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The authors are hopeful that this document will help to convey the research and extension information of the seminar across the stakeholders and facilitate the cross learning of ideas for the better livelihood of the farmers.

Umiam, 2012 The Editors

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G.C. Munda, S.V. Ngachan, Anup Das, Samborlang, M. and Samik Chowdhury
ICAR Research Complex for NEH Region, Umiam, Meghalaya

Introduction

The North Eastern Region of India constitutes the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. The North East of India is a region of mystic splendors and rich cultural heritage spreads over an area of 262179 sq. kms. It is stretched between 89.46° to 97.30° East longitude and 21.57° to 29.30° North latitude. Although agriculture is the mainstay of the economy of this region its agricultural base is very poor. The region is characterized by fragility, marginality and inaccessibility and the agriculture in the region is complex, diverse and risk prone. The farmers are small and marginal and about 80% of the population depends on agriculture for their livelihood. The basic issues facing agriculture in the region are small land holdings, low cropping intensity, low productivity, inadequate access to appropriate technologies and other external inputs, inadequate irrigation facilities, increased natural calamities etc. In order to address these issues the NAIP project (SRLS) component III "Livelihood Improvement and Empowerment of Rural Poor through Sustainable Farming Systems in North East India" is being implemented in the disadvantaged districts of North East India. The specific objective of the National Agricultural Innovation Project is to accelerate the collaborative development and application of agricultural innovations between public research organizations, NGOs, farmers, private sectors and other stakeholders to demonstrate the strength (also the need) of farming system approach at farmers field for production enhancement, natural resource conservation and livelihood improvement in a participatory mode to pave the way towards sustainable agriculture in NE region.

Methodology

The project has been implemented in seven disadvantaged districts of North East India since 2007. The implemented sites are located in the most backward districts namely Upper Subansiri (Arunachal Pradesh), Tamenglong (Manipur), South Garo Hills (Meghalaya), Saiha (Mizoram), Mon (Nagaland), North Sikkim (Sikkim) and Dhalai (Tripura) with an aim to improve the livelihood of the rural poor by adopting the strategies of sustainable natural resource management, productivity and profitability enhancement, building support systems and institutions. Various farming system models were demonstrated in identified clusters by the consortium partners in a participatory mode involving research Institutes, Universities, Govt. Departments, NGOs, Self Help Groups, Youth Clubs, Village Institutions and the farmers. The component of the farming systems were selected depending

on the climate, availability resources in the locality, farmers preference, demand etc. Extensive training, demonstration and visit programme were organized for the farmers and beneficiaries for developing skills in various aspects of agriculture, processing and value addition including subsidiary activities like mushroom cultivation, tailoring, weaving etc.

Results

Various site specific technological interventions such as integrated farming system for effective natural resource management, agro-forestry for rehabilitation of degraded land, resource conservation technologies viz. system of rice intensification (SRI), integrated crop management (ICM), zero *tilla*ge, poly-house technology for nursery and year round vegetables production, composite pisciculture, supplying seeds/breeds of high yielding crops/livestock breeds/fish, multiple cropping to increase cropping intensity, scientific cultivation and value addition of spices and horticultural crops, usage of farm implements, subsidiary income generation activities, etc. has been taken up during 2007-2012 as part of the project with an aim to ensure sustainable rural livelihood. Some of the site specific successful technologies identified were SRI/ICM in Dhalai and South Garo Hills where the average productivity of high yielding rice varieties under SRI/ICM has been 3.8 t/ha as against 2.4 t/ha with local variety and local practice. Farmers earned a net profit of Rs. 25,300 ha/year by adopting SRI/ICM methods of rice cultivation. In Tamenglong, zero *tilla*ge toria cultivation has been a success where 172 ha area has been brought under zero *tilla*ge cultivation and the average productivity realized was 0.80 t/ha. Farmers could earn a net income of Rs 16,000/ha/yr from toria cultivation. Terracing for *panikheti* was a success in Mon where the average productivity of high yielding rice varieties (Lampnah and Shahsarang-1) was 3.9 t/ha as against 1.2 t/ha with local variety. Farmers could earn a net income of Rs 19,400/ha/yr. In North Sikkim, high value vegetables such as tomato, capsicum, cauliflower and broccoli were cultivated under poly-house under year round vegetable production. An average yield of 23.43 t/ha was achieved as against 13.5 t/ha by farmers practice. Farmers could earn a gross income of Rs. 4, 66,300/ha. Fish based integrated farming system was a success in South Garo hills where the average productivity of fish was 2.98 t/ha/yr as compared to 0.6 t/ha/yr under farmers practice. Farmers could earn a net income of Rs. 20,000/500 m^2 pond water area. Fish based farming system has been identified as profitable interventions in Dhalai too. In Upper Subansiri, under year round vegetable cultivation; vegetables such as chilli, cabbage and french bean were grown under poly house. The average yield of these vegetables was 111.5 t/ha as against 82.8 t/ha by farmers practice. In Saiha, 70 ha area was covered under turmeric cultivation and one turmeric processing unit was installed for making dry turmeric powder. Depending upon the availability of dried turmeric rhizomes for making turmeric powder, 200 - 400 kg of powder is processed per month. Turmeric powder is sold at a wholesale price of Rs. 20/100 g packet. The impact of these technologies in the identified clusters has attracted other farmers and thereby, facilitating horizontal adoption of the technologies, thus paving the way towards marketable and proccessable surplus with associated benefit for livelihood improvement through agriculture and allied sector.

Economics of Integrated Farming System Modules in Dhule, Maharashtra

M.S. Mahajan, A.K. Kolage, S.B. Desale and S.C. Nerkar
Mahatma Phule Krishi Vidyapeeth, Dhule, Maharashtra

Introduction

Indian economy is predominantly rural and agriculture oriented. In agriculture, 85% of holdings are less than two hectares and the declining trend in the average size of farmers holdings, poses a serious problem. Farmers concentrate mainly on crop production which is invariably subjected to a high degree of uncertainty in income and employment. To sustain the income and productivity, the farmers has to integrate ancillary propositions with crop production. Under such circumstances, it will be required to undertake some land use based enterprises which will complement their exixting farming activity to get more income and employment, leading to better standard of living. Such enterprises include crop husbandary, dairy, backyard poultry and goat keeping etc. Agriculture is still the only means of sustainance in the rural area that is mostly characterized by low productivity and low income mainly due to poor adoption of technologies, low access to credit and extension, vulnerability to risks, poor soil and water management, limited input supply and poor infrastructure. A judicious combination of any one or more of such enterprises with cropping and effective recycling of residues / by –products would ensure better utilization of available resources and employment to the family lobour during off season. An effort has been made for a holistic integration of different land use based enterprises with the objectives of sufficiency in food, increased income and employment opportunity for the farm family.

Methodology

Under Component-3 (Recourse on Sustainable Rural Livelihood Security) of National Agricultural innovation Project (NAIP) a sub-project entitled, “Efficient land use based integrated farming system for rural livelihood security in Aurangabad, Dhule and Gondia districts of Maharashtra” is being implemented with two clusters in Dhule district of Maharashtra State since April, 2009 by Regional Extension Centre, College of Agriculture, Dhule which is a Centre of transfer of technologies working under Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist.Ahmednagar. One cluster is located in Sakri tahsil viz., villages Laghadwal and Navagaon, which comes under sub-mountain agro-climatic zone of Maharashtra. Another cluster is located in Shirpur tahsil viz. villages Zendeanjan and Hated, which comes under scarcity agro-climatic zone of Maharashtra. The unique features of Sakri tahsil cluster are undulating topography rice based cropping system, moderately high rainfall (1200 to 1500 mm) and sent per cent tribal population. Majority of soils are shallow with low fertility, livelihood partly dependent on forest. Whereas, the features of Shirpur

tahsil cluster are undulating topography at foot hills of Satpuda and annual rainfall 700 mm. Majority of soils are shallow with low fertility. Predominantly cotton based cropping system with tribal population. Ten integrated farming system modules (5 from each cluster) comprising of two marginal , three small , four medium and one semi-medium category farmers were studied and different parameters of economics and employment generation were computed undertaken during the year 2010-11 and 2011-12 with field and horticultural crops, dairy, poultry and gottery enterprises.

Crop husbandry

It consisted of field crops, viz. rice (Phule Radha), maize (Rajarshi), soybean (JS-335) and pearl millet (Shanti) in Sakri cluster and bt cotton, green gram(Vaibhav), pearl millet, *rabi* sorghum (Phule Chitra) in Shirpur cluster. Newly introduced horticultural crop of onion (Phule Samartha) was studied in Sakri tahsil. Crop rotation viz. soybean-onion and green gram-rabi sorghum are prominent in the clusters. All the crops were grown as per the recommended package of practices and improved varieties/hybrid of MPKV.

Dairy

Ten (five cows in each cluster) cross bred (H.F./ Jersey 50% cross) lactating cow units were supplied during 2010-11 as input of dairy component, having milk yield ranging from 8-10 liter per day, to provide added income to the farm family through supply of milk and cow dung as a manure. The by product from mini rice mill and mini dal mill agro-processing unit were also utilized from the crop component. Fifty per cent out of the total constituent of the concentrate dairy feed was obtained from the crop component besides supplying dry and green fodder round the year for the dairy unit.

Backyard poultry

A backyard poultry unit of 10 to 22 layer birds (Satpuda Deshi) was reared by each farmers under study for eggs in low cost poultry house with bamboo.

Goat keeping

A goatery unit of two animals (Osmanabadi breed) was reared by each farmers under study with half stalle fed condition.

Results

Marginal farmer (0.80 - 0.90 ha)

Shri. Dilip Rupla Bahiram of village Laghadwal , got net profit of Rs. 22,614 /- per year from all the enterprises in crop-dairy-poultry-goat IFS module. The best three components provided him the major income were dairy, crop production and poultry in that order. Gross return per rupee invested was 1.39 and generated employment for 166 man days per year. By inclusion of dairy and poultry components in IFS module, the net income

has been increased to Rs. 22,614 /- per year as against Rs. 7573/- from field crops and goat keeping only.

Shri. Kanhaiyalal Mansaram Chaure of village Zendeanjan , got a net profit of Rs.68549/- per year from all the enterprises with 1.97 gross return per rupee invested in crop-dairy-poultry-goat IFS module. The contribution in net income from field crops was the highest (67.79 %), followed by dairy (27.08 %). The employment generated from this IFS module was 195 man days per year. By inclusion of dairy component in IFS, the net income have been increased to Rs. 68549/- per year as against Rs. 49,989/- from field crops, backyard poultry and goat keeping only.

Small farmer (1.00 - 1.60 ha)

Shri. Murlidhar Sajjan Ahire and Shri. Murlidhar Shantaram Bagul of village Laghadwal has got net profit of Rs 37343 and Rs 47195, respectively from all components with 1.84 and 1.95 gross returns per rupee invested from all the componenets, respectively. Contribution in net income of field crops and dairy component were 70.99 and 19.55 per cent,respectively of Shri.Ahire. Contribution in net income of field and horticultural crops was 35.11 and 34.48 per cent, respectively of Shri.Bagul. By inclusion of dairy and poultry components in IFS of Shri.Ahire, the net income have been increased to Rs 37,343/- per year as against Rs 26,511/- from field crops only. Whereas, inclusion of horticulture and dairy components in IFS of Shri.Bagul, the net income have been increased to Rs.47,195/- per year as against Rs. 16,572/- from field crops.

Shri Sitaram Barku Kokani of villages Zendeanjan generated a net profit of Rs. 37,472/- per year from all components with 1.45 gross return per rupee invested. The contribution in net income from dairy component was the highest (49.53 %), followed by field crops (41.26 %). The employment generated from this IFS module was 297 man days per year. By inclusion of dairy component in IFS, the net income has been increased to Rs. 37,472/- per year as against Rs. 18,913/- from field crops, backyard poultry and goat keeping only.

Medium farmer (2.00 - 3.20 ha)

Shri. Ratan Uttam Bhoye of village Laghadwal from crop-horticulture-dairy-poultry (3.20 ha) IFS module, a net income of Rs. 3,10,317 /- per year was generated from all components with average B: C ratio of 2.76. The contribution to net income was the highest (63.79%) from horticultural component followed by field crops (29.78%). Total average employment generated was 942 man days per year. By inclusion of horticulture and dairy components in IFS module, the net income has been increased to Rs. 3,10,317/- per year as against Rs. 94,357/- from field crops and backyard poultry. Shri.Vinayak Pawar of Navagaon village, in crop-horticulture-dairy-poultry-goat keeping (2.80 ha) IFS module, a net income of Rs. 1,06,138 /- per year was generated from all components with average B: C ratio of 1.85. Horticultural crops contribution in net income was the highest (59.85%), followed by field crops (30.26%). Employment generated under this module was for 639 man days per year. By inclusion of dairy and horticulture components in IFS module, the net income has

been increased to Rs.1,06,138/- per year as against Rs. 35,313/- from field crops, backyard poultry and goat keeping only.

Shri Mahalu Hari Bagul (Zendeanjan village), in crop-dairy-poultry-goat (2.00 ha) IFS module, a net income of Rs.56,243/- was realised from an investment of Rs. 91,735/- (1.54 B:C ratio) and employment equivalent of 409 man days was generated per year. By addition of dairy component in IFS, the net income has been increased to Rs.56,243/- per year as against Rs.37,083/- from field crops, backyard poultry and goat keeping only. Shri.Bakaram Kokani (Zendeanjan village), in crop-dairy-poultry-goat (3.20ha) IFS module, a net income of Rs. 76,505/- was generated from all components with B: C ratio of 1.61. The total employment generated was 473 man days per year. Performance in respect of contribution of components in the total net income was in order of field crops **>** dairy **>** goat **>** poultry. By addition of dairy component in IFS module, the net income has been increased to Rs.76,505/- per year as against Rs. 57,745/- from field crops, backyard poultry and goat keeping.

Semi-medium Farmer (5.60 ha)

Shri. Ratan Murlidhar Mahale of village Zendeanjan, from crop-dairy-poultry-goat (5.60ha) IFS module, a net income of Rs. 79,884/- was generated with 1.47 gross return per rupee invested. The total employment generated from all components was 756 man days per year. The contribution in net income was the highest from field crops (72.59%), followed by dairy (22.73%), goat (2.36%) and backyard poultry (2.32%). Integartion of milch cow with cropping resulted in higher net returns was also reported by Arora (1980) and Chinnusamy and Purushothaman (1992). By addition of dairy component in IFS module, the net income have been increased to Rs.79,884/- per year as against Rs.61,724/-/ from field crops, poultry and goat keeping only.

On an average, in Laghadwal cluster, the net income of Rs. 66,043/- per ha was generated with 2.01 gross return per rupee invested. Total average employment generated for 308 man days per year per hectare from all the components. Performance in respect of contribution of IFS components in the total net income was in order of horticulture > field crops > dairy > poultry > goat. In Zendeanjan cluster the average net income of Rs.37,978/- per year per hectare was generated with 1.61 gross returns per rupee invested. Total average employment generated was 219 man days per year per hectare from all the components. Performance in respect of contribution of components in the total net income was in order of dairy **>** field crops **>** poultry **>** goat keeping.

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Role of integrated goat farming in sustainable livelihood in Bundelkhand region

M.K. Singh, A.K. Dixit, A.K. Roy and S.K. Singh
Central Institute for Research on Goats, Makhdoom, Mathura

Introduction

Bundelkhand region is located in Central India in Indo-Gangetic plains on Vindhya hilly tract consisting of 7 districts of Uttar Pradesh and 6 districts of Madhya Pradesh. This region suffers from many limitations mainly high vulnerability of natural calamities and poor infrastructural development which has made the agricultural productivity very low and; food availability and livelihood uncertain. Climate of this region is highly variable with extreme cold (1^0c) in winter and extreme hot (47^0c) in summer. Rainfall is moderate with 400 to 900 mm but precipitation is highly erratic and maximum rain water runoff due to impermeable rocks, very thin vegetation cover and undulating land.

Methodology

Data from 600 households belonging to 16 villages of Mahoba and Hamirpur districts was collected and compiled under "Goat Husbandry based Integrated Approach for Livelihood Security in Disadvantaged Districts of Bundelkhand Region (NAIP-Comp-3)" to address the issues of sustainable livelihood of people of this region (Table-1). Agriculture is the major source of income (50%) of majority of rural population (70%) with 125% cropping intensity. Productivity of crops and per capita income is one of the lowest in India. Due to single cropping, low yield of crops and lack of employment avenues about 30% households migrate for distant places to sustain their living being. Livestock is second important source of income and acts as lifeline in providing food and livelihood with an average contribution to total income of households was 21.4%. However, their contribution in food and livelihood increases manifold in draught years. Nearly 17% households also maintained bullocks for the agricultural operations. The milk (food) requirements of these households were also met out from these livestock. Goat, cattle and buffaloes are major livestock species and animal of one or more species are maintained by 89% households with average flock/herd size of 4.2 goat, 2.7 cow and 1.8 buffaloes. Proportion of cattle, buffaloes and goats to livestock population were 35.6, 26.4 and 38%, respectively in Hamirpur and 28.6, 24.74 and 47.70% respectively in Mahoba district. However, population of goat and buffaloes is increasing due to better income and easy access of market for milk and meat. Awareness and adoption of improved livestock management practices is meagre and

there is sever scarcity of quality breeding bucks and bulls. Animals are mostly reared on crop residues and stray grazing (*Anna Pratha*) as fields for crop cultivation are utilized for 4 to 5 months in a year. Area under fodder crops is very low (<2%). There is a critical gap between potential and actual production of different species of livestock (Table 1). Average milk yield of buffaloes, cows and goats under optimum feeding were 5.2±0.1, 3.1±0.2& 0.5±0.06litre/day, and 3.2±0.3, 1.7±0.5 and 0.3±0.04litre/day under extensive feeding system.

Table 1. Critical Gaps between potential and actual production of livestock

Item	Gaps (%)	Standard/Normal	Baseline Values
Goat mortality (%)	20	15	34
Kids body wt. at 12 month (kg)	43	24	17
Milk yield of goat (L/L)	82	100	55
Lactation length of goat (days)	73	130	75
Income/goat/year	91	2200	1150
Milk Yield of cow	84	1050	570
Lactation length of cow (m)	40	9	6.4
Milk Yield of buffaloes	67	1500	900
Lactation length buffaloes (m)	32	9	6.8
Number of irrigation	133	3.5	1.5
Fodder yield (t/ha)	6.6	50.0	30.0
No. of eggs/bird	100	150	75

Results

Technologies pertaining to Integrated Goat Farming supported by prophylactic and curative measure for other livestock species, agro-forestry & high yielding fodder crop varieties and backyard poultry were promoted in 16 adopted villages. Above interventions have resulted additional income of Rs. 16782/household/year (Table 2). Simultaneously consistent efforts are on to motivate and sensitized livestock keepers for adopting improved technologies for enhancing sustainable livestock productivity of this region.

Table 2 Intervention wise Impact of the Activities

Interventions	Activities	Impacts
Goat/Poultry	Distribution of goats to 135 HHS (446) & distribution of 38 elite bucks	Income of Rs 8916/ HH/ year increased
	Prophylactic (3720 goat, 1525 cattle, 840 buffaloes and curative measures (244)	Income of Rs 2114/HH/year increased
	Distribution of 375 chicks	Income of Rs. 3120/HH/year increased
	Employment generation through (goat & poultry)	182.5 and 45 man days/HH/year
Horti-silvi-pasture and fodder crop	Distribution of improved fodder seed, Horti-silvi-pasture, demonstration and dissemination of technical know how	An additional income of Rs 2720/HH/year through increase in milk yield of cattle and buffalo. Fodder yield increase by 50% and 240HHS adopted improved verities of fodder crops
Capacity Building	Training/ farmers day/field days, demonstration, formation of SHGS and group discussion	Motivation of farmers on scientific goat/poultry farming, adoption of improved management practices on crop, fodder, livestock and water conservation. Fourteen self help groups (SHGs) were formed

Overall an additional income/household/year from different intervention was Rs.16,782

Livelihood improvement of Konyaks through integrated farming system at Mon, Nagaland

Dibyendu Chatterjee, B.C. Deka, M.K. Patra, A. Thirugnanavel, B. Sahoo, Rakesh Kumar, B. P. Bhatt and Mhiesikedo Krose

ICAR Research Complex for NEH Region, Nagaland Centre, Jharnapani, Nagaland

Introduction

Mon District of Nagaland is recognized as the most backward district by the Planning Commission of India. There is no sustainability in livelihood of *Konyaks* due to the impact of low productivity and prevailing shifting cultivation (Ramakrishna, 1993). Approximately, 85% of the total cultivation in northeast India is involved in such primitive type of agriculture (Singh and Singh, 1992). Saha *et al.* (2011) studied soil erodibility characteristics under 6 land-use systems *i.e.*, agriculture, agrihorti-silvi-pastoral, natural forest, livestock-based land use, natural fallow, and shifting cultivation (*Jhum*). They observed that shifting cultivation showed the highest erosion ratio (12.46), followed by agriculture (10.42), indicating the need to adopt tree-based land-use systems for resource conservation. They also reported that soil loss was significantly higher in shifting cultivation (30.2–170.2 t ha^{-1} yr^{-1}), agriculture (5.10–68.20 t ha^{-1} yr^{-1}), and the livestock-based land-use systems (0.88–14.28 t ha^{-1} yr^{-1}) as compared to other modified land-use systems. Keeping the above facts in view studies on integrated farming systems were conducted for such disadvantaged area.

Methodology

Baseline survey

The experiment was laid down at Lampong Sheanghah Village, Mon district Nagaland which is located at the latitude of $26^0$46'54''N and longitude of $95^0$04'12'' E with an elevation of 890-1093 above msl. Prior to implementation of the project, PRA exercise was carried out besides frequent interaction with the villagers.

Agri-Horti Crop integration

Terraces were made in the lower part of the hillock with slope less than 30%. All the terraces were made at a vertical interval of 1m keeping intact the topmost soil there. Irrigation channels were prepared to divert water from the stream. For nutrient management, a thick row of hedge species like *Tephrosia candida* and *Crotolaria* spp were planted and the green biomass was mulched into the terraces. Approximately, planting materials of 100 kg of maize (*RCM 76*), 100 kg of lowland rice seeds (*Lampanah & Sahsarang*) during *kharif* and 250 kg potato (*Kufri Giriraj* and *Kufri Jyoti)*, 800g carrot, 700g radish (*Japanese white*),

500g knoll khol & cabbage (*Pride of India)*, 20 kg french bean (*Kamal*), 2.5 kg pea (*Arkel*), and 15 kg toria seeds during *rabi* were distributed to the farmers to increase productivity and were of very high quality.

Agroforestry-upland rice/foxtail integration

A total of 6250 nos. of multipurpose tree species were planted in an area of around 11.25 ha in *jhum* upland rice and foxtail millet (*Setaria italica)* fields. Eight spp. *viz*., Khokan (*Duabanga grandiflora* Roxb), Nahar (*Mesua ferrea* L), Himalayan Alder (*Alnus nepalensis* D.Don), Titachap (*Michelia champaca*), Phulsap (*Michelia oblonga)*, Bonsum (*Phoebe goalparensis)*, Hollock (*Terminalia myriocarpa)* and Puma (*Chukrasia tabularis)* were procured and planted at a spacing of 5m × 5m for plant to plant and row to row. Growth parameters of plants on the basis of plant height, collar diameter and the numbers of branches were recorded monthly on 15 plants in each species. Standing plant height was measured by using a wooden measuring scale from the ground level to the highest point of the ground while collar diameter was measured on the basal area of the standing plant by vernier calipers.

Fish-Animal Husbandry integration

Large Black X weaned piglets were procured from the ICAR Research Complex for NEH Region, Nagaland Centre with an average initial live weight of 23.17 kg (15–29 kg). These pig breeds were fed with the seasonally available non-conventional feeds, such as Phogok (*Ficus hispida*), Khokli (*Osbeckia spp*.), Utam (*Sauraira nepalensis*), Gakhsalin (*Spilanthes acenella*), Unglanhia (*Boreria hispida*), Shoinen (*Vernonia anthelmintica*), Phepot (*Bidens pilosa*), Ngomong (*Musa paradisiacal*), Pankhen (*Manihot esculenta*), Jung (*Colocasia esculenta*) and rice husk. The farmers also provided their normal management practices, drugs and vaccines to these pigs. The pigs were fed twice per day. As a supplementary feed, the paddy husk was fed in the morning and evening after mixing with the rest of the dietary ingredients. Fish pond of 31.0 m x 6.0 m x 1.52 m. was constructed scientifically for rearing with pig and 1000 nos. of fish fingerling of *rohu*, *catla* and grass carp were released.

Results

Baseline survey

As per the base line survey the total population of the village is 888 (436 males and 452 females) comprising 116 households, among which 107 (92%) are farming families. The total cultivable area of this village is about 1500 ha and the current area under jhum is approximately 175 ha. Monocropping of rice was practiced in the village before intervention for terrace and upland paddy. Indigeneous landrace, foxtail millet, colocasia, tapioca and some seasonal vegetables were grown by the farmers in the *jhum* fields. The productivity of upland paddy was found to be less than 1 ton/ha. In case of livestock, the non– descript type of pigs were reared in the village besides some goats.

Agri-Horti Crop integration

Among the different crops, the productivity of paddy was increased from 1.90 to 2.44 t/ha, maize from 0.70 to 1.20 t/ha, vegetables from 4.50 to 6.40 t/ha and tubers from 10.50 to 12.25 t/ha during 2011-12, which clearly depicts the results of integrated approach to the site. The enhanced net income for paddy, maize, vegetables and tubers were recorded as Rs. 79,056.00, 20,000.00, 38,000.00, 26,250.00/ha, respectively (Table 1).

Table 1 Enhanced crop productivity and net income under NAIP during 2011-2012

Crops	Cumulative		Productivity (t/ha)		Enhanced Net Income (Rs/ha)	Total Production (ton)
	Total area covered (ha)	No. of households	Initial	Improved		
Cereals						
a) Paddy	12.20	38	1.90	2.44	79,056.00	29.77
b) Maize	1.25	22	0.70	1.20	20,000.00	1.50
Vegetables	1.75	37	4.50	6.40	38,000.00	11.20
Tubers	3.25	35	10.50	12.25	26,250.00	39.81

During the year 2011 (upto December) total crop area, production, total income and income/household were increased significantly over previous years. However productivity showed stagnancy during 2010 and 2011. Because of severe draught in 2009, all parameters showed reverse trend, even lesser than the baseline.

Agroforestry-upland rice/foxtail integration

The plant growth recorded after 48 months of planting (Table 2) showed that the highest plant height and collar diameter of 434.40 cm and 11.52 cm respectively were observed in *Duabanga grandiflora*. The lowest plant height and collar diameter of 120.39 cm and 2.18 cm respectively were recorded in *Messua ferrea*. The average highest (36.50) and lowest (4.03) number of branches were recorded in case of *Alnus nepalensis* and *Chukrasia tabularis*, respectively.

Fish-Animal Husbandry integration

The initial average live body weight of pigs ranged from 15-29 kg which increased in subsequent months with advancing age and attained 59.0±10.78 kg within 12 months. There was a steady increase in the body weight with advancing age which may be due to physiological growth phenomenon. However, the final body weight under low input productive system was less than those fed with conventional balanced ration. The reason

Table 2 Growth status of multipurpose tree species after 48 months

SN	Multipurpose Tree Species (MPTs)	Plant height (cm)	Diameter at Breast Height (cm)	No. of branches
1	*Alnus nepalensis*	373.05±67.82	8.6±1.47	36.50±4.82
2	*Terminalia myriocarpa*	292.59±67.71	4.68±1.18	14.0±2.83
3	*Michelia champaca*	373.53±56.56	9.1±1.29	30.1±4.03
4	*Morus oblonga*	142.53±24.70	3.24±0.51	10.45±1.98
5	*Duabanga grandiflora*	434.4±129	11.52±2.7	19.92±3.78
6	*Messua ferrea*	120.39±26.3	2.18±9.8	7.65±1.63
7	*Phoebe goalparensis*	139.71±20.22	3.0±0.26	9.7±1.09
8	*Chukrasia tabularis*	161.73±39.39	3.67±0.98	4.03±1.92

may be due to the feeding of low level of DM to pig which was much lower than the DM content of commercial pig feed.

It can be seen from Fig 1 that the average monthly weight gain ranges from 1.76±0.78 to 5.53±1.46 kg/pig, respectively. Numerically the highest average monthly body weight gain was observed in the month of June, July, August and September which may be attributed to the higher crude protein and dry matter content of the feeds during the respective months.

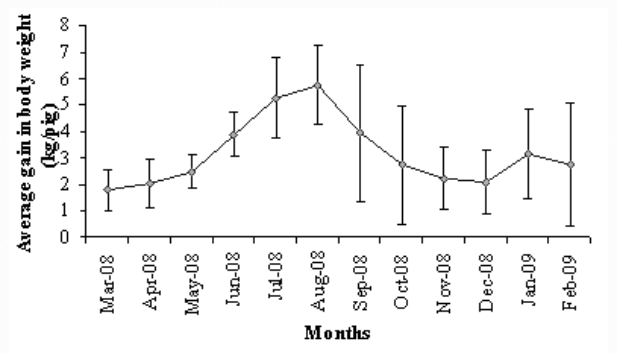

Fig 1 Monthly variation of average gain in body weight by a pig

Success story

Shri Taiyang Konyak of Lampong Sheanghah village of this District is a progressive tribal farmer who owns a land of about 2.0 ha on the hill slopes. His grand success in agro-horti-fish-animal consortium is tabulated in Table 3. Prior to the implementation of NAIP, he was doing *jhum* cultivation in which he used to carry out mixed cropping. Because of the interventions of ICAR Nagaland Centre under the NAIP (Component-III), within a span of four years, he was able to enhance his annual net family income from about Rs.19,600 to Rs.53,400, with an annual increase in net income of about 172.5% from baseline. Most of

Table 3 Success story of Shri Taiyang Konyak

Name of Farmer, Address	Adopted Technology	Land (ha) /unit		Productivity (ton/ha) / Production (quintal)		Net Income (Rs.)	
		Before	After	Before	After	Before project implement-ation (2007-08)	After project implement-ation (2011-12)
Shri Taiyang Konyak, Vill. Lampong Sheanghah, Distt. Mon, Nagaland Total land owned: 2.0 ha	Terrace rice cultivation (*Panikheti*)	NIL	0.41	NIL	11.50 / 3.22	NIL	Rs. 9700
	Improved *jhum* cultivation system (using conservation agriculture-Mulching, contour bunding)	Paddy: 0.75; Colocasia: 0.55; Tapioca: 0.16; Millet: 0.1; Banana (local variety): 0.005	Paddy: 0.32; Colocasia: 0.25; Tapioca: 0.10; Millet: 0.38; Banana (good variety): 0.005	Paddy: 1.07 / 8.00; Colocasia: 3.64 / 20.0; Tapioca: 1.60/2.56; Millet: 0.50/ 0.50	Paddy: 1.88 /6; Colocasia: 4.88 / 12.2; Tapioca: 3.7/3.7; Millet: 0.39/1.50	Paddy: 2600; Colocasia: 15200; Tapioca: 1548; Millet: 50; Banana: 200	Paddy: 4900; Colocasia: 13940; Tapioca: 4040; Millet: 1300; Banana: 900
	Vegetable cultivation (using multiple water use system)	NIL	Radish: 0.09; Potato: 0.12; F. beans: 0.05; Carrot: 0.08; Leafy vegetables: 0.01	NIL	Radish: 0.33/0.30; Potato: 3.58/4.30; F. beans: 0.46/0.23; Carrot: 0.43/0.34; Leafy vegetables: 4.0/0.40	NIL	Radish: 500; Potato: 8510; F. beans: 390; Carrot: 620; Leafy vegetables: 570
	Integrated Pig-cum-Fish farming system	1 Fish pond: 0.0722 ha	1 Pig : 0.90 quintal; 1 Fish pond: 0.0722 ha	NIL	1 Pig : 0.90 quintal; Fish: 0.11 /0.082	NIL	Pig: 7200; Fish: 832
	Total	1.6372	1.8872			19,598	53,400

his income comes from the cultivation of terrace rice, *jhum* rice, colocasia, tapioca, carrot, radish, potato, leafy vegetables, French bean, piggery, and pig-cum-fish integrated farming system. Under this scheme, about 0.41 ha of his *jhum* land was converted into terraces, wherein irrigation during lead period is supplemented by spring water harvesting meant for

rabi crops. In rest of his *jhum* lands, conservation agriculture is adopted. With the technical assistance of ICAR Nagaland Centre, he recycles his within-farm resources for improved agriculture. Recently, he has taken training on apiculture and provided with four units of bee hives. With his income, he was able to fulfil the livelihood and nutritional security of his family and was able to send his two children to a boarding school. His transformation from a primitive farmer to a successful modern farmer is exemplary as far as the agriculture scenario of Mon district is concerned.

By observing the splendid success of Mr. Taiyang, some other farmers *viz.* Mr. Yoao, Mr. Nahwang, Mr. Chiphang, Mr. Pankhe, Mr. Noko, Mr. Nokom, Mr. Shingwang, Mr. Letpong, Mr. Tonpha, Mr. Chuying, Mr. Panpha, Mr. Yuphung, Mr. Choli, Mr. Konwang, Mr. Chingoham were also motivated.

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Ensuring livelihood through integrated farming system

Pankaj Bezbaruah
AFPRO Task Force, Guwahati

Introduction

Integrated Farming System is the integration or combination of different enterprises such as Agro-Forestry, Horticulture, Livestock (Dairy, Goatry, Piggery, Poultry, Duckery etc.), Bee Keeping, Mushroom, Aquaculture, Biogas, Biodigester (Compost), Sericulture and bi product utilization with crops with the main goal of increasing the income and standard of living of small and marginal farmers. Dhemaji is a remote district of Assam where 47.29% of the total population is ST, which is the indigenous tribes of the state like Mishing, Bodo, Rabha, Lalung, Sonowal, Garo and Deori along with Hazong, ST Nepalis and some tribes of Arunachal Pradesh along the foothill region. The flood in the district became more devastative, people moved to newer places in search of cultivable lands at the cost of more devastation of the forest resources. The cultivable land which was abundant became scarce, the forest products vanished from the area, the fish habitats were destroyed, the earlier abundant grazing fields for the cattle diminished and the population lost their sustainable and eco-friendly livelihood pattern and part of the population became more marginalized due recurring flood devastation and displacement. The changes are so rapid that most of the families detracted from the agriculture and huge numbers of persons have migrated from the district in search of earning. In order to deal better with flood and their changing characters, one of the ways is to build peoples adaptive capabilities through raising their awareness, knowledge base and capacities to earn a living through a selection of appropriate crops and techniques. To address these challenges, the AFPRO has designed the project of promoting livelihoods through integrated farming system for the areas of Dhemaji with the theme of "***Live Better with the Flood***".

Methodology

A preliminary survey was conducted by AFPRO team in Dhemaji district. The flood affected and flood prone areas were identified along with the existing systems of farming and livelihood opportunities. Accordingly critical gaps were identified based on the present situation which were prioritized. Farming systems having similar resource base, enterprise patterns, household livelihoods, rural skills, constraints and short out the root causative factors during flood and post flood situation were analyzed and prioritized. The flood affected areas of 38 villages under four blocks were identified and 2 clusters were formed depending on the socio-economic and agro climatic situations. Identified the IFS Model as per the suitability and local context in order to improve the efficiency of the interventions so as to bring rapid action and/or impact. The modules consisted of rice, fish, livestock (cattle, pig and goat)/poultry, horticulture (fruit and vegetables).

There are four basic IFS modules which were intervened and being practiced by the targeted families to improve sustainable livelihood. Module 1 (Rice-Fish-Horticulture), Module 2 (Livestock-Fish-Vegetable), Module 3 (Dairy- fish – Horticulture) and Module 4 (Sericulture-Livestock-Horticulture). Amongst the all four models, Livestock-fish – vegetable model was found to be most successful in terms of improving the livelihoods of rural community. A brief of the model is given below:

Module 2 (Livestock-Fish-Vegetable)

This module consisted of three sub-modules i.e., poultry-fish-vegetable (55 HH in 24 ha), duck-fish-vegetable (50HH in 22 ha) and pig-fish-vegetable (180 HH in 81 ha). The technology involved was growing vegetables around the fishery pond and rearing of poultry and pig and ruminants above or nearby the fishery pond. There was coverage of altogether 127 ha with 285 HH under this module. Poultry houses have been constructed just above the fish pond so that waste product of poultry would be fed to the fingerlings. Inclusion of HYV of vegetables like Cabbage, Cauliflower, Chilli, Tomato, French bean, Pumpkin, Bottle gourd, Ladies finger, Brinjal, Potato etc. enhanced the production far above the previously grown local cultivars. Fingerlings of Rohu, Katla, Mrigal, Silver Carp, Grass carp etc. were distributed among the stakeholders. Upgraded 965 nos. of local pigs to cross breeds of pig (Hampshire) and 4528 nos. of poultry chick (Croiler) and 1125 nos. of duck (Chara Cambell) were integrated with fish farming at homestead. Bio-wastes from piggery, poultry were recycled into the fishpond to substitute fertilizers and fish feed and also used in the vegetable garden. Major intervention in animal components was used as balanced feed, de-worming, and vaccination.

