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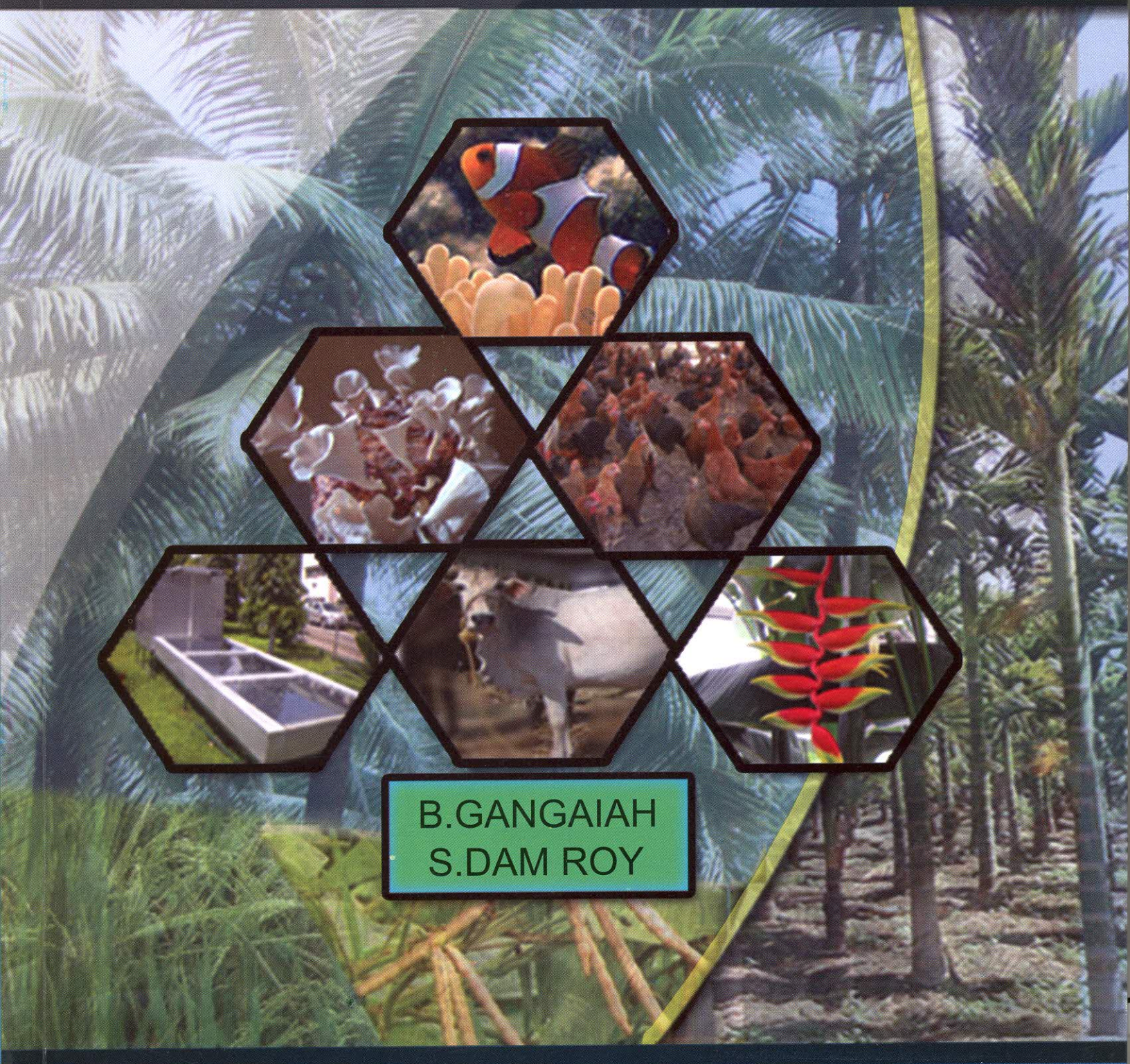

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Agricultural Technologies for Rural Prosperity of Islands Farmers

