



Cover : Horticulture-based Cropping Systems  
Courtesy : ICAR-Indian Institute for Farming Systems Research, Modipuram

### EDITORIAL COMMITTEE

Chairman

- Dr A K Singh

Members

- T Janakiram
- PL Saroj
- B Singh
- Nirmal Babu
- DB Singh
- Vishal Nath
- AK Srivastava
- BS Tomar
- Anvind Kumar Singh
- SK Singh

Member-Secretary

- Som Dutt

Editor : Som Dutt

Art : Narendra Bahadur

Design & Production : Punit Bhasin

Project Director (DKMA) : SK Singh

Incharge (EEU) : Aruna T Kumar

Chief Production Officer : VK Bharti

### Editorial Contact:

Telephone: 011-2584 1004, 2584 2828/612

Fax: 011-2584 1282

E-mail: indhort@icar.org.in

### Business, Subscription and Advertisement Contact:

SK Joshi, Business Manager

Indian Council of Agricultural Research

Krishni Anusandhan Bhavan, Pusa

New Delhi 110 012

Telephone: 011-2584 3657

E-mail: bmicar@icar.org.in

Price : Single Copy ₹30, US \$25

Special issue ₹100

Annual Subscription

1 Year ₹150, US \$30

3 Years ₹400, US \$85



ISO 9001:2008 Organization

# INDIAN Horticulture

September–October 2017

Published bimonthly, Vol. 62, No. 5

## CONTENTS

From the Editor	2
Exploring horticulture-based integrated farming for more return Akath Singh, SPS Tanwar, PR Meghwal, Pradeep Kumar and Praveen Kumar	3
Vegetable crops in farming systems for higher returns BS Tomar and Shrawan Singh	8
Protected citrus nursery production is a profitable enterprise Anirudh Thakur, HS Dhaliwal and Poonam Kashyap	14
Horticulture making farmers prosperous SS Roy, Ch. Basudha Devi, MA Ansari, B Sailo, SK Sharma, P Punitha, N Prakash and SV Ngachan	20
Livelihood security through natural resource management in Tehri Himalayas Poonam Kashyap, AK Prusty, MP Singh, VK Singh and AS Panwar	25
Cultivation of horticultural crops pays TP Swarnam, N Ravisankar, A Velmurugan, I Jaisankar, Ajit Wamen and AS Panwar	28
Enhancing income and nutritional security in Meghalaya Subhash Babu, Anup Das, Thoithoi Devi, Moutusi Tahashildar, Jayanta Layek, GS Yadav and AS Panwar	33
Marigold-globe amaranth sequential cropping fetches more K Nihad, V Krishnakumar and AA Haris	38
Horti-pasture system for livelihood security LR Meena, D Kumar, Lalit Krishan Meena and Amrit Lal	43
Plantation crops-based farming system is remunerative V Paramesh and EB Chakurkar	47
Coriander cultivation at farmers' field for livelihood security Sanjive Kumar Singh, Rajiv, Senjum Jinus Singh and Poonam Kashyap	52
Integrating potato in farming systems for food and nutritional security Manoj Kumar and Sanjay Rawal	55
Pomegranate – a viable fruit crop for integration NV Singh, J Sharma, KD Babu, Poonam Kashyap, Ram Chandra and RK Pal	59
Reducing post-harvest losses in an integrated way BVC Mahajan and Swati Kapoor	64
Horticulture-based plasticulture-cum-covered cultivation for livelihood security Awani Kumar Singh, Naved Sabir and Kohima Noopur	68
Exploring potential of horticulture-based farming system Som Dutt	75
Coriander at a glance T Janakiram	Cover III

### Acknowledgement

We acknowledge the cooperation rendered by by Dr Poonam Kashyap in commissioning of all articles along with their relevant photographs. We could bring out the state-of-the-art special issue of the *Indian Horticulture* due to her valuable and timely support.