Results

Production

Crop	**Initial yield (t/ha)**	**Improved yield (t/ha)**	**Average income/year (Rs/house hold)**
Vegetables	3	4.8	5200-6000
Fish	0.3	0.5	6000-25,000
Livestock (total No.)		2379	5530 18,300-40,000

Income

Component	**Particulars**	**Beneficiaries**	**Area adopted**	**Average income before the project implementation**	**Average income after project implementation**
Increased livelihoods through integrated farming systems	Livestock-Fish-Horticulture	285 Nos	127 ha	Rs 33,563.00	Rs 50,000 to 72,000.00/yr

Success story

Success Story of Poultry-Fish-Horticulture Integrated Farming System

Mr. Gadhal Mandal, a 48 years old farmer of Dharmapur village of Sisiborgaon Block, is one of the beneficiaries of NAIP who has got an excellent amount income from integrated poultry-fish-horticulture farming system. He has got 2 ponds measuring 0.13 ha each. After getting training from the project on integrated farming system, he has constructed a poultry shed over the pond by using locally available materials like bamboo and thatch. We have supported him from the project by providing inputs like 100 numbers of croiler chicks, feed, medicines, fingerlings for composite fish culture, fertilizers, vegetable seeds etc. He utilized bunds of both the ponds for vegetable crops and followed the multiple stock and multiple harvest of fish rearing. In one year, he earned Rs. 40,000 from selling the croiler birds and Rs. 25,000 from fish selling as well as Rs. 6000 from vegetable growing in the bunds of the ponds. Now, he is rearing broiler bird instead of croiler as the later takes more time to get economic return. He is happy enough as he has got good return from this integrated system to run his household of 6 family members.

Integrated farming system model is an option of livelihood improvement in unused tilla land area of Dhalai district, Tripura

P. Chakraborti and C. Mog
Dhalai Zilla Parishad, Ambassa, Dhalai,Tripura

Introduction

Dhalai district is the smallest district in Tripura. It was formed in 1995 covering an area of 2312.29 sq km. The district is reach in natural resources and 70% of the area is covered by hills and forest. Total population of the district is 3, 36,491 as per the census of India 2001. Population density of the district is 139 nos. per sq km. and more than 70% of the population lives below the poverty line. Majority of the population belongs to schedule tribe community. The temperature of the district is 36°C max. 16°C min in summer and 28°C max. and 5°C min. in winter. Cropping intensity is 158%. Socio-economic condition of the people is very poor. Basic source of income of the farmers is from agriculture and allied sectors. The farmers are very poor. They have tilla land but they do not use their tilla land for income. They have no idea about the scientific integrated farming system. They do not have proper training in such areas. The improved varieties of crop seeds are not available in those areas and farmers used to collect low quality crop seeds from the traders. Therefore it is very necessary to improve the livelihood of the rural farmers through utilization of specific land area and develop location specific farming system for the enhancement of income in a sustainable way. Keeping the above statement in view the present programme of integrated farming system (Agri-Horti-Piggery-Fishery) has been envisaged by the Dhalai Zilla Parishad (DZP), Ambassa through NAIP among Balaram and Maracherra clusters of Dhalai district. The primary objectives were

- To integrate agriculture, horticulture, animal husbandry and fishery for proper utilization of specific land area.
- To develop location specific integrated farming system.
- To enhance the production and economic status of the poor farmers through a sustainable way.
- To maintain the agro-ecosystem for sustainability, profitability and competitiveness.

With these objectives**,** Agri-Horti-Piggery-Fishery based integrated farming projects were taken up in Balaram and Maracherra clusters.

Methodology

We visited the Custer Area along with the technical staffs, examined several spots and selected the beneficiaries who have suitable land etc. The beneficiaries were imparted trainings and on field practical demonstrations for proper execution in all aspects. Improved

varieties of inputs and technology were provided to the beneficiaries. Seedlings of pineapple, tapioca, arcanut, banana, pigglets, pigfeed, fingerlings and fishfeed were provided to the farmers. Pig sheds were also constructed for better safety and health of the pigs. Also the pig excreta can be easily collected so that these can be used as manures and fishfeed. Requisite fertilizers were provided. Proper fencing materials were also provided. The fishery ponds were renovated with assistance from the Panchayats through MGNREGP. For all the projects, we monitored regularly the implementation of the whole project and necessary advices / suggestions were given as and when required.

Results

Farming systems were demonstrated in three farmers fields of this district. Out of these three farmers two of them have attained a good production and good economic returns from their produces (Table 1).

Table 1a Productivity and income of the farmers through integrated farming system (2010-11)

Name of Beneficiary	Component	Area (ha/ unit)	Before intervention		After intervention	
			Production (kg)	Income (Rs.)	Production (kg)	Income (Rs.)
Ramendra Marak	Pineapple (Kew)	1 ha	Nil	Nil	Growing stage	Nil
	Tapioca		Nil	Nil	24000	1,50,000
	Banana	0.8 ha	Nil	Nil	225 bunch	16,875
	Arecanut	1 ha	Nil	Nil	Growing stage	Nil
	Pisciculture	0.20 ha	1200	1,44,000/	1728	2,07,360
	Pig farming system	1unit (2 nos)	Nil	Nil	6 nos. piglets born.	19,000
	Total	3 ha		1,44,000		4,00,235
Marak Durga	Pineapple (kew)	2.18 ha	25,000 nos.	1,25,000	35,000 nos.	1,75,000
	Arecanut		Nil	Nil	Growing stage	Nil
	Lemon		500 nos.	1,000	1,500 nos	3,000/
	Banana		125 banch	9,375	275 banch	20,625
	Pisciculture	0.32 ha	700 kg.	84,000	1125 kg.	1,35,000
	Total	2.5 ha		1,43,775		3,33,625

Table 1b Productivity and income of the farmers through integrated farming system (2011-12)

Name of Beneficiary	Component	Area (ha/unit.)	Production (kg)	Income (Rs.)
Ramendra Marak	Pineapple (Kew)	1 ha	45 nos	270
	Tapioca		Growing stage	Nil
	Banana	0.8 ha	255 bunch	19,125
	Arecanut	1 ha	Growing stage	Nil
	Pisciculture	0.20 ha	2000	2,40,000
	Pig farming system	1unit (2 nos)	7 nos. piglets born.	14,000
	Total	3 ha		2,73,395
Durga Marak	Pineapple (kew)	2.18 ha	40,000 nos.	2,40,000
	Arecanut		Growing stage	Nil
	Lamon		2200 nos	4,400
	Banana		307 banch	23,025
	Pisciculture	0.32 ha	1780	2,13,600
	Total	2.5 ha		4,81,025

Conclusion

Before intervention the farmers did not use their tilla land properly for specific utilization for the development of farming system. After intervention they got the idea about the scientific utilization of specific land area for proper method of farming system development. They got the knowledge how to use their tilla land for integrated farming system model and enhance the productivity and profitability. Before intervention the productivity was Rs. 7, 20,000/ha at Balaram and Rs**.** 3, 25,137 at Maracharra but after intervention it has increased as Rs. 4,00,235/ha.during the year 2010-11 and Rs. 2,73,395/ ha during the year 2011-12 at Balaram and Rs. 3,33,625**/**ha during the year 2010-11 and Rs. 4,81,025**/**ha during the year 2011-12 at Maracharra. It is now a proven technology for the poor farmers of Dhalai district through which the marginal and poor farmers may increase their productivity and economic status through a sustainable manner.

Performance evaluation of rice + fish + vegetable integrated farming system in different clusters of Assam

J. Deka, P.K. Gogoi, N.C. Deka, N. Borah, T.C. Brahma, A. Rajbanshi, P. Gogoi, D. Malakar, P. Bora and P. Mahanta

Assam Agricultural University, Jorhat, Assam

Introduction

The Indian rural population is primarily dependent on agriculture and allied activities for their livelihood, but over 30 to 35% of them are threatened by the problems of unemployment and food security. Low land and labour productivity in agriculture are the real challenges resulting in widening gap between agriculture and non-agriculture sectors. Adoption of integrated farming systems (IFS) with profitable combinations of crop, livestock, horticulture, fishery, sericulture and other feasible farm enterprises will help to augment the land and labour productivity on one hand and secure the livelihood of the rural poor on the other. Keeping in view the above facts, the sub-project entitled 'Livelihood promotion through integrated farming system in Assam' was implemented under Component 3 of National Agricultural Innovation Project during 2008 in six clusters (Kokrajhar, Gossaingaon, Diphu, Hamren, Lakhimpur and Dhakuakhana) of three disadvantaged districts of Assam *viz*., Kokrajhar, Karbi Anglong and Lakhimpur). Rice is the most important agricultural crop in all the three districts and prevailing farming systems are basically rice based. Traditional system of rice production is not an economically viable enterprise but it is unavoidable and essential. An asset based approach for integrating fish and vegetable with rice as a viable farming system is required for livelihood promotion of the farm families as well as sustainable agriculture in the three districts.. The specific objectives for selecting the Rice+Fish+Vegetable IFS module were: i) to improve productivity through introduction of agro-ecologically appropriate technological intervention, ii) to protect natural resource base and environment through introduction of IFS.

Methodology

The IFS module of rice-fish-vegetable was given to 300 farm families in each of the three clusters (totaling 1800 farm families) during three years of project intervention. The rice crop was integrated with fish during the *kharif* season and a unit area of 2800 m^2 was put under this module. It was followed by vegetable crops *viz.*, french bean, chilli and knol khol on 650, 650 and 1300 m^2, respectively. Depending on the land situation, high yielding rice varieties *viz*., Ranjit, submergence tolerant variety (Jalashree and Jalkunwari) and staggered planting variety (Gitesh) were introduced. The design of the rice field was appropriately modified for integration of fish. The synchronous system for rice-fish

integration was adopted since submergence level of 50 cm to 1.00 m depth remains in the field continuously for three months. Peripheral trench of 60 cm depth and width was dug around the rice field as a fish refuse with a levee to prevent entry of wild aquatic organisms and escape of fish by jumping. In ideal situations, field ponds already existing near the rice field were connected to the rice field with the help of a ditch with levee which served as the fish refuse instead of constructing trenches. Rice is transplanted employing recommended package of practices. Fish (carp fingerings excluding grass carp) was released in the rice plot @ 3000 after 15 days of transplantation of rice. Fish was harvested as soon as the submergence of water from the rice field receded and fish withdrew into the refuse (trench/ field pond as the case may be). Data was recorded from 40 randomly selected beneficiary households in each cluster. Production data of different commodities was statistically analyzed. Net income, cost of production, benefit-cost ratio and link relative index were calculated.

The net income from the integrated farming system was calculated by a function (Amarasinghe, 1992):

$NI=(P_1XR_1+ P_2XR_2+ P_3XR_3+ P_4XR_4+ P_5XR_5) –(C_1+ C_2+ C_3+ C_4+ C_5)$ where, NI= Net income from IFS, P_1,P_2 ,P_3, P_4, P_5 are productivity; R_1, R_2, R_3, R_4, R_5 are prices and C_1, C_2, C_3, C_4 and C_5 are the cost of production of rice, fish, French bean, chilli and knol khol, respectively.

The Link Relative Index (LRI) was calculated by the following formula (Singh *et al*, 1994):

$$Link\ Relative\ Index\ (LRI) = \frac{NI_1}{NI_0} \times 100$$

Where, NI_0= mean net income of farmer's traditional farming practice and NI1=mean net income of the IFS with improved practices.

Results

The data presented in table 1 revealed that the highest production from rice was obtained in Diphu cluster and the lowest was in Dhakuwakhana cluster. In both the clusters of Karbi Anglong district *viz.* Diphu and Hamren, production levels achieved were higher than other clusters. This could indicate better conditions for rice cultivation and benefits of integrating fish with rice in this district. However, mean production of fish was comparatively higher in Kokrajhar district. The production of vegetables *viz*., french bean,chilli and knol khol was higher in clusters located in Karbi Anglong, Lakhimpur and Kokrajhar district, respectively. The mean net income from the IFS with improved practice ranged between Rs. 89,235 per hain Lakhimpur cluster to Rs. 1,47,933 per ha in Diphu cluster and the benefit-cost ratio varied between 2.5:1 in Lakhimpur to 3.8:1 in Diphu. The benefit-cost ratio from the traditional farming practice of rice monoculture ranged between 1.4:1 in Lakhimpur and

Table 1 Cluster wise productivity analysis of different commodities under rice-fish-vegetable integrated farming system

Cluster	Rice			Fish			French bean (t/ha)			Chilli (t/ha)			Knol khol (t/ha)		
	Av. Pr. (t)	SD (±)	CV (%)	Av. Pr. (kg)	SD (±)	CV (%)	Av. Pr. (t)	SD (±)	CV (%)	Av. Pr. (q)	SD (±)	CV (%)	Av. Pr. (t)	SD (±)	CV (%)
Kokrajhar	1.185	0.058	4.93	42.35	1.66	3.91	0.317	0.005	1.55	0.1563	0.008	5.11	0.620	0.005	0.82
Gossaigaon	1.187	0.044	3.76	41.93	3.51	8.38	0.323	0.017	5.23	0.1539	0.022	16.13	0.622	0.012	1.96
Diphu	1.252	0.068	5.44	41.65	2.32	5.59	0.677	0.56	82.69	0.1543	0.041	28.67	0.423	0.492	116.16
Hamren	1.224	0.090	7.41	38.30	5.96	15.57	0.615	0.03	4.87	0.1554	0.023	15.54	0.331	0.028	8.66
Lakhimpur	1.138	0.265	23.36	25.02	13.51	54.01	0.250	0.099	39.99	0.1580	0.064	35.53	0.221	0.080	36.45
Dhakuakhana	1.090	0.134	12.30	34.35	14.58	42.45	0.560	0.081	14.57	0.2531	0.060	26.14	0.341	0.074	21.76

Table 2 Net income, cost of production, benefit-cost ratio and link relative index of Rice + Fish +Vegetable IFS in different clusters

Name of cluster	IFS with improved practice		B:C ratio	Traditional farming		B:C ratio	Link Relative Index (LRI) of improved IFS
	Net income (Rs./ha)	Cost (Rs./ha)		Net income (Rs./ha)	Cost (Rs./ha)		
Kokrajhar	1,13,636	34,282	3.3	27,855	16,000	1.7	407.95
Gossaigaon	1,12,233	33,000	3.4	26,595	14,500	1.8	422.00
Diphu	1,47,933	38,200	3.8	25,053	14,800	1.6	590.48
Hamren	1,36,826	39,000	3.4	26,280	18,500	1.4	520.64
Lakhimpur	89,235	35,200	2.5	27,071	18,500	1.4	329.63
Dhakuwakhana	1,16,178	33,000	3.5	24,547	16,250	1.5	473.28

Hamren to 1.8:1 in Gossaigaon cluster. The highest LRI was found in the Diphu cluster while Lakhimpur registered lowest value of LRI.

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Location specific fish based farming system: a unique tool to improve the livelihood of small and marginal farmers

Ratan K. Saha and Dillip Nath
College of Fisheries, Central Agricultural University, Lembucherra, Tripura

Introduction

Dhalai District of Tripura is mainly a valley between two hilly terrains namely "Atharamura Range" and "Shakhan Range". The strengths of the district are its huge natural resources, favourable climate as well as adequate rain fall and vast water areas. If all these resources could be utilized properly, rapid development could be achieved. However due to lack of required infrastructure, the district was lagging behind. It was evident from the district profile that in most of the development parameters it is lagging behind. "Livelihood Improvement and Empowerment of Rural Poor through sustainable Farming Systems in North Eastern Region" under Sustainable Rural Livelihood Security (SRLS), Component – III to improve the socio-economic condition of the people of the area was undertaken under National Agricultural Innovation Project (NAIP) has launched during the year 2007. There is a great opportunity to improve fish culture along with other agricultural crops. Under this project, College of Fisheries has implement fish based farming system for the improvement of livelihood of rural small and maginal farmers by enhancing productivity, profitability, employment opportunity and sustainability. In this system, aquaculture was integrated with agriculture and animal husbandry practices to achieve the maximum gain. It provides efficient means of recycling agriculture and domestic wastes in the ponds as such as maintaining the energy flow and the environmental equilibrium. Therefore, 'Scientific Fish based Farming System Models' (aquaculture + agriculture (horticulture) + animal husbandry= A^3 models) have been introduced in both the clusters (Balaram and Marachara) at Dhalai district of Tripura.

Methodology

The present technology intervention is a location specific scientific modification of traditional farming system. The adjacent plain land near the fish pond was used for vegetables, fruits and rice culture according to specific location. A scientific layout of the available land have been planned in such a way that farmer can grow fish, rice, vegetable and fruits. Pig shed was also prepared at the farm site. To perform such activities various training programmes were organized on location specific fish based farming system modules and also provided different inputs such as quality fish seed, balanced fish feed, lime, vegetable seeds, rice seed, different planting materials, piglets, etc. The vegetable cultivation was done on pond embankment as well as on adjacent plain land and dyke whereas the fruit crops like banana, papaya and mango (Amrapali) were planted on pond embankment and

adjacent hilly areas. The maintenance of fish ponds, fruit field, vegetable field, pig sheds and the monitoring of their health, nutrition, soil and water quality of ponds and crop fields were followed regularly for better production.

Results

For proper implementation of the fish based farming system, total 9 interventions have been introduced. Out of them, 5 interventions have shown more suitability for this locality. The brief summary of the output are given below (Table 1).

Table 1 Output of five major interventions of fish based farming system in farmer's field

Sl. No.	Name of the farming system	Name of the farmer & Cluster	Total area (ha)	Net Income (in Rs) gained by the farmer		BCR	
				Before intervention	After intervention	Before intervention	After intervention
1	Fish-rice-vegetable-fruit farming	Mr. Surjasen Satnami, Maracherra	0.36 ha (Land Area= 0.24 ha Water area Before intervention=0.8 After intervention = 0.12 ha)	3,000.00	27,700.00	2.36	2.49
2	Fish-vegetable-fruit farming	Santineer SHG (New Pond)	0.48 (Land Area= 0.16 ha Water area = 0.32 ha)	16,500.00	64,700.00	3.35	2.48
3	Fish-fruit-vegetable-pig farming	Sri. Uttam Debnath	0.47 ha (Land Area= 0.32 ha Water area = 0.15ha)	5000	40,600	1.57	2.71
		Mr. Bimal Debnath	0.32 ha (Land Area= 0.32 ha Water area = 0.08ha)	5000	24,800		
		Mr. Bhagirath Debbarma	0.47 ha (Land Area= 0.32 ha Water area = 0.15ha)	500	18,400		
4	Fish - fruit -vegetable - pig - fish spawn farming	Mr. Biswakumar Debbarma	0.33 ha (Land Area= 0.24 ha Water area = 0.09ha)	300	5,800	1.66	2.87

Contd....

		Santineer SHG (Old pond)	0.18ha (Land Area= 0.08 ha Water area = 0.10ha)	0	12,000		
5	Fish spawn rearing	Mr. Baburam Satnami	Area= 0.08 ha (Water area = 0.08ha)	0	21,850.00	0	2.65

The farmers are going to enhance their economic status by adopting the fish based farming system. Out of nine interventions five of them were found to be more effective compared to the rests. The productivity and income from the farming systems are going in increasing trend. The people have learned about the scientific integration of fish, vegetable, rice, fruits and pigs for better economic growth and over all development of the society.

Conclusion

Small and marginal farmers have learned about the utility of integrated farming system options through proper land utilization and management practices in scientific way to get a profitable return. The other farmers are now very much interested to follow fish based farming system after releasing the potential economic benefit of fish based farming system.

Fish-rice-vegetable-fruit farming system: a livelihood option for small and marginal farmers in Dhalai, Tripura

Ratan K. Saha and Dilip Nath
College of Fisheries, Central Agricultural University, Lembucherra, Tripura

Introduction

Rice and fish go together as food in many parts of the world and our country particularly the north eastern region. Rice and fish are the major food items for the people of Tripura. Rice-fish culture under either capture systems or culture systems is a low-cost sustainable practice to obtain high value protein food and minerals. The rice field is a rich and productive biological system which can produce a crop of aquatic organisms, both plant and animal, for human consumption in addition to the rice. In many areas, irrigation-fed rice fields have also been adapted locally by the farmers to include fish farming. Traditional rice-fish production systems have an important socioeconomic part in the life of the farmers and fishers in the region. Rice-fish farming is an old aged practice for the people of Tripura and other north-eastern states. The system is known as paddy-cum-fish culture. However, the productivity of fish in most cases are very low (600 kg/ha) due to non adoption of scientific approach. The rice field and the embankment within the paddy-cum-fish culture may be used for vegetable and fruit farming and the system may be modified as "fish-rice-vegetable-fruit farming system". The vegetable may grow on the embankment as well as the rice field after harvesting the crops. The fruits like banana, papaya, etc. may be grown on the dyke which can help to protect the direct sunlight on pond. In the earlier system the ponds are mostly underutilized and farmers can hardly meet their daily needs. There is ample scope for enhancing fish and crop productivity scientifically by integrating them. Keeping this in mind the present intervention has been implemented with a objective to evaluate and validate the indigenous and improved fish based farming system model for enhancing production in agro-ecosystem of disadvantageous areas of Dhalai district of Tripura for sustainability, profitability and competitiveness.

Methodology

The present technology intervention is a location specific scientific modification of traditional paddy-cum-fish culture which gives low fish production and one crop of paddy only. In the traditional fish farming system farmers only practiced the fish culture in an unscientific way. They did not maintain proper methodology of fish farming. The adjacent plain land near the fish pond was used for rice culture only. No vegetable and fruit farming was practiced by them. A scientific layout of the available land has been planned in such a way that farmer can grow fish, rice, vegetable and fruits simultaneously. For fish culture we have renovated channels and main reservoir and also made use of water throughout the

season for rice, fruit or vegetable farming on the adjacent land. To perform such activities various training programme were organized on location specific fish based farming system modules and also provided different input such as quality fish seed, balanced fish feed, lime, vegetable seeds and different planting materials etc. The stocking ratio of fish species was maintained as 5 species @ catla (3): silver carp (1): rohu (3): mrigal/ prawn (1.5): common/ amur carp (1.5). Initial stocking density was @ 12,000 nos. /ha and periodical stocking @ 8,000 nos./ha. Rice (Gumoti variety) farming was practiced on plain land of that system. The vegetable cultivation (bottle guard, potato, ridge gourd, string bean, local bean) was done on pond embankment as well as adjacent plain land whereas the fruit crops like banana and papaya were planted on pond embankment. The monitoring and maintenance of fish pond, rice field, fruit field, vegetable field, pest management, and soil and water quality were followed regularly for better production. The success story of Sri Suryasen Satnami, Maracherra is documented and indicated below. The total land area of Mr. Satnami is 0.36 ha along with water area of 0.12 ha.

Results

The significant outcomes of the technology during 2011-12 are furnished below in the table 1. In the traditional paddy-cum-fish culture the production of fish was only 600-800 kg/ha but in IFS system fish productivity was increased to 1,250 kg/ ha. Sri Surjasen Satnami of Maracherra earned a net income of Rs. 27,700 from his IFS model through fish-rice-vegetable and fruit farming from an area of 0.36 ha in a single year (Table 1).

Table 1. Production and economics of fish-rice-vegetable-fruit farming based framing system

Particulars	Net Income (in Rs) Before intervention	Production after intervention	Net Income (in Rs) After intervention (2011-12)
Land Area= 0.24 ha	0	Vegetables (Bottle guard, Potato, Ridge gourd, String bean, Local bean) = 3550 kg	13,700.00
	1,500.00	Rice = 280 kg	4,000.00
Water area= 0.08 ha (Before intervention) Water area= 0.12 ha (After intervention)	1,500.00	Fish= 150kg	10,000.00
Total net income*	3,000.00		27,700.00
Cost of production	2,200.00		18,500,00
B:C Ratio	2.36		2.49
Employment (man-days)	33		65

*Fruit cultivation: Banana suckers have been planted during 2011-12; the fruiting will be started during the 2012-13 and due to that reason the income of fruits have not been given in the table.

Conclusion

Since aquaculture requires resources such as pond, land, water and other inputs, poor farmers cannot afford the requirements. If we really target to the rural poor of Dhalai region to develop their livelihood through integrated fish farming it should be done by the utilization of common water resources available in their rice-fields. So, fish- rice-vegetable-fruit farming system is the most appropriate technological intervention in recent times. Such approach may pave the way for enhanced farming system production and aquatic productivity from the natural waters.

Role of piggery in integrated farming system in north east region

N. Prakash, I.M. Singh, A. Suresh Kumar Meitei, L. Surchand Singh, and N. Johnson Singh
ICAR, Research Complex for NEH Region, Manipur Centre, Lamphelpat, Manipur

Introduction

As the hill farmers have small holding, crop production and animal husbandry are the main components for a majority of the farming system in the north eastern hill region (NEH) of India. Agriculture, however, is of subsistence type characterized by mono cropping, low cropping intensity etc. It alone cannot support the livelihood need of the population unless animal husbandry is incorporated as a component in the overall farming system. Pig is the most popular and valued livestock in the NEH region as almost majority of the tribal population are pork eaters. Thus, to revolutionize pork production in this region, skill up gradation of the pig farmers on quality, quantity and profitable mode of production is inevitable.

Comparative Performance of Local Desi Pig and Improved Hampshire Pig

It has been found that the performance of nondescript pig which farmers generally rear is very poor. The pig farmers are also aware of the fact that the rearing of nondescript pigs is not going to give them much economic return; therefore, they are reluctant to spend on their housing, feeding, management and health care. The pigs are simply let loose and allowed to pick up whatever they can get through scavenging.

Table 1: Comparative Performance of Two Different Genetic Groups of Pigs

Sl. No.	Traits	Manipur Local	Improved Hampshire
1.	Age at first farrowing (months)	12.11± 2.51	14.58 ± 0.27
2.	Gestation periods (days)	118.20 ± 2.27	114.24 ± 0.88
3.	Inter-farrowing interval (months)	8.33 ± 0.30	7.54 + 0.07
4.	Litter size at Birth (No)	7.20 ± 0.65	9.89 ± 0.40
5.	Litter size at weaning (No)	5.20 ± 0.65	8.33 ± 0.56
6.	Litter weight at birth (Kg)	6.50 ± 0.43	14.20 ± 1.04
7.	Pig weight at maturity (Kg)	43.40 ± 5.25	77.87 ± 4.10
8.	Birth weight of piglet (Kg)	0.88 ± 0.08	1.35 ± 0.08
9.	Weaning of piglet (Kg)	4.89 ± 0.27	8.10 ± 0.51
10.	Pre weaning mortality (%)	16.34	7.21

With a view to overcome these shortfalls and to give a boost to the status of pig production in the NE states by improving the commercial value of pigs through the application

of tested technologies developed by ICAR Research Complex for NEH Region has conducted as one programme on the development of technology for pig production by cross breeding improved Hampshire with the indigenous pigs. Improved Hampshire pig in their production and reproduction performance having over advantage than indigenous pig for traits like age at first furrowing, inter-farrowing intervals, body weight and litter size etc. The production economics of these groups of pigs were computed based on the present input components in integrated farming system.

Growth Performance of Piggery

Role of piggery is synergetic rather than primary producer in Integrated farming system. Data on growth performance of different categories of piggery have been collected and compared with growth performance of the same in traditional husbandry practices. The data indicated that the growth of pig was higher in Integrated farming system (0.32kg/day) compared to traditional farming system where the growth of pig was (0.22kg/day). The average slaughtering weight of pig was recorded 80 kg in Integrated farming system and 60 kg in traditional animal husbandry practices.

Fig.1: Growth of Pig in Integrated and traditional farming system (Vertical bars representing S.D.)

Impact of Improved Hampshire Pig

During 2008-09, a total of 18 farm families of three cluster villages *viz.* (Noney) Longmai, Raengkhong and Awangkhul has been selected for Scientific Pig Rearing under NAIP project and they were imparted training on improved package of practices and

management of improved breed of pig and the adopted farmers started rearing with cross-bred Hampshire piglets with initial body weight of 7 to 8 ± 1.5 kg (10 beneficiary farmers with unit of 3 piglets of one male and two female piglets each and other 8 beneficiary farmers with unit of 2 piglets of one male and one female each). In the initial growth stages, they were fed with balanced concentrate feed supplemented with vitamins and minerals according to their body weights and during the flattening stage fed with feeds gathered from common-properties or produced by the household on their smallholder farms and in their backyards and locally available feeds like Colocasia (*Colocasia esculenta*) or taro and tapioca (cassava). Total 28 reared sows gave birth to 140 piglets in the first farrowing and out of these, 74 piglets were kept as replacement stocks and remaining 66 piglets were sold to 33 other neighbouring non-beneficiary farmers @ Rs.2,000/piglet in the year 2009-10. During 2010-11, a total of 518 piglets were produced, 168 piglets from the second farrowing of 28 parental female stocks, 185 piglets from the first farrowing of 37 female replacement stocks of 18 beneficiary farm families and 165 nos. of piglets were produced from the first furrowing of other 33 farm families. Out of 518 piglets, 299 piglets were sold to 149 other non beneficiary farm families (one male and one female each) @ Rs 2500/ piglet and the remaining 54 piglets were kept as replacement stocks by 18 beneficiary farmers maintaining 3 piglets (1 male and 2 female) for further production programme in the year 2010-11and 164 piglets from 33 non beneficiary farm families were sold to neighbouring 84 farm families. Till date 272 farm families have started rearing the improved breed Hampshire in the adopted cluster villages. A net return of Rs 38,094.00 per farm family could earn from improved Hampshire pig rearing and thus improved the livelihood of poor farmers. During 2011-12,a total of new 21 farm families of four cluster villages viz Marangching, Noney, Reangkhong and Awangkhul villages were started rearing with improved Hampshire piglets under the programme of piggery.

Table 2 Adopted farmers, number of piglets, body weight and mortality rate under the programme "Scientific Pig Rearing", 2008-09

Sl No	Cluster village	Adopted farmers	No.of piglets	Breed	Body weight (Kg)	Mortality Rate (%)	
						Adopted	Check
1	Noney	8	24 (M8:F16)	Cross breed Hampshire	55±3.0 kg at 6 months	8.33	15
2	Reangkhong	5	15 (M5:F10)	Cross breed Hampshire	85± 3.0 kg at 9 months	6.66	16
3	Awangkhul	5	15 (M5:F10)	Cross breed Hampshire	75± 3.0Kg at 9 months	6.66	18
Total		18	54 (M18:F26)				

Table 3 Adoption of improved pig breed of Hampshire in the cluster area

Year	2008-09	2009-10	2010-11	2011-12
Farm families	18	51	251	272

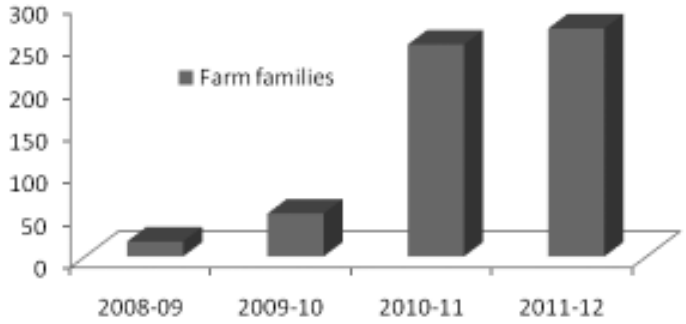

Fig 2 Adoption of improved pig breed of Hampshire in the cluster area

Table 4 Return per farm family for rearing a unit of 2 females and 1 male improved breed Hampshire (2 years rearing period)

Particulars	Quantity	Return (Rs)
1.Sale of adult pigs @ Rs 8000/ pig	3 nos.	24,000.00
2.Sale of piglets @ Rs 2000/ piglet from 1st furrowing	10 nos.	20,000.00
3.Sale of piglets @Rs 2500/ piglet from 2nd furrowing	12 nos.	30,000.00
Total Return (Rs)	74,000.00	
Cost Involved (Rs)	35906.00	
Net Return (Rs)	38094.00	

Conclusion

It is observed that crop-piggery in integrated farming system is very necessary for long term sustainable production in the region where shifting cultivation has already caused severe environmental degradation. The animal husbandry system of tribal society is organized on the basis of resource cycling within and between the forest and agricultural practices. If reared of piggery in an integrated fashion with judicious combination of piggery with other elements of agriculture, the overall productivity could increase many folds as evident from the present investigation.

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An integrated community-based service delivery model for small holders' piggery development

R. Deka, I. A. Wright and P. Mehta- Bhatt
International Livestock Research Institute (ILRI), Asia Office, NASC Complex, New Delhi

Introduction

The National Agricultural Innovation Project has funded a project entitled *'Livelihood Improvement and Empowerment of Rural Poor through Sustainable Farming Systems in North East India'*. ILRI is a partner institute for implementing the project in Mon district of Nagaland along with ICAR-Nagaland Centre and Nagaland University (SASARD). The project is being implemented in Lampongsheangha and Longwa villages in Mon district of Nagaland, a remote region with a high incidence of poverty – many people can barely access two square meals a day round the year. The primary sources of livelihood for the people of the project villages are agriculture, mainly cultivation of rice, millet, fruits, vegetables etc. in the *jhum* fields (slash and burn). Pig and poultry are the most common livestock species in the project area. Almost 80% households rear pigs (mostly 1 or 2 pigs) and poultry, mainly indigenous. The production systems in the villages still follow age old practices without many changes. Almost all the villages rear pigs for meat leaving the villages largely deficit in piglet production. The production systems largely fail to meet the market requirement and to deliver livelihood benefit to a larger group of people.

Methodology

Considering the remote location of the project villages and constraints of poor access to veterinary and other input/output services, it was realised that rapid transformation of low-input, low-out put system to high- input, high-output system would be difficult within a short time. Therefore, under NAIP, ILRI decided to bring incremental changes in the production system to make it more competitive and efficient over a period of time. Some locally suitable, simple, cost effective interventions were identified in consultation with the community to address the production and marketing constraints. A system of peer pressure was created through introducing a Pass on Gift (PoG) scheme in order to build accountability and to minimize the wastage of scarce project resources. To increase productivity, good quality cross bred pigs (both sows and boar) was introduced under this project. For improved housing, villagers were asked to construct a pig sty with a drainage system and two manure pits with their own resources. For improved feeding, food-feed crops (sweet potato, maize, tapioca, Colocasia etc.) planting materials were distributed among the villagers and it was suggested that they cultivate the same at the backyard. Villagers were also advised to offer a little concentrate feed along with minerals and vitamins especially during the time of pregnancy and lactation. For reducing the transmission of diseases, villagers were motivated

to adopt clean and hygiene practices in the farms. In order to provide veterinary First Aid and technical services, two young educated youths from each village were trained as Livestock Service Providers (LSP) and supported , including linking them to a veterinary doctor, and providing them with a starter kit of medicines to help the people in tackling minor ailments of pigs and improved management of pigs. Linkages were created between the LSPs and all relevant stakeholders. For assisting the farmers in marketing the animals, a Buyers-Sellers meet was organised in each village. For scaling up and scaling out the intervention, Business Development Services (BDS) were launched. Exposure visits were also organised from the neighbouring villages to the project villages. In order to extend assistance to the members outside SHG groups, a Pig Rearers' Club (PRC) was formed in each village. ILRI had a comprehensive plan of training need assessment, and design and delivery of need based training as and when required to address the relevant knowledge gaps. All the trainings had refresher courses to change the knowledge, attitude and behaviour of the target group permanently.

Results

The initiative has brought a high level of motivation, awareness, capacity and income to the pig producers. The pig system, which was earlier ignored as a women-led subsistence activity, is now an important livelihood activity involving both men and women. People, who initially asked for a daily wage for attending training programmes, now attend the training programmes voluntarily. The fatteners (indigenous) which used to take 4-5 years to achieve 70-80 kg weight earlier are now achieving (cross bred) the same weight in less than a year. The villagers, who never reared cross breed pigs, are now rearing cross bred pigs for breeding purpose making the project villages' surplus producers of piglets. ILRI initially targeted only 86 households belonging to 5 SHG's but following the interest and enthusiasm, ILRI eventually helped a total of 135 households for taking up piggery. On average, each pig rearing household earned Rs.14,020/- per annum from pigs which is 367% above the earlier income of Rs.3000/-. Some of the households even earned up to Rs. 34,000/- (from two farrowing while some others earned only Rs.7000/- (fattening herd.). The clean and hygiene practices introduced, not only helped in reducing the incidence of diseases of pigs but also motivated the villagers to adopt clean and hygiene practices in their day-to-day life. The introduction of food-feed crops has helped in reducing the women drudgery. Proper disposal of pig manure has reduced the contamination of source of water and increased the productivity of food-feed crops. Looking at the success at the project villages, neighbouring villagers have also adopted some of the improved practices on their own. Exposure trips organized by ILRI for the neighbouring villagers have helped to spread awareness about the benefits.

ILRI is now replicating the Livestock Service Delivery Model in 4 districts of Nagaland and 2 districts of Mizoram in partnership with respective state veterinary departments and other local organizations.

