Santhome High Road, R.A Puram, Chennai – 600 028, Tamil Nadu

The coastal districts on the eastern coast of India, particularly Nagapattinam, Cuddalore and Chennai were worst affected due to *tsunami* during December 2004. Many hatchery facilities in these regions were severely affected with damages to pump houses, fencing, etc. especially in Kovalam, Marakanam and Pondicherry belt. In anticipation that *tsunami* tidal waves might have brought some changes in the elemental composition of seawater, samples were collected from different places in and around Chennai (Kanchipuram District - Muttukadu sea and backwater, Mamallapuram, Mudaliarpet boat house; Thiruvallur District - Pulicat backwater and seawater; Cuddalore District – Thalanguda; Villipuram District – Marakkanam; Pondicherry - Kurshikuppam) along the east coast immediately after *tsunami* and were analysed for chemical parameters, major ionic composition and heavy metal concentration. The cationic values in these water samples were slightly lower than the values of normal seawater. Marakkanam in Tamil Nadu and Kurshikuppam in Pondicherry recorded higher concentrations of arsenic. The values of some metals were above the Criteria Continuous Concentration (CCC) values as per EPA. While comparing the values of heavy metals at seashore of Muttukadu during September 2002, February 2003 and after *tsunami* during December 2004 and January 2005, no significant variation was noticed.

(Key words: Tsunami, *Seawater, Backwater, Heavy metals)*

The *tsunami* caused extensive damage in southern regions of India and Andaman & Nicobar Islands affecting a total of 2,260 km of coastline. The waves were reported to be as high as 3-10 m in southern India and penetrated in the range of 300 m to 3 km inland. The coastal districts on the eastern coast of India, particularly Nagapattinam, Cuddalore and Chennai were worst affected. The fisheries sector in Tamil Nadu, Andhra Pradesh and Andaman & Nicobar Islands has suffered major damages in terms of lives, boats, gear and the infrastructure such as harbours and fish landing centers. According to NACA/FAO/SEAFDEC/BOBP-IGO report (Anon., 2004) many hatchery facilities in Kovalam, Marakanam and Pondicherry belt were severely affected with damages to pump houses, fencing, etc. Aquafarms to an extent of 5753 ha were damaged in Tamil Nadu. Shrimp farms at Cuddalore, Chidambaram, Sirkali, Tharangampadi, Vedaranyam, Nagapattinam and Velankanni were severely affected with collapsed *bunds* and damage to the equipment including motors and pumps.

The increasing impairment of coastal water quality resulting from the discharge of domestic, agricultural and industrial wastes in coastal waters has affected the aquaculture profitability in certain areas (Federico Paez-Osuna *et al.*, 1998). The four estuaries in Northern Oregon, USA have buried peat and sand lenses, evidence of seismic disturbances and post-seismic *tsunamis*. At least six great earthquakes were documented in the last 3,000 years, originating in the Cascadia subduction zone (Darienzo *et al.*, 1994).

The *tsunami* flood can be expected to initiate a series of damage events, including fire and toxic/hazardous release (Preuss and Hebenstreit, 1990). The zone of vulnerability and secondary hazards should be identified for a complete risk management plan. Because the San Francisco Bay region is in a seismically active area, the ponds were inundated as a result of seismically induced seiche or *tsunami*, causing a large discharge of contaminants into the Napa River. The resulting discharge would most likely result in substantial impairment of water quality in the form of a large and rapid increase in the concentrations of salinity, suspended sediment and other contaminants. Hazard evaluation and predictive toxicology play a useful and important role for protection of aquatic environment from pollutants such as heavy metals and pesticides (Draggen, 1978 and Hamelink, 1980). The negative changes in the environment and biodiversity of source water bodies if any due to *tsunami* may affect the shrimp farming. In this direction, monitoring the quality of seawater and backwaters is receiving adequate attention in India.