— Editor



## Cultivation of horticultural crops pays

With increasing population and the need to ensure livelihood security, imperative to evolve a suitable strategy for augmenting production through farm and off-farm activities. By integrating horticulture crops and agricultural activities based on the resource endowment and constraint different locations, it is possible to improve the farm production as well employment opportunities of the individual farm households in the island. Compared to a monocropped situation, intercropping with spices, tubers, vegetables with the existing coconut and arecanut plantations enhance employment opportunities and diversified farm produces. Land shaping, rainwater harvesting in the coastal lowlands opens up wide opportunity for intensive vegetable cultivation in these areas. Such system presents a high degree of resource use efficiency, productivity, sustainability and nutritional security. This will reduce the external dependence of islands for livelihood.

**T**HE role of horticulture is changing rapidly from traditional to high-income generating activity due to generation of new technologies, crop varieties to face the challenges and its ability to offer solutions for various situations and entrepreneurs. In island agro-ecosystem, horticulture-based farming system has emerged as economically-viable system for small and marginal farmers and income of farm families could be enhanced significantly. Coconut, arecanut, black pepper and tree spices are important plantation crops, therefore, plantation based farming systems and location-specific integrated farming system models offers ample scope for increasing the farm income through crop diversification and intensification.

### HORTICULTURE-BASED FARMING SYSTEM

#### Coconut-based Farming System

Coconut plantations are mostly found on hill

slopes in Andaman Islands while in Nicobar it is mostly found in the coastal areas. In Islands mostly tall growing coconut trees in areas having more than 25% slopes. Sometimes dwarf varieties are found in private plots. The structure of coconut crown and the shape of the leaf allow part of the incident solar radiation to pass through the canopy and fall on the ground. It was estimated that as much as 56% of the radiation was transmitted through the canopy during hours (10-16 hours) in palms aged around 10 years.

A large variety of annual and perennial crops are found suitable for growing under coconut plantation. Experiments showed that crops like tapioca, foot yam, amaranthus, okra, snake gourd, bitter melon, coccinia, brinjal and bitter melon can be grown which yields 50 to 70% of their pure crop stand (Table 1). The advantage of coconut+vegetable systems is that separate



Intercropping in coconut garden



ty, it is  
gh on-  
other  
ints of  
well as  
island.  
rs and  
nances  
g and  
ity for  
higher  
ditional  
d.

obar Islands  
n Andaman  
s are found  
. In recent  
plantations.  
orientation  
ar radiation  
he ground  
he sunlight  
ng the peak  
d 25 years.  
ial crops is  
plantation.  
a, elephant  
ard, bottle  
an also be  
respective  
antage of  
vegetables



Arecanut and cinnamon system

Table 1. Economic analysis of coconut-based cropping systems for Andaman

Cropping system	Total cost (₹)	Gross return (₹)	Net return (₹)	Additional benefits by intercrop:	
				Net return (₹)	Employment generated (man days year/ha)
Coconut	17000	49000	32000	-	-
CN + Elephant-foot yam	64100	110900	46800	14800	131
CN + Ginger	74500	142000	67500	35500	500
CN + Tapioca	34700	100400	65700	33700	130
CN + Vegetables	33000	83000	50000	18000	125
CN + Clove	47880	101000	53120	21120	150
CN + Banana	59680	130150	70470	38470	230
CN based HDMSCS	52000	140000	88000	56000	191
CN + Fodder	29000	95000	66000	34000	120

for monsoon and post-monsoon seasons can be grown which provides for diversity and additional income. This also helps to ensure local supply of seasonal vegetables as most of the vegetables are transported from mainland India. In well aerated and soils with high organic manures, flower crops like *Heliconia*, *Anthurium*, *Jasminum pubescence*, crosandra, marigold besides medicinal and aromatic plants like long pepper and patchouli were found suitable. Ginger and turmeric are the important spice crops

commonly intercropped in coconut gardens. The intercropping of tapioca and ginger in coconut recorded higher net returns when compared to other crops like turmeric, elephant foot yam, amaranthus and bhendi.

High density multi species cropping systems (HDMSCS) involves growing a large number of crops at very high plant population per unit area to meet the diverse needs of the farmers such as food, fuel, timber, fodder and cash. It includes growing of large,





Cross-sectional view of typical physiography of the island

medium and small canopy crops arranged in a systematic way. In this Islands spice based HDMSCS can be promoted among the farmers which will generate high net returns and additional employment.