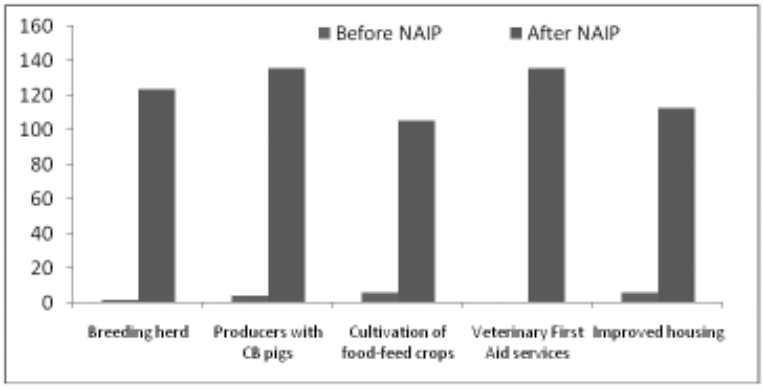

Fig 1 Pig profile of the project villages before and after NAIP interventions

Table 1 Performance indicator of pig rearing before and after NAIP intervention

Indicator	Before	After
Households with a breeding pig herd:	2	135
Households with cross bred pigs:	4	135
Number of pigs per piggery unit	1	1
Production/yield:		
Growth rate (kg per annum)	30 kg	76 kg
Number of piglets per farrowing	4-8	8-11
Average cost of rearing a sow up to 1st farrowing (Rs)	1000	4380
Average revenue per sow (Rs) per farrowing	4000	18400
Profit per sow per farrowing (Rs)	3000	14020
Increase in income (%)		367 %

Some other national and international organizations including World Bank, IFAD, MRDS, NRLP-Assam are also seeking ILRI's help in replicating the model in different parts in the region. In order to help interested organization in replicating the model, ILRI has already developed three training manuals[1] , 1 booklet, 2 brochures, 8 handouts and one film.

References

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Impact of seed village, zero tillage, toria and pea in system approach after rice fallows

I.M. Singh, N. Prakash, N.J. Singh and L.S. Singh
ICAR Research Complex for NEH Region, Manipur Centre, Imphal, Manipur

Introduction

Seed is the starting point of agriculture and dictates ultimate productivity of other inputs. Good quality seed alone increases the yield by 15-20 per cent. To meet the potential challenge of catering to the food need of 1.4 billion people of our country by 2025, a quantum increase in agricultural productivity is very much essential and hence production and distribution of high quality seeds of improved varieties/ hybrids to the farming community is becoming increasingly important. The expansion of agriculture under tropical conditions due to the improvement of cultivars with juvenile period imposed scientific and technological challenges concerning the seed production under different environmental conditions. Usage of quality seeds in the remote regions has been limited due to a number of inherent factors. Non availability of quality seeds like oilseeds and pulses is one of the main reasons for its lower seed replacement rate as well as limiting the area coverage and expansions. Ignorance of quality seed and its production practices were the major problems in our Project sites. Therefore, immediate increase in the productivity and production of these corps could be achieved by the usage of quality seeds of new and high yielding varieties. There is vast scope to produce and distribute quality seeds in these crops for which seed village concept is a nobel and highly practical approach. It needs to be promoted to facilitate production and timely distribution of quality seeds of desired varieties at village level. In this context, the concept of seed village which advocates self-sufficiency in production and distribution of quality seeds is getting momentum. The agriculture in Manipur state is mono-cropped keeping the lands fallow during the *rabi* season except in few pockets in the valley where the irrigation facilities are available. Non availability of irrigation is a major constraint in adoption of *rabi* crops in the state.

Methodology

The success story of zero tillage technology in rapeseed variety M-27 in system approach after rice crop in the cluster sites by our project leads to the transformation of the monocropped rice cropping system to doubled cropped rice-rapeseed cropping system. Traditionally, just 10 years ago, the tillage practice of rapeseed showed that there were over 3 ploughings with the tractor/ power tiller. The zero tillage technology is becoming a savior to the farmers of the state. The farmers are mostly risk averters due to varieties of weather and other climatic conditions. For a technology to be adopted and really effective, it is a pre-

requisite that it has been evaluated with respect to its economic feasibility and viability which is a major determinant of its adoption. A judicious mix of agricultural enterprises in system approach like dairy, poultry, piggery, fishery, sericulture etc. were suited to the agro-climatic conditions and socio-economic status of the marginal farmers of the cluster sites would bring prosperity in the farming system. Therefore, the integrated farming system approach introduced a change in the farming technique for maximum production in the cropping pattern and takes care of optimal utilization of resources.

Results

Seed village

The study on seed village was conducted consecutively for three years during the *kharif* season of 2007-2011 under the programme "Introduction of seed village on important crops" in four cluster villages viz., Tupul, Noney, Reangkhong and Awangkhul. After it's successfully implementation, particularly in four *kharif* crops viz., Rice (RC Maniphou-6 & RC Maniphou-10), Maize (PEMH-2) Soybean (JS-335), Groundnut (ICGS-76) and Blackgram (T-9), the seed production practice and non availability of quality seeds has been decreasing. The data in the table 1 showed that rice variety RC Maniphou-10 was observed to be little better than RC Maniphou-6 producing the average yield of 3.78 t/ha, 3.55 t/ha, 3.77 t/ha and 3.8 t/ha, 3.31 t/ha, 4.07 t/ha, respectively during 2008-09, 2009-10 and 2010-11 with a pooled mean of 3.77 t/ha and 4.07 t/ha, respectively. Between the two rice varieties in similar cost of production, the gross return was Rs. 51,800 and Rs. 51,940 and net return Rs. 21,800 and 21,940 in RC Maniphou-6 and RC Maniphou-10, respectively.

It is perceptible from the data that the maximum net returns (Rs. 33,400) was observed. Soybean (JS-335) and groundnut (ICGS-76) crops also took important roles in producing quality seeds at the seed villages. For the consecutive three years of cropping season (2008-2011) of soybean, the average yield was almost at par producing 1.54 t/ha, 1.35 t/ha and 1.50 t/ha, respectively with a pooled mean of 1.46 t/ha. Data on economics of soybean cultivation revealed that the return was Rs. 58,400, Rs. 33,400, respectively in gross and net incomes. The recorded yield of groundnut ranged from 1.04 t/ha to 1.20 t/ha which gave a gross and net income of Rs. 44,000 and Rs.14,000, respectively. Again data on blackgram (T-9) showed that the maximum yield (0.75 t/ha) was recorded followed by 0.06 t/ha during 2009-10 and 2008-09 respectively. The gross income was found as Rs 16,400 t/ha thereby showing net returns of Rs. 4,400 t/ha. The data of maize (PEMH-2) in the table 1 revealed that the average yield of the crop ranged from 0.99 t/ha to 3.15 t/ha with a pooled mean yield of 2.42 t/ha.

M-27 zero tillage

In the same field after *kharif* crops, the traditional cultivation of pea var. Arkel and high yielding rapeseed variety M-27 were taken under zero tillage cultivation as system approach after rice fallows. The variety M-27 could reach pooled mean yield of 0.65 t/ha

with a maximum of 0.88 t/ha during 2010-11 and minimum in 0.29 t/ha during 2011-12. Pea var. Rachana could give maximum of 3.95 t/ha and minimum of 2.75 t/ha during 2008-09 and 2011-12 respectively with a pooled mean yield of 3.74 t/ha (Table 2). Evidently from table 2, the economics of pea and M-27 rapeseed zero tillage realized higher net returns of Rs. 55,856.00 and Rs. 14,796.00, respectively. However, regarding returns per rupees invested pea (Rs. 2.48) was deserved much lower than rapeseed (Rs. 4.41). It was due to too low cost of production when compared to pea.

Estimation of return per rupees invested

Considering realisable returns per rupees invested in rapeseed from the fig 1 afforded highest and was also determined to be cheapest cost of production as well as the technology adopted was positively significant to the farmers which was followed by maize, pea, soybean, rice (RC Maniphou 10 & 6) groundnut and blackgram respectively. Therefore, the study concludes that zero tillage under rapeseed with high yielding variety is highly remunerative crop in the state. The adoption of zero tillage technology thus, would improve farmer's profit and eventually contribute towards reducing poverty and keeping environment clean.

Table 1 Different crops under seed villages in four cluster villages (Tupul, Noney, Reangkhong and Awangkhul) of Tamenglong District, Manipur during the three consecutive years 2008-2011

Crop/Variety	Combined average yield (t/ha)				Cost of production (Rs ha $^{-1}$)	Gross Income (Rs)	Net Income (Rs)	Return /Rs. invested
	2008-09	2009-10	2010-11	Pooled mean				
Rice (RC Maniphou-6)	3.78	3.55	3.77	3.70	30000	51,800	21800	1.72
Rice (RC Maniphou-10)	3.8	3.31	4.07	3.71	30000	51,940	21940	1.73
Maize (PEMH-2)	3.13	0.99	3.15	2.42	15000	48400	33400	3.20
Soybean (JS-335)	1.54	1.35	1.5	1.46	30000	58400	28400	1.90
Groundnut (ICGS-76)	1.07	1.04	1.2	1.10	30000	44000	14000	1.50
Blackgram (T 9)	0.06	0.75	0	0.41	12000	16400	4400	1.40

Selling price of RC Maniphou-6 @ Rs. 14, RC Maniphou-10 @ Rs. 14, Maize @ Rs. 20, Soybean @ Rs. 40, Groundnut @ Rs. 40, Blackgram @ Rs. 40

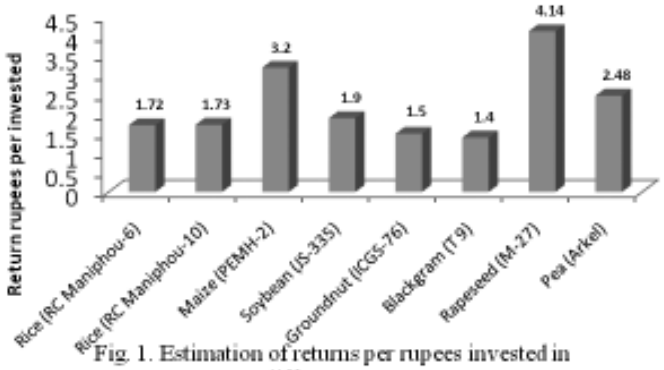

Fig. 1. Estimation of returns per rupees invested in different crops

Table 2. Average yield and economics of rapeseed M-27 and pea (Arkel)

Crop/ Variety	Average yield (t/ha)						Cost of production (Rs. ha $^{-1}$)	Gross Income (Rs)	Net Income (Rs)	Return/ Rs. invested
	2007-08	2008-09	2009-10	2010-11	2011-12	Pooled mean				
Rapeseed (M-27)	0.64	0.73	0.75	0.88	0.29	0.65	4,704	19,500	14,796	4.14
Pea (Arkel)	3.27	3.95	3.50	3.76	3.30	3.74	37,644	93,500	55,856	2.48

Selling price of Rapeseed (M-27) @ Rs. 30 and pea (Arkel) @ Rs. 25

Agri-horti-livestock-cum-pisciculture for rural livelihood in high altitude area of West Khasi Hills, Meghalaya- a case study

Anup Das, G.C. Munda, N.S. Azad Thakur and S.V. Ngachan
ICAR Research Complex for NEH Region, Umiam, Meghalaya

Introduction

The North Eastern Region is known for its high rainfall (2450 mm/annum), and most of the rain water goes waste as runoff. Out of 42 m ha m water received as rainfall, only 0.88 m ha m is tapped till date. The water availability for domestic use, crop production and animal husbandry is very meagre not only during dry season (November to March) but sometimes, the residents of hillocks suffer water shortage during rainy season as well. Enormous amount of energy is put by women and children to collect water from distant places. Efficient water harvesting and its efficient use will provide new livelihood options for the resource poor hill farmers. Rainwater harvesting and its recycling can increase productivity and diversify agricultural production by growing remunerative agricultural and horticultural crops and it can also be integrated with composite pisciculture and livestock components. Sustainable rural development through conservation of land and water resources gives plausible solution for alleviating rural poverty and improving the livelihoods of rural poor through integrated watershed development approach. In an effective convergence mode for improving the rural livelihoods in the target area with watershed as the operational unit, a holistic integrated systems approach would enable change and improve the livelihoods of the rural poor (Wani *et al.* 2009).

Methodology

Integrated watershed development programme was undertaken during 2004 - 2008 at Mawlangkhar, West Khasi Hills district (25^0 32' 14. 6" N & 910 21' 55.5" E) of Meghalaya, India. The project site is characterized by high altitude area with an elevation of more than 1500 m from mean sea level. The climate of West Khasi Hills is temperate sub-alpine type. The watershed covered about 20 hectare area with 50 households. The area receives more than 2500 mm of rainfall annually; even then water availability remained a great problem during the winter months (November to March). Pig is the most common livestock but their productivity is low mostly due to rearing of local breeds. Rice is the most common cereal followed by maize. Rice-potato and maize-potato are common cropping systems. Average productivity of rice is only about 1.5 t/ha and that of potato 13-15 t/ha. Low temperature, stray animals and lack of irrigation facilities during winter season limits the scope for double cropping. Low crop/livestock productivity and soil health were identified as major problem. Accordingly the programmes were undertaken to address these issues. Systematic efforts

for soil and water conservation along with integrated development of agriculture, horticulture, livestock and pisciculture were made for livelihood improvement of the tribal populations. Bench terrace (0.25 ha) and half-moon terraces (0.25 ha) on unutilized hill slopes were developed in 2004 to bring additional area under cultivation. Half-moon terraces were used for growing fruits like peach, pear and plums. All the activities were undertaken in a participatory mode with the farmers. The men and women including members of youth club from the area actively participated in the activities of the watershed.

Results

Two new ponds were constructed in community land, which remained barren and unutilized and never before could hold rainwater during off-season prior to undertaking the watershed programme. After proper survey, these two ponds [49m (L) x 26m (B) x 1.8m (D), & 20m (L) x 20m (B) x 1.0m (D)] were scientifically constructed during the year 2004-2005. These two ponds together have the water storage capacity of 2.69 million litre of water. These ponds are not only utilized for pisiculture but also have become a source of irrigation water during lean period (November – March) for potato and carrot cultivation in the adjacent area. Apart from new ponds, two old ponds (20m x 20m x 1.5m each) belonging to farmers were also renovated for higher productivity. The two renovated ponds in individual farmers land have the storage capacity of 1.20 million liter (0.60 million litre each). Thus, the quantum of water harvested at one point of time during monsoon season through two ponds in community land and two ponds in individual farmers land is 3.89 million litre. The most significant point in the construction and renovation of the entire watershed pond is that this project created employment to the villagers because they actively participated in the construction and development process.

Having seen these successful water-harvesting ponds, some farmers in the project area constructed ponds at their own for pisciculture. The two newly constructed ponds together have the water storage capacity of 2.69 million litres (L). Total expenditure incurred was about Rs. 2.12 lakh. Therefore, in the first year, per litre of harvested water costs about Rs.78.5 /1000 L. Considering 75% capacity harvesting of water and a minimum life of 20 years for the ponds with a maintenance cost of about 5% per year Rs.10,640/year), a total of 40 million litre water would be harvested. Therefore, after 20 years per litre harvested water would cost only a negligible amount of about 1 Paisa/ L. The harvested water is now used for dairying, fishery, irrigation (of about 0.5 hectare of high yielding potato, carrot etc.). Thus, increasing area under second crop after rice would boost total production of the watershed areas. A micro rainwater harvesting structure called *jalkund* suitable for hilltop was introduced in the watershed area in the year 2007-08. The dimension of *jalkund* was 5 m length x 4 m breadth and 1.5m depth which could store about 30,000 litre of water in the hilltop. The inner surface of the *jalkund* was plastered with slurry of clay mud and cow dung and there after cushioned with pine leaf to support the lining material. LDPE agri-film of 250 micron was used for lining the *jalkund.* The water of the *jalkund* could be used for

domestic use, livestock and irrigating important crops. Fifteen numbers of such *jalkunds* were constructed in the watershed area. Each *jalkund* costs about Rs. 6380. The average cost of storing per litre water in *jalkund* was computed at Rs.74.5/ 1000 L considering the life span of three years. Peach and pear plants of the locality were found low yielding and poor in quality. Two peach varieties Shan-e- Punjab and TA 170 were introduced in 2005. One peach variety at farmers field was already in fruiting stage. The yield and size of fruit was significantly higher than local peach. Feedback indicated that some farmers earned up to 500 per plant from selling of peach. Two passion fruit varieties (Kaveri hybrid and Meghalaya local) were also introduced which were at the flowering stage and expected to bear good fruits. Potato is cultivated in upland as well as in lowland rice fallow by the farmers. But the productivity found to be low due to cultivation of low yielding local varieties. A total of 0.8 tonne high yielding varieties (HYV) of potato (Kufri jyoti and Kufri giriraj) were distributed to 25 farmers each year over four years (2005-2008). There was increase in productivity of potato up to 30 to 40 % due to adoption of improved variety. The farmers of the watershed showed keen interest to grow both the high yielding potato varieties and kept their own seeds for the next. Two tomato hybrids (Avinash-2 and Rocky) and one variety (Manikhamnu) were also introduced first time. Highest yield was recorded in Avinash-2 (25.0 t/ha) followed by Rocky (21.5 t/ha) and Manikhamnu (18.9 t/ha). The tomato crop took more than 4 months to mature due to prevailing low temperature. In the subsequent year, on-farm trial on sweet potato was conducted with 5 varieties namely, Gouri, Kokrajahr Local, Meghalaya Local, Sree Bhadra and Sonipat. Highest yield was recorded with Sree Bhadra (30 t/ha), an early maturing variety (4 months). The rice yield in the high altitudes are low mainly because of low yielding local varieties and poor agronomic practices (high seed rate, random planting, broadcasting, no fertilizer and manure, poor weed management etc.). The four years (2005 –2008) results indicated that, variety Megha rice-2 recorded highest grain yield (3.4 t/ha) followed by Megha rice-1 (3.2 t/ha) and RCPL 1-10C (3.2 t/ha). Local variety Bahkhawlih recorded a grain yield of 2.2 t/ha. Other varieties were inferior to the local variety. Farmers ultimately have accepted three varieties viz. Megha rice-2, Megha rice-1 and RCPL 1-10C and maintained their seeds. The yield increase with these varieties over local varieties ranged from 45 to 54 %. Composite fish culture involving surface feeder (Catla, silver carp and puntius/java punti), column feeder (Grass carp and rohu), and bottom feeder (mrigal, common carp and gonius) constituting 40%, 30% and 30%, respectively were adapted both in community pond and individual farmer's pond. Around 2000 fingerlings each year were released @ 1 fingerling/sq. m at the initial two years. Grass carp attained maximum weight (510 g/fish) followed by common carp in one year. Common carp was found to be self-breeding and as a result its population increased in the subsequent years and liked by farmers as well because of its good taste. This species was, therefore, found most suitable for the locality. In general, the performance of exotic carp was good especially the grass carp mainly because of availability of grasses to fish from pond banks as well as surrounding areas near pond. Farmers provided grasses, banana leaves etc. as feed for the grass carp. The fish productivity in general was low (1.75 t/ha)

mainly due to low water temperature and poor feeding by the villagers. About 300 kg fish was harvested annually from two community ponds. A net return of about Rs.20, 000 was achieved from the fish culture. Pig is a household animal in the tribal community. Almost every family maintains 1-2 local breeds of pig. Five unit (Two female and one male constitute one unit) of upgraded pig having 75% Hamshire and 25% Meghalaya local inheritance were given to the farmers. The farmers made good housing with brick wall and corrugated tin roof with the technical support from the Institute. The farmers were using kitchen waste, local grasses, vegetables such as carrot, radish, sweet potato, squash etc. grown in their farm and mesh feed made-up of rice bran, rice polish, salt and mineral mixture as pig feed. One farmer in two furrowing got 16 piglets in a year from one sow and sold 3 months old piglet at Rs.1250/piglet. In three years, that farmer could get 72 piglets from one unit of piggery (2 sow + 1 boar). However, only 65 piglets survived out of which 61 were sold by the farmer. Contrary to this the local pig in two furrowing delivered only 11 piglets that fetched about Rs.1000 /piglet. The performance of improved breed of pigs was highly remunerative. About Rs. 21000 / year were earned from piggery unit by the farmers. The cost of production per piglet up to marketing age was estimated at about Rs.5300 /piglet, excluding the cost of family labour. A dairy unit (one improved crossbred Jersey milch cow with a calf) was maintained in the watershed to serve the dual purpose of milk and supplying manure for fish pond and crops. The cowshed on the bank of the main water harvesting pond in community land has been designed in such a way that the washings of the cow unit are diverted to the fish pond that helped in growth of phytoplankton and zooplankton which served as feed for the fish. The villagers were getting about 8-10 L of milk daily. On an average about Rs.100/day and more than Rs.3000 /month was coming as net profit from dairy unit. Vermi-compost and FYM were prepared adjacent to the cow shed using cow dung, straw, weed biomass etc. and applied to crops and vegetables. Thus, there was an effective recycling of biomass/nutrients in the system. Mawlangkhar village has become a successful model village for agricultural development in the most backward district of Meghalaya, India. As a part of disseminating the improved technology, the villagers are selling the piglets, rabbits, milk etc. at 10-20 % lower than the market rate to the neighbouring farmers. The productivity of crops especially rice, potato, maize and vegetables were increased substantially and farm income in general has gone up by at least 25 % in the adopted village. For overall development more number of such models need to be demonstrated in the various identified pockets of the NEH states and in other similar ecosystems.

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Innovations in pond based farming system for sustainable livelihood in South Garo Hills, Meghalaya

Anup Das[1], Amit Das[2], T. Samajdar[2], A.S. Singh[2], Syed B. Islam[2], Md. M. Islam[2], S. Malngiang[1]

[1]ICAR Research Complex for NEH Region, Umiam, Meghalaya

[2]Krishi Vigyan Kendra, Tura (ICAR)

Introduction

The South Garo Hills district of Meghalaya adjacent to the Bangladesh border covers the geographic area of 1,887 sq km with a population of 1,42,574 (2011) in its 804 inhabited villages. Owing to the nature of remoteness with minimum facilities, the Planning Commission has declared the district as backward. The Krishi Vigyan Kendra (KVK), ICAR, Tura and Rural Resource and Training Centre (RRTC), Umran had been selected to implement component-3 "Livelihood Improvement and Empowerment of Rural Poor through Sustainable Farming Systems in North East India" under Sustainable Rural Livelihood Security (SRLS) of National Agricultural Innovation Project (NAIP) at Sibbari cluster consisting of 11 villages under Gasuapara Development Block through various agriculture and allied interventions. Fish is one of the most important components of everyday food and one of the largest sources of animal protein to majority of the people of South Garo Hills due to non- vegetarian food preference coupled with scarcity of other meat items and lack of stable daily markets. Integration of different farm components not only resulted in higher yield of crops per unit area in this cluster, but also it has substantially reduced the cost of production with the noble innovations shown by the farmers and improved the nutritional heath of the farm families.

Methodology

Through NAIP several methods of pond based integrated farming systems have been strategized and implemented during 2009-2012 in the project area where nearly 80 farmers have been given trainings, direct technical and financial assistance and another 100 farmers received indirect assistance for developing integrated model farms for sustainable livelihood.

Fish - duck cum vegetable farming: It is essentially a pond based farming system that is conducted in earthen ponds of average 1.5 m depth, with one low cost duck housing (4 sqm.) made up of bamboo and other locally available materials on one of the pond dykes and one or two of the peripheral dykes are utilized for cultivation of seasonal vegetables in one or two tier system. Area under vegetable cultivation typically ranged between 40 to 700 m^2 (average 0.05 ha). In this system duck droppings served for natural food (plankton) production in the pond and no other fertilizers or supplementary feed was provided, whereas

the irrigation needs for vegetables on the dyke was met from the pond water. 10 numbers of *Sonali*, a locally available duck variety was reared per 0.05 ha water area. Fingerlings of Indian major carps viz. Catla (*C. catla),* Rohu (*L. rohita*), Mrigal (*C. mrigala*) and two of the Chinese carps viz. grass carp (*C. idella*) and silver carp (*H. molitrix*) (stocking ratio 2:2:2:2:2) of 4-10 cm sizes have been obtained from local fish seed seller and stocked at a rate of 7000/ha and was reared for a period of 6-8 months in all the pond systems. The size of the ponds varied from 300 sqm to 1000 sqm. (average size 0.065 ha) with 90% of the ponds being seasonal in nature, holding water suitable for aquaculture between the months of June-January.

Fish - pig cum vegetable farming*:* This was basically the same as the *fish cum duck cum* vegetable farming only the animal component was replaced by improved pig breed and in some cases local breed of pigs. 2 females and 1 male (3 piglets per 0.05ha pond area) of either Hampshire cross or TND breed were reared in low cost pig sheds of 9 sqm. To 12 sqm. sizes on one of the pond dykes and the pig manure was allowed to slowly drain in the ponds or to adjacent areas where vegetables are grown. After initial starter feed for 2 months the pigs were fed with kitchen waste, rice barn, tuber crops etc. locally available feed items. Periodic cleaning of pig shed and occasional de-worming was carried out to ensure good health and hygiene.

Results

The production of each component viz. fish, duck eggs, piglets, and vegetables under pond based farming system has increased significantly. A growth rate of more than 364% was observed in fish production whereas 288%, 200%, 194% increase was observed in egg, piglet and vegetable production respectively. The utilization pattern of different farm components also has shown a positive trend with time. Table 1 describes the utilization pattern of farm produce from 2009-2012.

Table 1. Utilization pattern of different components in pond based farming systems

Crop ↓ Year.➜	2009-10		2010-11		2011-12	
	Consumed	Sold	Consumed	Sold	Consumed	Sold
Fish (kg/ unit farm)	62	65	73	81	90	92
Egg (nos/ unit)	115	149	170	235	177	341
Piglets (nos/ unit)	2	7	3	8	4	8
Vegetable (kg/ unit)	34	43	47	51	51	54

Economic analyses of different components have been presented individually in Table 2. B: C ratio was higher than unity for all different components (except for the duckery unit in the initial year) .

Table 2 Economic analysis of individual components under pond based farming systems

	2009-10				2010-11				2011-12			
	Fish	Egg	Piglet	Veg.	Fish	Egg	Piglet	Veg.	Fish	Egg	Piglet	Veg.
*COP/ unit (Rs.)	3980	1700	5000	200	4100	615	6700	270	4650	723	7500	410
MP (Rs.)	80 /kg	4 /egg	1500 /piglet	10 /kg	100 /kg	5 /egg	1800 /piglet	12 /kg	120	5/egg	2000 /piglet	15 /kg
GR/ unit (Rs.)	10140	1056	13500	850	15373	2025	19800	1170	21840	2590	24000	1748
NR / unit (Rs.)	6160	-644	8500	650	11273	1410	13100	900	17740	1867	16500	1338
B: C	2.5	-1.6	2.7	3.4	3.7	3.3	2.9	4.3	4.6	3.6	3.2	4.3

*COP=cost of production (excluding the cost of fixed capitals), MP=market price, GR=gross return, NR=net return, B: C= benefit cost ratio; unit= fish from 0.065ha pond/ egg from 10ducks/ piglets from (1M+2F)=3 pigs/ vegetables from 0.05ha garden etc.

Overall economic analyses has shown that B: C ratio was lower for *fish-duck-vegetable* model than the fish-*pig-vegetable* model only during 2009-10 (2.04), but higher during 2010-11 (3.7) and 2011-12 (4.5).The B:C Ratio for the f*ish - pig cum vegetable farming* were 2.7, 3.3 and 3.8 during 2009-10, 2010-11 and 2011-12, respectively.

The benefit-cost analysis showed that each of the farm components can benefit the farmers and profit levels goes up with time. A negative B:C ratio in duck egg production during 2009-10 is owed to the higher cost of purchase of ducks than the return from sale of eggs in that year. *Fish-duck-vegetable* model gave higher benefit from second year onwards than the *fish-pig-vegetable* model possibly due to smaller maintenance cost in ducks. Although the pond based farming systems have gained popularity across project villages over time, the adoption of innovations/technology differed from village to village due to socio cultural reasons. Spread of pond based farming systems in Sibbari cluster where largest number of pond based farms are observed in Defuliapara village (18%), followed by Mandangre (16%), Dimaggre (13%), Dima Chigitchak (12%) owed to higher number of ponds (available/ constructed). However, Goosegaon, Chambli, Onajara villages the number of such models were meager might be because of few number of ponds coupled with the social unrest prevailing due to porous border with Bangladesh etc. An analysis of impact created (as in April, 2012) due to adoption of pond based farming system shows a significant increase in creation of village level employment over the time with more diversification of innovations/ technologies as well as increase in number of farmers practicing pond based farming system, but a decline in the number of farmer groups taking up pond based farming system possibly because of multifarious needs and interests of different members, or possibly because of unorganized nature of the group creating disputes over ownership, management and profit sharing in the absence of a guideline.

Organic food production through integrated farming system approach for enhancing productivity and livelihood of small and marginal farmers

Manoj Kumar, Naropongla, Anup Das, Juri Buragohain, Kevizhalhou Kuotsu and Ramkrushna G.I.

ICAR Research Complex for NEH Region, Umiam, Meghalaya

Introduction

Achieving sustainable development through organic farming, emphasis should be made on sound management of farm resources to enhance farm productivity with minimal requirement of purchased external inputs. One of the major constraints confronting Organic Agriculture is the non-availability of huge quantities of organic inputs to meet the farm demand. It is therefore, necessary to focus our attention on organic agriculture based farming system models by integrating various farm enterprises such as crop, livestock, poultry, fish, mushroom, etc. including provision for nutrient recycling. Integrated Farming System (IFS) is a resource management strategy to achieve economic and sustained agricultural production to meet the diverse requirements of the farm household while preserving the resource base and maintaining high environmental quality (Palaniappan, 1992). Components of farming system when carefully chosen and executed depending upon the suitability of the farm fulfills the input demand internally and totally avoids purchase of any external inputs. This will not only help to reduce the production costs but also enhances the quality and quantity of produce and improves environmental quality through recycling of farm wastes. Practices such as composting of animal wastes, weed biomass and crop residues, mulching, green manuring, organic liquid manures, crop rotation especially with legumes, intercropping, trap cropping, leguminous hedge row in fences, weed management, bio-fertilizers and bio-control of pest and diseases, etc. should be optimized through IFS for achieving the objectives of organic farming. By adopting farming system approach all the farm wastes can be recycled in a scientific manner so that every enterprise is complementary and supplementary to each other.

Methodology

A model on organic food production system under IFS mode was developed during 2005-06 in an area of 0.68 ha. The area allotted to various components is given in Table 1. The cereals like rice, maize, oilseed and pulses like toria, soybean, lentil (under utera cultivation), vegetable crops like frenchbean, carrot, tomato, potato, brinjal, bhindi, cabbage fodder crops etc. were introduced in the farming system in Lowland Agronomy Farm, Division of Natural Resource Management, ICAR Research Complex for NEH Region, Umiam,

Meghalaya. A dairy unit (one milch cow with calf) was introduced for milk purpose. Cow dung is used for manuring of different crops. The existing farm pond (575 m^2) was renovated and integrated with the model for composite pisciculture and also for life saving irrigation during dry season. The pond dyke was used for growing fruits crops like papaya, Assam lemon, pitch, guava. Washing of dairy unit was diverted to fish pond. Fodder crops were grown to feed the cattle and excess fodder was preserved for lean period. All the crop/weed residues were recycled in-situ for improving the fertility of soil. The excess crop residues and weed biomass were used for vermicomposting. Insect pest and diseases were controlled through organic means. Organic block was protected from all possible contaminations by giving proper drainage, buffer zone, bunds, etc.

Table 1 Area, production and economics from various components of organic based FS

Components	Area (m^2)	Production (t)	Cost of Production (Rs)	Gross income (Rs)	Net income (Rs)	B:C ratio
Cereals						
Rice	1056	0.51	2766.7	5100	2333.3	1.84
Maize	1726	0.67	4056.1	8040	3983.9	1.98
Pulses/Oil seeds						
Toria	420	0.05	894.6	1000	105.4	1.12
Soybean	646	0.09	1498.7	1980	481.3	1.32
Lentil	288	0.034	197.3	1088	890.7	5.51
Vegetables						
Frenchbean	562	1.21	2667	18150	15483	6.81
Tomato	530	1.28	2538.7	12800	10261.3	5.04
Carrot	60	0.097	238.1	1164	925.9	4.89
Bhindi	171	0.16	717.5	1920	1202.5	2.68
Brinjal	144	0.32	657.1	3520	2862.9	5.36
Cabbage	123	0.24	504	1440	936	2.86
Potato	130	0.24	851	1920	1069	2.26
Fodder crops	182	1.91	827.5	9550	8722.5	11.54
Fruits						
Assam lemon	81	0.054	324	864	540	2.67
Papaya	40	0.286	545	2288	1743	4.20
Composite fish culture	575	0.13	2654	9750	7096	3.67
Dairy (1 milch cow with 1 calf)	36	-	-	-	-	-
Milk (Litre/year)		1630	31256	38060	-	-
Cow dung (t/year)	30	13.10	-	7480	-	-
Calf	-	-	-	2000	-	-
Total	6800		53,193	12,8114	74,920	2.41

Results

Rice and maize crop were grown in area of 1056 and 1726 m^2, respectively. The production of rice and maize were found 0.51 and 0.67 t and productivity 4.86 and 3.87 t/ha,

respectively. Net return of Rs.2333 and 3984 were obtained with rice and maize crop, respectively (Table 1). Pulses and oil seeds were sown in area of 1354 m^2. In which Toria, soybean and lentil (as *utera* crop) were grown in 420 m^2, 646 m^2 and 288 m^2 area, respectively. Good amount of toria (50 kg), soybean (90 kg) and lentil (34 kg) were obtained from the system. Productivity of toria, soybean and lentil were found 1.16, 1.36 and 1.17 t/ha, respectively.Net return was recorded Rs.105, 481 and 890 from toria, soybean and lentil, respectively. Maximum benefit cost ratio was found (5.51) in lentil crop which was sown as *utera* crop in rice fallow. Vegetable (Frenchbean, Tomato, carrot, bhindi, brinjal, cabbage and potato) crops were grown in an area of 562 m^2 and from where a total production of 0.51 tonne was obtained. The gross and net income was computed at Rs.40914 and Rs.32740, respectively. Highest benefit cost ratio (6.81) was obtained with frenchbean crop. Total fruit production from the system was 340 kg. Average productivity of Assam lemon and papaya were recorded 6 kg/tree/year and 26.6 kg/tree/year. Gross and net income from fruit was found Rs. 3150 and Rs.2283, respectively. Total fodder production was 1.91 tons from the system.

The fish production and productivity of the system was 130 kg and 2210 kg/ha, respectively. Net income and benefit cost ratio were Rs.7096 and 3.67, respectively. From dairy unit, total milk production was 1360 lit /year with gross and net income of Rs.47540 and Rs.16284.00, respectively.

Considering the IFS model as one unit, the gross and net income from the system was Rs.12, 8114 and Rs.74, 920, respectively. The daily income from the system was computed at Rs. 205, which is almost sufficient for a farm family of 6 people for their livelihood. Therefore, organic food production system integrating crop-livestock-fishery is a viable option for enhancing productivity and income of small and marginal farmers in North Eastern Region of India.

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Efficacy of IFS model as alternative to *jhum* cultivation: a case study of Theiva village, Mizoram

Y. Ramakrishna, S.B. Singh, B.K. Singh, T. Boopathi, L.H. Puii, K. Rajasekar, A.K.R. Singh, S.K. Dutta, M.Chinlampianga and K.A. Pathak
ICAR Research Complex for NEH Region, Mizoram Centre, Kolasib, Mizoram

Introduction

Most of the villagers of Theiva, Saiha Districts depend upon the Jhuming. Annual crops like maize, upland rice, *kharif* vegetables etc grown during the *kharif* season only. Animals mainly local breed of pig are reared in 2-5 numbers and some local birds are raised at the backyard. The village is under food deficit condition where 85 % of food grains were received through PDS or import from other state. For animal protein villager use to go for hunting till date. The average incomes of the farmer were about Rupees 25,000 per annum. The intervention site lies at an altitude of 320 m MSL to 1100 m MSL with slope angle of 30 to 70°. Soil erosion is common due to high rainfall of about 2000-3000 mm per annum, out of this 80-90 percent of rainfall were received during five month of kharif season. In the later months onward soil become dry in absence of the rainfall. The top soil moisture remains near to the permanent wilting point or less with visible cracks. Under the livelihood improvement project of NAIP-III, on the "Introduction and Development of Integrated Farming System Technology" Mr. N. Thulanga, resident of Theiva village, Saiha district of Mizoram, a typical farmer with an annual income of Rs 32000 from his two 0.8 hectare of piece of lands. The income received from cultivation of maize and rice were Rs 9000 and Rs 21000 from rearing of local pig (Burmese breed).

Methodology

For the sustainable growth of the farmers, the intervention should meet both long-term and short-term goal. The resource can be utilized when the relationship between components are symbiotic or complimentary type. So his land was partitioned into annual crops 0.3ha (maize and rice), vegetable crop 0.2 ha (Okra, French beans Cabbage, Chinese mustard) fruits tree 0.4 ha (Banana: 700, Lemon: 5, Khasi mandarin 20, Pineapple 200, Mango: 25) forest tree 0.8 (teak) and intercropped with tuber crops (sweet potato, tapioca and colocasia). The remaining land used for construction of water storage structure, piggery unit, poultry unit and vermicompost unit. To develop an integrated farming system model, some investment on water harvest structure (Rs 45,000), shade house (Rs 35, 000) pigsty (Rs 10,000), poultry house (Rs 5,000) and planting of economic important perennial tree or fruit tree were made. Terracing was undertaken in an area of 4.5 ha for demonstrating settled agriculture in the cluster village. During first year soyabean (variety JS 335) and rice bean

were grown for fertility build up. The crop and weed residues were used for mulching and manuring**.** During the subsequent year maize and rice was grown in the same plots were pulses were grown.