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Rural development in India requires priority because more than 65% of the population are still living in villages and over 85% of the rural people are dependent on agriculture for their livelihood. More than 75% being small and marginal holders, most of their earnings are utilised to ensure food security. With the growing population and over-exploitation of natural resources, the pressure on food security and employment generation will continue to mount, further affecting the quality of rural life. Hence, it is necessary to develop a suitable strategy to improve the economy of the rural sector through agricultural development and sustainable use of natural resources. To achieve rural prosperity, the development strategy should focus on improved agricultural production while generating gainful self-employment for small farmers and weaker sections of the society. Agriculture is the main source of rural employment, but being deprived of irrigation facilities, a majority of the small and marginal farmers are heavily under-employed for 6-8 months in a year. Therefore, the policy makers and agriculture experts have been urging for the second Green Revolution to accelerate growth in the agriculture sector.

Green revolution that started in mid 1960s was successful in ensuring quantitative food security in India. Today, our food supply is well secure. Meeting the growing needs is within reach. Therefore, the second Green Revolution should aim at promoting sustainable livelihood, enabling the poor to come out of poverty by generating gainful self-employment for Providing Urban Amenities in Rural Area (PURA) leading to rural prosperity.

Andaman and Nicobar Islands have great significance to the country both strategically as well as environmentally. Lately, it has also emerged as promising tourist destination. Further, the Islands have a fragile ecosystem with tropical rain forests which forbids any horizontal expansion of cultivated area. After Supreme Court ordered closure of all wood based industries in 2003, there is virtually no industry. Therefore, the Island economy has to be developed on two pillars of tourism and agriculture. Thus the real challenge to the future Island agriculture is to meet the requirement of local population and tourists at a reasonable cost. The cause of this challenge is rooted in high transport cost of perishable items *viz.* vegetables, fruits, flowers, meat, milk and milk products etc. from mainland, which if not produced by local production and hence is detrimental to the growth of the tourism.

The contribution of primary sector (crops, livestock, fisheries, forest logging) to Island GDP was 9.2% and the rest comes from service (mainly) tourism and industry sectors (2013-14). The share of primary sector (excluding forest logging) has fallen sharply to the present level from a peak of 55.83% during 1980-83. Perceptible shift in the farmers' mindset as well as timely delivery of appropriate technology at affordable cost are the trigger points for heralding the needed change in this sector which still employs more than 21% of Island's population directly and indirectly. The challenges of farming arise from shrinking farm size and increasing food demands.

Shrinking agricultural land holding

The land distribution system was 2 ha each of paddy and hilly land and 0.4 ha of homestead land to each settler during the settlement, however with time, this holding has been fragmented. Island agriculture is rainfed, carried out on small holdings thereby putting limitations on large scale investments. Agriculture farm families in the Islands is approximately 14,000, wherein small and marginal farmers have 57% of the land holdings and own only 25% of the total area, while 43% of the land holdings owned by medium and big farmers have 75% of the area. The average size of the agriculture landholding in the Islands is only 1.89 ha which is declining rapidly; if this trend continues in the same pace the average size of holding will be reduced to threshold level by 2030.

The livelihood opportunities in the Island are limited to tourism and agricultural sectors. With tourism being Port Blair centric, agriculture & allied sectors are only options for livelihood for people located in far flung Islands. With the limited land availability only vertical expansion is possible to facilitate increase in yield per unit area to meet the food demand of the increasing population. Though the total rainfall received in the Island is predicted to be normal but variations may cause water shortage particularly during dry season. In addition, the Island will be confronted with the changing climatic pattern and extreme events. The cropping intensity should be increased to 300% through

multistoried cropping system involving fruits, vegetables, tuber crops, flowers and medicinal plants as components in order to get maximum output per unit area.

