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PROSPECTS FOR ORGANIC FARMING IN ANDAMAN AND NICOBAR ISLANDS

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ABSTRACT

The area available for cultivation in these islands is limited therefore efficient use of land and remediation of degraded areas through organic farming practices are viable alternate strategy to increase the crop production and enhance the livelihood support. The locally available organic materials can be effectively recycled to meet crop nutrient requirements. There is a huge potential for organic farming especially cultivation of spices, coconut, tropical fruits and high value vegetables. Organic waste recycling and other nutrient management strategy can meet 100 % , 60 % and 30 % of N, P and K requirements, respectively. In organic cultivation of selected crops in the islands with best management practices the yield of potential crops can be increased by 10 - 30 % and the average net profit by 15 - 22 % higher than the conventional farming.

Key words: island ecosystem, organic farming, spices, technologies, waste recycling

INTRODUCTION

Growing awareness of health and environmental issues associated with the intensive use of chemical inputs has led to interest in alternate forms of agriculture in the world. Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment and healthy products. FAO (1999) also suggested the use of management practices in preference to the use of off - farm inputs because regional conditions require locally adapted systems. Organic agriculture is defined as a unique production management system which promotes and enhances agro - ecosystem health, including biodiversity, biological cycles and soil biological activity, and this is accomplished by using on - farm agronomic, biological and mechanical methods in exclusion of all synthetic off - farm inputs (FAO, 2001).

In the present era, the agrochemicals used in agriculture are produced from fossil fuel and are not renewable and diminishing in availability. Therefore, it is imperative to optimize the use of locally available resources particularly at farm level and maintain the balance between production system and environment by using organic inputs. In addition significant area of marginal and degraded land can be reclaimed and brought under organic cultivation as the cultivated land is diminishing due to industrialization and urbanization.

Organic agriculture is now practised in more than 130 countries with a total area of 30.4 million hectares in 0.7 million number of organic farms. This constitutes about 0.65 % of total agricultural land of the world (Willer 2008). Global demand for organic products remains robust, with sales increasing by over US$ 5 billion a year. In India, about 528,171 hectare area is under organic farming (this includes certified and area under organic conversion) with 44,926 number of certified organic farms. This accounts for about 0.3 % of total agricultural land (Bhattacharyya and Chakraborty, 2005).

The Andaman and Nicobar Islands (ANI) is rich in biodiversity and suitable for wide variety of crop plants particularly plantations and spices. But, the land available for cultivation is only 50,000 ha. In general, the level of inorganic input use in agriculture is minimal and the entire Nicobar Island is organic by default. The climatic conditions favours luxuriant vegetations and provide scope for organic waste recycling. In addition, there is a possibility to increase the productivity of the acid soils by suitable organic amendments which can provide enhanced

income to the farmers (Swarnam and Velmurugan, 2013). Therefore, the present study was aimed to assess the organic farming potential of the islands and enumerate the technologies and strategies to enhance the production of organic farming.

MATERIALS AND METHODS

Island ecosystem

The climate of ANI is typified by tropical conditions with little difference between mean summer and mean winter temperatures. The annual rainfall varies from 2900 to 3100 mm representing perhumid climate. As the islands are situated close to the equator the evaporation is very high due to intensive solar radiation especially during dry months far exceeds the rainfall resulting in water deficit condition (Fig. 1). The relative humidity varies from 68 to 86 % and the maximum and minimum temperature is 32°C and 22°C, respectively. The length of growing period is more than 210 days which is long enough to support double cropping and plantation crops grown in the area. The area experiences Udic soil moisture and Isohyperthermic soil temperature regime (Velayutham *et al*., 1999). The soils of the Andaman and Nicobar Islands are dominantly influenced by the climate and vegetation. It is medium to deep, red loamy soils including marine alluvium derived soils along the coast. These are slightly to strongly acidic in nature and are moderate to low (40 - 70 %) in base saturation (Ganeshamurthy *et al*. 2002).