MATERIALS AND METHODS

In anticipation that *tsunami* tidal waves might have brought some changes in the elemental composition of seawater which may lead to alteration in biodiversity of flora and fauna, composite water samples were collected during 4 – 9 January 2005 from about 5 - 10 m off the shoreline and at 0.5 m depth in triplicate from different places in and around Chennai (Kanchipuram District - Muttukadu sea and backwater, Mamallapuram, Mudaliarpet boat house; Thiruvallur District - Pulicat backwater and seawater; Cuddalore District – Thalanguda; Villipuram District – Marakkanam; Pondicherry - Kurshikuppam) on the east coast. The water samples for heavy metals analysis were preserved by acidifying with nitric acid (Fig. 1).

In the experimental station of Central Institute of Brackishwater aquaculture (CIBA) at Muttukadu, a clean and empty 20,000 litre capacity cistern kept for drying got filled up by *tsunami* tidal waves on 26 December 2004. This water was considered as a representative sample of '*tsunami* water'. The collected water samples were analysed in the Environmental laboratory of CIBA for chemical parameters and major ionic concentrations, viz. pH, salinity, nitrite-nitrogen (NO_2-N), total ammonia - nitrogen (TAN), sodium (Na^+), potassium (K^+), calcium (Ca^{2+}) and magnesium (Mg^{2+}) using the standard methods (APHA, 1989). Most of the parameters were analysed using spectrophotometer, flame photometer.

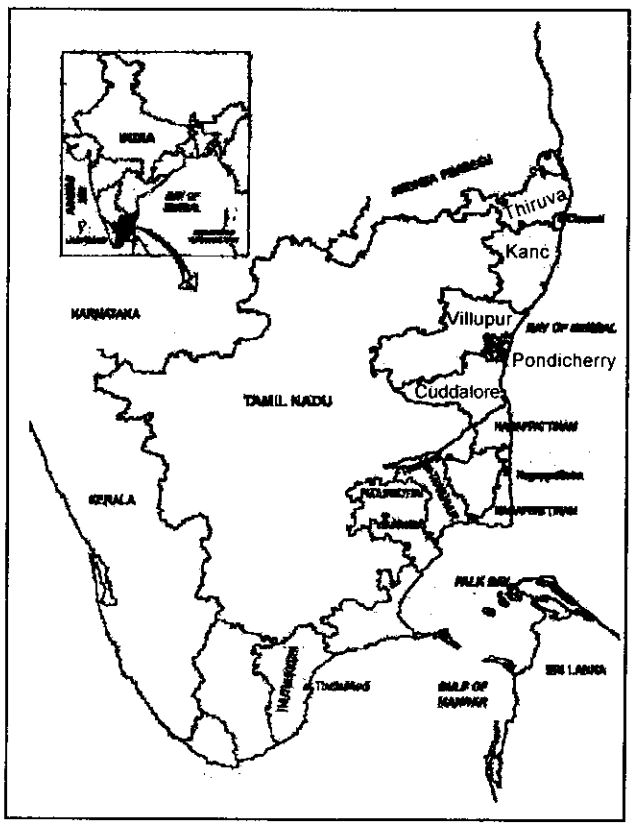


Fig. 1. Study area map

Water samples were also analysed for heavy metals, viz. lead (Pb), chromium (Cr), zinc (Zn), cadmium (Cd), mercury (Hg) and arsenic (As). The determination of heavy metals, such as cadmium, lead, chromium and zinc was carried out by extracting water with APDC/MIBK according to the method described by APHA (1989) using heated graphite atomiser on Atomic Absorption Spectrometer. Mercury was analysed by cold vapour generation followed by flameless atomic absorption technique using electro thermal atomizer. Arsenic as total was measured by electro thermal atomic absorption spectrometry with graphite furnace.

RESULTS AND DISCUSSION

Specialised analysis of recent satellite imagery of a *tsunami* ravaged section of Porto Nova, India, near Sri Lanka has revealed a devastating impact on local water quality. Contaminated sediment impacted a large number of inland water bodies in the area and was evident more than two kilometers offshore in the Indian Ocean. The influence of tsunami on the average chemical composition and concentration of major ions, heavy metals in seawater and backwaters are presented in Tables 1 and 2.