Growing food demand

The local human population in these Islands is about 3.80 lakhs (Census 2011) with a growth rate of about 6.68% in the last decade and is projected to reach 5.30 lakhs by 2051 (Population Foundation of India, 2007). The requirements of growing population in terms of drinking water, various agricultural commodities including animal products and green fodder need to be met through Island-specific technological innovations. The demand of cereal, tuber crops and milk needs to be increased to more than 200%. The area under paddy is 8005 ha with production of 24 368 tonnes (2013-14) against the requirement of 33210 tonnes accounting for 26.6% deficit. The demand of the meat, milk and other byproducts of livestock and poultry need to be doubled to meet the requirement of the fast growing population and tourism. Therefore, to meet the challenge of growing food demand crop intensification/ diversification with vegetable, spice and fruit crops are considered to be the better options of farm income (Vision 2050, ICAR-CIARI, Port Blair).

Technological application leading to rural prosperity

Integrated Farming System (IFS) for Sustainable productivity of Island eco system

Agricultural transformations have to occur at the level of small holding farmers so that these complex - farming systems can be made more productive and efficient in the use of resources. Even in these islands there is an alarming increase in population and the production of various commodities are falling short of demand. The land area, specially cropped area cannot be substantially increased. Multiple land use through integration of crops, livestock and aquaculture can give the best and optimum production from unit land area. The concept of faming system, which brings together all these components to make it wholesome system, is a paramount importance as it ensures for optimum land use, maximum return, soil conservation, build up of soil fertility, better use of production resources, recycling of wastes freedom from pollution, providing year round employment for farming family, risk management, reduction at the cost of production and supply of essential commodities throughout the year. Agro-ecosystem analysis of the farming systems in these islands revealed four distinct micro farming situations (MFS) in the farmers' field .They are MFS I: Hilly, MFS II : Slopping hilly upland, MFS III : Medium upland valley, MFS IV : Low lying valley. Farmers are getting additional income of Rs. 30,000 to Rs. 50,000 from 0.20 ha/ year depending upon the technology and Rs. 2.55 lakhs /ha /annum (Ravisankar *et al.,* 2007; Srivastava *et al.,* 2009).

Broad Bed and Furrow (BBF) system

Since vegetables are fetching higher price during monsoon season, BBF system was developed for growing vegetables in the bed and paddy + fish in furrows giving better option for farmers to realize higher income from unit land area (Ravisankar *et al.*, 2003, 2009; Srivastava *et al.,* 2008). In BBF system, among the cropping system, *okra*-amaranthus-*okra* (with brinjal+moringa+banana in border areas) recorded maximum net return of Rs. 1,06,134 from 0.4 ha area of beds formed in one ha, and Rs. 10,840 was obtained from furrows growing rice + azolla +fish. Thus, from one ha of BBF, Rs.1,17, 532 /ha was obtained, which is 11 times higher than the normal paddy-pulse/fallow cropping.

Homestead based Integrated farming system for tribal's

A small scale Homestead based IFS model, comprising Home garden (400m^2), backyard poultry (25 no's), goatery (3 no's) and composting has been developed in participatory mode for tribal's at Car Nicobar. The model aims at improving nutritional security of the tribal household besides improving the farm production and employment generation. In the home gardens 100 m^2 area is used for growing seasonal vegetables *viz.,* okra, brinjal, tomato, green amaranthus, cucumber, bitter gourd, bottle gourd and sweet corn. In another 125 m^2 area fruit crops like banana, pine apple and papaya was grown. Tuber crops *viz.*, tapioca, sweet potato, greater yam and colacasia were grown in an area of 150 m^2. Besides, fruit trees of *Pandanus* sp. and *Morinda citrifolia* and guava were grown in corners of the field. *Sesbania grandiflora* (agathi) and *Gliricidia sepium* were grown as border trees to act a bio fence besides serving as green fodder and green leaf manure. Compost tanks were made at a corner of the homestead garden for composting crop residues and farm wastes. Above the compost tank, pandal was made with local materials and perennial crops like *Coccinia* were grown. The manure obtained from goat and poultry along with crop residues were used for making vermicompost. After the intervention, the frequency of consumption of food items *viz.,* greens, vegetables, fruits, meat, poultry, egg by the farm family increased (Swarnam *et al.,* 2014).