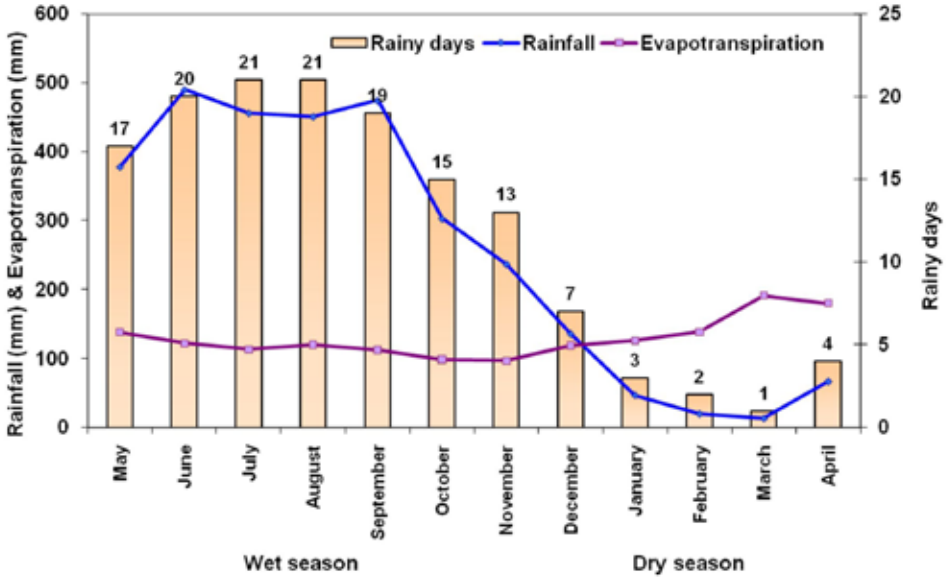

Fig. 1. Climatic parameters of ANI

Estimation of cropped area and productivity

Estimation of cropped area is essential to explore the possibility of bringing some of these areas under organic cultivation. In general crop cutting experiments were conducted to collect data on crop productivity. On the other hand, reliable data source is essential for crop area estimation. Standard products of IRS – P6 2007 and 2008 pertaining to Andaman and IRS - LISS III of Nicobar were used along with other literature sources to estimate the cropped area. All the satellite images were geometrically corrected to the Universal Transverse Mercator coordinate system, WGS 84 datum and integrated with district vector layers in a geographical information system (Arc GIS ver 9.3). Ancillary data sources *viz.* topo sheets and district plan document were also used. The data on the location of various ground features were collected and their locations were identified in the field map. For annual crops crop cutting experiments were conducted to estimate the crop productivity during 2007 - 2012. Further, the requirements of different nutrients are worked out on the basis of actual area of crops under cultivation and crop nutrient requirement.

Biomass and nutrient potential

The data pertaining to crops and its area were harmonized with the district - wise crop production statistics (DES, 2011) of all crops of Andaman and Nicobar and used for estimation of biomass potential. Forest type map, its litter fall and organic residues were collected from literature sources and our own published data bases. These were converted into biomass using crop - wise conversion factors (Dadhwal *et al.* 1994) by following the equation given below:

$$Bc = Y_E x (1 - MFg)* CF$$

where,

Bc - Total biomass of crop considered; Y_E - Economic yield/Production; MFg - Moisture fraction in grain/economic part and CF - Conversion factor i.e., 1/HI where HI is harvest index. Availability of animal manure was estimated using district wise livestock population and livestock type wise conversion factors.

The total nutrient content of each crop residues was calculated based on the average nutrient content (N, P and K) of each crop which was multiplied with its total biomass production in a year. The amount of recoverable nitrogen, phosphorus and potassium associated with livestock manure was calculated for each farm based on tons of manure produced and the nutrient content of the manure. The resulting value was adjusted for typical nutrient losses that occur during storage and handling to generate an estimate of total available nitrogen, phosphorus and potassium from livestock manure.

Organic farming potential

Soil samples were collected throughout ANI by following stratified random sampling to estimate the nutrient content and organic carbon. The pesticide use and its residues in soil and plant products were estimated using GCMS which is essential to know the hot spot areas of pesticide use which can be avoided for immediate conversion into organic cultivation. Crop wise yield under organic management at farmers field and experimental condition with recommended package of practices were collected and compiled. These data were used to estimate the yield gap and organic farming potential. In addition, some of the organic production technologies for spices and vegetables were collected and combined from the published literature sources of CARI (1995 - 2010).