Chemical composition

The pH and salinity of seawater and backwater ranged from 7.23 to 8.18 and 30 to 35 ppt and 6.75 to 7.32 and 26 to 32 ppt, respectively (Table 1). The pH values in the present backwater samples were slightly lower than the normal reported values (Joseph *et al.*, 2002). The seven ions mainly Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, SO_4^{2-} and HCO_3^- contribute to the saline nature of water. TAN and nitrite- N values in the study area varied from 0.072 to 0.180 ppm and 0.001 to 0.076 ppm, respectively. The cationic values of Na, K, Ca and Mg in the water samples of these worst affected areas of Tamil Nadu were slightly lower than in the normal seawater. However in all the samples magnesium concentration was higher than the calcium and Ca/Mg ratio (0.270-0.305) was more or less same as that of normal seawater (0.296). High and low sodium concentrations of 10600 and 8200 ppm were observed in seawater at Mamallapuram and backwaters at Mudaliarpet. The normal level of

Table 1. *Salinity, pH and ionic concentration (ppm) of water samples collected from* tsunami *affected places in and around Chennai*

District	Collection site	pH	Salinity (ppt)	NO_2-N (ppm)	TAN (ppm)	Na (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)
Kanchipuram	*Tsunami* water (Muttukadu)	8.18	33	0.074	0.116	10500	350	320	1176
	Muttukad seawater	7.98	32	0.076	0.118	10500	360	332	1194
	Muttukadu backwater	6.94	30	0.003	0.109	9000	350	280	1008
	Mamallapuram seawater	7.10	35	0.009	0.082	10600	340	376	1334
	Mudaliarpet boat house (backwater)	6.75	26	0.008	0.072	8200	280	264	946
Thiruvallur	Pulicat (backwater)	7.32	32	0.007	0.083	10000	350	320	1104
	Pulicat (seawater)	7.39	32	0.001	0.076	9200	370	328	1075
Cuddalore	Thalanguda (seawater)	7.33	31	0.017	0.180	10200	370	320	1080
Villipuram	Marakkanam (seawater)	7.23	31	0.005	0.079	10000	360	320	1080
Pondicherry	Kurshikuppam (seawater)	7.31	30	0.006	0.102	10400	290	304	1065

Table 2. *Concentration (ppb) of heavy metals in water samples collected from* tsunami *affected places in and around Chennai*

District	Collection point	Pb	Cr	Zn	Cd	Hg	As
Kanchipuram	*Tsunami* water (Muttukadu)	1.00	5.12	13.12	1.45	0.11	BDL
	Muttukad seawater	1.00	5.25	13.25	1.50	0.11	BDL
	Muttukadu backwater	BDL	8.25	5.35	6.65	15.33	BDL
	Mamallapuram seawater	4.00	22.25	15.18	11.90	10.68	BDL
	Mudaliarpet boat house (backwater)	3.5	5.50	3.15	3.38	6.56	BDL
Thiruvallur	Pulicat (backwater)	BDL	8.50	2.18	10.45	6.15	BDL
	Pulicat (seawater)	5.75	7.75	2.90	11.03	6.54	BDL
Cuddalore	Thalanguda (seawater)	BDL	8.25	12.70	BDL	1.63	21.75
Villipuram	Marakkanam (seawater)	BDL	8.75	12.30	BDL	2.28	38.25
Pondicherry	Kurshikuppam (seawater)	BDL	8.00	12.90	BDL	2.01	47.75
Criteria Maximum Concentration CMC)		210	1100	90	42	1.8	69
Criteria Continuous Concentration (CCC)		8.1	50	81	9.3	NA	36

BDL – Below detectable level

NA – Not available

cations in seawater of 35 ppt are 10500, 380, 400 and 1350 ppm for Na, K, Ca and Mg, respectively. The *'tsunami water'* appeared to be more or less similar to normal seawater though the values of Na, K, Ca and Mg were slightly in lower range in case of the former.