Seed village concept for production of truthfully labelled seed (TLS) of rice

Rice is the principal cereal crop of Andaman and Nicobar Islands has low productivity (3.04 t/ha in 2013-14) that was ascribed mainly to non availability of quality seed of high yielding varieties. It is well established fact that use of quality seeds of improved varieties in lieu of self saved local varieties seed) results in 40 - 60% improvement in

crop productivities, of this, quality seed alone makes 15-20% contribution.

An innovative technology was introduced to provide truthfully labelled seeds (TLS) in participatory mode from 2011 to 2014 involving breeders, farmers and social scientists. As a result of seed village production programme, a total of 20.3 tonnes of seeds (7 HYV of paddy CSR 23, CARI Dhan 3, CARI Dhan 4, CARI Dhan 5, CSR 36, Gayatri and Ranjit) were produced from 7.9 ha by 33 farmers. Seeds produced were purchased through buy back arrangement amongst the farmers & NGOs.

Satellite fish nursery for production of fresh water IMC seeds

Satellite Fish Nursery Technique was introduced for the first time in 2012 at Diglipur under the technical guidance of Division of Fisheries in association with Department of Fisheries, A&N Administration, KVK and ORC, with an objective to raise nursery of fresh water fishes of exotic carps and made available in time to the fishers. In a span of six months a farmer could earn Rs. 2,70, 000 by adopting the technology at North Andaman and presently eight farmers have taken the technology into practice for livelihood and many more youth have come forward to adopt the technology. Department of Fisheries is promoting the concept across the Island.

Pekin duck under backyard

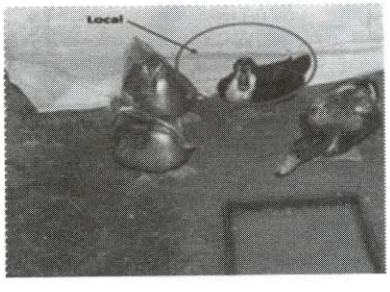
Pekin duck, a demand driven technology for small farmers was introduced in the year 2011, by ORC with three (3) ducklings to a single farmer. Over the time it could spread to 63 farmers with 3-5 ducklings in the backyard totalling to 388 numbers, spread over 15 villages by 2014. The farmer could earn Rs.16/- by selling eggs, Rs 400-450/- from adults and Rs 50-55/- for ducklings when compared to desi duck for Rs. 200, 10 and 5 -7, respectively. The duck would grow to average weight of 2.64 kg with low level of mortality, when compared to desi i.e. 1.98 kg of weight with high mortality rate. Pekin duck under backyard with a unit size of 03 birds could give a net return of Rs. 4,350 against the desi birds (Rs.1,140) thus giving an additional income of Rs. 3,210. A total of 881 eggs of pekin duck were spread to fifteen cluster of villages by a single farmer, which is a remarkable beginning of a credible technology given by Division of Animal Science of the Institute.

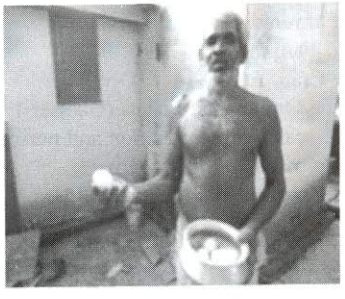
Composite Fish Culture for Fresh Water Fishers -A Market Led Technology