RESULTS AND DISCUSSION

Area and production

The area under different crops and land uses are given in the Fig. 2. In ANI plantation crops such as coconut and arecanut occupy the maximum area under agriculture. This was followed by annual crops like paddy, pulses and vegetables. The total area under major plantation crops in ANI is around 69 % of total cultivated area of 55,598 ha which includes area under intercrop as well. Coconut and arecanut grown mostly in the side slopes of longitudinal hills accounts for 53 % of cultivated area followed by oil palm and rubber grown in the undulating terrain. Owing to several reasons productivity of various crops is lower than the national average. The area under coconut is 21,689 ha with a production of 172 million nuts and the productivity of 7965 nuts/ha as per the recent estimates. Arecanut occupies 4,147 ha area which yield 5721 MT. The cashew nut production is reported to be 362 MT from 800 ha of area. The estimated area and production of vegetable crops in Andaman and Nicobar Islands are about 5150 ha and 31300 tons, respectively (DES, 2011). Among the food grains, paddy is predominantly grown in the coastal saline, acid sulphate and waterlogged areas. In the Islands most of the plantation crops are grown with minimal management and less inputs in tropical acid soils resulting in lower productivity. While the production of vegetable and rice is limited by moisture stress, water logging and salinity at different periods of its growth.

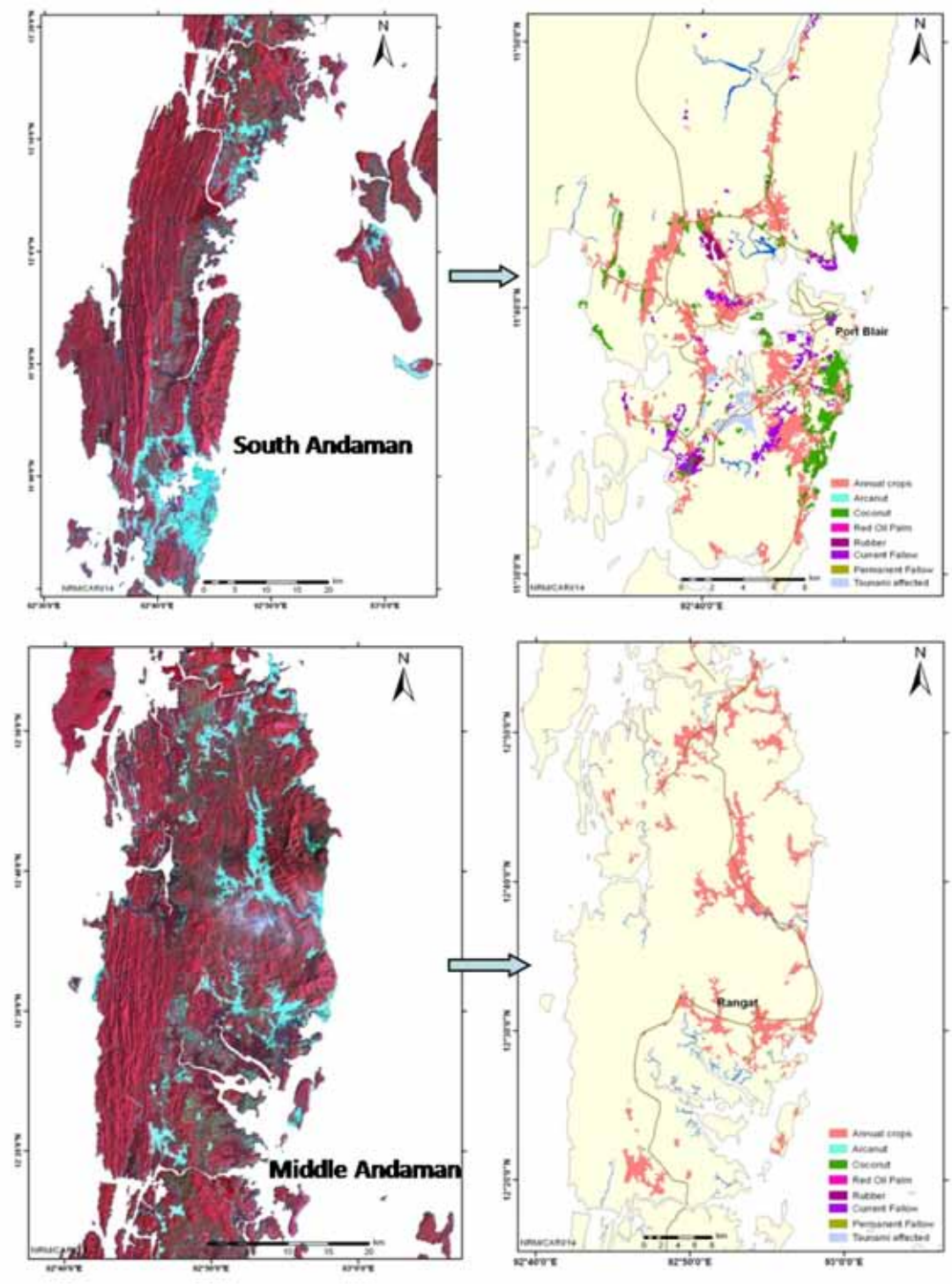

Fig. 2. Remote sensing image and Crop Map of Andaman islands

Level of input use

These Islands are rich in biodiversity with valuable medicinal, aromatic and dye herbs, trees and shrubs which can be produced organically. Besides, poultry, pig and cattle can be integrated with the crop components which provide scope for efficient resource recycling and stability to farm income. Nitrogen use intensity is low (8.0 kg/ha) due to selective use of N fertilizers in Andaman and socio - economic reasons in Nicobar Islands. In addition, the prevailing hot and humid climatic conditions favour rapid decomposition of organic residues of annual crops which rapidly releases nutrients into the soil. The island is free from several pest and diseases especially in plantation crops which are prevalent in mainland India. As a result the level of pesticides use and its residues in plant and soil is low with values ranging from 0.008 to 2.099 ppm except its use in vegetable crops as compared to the mainland (Murugan *et al*. 2013).

Requirement of nutrients

The nutrient requirement of major crops are presented in the Table 1 which indicates annual requirement of 2061, 1524 and 3638 MT of NPK / annum for the major crops *viz.,* paddy, pulses, vegetables, black pepper, ginger, coconut and fruits. The nutrient requirements were worked out on the basis of actual area of crops under cultivation. However, the fertilizer requirement may vary with efficiency of nutrient use and crop management. According to fertilizer use statistics annually 600 MT urea, 750 MT DAP, 200 MT rock phosphate and 300 MT of MOP are brought from mainland worth more than crores of rupees which can be considerably reduced if proper planning is made on utilization of plant and animal residues.