Results

Maize variety RCM 76 was given to the farmers for cultivation in the terraced land. The RCM-76 variety can be harvested at 90-95 DAS (dough stage) and accommodate more plant per unit area to produce higher yield. The famers fetch higher price due to early availability of maize cobs in market beside their own consumption. After the maize crop, farmer grown a second crop of soyabean (JS 335), during month of late July and August. Previously farmers were practicing mix cropping of maize with vegetable like pumpkin, Chinese mustard etc. Out of the area, about 2600 numbers of cobs and 550 kg of rice were harvested. About 2500 maize cobs were sold to market and rest were self-consumed. All rice grain was milled and 300 kg of rice was kept for self-consumption. Bran weighing about 250 kg used as feed for poultry and pig. Soyabean production was 350 kg grain, out of which 30 kg was preserved for seed purpose, 50 kg was utilized for family consumption and rest was used as feed for poultry and pig. Vegetable crops were grown in an area of about 1600 m^2. Ginger, okra, pumpkin, cowpea, French bean bird eye chili in the field while coriander and tomato in low cost shade net were grown during the *kharif* season. In the *rabi* season nursery of cole crop were raised in shade house for sell and remaining plant were subsequently transplanted in terraced land. Green coriander fetches higher and regular income than any other crop under shade house. The coriander required 45-55 days to give economic yield, so five crops per year were taken under shade house. The gross income generated by the vegetable cultivation has been Rs 32,000 as depicted in the pie chart. The net income from the vegetable was Rs 25,000 with benefit cost ratio of 1.79. Improved breed of Hamshrire cross (4 female: 1 male) for fattening and dual purpose birds Vanaraja birds (25 No's) were distributed to the farmer. The Vanaraja birds with similar management of local bird gained a body weight of 2.79±0.51kg female and 3.82±0.84kg male, while the local folk weighed 1.25 ±0.46 kg female and 2.5±0.53 kg male after 6 months. To boost the body weight in addition to local feed supplement mineral mixture, deworming, vaccination etc were advocated. Supplements feed for vanaraja consisted of mainly broken rice, grass and some weeds, vegetable waste and kitchen waste. The Hamshrire cross produced 30 to 40 per cent more body mass compared to local Burmese breed which could able to gain body mass of 75-80 kg. The Hamshire cross-recorded a body weight of 129±5.8 kg under the IFS condition. The pig feed consisted of cooked little rice, bran, tuber or leaves of plants, damage vegetable etc. About 600 kg vermicompost produced within the system was utilized for the vegetable production mainly under shade house. An additional 1.0 ton of manure generated from piggery and poultry unit, utilized for terraced land fruit crops. So fertility of the farm maintain by the utilization of local resources. Due to all the above interventions, Mr. N. Thulanga could earn a net income of Rs 1, 38,500 (Table 1). The man-days were also increased from

120 days to 305 days. The farmers of Theiva village realized the importance of cereals, horticulture crops and animal component for higher productivity and income generation. With all this integration of component, income from the farming can be improved for sustainable economic development of the backwards peoples of Saiha district.

Table 1 Economics of IFS in Theiva village, Saiha (Farmer- Mr. N Thluanga)

Component	Area (ha)	Cost of production (Rs)	Net income (Rs)	Benefit :cost ratio
Silvi-pastoral crops	0.064	1200	500	0.42
Fruits	0.30	11000	15000	1.36
Vegetable	0.16	14000	25000	1.79
Cereals	0.26	6000	9000	1.50
Other	0.016	-	-	-
Poultry		2000	6000	3.00
Piggery	4 female + 1 male	21000	80000	3.81
Vermicompost	2 x 3 x 1 m	1000	3000	3.00
Total	0.80	56200	138500	2.46

Innovations in Agroforestry based Farming System for Sustainable Land Use and Rural Livelihood in Tripura

M. Datta, Anup Das and S.V. Ngachan
ICAR Research Complex for NEH Region, Lembucherra, Tripura

Introduction

In Tripura, the total geographical area (TGA) is 10,491 km^2 and out of this, an area of 6294 km^2 is under forest thus contributing nearly 60 % of the TGA. Of this, the reserve forest covers an area of 3588 km^2 and the unclassified forest area is 2195 km^2 comprising of 34.2 and 20.93 % of the TGA, respectively in Tripura. The forest cover also includes 2446 km^2 of culturable Non-Forest Area (CNFA) having 13.6 trees per ha. The State also has 116 km^2 area under Tree Cover, which is 1.11% and 4.74% of geographical and CNFA areas, respectively. Forest cover together with tree cover make up for 8209 km^2 area in the state, which is 78.3% of states' geographical area. Per capita forest and tree cover in the state stands at 0.26 ha. The dissected hilly terrain and hill slopes cover an area of 5070 km^2 comprising of nearly 48 % of TGA and this land in Tripura is under Class IV and VII depending upon the slope characteristics. In soils under undulated terrain, farmers grow a number of forest tree species for their daily need of timber, firewood and minor forest produce. The forest tree species are mainly Gamhar (*Gmelina arborea*), Teak (*Tectona grandis*) and Koroi (*Albizia procera*). Besides, these forest trees, farmers also grow Rubber (*Hevea brasiliensis*) which presently covers an area of 317 km^2 in Tripura. Forest tree species have the potentiality to supply the timber and other products after a period of 20-25 years of their planting and tapping of rubber latex generally starts 7 years after rubber plantation. So, the immediate economic activity can be made possible only through the introduction of agriculture or horticultural crops in association with forest trees and rubber. So, the objectives of the project were

- to demonstrate the cultivation of fruit crops/vegetables/spices etc in association with forest and rubber trees.
- to develop a model of agroforestry land use system in hilly undulated infertile terrain for enhancing productivity and income.

Methodology

Multipurpose tree species suitable for subtropical humid climate were planted in an agroforestry systems in Tripura. MPTs we divided into three groups in the planting geometry.

Group-I (2 m x 2 m spacing)

1. Akashmoni (*Acacia auriculiformis)* 2. Mulberry (*Morus alba*) 3. Subabul (*Leucaena leucocephala*) 4. Shisam *(Dalbergia sissoo)*

Group-II (3 m x 3 m spacing)

1. Gliricida *(Gliricidia maculata*) 2. Neem (*Azadirachta indica*) 3. Champa (*Michelia champaca*) 4. Safeda (*Eucalyptus hybrid*).

Group-III (4 m x 4 m spacing)

1. Teak (*Tectona grandis*) 2. Gamahar (*Gmelina arborea*) 3. Raintree (*Samania saman*) 4. White Siris (*Albizzia procera*).

Results

Multipurpose tree species were clear felled at 20 years of age and data on the growth characteristics are presented below.

Out of the 12 MPTs, *Eucalyptus hybrid* attained the maximum height of 23.8 m followed by *Samania saman* (23.10 m), *Albizzia procera* (21.10 m), *Acacia auriculiformis* (20.6 m), *Gmelina arborea* (17.40 m), *Tectona grandis* (16.60 m) and *Michelia champaca* (16.30 m). Bole height of tree species was found to vary from 2.50 to

Table 1 Growth characteristic of MPTS on clear felling at 20 years of age

MPTs	Tree height (m)	Bole height (m)	Basal diameter (cm)	Diameter at breast height (cm)	Timber volume (m^3/tree)	Total timber volume (m^3/ha)
			Density 2500 trees /ha			
Acacia auriculiformis	20.6	12.8	45.59	36.94	0.37	925
Morus alba	7.40	2.50	21.33	17.52	0.019	48
Leucaena leucocephala	16.45	6.40	23.89	16.56	0.033	83
Dalbergia sissoo	10.70	6.40	17.52	15.92	0.038	95
			Density 1111trees /ha			
Gliricidia maculata	11.8	7.55	16.24	14.33	0.031	34
Azadirachta indica	8.65	6.10	18.47	16.56	0.035	39
Michelia champaca	16.30	10.0	36.31	27.07	0.16	178
Eucalyptus hybrid	23.8	14.5	42.04	35.03	0.35	389
			Density 625 trees /ha			
Tectona grandis	16.60	9.20	41.40	30.25	0.19	119
Gmelina arborea	17.40	12.0	44.59	36.62	0.31	194
Samania saman	23.20	10.75	42.99	29.62	0.19	119
Albizzia procera	21.10	11.8	44.58	40.45	0.34	213
Mean	16.17	9.17	32.91	26.41	0.17	203
LSD (P= 0.05)	1.37	0.88	3.14	2.28	0.04	61

14.5 m. *Samania saman* showed only 46 % of its height as bole while *Gmelina arborea*,69 %, *Acacia auriculiformis* ,62 % and *Eucalyptus hybrid*, 60 % of its height as bole. Basal diameter and DBH showed a variation from 44.58 to 16.24 m and 40.45 to 14.33 m, respectively, thus indicating the highest in *Albizia procera* and lowest in *Gliricidia maculata.* Timber producing tree species showed a variation from 0.16 to 0.37 m^3 /tree in volume/tree with 0.67 to 0.84 in quotient (Fig. 1). So, at 2500 trees /ha, the highest timber volume could be obtained from *Acacia auriculiformis.* At 1111 trees /ha, *Eucalyptus hybrid* could supply 389 m^3/ha and at 625 stand /ha, the maximum wood production was from *Albizia procera* (213 m^3/ha) followed by *Gmelina arborea* (194 m^3/ha) and *Tectona grandis* (119 m^3/ha).

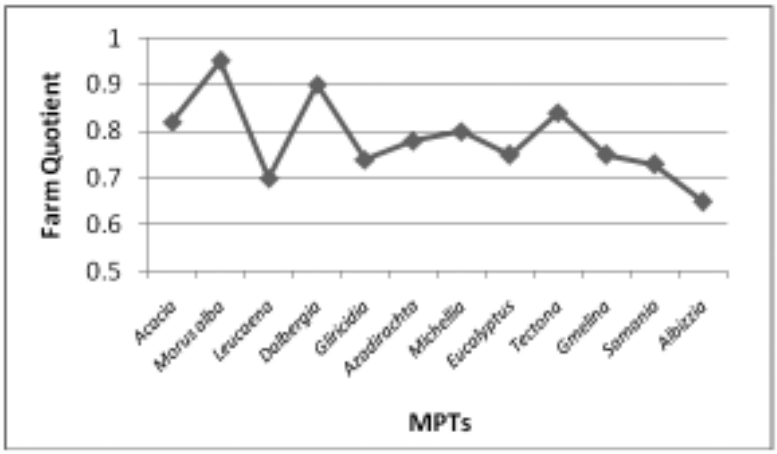

Fig 1 Farm Quotient of important MPTs in Tripura

Above Ground Biomass

After 20 years of age, MPTs was clear felled and above ground biomass was recorded. The data indicated that leaf + twig biomass on dry matter basis varied from 5.40 to 60.06 kg /tree, branch,16.08 to 320.76 kg/tree, bark, 1.98 to 28.47 kg/tree and bole, 38 to 6220 kg/ha. In contrast with *Dalbergia sissoo* which showed the least above ground biomass, *Dalbergia sissoo* could produce 10.88 kg leaf, 20.32 kg branch, 5.87 kg bark, 83 kg bole at 20 years of age. *Acacia auriculiformis* planted at 2 m x 2 m spacing as energy plantation could produce 15.5 thousand tones of fuel wood (or timber) /ha over a period of 20 years. But *Eucalyptus hybrid* could produce (Fig.2) 1389 t timber /ha followed by *Albizzia procera* (663 t/ha), *Gmelina arborea* (469 t/ha), *Michelia champaca* (467 t/ha), *Samania saman* (194 t/ha) and *Tectona grandis* (175 t/ha).

Table 2 Above ground biomass (kg/tree) of MPTs on dry matter basis

MPTS	Leaf + Twig	Branch	Bark	Bole
Acacia auriculiformis	34.62	196.27	28.47	6220
Morus alba	6.25	17.64	2.12	60
Leucaena leucocephala	9.68	33.60	3.58	86
Dalbergia sissoo	5.40	16.08	2.69	38
Gliricidia maculata	24.32	35.75	3.17	224
Azadirachta indica	7.79	25.78	1.98	92
Michelia champaca	36.35	56.75	11.66	420
Eucalyptus hybrid	73.18	205.89	14.67	1250
Tectona grandis	60.06	74.69	9.26	280
Gmelina arborea	28.92	248.26	15.28	750
Samania saman	31.02	56.32	20.86	310
Albizia procera	46.21	320.76	17.49	1060
Mean	30.32	107.32	10.94	899
LSD (P = 0.05)	5.37	26.11	2.26	426

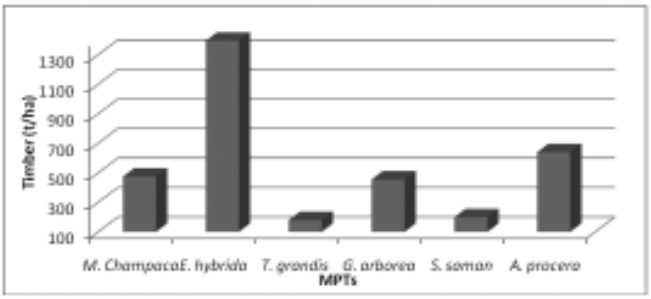

Fig 2 Timber volume of MPTs

Various crops were grown in association with MPTs and their productivity in Horti-Silvi systems are narrated below (Table 3).

Table 3 Productivity of pineapple

MPTs	Fruit weight (g/fruit)	Fruit yield (t/ha)	MPTs	Fruit weight (g/fruit)	Fruit yield (t/ha)
Leucaena leucocephala	890	14.85	*Albizzia lebbeck*	760	10.04
Dalbergia sisoo	820	7.03	*Samania saman*	816	15.21
Eucalyptus hybrid	743	12.69	*Morus alba*	790	10.98
Azadirachta indica	815	10.82	*Gmelina arborea*	705	11.11
Tectona grandis	657	12.42	*Michelia champaca*	620	5.58
			Mean	762	11.07

Dioscorea alata was grown in association with various tree species and its productivity was presented below (Table 4)

Table 4 Productivity of *Dioscorea alata*

MPTs	Productivity (kg /plant)	Productivity (t/ha)
Leucaena leucocephala	2.39	10.18
Azadirachta indica	3.22	6.36
Albizzia lebbeck	1.08	4.55
Samania saman	2.58	5.69
Morus alba	2.34	8.68
Michelia champaca	1.28	5.13
Mean	2.15	6.77

Black pepper was grown in a 3 –tier system with *Azadirachta indica* and *Michelia champaca* and the average productivity of 1.25 kg/plant was obtained.

Demonstration of agroforestry systems

West Tripura District

The farmers selected for demonstration the agroforestry project are 14 nos residing in the adjoining area of Lembucherra in Mohanpur Block and the total area under the demonstration was 3.75 ha. The summarized information of demonstration is as follows (Table 5).

Table 5 Summary of demonstrations

No of demonstrations	14
Area under demonstration	3.75 ha
Tree species available in the farmers plot	Akashmoni (*Acacia auriculiformis*) Gamahar (*Gmelina arborea*), Teak (*Tectona grandis*), Rubber (*Hevea brasiliensis*), Arecanut (*Areca catechu*)
Crop grown as agroforestry intervention	Pineapple, Turmeric,Vegetable, Patchouli, Black pepper, Radish

Dhalai district

The tilla land (small hillocks with gentle to moderate slopes) of Tripura are very much suitable for developing agroforestry based farming systems. However, in most of the cases, the land remains unutilized or underutilized and are infested with weeds and shrubs. Hence, scientific utilization of tilla lands with appropriate soil and water conservation measures were undertaken under NAIP-3. MPTs with Pineapple, tapioca, mango, guava, ginger, pepper etc can be grown on slopes, whereas, banana, vegetables etc. can be grown on valleys/foot hills, pond dykes etc. Beneficiaries and self-help groups were brought under

the purview of the programme in the clusters of Balaram and Moracherra in Dhalai district in Tripura and the area selected is presented in table 6.

Table 6 Area under selection in Dhalai

Cluster	Name of the village	Name of locality	Name of beneficiary/SHG	Total no. of farmers
Balaram	West Balaram	Deb Para	Bhairav SHG	11
		Uttar Para	Beneficiary	2
		Bazar Tilla	Beneficiary	17
	Balaram Village Council	Jharmanjoy Para	Abhachanga SHG	10
Moracherra	Chota Surma Gram Panchayat	Langutia Para	Dayamoyee SHG	10
		Sudhan Para	Beneficiary	5
	Kuchainala Gram Panchayat	North Part of Ashram Road	Beneficiary	6

Agroforestry Models

At Balaram, the total area under implementation of the agroforestry based farming system models was 2.2663 ha and the information of the agroforestry models as developed is presented in table 7.

Table 7 Agroforestry based farming system models at Balaram

Name of the locality	Area (ha)	Tree components	Crops grown
Deb Para	1.0	Mixed vegetation	Ginger
Uttar Para	0.17	Teak (*Tectona grandis)*	Ginger /black pepper
Bazar Tilla	0.9463	Teak (*Tectona grandis)*	Ginger /black pepper, Banana
Jharmanjoy Para	0.15	Mixed vegetation	Ginger

Moracherra, the agroforestry models are developed in an area of 5.436 ha of land and the components are of various tree and crop combinations and the locality wise models are presented in Table 8.

Table 8 Agroforestry based farming system models at Moracherra

Name of the locality	Area (ha)	Tree /Plantation crops	Crops grown
Langutia Para	1.0	Mango, Arecanut	Pineapple, Banana
Kuchainala	3.79	Arecanut, Coconut	Banana, Cabbage, Bhindi, Ginger and Pineapple
Sudhan Para	0.6460	Coconut, Cashewnut	Ginger, Lemon

Fishery/Livestock component

Wherever possible, ponds were developed by constructing earthen dykes in depressed places (lungas) in between two hillocks for fish culture. Piggery was integrated with ponds and pig shed washing was diverted to water bodies for promoting plankton growth. Fishery and piggery components further enhanced farmers income and employment.

Conclusion

Besides multipurpose tree species, there is a great demand for growing of fruit based cropping system in Tripura. The fruit crops for utilization of land resources in Tripura are Jackfruit, Mango, Banana, Pineapple, Sweet Orange and Litchi etc. Agri-silviculture, Silvi-Horticulture, Agri-Silvi-pastoral systems are to be demonstrated among the farmers for sustainable land use and livelihood improvement.

Livelihood security through integrated goat farming system in Barabanki and Raebareli Districts of Uttar Pradesh

B. Rai, M.K. Singh and R. B. Rai
Central Institute for Research on Goats, Makhdoom, Farah, Mathura-281122, India

Abstract

The Uttar Pradesh is one of the densely populated states. Barabanki and Raebareli are the disadvantageous districts of Uttar Pradesh due to limited bio-resources and livelihood opportunities. Repeated natural calamities, poor cropping intensity, low return and profitability, high rate of unemployment and poor adoption of technologies are the major characteristics of these districts. Goat is major livestock species kept by the poor people of these districts. Goats found in this region are non-descript type with low productivity. Under the NAIP Comp-3 project, goat was integrated with crop/horticulture and other livestock species. Data collected from 12 villages of Raebreilly and Barabanki districts indicated that most of the goat keepers (80%) belonged to Socio-economically backward (SC, OBC and Muslims) communities. The major occupation of these goat keepers was working as labour in fields, MGNREGA and petty works in nearby towns. Some (18%) goat keepers having small piece of land were growing vegetables and with the intervention of the project are also producing fruits and flowers to sustain their livelihood. The goat rearing in this region is practiced under extensive system of management. Under the project, 183 Sirohi goats and 29 adult breeding bucks of Sirohi breed were distributed in the adopted villages of both the districts. Goats distributed are providing 1.0-2.0 litre per day milk with a lactation length of 6-7 months. Most of milk consumed within the family and surplus milk sold @ Rs. 15/ litre to sustain their livelihood. Breeding bucks distributed in these adopted villages produced upgraded kids with higher birth weight and body growth rate. The upgraded kids are fetching 35-45% higher price as compared to non-descript kids in the market. Prophylactic measures provided under the project resulted in low morbidity and mortality (11%) as compared to baseline situation of 28% mortality. With the intervention of this project the goat keepers in the adopted areas are sensitised for supplementary feeding and health care of their goats. Goat keepers by adopting improved interventions introduced under the project earning Rs 2400 to 3200 per adult goat per year. Goat rearing on commercial scale is also coming up in some adopted villages. Goat + rural poultry + fruit or vegetable crops emerged as a successful IFS model for Landless people and marginal - small farmers of this region. This model is fit for earning livelihood and creating employments with limited resources in fragile areas of the country.

Specialized integrated farming system – a sustainable option for rural livelihood security

R.B. Rai[1] and T. Damodaran[2]
[1] Indian Veterinary Research Institute, Bareilly, India
[2] Central Soil Salinity Research Institute, RRS, Lucknow, India

Introduction

The deteriorating performance of Indian agriculture and slowing of agricultural growth are major concerns for our policy makers in achieving the targeted overall economic growth during the Tenth Five-Year Plan (2002-07). Agricultural growth has decelerated sharply from 3.2 per cent between 1980-81 and 1995-96 to a trend average of 1.9 per cent subsequently. Small and marginal farmers, whose land holdings are below 2 ha, constitute almost 80% of all Indian farmers, and more than 90% of them are dependent on rain for their crops. Such a poor performance of the agricultural sector is attributed to declining investment and rising input subsidies in agriculture, fatigue in technological change, deceleration or stagnation in the productivity growth of major crops, and fall in the total factor productivity (Rao *et al.*, 2003). Agricultural diversification towards high value commodities (HVCs) is viewed as one of the most promising strategies to reverse the declining growth trend in agriculture (Government of India, 2005). Mere crops pose various risks in commercial agriculture both from nature and from humans. However, as per the concept and existing practices crop-livestock-horticulture-aquaculture integration is considered as Integrated Farming System (IFS). It is to be analyzed whether each component of IFS are performing at their desired optimum level or not? It is certainly a issue to be examined. Under this scenario, an improved system (named as Specialized Integrated Farming System, SIFS) has been developed where each component performs at their optimum level and depending upon the interest of the unemployed youth in the family, one or more components are raised to the level where it serves as self employment venture. While the profitability in the self employment component(s) grow around or more than 50% annually, the whole system profitability must witness profitability growth of 15-25% annually (Damodaran *et al.*, 2011). Under an NAIP project on "Holistic approach for livelihood security through livestock based farming system in Raebareli and Barabanki districts of U.P." need based integration of technologies developed in specialized IFS models which can be replicated and implemented in other parts of the country with similar ecology and social status.

Results

Integration of commercial banana with rural poultry, dairy and summer pulse production for economic security

Most of the small and marginal farmers of Uttar Pradesh adopt rice-wheat or rice-mustard cultivation for years. Banana is a sustainable medium duration cash crop with high return in irrigated lands. But small farmers fear to adopt it due to fear of risk, high input cost and lack of complete technical back up.

In this scenario present technological approach was developed.

- Commercial banana cultivation was integrated with moong and urd dhal as intercrop at the time of planting (Febraury, March) and rural poultry in 0.30 ha with 0.30 ha under paddy-wheat with resource conservation technologies.
- About 800 tissue cultured banana G-9 variety were planted at a spacing of 1.8 x 1.8m for each beneficiary.
- 50 backyard poultry birds of Nirbhik and Shyama cross breed were integrated with the system. The birds feed cost was made near to nil by supplementing with *in-situ* azolla cultivation and introduction in the village ponds.
- Bio-priming of the primary hardened plant with native endophytes of Psuedomonas and Trichoderma was done.
- The fertilizer requirement should be supplemented with vermi-composting, *Trichoderma* and *Psuedomonads* based liquid and farm manures which also reduced the cost on fertilizers.
- The entire dried leaves were used as mulch in the orchard and poultry birds were allowed to graze in the banana fields.

The technology has resulted in increase in production and productivity of banana the main crop (when compared with the average productivity of state in 2009) from 20 kg/ bunch to 24 kg/bunch on average. The highest bunch weight of 55 kg has been recorded in the intervened farmer's field. Also it has increased in an average total income of Rs.179314 when compared with the pre intervention income of Rs.60,000.

Intervention of Commercial flower production using elite variety and bioregulators linked with market security and integration of the same with rural poultry and infertility management in dairy

Gladiolus is a monocotyledonous floral crop which is considered one of the most important flowering bulbs grown in India. It can be cultivated throughout the year under protected cultivation or from September to March under Indo-Gangetic plains of Uttar Pradesh. The crop becomes remunerative and a very good short duration income generator when it is cultivated during October to February which coincides with the peak marriage and festival seasons of the local market. Keeping these in considerations the technology of commercial cultivation of gladioulus was intervened in the farmer field of Trivediganj and Haidergarh block of Barabanki districts.

- The bulbs of the gladiolus are planted in raised beds during the first and second week of November or last week of October. To suit the regular market requirements and to adjust the harvesting time the corms are planted in two different dates with an interval of 4-5 days.
- Corms of >4cm was selected for planting and the farmers were provided with the planting materials of the following varieties.

Plum Part, Advance Red, Odyssee, Forta Rosa

- The corms are planted at a distance of 15 cm between plants and 30 cm between rows at a depth of 6-8 cm. About 88000 corms can be accommodated in one acre of land. This corm will further produce a minimum of 4-8 cormlets after the harvest of the flower.
- The native strains of the *Psuedomonads auerogenosa* (CSR-P-1) and *Trichoderma herzianum (*CSR-T-1) which were isolated and screened at CSSRI, RRS and CISH Lucknow were mass multiplied and utilized as the bioagent for foliar spray during the 3rd leaf and 6th leaf stage of growth apart from the chemical fertilizers whose dosage was reduced to 30-40 % of their recommended dose.
- Nearly 90 percent of the stalks produced will produce flowers; the flowers are harvested and are sent to the auction centre on the same day. About 8000 spikes are obtained from 500m^2 and the yield potential is 70000 spikes from one acre. Each spike is valued at price ranging from Rs.2-6/-. (Table 1)

Table 1 Profitability of the technology during the post intervention period

	Gross income	Expenditure	Net income	No of mandays
Paddy	12000	6500	5500	18
Gladiolus	67500	15000	52500	21
vegetable	24000	8930	15070	35
Poultry	8000	2826	5174	22
dairy	38000	8500	29500	42
Land lease	0	10000	0	0
Miscellaneous	5000	-	5000	45
TOTAL	149,500	51,756	107,744	138

Infertility control and estrous synchronization

To boost the milk and improved calf production, mass infertility control with estrous synchronization using indigenously developed economical non-hormonal technology was intervened. The aim of the intervention was to produce around two lactations instead of one which is being had. At the same time one more improved calf will also be produced which

will help in expanding the dairy without any external cost. The two lactations will result in increase of milk by about 80% during the same period in intervened populations. With this intervention even repeat breeders came to heat and were conceived. The birth of the calves and bringing pregnancy in repeat breeders had created a mark and change in the milk production status of the village as whole.

Strategic research in the field has been initiated to enhance the profitability of bovines where low milk production of existing germplasm becomes secondary source of income in terms of cash. The improved calves produced will establish the dairies in coming years. Mass vaccination resulted in reduction of cases of death from H.S. and foot and mouth disease and these programmes are being linked with state government activities. Strategic deworming, awareness and mineral mixture supplementation enhanced the milk production by 10-20% along with extra-lactation.

To enhance the availability of green fodder cultivation of high yielding perennial fodder like Hybrid Napier CO-3 has been taken up. Thus, less land is required for fodder and yield may touch 225-250 t/ha with continuous harvesting at 40 days intervals (depression in growth occurs during peak winter month).

Self sustenance model of the Specialized Integrated Farming System Model based on poultry and vegetables developed during 2009-11

Vegetable cultivation has been taken by the small farmers in small scale and with low and marginal returns. Here vegetable cultivation was intervened effectively with rural backyard poultry of 50 birds initially later when sufficient experience have been attained with it commercial poultry with 250 birds were intervened which was subsequently linked with buyer. *In-situ* azolla cultivation a protein rich supplement of feed for poultry was disseminated successfully in about 800 households of poultry farmers.

Some of the technologies intervened in vegetable cultivation are

- Early or late cultivation of hybrid tomato (var. NS506 or Naveen), bhendi (var. Hybrid 10 & 564) and cucurbits on riverbeds based on market intillegence.
- Seed treatment with *Trichoderma herzianum* stratin CSR-T-1 which reduced the soil borne disease incidence by 40%.
- Effective and efficient management of nutrients plays a key role in commercial vegetable cultivation. Most of the intervened farmers are marginal farmers who could not effort for high input cultivation; hence they were substituted with technologies of vermin-composting, *Trichoderma* and *Psuedomonads* enriched FYM. This resulted in reduction of threat 30-40% of recommended fertilizer schedule.
- About 0.2% Psuedomonas and Trichoderma are sprayed from the day of first flowering to harvest at an interval of 20 days. This not only takes care of control of diseases but also acts as a source of auxin and gibberellins to increase the fruit set percentage.

Conclusion

Therefore, based on the experience and knowledge acquired in the field level implementation of integrated interventions under various livelihood projects at different eco-systems of the country in the backward districts a holistic approach with realtime integration as in SIFS model can be feasible at the field level and can provide economic with nutrient security to the small and marginal farmers of the country.

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Soil and Water Conservation Measures in Hills and Rainfed Areas

Comparative study of *jhum* with and without site specific treatments at Upper Subansiri, Arunachal Pradesh

V.K. Choudhary, M. Kanwat and R. Bhagawati
ICAR Research Complex for NEH Region, Arunachal Pradesh Centre, Basar

Introduction

The people of North East India represent fascinating variety of cultures. Shifting cultivation, locally known as *jhum* is a widely distributed form of agriculture in the upland areas of North-East India. The practice involves site selection, slash and burn, followed by mixed cropping for a year or two and fallowing for certain years for recuperation of the land (Tawnenga and Tripathi, 1997). *Jhum* plays an important cultural role in local customs, traditions, and practices, besides offering economic security to farmers. Agriculture is the main occupation of about 80% of the population of Arunachal Pradesh. Being a mountainous state, majority of them practice *jhum* along the mountain slopes. The shortening *jhum* cycle to =5 years on an average now is indeed a matter of concern. This is seriously impacting on the local livelihoods and environmental security in many pockets of the region. Considering the adverse impacts of the *jhum* such as loss of precious top soil, nutrients, forest biodiversity, destabilization of slopes and its low productivity, we need to develop and implement sustainable farming alternatives. If the *jhum* in its present form is allowed to continue, land degradation and the impoverished living conditions of resource-poor upland farmers are bound to worsen with time (Cairns and Garrity, 1999).

But the farmer who has minimal land available for cultivation, has no option but to come back to his or her land for cultivation, no matter how short the fallow period is. Therefore, the urgent treatment is required to take care of those farmers. In this context, the present study was conducted.

Methodology

Soil condition of the experimental unit had great variability with temporal and spatial scale; it largely varied with origin from the parent materials and also on the fallow periods. As per the need of site, various location specific treatments were followed. Among the treatments replacement of existing varieties with HYVs and hybrids, inclusion of sequential crops, soil and water conservation measures (mulching, grasses across the slope, contour bunding etc), in-situ nutrient management (by composting of weed biomass), integrated insect, disease and weed management etc were adopted. Most of the farmers used to dibble the seeds of mixture of crops on *jhum*. They were suggested to put the crops as per their suitability and in sequence (topo-crop sequencing). As per the requirements small height contour bunds were formed and grasses like guinea and broom grasses were planted across

the slope to reduce the free flow of water and erosion of soil. Broad spectrum pesticides were used to minimize the menace of insects and diseases. However, weed population were reduced by using herbicides. Weeds available at the site along with dung of mithun (*Bos frontalis*) and cow were used for composting and were recycled into the crops. Some of the leguminous sequential crops were introduced after slashing the paddy straw. The collected data from the field were used for statistical analysis and comparison.

Results

Seed replacement ratio

Farmers of the area used 88% local varieties and only 12% of high yielding varieties. After the initiation of activity, firstly the least yielding varieties were surrogated with high yielding and hybrids and as per the acceptability of the farmers some of the local varieties were also allowed to grow on the site. Overall in the *jhum* land, about 46% of high yielding varieties, 24% of hybrids and 30% of local varieties were used.

Production analysis

Production analysis of improvement of cropping system in *jhum* land revealed that production increased with the activity followed in farmer's field. The crops like blackgram, frenchbean, pea and soybean had registered absolute growth because farmers had not grown these crops earlier. However, cereals like rice and maize were recorded with 30 and 44% higher yield, respectively. Similarly, sesame had 40% higher yield. Among the vegetables, okra, tomato, brinjal and chilli recorded 49.8, 41.8, 17.4 and 92.6% respective higher productivity Vegetables, cucurbits like pumpkin, cucumber, ridge gourd, bitter gourd, sponge gourd and ash gourd were produced with a yield advantage at 48.0, 50.4, 47.2, 113.8, 38.2 and 45.8%, respectively higher over pre project cultivation practices (Table 1). The main improvements in yield were due to use of high yielding varieties and hybrids, soil and water conservation measures, weed and nutrient management followed in the sites.

Livelihood analysis

It is evident from the table 2 that cost of cultivation, gross and net returns were higher after the intervention. The main reason for escalation of cost was due to more number of labour engaged in farm activity, use of costlier seeds and use of agrochemicals to minimize the incidence of insect, disease and weed. Similarly, B: C ratio was higher (1.33) than the normal practices followed on *jhum*. By inclusion of some of the crops on *jhum* land around 5.65 ha area was brought under cultivation during post monsoon. With these the 391 man days were used against 266 man days/ha/year. With the intervention initiated in *jhum* land, it generated the employment of 30.3%, with improvement of cropping intensity of 131.6% and land were used to 281 days against 210 days/year with land use efficiency of 79.7% (Table 2). With the intervention the land were used 22.2% more, which is a significant contribution made at the *jhum* site.

Table 1 Production analysis of beneficiaries of the *jhum* improvement

Name of crops	Area (ha)	Production (tones)		Productivity (tones/ha)	
		Before	After	Before	After
Cereals					
Rice	4.99	4.94	7.12	1.10	1.43
Maize	1.66	2.66	3.82	1.60	2.30
Pulses					
Black gram	0.67	-	0.36	-	0.53
Frenchbean	0.97	-	5.10	-	5.35
Pea	1.75	-	2.10	-	1.20
Soybean	1.40	-	0.87	-	0.60
Oilseeds					
Sesame	0.65	0.14	0.19	0.22	0.28
Vegetables					
Okra	1.83 (1.00 M and 0.83 PM)	9.15	14.52	5.00	7.49
Tomato	0.86	5.16	7.34	6.00	8.51
Brinjal	0.75	4.13	4.88	5.50	6.46
Chilli	1.40 (0.7M and 0.7PM)	2.66	4.99	1.90	3.66
Cucurbits					
Pumpkin	0.52	6.24	7.76	12.00	17.76
Cucumber	0.75	3.97	5.95	5.30	7.97
Ridge gourd	0.64	3.00	4.46	4.70	6.92
Bitter gourd	0.80	1.68	3.59	2.10	4.49
Sponge gourd	0.50	3.10	4.19	6.20	8.57
Ash gourd	0.50	5.20	4.47	10.40	15.16

M: monsoon, PM: post monsoon ; 5.65 ha area is under second crop (0.97 ha frenchbean, 1.75 ha pea and 1.40 ha soybean, 0.7 ha chilli and 0.83 ha okra); Total area under cultivation before intervention was 17.85 ha and after intervention gross cultivation area increased up to 23.49 ha.

Table 2 Livelihood analysis of beneficiaries of the *jhum* improvement

Particulars	Before	After
Total area (ha)	17.85	23.49
Cost of cultivation (Rs/ha)	18400	23731
Gross return (Rs/ha)	35000	55167
Net return (Rs/ha)	16600	31454
Additional income (Rs/ha)	-	14854
B:C ratio	0.90	1.33
Area under cultivation during post rainy season (ha)	-	5.65
Man days required (man-days/ha/year)	266	391
Employment generation (%)	-	30.3
Cropping intensity (%)	100	131.6
Land use (days)	210	281
Land use efficiency (land use/365) (%)	57.5	79.7

Soil and water conservation

Following practices were followed in *jhum* to restrict the loss of soil, nutrient, biodiversity etc

a) Growing of sweet potato: Most of the farmers plant sweet potato vines in *jhum* land. As per their belief, heavy growth of vines covers the soils early. Therefore, during intensive rains the top soils can be protected. Generally, farmer plant vines after establishment of all the important crops. Sweet potato is used for food (tuber), vegetables (vines), feed of pig and poultry (tuber) other than soil and water conservation.
b) Growing of grasses across the slopes: Some of the farmers of the area grow especially guinea grass and broom grass across the slope to prevent the soil and nutrient loss through runoff water.
c) Placement of slashed trees: In *jhum* land, after burning the slashed jungle the Jhumias keep the unburnt or half burnt tree trunks across the slope. These reduce the velocity of free runoff and also help the water to infiltrate and percolate by which soil and water are conserved. On the other hand, those tree trunks are important source of fuel throughout the year for the *jhummias*.

Conclusion

With the findings at the *jhum* land we infer that appropriate, soil and water conservation measures, with the judicious use of different varieties and other agricultural inputs not only increased the production and productivity but also helped in checking soil loss. This has contributed in improving the livelihood of the Jhumias.