The study revealed that Composite fish culture with CRM could give an additional return of Rs. 19,450.00 followed by Broad Bed and Furrow system (BBF) (Rs.17,250), HYV of rice of CARI (Rs. 9,400), Improved Nicobari fowl (Rs. 7,100) and Pekin duck (Rs. 3,210). Farmers acceptance of the technology graded in scale from 1 to 5 (low to high), with four parameters i.e., technological backup, input provider, Governance and marketing , indicated Composite fish culture with CRM to be highly accepted while other technologies *viz.* BBF, HYV of rice, Nicobari fowl and Pekin ducks were at medium level. A cross sectional analysis of the preferred technology i.e. Composite Fish culture revealed to be supported with better governance and input provider mechanism (fish seeds & other logistic) by A & N Administration which has up scaled to 11.51 lakh in 2013 from 4.5 lakh in 2000, to around 1500 pisciculturist. Beside, government schemes of providing financial assistance for renovation of fish ponds, construction of nursery ponds, purchase of breeding material for fish seed production and purchase of fish harvesting net has given a good governance support to the technology. On the other hand total fresh water fish sold (188 ton) in the island @ Rs. 70/kg fetches an economy of Rs. 131,60,000 of which Catla, Rohu & Mrigal (the target fishes) contributed 86.66 t (47%) i.e. Rs.60,66,200/year to the island exchequer. Finally we conclude that, Composite Fish Culture technology was found to be encapsulated with all the four major ingredients i.e. technology back up , input provider, good governance and the market which is needed for its acceptance, adoption, horizontal spread and thus making it a market led technology for the Islanders. Horizontal spread of the technology to many cluster of villages in South, Middle and North and also has led to off shoot development, like farmers have started production of fish seeds and earning not less than Rs.1.5 to 2 lakh in a span of 4-5 months as an additional income. The quality of life has improved and also the purchasing power of the farmer, thus getting social recognition in the society.

Convergence of technologies as Micro Business Module

National Sample Survey envisages that about 40% of





the farmers are ready to leave agriculture if an alternate livelihood option is available. Similarly 60% of practicing farmers are above 50 years, which means that the youth are not viewing farming as an occupation. The situation in the islands is even more peculiar wherein the first generations of settlers who were either freedom fighters/convicts or displaced persons from Bangladesh/Burma/Sri Lanka took up farming as it was the only source of livelihood. However with globalization and information explosion, the aspiration level of today's youth has risen. This young population does not find quality of employment available in traditional agriculture compatible to their aspirations to lure them towards farming. Thus our agricultural production system has to be reoriented by appropriate intervention for reducing drudgery, value addition, increased productivity and improved profits to match his aspiration.

To retain farm youth in agriculture, an innovative approach of translating fourteen technologies in agricultural and allied fields as Micro Business Modules (MBM) for providing decent livelihood options to the youths of the Island has been developed in association with NABARD. The details of the technology are available on our website http://icar-ciari.res.in. (Srivastava and Ahmed, 2008).

The investment requirement for different enterprise varies as per the area / unit size suiting stakeholders' budget and risk taking capacity. The details of the technological options, area required, minimum investment and net return after the gestation period befitting to different socio-economic situation is given in the Table 2 (Dam Roy and Ahmed, 2013).

Transfer of technology (ToT) activities

The research findings generated at the Institute's farm are being translated into practice through well organized Transfer of Technology (TOT) programmes of the Institute. TOT programmes have to be taken up as a group approach rather than an individual farm family approach. For the successful implementation of the village development programmes, all the research sections of CIARI have been linked with the State Development Departments like Agriculture, Animal Husbandry and Veterinary Services, Fisheries, Rural Development, Health services, Social Welfare Advisory Board and Nationalized Banks and the NGO's for bringing about all round development and also to reach the unreached in the far-flanged islands of these territory. This has ensured in facilitating a holistic approach within research – extension – farmers – marketing. The programmes through different Institute and externally funded projects like DBT, FPARP, NAIP, IFS etc has made significant and visible impact at farmers holdings adopting IFS & BBFS.They act as a role model in their respective District. We are mentioning below our ambassadors of the technological interventions through whom the dissemination was accomplished and getting replicated by the peer groups