Table 1. Nutrient requirements of crops in Andaman and Nicobar Islands

Crops	Area (ha)	Recommended dose (kg/ ha)			Nutrient requirement / annum (MT)		
		N	P	K	N	P	K
Paddy	7686	90	60	40	692	461	307
Pulses	430	30	60	30	13	26	13
Vegetables	3669	30	60	60	110	220	220
Black Pepper	698	56	22	67	39	16	47
Ginger	200	40	100	80	8	20	16
Coconut	20927	53	35	142	1111	741	2963
Fruits	2925	22	14	25	88	40	72
Total	**36535**	**-**	**-**	**-**	**2061**	**1524**	**3638**

* MT – metric tones

Nutrient availability from plant and animal wastes

The annual production of residues from six major crops *viz*., rice, pulses, coconut, areca nut, vegetables and fruits alone accounts to 2,01,962 MT (Table 2). In addition, there is a possibility of utilizing vegetations grown in waste lands and cropped areas. Collectively, they are potential source of supplying crop nutrients and recycled back into the agricultural production system after appropriate composting methods. Among the crops, coconut and arecanut produce maximum residues of 6.40 and 8.50 MT/ha annually. Similarly, the annual production of wastes from major livestock types *viz*., cattle, goat, buffalo and poultry accounts to 3,75,710 MT which can be recycled by composting or used directly as animal manure after drying. Among the livestock components, cattle are the largest producer of dung (230776 MT/ annum) in the island.

Table 2. Availability of organic manures through plant and animal residues

Crop / Animal	Residue/ excreta production/ unit area	Area / Population in ANI	Total residue / excreta availability / annum
Crop residues	MT /ha	ha	MT
Rice	3.00	7686	23058
Pulses	5.00	430	2150
Coconut	6.40	20927	133932
Areca nut	8.50	4046	34394
Vegetables	1.50	3668	5503
Fruits	1.00	2925	2925
Sub total	**-**	**39682**	**201962**
Livestock wastes	kg	No.	MT
Cattle	7000 kg / animal /year	32968	230776
Goat	185 kg /goat / annum	27406	5070
Buffalo	9125 kg /animal /year	14200	129575
Poultry	25 kg / bird / annum	411444	10286
Subtotal	**-**	**486018**	**375707**
Total	**-**	**-**	**577669**

The total availability of organic wastes in Andaman and Nicobar islands accounts to 5,77,672 MT per annum. According to the estimates, the entire quantity of residues and animal wastes will not be available for recycling. 60 - 70 % waste can be collected for recycling. The balance sheet of nutrients calculated for major crops of ANI is presented in the Table 3. Nutrient availability from plant residues and animal wastes are calculated based on the assumption that 60 % weight loss and on an average of 0.75: 0.15:0.40 % NPK in the final product of compost. On this assumption, 1733, 346 and 924 MT of NPK requirement can be met from the composted plant residues and animal wastes. In total, out of 7200 MT of nutrient requirement / annum, 3003 MT of nutrients is made available from the plant and animal wastes. The balance of 4197 MT needs to be met from other sources such as biofertilizers, rock phosphate, biopotash and concentrated meals.