Heavy metal concentration

In Kanchipuram and Thiruvallur Districts slightly higher value of cadmium in the range 10.45-11.90 ppb was observed. Criteria Continuous Concentration (CCC- Highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time) and Criteria Maximum Concentration (CMC - Highest concentration of a pollutant to which aquatic life can be exposed for a short period) are used to assess the safe concentration of heavy metals. Except for the Muttukadu seawater sample, the observed values for mercury were higher than the normal value and previously recorded value of 0.3 ppb (Qasim and Sengupta, 1981) in most of the districts. The CMC value for mercury was 1.8 ppb but it is interesting to note that the concentration of mercury ranged from 6.50 to15.33 ppb, 6.15 to 6.54 ppb, 2.28 ppb and 2.01 ppb in the coastal areas of Kanchipuram, Thiruvallur, Villupuram and Pondicherry respectively. Though below the CCC value, a rise in concentration of cadmium when compared to previously recorded values (Qasim and Sengupta, 1981) was observed in samples from Mammallapuram, Muttukadu and Pulicat. The value for arsenic was high in Villupuram (38.2 ppb) and Pondicherry (47.75 ppb) whereas at other places it

Table 3. *Heavy metal concentration (ppb) in Muttukadu seawater before and after* tsunami

Period of collection	Pb	Cr	Zn	Cd	Hg	As
Dec, 1999	NA	BDL	16	0.17	BDL	BDL
Sep, 2000	NA	NA	19.5	0.17	0.1	NA
Feb, 2003	BDL	NA	7.0	BDL	BDL	NA
Dec, 2004*	1.00	5.12	13.12	1.45	0.11	BDL
Jan, 2005	1.00	5.25	13.25	1.5	0.11	BDL
Desired safe level	NA	1.00	100	2	0.01	0.2

*- *Tsunami* water

NA - Not available

BDL - Below detectable level

was in below detectable level. Areas where higher values were recorded for heavy metals were probably due to anthropogenic inputs in those places rather than impact of *tsunami*.

The values of Pb, Cr, Zn, Cd, Hg and As were lower in the '*tsunami* water' than those found in most of the places mentioned elsewhere. The values of these heavy metals were very low when compared with the CCC and CMC values of US Environmental Protection Agency. The safe levels of zinc, cadmium, mercury and chromium are 100, 2, 0.01 and 1.0 mg l^{-1}, respectively (MPEDA, 1991).

Comparison of heavy metal concentration in Muttukadu seawater before and after *tsunami*

The values of heavy metals in seawater at Muttukadu before and after *tsunami* were compared since 1999 (Table 3). No significant difference was noticed in the concentration of heavy metals in post-tsunami seawater except in cadmium (1.5 ppb) which was 8 times more. However this value of cadmium was much below the prescribed value for CCC (9.3 ppb).

The mean values of zinc and mercury in seawater at Muttukadu during 1999 (Muralidhar *et al.*, 2003) were below the Environmental Protection Agency's (EPA) safe limits (MPEDA, 1991) and WHO's standards (Qasim and Sengupta, 1981). Perhaps, this could be due to alkaline nature of waters with high concentration of bicarbonates and total hardness. Calcium and magnesium could reduce the toxicity of metals because of their competition for sites with cationic speciation form of heavy metals (Rai *et al.*, 1981).

From the results of the investigations it can be broadly concluded that the *tsunami* of December 26, 2004 has not brought about any significant changes in the quality of the coastal waters in general.

ACKNOWLEDGEMENTS

Dr. M. Natarajan, Dr. Amba Sankar and Dr. M. Kumaran who have helped in the collection of samples are thankfully acknowledged.

REFERENCES

American Public Health Association (1989). *Standard Methods for the Examination of Water and Waste Water*, 17th Edn, American Public Health Association, Washington, D.C.

Anon. (2004). ftp://ftp.fao.org/FI/DOCUMENT/tsunamis_05/jan_07_2005 NACA/FAO/SEAFDEC/BOBP-IGO. Report *Update on the Situation of the Tsunami Affected Areas.*

Darienzo Mark, E., Peterson Curt and Clough Charles (1994). Stratigraphic evidence for great subduction-zone earthquakes at four estuaries in Northern Oregon, USA. *Journal of Coastal Research* **10**(4): 850-876.