Table 2. Technological Options, area required, investment and net return

Technological Options	Area / Land needed (Unit)	Minimum Investment		*Net Return	
		Duration (in Months)	Amount (In Rs.)	Duration (Month onwards)	Amount (In Rs.)
Integrated Farming System (IFS)	2000 m^2	16	1,40,000	40	1,53,565
Broad Bed and Furrow (BBF) System	2000 m^2	12	40,500	24	31,825
Raised bed technology	1153m^2	12	18,981	12	33,179
Oyster Mushroom cultivation	46 m^2	12	59,000	12	21,000
Black pepper cultivation on hedgerows with *Gliricidia* standards	10,000 m^2	12	36,200	60	2,90,600
Floriculture (crossandra, marigold and tube rose)	10,000 m^2	12	64,500	12	98,000
Protected cultivation of High value vegetables	75 m^2	12	11,500	12	58,,500
Goat Farming	4500 m^2	25	2,70,200	32	2,37,340
Pig Farming	600 m^2	16	2,35,350	28	1,49,820
Quail Farming	1000 m^2	12	2,55,000	12	99,625
Mud Crab Culture	1,000 m^2	6	2,600	6	2,080
Marine Ornamental Fishes (Damsels)	2000m^2	12	1,34,000	12	1,06,000
Small scale seed production and nursery raising of Indian major carps	2000m^2	12	2,57,000	24	1,63,000
Vermicompost Production	Unit capacity 10 t/ ha.	12	28,000	12	62,000

* Net return is after deducting the fixed cost

(Zamir Ahmed *et al.*, 2015).

Farmers Participatory Action Research Programme (FPARP)

Farmers Participatory Action Research Programme (FPARP) was initiated to demonstrate four technologies namely tank-well (T-W), micro-irrigation (MI), pond based integrated farming (IFS) and broad bed and furrow (BBF) systems to promote water management in agriculture. Altogether 48 demonstrations in the farmers' field were made in South Andaman, Little Andaman, Havelock and Neil Islands. Out of 48 demonstrations, 10 demonstrations of T-W system, 12 of MI system, 14 of IFS and 12 of BBF were made.

In general, farmers have received well all the technologies. They were quite satisfied with the broad bed and furrow system technology for the waterlogged conditions in which they were neither cultivating any crop nor used it for any other purpose earlier. Most of the BBF farmers have shown interest on vegetable cultivation on the beds and only fish culture in the furrows. Since vegetables are costlier in the Islands during monsoon season, all the farmers are adopting vegetables on the beds. The commonly grown vegetables are okra, brinjal, chillies, bitter gourd, amaranthus, radish, pumpkin. The net returns from vegetable cultivation in beds ranged from Rs. 67,091 to as high as Rs. 89,000/ha in 11 months depending on the management of crop. All the farmers released fingerlings in their furrows. Cultivation of rice in furrows was adopted by limited farmers due to high cost involved in transplanting and harvesting of rice in furrows. Few farmers have adopted innovative utilization of furrow area by planting creeper type vegetables on beds and climbing it on bamboo supported structure over furrow areas. The average B:C ratio was estimated around 2.5. Seeing the success hundred farmers were adopted in the succeeding year, of which twenty five each represented IFS and BBF.

BBFS with crop diversification to grow vegetables, fish was taken under Rashtriya Krishi Vikas Yojna (RKVY) with 100 acres of land identified for demonstration by A & N Administration. The places like Chouldari, Mamyo, Tusnabad, Calicut, Makkapahar, Temple mayo, Collinpur and Hutbay were selected for demonstration of technology in participatory mode.

Management of Degraded Coastal Land and Water for Enhancing Livelihood through Land shaping

Under NAIP, systematic, need based integrated approach was followed in which land improvement activities comprising of six different methods viz. broad bed and furrow, rice-fish, three tier farming, farm pond, paired bed and furrow and pond-nursery systems was made as a means of reclaiming these areas and bring them under cultivation. Nearly 200 acres of degraded land spread over several villages have been brought under intensive cultivation of rice, vegetables, plantation crops and fish culture.

After the intervention, during rainy season salts and toxic substances from the raised beds have been slowly removed resulting in favourable soil conditions for crop growth. With in a year nearly 831m^3/0.2 ha, 1200 m^3/0.2 ha, 1080 m^3/0.2 ha and 8000 m^3/0.09 ha of fresh water was harvested for multiple uses through BBF, paddy - fish, 3-tier farming and farm pond, respectively. During the implementation process all the beneficiaries were imparted with practical training and provided with critical inputs. The net farm income from approximately 0.2 ha area through different interventions was in the range of Rs. 35,000 to 80,000.