Table 3. Balance sheet of nutrients

Nutrients	Nutrient requirements (MT)	Available organic wastes (MT)*	Balance requirement (MT)
N	2061	1733	328
P	1524	346	1178
K	3638	924	2714
Total	**7200**	**3003**	**4197**

* 0.75: 0.15: 0.4 % NPK with recovery rate of 40 % after composting residues

Technological gap

Yield in organic farming is generally lower than those on conventional or integrated farms while yield from farmers field practicing organic farming is lower than the experimental stations. The magnitude of these yield differences varies considerably in the literatures which are summarised in table 4.

Table 4. Yield gaps between organic and conventional system under island conditions

Crops	Yield in organic management (MT/ha)		Average yield in conventional system	Yield in organic as % of conventional system
	Experimental conditions	Farmers field as % of experimental condition		
Okra	8.6 (1.6)	70 - 81	10.5 (1.4)	60 - 65
Tomato	8.2 (1.3)	75 - 80	9.1 (0.9)	73 - 76
Brinjal	5.2 (1.4)	61 - 66	6.5 (0.8)	49 - 56
Bitter gourd	2.5 (0.4)	75 - 81	2.9 (0.7)	72 - 76
Coconut *	70 (15)	80 - 90	90 (12)	70 - 75
Arecanut	2.6 (0.3)	98 - 93	2.9 (0.4)	80 - 83
Pepper	1.3 (0.2)	80 - 84	1.5 (0.2)	75 - 77
Cinnamon#	150 (18)	92 - 96	160 (14)	85 - 90
Ginger	18 (1.8)	80 - 84	23 (1.2)	74 - 76
Rice	2.8 (0.9)	82 - 85	3.4 (0.4)	68 - 72
Maize	4.0 (0.7)	77 - 80	6.5 (1.2)	47 - 49
Pulse	0.7 (0.3)	78 - 81	0.9 (0.2)	60 - 65

* nuts / tree ; # g/tree : values in parentheses are standard deviations

Based on field experiments conducted in research establishments the average yields of all crops grown organically were 9 - 15 % lower than those grown conventionally (Badgley *et al.,* 2007 and Ramesh *et al.* 2010). The yield in organic farming as % of conventional system is higher for spices (74 - 90 %) followed by vegetables and food grains. In fact, most of the data came from trials conducted on research stations and the actual productivity gap may have been underestimated in this meta - study (Pretty *et al*. 2003 and Edwards 2007). A compilation of data from different experiments conducted in these Islands is summarized in Table 5 which indicates that the productivity in organic farming is 10 - 40 % lower than the conventional farming and 5 - 15 % lower than the organic farming under experimental conditions. On marginal soils, in less favourable climatic conditions and under permanent or temporary water stress conditions of these Islands subsistence or low input agriculture is practised wherein organic agriculture can enhance crop productivity in addition to improving soil condition.

Table 5. Potential for organic cultivation in Andaman and Nicobar Islands

Crops	Area (ha)	Production (MT)	Yield (MT/ ha)	Organic farming method	Potential yield (MT/ha)	Potential production (MT)
Spices	1659 existing	2535.2	1.5	Rock phosphate &micronutrient enriched vermicompost, high yield cuttings/ planting materials, organic oplant protection, oil &water conservation	2.0	3318
	1500 additional	-	-	Intercropping & density planting of spices in coconut garden and reclaimed areas	2.0	3000
Coconut (M/nuts)	21689	172.0	45.0 Nuts per tree	Phased conversion to high yield varieties, organic waste recycling, compost enrichment with P and micronutrients, through vermicomposting, organic plant protection	70 Nuts per tree	268
Fruits	3005	24941.5	8.3	Improved root stocks, enriched compost, organic plant protection, soil & water conservation	10.0	30050
Root crops	1005	8236.3	8.2	Improved varieties, enriched compost, organic plant protection, soil & water conservation of existing areas	10.0	10059

The effects of organic input use suggested that the yield can be increased by 10 - 30 % through practicing best organic management practices suitable for different crops and soil conditions. More significantly spices can be grown in the interspaces of coconut garden in 1500 ha of area. By following suitable organic management practices, 6318 MT of spices can be produced indicating 149 % increase over the existing production. Similarly, organic coconut production can go up by 56 % , fruits by 21 % and cashewnut by 17 % . The production of pulses, root crops and vegetables can also be increased by organic management practices and most of its potential can be realized by linking it with the local market and tourism sector.