### Arecanut-based Farming System

Similar to coconut, arecanut as a sole crop does not utilize the available natural resources, i.e. soil, space and light effectively. Orientation and structure of arecanut canopy permits upto 40% of incident radiation to penetrate down. Studies on rooting



Arecanut + black pepper on gliricidia

pattern revealed that palms planted at 2.7 m could use effectively of land area. Under island climatic conditions arecanut plantations are more in inter/mixed cropping than storeyed cropping than plantations. The compact of arecanut crown raises above the ground (10 allows more sunlight to ground and maintain humidity which in turn excellent growth of shade shrubs/trees (banana and vines (betel leaf and pepper) and various short statured biennials and annuals (pin ginger, turmeric, yams and other tuber). Evaluation of arecanut based cropping showed that arecanut+cinnamon and arecanut+pepper are more profitable in the island. Return high as ₹2,50,000/ha could be obtained by cropping of arecanut as against ₹1,60,000 in case of sole arecanut. In recent years, value mixed crop with arecanut has become the profitable spice in similar climatic conditions in Kerala.

### Site-specific Integrated Farming Systems

The promotion of agricultural diversity through integration of different enterprises will have a positive impact on food and nutritional security at household level. Integrated farming system provides an opportunity for diversification of different agricultural activities and it can enhance productivity and profitability of existing farming systems, to ensure livelihood security of farmers. Considering the natural resource base, climatic, economic and social factors of the island, site specific integrated farming system provides greater opportunity to enhance the income and sustain the production. In the island

Table 2. Performance of different integrated farming systems over conventional practice

Farming system	Gross income (₹/ha)	Expenditure (₹/ha)	Net return (₹/ha)	Employment generated days)
(a) Hilly uplands				
Plantation + Buffalo + Poultry	4,74,440	83,732	3,90,708	528
Existing system	3,72,560	46,152	3,26,408	365
Additional benefit	1,01,880	37,580	64,300	163
(b) Mid slope or medium uplands				
Crop + Cattle + Poultry + Fish	5,52,017	1,57,850	3,94,167	438
Existing system	4,00,107	1,05,758	2,94,349	240
Additional benefit	1,51,910	52,092	99,818	198
(c) Low-lying valley and coastal plains				
Vegetable + Cattle + Rice + Fish in BBF	2,94,000	94,000	2,00,000	338
Existing system	80,000	39,000	41,000	40
Additional benefit	2,14,000	55,000	1,59,000	298



that arecanut  
2.7 m × 2.7 m  
ely only 30%  
er island agro-  
ons arecanut  
ore ideal for  
ing and multi-  
than coconut  
compact nature  
n raised well  
d (10-15 m),  
t to pass down  
aintain high  
turn favours  
shade loving  
a and cocoa)  
d variety of  
s (pineapple,  
uber crops).  
ing systems  
ecanut+black  
d. Returns as  
ed by mixed  
0,000/ ha in  
s, vanilla as  
ne the most  
conditions in

ems

sity through  
ave positive  
at household  
des such as  
f different  
hance the  
ing farming  
y of island  
ource base,  
the islands,  
em models  
ce the farm  
the islands,

rated (man



Horticulture based farming system for low-lying areas

based on the physiographic location and crop composition three distinct horticulture based IFS models for each of the farming situations are found highly suitable. These are discussed below.

### Hilly Uplands

In the hilly uplands having more than 25% slope, plantation crops such as coconut and arecanut are dominant with few fruit trees like jackfruit, guava, and sapota in the homestead gardens. Majority of the farmers are doing mixed farming which also includes dairy, poultry and goat. Lack of linkage and resource flow between different components and soil conservation measures are the major drawbacks of the present system. Under such situations, coconut based farming systems involving cultivation of compatible crops in the interspaces of coconut and its integration with animal component will provide considerable increase in production and productivity per unit area, through more efficient utilization of sunlight, soil, water and labour. A study conducted at farmers field in a participatory approach showed that coconut based integrated farming system enhanced the net farm income to ₹3.9 lakhs/ha/year as compared to plantations alone (Table 2). There was an additional employment of 163 man days/ha/year. In addition to this, the modified system is inclusive of soil conservation and *in-situ* water harvesting strategies. At certain locations where arecanut is the predominant crop arecanut based IFS model can be practiced which also provide comparable advantage.