Draggen, S. (1978). TSCA: The US attempt to control toxic chemicals in the environment. *Ambio* **7**: 260.

Federico Paez-Osuna, Saul, R., Guerrero-Galvan and Ruiz-Fernandez Ana, C. (1998). The environmental effect impact of shrimp aquaculture and the coastal pollution in Mexico. *Marine Pollution Bulletin* **36**(1): 65-75.

Hamelink, J. (1980). Bio-availability of chemicals in aquatic environments in biotransformation and fate of chemicals in the environment. *American Society of Microbiology*, A.W. Maki, K.L. Dickson & J. Cairns Jr.(eds.), Washington, D.C. 56p.

Joseph, K.O., Muralidhar, M.,.Gupta, B.P. and Krishnani, K.K. (2002). Characterisation of intake, pond and outlet water of creek and seawater based shrimp farms in Nellore district of Andhra Pradesh. *Aquaculture* **3**(1): 51-59.

MPEDA (1991). Aquaculture. *Drops for Farmers* **IV** (11&12): 2.

Muralidhar, M., Gupta, B.P., Krishnani, K.K. and Nagavel, A. (2003). Heavy metal and pesticide levels in shrimp culture areas of Nellore (Andhra Pradesh) and Tuticorin (Tamil Nadu). *Aquaculture* **4**(2): 153-159.

Preuss, Dr.J. and Hebenstreit, G.T. (1990). *Integrated Hazard Assessment for a Coastal Community, Grays Harbor, Washington*, Urban Regional Research, Seattle, Washington, USA. 36p.

Qasim, S.Z. and Sengupta, R. (1981). *Water Pollution and Management Reviews*, C.K Varshney (ed.), South Asian Publishers Pvt. Ltd Delhi. 139p.

Rai, L.O., Gaur, J.P. and Kumar, H.D. (1981). Phycology and heavy metal pollution. *Biological Review* **56**: 99-151.

J. Indian Soc. Coastal agric. Res., 24(2), 391-392, 2006

Impact of *Tsunami* on the Ground Water Quality in Pondicherry Region

A. BASKAR, U. BAGAVATHI AMMAL, R. SANKAR, L. ARUNA, D. JAYANTHI, M. BALACHANDER and K. COUMARAVEL

Department of Soil Science & Agricultural Chemistry
Pandit Jawaharlal Nehru College of Agriculture & Research Institute
Karaikal - 609 603, U.T. of Pondicherry

To investigate the impact of *tsunami* on the ground waters of Pondicherry, a study has been conducted after the incident in Pondicherry. The analytical results of 203 water samples collected before *tsunami* were compared with the samples analysed after the incident for studying its impact on ground waters of Pondicherry. The results had shown that there were no marked variations in the pH, EC or on their ionic composition between pre-*tsunami* and post-*tsunami* samples. Similarly the quality indices like soluble sodium percentage (SSP), residual sodium carbonate (RSC), sodium adsorption ratio (SAR), potential salinity (PS), Puri's salt index (PSI), and permeability index (PI) did not show marked variations between the two stages.

(Key words: Tsunami, *Ground water quality)*

The impact of *tsunami* on the soil quality has been found to be in terms of loss of productivity in the agricultural lands. It was also opined by a group of people including the farmers that the *tsunami* had also deteriorated the ground water quality by underground seawater intrusion. In Pondicherry region the main source of irrigation is ground water which was found to be intruded with seawater. To delineate the areas which were prone to seawater intrusion, a research project was sponsored by the Government of Pondicherry and it has been in operation at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal from June 2003 to till date. To investigate the impact of *tsunami* on ground water quality, a study has been conducted after the *tsunami* in the Pondicherry region which is presented in this paper.