In many situations, the adaptation of state - of - the - art organic farming offers considerable potential for yield increase and yield stability under island conditions. Simultaneously, it is argued that there was a reduction in the average cost of cultivation in organic farming by 12 % compared to conventional farming. Further, due to the availability of premium price (20 – 40 %) for organic produce in most cases, the average net profit can be 15 - 22 % higher in organic compared to the conventional farming. Therefore, the organic approach for these islands should involve optimizing the yields of different cross linked farm activities rather than optimizing the output of single crop and livestock production units.

Technologies for organic farming in the Islands

In organic farming system, certain minimum requirements are to be met to fulfill its objectives so that, the farm is certified as organic. Establishing organic production system suitable for the island conditions

involves two steps, conversion and integration. The key characteristics of organic farming technology suitable for the Island conditions should include the following;

- Protect the long term fertility of soils by maintaining organic matter level, encouraging soil biological activity, and careful mechanical intervention;
- Nitrogen self - sufficiency through the use of legumes and biological nitrogen fixation, as well as effective recycling of organic materials;
- Provide crop nutrients from relatively insoluble nutrient sources by the magnified action of native soil micro - organisms;
- High yielding varieties of important crops, suitable crop combinations and water harvesting techniques;
- Weed, disease and pest control should primarily rely on crop rotations, natural predators, diversity, organic manuring, resistant varieties;
- Pay full regard to livestock evolutionary adaptations, behavioural needs and animal welfare issues and integrate them with crop component.

However, organic techniques are still poorly developed for some areas of crop and livestock production suitable for these islands. Therefore, efforts should be made to standardize or develop such techniques to favour organic cultivation.

Strategies for future development of organic farming

The strategies to promote organic farming in the Island should essentially encompass organic farming technologies, adequate infrastructure, appropriate policy framework and capacity building of the stake holders.

- The approach should be in a phased manner and from selected to wide area.
- Compact area group approach should be employed by encouraging the formation of organic farmers groups, clubs, SHG's and cooperatives for the purpose of cultivation, input production, seed / seedlings / planting materials production, certification and marketing.
- The entire Nicobar group of Islands offers scope for organic cultivation of coconut and other plantation crops whereas Andaman is highly suitable for organic spice production which should be promoted.
- Implementation of a simple certification process for all the organic farmers and promotion of specific brand name for the Island.
- Make crop - livestock integrated farming as part of organic farming, with women centered ownership and management in the farmer households and groups.
- Promotion of farm level processing, value addition and encouragement of the use of organic farm produce in food industry.
- Other promotional services like financial assistance and specific crop and livestock insurance for organic farmers is expected to instill confidence among the farmers.
- Reorientation of research, education and extension is essential to support the organic farming in the Islands. Task force should be formed involving scientist, developmental agencies and policy makers to develop seed to seed package and market network to promote organic cultivation.

These strategies are aimed to promote innovations and technologies in organic farming system which will play an important role in pushing agriculture and food production generally towards sustainability, quality and low risk technologies for the Islands. Additionally, the soil can also act as a major sink for atmospheric CO_2 (Lal, 2004) there by supports the mitigation efforts of global warming.

CONCLUSION

The most favourable aspects of the Island agriculture are the minimal level of chemical inputs used in majority

of the cultivated areas and crops. These Islands are rich in biodiversity and the agro - climatic conditions are very much congenial for the organic cultivation of crops which are in high demand in international markets. There is a huge potential for organic cultivation of spices, coconut, tropical fruits, high value vegetables and to some extent fine quality rice varieties in an integrated farming system mode which provide more stability and income to the farmer. However, organic cultivation of these crops will largely depend on the capacity of the production system to meet the crop input demand. The success lies in the effective use of locally available organic materials which can even act as an amendment to acid soils. At the same time farmers should be given access to attractive markets through value added and certified products which will enable the farmers to get premium price for their produce. Therefore, it is worthy to invest in organic farming in general and in particular spices in order to improve and further develop the system in Andaman and Nicobar islands.

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