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Effect of organic mulch types on soil moisture conservation and performance of rain-fed turmeric in Saiha, Mizoram

K. Vanlalhriatpuia, U.K. Sahoo, Lalnilawma and Soibam Lanabir Singh
Mizoram University, Aizawl, Mizoram

Introduction

Turmeric (*Curcuma longa* L.) is an important spice crop grown under shifting agriculture, traditional homestead garden and in agroforestry systems purely on organic culture in Mizoram and its yield is reportedly low. Its' productivity can be increased by adopting improved package of practices, particularly *insitu* moisture conservation through mulching. Mulches have been found to moderate soil hydrothermal regime Srinivas *et al.*,(1990); Chovatia, *et al.*, (1992) and increase fruit yield mainly due to increased soil moisture status Chattopadhyay and Patra (1992); Mage (1982). Mulch materials are also well known to improve conservation of soil moisture during dry period Haynes (1980), help supply moisture to the root zones and thereby improve crop performance Moitra *et al.* (1994). The prevailing traditional '*jhum*' farming practice being unscientific contributes to the loss of soil moisture and subsequent degradation of the sites. Therefore, there is a need for conserving soil moisture to avert moisture deficit during crop growth period. The present study was undertaken to compare the relative efficacy of different organic mulches (both type and quantity) for moisture augmentation and to assess the role played by mulches for improving turmeric productivity in the hilly terrains.

Methodology

The present study was conducted at Kawlchaw east village, Saiha District, Mizoram. The study was carried out during 2009-10 on a sole turmeric cropping using RBD (Randomized Block Design) involving 10 treatments as three mulch types (rice straw, weeds, subabul leaves) and three mulch quantity (6, 8 and 10 t/ha) and a control (without mulch) and each treatment was replicated thrice resulting into a total of 30 subplots (size 2.5 m x 2.5 m) marked from the main plot for evaluating soil moisture retention and growth productivity of turmeric. Turmeric was planted in the sub-plots at a uniform spacing of 25 cm x 35 cm. Mulches were applied immediately after sowing of the crop. Three weeding were carried out during a cropping period in order to prevent the growth of weeds and improve crop growth. The first weeding was done in mid-June, the second weeding in mid-August and the last weeding in the first week of October, prior to harvesting of turmeric every year and the experiment continued for two years. Chemical control measures and irrigation of any sort were not provided and the crop was raised purely under rainfed condition. Observations were recorded in respect of vegetative growth such as sprouting frequency;

tiller height and average sprout height at monthly intervals. The average yield, finger number and finger size were recorded after harvest.

Soil moisture content was determined from the soil samples collected from 0-15 cm depth at monthly interval, which were properly tagged and sealed in plastic packets before being brought to the laboratory for analysis. Soil moisture loss on drying to constant weight was determined for 100 gm of fresh soil. The soil moisture percent was expressed as percent fresh weight. Economics was found out by taking into account the existing market rate of the crop, mulch materials and cost of cultivation. The data were subjected to analysis of variance to see the effect of mulch materials on soil moisture conservation and growth and yield attributes of turmeric.

Results

Growth

Plant height of turmeric increased with increasing rates of the application of mulch materials. Maximum height was recorded with 10 t mulch/ha, followed by 8 t/ha and 6 t/ha (Table 1). In general, higher number of sprouts and tiller frequency were observed with higher rates of mulch application. Similar findings were reported by Mohanty *et al.* (1990); Sharma *et al.* (2011) and Dinesh Kumar *et al.* (2003). The sprouting number and its frequency was in the order of subabul leaves mulch > rice straw > weeds. Similar was also the case with the tiller height. The better growth of the tillers in the subabul leaves mulched plots could be related to the nitrogen supply of the rapidly decaying legume (subabul) leaves although the soil did not retain maximum moisture. More moisture was retained by rice straw mulch but it alone did not improve the growth.

Yield

Among the different mulches, subabul leaf mulch showed maximum turmeric yield, higher number of finger and better finger size over rice straw and weed mulches (Table 2). Quick decomposition of subabul leaves must have released some nitrogen to the soil favouring crop growth in the system. Further, maximum crop yield and finger number and better finger size were obtained with 10 t mulch/ha, followed by 8 t mulch/ha and 6 t mulch/ha (Table 2). Improved growth resulted in more finger number and better size per mother rhizome thereby depicting 10 t mulch/ha as appropriate dose for bringing beneficial effects on crop productivity.

Table 1 Plant height, tiller number, tiller frequency percent of turmeric as influenced by different treatments

Plant height/tiller height (cm)			
Mulch	2008-09	2009 –2010	Mean
Quantity:			
6 t/ha	29.50	28.94	29.22
8 t/ha	30.89	30.27	30.58
10 t/ha	32.43	31.89	32.16
CD at 5%	3.94	3.97	
Quality:			
Rice straw	32.67	30.24	31.46
Weeds	30.68	28.67	29.68
Subabul leaves	34.49	31.90	33.20
CD at 5%	3.84	3.56	
	Sprout numbers		
Quantity:			
6 t/ha	1.17	1.14	1.16
8 t/ha	1.19	1.15	1.17
10 t/ha	1.23	1.16	1.20
CD at 5%	0.04	0.02	
Quality:			
Rice straw	1.18	1.16	1.17
Weeds	1.16	1.14	1.15
Subabul leaves	1.20	1.18	1.19
CD at 5%	0.03	0.02	
	Sprouting frequency percent		
Quantity			
6 t/ha	62.29	61.72	62.01
8 t/ha	63.86	62.95	63.41
10 t/ha	65.41	64.66	65.04
CD at 5%	2.95	2.86	
Quality			
Rice straw	64.62	63.23	63.93
Weeds	63.33	61.69	62.51
Subabul leaves	66.30	64.23	65.27
CD at 5%	2.21	2.15	

Table 2 Turmeric yield, number of fingers and finger size as affected by different treatments

Turmeric yield (t/ha)			
Mulch	2008-09	2009 –2010	Mean
Quantity			
6 t/ha	10.79	10.14	10.47
8 t/ha	11.53	10.57	11.05
10 t/ha	12.08	11.25	11.67
CD at 5%	2.64	3.62	
Quality			
Rice straw	11.47	10.95	11.21
Weeds	10.69	10.57	10.63
Subabul leaves	12.04	11.44	11.74
CD at 5%	2.56	2.15	
	Number of fingers		
Quantity			
6 t/ha	6.33	6.22	6.28
8 t/ha	6.47	6.36	6.42
10 t/ha	6.58	6.51	6.55
CD at 5%	0.84	0.60	
Quality			
Rice straw	6.49	6.38	6.44
Weeds	6.31	6.20	6.26
Subabul leaves	6.58	6.51	6.55
CD at 5%	0.82	0.55	
	Finger size (cm)		
Quantity			
6 t/ha	6.65 x 6.26	6.27 x 6.14	6.38 x 6.17
8 t/ha	6.35 x 6.20	6.28 x 6.17	6.29 x 6.16
10 t/ha	6.52 x 6.31	6.39 x 6.23	6.43 x 6.24
Quality			
Rice straw	6.65 x 6.28	6.27 x 6.14	6.38 x 6.18
Weeds	6.22 x 6.16	6.18 x 6.12	6.19 x 6.13
Subabul leaves	6.71 x 6.30	6.30 x 6.23	6.43 x 6.24

Soil moisture conservation

Soil moisture retention varied significantly (P = 0.05) with mulch types and quantity (Table 3). Among the mulch types the application of rice straw conserved more moisture than subabul leaves and weeds (Table 3). Higher moisture retention by rice straw over other mulches could be due to its slower rate of decomposition. The mulch quantity also significantly (P = 0.05) affected soil moisture retention; an increasing mulch rate increased

moisture retention therefore moisture retention was in the order of 10 t mulch/ha> 8 t mulch/ ha > 6 t mulch/ha. A higher rate of mulch application could have caused reduction in soil surface evaporation and weed intensity thereby facilitating more moisture retention and crop yield. Ross *et al.* (1985) has ascribed such a situation to thermal insulating and cooling effects. Jiang Ping *et al.* (1997) advocated that mulching can reduce soil temperature in summer and increase in winter and hence the application of mulches in dried parts of the year can be more beneficial to the crop than the wet seasons.

Table 3 Soil moisture retention (%) as influenced by different treatments.

Mulch	2008-09	2009 –2010	Mean
Quantity			
6 t/ha	39.73	20.26	30.00
8 t/ha	48.88	28.70	38.79
10 t/ha	59.95	37.31	48.66
CD at 5%	2.02	2.18	
Quality			
Rice straw	59.51	37.15	48.33
Weeds	39.46	20.35	29.91
Subabul leaves	49.73	29.08	39.41
CD at 5%	2.13	2.39	

Economics

Benefit: cost ratio was highest for the crop applied with 10 t mulch/ha and was most economical under subabul leaves than other mulches (Table 4). A higher yield with subabul leaves was the reason for its higher B:C ratio. The reduced management cost in the second year compared to first also contributed to better B: C ratio suggesting the beneficial effect of the mulches to the soil over the years.

Table 4 Benefit: cost of turmeric as influenced by different treatments

Mulch	2008-09	2009 –2010	Mean
Quantity			
6 t/ha	1.95	1.79	1.87
8 t/ha	2.13	1.89	2.01
10 t/ha	2.27	2.06	2.17
Quality			
Rice straw	2.12	1.99	2.06
Weeds	1.92	1.64	1.78
Subabul leaves	2.26	2.11	2.19

Conclusion

Our investigation revealed that moisture conservation is essential for better performance of turmeric. Mulching with subabul at the 10 t/ha is best in maximizing its yield and spreading the beds with locally available weeds (after weeding) could be an effective tool to enhance moisture conservation and productivity in the hilly terrain of Mizoram.

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Multiple use of water for enhancing water productivity and rural livelihood

Ramkrushna G.I., Anup Das, B.U. Choudhury, A.K. Tripathi, R.K. Singh, D.P. Patel, G.C. Munda and S.V. Ngachan
ICAR Research Complex for NEH Region, Umiam, Meghalaya

Introduction

The farmers of the North Eastern Region of India are mostly small and marginal, and depend on agriculture for their livelihood. The agricultural productivity in the region is very low and the region is in severe deficit of food grains (33%), fish (54%), meat (58%) and eggs (85%). The region is very rich in water resources (42 million ha m), receives very high rainfall (2450 mm) but most of it goes waste as runoff. Therefore, water harvesting and their efficient utilization is the major approach for promoting livelihood in hills of North East India. The harvested water should be efficiently utilized for enhancing water productivity. There are many existing small and large water bodies, farm ponds which are mostly underutilized. The fish productivity is very low (500 kg/ha) mainly due to non adoption of improved species and husbandry practices. The water productivity in the region is very low mainly due to lack of scientific integration among different enterprises of agriculture, livestock, horticulture and fishery. Adoption of farming system approach for promoting multiple use of water allows efficient recycling of farm wastes and dependency on external input is reduced to a great extent. There will be year round employment and continuous generation of food and income from one or other component and thereby, promoting food and nutritional security at house hold level. Multiple use of water has been used in different parts of NE particularly in plains in small scale with limited interaction. Tribal farmers in general do not have adequate knowledge in integrated farming system for enhancing crop and water productivity. Hence, the current demonstration were undertaken in 15 farmers field under the project "Farmers' Participatory Action Research Programme, Phase II' to diversify agriculture, enhance water productivity and income of farmers..

Methodology

A total of 15 models for multiple use of water ware demonstrated in different villages of Ri-Bhoi district of Meghalaya. The average pond size was 500 m^2 area with a depth of 1.25-1.5 m. The farmers were provided financial and technical help for renovating their ponds, liming, fingerlings, piglets, ducks, vegetable seeds and fruit saplings. Electric *tulu* pump (1HP), rose cans, knapsack sprayer, cono-weeder, etc were given to each farmer for irrigating their crops, cleaning the animal sheds, weeding the crop, plant protection etc. Necessary training for integrated farming system for multiple use of water was provided at

the ICAR Research Complex for NEH Region, Umiam. In integrated farming of fish and livestock, fish farming is done in association with the husbandry of domesticated animals such as pigs, ducks, etc. Low cost pig and duck shed were made on the pond embankments utilizing locally available materials like bamboo, wooden logs, thatch grass, GI sheet, etc. for providing shelter to pigs and ducks. This system involves recycling of waste or byproducts of one system as an input of another system, with a view to optimize the production efficiencies and achieve maximal bio-mass harvest from one unit area, with due environmental consideration. Fruits like citrus, guava and vegetables like carrot, tomato, broccoli were cultivated in the vicinity of the pond/animal shed to generate additional income. This minimizes the operational expenses in feed, fertilizers and maintained a balanced ecosystem with no wastes.

Results

After one year, the farmers were able to harvest on an average about 154 kg fish from their respective pond with an average productivity of 2900 kg/ha (Table 1). The ducks started laying eggs (about 790 eggs/annum by nine ducks). Piglets gained weight of around 100 kg by which farmers could get the return of Rs. 35,760 from three piglets as gross

Table 1 Average production, employment and income from the multiple use of water

Particulars	Area allotted (m^2)	Production (kg)	Employment (Man days)	Annual Cost Involvement (Rs.)	Gross income (Rs.)	Net income (Rs.)
Composite fish culture	500 m^2	154.07	10	5040	15407	10367
Tomato	192 m^2	429	10	1860	4290	2430
Frenchbean	150 m^2	148.5	5	1200	1485	285
Mixed vegetables: Chow-chow, *laipata*, chili, cucumber, broccoli	308 m^2 (all sides of Pond dyke)	121.66	10	1500	2433.2	933.2
Banana (20 plants)	142 m^2 one side of Pond dyke	125	5	1000	3125	2125
Assam lemon, peach, orange (20 plant)	208 m^2 – pond dyke in three sides	43.89	2	500	877.76	377.76
Eggs (Duck)	9 female + 1 male	790nos.	5	2000	3950	1950
Piglets	3 piglet (fattening)	298	20	24000	35760	11760
Total	1500		67	37,100	67,328	30,228

income and Rs. 11,760 as net income. The income from vegetables (Tomato, frenchbean, laipatta etc) and fruits (Banana, Assam lemon, peach etc) grown on pond dykes were also quite good. For effective utilization of space vegetables like *laipatta*, chili, etc. were intercropped in between fruit plants. The average pig dung production was 6 kg/day (2000 g/pig/day) and considering 10% washings, at least 600 g pig manure was diverted to pond every day. Similarly, average duck dropping per day was 1.5 kg (150 g/day) which was directly allowed to fall on the water body. On an average, farmers could earn a gross income of Rs. 67,328 and a net income of Rs. 30,228 per annum from an integrated farming system unit of 1500 m^2 area. Whereas, the net income was only Rs.8,500 from farmers practice from same area. The income after stabilization is expected to be about Rs.50,000 per annum from various components from 1500 m^2 area. Due to adoption of diversified farming system activities, the farmers' employment enhanced by about 100% and income by 350 %.

Conclusion

Multiple use of water through integrated farming system approach enhanced production, productivity, employment and reduced dependence on external resources. It is possible to get year round employment and income from a small area of land with effective harvesting and recycling of water.

Organic manure production through vermicomposting for sustainable hill agriculture

H. Kalita, Kundan Kishore*, Boniface Lepcha and S. Babu
ICAR Research Complex Sikkim Centre Tadong, Gangtok-737102
*Directorate of Research on Women in Agriculture, Bhubaneswar, Odisha

Introduction

Sikkim is the least populous and the second smallest state of India having only four districts viz., North, South, East and West. Among them, North district is the largest district in terms of land mass (59.5%). However, according to 2011 Census, it is inhabited by only 7% (43354) of the state population (6.1 lakhs) and majority of inhabitants are schedule tribe (55%). The socio-economic and agricultural situation in North district is relatively challenging than other districts. Dzongu area is a part of the North district which is considered as restricted area for Lepcha community. The per capita operational land holding is less than 0.20 ha. Agriculture is the main stay of the economy of Dzongu which engages more than 75% of the workforce. However, the quantitive and qualitative food security is still challenging as most of the agricultural activities are subsistence, small scale and technology- starved which consequently reduces productivity and profitability. Among the factors responsible for low production in agriculture and horticulture, application of insufficient manure is one of the most important factors as the state had been declared as organic in 2003. The farmers have only alternative to fertilize their land through bio-fertilizers. But for the farmers of remote area like Dzongu it is very difficult to get commercial bio-fertilizers. Besides, as the most of the areas are in hilly terrain the carrying of FYM manure takes more time and involves huge labour requirement to the site of application in some areas. During survey period it was observed that few farmers took initiative to produce vermicompost though traditional way (preparing the pit with rocks) utilizing local earthworm. Vermicomposting is a method of enriching compost with the use of earthworms. It is one of the easiest ways to recycle animal waste and plant parts to produce quality compost. Therefore, an attempt was made to demonstrate the improved technology for production of enriched vermicompost utilizing easily available raw materials to the farmers of Dzongu area under NAIP-lll project on livelihood improvement of rural poor through sustainable agriculture with the objectives of sustenance of productivity, income generation and livelihood improvement.

Methodology

The problems as well as need of the farmers were determined through base line survey and PRA. Accordingly some Self Help Groups (SHGs) were selected to construct vermicomposting unit to fulfill their requirement and to earn profit. Each vermicomposting

unit consists of 6 beds of size-5' x 4' x 1' and one harvesting floor. Between two rows of beds there is one passage of 2' for easy handling of the different operations. Generally, vermicomposting is done by pit method and bed/windrow method. In bed method vermicomposting is done on the kachcha/pucca floor by making beds. The bed method of vermicomposting is relatively easy to carry out all the operations and also cost effective. In bed method the chance of water logging is less and aeration is better which in turn speed up the conversion process. Therefore, bed method was demonstrated to popularize among the farmers. The sites for construction of units were selected in cooler place. Firstly cow dung and leafy materials which were free from plastic, chemicals, pesticides, metals, etc. were mixed in the proportion of 3:1 and left for 15 days for partial decomposition. Then all the beds were filled with the partially decomposed raw materials so that each bed could accommodate 300-400 kg of raw materials. Bio-fertilizers like Azospirilum+ PSB @ 400g each were added with the raw materials to enrich the compost. Exotic highly efficient Earthworm like *Eisenia foetida* (2-3kg/bed) was released in the upper layer of bed. Water was sprinkled after release of earthworm and beds were covered with gunny bags/polythene to maintain moisture level. Turning was done after 25-30 days for maintaining aeration and moisture. Regularly water was sprinkled to keep the heap moist (30-40%). To avoid water stagnation a hole was kept in each bed for drainage of excess water. Vermicompost generally get ready between 60-75 days when the colour of the raw materials changed to brown/black. From the upper side harvesting was done and sieved to get the fine vermicompost. The farmers were trained by organizing training and through demonstration. After that the units were being maintained by the farmers/ SHG.

Results

Initially one unit was constructed at Lingdong and, production and demonstration had been done accordingly. From six bedded unit 550 kg vermicompost had been harvested and recovery was around 60 %. The nutrient content in vermicompost was N 1.5% and P 0.7%. Subsequently, the farmers and SHGs got motivated with the results and showed their willingness to adopt this technology and consequently, 14 more vermicomposting units were constructed at Passingdang, He-Gyathang Sudurbringbong, Tingvong and Gor and started production of vermicompost. The SHGs of Lingdong, Passingdang, Tingvong He-Gyathang, Gor and Sudurbringbong produced sufficient quantity of good quality vermicompost after our intervention and they are applying vermicompost to the crops especially vegetables and citrus nursery. The production of crops especially vegetables is increased significantly due to application of

Table 1 Nutrient Analysis of biofertilizer enriched vermicompost made from *Eisenia foetida*

Parameters	Content
pH	6.7
OC %	11.54
OM %	21.20
N %	1.96
P %	1.12
K %	2.00

vermicompost. Farmers are getting 2-3 times more income than earlier and getting employment through vermicomposting.

Table 2 Production of vermicompost in different units

Sl. No.	Year	No. of units	Expenditure for construction (Rs.)	Expenditure for inputs	Total harvest(t)	Total Income (Rs.)	Financial Benefit (Rs.)
1	2008-09	2	59000	7000	4.0	28000	21000
2	2009-10	2	33000	14000	10.0	70000	56000
3	2010-11	10	110111	90000	30.0	210000	120000
4	1011-12	1	18000	100000	32.0	224000	124000

The demonstration of technology for vermicompost production has motivated the farmers and most of the farmers and SHGs are showing interest to adopt this technology. Income is being generated by selling vermicompost and through increased production of vegetables and other crops by applying vermicompost as nutrients in vermicompost is found in readily available form and releases most of the nutrients in the same year of application. The farmers and SHGs got motivated with the results and showed willingness to adopt this technology because it provides better usages of organic wastes/crop/animal residues, it is a stable enriched soil conditioner, it is economically viable and environmentally safe and it makes farming sustainable for organic food production. The application of vermicompost was done at different rates based on nature and requirement of the crops.

Crops	Rate
Field crops	6-8 t/ha
Fruit crops	3-5 kg/plant
Pots	100-200 g/pot

Conclusion

Vermicomposting has been a profitable venture for those who have dairy units. It is possible to earn up to Rs 1.24 lakh annually by maintaining a unit of 3.2 tonnes capacity. The importance of vermicompost in organic production system has far reaching impact on the sustainability of the system as well as the economy of the farmers. Farmers are not only getting more income but also get employed in vermicomposting operation.

Low-cost polyhouse and plastic film lined pond: A noble technique for cultivation of high valued crops and multiple use of rain water

S. Mandal, R.K. Singh and Ramkrushna G.I.
ICAR Research Complex for NEH Region, Umiam-793 103, Meghalaya, India

Introduction

There are good prospects of use of poly-houses as protected cultivation systems at high and mid altitude of North East Region (NER) of India, where temperature is low and cultivation season is short. High intensity of rainfall makes nursery raising a difficult and risk prone task. Low cost poly-house is one of the best proven green house technologies with less cost input for the farmers of this region. For growing off-season vegetables and high value crops there is need of irrigation but cultivation during winter season is restricted to homestead due to scarcity of water. Water harvesting by small ponds offers a solution to mitigate water scarcity during dry period. In upland, due to high hydraulic gradient, seepage loss is very high and ponds very often do not retain water for entire dry period during November to March. Therefore, LDPE lining is one of the viable options to control seepage loss. A plastic film lined pond will fulfil the requirement of irrigation for off-season cultivation as well as animal rearing.

Methodology

A sub project was undertaken under NAIP component III at South Garo Hills district of Meghalaya. In the selected cluster, 11 villages were there. One farmer (Mr. Wilstone) was selected for a low cost bamboo framed polyhouse with floor area of 100 m^2 and two farmers were selected from the same cluster Mr. Lettle and Mr. Hentus to construct two LDPE lined ponds of size 6 m × 4.5 m × 1.5 m to harvest water and grow vegetables in the kitchen garden. The low cost bamboo framed polyhouse roof was covered with 200 micron ultra violet (UV) proof low density polythene (LDPE) and sides were protected with 50% shade net.

The beneficiaries of LDPE lined pond of size 6 m × 4.5 m × 1.5 m were provided with seeds of high value vegetable crop seeds like tomato, capsicum, lettuce, etc. They were trained and continuous technical support was given by the team to harvest rain water in plastic lined pond and grow high value offseason crops.

Results

The beneficiary Mr. Wilstone could grow only one crop on his plot for long time. He cultivated lettuce, tomato and capsicum in the polyhouse with 100 m^2 under each crop. The

farmer could get Rs. 3220 from lettuce, Rs. 7596 from tomato and Rs. 6300 from capsicum (Table 1). The NAIP team converted this piece of land to help him earn Rs. 17,116 annually by growing vegetables. He is now planning to grow seedlings of tomato and capsicum crops in next year to get more profit.

Table 1 Economics of round-the-year vegetable cultivation in polyhouse

Crop	Month of planting/ sowing	Gross Area (m^2)	Production (kg)	Total value of produce (Rs)
Lettuce	November	100	161	3220
Tomato	June	100	422	7596
Capsicum	February	100	252	6300
Total	17116			

Other two beneficiaries under LDPE lined pond, Mr Hentus and Mr. Lettle could achieve good earning from combination of kitchen gardening and pig rearing by utilizing the rain water harvested through plastic lined pond. Along with rainwater harvesting, the pond also was used as storage tank to supply water for domestic use. A significant amount of drudgery was reduced because they were had not to carry water from down to uphill from a perennial stream. These two farmers could get Rs. 2440 and Rs. 5850 from cultivating lettuce and tomato, respectively. Integrating kitchen gardening and pig rearing, they could make on an average Rs. 24,750 from the fattening of the two pigs provided to the farmers. For the next year they are planning to rear fish in the ponds.

Table 2 Economics of round-the-year vegetable cultivation and pig rearing from the harvested water of plastic lined pond

Crop/Animal	Gross Area (m^2)	Production (kg)	Total value of produce (Rs)
Lettuce	80	122	2440
Tomato	80	325	5850
Pig	2 Nos	165	24750
Total	33040		

Seeing the success of these three families other nearby farmers also came forward for technical guidance to adopt these two technologies.

Intensification of greengram based cropping system through organic toria cultivation

G. S. Yadav[1], M. Datta[1], Anup Das[2], Subhash Babu[3], Chandan Debnath[1], S. N. Bhowmik[1], S. P. Das[1], B. L. Meena[1], Jayanta Layek[2] and S. V. Ngachan[2]

[1] ICAR Research Complex for NEH Region, Tripura Centre

[2] ICAR Research Complex for NEH Region, Umiam, Meghalaya

[3] ICAR Research Complex for NEH Region, Sikkim Centre

Introduction

Rapeseed and mustard group is the second most important sources of edible oil after groundnut. Among rapeseed-mustard, toria is a short duration and inter-season cash crop, which can assume a great importance in intensive cropping system (Charak *et al*. 2006). This crop is most suitable for growing on residual soil moisture and fertility. Because of its shot duration it can grow in rainfed areas after harvest of kharif crops like rice, maize, green gram, blackgram etc. on residual soil moisture and fertility with life saving irrigation and increase the cropping intensity and farmers income. The adequate mineral nutrition particularly nitrogen fertilization is considered to be most important for exploiting potential of toria due to its involvement in various processes of physiological significances. The continuous use of chemical fertilizer may cause environmental hazards and responsible for climate change. In view of these facts, the present study was undertaken to investigate the effect of poultry and farm yard (FYM) manures on growth and productivity of Toria grown on tilla land of Tripura

Methodology

A field experiment was conducted in post rainy season (November – January) in 2011-12 at agronomy research farm of ICAR (RC) NEH Region of Tripura centre, Lembucherra, West Tripura. The objective of study was to evaluate the effect of poultry manure (PM) and farm yard manure (FYM) on productivity and economics of toria grown on tilla land. The experiment was conducted in complete randomize block design with 6 treatments (control, PM @ 5 t ha^{-1}, PM @ 10 t ha^{-1}, FYM @ 5 t ha^{-1}, FYM @ 10 t ha^{-1}, FYM @ 15 t ha^{-1}) and replicated thrice. Toria was sown in the last week of November with a seed rate of 5 kg ha^{-1} at a spacing of 30 cm x 10 cm and harvested in last week of January.

Results

There was a significant effect of organic manure (PM and FYM) on growth and yield of toria (Table 1). Plant height, root depth and branches $plant^{-1}$ were significantly increased with the application of PM and FYM. Application of FYM @ 15 t ha^{-1} produced maximum

plant height, root depth and branches plant^{-1} over control, but at par with all other treatments. Plant height was more with FYM as compared to PM on same level of application. However, root depth and branches plant^{-1} was higher with PM as compared with FYM on same level of application. Yield attributes and seed yield of toria was also significantly affected with the application of organic manures (PM and FYM) (Table 1). Application of FYM @15 t ha^{-1} produced significantly higher number of siliqua plant^{-1} and seed siliqua^{-1} over all other treatments except PM @ 10 t ha^{-1}. However, 1,000 seed weight (g) was higher with the application of PM @ 10 t ha^{-1} over control and at par with all other treatments. At the same levels of application of manure, PM was more beneficial for higher expression of yield attributes. Seed yield of toria was significantly affected by PM and FYM applications. Application of FYM @ 15 t ha^{-1} has produced more seed yield, which was at par with 10 t ha^{-1} PM and was significantly superior over rest of the treatments. PM produced more seed yield as compared to FYM at similar doses of application. Ghosh *et al.*(2010) reported the poultry manure @ 5 t ha^{-1} gave highest mustard seed yield fallowed by *Ambrosia* @ 10 t ha and FYM @ 10 t ha^{-1}. Seed yield showed quadratic relationship with FYM and PM. Economic yield of toria was obtained with the application of 7.3 t ha^{-1} FYM while for PM, it was 6.6 t ha^{-1}. That could be estimated from the equation (Figure 1). Toria grown with 15 t FYM ha^{-1} incurred highest cost of cultivation. This higher amount of FYM resulted more cost for FYM and require more man power for application, thus total cost was higher with application of FYM @15 t ha^{-1} compared to other treatments. Gross returns was also significantly more with application of FYM @15 t ha^{-1} compared to other treatments; however it was at par with application of PM @10 t ha^{-1}. Net returns showed different trends as compared to gross returns. The highest net returns was recorded with application of PM @ 10 t ha^{-1}, which was statistically at par with FYM @ 10-15 t ha^{-1} and PM @ 5 t ha^{-1} and significantly superior over rest of the treatments. Benefit: Cost ratio (B: C ratio) decreased with the increase in the amount of PM and FYM. The highest B: C ratio was recorded with the application of PM @

Table 1 Effect of poultry manure and FYM on growth, yield attribute, yield and economics of Toria

Treatment	Plant height (cm)	Root depth (cm)	Branch/ plant	Siliqua / plant	Seed/ siliqua	1,000 Seed weight (g)	Seed Yield (kg ha^{-1})	Net returns (Rs ha^{-1})	B: C Ratio
Control	87.7	8.2	3.5	113.3	13.8	2.5	626.7	15528	2.63
PM @ 5 t ha^{-1}	92.5	9.7	4.4	139.0	15.2	3.1	1026.7	26059	2.74
PM @ 10 t ha^{-1}	94.9	10.9	4.6	144.2	15.3	3.3	1186.7	26989	2.32
FYM @ 5 t ha^{-1}	90.7	9.5	3.9	127.8	14.6	2.8	906.7	21131	2.40
FYM @ 10 t ha^{-1}	100.4	10.6	4.4	131.2	15.1	2.9	1080.0	22468	2.08
FYM @ 15 t ha^{-1}	101.0	10.9	4.9	153.8	15.5	3.0	1226.7	22739	1.86
SEm±	2.26	0.35	0.082	6.39	0.31	0.14	50.93	1608	0.08
LSD (*p=0.05*)	7.12	1.12	0.259	20.13	0.97	0.45	160.49	5067	0.24

5 t ha^{-1}, which was statistically at par with control and significantly superior over all other treatments.

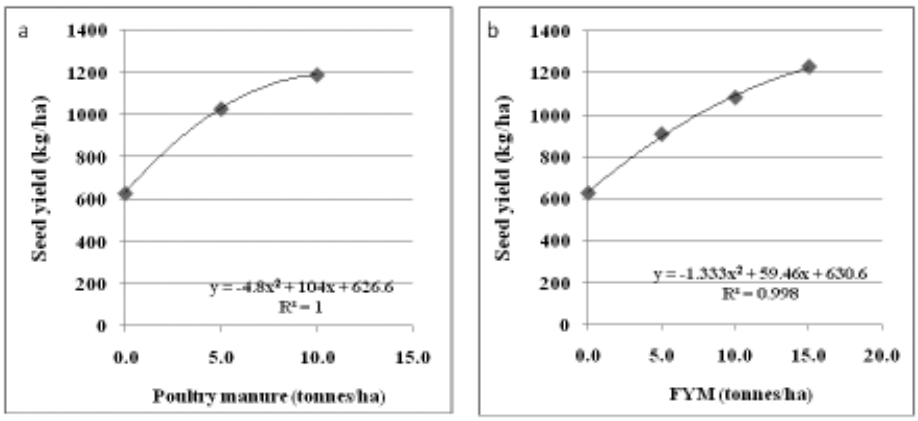

Figure 1. (a) Effect of poultry manure (a) and FYM (b) on seed yield of Toria

Conclusions

Productivity of Green gram – toria cropping system increased through soil moisture conservation and organic nutrient management practices. However, maximum net return and Benefit: Cost ratio was obtained with PM @ 5 t ha in toria.

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Resource Conservation Technology Based Innovation for Sustainable Livelihood Improvement of Farmers in South Garo Hills, Meghalaya

Mokidul Islam[1], Anup Das[2], D.P. Patel[2], Tanmay Samajdar[1] and L.K.Nath[1]
[1] Krishi Vigyan Kendra (ICAR), Tura, West Garo Hills -794 005, Meghalaya
[2]ICAR Research Complex for NEH Region, Umiam, Meghalaya

Introduction

Rice (*Oryza sativa* L) – fallow is a prevalent cropping system in Sibbari cluster of Gasuapara Community Development block in particular and South Garo Hills district of Meghalaya in general. The cropping intensity in the district is hardly 120 per cent. The farmers of this locality are mostly small and marginal. Wages, agriculture and allied small scale activities are their main source of income with traditional method of cultivation. The total area of rice in South Garo Hills district is 3338 hectare with the productivity of 1053 kg/ha. However, Gasuapara Community Development Block in the district covers an area of about 1177 hectare with the productivity of only 986 kg/ha (Annonymous, 2008-09). Soil and climatic conditions of valleys of South Garo Hills are suitable for rice cultivation but the field remain vacant after its harvest. Conventionally, after Sali rice, fields remain fallow in lowland. Fallow land after rice might be due to traditional custom of free grazing of animals after Christmas (25 December). So, the resource conservation technologies (RCTs) like system of rice intensification (SRI) and integrated crop management (ICM) followed by zero tillage toria in the context of farmers' realities in lowland rice ecosystem is necessary for sustainable livelihood improvement. The RCT of SRI and ICM in rice cultivation followed by zero tillage toria could conserve resources like seeds, water, nutrients, soil health and environment, reduce cost, higher yield etc compared to farmers' practice (rice-fallow) (Satyanarayana *et al*., 2006, Balasubramanian *et al.*, 2007, Rajendran *et al*., 2005). Hence, KVK, Tura and ICAR Reseach Complex for NEH Region, Umiam has undertaken the interventions on RCT based innovations like System of Rice Intensification (SRI) and Integrated Crop management (ICM) in Sali rice followed by zero tillage toria to increase the productivity, income and cropping intensity for the improvement of livelihood of farmers in South Garo Hills district of Meghalaya.

Methodology

An intervention on resource conservation technologies (RCTs) was undertaken at Sibbari cluster in nine different villages of South Garo Hills district of Meghalaya during 2010-11 and 2011-12. The intervention consist of three RCT based innovations viz., SRI rice – zero tillage toria, ICM rice – zero tillage toria and Farmers practice (rice – fallow)

replicated fifteen times in different farmers' field. The RCT based innovation techniques of system of rice intensification (SRI) involves 10 days old seedlings at 1 seedling/ hill was transplanted in square system with 25 x 25 cm^2 spacing and 20 days old seedlings at 2 seedlings/hill in 20 x 20 cm^2 spacing under Integrated Crop management (ICM) techniques. However, in farmers' practice, sali rice of 35 -40 days old seedlings at 3-4 seedlings/hill were transplanted randomly. The Sali rice variety "Ranjit" was transplanted in July and harvested in November. Application of 40:30:20 kg NPK/ha along with vermicompost 2 t/ ha was done in SRI and ICM rice field. Two cono-weeding and one hand weeding was done in both SRI and ICM plots. However, only one hand weeding was done in farmers practice (rice-fallow). Sali rice harvesting was done at least 7 to 12 days advance in RCTs of SRI and ICM than farmers' practice which leads to timely sowing of *rabi* crop. Zero tillage toria was sown after harvest of Sali rice in SRI and ICM plots by opening a furrow by small hand hoe. Fertilisers @ 30:50:20 kg NPK/ha field was applied in furrow and mixed with soil. Toria (variety TS 36) seeds @ 5 kg/ha were sown in the furrow and covered with the soil in the month of November and harvested in February/March in the following year. Data on productivity of rice and toria under RCT based innovation were recorded in both the years and pooled. System productivity in terms of rice equivalent yield (REY), economics based on prevailing market price were also calculated. Data obtained from various studies were statistically analyzed in Randomised Block Design using the technique of Analysis of Variance. The difference between the treatment means were tested as to their statistical significance with appropriate critical difference (C.D) value at 5 per cent level of probability.

Results

The two years pooled data on RCT based innovation revealed that the productivity of sali rice was recorded significantly highest in SRI (4.77 t/ha) which was followed by ICM (4.22 t/ha) but superior to farmers practices (Table 1). The higher productivity in SRI and ICM compared to farmers practice was due to higher yield attributes (15-20 tillers/hill, 24-25 cm panicle length etc). Zero tillage toria after the harvest of Sali rice also recorded highest productivity in SRI (0.56 t/ha). However, farmers practice (rice-fallow) produced

Table 1 Productivity performance of RCT based innovation in South Garo Hills

RCT based Innovations	Rice productivity (t/ha)	Toria productivity (t/ha)	System productivity (REY t/ha)
SRI Rice-Zero tillage Toria	4.77	0.56	6.16
ICM Rice – Zero Tillage Toria	4.22	0.54	5.58
Farmers' Practice (Rice-fallow)	2.19	-	2.19
CD(P=0.05)	0.28	-	0.29
CV (%)	10.31	-	8.46

SRI: System of Rice Intensification, ICM: Integrated Crop Management, RCT: Resource Conservation Technology

significantly lowest yield. SRI rice- zero tillage toria produced significantly higher REY of 6.16 t/ha which was followed by ICM rice- zero tillage toria (5.58 t/ha REY). Moreover, RCT based innovative rice based system recorded 182 and 155 per cent higher productivity in comparison to farmers practice (rice-fallow). Co-efficient of variation (CV) was estimated to 10.31 per cent in rice productivity as compared to system productivity (8.46 per cent) of RCT based interventions.