### Medium Uplands/ Mid Slopes

In the mid hill portion of the longitudinal hills

and small hillocks with 10-15% slope, coconut gardens are intercropped with banana and pineapple. The soils are coarse, of medium depth with low nutrient and water retention capacity. Normally at the end of the slope unmanaged fish ponds are present. Backyard poultry, cattle and goat rearing in a free ranching mode is commonly practiced. Study revealed that integration of vegetables, pulses, flowers and tuber crops with coconut and dairy goat gave an additional net return of about ₹1 lakh and employment generation of 198 man-days/ha/yr (Table 2). Organic waste recycling, composting, mulching and soil conservation measures should be an integral component so as to improve the resource use efficiency and farm productivity.

### Low-lying Valley and Coastal Plains

In low-lying valley areas, rice cultivation alone is possible due to waterlogging for more than 6 months. In these areas soils are deep however, waterlogging during monsoon season and high tide is a major problem. At certain locations acid sulphate soil is encountered which not only limits the crop production but also fish culture. In these areas modifications of existing cropping system with short duration rice followed by vegetables and integration of cattle, poultry and fish resulted in an additional net farm income of ₹1.07 lakhs and employment generation of 201 mandays/ha/year (Table 2).

Alternatively land manipulation technique such as broad bed and furrow system (BBF) will help tide over the water logging and diversification of existing farming systems. Studies conducted at Central Island Agricultural Research Institute





revealed that BBF based integrated farming system was highly remunerative and most suitable for low-lying areas. The crop component include rice and vegetable in 0.35 ha, 0.30 ha BBF with vegetables in the beds and rice-fish in the furrows. Land manipulation also helps to harvest rainwater in the furrows which enables fish culture and provide supplemental irrigation to the vegetables grown in the beds. In addition, two HF cross cows integrated with the vegetable production constitute the integrated farming system. The system recorded a total net income of ₹2,00,000/- from an area of 0.75 ha with employment generation of 338 mandays/year. In the beds different seasonal vegetables are grown with high rate of returns.

#### **Land and Water Management**

The large-scale cultivation of improved crop varieties together with efforts to maintain good soil fertility and water management helps to increase production through higher yield per hectare. But

land is a shrinking resource for island agriculture therefore, a rational land use plan is needed to increase agricultural production by achieving maximum yields per ha through intercropping, multiple cropping and increasing cropping intensity according to island agro-climatic conditions, broad bed and furrow system in the coastal lowlands, terracing for soil conservation in sloppy land, rainwater harvesting, integration of animal component in the farming system and organic waste recycling are important resource management strategies for horticulture based farming systems to realise their maximum potential.

*For further interaction, please write to*  
 Drs TP Swarnam, A Velmurugan, I Jaisankar, Ajit Wamen (Scientists), Central Island Agriculture Research Institute, Port Blair 744 101. Dr AS (Director), IIFSR, Modipuram, Meerut. Corresponding email: Swarnama8@yahoo.com.

#### **Attention readers**

- All disputes are subject to the exclusive jurisdiction of competent courts and forums in Delhi/New Delhi.
- The Council does not assume any responsibility for opinions offered by the authors in the articles.
- No material in any form can be reproduced without permission of the Council.
- The Council is not responsible for any delay, whatsoever, in publication/delivery of the periodicals to the subscribers due to unforeseen circumstances.
- Readers are recommended to make appropriate enquiries before sending money, in order to avoid postal delay.
- Expenses or entering into commitments in relation to any advertisement appearing in this publication. The Council does not vouch for any claims made by the advertisers of products and services. The publisher and the editor of the publication shall not be held liable for any consequences in the event of such claims not being honoured by the advertisers.