MATERIALS AND METHODS

Water samples in 203 borewells distributed in 101 villages of Pondicherry region were sampled at bimonthly intervals starting from June 2003 to October, 2004 and analysed for the various ionic compositions. The determinations of ions were done by adopting the methods following Tandon (1993) for SO_4 using turbidimetry and rest as per methods described by USSL Staff (1954) (Table 1).

Table 1. *EC, pH and ionic composition {cmol(p±) L^{-1}} before and after* tsunami *(average of 203 wells taken at bimonthly intervals)*

Characters	Before *tsunami*			After *tsunami*		
	Min	Max	Mean	Min	Max	Mean
pH	6.26	8.24	7.54	6.21	8.56	7.29
EC (dS m^{-1})	0.28	6.62	1.36	0.26	7.90	1.33
Ca^{2+}	1.70	27.60	4.47	1.00	13.60	4.35
Mg^{2+}	0.33	23.27	2.71	0.00	23.00	3.20
Na^{+}	0.96	25.22	6.74	0.09	38.35	6.95
K^{+}	0.008	1.167	0.091	0.021	2.064	0.157
CO_3^{-}	0.00	2.30	0.99	0.00	3.40	1.12
HCO_3^{-}	1.03	9.30	5.78	1.20	10.20	5.90
Cl^{-}	1.77	57.30	6.15	1.60	64.20	6.08
SO_4^{-}	0.03	14.65	1.86	0.00	13.88	1.40

Table 2. *Quality indices before and after* tsunami *(average of 203 wells taken at bimonthly intervals)*

Characters	Before *tsunami*			After *tsunami*		
	Min	Max	Mean	Min	Max	Mean
Puri's Salt Index (PSI)	-30.60	2.91	-17.45	-27.77	4.95	-16.47
Potential Salinity (PS)	0.35	54.78	5.22	1.69	69.11	6.78
Permeability Index (PI)	31.94	129.71	92.95	32.75	135.30	89.64
SSP	11.78	78.20	45.95	1.58	88.36	44.54
RSC	-44.30	5.37	-0.41	-30.00	7.10	-0.54
SAR	0.52	13.38	3.60	0.05	17.60	3.61
Cl ratio	0.25	10.47	0.99	0.27	9.73	0.94

The quality indices of irrigation water were also computed from the ionic composition as per RSC (Eatson, 1935), SAR and SSP (USSL Staff, 1954), $Cl^-/CO_3 + HCO_3^-$ (Todd, February, 2005) as per the following references (Table 2). A fresh sampling was done in the same 203 wells during Feb, 2005 (after *tsunami*) and analysed for their ionic compositions.

RESULTS AND DISCUSSION

The results of the water sample analyses for their ionic compositions before and after *tsunami* is given in Table 1. The results have clearly revealed that there were only marginal influences in EC, pH and ionic compositions.

As regards quality indices of irrigation water before and after *tsunami* (Table 2), though there were wide variations between the minimum and maximum values, the mean values suggest only marginal differences due to *tsunami*. The above trend of results had suggested that the *tsunami* had very little impact on the ground water quality in the region. The Cl^- to $CO_3^{--} + HCO_3^-$ ratio which was taken as an index of seawater intrusion was also found to decline marginally from 0.99 to 0.94.

ACKNOWLEDGEMENT

The authors wish to express their gratefulness to PAJANCOA (Karaikal) Society for providing the financial assistance for the conduct of the above study.

REFERENCES

Doneen, L.D. (1963). *Water Quality for Irrigation*, Agricultural Department, University of California, Davis. 48p.

Eaton, F.M. (1935). *Boron in Soils and Irrigation Waters and its Effect on Plants with Particular Reference to the San Joaquin Valley of California*, USDA Technical Bulletin **448**.

Tandon, H.L.S. (1993). In *Methods of Analysis of Soils, Plants, Waters and Fertilizers*, pp. 83-110, Utilization Development Consultant Organisation, New Delhi.

Todd, D.K. (1995). *Ground Water Hydrology*, John Willey and Sons. 516p.

USSL Staff (1954). *Diagnosis and Improvement of Saline and Alkali Soils*, USDA Hand Book **60**. 147p.