Results further revealed that the farmers could earn a net income of Rs. 30,800 and Rs. 30,270/ha with profitability ratio of 2.37 and 2.18, respectively, through RCT based innovation of SRI and ICM method of rice cultivation followed by zero tillage toria, respectively (Table 2) which were superior to farmers practice (rice-fallow).

Table 2 Economic performance of RCT based innovations in South Garo Hills

RCT based Innovations	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Profitability ratio
SRI Rice-Zero tillage Toria	26050	61650	30800	2.37
ICM Rice – Zero Tillage Toria	25550	55820	30270	2.18
Farmers' Practice (Rice-fallow)	14500	21900	7400	1.51

SRI: System of Rice Intensification, ICM: Integrated Crop Management, RCT: Resource Conservation Technology, Sale price (Rs/100 kg): Toria-2500, Rice-1000

Conclusion

The RCT based innovative interventions in the Sibbari cluster of South Garo Hills district of Meghalaya have made great impact on farming communities in terms of productivity, economic benefits and profitability in comparison to farmers' practices (rice-fallow) which leads to self-sufficiency of food for sustainable livelihood improvement. The significant aspect of RCT based innovations in the Sibbari area was that SRI and ICM rice matured 7 to 12 days earlier compared to same variety under farmers practice. Hence, it paved way for timely cultivation of second crops of toria with residual moisture in rice field and thereby, enhancing cropping intensity, productivity and income.

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Genotypic response to differential fertilizer management practices in acid soils of rainfed lowlands - an approach to improve rice productivity of resource poor farmers of Meghalaya, NEH region of India

B.U.Choudhury, M. S. Lyngdoh and S.V.Ngachan
ICAR Research Complex for NEH Region, Umiam, Meghalaya

Introduction

Rainfed lowland rice is one of the major crops of the North-Eastern Himalayan region (NEH) occupying 3.51 million hectares, which accounts for more than 80% of the total cultivated area of the region and 7.8 per cent of the total rice area in India. Meghalaya, one of the NEH states of India is basically an agrarian state with about 80% of its total population depends on agriculture for their livelihood. Today, the state covers about 42 percent area (103 ha) under rainfed lowland rice with an average productivity of about 1.1 t/ha (Prakash *et al*., 2010). Despite being located in one of the highest average annual rainfall receiving zones of the world, rainfed lowland rice production system in the state most often suffers from the occurrence of droughts during the peak growing seasons. This is mostly due to heavy dependence on erratic distribution of rainfall (rainfed) followed by uncertainty in availability of water during lowland rice cultivation. Secondly, since majority of the soils in the state is acidic (pH<5.5) (Sharma *et al*., 2006) and soil acidity induced deficiency of major nutrients, particularly phosphorous due to high fixation in upland condition is one of the major bottlenecks in achieving crop productivity of more than 1 t ha^{-1}. As a result of low productivity in upland condition, recently, extensive studies have been initiated to know the phosphorus dynamics (availability, fixation mechanism, uptake pattern etc.) and its impact on the productivity of rice and other upland crops. However, no such importance has been given in knowing the phosphorus availability in lowland/saturated condition and its impact/ role on rice productivity under acid soils of Meghalaya. By default, it has been assumed that phosphorus will have no response in lowland condition. Moreover, suitable cultivars of rice to use both native and applied phosphorus and other major plant nutrients (N and K) efficiently in acid soils are also not adequately evaluated. By and large, farmers in this region don't go for any periodic replenishment of plant nutrients, soil health improving additives and use of high yielding genotypes. They depend primarily on natural fertility condition as well as local low yielding genotypes. Perhaps, that results the rainfed rice production in Meghalaya synonymous to absence of controlled water, occasional droughts of different magnitudes, abrupt flood/submerged conditions, low input intensive or marginal external input supplying subsistence nature of under optimal production systems. Under such circumstances, identification of suitable cultivars, efficient to plant nutrients including phosphorus (both native and applied) as well as water use can substantially increase the lowland rice

productivity *vis-à-vis* food grain and livelihood security of the resource poor farmers of the state. In the present investigation, an attempt has been made in this direction to meet the above requirements

Methodology

The experiment comprised four low land rice genotypes (*viz.* Shasarang, Ngoba, RCPL-1-75 and RCPL-1-160) grown under natural condition (without external application of NPK-0-0-0 kg N P_2O_5 K_2O, representative of farmers' practice) and under fertilized condition with four doses of phosphorous (90-0-40 kg/ha, 90-30-40, 90-60-40 and 90-90-40 kg N: P_2O_5: K_2O per ha) in 20 treatment combinations, conducted in the experimental farm field, ICAR Research Complex for NEH Region during 2011. The experiment was laid out in Factorial Randomized Block Design with three replicates and a plot size of 10 m x 7m for each treatment. Rice was grown in summer (June/July to November/December). Twenty days old seedlings were transplanted in a puddled field with a spacing of 20 cm row to row and 15 cm from plant to plant. The crop was grown entirely under rainfed condition where sole source of water input was rainfall, without any supplement from other sources. Nitrogen in the form of urea was applied at the rate of 90 kg ha^{-1}, of which 50% at basal, 25% at maximum tillering and the remaining 25% at flowering while the full doses of P in the form of SSP and K in the form of MOP were applied at the time of transplanting. Daily monitoring of water balance components, periodic observation on plant growth parameters, soil properties and finally grain yield and its attributes were recorded following standard procedures.

Results

Grain yield

Results revealed that under natural fertility condition (absolute control representing farmers practice), genotype Ngoba produced highest grain yield (3.82 t ha^{-1}) while RCPL-1-160 produced lowest yield (2.83 t/ha). However, under fertilized condition, genotypes Shasarang and RCPL-1-160 demonstrated consistent increase in grain yield with the increase in rates of phosphorous (P_2O_5) application from 0 up to 90 kg ha^{-1} along with constant 90 kg N and 40 kg K per hectare (Fig 1). This was exhibited by an increase in grain yield from 3.29 to 5.67 t ha^{-1} and 3.16 to 5.41 t ha^{-1} in Shasarang

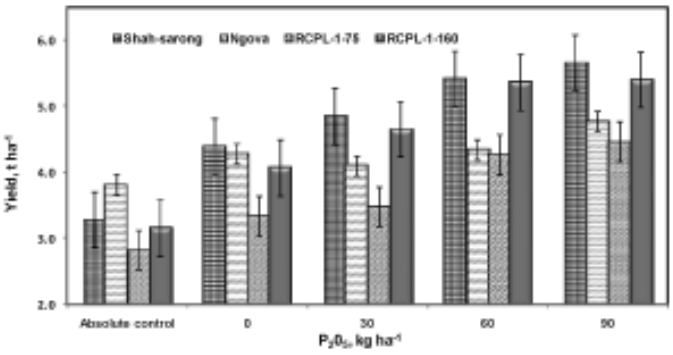

Fig 1 Differential response of low land rice genotypes to fertilizer (particularly P) applications

and RCPL-1-160, respectively. On the contrary, genotypes Ngoba and RCPL-1-75 under intensive fertilized condition (90-90-40 N: P_2O_5: K_2O kg per ha) to produced only 4.47-4.77 t $ha^{-1,}$ which was 16-21% less compared to Shah-sarang in the respective level of fertilization. Plant growth and other yield attributing characters also reflected significant variation in bi-directional way: among the genotypes as well as at varying rates of phosphorous application. Interaction of phosphorous doses and genotypic response reflected a significant variation in Nutrient uptake (N: 217-324 kg/ha; P: 73-87 kg/ha and K: 230-260 kg/ha).

Diffogram studies reflected significant effect of genotypic variations and differential fertilizers (phosphorus) on grain yield production of rice and with a shift from natural fertility (farmer's practice-control) to high intensity fertilization (N, P and K), grain yield increased significantly, more particularly in Shah-sarong and RCPL-1-160 genotypes (Figs.2a & 2b).

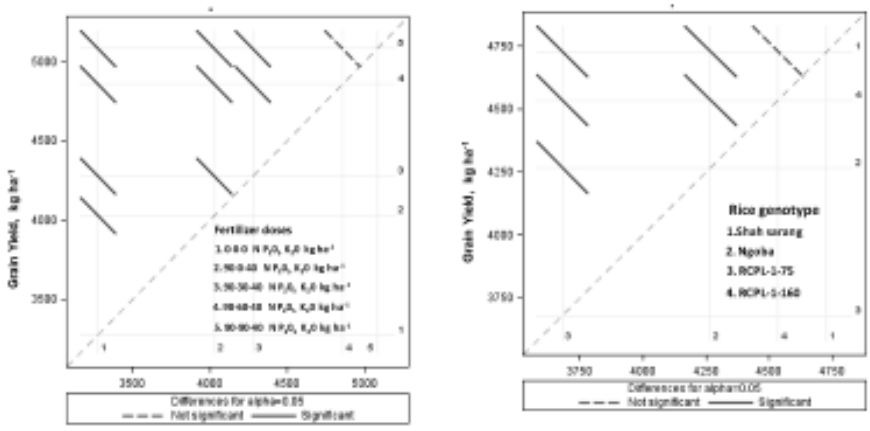

Fig. 2: Diffogram showing the effect of genotypic variation (a) and differential fertilizer response (b) to grain yield of rice. Small horizontal and vertical lines represent four genotypes (Fig.2a) and five fertilizer doses (Fig.2b) while bold lines passing through the squares diagonally represents significant (solid lines) or non-significant (dash lines) differences among the genotypes (Fig.2a) as well as differential fertilizer doses (Fig.2b)

Water balance and crop water productivity

Quantification of different components of water balance (*through field water balance approach*) showed that a total of 1261-1275 mm of water input in the form of rainfall was received during crop growth seasons. Out of the total rainfall (1251-1275mm) received percolation and underbund seepage loss accounted for 66-73% while crop used consumptively only 27-34% as actual evapotranspiration loss (AET) losses. Crop water productivity with respect to AET loss (WP_{ET}) varied from *1.05 to 1.55 g grain* kg^{-1} *water*, which was much higher than some of the most productive rice growing areas of India (IGP and others). However, water productivity w.r.t. total water input (rainfall utilization) during crop growth periods (transplanting to harvest) was relatively low: *0.26-0.43 g grain* kg^{-1} *water*. To produce

1 kg grain, nearly 2600 to 4100 liters of water in the form of rainfall was supplied/ applied to the field, of which only 646 to 1050 liters were used by the crop for the production of same amount of grain (1 kg). Therefore, water management practices must be initiated in the rainfed rice ecosystems to arrest the wastage of huge water resources in the form of unproductive underbund seepage and deep percolation losses for increasing the land & water productivity as well as crop diversity.

Conclusion

The present study, thus, reflects that there is a need to device efficient water management strategies for rainfed lowland rice ecosystems especially in the mid altitude of Meghalaya since only 29% of the total water was utilized by the crop for productive purposes. More than 70% of the total water lost in the form of deep percolation and underbund seepage losses and it may be true for other rainfed lowland rice growing regions of North eastern Hills with varying topography including even in imperceptible slopes and comparable agro-climatic conditions. For producing 1 kg rice grain, nearly *2600 to 4100 liters of water (rainfall) was supplied to the field, of which only 646 to 1050 liters* were used effectively by the crop for the production of same amount of grain (1 kg). As a result, there is a wide gap between real (productive loss in the form of evapotranspiration) and apparent (including unproductive losses in the form of seepages, percolation) crop water productivity. Therefore, it is imperative now to implement water management practices to arrest the wastage of more than 2000 liters of water (in the form of unproductive over bund flow, underbund seepage, and deep percolation losses) in producing every kilogram rice grain in rainfed lowland ecosystems of Meghalaya. The study also reflected that for resource poor farmers of NE region, genotypes like Ngoba having the potentiality to produce optimum productivity under natural fertility conditions (without any external inputs) should be explored for improving the productivity and profitability without much economic burdens (input cost) while for resource rich farmers, adoption of high yielding Shah-sarang and RCPL-1-160 genotypes under intensive fertilization can significantly improve the rice productivity *vis-à-vis* food grain security to the state granary . This will certainly bring a sea change in improving the land & water productivity, agricultural production *vis-à-vis* food and livelihood security to the region. However, the study demands involvement of more number of genotypes (both local and improved) for evaluation to achieve bigger goal at regional level.

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Scope of Horticulture for Livelihood Improvement and Nutritional Security

Tribal livelihood improvement in Odisha through cultivation of high value off-season vegetables

B. Behera, S. N. Dash, A. Lenka, P. Nayak, L. Rout and R. K. Paikaray
Odisha University of Agriculture and Technology, Bhubaneswar, Odisha

Introduction

Kandhamal, a centrally located tribal district of Odisha, lies between 19^0 34' N to 20^0 54' N latitude and between 83^0 30' to 84^0 48' E longitude. The district has geographical area of 8, 02,000 ha and represents 7.14% of the total geographical area of the state. It is located in North Eastern Ghat Zone of Odisha. It is situated in high elevation of 300 to 1100 m above mean sea level. The district receives average annual rainfall of 1427.9 mm. About 71% of the geographical area (5, 71,000 ha) is covered with forest. *Kharif* and *rabi* irrigated area constitute 11 and 5% of the cultivated area respectively. The district is dominated by tribal community 'Kandha' and they constitute 52% of the total population in the district. They practise age-old traditional agriculture. The per hectare fertilizer consumption is the lowest (10.11 kg/ha during 2009-10) in the state. Upland, medium and low land account for 75, 16 and 9 % of the total cultivated area of 1,28,000ha in the district. The livelihood condition in three districts is very wretched due to several bio physical, socio economic, institutional and technological constraints. Planning commission, Govt. of India has identified this district as disadvantaged on the basis of index of backwardness under 'National Food for Work programme'. Cultivation of off season vegetables during *kharif* season can contribute significantly towards improvement of tribal farmers of the district. The high altitude nature of land creates a congenial environment for growing vegetables round the year, particularly off-season vegetables in rainy season. Due to higher elevation ranging from 300-1100m, the mean temperature remains 2 - 6^0 C less in comparison to places in coastal districts. Round the year cultivation of cole crops is possible in the district. During rainy season, a number of off-season vegetable viz. cauliflower, cabbage, knol-khol, tomato, radish, runner bean, onion and potato are grown profitably. Behera *and* Mohanty (2008) found off season vegetables highly remunerative in high altitude districts of Odisha, particularly in Kandhamal. There is acute shortage of vegetables in coastal district during *kharif* due to non-availability of adequate uplands for cultivating these crops. Popularization of off-season vegetable cultivation during *kharif* and market linkage has potentiality to improve livelihood of tribal farmers.

Methodology

The NAIP component-3 sub - project entitled " Sustainable rural livelihood and food security to rainfed farmers of Odisha" started functioning in 2008-09 to improve livelihood

conditions of the people living in three disadvantaged districts of Odisha including Kandhamal with objectives to increase farm productivity, enhance farm profitability, create more employment opportunities and to promote capacity building through training and demonstration for farmers and farm women, formation of self help groups and creation of Farm Knowledge Centres. The sub-project is operating in consortia mode comprising multi-institutional and multi-disciplinary team of scientists from OUAT, Bhubaneswar (Lead Centre), Regional Centre of CTCRI, Bhubaneswar and Directorate of Water Management, Bhubaneswar and officials from IMCO and KARRTABYA, Kalahandi. Cluster approach was adopted and 3-5 contiguous villages with approximately 300 households constituted a cluster. Works were concentrated in two cluster of villages per district. Holistic development of clusters was attempted. Six - member landless, marginal and small farm families in rural Odisha with 0, < 1.0 and 1-2 ha land should earn more than Rs 56,940 per annum to cross the threshold of poverty line conceptualised by Planning Commission, Govt of India to reside in sustainable rural livelihood security system. The landless, small and marginal farmers were provided with technical and critical input support. In Kandhamal, Katadaganda, Kilakia and Bearpanga village under Ghumusar Udayagiri cluster and Pradhanpada, Adasipada, Bhuktakanali, Kurupadi and Badabhuin village under Khajuripada cluster were adopted. The high value vegetables viz. cauliflower, tomato, cabbage, radish and runnerbean were taken up during *kharif* seasons of 2009, 2010 and 2011.

Results

Off-season vegetables viz tomato (Utkal kumari), cauliflower (Megha, Mahima and Himlata), runner bean (Local) and radish (Pusa chetki) were taken up in two clusters of Kandhamal in an area of 12.0, 6.6, 8.5 and 2.4 ha during three years (Table 1). Among the vegetables, cauliflower proved most remunerative with mean net return of Rs. 1,56,250 /ha (Table 2) followed by runnerbean, tomato and radish with net return of Rs. 85,625, Rs.85,625 and Rs 31,666/ha. The farmers of G. Udayagiri and Khajuripada cluster sold the vegetable

Table 1 Variety, area and households involved in cultivation of off season vegetable during rainy seasons of 2009, 2010 and 2011

Crop	Variety			Area(ha)				Household(No)		
	2009	2010	2011	2009	2010	2011	Total	2009	2010	2011
Tomato	BT-10	BT-10	BT-10	1.0	5.0	6.0	12.0	14	40	60
Cauliflower	Megha	Mahima, Megha	Himlata, Megha	1.0	1.6	4.0	6.6	09	28	56
Runner bean	-	Local	Local	-	1.3	7.2	8.5	-	29	90
Radish	Pusa Chetki	Pusa Chetki	Pusa Chetki	0.4	1.6	0.8	2.4	10	08	20

in nearly market located at G. Udayagiri and Phulbani, respectively and transported to Bhubaneswar and Berhampur city market for getting better price.

Table 2 Yield and net return of off season vegetable crops grown under NAIP 3 during rainy seasons of 2009, 2010 and 2011

Crop	Yield (t/ha)				Net return (Rs/ha)			
	2009	2010	2011	Mean	2009	2010	2011	Mean
Tomato	18.00	18.45	19.58	18.67	72,500	80,000	87,500	80,000
Cauliflower	14.50	8.125	23.20	15.275	1,07,500	1,36,250	2,25,000	1,56,250
Runner bean	-	3.00	8.75	5.875	-	80,000	91,250	85,625
Radish	5.40	11.25	10.05	8.9	27,500	30,000	37,500	31,666

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Floriculture cropping helped to establish special identity of farmers in Champawat district of Uttarakhand

P. C. Vaishnava, S.K. Singh and S. B. Khadilkar
BAIF Development Research Foundation, Haridwar

Introduction

Champawat district of Uttarakhand was identified as one of the most backward districts in western Himalayan region by planning commission of India. Near Khetikhan, Pardhiyani is a small village in Pati block of Champawat district. Mr Rajendra Prasad Joshi owned a small home in hilly area of Pardhiyani. His family included his mother, brothers, wife and two children. He was a general mason and earned his meager livelihood through masonry. He owned a small portion of land which he used for cultivation of potato, tomato and capsicum and tried to bring his both ends together. His farming was typical to hill agriculture which is characterized by terrace farming, rain-fed and hence no certainty to the income. The BAIF Development Research Foundation (BAIF) is a non-government agency known for enhancing livelihood of poor to poorest through sustainable use of natural resources and extension of environment friendly development activities. During the year 2007, BAIF in collaboration with S D Tata Trust initiated a project entitled "Strengthening Development Programme and Laying Newer Directions". Khetikhan cluster was included as one of the operational areas. The project was specially designed for exploring sustainable livelihood options for the families struggling for survival in fragile eco-system of Himalayas. The scientists of the organization felt that the agro-ecological climatic conditions in Khetikhan cluster being placed at altitude of 1800 above MSL and temperature ranging between 0-30^0 C throughout the year are favorable for temperate floriculture. Until then no one in the area had never tried temperate floriculture. In initial situation analysis using Participatory Rural Appraisals the team tried to find the reasons. It was revealed that the farmers are aware about the cultivation of flowers but major reason for non adoption is lack of access to market as the area is remotely placed.

Methodology

During 2008-09 the farmers were advised to opt for floriculture. Farmers needed an assurance for marketing linkage. The responsibility of developing this linkage was entrusted to BAIF. And thus ten farmers were ready to adopt. BAIF team also assured them to arrange regular need based training inputs on scientific farming of gladiolus. Bulbs worth Rs 12500 were procured and supplied to each of them with each participant contributing Rs 1500/- in it. BAIF selected good quality bulbs (planting material) of gladiolus of White Prosperity, Saturn & Royal Velvet varieties initially. As committed, BAIF team also organized regular

need based training. Since the participant farmers were yet not sure about the possibility of development of market linkage through BAIF, all of them used the bulbs on their barren and uncultivated lands. But Mr. Rajendra Prasad was an exception. He proved his sincerity by observing the advice of using land which was already under cultivation. BAIF's local team & subject matter specialists gave regular periodic field visits. These visits were useful for assessing the progress and giving on the spot technical guidance. Rajendra Prasad implemented every technical advice almost religiously. In June 2009 the sticks of gladiolus in his farm reached the pre-harvest stage. Meanwhile, a Common Interest Group of these new floriculture farmers was formed. Taking this group BAIF explored & established their linkage to New Delhi Flower market through local floral merchant Mr. Murari. An exposure visit to Delhi flower market proved very useful.

Results

The group learned to grade the floral sticks and packaging methods. The floral sticks were graded in A, B, & C categories as per the requirement of the market. This gradation helped them to market the flowers of A B & C grades at an average rate of Rs. 36, 22 and 14 per dozen sticks, respectively. From the produce Mr Rajendra Prasad sold 227, 47 and 25.5 dozens gladiolus floral sticks of these grades respectively to fetch a gross income of Rs 9563. He compared it to the gross income in previous year with potato crop in the same portion of land which was Rs 3500 only. By opting floriculture during 2009-10 year, apart from this gross income, he also had bulbs & bulblets as planting material produced from his own farm, which he could use for the subsequent crop. Mr. Prasad was thus in a leading position to guide the rest of the farmers. Other farmers regretted for not using the cultivated land, because their produce was much lower than Mr. Prasad. Each of them then decided to follow Mr. Prasad and gain good income like him in the subsequent year. During the year 2010-11, Mr. Prasad reinvested all the gross income of first crop to extend the gladiolus crop by 1,000 sqm. The BAIF's project team also appreciated his involvement and potential and as an encouragement to him provided 200 bulbs of Lilium. From both the floral crops Mr. Prasad recorded a gross income of more than Rs 25,000.

Now Mr Rajendra Prasad is no more a general mason. The floriculture crops have changed his main occupation from mason to agriculture. He works on his own land and needs no migration daily. As on today there are more than 50 farmers in the same area who have opted for flower crops.

Lessons learnt

- If we are able to demonstrate and prove by involving a local and progressive farmers that a handsome profit can be realized, extension becomes easy.
- Most important for such a success is to be able to identify an innovative local farmer, who implements the advice meticulously.
- In reality gaining the trust of farmers for a change cannot be achieved in a short time easily.

Horticulture based farming system for better livelihood in mid-hills of Meghalaya

N.A. Deshmukh, R.K. Patel, V.K. Verma, A.K. Jha, P. Lyngdoh and A. Nath
ICAR Research Complex for NEH Region, Umiam-793 103, Meghalaya

Introduction

Meghalaya is one of the important state among the seven sister states of NE India; lies between 25° 40' to 25° 21'N latitude and 90° 55'15 to 91°55'16 E longitude. The traditional shifting cultivation practice, fragmented land holding coupled with population pressure reduce the farmers share in total farm income. Along with unavailability of required quantity and quality balance food generates multifold problems among tribal communities. Further, excessive dependence on the single crop makes the situation more pathetic. Diversification in agriculture is the way ahead which paves the way for horticultural interventions in the region (Chadha 2011). Horticultural crops are rich in vitamins, minerals, fibre and anti-oxidants and with its diversification in dietary pattern can ensure the nutritional security (ICMR recommends 120 g fruits & 300g vegetable per capita/day). This was supported by diverse agro climatic conditions, varied soil type and abundance of rainfall which offers immense scope for cultivation of different types of horticultural crops integrated with others income generating activities. The horticultural land use system with mixed horticultural crops including fruits, vegetables, root crops, spices and ornamentals grown under optimum management conditions can be more remunerative on long term basis with least gestation cycle. Similarly, perennial crop based cropping system offer efficient alternative for improving the total factor productivity of stressed lands. Farming systems are dynamic interactive practices aimed at better use of the production components such as soil, water, air space, solar radiation and all other inputs on an integrated and sustainable basis. The region offers opportunities for successful intervention of horticultural crops with other component with a conceptualized ways as by product on component being utilized by other component as main component for supplementing nutrient and energy which enhance farm income. Considering these facts in view, the present study was carried out to quantify the performance of various components *viz.*, horticultural crops, low cost polyhouse, vermicompost etc to develop suitable horticultural based farming system model for achieving better livelihood in mid hills of Meghalaya.

Methodology

Present investigation was carried out during 2011-12 at Horticultural farm, ICAR Research complex for NEH Region, Umiam, Meghalaya. The experiment was carried out in 1.0 Acre area occupied by the different fruit crops like Sweet orange var. Valencia of 4 yrs

old (2000 m^2) spaced at 4m x 4m with intercropping of vegetable (French bean + Brinjal + Pea). Besides, the block of guava meadow orchard (2m x 1.5m) of 2 yrs old (200 m^2), pineapple var. Kew intercropped with Assam lemon of 3 yrs old (1500 m^2) and chow-chow block (200m^2). A low cost polyhouse (100 m^2) was also constructed for offseason production of vegetables, tomato–cucumber-capsicum under cropping sequence. Biomass produced under the system was utilized for preparation of vermicompost and vermiwash. A vermicompost unit consist of 3 pit (3x3x2 feet) and 2 units of vermiwash were maintained. The observations on yield form various component were recorded. The cost of cultivation, gross return, net return and benefit:cost ratio was computed by keeping in view the present market price.

Results

The performance of different components *viz.*, horticultural crops, low cost polyhouse, vermicompost etc used to develop suitable horticultural based farming system model for achieving better livelihood was depicted in Table 1. The findings of the present investigation were given into following sub heads.

Performance of fruit crops

The perennial fruit crops had capacity to generate higher returns either as sole crop or in combination with others. The early gestation period of perennial fruit crops which usually spaced widely create the opportunity for the inclusion of short duration crops e.g. pineapple. Meadow orchard in guava found profitable enterprise to get higher return per unit area at 2nd year onwards. Among the fruit crops tested, highest gross return and net return (Rs. 9100/- and Rs. 4300/-) was recorded in pineapple followed by sweet orange (Rs. 3000/- and Rs. 1400/-) and guava (Rs. 2640/- and Rs. 1240/-). Similarly, highest benefit cost ratio was recorded in pineapple (2.03). The variation in the performance may be due to genetic makeup of particular crop affecting bearing age and response to particular agro-climatic condition.

Performance of vegetable crops

Farming system model for better livelihood cannot be sustainable without vegetable crops. They are the high income and employment generating with least gestation period. When cultivated under protected environment (off season) vegetable crops were given three to four fold higher returns. The vegetables grown as intercrop in sweet orange were produced gross return of Rs. 36,840/- (Aiyeloagbe 2001). Among the vegetable crops tested highest yield was recorded in Brinjal (1431.8 kg) followed by Pea (792 kg). To get high return (offseason) and adjust with glut and shortage of market, a low cost polyhouse was introduced in the system. In low cost poluhouse of 100m^2 cropping sequence viz., tomato-cucumber-capsicum was followed. The sequence produced a Gross return of Rs. 17790/- , Net return of Rs. 8990/- at highly competitive benefit: cost ratio (2.02). By understanding food habit, liking of tribal's a separate block of chow-chow was maintained. From 200m^2 area an average

165 kg yield was recorded with benefit:cost ratio (2.06). Adoptability of the selected vegetable crops to agro ecological condition helps in getting better return from the farming system model.

Table 1 Performance of different components in horticultural based farming system model

Components	Area (m^2)	Yield (kg)	Cost of cultivation (Rs./acre)	Gross return (Rs./acre)	Net Return (Rs./acre)	B:C Ratio
Fruits						
Sweet orange cv. Valencia (4^{th} year)	2000	50	1600	3000	1400	1.88
Pineapple	1500	750	4800	9100	4300	2.03
Assam lemon (2^{nd} year)		160	1000	1920	920	1.92
Guava (2^{nd} year)	200	132	1400	2640	1240	1.89
Intercropping with Sweet orange						
French bean + Brinjal + Pea	1800	668 + 1431.8 +792	19200	36840	17640	1.92
Low Cost Polyhouse						
Tomato/Cucumber/ Capsicum	100	387 + 225 + 312	8800	17790	8990	2.02
Chow-chow	200	165	800	1650	850	2.06
Vermicompost Unit 3 pit (3x3x2 feet), Biomass used 500 kg in 1 cycle	Conversion period-9 weeks	720 from 3 cycle/year	3000	5760	2760	1.92
Vermi-wash	2 units	200 liters / year	1050	2000	950	1.90
Total			40550	79100	38550	1.95

Performance of other component

Diversification in the components portfolio by inclusion of vermicompost and vermiwash were done to generate higher profit through the model. These component help in the utilization of biomass by recycling it and produced by products viz., vermicompost and vermiwash. These organic sources of nutrient can be used for the same system for enhancing the nutritive status of the soil to get higher crop productivity and unutilized byproduct can be marketed (Chadha 2012). The vermicompost unit had three pits 3 pit (3x3x2 feet) which utilized 500 kg biomass in 1 cycle. In one year three cycles of the vermicompost were produced an average 720 kg vermicompost which had given an amount of Rs. 2760 as a net return/year. The two unit of vermiwash were produced 200 liter/ vermiwash/year with high benefit: cost ratio (1.90).

Overall performance of the component

With the help of components *viz.*, horticultural crops, low cost poly-house, vermin-compost and vermin-wash a suitable horticultural based farming system model was developed which given higher Gross return and Net return (Rs. 79100/- of Rs 38550/- respectively). The highly competitive benefit:cost ratio was recorded 1.95 form the model conforms its suitability of different component used for achieving better livelihood. Besides this, model had the capacity to supplement nutritional needs of five member family, generate round year employment with high remunerative returns.

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Subsistence to sustainability in large cardamom cropping system

T.N. Deka, Harsha K.N., U. Gupta, B.A. Gudade, N.K. Bhattarai and A.K.Vijayan
ICRI, Regional Station, Spices Board, Tadong, Sikkim

Introduction

Cropping systems at farmers' level intensifies potential productivity and monetary benefits. These systems with respect to choice of crops further influence to several other forces related to infrastructure facilities, socio-economic factors and technological developments and all the related factors operating interactively at micro-level. Large cardamom (*Amomum subulatum* Roxb.) is the major cash crops of Sikkim. In-spite of it, it is associated with forest ecosystem from the time immemorial. North Sikkim consisting of Dzongu region is known for cultivation and production of *Dzongu golsey* and *Ramsey* cultivars of large cardamom. *Dzongu golsey* is very much location/region specific in nature. In the recent past area, production and productivity of large cardamom in entire Sikkim particularly in Dzongu area is diminishing at an alarming rate. Major reason for decline in area production and productivity of large cardamom in Dzongu area are menace of *Colletotrichum* blight, *Chirkey*, *foorkey*, pest incidence, cultivation of large cardamom in open area, lack of phytosanitary measures and irrigation during dry periods. All these factors affected livelihood of Dzongu farmers. To restore and rejuvenate the damaged plantations and to save farmers life in Dzongu area, NAIP intervention started 2007 onwards for improving the livelihood status of large cardamom.

The higher productivity in any crop can be realized with efficient and effective utilization available resources *viz.*, land, time, water and nutrient. With the objective of evaluation and validation of indigenous farming system model for large cardamom ecosystem, NAIP beneficiary farmers were advocated with to develop their capacity to implement the scientific way of cultivation and management practices of large cardamom, ginger and garlic for obtaining maximum productivity and economic return for their survival. Large cardamom is a crop with perennial nature. Economic bearing starts third/forth year onwards after planting (Anon., 2010). To safe guard the farmer's livelihood security, additional spice crop component (ginger and garlic) was intensified in the intervention site.

Methodology

Fifteen NAIP beneficiary farmers were randomly selected from two gram Panchayat unit of Dzongu area viz., Tinvong and Passingdang. Data collected from these farmers pertaining to production, net income and BC ratio of large cardamom, ginger and garlic periodically. Collected data was converted in to per ha basis for analysis. Selected farmers were supported with supply of quality planting material such as large cardamom suckers, rhizomes of ginger and garlic cloves. Training /awareness programme, field demonstration

on scientific cultivation was conducted regularly as per the crop calendar. Supplementation of agricultural infrastructure such as jalkund, ICRI improved *bhatti*, irrigation pipes, bioagent, bee hives, farm implements etc, were distributed to farmers for improving the productivity and livelihood. Development in livelihood of the benefitted farmers was assessed periodically. Economic impact of intervention was worked out by estimating gross income, net income and BC ratio.

Results

The average productivity of large cardamom among the sampled farmers was 102 kg ha^{-1} (Table1) before the NAIP intervention. This ranged from 41 kg/ha to 460 kg/ha. To improve the livelihood status of the farmers, large cardamom, ginger and garlic cultivation was intensified with scientific approach. Due to adoption of strict phytosanitary measures, maintaining recommended plant spacing, population, supply of manure at the recommended rate and time and irrigating during the dry periods from Jalkund, 59 % of higher productivity (162 kg/ ha) was observed (Anon., 2011) (Table1& Fig.1). This increase in productivity signaled positively, with generation of additional net income of Rs.98196.0/ha with Rs 7.0 as return for every rupee invested. This much of higher return was realized mainly due steep rise in cardamom price in 2010 and onwards. Moreover curing the capsules in the ICRI improved bhatti will fetch on an average additional R 40-50 /kg of dry capsule due to retention of prescribed aroma and colour.

Table 1 Economics of spice crops at NAIP intervention site

Sl No	Year	Productivity (Kg/ha)	Price (Rs/kg)	Cost of production (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	BC Ratio
Large cardamom							
1	2007	102	120	4500	12240	7740	2.7
2	2008	116	125	7000	14500	7500	2.1
3	2009	124	125	7000	15500	8500	2.2
4	2010	150	234	12000	35100	23100	2.9
5	2011	162	708	16500	114696	98196	7.0
Ginger							
6	2009	3500	22	24000	77000	53000	3.2
7	2010	3850	25	30000	96250	66250	3.2
8	2011	4500	25	34000	112500	78500	3.3
Garlic							
9	2010	980	95	28000	93100	65100	3.4
10	2011	1120	100	28000	112000	84000	4.0

Initially ginger and garlic was cultivated to fulfill the domestic requirement only. After the intervention, intensive cultivation of ginger was started in scientific approach.

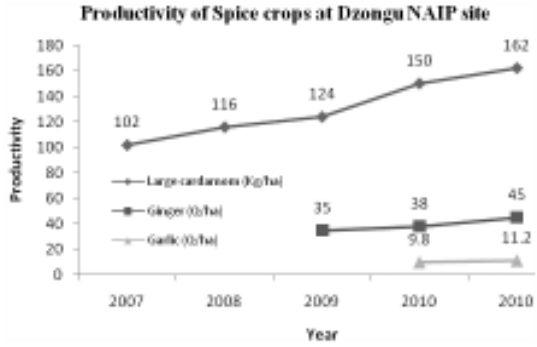

Fig 1. Productivity of Spice crops at Dzongu NAIP site over the time

This approach had helped the farmer not only in utilizing the cultivable land effectively but also profitably. Introduction of additional crop component at the intervention site had resulted in generation of additional yield and income for the farmer (Table.1). With introduction of ginger from 2009 onwards farmer had got return of Rs. 3.2 to 3.3 for every rupee invested with net income of Rs. 53,000.00 to 78,500.00/ha (Table.1). Similar monetary benefit was observed with cultivation of ginger. Relatively higher returns were realized in garlic (BC ratio of 4.4) as compared to ginger. The percentage of income from large cardamom is higher as compared to ginger and garlic (Fig.2). This is due to the steep rise in cardamom price in 2010 and onwards. Due to introduction of component crop (Ginger and Garlic) in the large cardamom cropping system on an average additional income of Rs.78,500.0 to 84,000.0/ha (Fig.2) was realized with the effective utilization of available resources, generation of employment opportunity and production of quality produce.

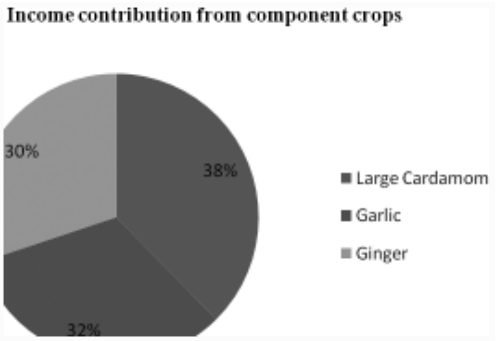

Fig 2 Per cent contribution of Income from component crops

The glory of recognition as "Capital of Large cardamom "to North Sikkim was lost due to menace of *Colletotrichum* blight, *Chirkey*, *foorkey* and adoption/fallowing unscientific cultivation practices from time immemorial. With the efforts of NAIP intervention, through rejuvenation of existing large cardamom plantation and establishment of large cardamom sucker multiplication nursery for area expansion, introduction and intensified cultivation of additional spice crop component (ginger and garlic) the lost glory may come back.