Salt tolerant high yielding varieties of rice (CSR-36, 23 and CARI Dhan-5) and varieties of arecanut (Mangla, Samrudhi and Calicut 35), coconut (Andaman Green and Yellow Dwarf) and black pepper (Panniyur) have been introduced with package of practices in the intervention areas. Due to the introduction of salt tolerant high yielding varieties of rice the average yield increased to 3.5 ± 0.4 t/ha with a yield gain of 1.1 ± 0.4 t/ha. A total of 500 farm families have been directly benefited by NAIP interventions besides 14 farmers groups have been formed and interlinked for benefit and knowledge sharing (ICAR News, 2015).

Other Extension Programmes

Following programmes have been conducted for facilitating rural prosperity (Table 3).

Table 3. Other Extension Programmes for facilitating rural prosperity

Sl. No.	Activity	Intervention	Location	Year
1.	Farmers participatory Action Research Program – 1	• 25 on farm demonstrations on technologies like BBF, IFS, ground nut cultivation under plantations.	South Andaman, Havelock, Little Andaman	2008-2010
2.	Farmers Participatory Action Research Programme-II	• 100 on farm demonstrations on technologies like BBF, IFS, ground nut cultivation under plantations.	South Andaman, Havelock, Little Andaman	2010-12

Table 3. *Continued ...*

Sl. No.	Activity	Intervention	Location	Year
3.	AICRP on IFS	• 10 on farm participatory research for developing IFS models for homestead farming in tribal areas of Nicobar Islands.	Kinmai, Kimios, Car Nicobar	2012-13
4.	National Agricultural Innovation Project	• On farm demonstration of technologies like BBF, three tier system, Rice – fish culture, IFS, introduction of CSR 36 in degraded coastal areas. A total of 500 farmers have been directly benefited.	North, Middle and South Andaman	2010-2014
5.	AP Cess Fund – on IFS	• On farm participatory Research on IFS for different micro farming situations in 4 farmers field.	Calicut, Guptapara, Chouldhari	2003-2007
6.	Agro Advisory services	• Issue district wise weather based agro advisories twice in a week for the benefit of farmers of A & N Islands, which is being disseminated through print and electronic media.	A & N Islands	Since 2008
7.	AICRP on tuber crops	• Demonstration of tuber crops technologies	Harminder Bay	2013 onwards
		• Demonstration of Elephant foot yam in collaboration with KVK, Car Nicobar & South Andaman	Car Nicobar / South Andaman	2013 onwards
		• Demonstration on Sweet Potato CARI-SP1 & CARI SP2 in collaboration with KVK, Car Nicobar & South Andaman	Car Nicobar/ Mayabunder	Since 2012
8.	CSS-NHM on spices	• Demonstration on ginger	Car Nicobar & South Andaman	2013 onwards

(*Source:* Dam Roy *et al.*, 2015)

CONCLUSION

Finally we want to emphasize that agricultural growth needs to be stepped up. The strategy should focus on low input-low volume high value agriculture. Food grain production should be at subsistence level; vegetables, oilseeds and perishables should be at semi-commercial level; and coconut, arecanut, should be at commercial level. In the context, the following measures need special attention i.e., high quality seeds, modern production techniques, irrigation, access to credit, transport and marketing facilities, integrated pest management, and farmers' training.

There is a good scope for export of high value products like coconut, spices, fruits and flowers. Organic farming should be promoted and product certification system should be developed to help farmers fetch relatively higher prices for their products. Coconut and arecanut are important crops in ANI, however yield of these crops is low. Farmer's training in modern techniques of cultivating will improve the yield of these crops; and multi-tier cropping (with pepper, cloves and nutmeg) will increase the value of produce per unit area. Modern methods for processing of copra should be used. In order to exploit the export potential, commercialisation of identified products needs to be encouraged by investing in marketing and storage facilities, promoting/ developing linkages with food processing industries and creating efficient transport facilities.

Over all agricultural extension services should be strengthened with convergence of activities focusing on popularising farming system approach. The most viable

and time tested location specific technologies should be applied for empowering the stake holders with round the year employment, cafeteria of crop, good remuneration, risk mitigation and market opportunities, thus ensuring rural prosperity and agripreuneurship to the generation next.

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