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Constraints analysis in adoption of scientific vegetable cultivation for livelihood improvement in Sikkim Himalayan region

Ashok Kumar, A.K. Mohanty and B. Lepcha
ICAR Research Complex for NEH Region, Sikkim Centre, Gangtok

Introduction

Vegetables provide essential vitamins, minerals, fibres *etc.* for maintaining a good health. The daily requirement of vegetables in human diet in India is 300g/day/person but we are able to produce only 245g/day/person; still short of 55g/day/person. However, a planned development in the field of vegetable production is very much essential to improve the livelihood and nutritional security for masses. The livelihood security for the rural people can be brought with any developmental intervention, congruent with their existing living pattern and ability to adapt. Sikkim, the 22nd State of Indian Union, is based upon agrarian economy. Agricultural land in Sikkim is estimated to be around 1, 09,000 hectares, *i.e.* 15.36 percent of the total geographical area. Sikkim has a net cultivable area of about 79,000 hectare (11.13%); with irrigated area of 15% of the total operational holdings of 110000 hectare. More than 64 per cent of the population depends on agriculture for their livelihood. Since Sikkim enjoys as much as 8 agro- climatic zones with varied distribution of rainfall and soil texture, there is enough scope to grow a variety of vegetables throughout the year in the state with different topographic features. Under these conditions scientific technologies in the potential sectors like vegetable cultivation can be identified and the most pressing constraints may be explored to find out the best possible opportunities for the growth of farming sector. Keeping this in mind, the present study was undertaken to find out the constraints faced by the vegetable growers of the north district of Sikkim Himalayan region under the Livelihood development project sponsored by NAIP III.

Methodology

The study was carried out in the Dzongu block of North Sikkim district of Sikkim comprising 12 vegetable growing villages. The villages covered under the study were *Tingvong, Kusung, Passingdang, Lingthem, Lingdong, Burfok, Hee-Gyathang, Sudur, Bringbong, Sangdong, Gor* and *Shagyong*. The village selection was made through purposive random sampling method. The sample of respondents were taken from all the categories of farmers comprising of marginal (< 1ha), small (1-2 ha), medium (2-5 ha) and large farmers (> 5 ha). The selection of sample was based on the criteria that farmers having aptitude for year round vegetable cultivation with market oriented behaviour to earn their livelihood. Ten vegetable growers from each village with preference for vegetable cultivation were selected through purposive random sampling technique to constitute a total sample size of 120 (12x10 nos.). The constraints faced by the respondents were classified into three

categories namely socio-economic, organizational and technological constraints measured with the help of a 5 points continuum scale as Strongly Agreed Farmers (5), Agreed Farmers (4), Neutral Farmers (3), Disagreed Farmers (2) and Strongly Disagreed Farmers (1) and accordingly each respondent was given score as per their preference to various constraints and mean weighted score worked out for each statement under above mentioned five categories. The index values of observations were measured with the help of mean score figure. The data were collected through personal interview method using a pretested semi-structured interview schedule.

Results

The results (Table 1) showed that highest proportion (49.17 %) of the respondents was in young age group (= 40 years) as compared to 35.83 % that belonged to middle age group and only 15 % to old age category. This led to the conclusion that maximum of the young respondents opt for vegetable cultivation which may be due to its better return as compared to other crops. With regard to educational status, the respondents varied from illiterate to graduate and above with a mean 8.32, standard deviation 5.05 and coefficient of variation 76.46 % (Table 1) and the result revealed that maximum (51.68 %) of the vegetable growing farmers are confined to educational level up to secondary followed by higher

Table 1 Distribution of category of respondents according to SES (N=120)

Sl. No	Variables	Category	Freq. (f)	Percentage (%)	Mean	S.D.	CV %
1	Age (*in years*)	Young (= 40)	59	49.17	41.24	11.84	27.54
		Middle aged (> 40 to = 55)	43	35.83			
		Old aged (>55)	18	15.00			
2	Education	Illiterate (nil)	8	6.68	8.32	5.05	76.46
		Primary (Class: 1-5)	14	11.67			
		Secondary (Cl. 6-10)	62	51.68			
		High Secondary (Cl. 11-12)	26	21.67			
		Graduate and above	18	15.00			
		Joint family	99	82.5			
3	Land holding (*ha*)	Marginal farmers (<1 ha)	26	22.66	1.93	2.88	158.69
		Small farmers (1-2 ha)	48	40.00			
		Medium farmers (2-5 ha)	37	30.83			
		Large farmers (>5 ha)	09	7.60			
4	Annual income (*Rs/Annum*)	Poor (up to 30,000/-)	12	10.00	62.58	55.42	68.88
		Low (>30,000/ –60,000/-)	52	43.34			
		Medium(>60,000–1,00,000/-)	41	34.17			
		High (>1,00,000 – 5,00,000/-)	11	9.16			
		Very high (>5,00,000)	4	3.33			
5	Extension agency contact	Low	56	46.67	49.23	6.87	72.41
		Moderate	48	40.00			
		High	16	13.33			

secondary (21.67%). An educated individual is likely to be more receptive to the modern technologies, because education empowers individuals in terms of decision making, problem solving and change proneness, and hence leads to the understanding that since most of the respondents in the array of the study are having secondary level of education they may be considered as potential adopter of improved vegetable production technologies.

Similarly in case of land holding status, the respondents have been distributed in the category of marginal, small, medium and large farmers with a wide range of land holding. It was observed that the highest percentage of farmers (40 %) were small farmers followed by medium farmers (30.83 %) and marginal farmers (22.66 %) in addition to a meagre percentage of 7.6 under large farmers as shown in Table 1. The results implied that majority of the respondents were having good land holding capacity, hence as one of the important factor of production (land, labour, organisation & capital) land holding influences many innovative –decision issues and their compatibility and adaptability thus leading to better adoption of technologies provided other constraints were minimized.

The distribution of the farmers in different categories on the basis of their annual income is shown in Table 1, revealed that the highest proportion (43.34 %) of the respondents belonged to low income group (Rs 30,000/ to 60,000/-) followed by medium income group (Rs 60,000 to 1,00,000/-) showing the mean, standard deviation and coefficient of variation as 62.58, 55.42, and 68.88 %, respectively. The percentage of farmers in the poor, high and very high categories was 10, 9.16 and 3.33 percent, respectively. Since the greater proportion (77.51 %) of the farmers were in low and medium income groups, it is logical to assume that they had limited access to modern high-cost technologies. This is so because the purchasing power is associated with income of an individual. The observations on extension agency contact which is considered as an important factor that influences some factors of constraints implied that 46.67 percent of respondents were having low and 40 percent having moderate extension agency contact while only 13.33 percent of them had high contact with an average 49.23, coefficient of variation 72.41%, and standard deviation of 6.87. So, it could be concluded that the majority of the respondents of the study area do not have sufficient information about improved vegetable production technology and there is least chance of getting the latest information leading to low adoption.

It is evident from the study that among the three major types of constraints identified, technological and socio-economic constraints were the major problems faced by the vegetable growers of North Sikkim resulting vegetable cultivation as a non-profitable enterprise. Besides it was also observed from the study that inadequate storage facility, lack of crop insurance, lack of effective supervision and monitoring by extension workers and low credibility of extension workers were some of the major organisational constraints that impedes the vegetables production though government of Sikkim had taken lot of programmes to establish strong linkage with farming community in terms of availability of quality seeds and planting materials and other organic inputs provided by the line departments.

Out of ten enlisted major constraints under the category of *technical constraints*, it was observed that farmers were very much lacking in knowledge on some important areas

that ranked high viz., conservation of natural resources, regular soil testing programmes, mechanization of agriculture and integrated pest and disease management that facilitate the enhancement of vegetable production. But it was also observed that all the type of constraints under the category of technological constraint were more or less responsible as per the ranking hierarchy to hinder the vegetable production. Nine important socio-economic constraints were identified and ranked which acted as barrier against increasing production and productivity of vegetables. The farmers/growers very much lacked the entrepreneurial ability for taking up any venture in a profitable manner which was followed by the lack of innovativeness and low responsiveness by the farmers. On the other hand, farmers were quite enthusiastic to build up the entrepreneurial ability provided the scopes and opportunities of various agro-preneurship are properly highlighted through capacity building programmes. The score analysis revealed that lack of awareness, co-ordination among farmers, groupism in village, low adoption by neighbours, traditional norms and adverse socio-political system in the villages are the most important constraints which do not permit farmers to accept and adopt new technology in vegetable farming (Arya, *et. al*, 1984). The study revealed that the inadequate storage facility for vegetable produces in the area leads to the low adoptability of growing vegetable as ventures. Most of the growers loose their produces even after bumper production of crops. No other constraints are as important as organizational constraint in making farming of Sikkim a profitable enterprise. Rolle (2006) indicated fresh produce losses ranged from 10 to 40% globally, with losses in India at the high end. Chikkasubbanna (2006) has reviewed some of the issues and priorities for improving the post harvest sector for vegetable handling.

Above all, out of three major classified constraints, the technological constraints was considered to be main impact factor that hinders the adoption of vegetable production technologies in North Sikkim district with highest average mean score of 3.05 where as organisational constraints were found to be placed at lowest average mean score of 2.87.

The data presented in table 2 revealed that most of the large farmers (41.66 %) are facing the technological constraints and maximum of marginal farmers (35 %) have the organisational constraints in adoption of vegetable production technology. This may be because of the fact that the marginal farmers are neither aware of the modern technology due to lack of information source nor have the interest to take up some technologies like soil testing, post harvesting and farm mechanization due to small land holdings and less family

Table 2 Constraints-wise mean score of respondents according to land holding status

SN	Type of constraints	Category wise respondents (N=20)				Mean score
		Marginal	Small	Medium	Large	
1	Technological constraints	22(18.33)	11(9.15)	37(30.83)	50(41.66)	3.05
2	Socio-economic constraints	36(30.00)	35(29.16)	21(17.50)	28(23.33)	2.89
3	Organizational constraints	42(35.00)	22(18.33)	30(25.00)	26(21.66)	2.87

(Figures in parentheses indicate percentage)

requirement. Among the beneficiaries, the marginal farmer category has shown maximum percentage (30 %) of socio-economic constraints as compared to other categories with a mean score of 2.89%. But the trend of mean score value indicated that mostly the farmers are facing the technical constraints with highest mean value of 3.05 in respect of adoption of improved vegetable production technology.

Table 3 Categorization of respondents according to level of constraints (N=120)

Sl. No	Constraints wise category	Frequency(f)	%
1	Low < (mean - SD)	28	23.33
2	Medium (mean - SD)	68	56.67
3	High> (mean + SD)	24	20.00

A significant percentage (56.67 %) of the beneficiaries have faced the medium level of constraints in respect of all the three sectors of major constraints *viz.*, technological, socio-economic and organizational (Table 3). The low (23.33%) and high (20.00%) level of constraints are being perceived by the rest of the farm beneficiaries. On the basis of above results, it is evident that the major constraints like lack of regular soil testing, lack of mechanization in agriculture, poor knowledge of IPM, lack of innovativeness, lack of entrepreneurial ability, lack of low responsiveness, absence of storage facilities, post harvest technologies and lack of effective supervision and monitoring by extension workers are faced by the growers. The study has confirmed that inadequate marketing networks, inadequate soil management, lack of awareness on improved technologies, lack of achievement motivation, poor sources of information and lack of commitment to farming as enterprise are also contributing to low production. Thus, there is a need to organize awareness and training programmes, timely soil testing for acid soil management, and introduction of post harvest technologies to encourage the farmers for vegetable production so that the farmers become economically independent. Moreover, it will improve nutritional status of farm family thus indirectly improving their socio-economic status.

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Horticulture based farming system for economic upliftment of farmers in Tamenglong, Manipur

W. Ingo Meitei, M. Romesh Singh, N. Sunil Singh and Ch. Yaipha
Central Agricultural University, Imphal, Manipur

Introduction

NAIP project sites namely Joujangtek, Dolang and Luwanglon Khullen village under Tamenglong district are the most backward areas of the Manipur. The project site is not only historically important but also possesses high potential for horticultural development and improving farm economy of the region. Due to rugged topography, improper transport and communication system, the area still remained backward and this region remained unexplored for developmental process and movement of farm produce to leading markets like Bishenpur. Transportation of goods by human being is still in practice and hence, the district remained backward in spite of its high potential for exploration of commercial horticulture. Most of the available land remains unexplored due to lack of knowledge and awareness of the modern production processes. The project area, despite being rich in biodiversity and water resources, has not been able to meet regional food self –sufficiency owing to complex, diverse and risk prone agricultural scenario of the district. Horticultural transformation following the enhancement in productivity, diversity and economic profitability for the farmers of area is very much in need.

Methodology

With the aim of improving the above mentioned areas, NAIP programme was undertaken by introducing horticultural based farming system during October 2007 so as to boost horticultural sector in these areas for economic development of the farmers.

Table 1 Geographical position of the villages

Sl.No	Village	Latitude	Longitude	Elevation (m MSL)
1.	Joujangtek	24°44'N	93°51' E	920
2.	Dolang	24°44'N	93°51' E	920
3.	Luwanglon Khullen	24°39.020'	93°35.282'	1156

Table 2 Physical and chemical properties of the soil at the project site

Particulars	Joujangtek	Luwanglon Khullen	Dolang
Sand %	5.1	4.9	5.5
Silt %	10.1	9.6	11.1
Clay %	81.2	82.1	81.1
Organic Carbon%	2.2	2.1	2.9
Available N (kg/ ha)	340	330	336
Available P (kg/ ha)	12.6	13.0	12.9
Available K (kg/ ha)	330	332	333
pH	5.1	5.5	5.4

Table 3 Recommendation of Agro techniques under NAIP at Joujangtek, Dolang and Luwanglon Khullen villages

SN	Crops	Variety	Season	Spacing	Seed rate
1	Ginger	Bhaisey	Feb-Dec	(30×50) cm	600 kg/ha
2	Turmeric	Lokadong	Feb-Dec	(30×50) cm	600 kg/ha
3	Gaint Chilli	-	Feb-Dec	(50×50) cm	4000 plants/ha
4	Potato	Khufri Jyoti	a)Feb-April b) Oct-Dec	(25×50) cm	3000 kg/ha
5	Pea	Arkel	a)Oct-Dec b)Feb-May	(10×10) cm	80-100 kg/ha
6	Banana	Meitei Hei	April-Dec	(2×2) m	1600 sucker/ha
7	Passion fruit	-	May-Sept	(2×6) m	
8	Pineapple	Kew	April-Dec	(25×50) cm	61,538 sucker/ha

Results

The yield data of the various horticultural crops since in the inception of the project are given below

Ginger (Var. Bhaisey): HYV of ginger was introduced in field of 40 farm families of project site covering an area of 10 ha. Yield was 20t/ha. Farmers could earn Rs.2, 00,000/ ha.

Turmeric (Var Lokadong): Lokadong variety of turmeric was introduction in field of 45 farm families covering an area of 11.3 ha. The production was recorded as 27.8t/ha which was higher than the yield from local variety. A farmer could earn of Rs. 2, 25,000/ha.

Gaint Chilli: Under NAIP programme, gaint chilli was cultivated in 1 ha and farmer could produce 5.2 t of fresh fruits of gaint chilli. Farmer could earn of Rs. 2, 25,000/ha.

Potato (Var. Khufri Jyoti): A high yielding varity of potato was introduced in the field of 9 farm families in 2.3 ha and yield was recorded as 31.3t/ha. The farmer could earn about Rs.3, 60, 00/ha.

Pea (Var. Arkel): Pea variety, Arkel, was introduced to 8 farm families at the project site covering an area of 2.10ha. The yield was 8t/ha. Farmer could earn of Rs. 2, 00,000/ha.

Banana (Var. Meitei Hei), Passion Fruit and Pineapple (Var. Kew): For increasing yield, economic upliftment of farmers at the project site, of 3.74 ha, 2.6 ha and 2.40 ha of pineapple, banana and passion fruit, respectively were grown. Yields were recorded as 8.02t/ha, 10.2t/ha and 9t/ha of pineapple, banana and passion fruit, respectively. New planting system of pineapple was introduced in the area.

Conclusion

After implementation of NAIP (SRLS) component-III project "Livelihood Improvement and Empowerment of Rural Poor through Sustainable Farming Systems in North East India" in Tamenglong district of Manipur by introduction of high yielding horticultural crops, the livelihood of the people have improved due to increased production and productivity of crops. Interventions were widely accepted by the farmers which have potential to improve livelihood of farmers owing to higher productivity, employment, upscaling and or replicating them in larger areas for sustainable development.

Horticulture for livelihood improvement and nutritional security in Saiha, Mizoram

Zohmingthanga and H. Prasad
Central Agricultural University, Aizawl, Mizoram

Abstract

Mizoram is a hilly state with deep gorges and steep slopes. Maximum inhabitants are tribals belonging to Mizo, Chakma, Reang (also Bru tribe), etc. Shifting cultivation is the most common farming system practiced for livelihood like in many of the other states in the Northeast India and hunting is a common past time for the men. The socio-economic condition remains almost unchanged as their basic source of livelihood still remains agriculture and the allied activities. Inaccessibility, fragility, marginality, heterogeneity, natural instability and human adaptation mechanism are the mountain specificities which has been identified to be the factors to be addressed for sustainable agricultural development in hills.

In the previous implementation of the projects, chicks (day old Vanaraja) were distributed to the farmers to meet the family protein requirement and for income generation. Feeds were also provided to reduce their expenses. But the program was unsatisfactory due to the following reasons:

i) The selected farmers could not continue rearing the chick after the feeds provided exhausted as feeds were not readily available. ii) When feeds were available, the quality of feeds availability was poor. iii) Cost of feeds is high. iv) Transportation cost was also high. Keeping in mind the previous unsatisfactory livelihood measures, a meeting was called to discuss about the farmers problems and how to increase their livelihood conditions and nutritional security. Neither government officials nor the village council (Gram Panchayat) were given priority. In the group discussion, it was realized that perennial fruit crops will be a good option. Farmers themselves made the decision and twenty (20) farmers were selected for the adoption of technology. Mango (local variety rangkawi) and banana (local *Musa spp.*) were distributed. In pure block plantation the spacing of mango and mango was 4 m × 4 m, banana was 4 m × 4 m. In intercropping mango and banana spacing was 2 m × 2 m. One hundred each of mango seedling and banana sucker each were distributed to the farmers. The total area covered under this particular program was 8,000 sq meter.

Processing and Value Addition for Income Enhancement

Small scale Food Processing unit –A boon for strengthening rural women Livelihood

Ravi C. Deshmukh, Biradar Gayatri and Jadhav Balaji
Krishi Vigyan Kendra, Bidar, Karnataka

Abstract

Agriculture being an important occupation in India, there is huge wastage of perishable agricultural commodities. Despite India is being one of the largest producers of the cereal grains and pulses, the demand for consumption is growing owing to a large increase in population. Processing of cereal grains and pulses has a bright future ahead. The processing of the food commodities at the village level will not only check the post harvest losses but also provide additional employment (both direct and indirect) to the local people. Bidar district is considered as pulse bowl of Karnataka where in pulses like Blackgram, Greengram, Redgram and Bengalgram are major crops comprises 206717 ha. Hence the main objective of this study was to strengthen the livelihood security by establishing 24 small scale food processing units under NAIP-3 Bidar. The research on small scale food processing unit was conducted by team of NAIP-3, Krishi Vigyan Kendra, Bidar, under an ICAR sponsored project on "Livelihood Security through Resource and Entrepreneurship Management in Bidar district", for 240 selected participants by forming 24 Community Based Organization consisting of 10 members in each group and introduced mini dal mill, vermicelli machine, chilli pounding machine, flour mill and weighing balance. The project area includes 24 selected villages of 4 clusters viz, Aurad, Bhalki, Basavakalyan and Humnabad in Bidar district of Karnataka state, the average income of food processing group was Rs. 32,640 per month per group during season by generating an employment opportunity of 190 man days for 240 members.

Processing and value addition for income enhancement in South Garo Hills, Meghalaya

C. Tirkey, J. Mani and Arjun Ryngkhlem
Rural Resource Training Centre, Umran, Meghalaya

Introduction

The farmers of south Garo Hills of Meghalaya are small and marginal and depend on agriculture for their livelihood. The agricultural productivity is low due to non adoption of improved technologies. The farmers are poor and have less resource to invest in agriculture. However, the region is rich in indigenous fruit resources like pinapple, carombola, orange, jackfruit etc. which hardly fetch any price in the market and hence are underutilized crops. There is good potential for converting these items to value added products for enhancing livelihood of small and marginal farmers.

Methodology

Food processing unit was constructed at the project sites and it's well equipped with all the required machines and tools. The unit was handed over to Nanggrimgipa Multipurpose Co-operative Society, Sibbari. Hands on training program were conducted on food processing for the co-operative society, sibbari on various aspects during 2009-10 by the RRTC, Umran, Meghalaya.

Results

During the first year of its operation the processing unit have earned a total income of Rs 25,000. The main products like pickle (mixed vegetables, mango, bamboo shoots, chilli, ginger, gooseberry, pork and fish pickle), jam, candy and jelly, RTS juice (litchi, carombola, orange, pineapple) are produced. Till date the processing unit is functioning and earning. The farmers are greatly benefitted as they can sell their processed products and thus wastage is reduced. Even the fruits which they use to throw (like carombola) can now be utilized for producing jams, jelly and other by-products. From processing and value addition of various fruits, the Society is earning a net income of Rs. 26,250 annually (Table1).

Table 1 Total production and income generated annually from processing and value addition of various fruits

Items/products	Annual production	Gross annual income (Rs.)	Net annual income (Rs.)
Pickles (mixed vegetables, mango, bamboo shoots, chilli, ginger, gooseberry, pork and fish)	100-120 kg	25,000	15,750
Jam, jelly & candy	45 kg	9500	6000
Juice RTS (pineapple, carombola, orange, mango, litchi)	90 litres	6400	4500
Total	-	40,900	26,250

Economics of turmeric cultivation and prospects of its processing in Saiha district of Mizoram

K. Vanlalhriatpuia, S. Lanabir Singh, U.K. Sahoo, Lalnilawma and K. Upadhyaya
Mizoram University, Aizawl-796004, Mizoram

Introduction

Turmeric (*Curcuma longa* L.) is one of the most important spice crops used in many culinary preparations. It has numerous medicinal uses such as in stomach ache, tonic, blood purifier and as an antiseptic. Its oil also acts as an appetizer and aids in digestion. Its powder is used for the preparation of medicinal oil, ointments and poultices. Turmeric powder has varied uses chiefly to impart colour and flavour to vegetables, pickles, fish and meat preparations. Its special use in culinary as condiment is due to presence of yellow-colouring matter called curcumin, volatile oil and rich contents of carbohydrates and minerals. Turmeric is used as colouring matter in pharmacy, confectionery, textile, paint, cosmetic goods and food industries. The Hindus practice turmeric as an offering on religious and ceremonial occasions too (Madan, 2007). The North Eastern region offers great potential for large scale cultivation of many spices. In terms of area, turmeric is the third largest crop in the region. However, its productivity in the region is only 1.5 t/ha against 3.9t / ha in the country. Turmeric comes up well in warm and humid climate, grows on different types of soils from light black, loamy red soils to stiff black clay loams. The crop cannot tolerate water logging. At such climate and edaphic conditions in North-eastern region of India has a potential for turmeric plant growth and development. Turmeric is widely grown in the state of Mizoram. The yield of turmeric can be enhanced using suitable intercropping and/ or use of mulches (Mohanty et al., 1991). The crop demands heavy inputs of fertilizer for sustained production while the market demand for raw turmeric is very poor in the state. So, the farmers generally do not harvest the crop every year and leave them to grow for longer periods, hereby generating less economic returns. In order to fetch a better market return, value addition of turmeric becomes very essential. The biggest challenge faced by the turmeric growers in the region is lack of premium price for the produce. Post harvest losses of almost all the farm produce in the region are very high due to near zero facility for their handling, processing, value addition, and packaging and even organized marketing. The present study has been taken to assess the economics of cultivation and its prospects of turmeric processing for better income generation.

Methodology

Economics of turmeric cultivation was carried out in the fields that were grown by the farmers at East Kalcho, Saiha district of Mizoram. Turmeric cultivations were done in

approximately about 70 hectares of land covering 148 prospective households. The average land per household under turmeric cultivation was 0.5 ha (approx.). Lakadong variety of turmeric was planted following pure organic methods. Disease free whole rhizomes were grown in the month of April to May by dibbling method. About 2 tonnes of the rhizomes are used for planting per ha at a spacing of 30 cm between rows and 20 cm between plants. Fifteen tonnes of FYM along with 10 tonnes of green leaves, weeds, subabul leaves and 2 tonnes of paddy straw were applied as mulches at the time of planting turmeric. The crop is raised under rain-fed condition. Two to Three hand weeding were carried out. No herbicide/ pesticides were used during the cultivation period. The crop was raised either as sole crop or as mixed cropping with maize, common bean, or along with *Jatropha*, mango and pineapple. Economics was found out by taking into account the existing market rate of the crop, mulch materials and cost of cultivation. The benefit: cost analysis was carried out using standard methods. All input and output costs were based on the local market price. The freshly harvested turmeric was cleaned, dried and powdered in the turmeric processing unit. The grounded turmeric powder was further packed in 100 g packets before releasing to market.

Results

Yield: The crops were harvested within 8-9 months time during Janaury-February by digging using a spade. The average yield under sole crop is about 10.47 t/ha (without mulches) and under mixed cropping 12.5 t/ha and with mulches about 13.29 t/ha (Table 1). There was no significant year-wise variation with respect to turmeric production in the farmers field.

Table 1 Turmeric yield under sole crop and with crop mixture (intercropping) at Saiha, District of Mizoram

	Turmeric yield (t/ha)		
Treatment	2008-09	2009 –2010	Mean
Sole turmeric	10.79	10.14	10.47
Turmeric+maize	11.53	10.57	11.05
Turmeric+jatropha	12.08	11.25	11.67
Turmeric+pineapple	11.07	10.20	10.64
Turmeric +organic mulch	13.57	13.00	13.29

Benefit: Cost analysis: The benefit: cost analysis of turmeric pooled together for all plots was 1.21. A farmer could earn as high as Rs. 19,600 from raw turmeric from one ha of

land, however, when the same is processed, it fetched as high as Rs. 2,13,600 from the same unit of land. The processed turmeric had better market demand. However, the frequent failure of power supply load shedding caused disruption of processing resulting in processing of about 200-250 kg of turmeric per month in the cluster benefiting 148 households. It is estimated that even though farmers do not make use of all the harvested turmeric for value addition, from one ha of land, a house hold can earn as high as Rs. 12,390which provide an increase of 36.63% income, thus is quite promising. Use of organic mulches and intercropping with maize and other crops provided 30-35% more yield than the traditional practice of sole crop. The intervention of scientific cultivation of turmeric with value addition provided 25-30 % more income. Earlier, farmers were incurring heavy loss due to huge transportation cost for ferrying their produces to processing units in far off places. But now farmers, after drying the turmeric in the field can bring them to the unit for processing. After packaging, they sell it either directly or through the ICAR Farmers' Association for marketing under the logo of ICAR.

Table 2 Economics of turmeric cultivation in Saiha district of Mizoram

Particulars		Input (INR)	Output (INR)
(i)	Land tilling including bed preparation:	8000	-
(ii)	Cost of rhizome 2 tonnes @Rs.8/kg:	16000	-
(iii)	Treatment before sowing	2000	-
(iv)	Seed sowing/labour cost*:	4600	-
(v)	Application of FYM (15 tonnes/ha @ Rs.3/kg)	45000	-
(vi)	Application of green mulches:**	Nil	-
(vii)	Cost of paddy straw (2 tonnes/ha @ Rs.2000/tone):	4000	-
(viii)	Hoeing/weeding**:	3000	-
(ix)	Cost of digging/labour charge**:	6000	-
(x)	Transportation cost:	1400	-
(xi)	Yield @ 10.5-13.7 tonnes/ha (varies with cropping type):	1, 09,600	
(xii)	Market price for freshly harvested turmeric @ Rs. 8/kg		
	Total:	90,000	1, 09,600

* partly borne by the farmers, ** available around the field; labour towards collection of mulch materials are borne by the farmers; Benefit: Cost ratio: 1.21; Net Benefit from cultivation of turmeric from 01 ha of land: Rs. 19600.00/ha

Value Addition/Processing cost of Turmeric:

One kg of freshly harvested turmeric after curing and drying gives rise to 230 g, of which during processing it comes to nearly 200 g in powdered form.

The cost for processing 1 kg of fresh turmeric (i.e roughly 200 g powder):	Rs 40
Packaging cost per 1kg of powdered turmeric:	Rs. 80
Total cost of processing of 1kg powdered turmeric:	Rs. 120
Cost of processing of a 100g packet:	Rs. 12
Total weight of processed powdered from 1 ha of land (from the site):	2670 kg
The total cost of processing @ Rs. 120/kg:	Rs. 3, 20,400
No. of 100 g packets/pieces	26700 nos
The selling price @ Rs. 20/100g pack in local market:	Rs. 20.00
Total cost of processed & packed turmeric from 1 ha	Rs. 534000
Net benefit (Rs. 534000-Rs. 320400)	Rs. 213600

10% of the total benefit was deposited in the revolving fund/sustainability fund i.e Rs. 21360. Ninety percent of the profit was equally distributed among the 148 HHs which comes to Rs 12390.00/year.

Conclusion

Before installation of the processing unit, the turmeric growers in the project site were not harvesting the crops regularly owing to low market demand for the raw turmeric product, however, now the scenario is quite changed. Now, the processing unit is being managed by the Apex body, Paradise Valley, East Kalcho, Saiha district and the plant is being used only for the processing of turmeric grown by the SHGs. It is expected that in future when the production of processed turmeric will increase, more benefits will be available to the SHGs promoting turmeric and the other farmers growing turmeric in the area can take advantage of this processing unit.

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Enhancing livelihood of rural women through value addition in horticultural crops: a case study in Ri-Bhoi, Meghalaya

S. R. Baruah, A.K. Tripathi and A. Roy
ICAR Research Complex for NEH Region, Umiam – 793103, Meghalaya

Introduction

Horticulture is an important sub-sector of agriculture in north-eastern Region particularly in Meghalaya. The State has seven districts namely, East Khasi Hills, West Khasi Hills, East Garo Hills, West Garo Hils, South Garo Hills, Ri-Bhoi and the Jaintia Hills. The bulk of the population belongs to three major tribal communities i.e., the Khasis, the Garos and the Jaintias (also better known as the Syntengs or the Pnars). In Meghalaya, the percentages of rural and urban tribal population are 86.44 per cent and 13.56 per cent respectively. Agricultural operations having limitations in Meghalaya due to its topography, climatic conditions and socio-economic conditions claiming only about 10 per cent of the total land for cultivation. Diverse agro climatic conditions of Meghalaya is highly suitable for growing of a number of horticultural crops such as ginger, capsicum, tomato, turmeric, broccoli, strawberry, etc. Ginger is an important cash crop of Meghalaya. The total area under horticultural crops was 101.1 thousand hectares amounting to a production of 689.9 thousand tonnes (Area & Production Estimates for Horticulture Crops, NHB, 2010-11).Total area under fruits during 2010-11 was 30.2 thousand hectares with the production of 241.9 thousand tonnes. The marketable surplus of ginger is very high, ranges between 40 % and 75 % (Table 1). In 2010-11 the production of vegetables was 356.5 thousand tones from an area of 41.8 thousand hectares in Meghalaya. In the avenue for small farmers of the country to involve in different horticulture based agribusiness are wide and open. Processing of

Table 1 Current Status of selected horticultural crops in Meghalaya (2009-10)

Crops	Estimated Marketed Surplus	Estimated marketed surplus of total production (%)	Harvesting & Marketing Season	Value Added Products
Ginger	35048	75	Dec-March	Ginger candy, ginger cake & Ginger oil
Turmeric	6914	80	Dec-March	Turmeric powder dried spices
Tezpatta	15162	95	Oct-March	Oil extract
Potato	117519	70	June-Aug	Potato chips starch extract
Pineapple	70833	85	Dec-Feb	Fruit juice concentrate canning
Arecanut	9208	65	Oct-March	Dried
Chili	460	40	Dec-April	Qleoresin extract
Orange	22954	70	Dec-March	Fruit juice concentrates

horticultural commodities is an important sector of economy to reduce post-harvest losses, ensure better return, generate employment and earn foreign exchange. Meghalaya bestowed with varied agro-climate conditions has enormous potential for economic growth through promotion of horticulture based industries. Major fruit crops grown in the State are pineapple, orange, banana, jackfruit passion fruit good quality of pear. Major Spices like Chillies, ginger, turmeric and black pepper are also grown commercially. The processing opportunities emerging from horticulture production in Meghalaya are pineapple based unit (juice concentrate, canning of slices, soft drink jam and tidbits), orange based (juice concentrate and beverages), jackfruit based unit (Wine, pickle, papad), and ginger based unit (dehydrated ginger, pickle, candy, powder).

Case Study

Mrs. Teilang Rani is a primary level school teacher from the Umden Arka village of Ri-Bhoi district in Meghalaya. Being one of the few educated persons from the village, she had a strong desire to help other village women. Therefore, she had formed an all women SHG named Nangkiew Irat and became its Secretary in the year 2008. During the first year, the group members had cultivated ginger and sold in the local market, but soon they realized that fetching a good price is not an easy task as during the peak harvest season, often the market is glutted with fresh ginger and price crashes down. At that point, they had approached KVK Ri-Bhoi for guidance and technical help. After much discussion, it was decided that the group would be trained on processing and preservation of ginger, as it is their favoured crop due to its easy availability.

As requested by Mrs. Teilang Rani, training programmes on preparation of ginger pickle, candy and ale was organized for their group members. These 'hands on' training programmes were modulated in such a manner so that they can understand the scientific methods of processing and preservation. They were also trained on group dynamics of SHG formation so that they can maintain the cohesiveness. Initially these farm women prepared ginger pickle at home scale, which was liked by their family members and other villagers. Looking at its demand, the SHG decided to prepare ginger pickle, ale and candy in group manner by investing an amount of Rs. 5000, from which they earned a profit of Rs. 6860.

Towards the mid of 2011, the group had sold about 150 bottles (150 g each) of ginger candy, 250 bottles (100 g each) of ginger pickle and 100 bottles (500 ml each) of ginger ale earning a total income of Rs 27,750 with a benefit: cost ratio of 1.6. During the process of value addition the SHG had utilized 1330 kg of raw ginger for preparing these products, which they would have sold in the local market with a meager price of Rs. 20 per kg to earn Rs. 2660. By value addition they have enhanced their gross income by Rs. 25090. This was really an encouraging fact for the SHG members. The group was selected for participation in 2 nos. of block level horticulture exhibitions during March and April, 2011. Due to the immense success of the Self Help Group, other women SHGs in and around the village were greatly influenced and motivated. Around 4 nos. of SHGs have already started making

and selling bamboo shoot pickles, pineapple squash, tomato sauce, etc. under the technical guidance from KVK Ri-Bhoi. Presently the group is engaged in preparing bamboo shoot pickle, ginger pickle, ginger ale, tamarind pickle, chili pickle. With the able support and technical guidance from KVK the group is now well confident in value addition of ginger and is looking forward to market their products in a big way. Therefore, KVK is trying to support them in getting FPO license in near future, which will benefit the group in the long run.

Empowering Farmers through Subsidiary Activities

Poultry rearing: a profitable rural venture in hilly terrain of the Himalayas

S.K. Singh, S. B. Khadilkar and P. C. Vaishnava
BAIF Development Research Foundation, Haridwar

Introduction

Poultry is one of the fastest growing segments of agriculture sector in India. Agriculture crop production has been rising at the rate of 1.5–2% per annum whereas production of eggs and broilers has been rising at the rate of 8–10% per annum (Mehta *et al*., 2003). National annual consumption is 37 billion eggs and one billion broilers. Per capita consumption of eggs in rural area is less than half that of the urban areas (Mehta *et al*., 2003). India has emerged as 5th largest producer country in the world. Per capita consumption of poultry meat rose from 0.2 kg in 1970 to 1.6 kg in 2003 (FAO, 2008). Growth in the sector has been primarily driven by large-scale commercial farms whilst small farmers and the landless, which form the majority of the poultry producers, have largely been by-passed by this growth (GOI, 2005). In the most recent years, however, the Government of India has recognized the potential of small-scale poultry sector development for poverty reduction (GOI, 2005; GOI, 2008). In the hill area BAIF under the Project entitled "Enhancement of livelihood security through sustainable farming system and related farm enterprises in north-west Himalaya" supported by NAIP-ICAR, New Delhi worked on two major problems of poultry rearing in Mudiyani cluster of Champawat district.

1. High mortality (up to 50%) due to poor brooding management: The high fluctuations in ambient temperatures of night and day time as birds of 1 to 15 days age are highly susceptible to temperature fluctuations.
2. High cost of commercial feed: The procurement of commercial feed is only by transport. The cost of feeding amounts to about 70% of the total expenditure.

Methodology

To overcome the problems in brooding and feeding management, innovative approaches were tried as described below:

Modified Poultry House

In the hilly terrain there is a wide variation in day and night temperatures ranging from 0^0 to 35^0C. To maintain inner temperature, some changes were done in poultry house construction. The area of 14x12x8 ft in a place with good sun light was selected for poultry house. Size of the windows was reduced to 1 to 1.5 ft (against about 4ft in commercial) and gunny bags were used to cover windows to reduce flow of cold air during night.

Brooding Management

During first two weeks, maintaining temperature between 85 to 95 ^{0}F (30-35^{0}C) for better management and growth is necessary in poultry. To achieve this, finally a hover like structure was designed by using locally available materials. A iron sheet of 10ft X 3ft was placed at the height of about 1.5 ft from the floor along one wall in the shed. Three bulbs of 200 watt are fitted under it at uniform distance. This helped to equally distribute light and heat. In case of power failure a Kerosene stove was glowed. Modification over traditional method is the reduction in the size of the incubated space. Chicks moved in and out of this incubated space as per their need. Testing of structure had three treatments *viz*., T_1 - No incubation, T_2 -Incubation without using hover, T_3 -Incubation using hover.

Feeding Management

Feeding contributes the major expenditure in poultry rearing. In the hill area availability of commercial feed is difficult. To overcome this difficulty customization of the feed was done by partly replacing with locally available resources like Bichuu grass (*Urtica dioca*) and other grasses, Pear fruit, vegetables (brinjal, pumpkin, sponge guard) ghingharoo (a wild fruit), vegetable waste, etc. Farmers were trained in preparation of poultry feed locally. Two treatments of restricted feeding were compared commercial feed versus customized feed (Table 1). Farmers were also encouraged to crush insects trapped in light trap and feed to poultry birds. It provides higher protein to the birds and found useful in increasing the growth rate (Gene De Foliart, 1992).

Table 1 Feeding Customization

S. No.	Period	Feed (T_1)	Feed (T_2)
1.	1 day	Jaggery + Water	Jaggery + Water
2.	2-15 days	Commercial Feed 100%	Commercial Feed 100%
3.	16-25 days	Commercial Feed 66% + locally available items	Commercial Feed 100%
4.	26-35 days	Commercial Feed 50% + locally available items	Commercial Feed 100%
5.	36-45 days	Commercial Feed 34% + locally available items	Commercial Feed 100%

Results

Modification in poultry house structure helped to protect birds from cold air and maintain the temperature of the poultry house. Brooding management provides a microclimate that helps to reduce mortality of the chicks during the first fifteen days from 47% to 4.5% as detailed in Table-2. After adopting the recommended feeding practices of different feeding duration and feed customization it is seen that on 45th day the mean weight in case of T_1 was 1096.05±18.02 g and in T_2 was 1130.67±36.63g (Table-3). There is a difference of approx 35g which @ Rs. 110/- per kg would fetch just Rs. 3.85, whereas saving in expenditure on feeding was Rs. 25.60. As a result, farmers are highly motivated to adopt customized feeding in poultry. Proximate analysis of feed used was done. The results are given in Table 4. FCR

on commercial feed used comes to 1.37 and 2.21 for T_1 and T_2 respectively. There is quantum jump of Rs 2175/- per unit of 100 birds net profit in a single crop.

Since meat and eggs have good demand in the hilly tract, introduction of improved management practices with poultry rearing in hill areas is recommended for improving livelihood in a sustainable manner. Easy access to market, availability of health services, timely suggestions to project participants for poultry rearing are major factors responsible for the success.

Table 2 Comparison of various treatments for brooding

Sr. No.	Parameters	T_1	T_2	T_3
1.	Avg. Min. Temperature ^{0}C	9.13	21.30	26.58
2.	Avg. Max. Temperature ^{0}C	26.33	32.97	38.07
3.	Difference	17.20	11.67	11.49
4.	Avg. mortality %age	47.00	10.00	4.50

Table 3 Effect Mean & SEM of birds at various ages in commercial & customized feed

Age	Commercial feed (T_1)		Customized feed (T_2)	
	Mean	Std Error	Mean	Std Error
Day 1	27.60	0.43	28.26	0.49
Day 7	80.04	1.47	89.76	1.61
Day 14	187.43	5.34	213.40	4.64
Day 21	320.61	7.95	367.60	9.37
Day 28	500.02	12.71	550.06	14.26
Day 36	760.59	17.32	813.57	18.52
Day 45	1096.05	18.02	1130.47	36.63

Table 4 Proximate analysis of Feed

Sample	Moisture (%)	Percent on Dry matter basis				
		CP	CF	EE	Ash	AIA
Pre starter	9.40	23.45	12.11	4.42	7.00	0.95
Starter	8.70	24.79	7.76	4.56	8.38	1.9
Commercial Feed 66% + locally available items	28.40	19.56	9.55	4.72	9.24	2.06
Commercial Feed 50% + locally available items	49.80	19.84	10.29	5.08	10.32	1.96
Commercial Feed 34% + locally available items	25.60	20.86	4.99	5.32	11.12	2.28

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MGNREGA: impact on income and consumption expenditure of beneficiaries in Meghalaya

[1]D.S. Dkhar, [2]A.K. Tripathi, [1]S.M. Feroze, [1]R. Saravanan, [2]N.U. Singh and [2]A. Roy
[1]College of Post Graduate Studies (CAU), Umiam, Meghalaya
[2]ICAR Research Complex for NEH Region, Umiam, Meghalaya

Introduction

Promotion of economic development in developing countries has been the biggest challenge in this twenty first century. One such path breaking and fundamental programme in independent India has been rural employment creation and its guarantee through the National Rural Employment Guarantee Act (NREGA), introduced and implemented by the UPA Government of India. The scheme was launched on 26th February from Anantapur district in Andhra Pradesh. The scheme was first initiated for 200 districts then subsequently enlarged twice to cover all the 593 rural districts of the country. The scheme has now been re-christened as Mahatma Gandhi National Rural Employment Guarantee Scheme. The unique feature which distinguishes this scheme from previous employment programme is that NREGS is endorsed by a legal guarantee (IIM, 2009). MGNREGA continues to be one of the most ambitious centrally sponsored schemes of independent India (IRMA 2010). Change in the consumption pattern and purchase behavior of household durables among employment beneficiaries and assessing the impact of the scheme on rural livelihoods were studied by different scholars in different parts of the country (Ahuja et al. 2011), however, study on MGNREGA in Meghalaya is very meager. With this background, a study has been conducted to evaluate the impact of MGNREGA on livelihood of the beneficiaries in East Khasi Hills District of Meghalaya to evaluate the impact of MGNREGA on income and consumption expenditure of the beneficiaries.

Methodology

The primary data was collected from the study area with pre-structured interview schedule. The present study had been conducted in East Khasi Hills district of Meghalaya which was selected purposively on the basis of highest population as well as highest population density in the state. Two blocks *viz.*, Pynursla and Khatarshnong-Laitkroh were randomly selected from the district and in turn two villages from each block had been randomly selected. In the multistage random sampling, 15 beneficiaries were identified randomly from each village making a respondent of 60 beneficiaries and 30 non-beneficiaries were selected from 2 villages making the total numbers of 90 respondents, all of whom belong to Below Poverty Line (BPL) households. Simple tabular analysis, index numbers, averages and percentages were used to analyze the primary data.

Results

The income of beneficiaries before and after MGNREGA is presented in Table 1. The average income was worked out to be Rs.3612.50 per month before MGNREGA and about Rs.4524.33 per month after MGNREGA. It was observed that there was 27.43 per cent increase in the income after working in MGNREGA than before working in MGNREGA indicating that income has increased reasonably after participation in the scheme.

Table 1 Comparison of income of beneficiaries (Before and after MGNREGA) (N=60)

Village	Previous income (per month) (Rs.)	Present income (per month) (Rs.)	Income relatives (IR)	Log (IR)
Laitlyngkot	3957.00	4964.00	127.00	2.10
Lumthangding	3620.00	4580.00	129.00	2.11
Lyngkyrdem	3540.00	4273.00	122.00	2.09
Mawpran	3333.00	4280.00	132.00	2.12
Average	3612.50	4524.33		2.105

Antilog 127.43, Figures in parenthesis indicate percentage to total.

The present income of the non-beneficiaries and beneficiaries are presented in Table 2. The households from both the categories were selected on the basis of equal number of earners from each household. Only one and two number of earners from each household was selected as they account about 85 per cent among the beneficiaries and 80 per cent among the non-beneficiaries respectively. The average present income of the non-beneficiaries was worked out to be Rs.3750.62 per month and that of the beneficiaries was Rs.4523.75 per month. It was found that the income of the beneficiaries increased by 19.66 per cent over the income of the non-beneficiaries. This shows that such economic development programme aims not only at providing wage employment but also creation of better income to the family.

The average monthly expenditure on various food and non-food items of beneficiaries is presented in Table 2. It was found out that the overall consumption expenditure on food items of the beneficiaries after MGNREGA increased by 5.2 per cent than before MGNREGA.

The increase in monthly expenditure on non-food items like clothes (10.87%) and shoes (9.74%) was seen to be to be comparatively high due to the fact that the media in all its forms and advertising has projected the necessity of buying more fashionable items to add to the already existing attire. Electricity expenditure also increased by Rs.6.25 (1.87%) since with the introduction of the latest gadgets nothing operates without the consumption of electricity (Table 3). Most of the households possess atleast a television set and a low cost mobile phone which requires the use of electricity for operation.

Table 2 Average monthly household expenditure on food items of beneficiaries (Before and after MGNREGA, N=60)

Food items	Average monthly expenditure (Rs.)		Expenditure Relatives (ER)	log (ER)	Increase in monthly expenditure (Rs.)
	Before	After			
a. Cereals	170.75 (4.54)	170.75 (4.17)	100.00	2.00	0.00 (0.00)
b. Pulses	93.50 (2.48)	95.00 (2.32)	101.60	2.01	1.50 (0.45)
c. Vegetables	121.83 (3.24)	132.17 (3.23)	108.48	2.03	10.34 (3.10)
d. Oil	112.00 (2.98)	112.00 (2.74)	100.00	2.00	0.00 (0.00)
e. Meat	293.22 (7.80)	355.67 (8.69)	121.30	2.08	62.45 (18.73)
f. Milk & milk products	190.00 (5.05)	190.00 (4.69)	100.00	2.00	0.00 (0.00)
g. fruits	122.67 (3.26)	138.82 (3.39)	113.17	2.05	16.15 (4.84)

Antilog 105.20, Figures in parenthesis indicate percentage to total

Table 3 Average monthly household expenditure on non-food items expenditure of beneficiaries (Before and after MGNREGA, N=60)

Non-Food items	Average monthly expenditure (Rs.)		Expenditure Relatives (ER)	log (ER)	Increase in monthly expenditure (Rs.)
	Before	After			
a. Cooking gas/fire wood	908.33 (24.14)	915.00 (22.34)	100.73	2.00	6.67 (2.00)
b. Electricity	179.82 (4.78)	186.07 (4.54)	103.47	2.01	6.25 (1.87)
c. Transportation	84.13 (2.24)	104.08 (2.54)	123.71	2.09	19.95 (5.80)
d. Medical	85.10 (2.27)	92.52 (2.26)	108.71	2.04	7.42 (2.22)
e. Clothes	142.28 (3.78)	178.55 (4.36)	125.49	2.10	36.27 (10.87)
f. Shoes	128.62 (3.42)	161.08 (3.93)	125.24	2.10	32.46 (9.74)
g. Education	292.86 (7.78)	326.81 (7.98)	111.59	2.04	33.95 (10.18)

Antilog 114.23, Figures in parenthesis indicate percentage to total

Conclusion

The study confirms that there was significant increase in the income of the beneficiaries after implementation of MGNREGA. The income of the beneficiaries increased by 19.66 percent over the non-beneficiaries which signifies that beneficiaries have more advantage in increasing their livelihood options by participating in MGNREGA activities. The increase in expenditure on the food and non-food items was due to increased income of the beneficiaries after working in MGNREGA activities. After successful implementation of MGNREGA, beneficiaries were spending more on food as well as non-food items as they have more purchasing power.

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Economic impact of goat rearing among tribal families of operational villages of NAIP - III in Gujarat state

K.A.Thakkar
SDAU, Sardarkrushinagar, Gujarat

Introduction

The National Agricultural Innovation Project was implemented in the year 2007-08 in three disadvantaged districts namely: Banaskantha, Dahod and The Dangs of Gujarat state. The Project aims at achieving sustainable livelihood security of the farmers. For achieving the same, number of interventions has been implemented in the project area. Goat husbandry is one of these interventions. In two clusters (Sanali, Taluka-Danta and Vagadadi, Taluka-Amirgadh), of Banaskantha district total 160 farmers had been provided five sirohi breeds of goat each. It was therefore, felt necessary to study the increase in income of farmers through goat rearing.

Methodology

The present study was conducted in six operational villages namely; Vagadadi, Khemrajiya, Mandaliya, Sanali, Hathipagala and Chhotabamodara of Banaskantha district of Gujarat state. Total 160 farmers had been provided five Sirohi breeds of goat each. All these farmers were included in the sample. However, 10 farmers were absent at the time of interview. Hence, final sample comprised 150 respondents. The data were collected by personal interview with the help of structured interview schedule. The interview schedule was developed with the help of experts keeping in view the objectives of study. The data were transferred in to master table and analyzed in terms of frequency and percentage in order to make findings meaningful.

Results

Economic impact of Goat husbandry

The economic impact was assessed in terms of annual earning of the respondents through goat husbandry the finding in this regard are presented in Table-1.

It can be seen from Table 1 that little more than half (51.34 per cent) of the farmers had earn more than Rs.5500/year through goat husbandry. The farmers annually earning up to Rs.2500/- through goat husbandry were 29.33 per cent. Remaining 19.33 per cent farmers earned Rs.2501/- to Rs.5500/- year through goat husbandry.

Table 1 Distribution of the farmers according to their annual earning through Goat husbandry

Sr. No.	Annual earning through goat husbandry (Rs)	No. of farmers	Per cent
1	Up to 2500	44	29.33
2	2501 to 5500	29	19.33
3	Above 5500	77	51.34
	Total	150	100.00

Table 2 Distribution of the farmers according to their average increased income over traditional goat husbandry

Sr. No.	Income source	Average Rs. earned/year		% increase in income
		Prior to Project	After Project	
1	Sale of milk	3358	3842	14.38
2	Sale of male	2149	2332	8.50
	Total	5507	6174	22.88

The farmers in case of goat husbandry were found earning through sale of milk and sale of male. Table indicates that on an average, 14.38 per cent increase in the farmers' income was observed through sale of milk. In addition, 8.50 per cent income was increased through sale of male.

Relational Analysis

The data on relational analysis are presented in Table-3.

Table 3 Relationship between selected variables of the respondents and their income from goat husbandry

Sr. No.	Character	Co-efficient of Co-relation(r)
1	Age	0.1470
2	Education	0.4237**
3	Family size	0.0913
4	Land holding	0.3896**
5	Occupation	0.1376
6	Herd size	0.4019**
7	Annual income	0.4317**

It can be seen from Table 3 that four variable namely, education (0.4237), land holding (0.3896), herd size (0.4019) and annual income (0.4317) of the respondents were found having significant relationship with their earning from goat husbandry. Remaining variables namely, age, family size and occupation have failed to establish significant relationship with income.

Conclusion

It can be concluded from the findings that goat husbandry is a remunerative enterprise for the landless and marginal farmers as it increased 22.88 per cent income of the farmers.

Success story of a new improved layer germplasm (25 % Tripura black × 75 % Dahlem red) in enhancing livelihood security in Tripura

S. Malik and M. Datta
ICAR Research Complex for N.E.H. Region, Tripura Centre, Lembucherra, Tripura

Introduction

The backyard poultry production is a traditional venture of people of North East region. Majority of farmers rearing livestock and poultry in their backyard to support their livelihood throughout the year. Out of total population of poultry of N.E. region, nearly 80 % consist of desi/nondescript, in which growth and production is very low. Therefore, the average per capita availability of eggs in North East region is only 23, which is far below than the recommended allowance viz. 180 eggs per capita per year (@ half egg per day per person) as suggested by Nutritional Advisory Committee of ICMR. So there is huge short fall in egg production particularly in rural areas of whole of the North East. To fulfill requirement of recommended allowance, it is not feasible to establish commercial layer farms due to very high cost of feed, which is reflecting on the cost of egg. So that backyard poultry production is the only option to fulfill their requirement by replacing local nondescript birds with the improved germplasm so that egg production would be enhanced upto double than the present production. Majority of the farmers of Tripura maintaining nondescript birds, in which growth and production is very low (60-70 eggs per bird per annum, 1.5 and 2.0 kg body weight per bird in male and female, respectively). The farmers rarely providing feed supplement to the birds, the birds fulfill their nutritional requirements by scavenging in the backyard and maintained nearly on zero input. The birds have broody character so that instead of low production, their self propagating character helps to the farmers in sustainable poultry production. The state has lot of shortage of eggs and procuring 300-400 lakhs eggs per annum from other states.

Methodology

The new improved germplasm was developed under AICRP on Poultry Breeding using 25 % inheritance from Tripura black local germplasm and 75 % inheritance from Dahlem red. The chicks were brooded and rear upto 6 weeks of age at the farm. During the brooding period, chicks were inoculated by the vaccines for the deadly viral diseases. After 6 weeks of age, the chicks were supplied to the farmers. On average, 12 chicks were given to each farmer of the village. Farmers were also given some essential medicines. Before distribution of chicks, farmers imparted short training for the scientific poultry farming. Farmers' houses were visited frequently to assess the performance as well as to support and advise to the farmers in case of any problem in rearing.

Results

Farmers reared improved germplasm successfully in backyard system of rearing. The average adult body weights were: 1.50 kg and 2.0 kg in female and male, respectively. The average annual egg production was recorded 170-180 eggs. The germplasm perform better in case its nutritional requirement is supported by providing some feed supplement i.e. farm byproduct, kitchen waste, etc. The average mortality from 8 to 40 weeks of age at farmer's house was 10-12 %. The table given below depicting the differences in the performance in nondescript and improved germplasm.

The new improved germplasm thrive well in the agro-climatic conditions of Tripura in backyard system of rearing. The farmers are getting good numbers of eggs with higher body weight of the birds (Table 1). The farmers used some eggs in their own consumption and extra eggs sold @ Rs. 5.00 – 6.00 per egg in local market. Overall farmers got Rs. 600-900/- as income from one bird. The money earned from the sale of eggs and birds used to pay the fee of the school of their children and day to day expenditures. The poultry manure earned from the birds was used in their crop production. The farmers were satisfied by the performance of the improved cross stock. The mortality at the farmers houses was lower than other stock due to moderate body weight and inheritance from native germplasm Tripura black (Annual Report, 2010-11).

Table 1 Comparison of intervention of technology

Backyard Poultry Performance	Before	After
Variety introduced	Non descript	Improved layer germplasm
Nos. of chicks supplied	—	4,453 chicks
Production	60-70 eggs, Av. Adult B.W. = 1.5 kg. (@ Rs. 5/- egg & Rs. 150/- kg meat).	170-180 eggs, Av. Adult B.W.= 2.0 kg. (@ Rs. 5/- egg & Rs. 150/- kg meat).
Increase in production	N.A.	100 eggs /year & 0.50 kg B.W.
Cost expenditure	Rs. 50/-	Rs. 300/- bird
Total output	Rs. 525/- bird	Rs. 1150/-
Profit	Rs. 475/- per bird	Rs. 850/- per bird
Increase in income, %:	—	178.94 %
Increase in employment, %	—	20%

There is lot of scope of improvement in backyard poultry production as the production performances of nondescript birds are very poor. The average per capita per year egg availability in Tripura is only 35, therefore, Tripura procuring nearly 300 - 400 lakhs eggs per year from other states to supplement their requirement. However, if 75 % of the total nondescript birds, which have the poor production potential is replaced by improved scavenging stock (laying more than 150 eggs in a year), then more than 400 lakh eggs could be added without much extra effort (Malik and Singh, 2009). By this way, at least procurement

of eggs from other states may be avoided. The intervention of use of improved germplasm in backyard poultry farming can be a potential tool in improving economic status of poor farmers and landless labourers to provide sustainable livelihood security. It helps in food security, income and employment generation of the poor rural families.

Farmers are advised to hatch fertile eggs of improved germplasm by using local desi/ nondescript birds. Initial care is needed for brooding of chicks by providing heat particularly in winter season to the chicks so that mortality may be reduced. The chicks should always be vaccinated for viral diseases by taking help of the local Veterinary dispensatory. In case of infection of disease to the chicks/birds they immediately be isolated from healthy birds and providing separate feed and water as well as medicine in consultation with veterinary doctor. Always provide clean drinking water at the morning and supplement balanced feed formulated by locally available ingredients particularly at afternoon to the birds so that they may scavenge properly in the morning.

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Ornamental fish farming as a tool for socioeconomic development of *Matrusakti* women SHG at Rengali Cluster, Sambalpur, Odisha

S.K. Swain, D.K. Sahoo, P.K. Meher, S. Kar, B. Patro, Rajesh, N., B.C. Mohapatra and Jayasankar P.

Central Institute Freshwater Aquaculture, Kausalyaganga, Bhubaneswar-751002

Introduction

Indian ornamental fishes with their brilliant colors and unique features need no introduction to the World market. It is one of the important items among the various types of commercially important fish marketed nationally and internationally. Culturing and keeping aquarium fish began as a stress relieving hobby and is now emerging as a commercial venture. The farming of Ornamental fish made a paradigm shift among entrepreneurs ushering in economic development. However India's share in ornamental fish trade is estimated to be less than 1 % of the global trade. Due to its increasing demand, this has offered good opportunities and opened up new avenues for the economic betterment of rural women and augments scope for more revenue generation within a short period of time. With these opportunities in mind, the Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar, as a part of its activities to bring technological empowerment to rural women under the NAIP- Livelihood project extended the ornamental fish farming technology by involving rural women through self-help group which will play an important role to maintain livelihood of the local people**.** Therefore, there is an urgent need for up scaling the operations in this area keeping in view the mammoth requirements in the country. The present communication reports a success story of one self-help group at Sambalpur district, Odisha.

Methodology

The experimental work has been carried out in Nuapali village of Rengali block of Sambalpur district of Odisha, India. This village is 50 kms away from district headquarter, Sambalpur and 35kms from Jharsuguda, the district head quarter and trading centre in north western Odisha. After preliminary survey on the practices of farming through interaction with the farmers, Matrushakti SHG having around 12 women farmers as member was identified for exposing them with the demonstration of ornamental fish farming. The members of the SHGs were mainly from weaker sections of the society. The president of the group Mrs Puspamanjari Nayak and secretary Mrs Padmasini Nayak were very active and always motivate other members. Several village level training activities were conducted through screening of documentary films on successful farming practices, meetings and other related activities such as brood stock management, larval care, collection and production of natural foods, water management and management of production units were carried out for capacity

building among the participating women of the self-help groups. A two day exposure visit to CIFA was facilitated with the field work and practical aspect of ornamental fish farming. In addition, lectures were also delivered in local language to create interest in ornamental fish breeding and culture. In the meeting it was also decided that initially, the self-help group on their own expense has to invest some amount for a cement platform and few cement tanks under Public Private Partnership mode (PPP). Prior to the intervention, the self-help groups were advised to construct a cement platform of 7.5 x 5 m and six tanks each of 1.5 x 1 x 0.6 m. The construction work as per the required size was completed at a total expense of Rs. 12,000/- drawn from the savings of the self-help group. However CIFA provided eight rectangular FRP tanks of 450 liters capacity and a circular hatchery specially designed for breeding of fishes. The water from the open well is used directly for the purpose, however sometimes the bore well water is also used directly. Initially livebearers like guppies, sword tail, platys and mollies were introduced into the tanks. Before stocking all the species were kept for 2 minutes in potassium permanganate solution and then the fishes were segregated sex wise and stocked separately in the tanks. After attending the sexual maturity the fishes were kept in a common tank for breeding. The females were separated and then kept in the perforated basket inside the tank for escaping the young one from their mother to avoid cannibalism. Hatchlings were separated by fine meshed scoop net to another tank and the parent fish were maintained for the next breeding. The larvae produced from livebearers has been taken care by the farmer by feeding with low cost alternative live food like algae, water fleas, initially for one month and further readymade pellet carp floating feed containing 30% protein and 7% lipid. Since water scarcity is there in the region, a partial water exchange (10%) per week was done while siphoning the bottom faecal matters The tanks were provided with proper aeration through portable aerator which was provided to the unit during the period of culture. With the effort of SHG members and constant supervision all the works were performed efficiently.

Results

The approach of the study is participatory. The model yielded good results. The average temperature of the rearing water in the tanks varied from 18- 28$^{?}$C, pH 7.3-7.9 and alkalinity within the range of 120-152 mg/l. Analysis of physico-chemical parameters of water showed that they were within the permissible limits. The breeding performance of Molly, Guppy, Sword tail and Platy were satisfactory. Most live bearing species give birth to their young and the real skill lies in ensuring that the babies are not taken by the brood fish. Few works has been done regarding the involvement of women in ornamental fish culture, breeding, management and marketing (Ako *et al*., 2000; Sinha and Das, 2004; Mohapatra and Sardar, 2007 and Swain *et al*., 2011). The fish were sold at Rs. 5-7/- per piece as per demand and negotiation with the local traders. From this venture, the groups made a gross income of Rs. 13000/- in one breeding cycle. The result of economic analysis of ornamental fish farming indicates that low investment and quick return is possible within very short period. The

members spent on an average one hour in their ornamental unit. After continuous monitoring, the results indicated that their skills had been enhanced and each woman was able to earn a net income of Rs 500 per month from the activity. After each harvest of ornamental fish, the revenue was collected and deposited in the Group's account. From this it was found that, the Self-Help Group is a process oriented scheme which involves organization of rural poor, their training and capacity building to enable them to evolve into a self managed organization.

Conclusion

Ornamental fish farming can be a promising alternative for many people. It requires little space and less initial investment than most other forms of aquaculture. The profit of ornamental breeding and rearing unit depends on the carrying capacity, candidate species, management practices and infrastructure. Many of the members were housewives and they avoided in working as farm laborers in others field. Also the unit was located in their backyard so they do not have to move very far away to work along with their other household work. This gave them very good opportunity to work and make some income of their own.

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Measures relating to animal human healthcare interface - contemporary issues and evolving scenario

A. Sen, I. Shakuntala, R.G. Laha, S. Ghatak, Z.B. Dubal, K. Puro, R. Sanjukta, A. Ahuja and S.V. Ngachan
ICAR Research Complex for NEH, Umiam, Meghalaya

Introduction

Infectious diseases have shaped human history. They are dynamic, and will continue to influence where and how humans live—and human activities will alter the paths and expressions of infectious diseases. A broad range of societal, biological, and physicochemical factors influence the distribution, incidence, and burden from infectious diseases. In recent years, patterns of infectious disease have changed. These changes include the description of diseases caused by pathogens long present but not previously identified, recognition of seemingly new microbes, changes in old pathogens (for example, changes in distribution, incidence, virulence, resistance to drugs), new disease—disease interactions, and the spread to humans of organisms never previously known to be human pathogens. Although much media attention has focused on tropical, remote locations and on exotic viral infections such as Ebola, the changing pattern of infections involves all geographic regions and all classes of pathogen (such as viruses, bacteria, fungi, helminths [parasitic worms], and protozoa). Most of the major global causes of death from infectious disease are common, widely distributed infections, such as tuberculosis, measles, HIV, influenza, pneumococcus, and rotavirus.

Microbes

It is useful to take a broad view of microbial life before focusing on microbes that harm humans. Only a tiny fraction of microbes that exist on Earth have been identified and characterized. Of those identified, most do not infect humans; some are essential for shaping and sustaining life as we know it. Microbes are old, diverse, abundant, and resilient. They live in communities, send signals to communicate with each other, and change in response to changes in the environment. Microbial communities living deep in the Earth metabolize organic materials bound to rocks and sediments and shape the physical environment. Some microbes have short generation times (for example, twenty to thirty minutes for an organism like staphylococcus, compared with twenty to thirty years for a human), and hence can undergo rapid change. Such organisms change via mutation, but also by a variety of molecular maneuvers that involve acquisition and exchange of genetic information (for example, transfer, reassortment, recombination, conjugation, and so forth). These can alter microbial traits relevant to human health—virulence, resistance to drugs, and even transmissibility.

Changing patterns of infectious diseases

Infectious diseases have shaped the evolution and history of animal kingdom especially human and animals. Infectious diseases are dynamic and will always continue to influence the overall activities of human being in all the spheres of their lifestyle. It is very obvious by now that human activity will alter the paths and lexis of infectious diseases. The distribution, incidence, and burden due to infectious diseases are influenced by a range of societal, biological, and physicochemical factors. The pattern of infectious disease has been changing continuously which has been responsible for sustained microbial evolution. These changes include the description of diseases caused by pathogens long present but not previously identified, recognition of apparently new microbes, changes in epidemiology (e.g., changes in distribution, disease incidence, virulence of microbial strains, microbial resistance to drugs) of old pathogens, new disease—disease interactions, and the spread (to human/animals) of organisms never previously known to be human/animal pathogens.

The understanding of how these factors influence the emergence, re-emergence and spread of infections is of paramount importance in control and eradication of infectious diseases. The changing pattern of infectious disease is typically affected by interaction of multiple factors. The emergence/re-emergence of a disease could be an unintended consequence of many developmental activities which is perceived as progress. Various developmental activities which can be attributed to many ecological changes include: (i) building of a dam; (ii) clearing of lands; (iii) change in landscape, (iv) mass processing and wide distribution of foods and water; (v) medical/veterinary interventions (transfusions of blood/blood products; vaccines; animal feed containing livestock/fish/poultry offal); (vi) mass immunization; (vii) use of drugs and chemotherapeutics; (viii) use of antimicrobial agents; (ix) inland/national/international travel and trade; (x) changing pattern due to land use (intensive cropping, animal husbandry); (xi) indiscriminate use of fertilizers, insecticides, pesticides, hormones in agricultural operations, (xii) use of probiotics and unconventional feed additives in animal feeds and use of hormone injections (oxytocin) for realizing over production; (xiii) extensive mechanization of agricultural operations; (xiv) practice of extensive undefined livestock husbandry systems inappropriate to a particular region, state or a nation; (xv) international/inter-continental movement of migratory birds.

Factors contributing to change in disease pattern

Many factors are contributing to the changing patterns of infectious disease. Those commonly identified are microbial adaptation and change, human demographics and behavior, environmental changes, technology and economic development, breakdown in public health measures and surveillance, and international travel and commerce (Lederberg et al., 1992). How these influence the appearance, reappearance, and spread of infections will become apparent in the discussion of specific disease examples. Typically, multiple factors interact, leading to changes in a disease. The emergence of a disease may be an unintended consequence of what is viewed as progress: the building of a dam, clearing of

lands, mass processing and wide distribution of foods and water, medical interventions (namely, transfusions of blood and blood products, tissue and organ transplantation, cancer chemotherapy), and use of antimicrobial agents. The burden of disease in humans can increase through (i) increased contact between a pathogen (disease-causing agent) and host, (ii) increase in virulence or resistance of the pathogen, (iii) increase in the vulnerability of the host, or (iv) limited access to effective prevention or therapy. A human or a population can be completely or relatively invulnerable to some infections because of (i) immunity (past infection or immunization), (ii) genetic factors, or (iii) a whole range of barriers (such as shoes, screens, good housing) or (iv) interventions (for example, provision of clean water and adequate waste disposal, control of organisms responsible for transferring pathogens between hosts) that prevent contact between human and pathogen. Good nutrition, including adequate intake of micronutrients, can lead to an improved outcome in at least some infections.

Prioritization in National Emergency Disease Eradication Programmes

Much of the discussion has been based on the presumption that an emergency disease outbreak has been detected relatively early and is still only present in one or a few separate pockets. Many countries are not in this fortunate position and have to contend with an epidemic livestock disease that has become well established in the country, and may well have been present for a number of years. In these circumstances, commencing a national disease eradication campaign that covers the whole country at once may be neither practical nor wise. The spreading of resources too thinly over too large an area may result in overall setbacks and frustrations. It may be more effective in the long term to tackle the eradication in a step-by-step progression moving from one region to the next. In this case regions should be defined and selected on the basis that once eradication has been achieved in one region, and the campaign moves on to the next, there can be confidence that the disease will not re-enter the first region. Geographic barriers should be utilized wherever possible. In this respect, archipelago countries are fortunate in that the eradication can take place as an island-hopping campaign. Otherwise, utilization should be made of any epidemiological or livestock production and marketing patterns that tend to make an area a discrete unit in terms of disease spread. Next is the question of prioritization - which region(s) to tackle first. There is merit in selecting the major livestock breeding areas in the country since they are often important source areas for the disease, and livestock movements (and possibly infection) tend to spread centrifugally from there. The other advantage of tackling these areas first is that, when free, they will act as a valuable source of disease-free animals for restocking other areas. Further prioritization should also be based on an understanding of epidemiological factors and livestock production and marketing systems which influence how the disease spreads and to where. A policy could be to follow the spread of the disease, starting regional campaigns at its source and ending where it finishes. In tropical and semi-tropical countries, livestock movements and direct contact among animals are often overwhelmingly the most important method of spread of infection. Therefore a thorough

understanding of livestock movement patterns and routes is often vital for effective prioritization within epidemic disease eradication campaigns.

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Livelihood improvement through poultry and kitchen garden concept in Mon district of Nagaland

M. Alemla Ao, Pauline Alila and Medovi Chizo
School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema

Introduction

The Longwa village is one of the largest villages with a population of about 5000 under Mon district which is 42 km away from the district headquarter. It is located near the international border between Myanmar and India with an altitude of 1528 above sea level (MSL). The geographical location of the village is 26° 39' N latitude and 95° 12' E longitude. It gets an average annual rainfall of 280 cm, the relative humidity ranges between 40-80% and the mean temperature varies between 6°C – 28°C. Agriculture (Jhum cultivation) is the main stay. Malnutrition prevails in almost all the families. People mainly grow rice, millet, colocosia, maize and some vegetables. About 87% of the population is very poor and no technology was made available till National Agricultural Innovation Project (NAIP) intervened since the year 2008. Keeping in mind about their poor health condition, lack of proper nutrition and the suitability of agro climatic conditions of the village for growing vegetables and potatoes, suitable improved seeds of vegetables and potatoes were identified and introduced to 260 households covering an area of 10.7 ha with an objective to overcome malnourishment by making vegetables available throughout the year. The villagers were rearing local breed of poultry birds which were very small in size that could not give them any economic return. Therefore, improved breed of birds (croiler and vanaraja) were introduced to 80 households with an aim to generate income.

Methodology

At the beginning of the project in 2008, awareness and training programs were conducted. Simple trials were conducted at individual farmer's fields by introducing improved seeds of vegetables and potatoes to find out the most suitable variety to be grown in the village.

Among the vegetables, beans (Selection-1 and Anupam K5), chili (Selection PHS 21), tomato (Selection 451), radish (CCS Korea and Pusa Sweta) and knol khol (EWV) were identified as suitable for the village. Since then, each year these seeds are distributed to the households as summer and winter vegetable crops. A total of 260 households were covered with an area of 10.7 hectare.

Potato as a crop was not known to the villagers. However, after knowing that tuber crops such as Tapioca and Colocasia are popularly grown by them, seeds of three varieties of potato i.e. Kufri-Kanchan, Kufri-Jyoti and Kufri-Giriraj were procured from the Potato

Seed centre, Mao Gate, and introduced in the farmers' field during the month of October 2008. The main objective of introducing potato is to utilize the fallow *Jhum* land after harvest so as to get additional food with nutritional value for the farm families. Side by side, training was imparted on scientific package of practices such as spacing, planting method, pest and disease management of the introduced crops. Every year, potato seeds were distributed in the month of October covering a total of 109 households with an area of 17.68 hectares during the four years.

During the base line survey, it was observed that the villagers were rearing local poultry birds which were very small in size that even after one year, it could hardly weigh 1 kg or less. This could not give them any economic return. Therefore, 80 numbers of croiler chicks were distributed initially, but 60% mortality rate was observed. Though the mortality rate was high, the Longwa villagers were much impressed with the meat production within a span of five to six months. In 2010, another 500 numbers of Vanaraja were procured from the poultry farm, ICAR- Jharnapani and distributed to 50 families with 10 numbers each along with poultry feeds. Vanaraja could perform very well in terms of growth rate, meat and egg production and their adaptability to the village environment. Accordingly, to their increased demand, another batch of 500 chicks of Vanaraja had been distributed to more families during this year which are also performing very well.

Results

Among the different improved varieties of vegetables that were introduced, Beans (Selection 1, Anupam K5), Chilli (Selection PHS 21), Tomato (Selection 451), Radish (CCS Korea, Pusa sweta) and Knol khol (EWV) are performing very well. As expressed in table 2, total of Rs. 76996 (Rupees seventy six thousand nine hundred ninety six) only was incurred during the period of 2008-2011 for procurement of vegetable seeds while the gross return was estimated to be Rs.1, 95,451 (Rupees one lakh ninety five thousand four hundred fifty one) only, with a net profit of Rs. 1, 18,455 (Rupees one lakh eighteen thousand four hundred fifty five) only and exhibited cost: benefit ratio of 1:1.53.

All the three varieties of potato performed well, however, the performance of Kurfi Jyoti and Kurfi Kanchan were better in terms of production. A total expenditure of Rs. 1,73,000 (rupees one lakh seventy three thousand) only had been spent for the procurement of seed while the gross return was Rs. 3,18,746 (Rs. Three lakh eighteen thousand seven hundred forty six) only with a net profit of Rs. 1,45,746 (Rupees One lakh forty five thousand seven hundred forty six) only. The Cost: Benefit ratio had been calculated as 1:0.84 during the four years observation.

Altogether, 580 improved breed of croiler and Vanaraja (80 and 500, respectively) are introduced. The total cost was estimated to be Rs. 76,800 (Rupees seventy six thousand eight hundred) only, with a gross return of Rs. 1, 62,500 (Rupees one lakh sixty two thousand five hundred) only, exhibiting a cost: benefit ratio of 1:1.1.

Table 1 Cumulative results obtained during 2008-2012

Activities	Area (ha)	No. of households	Total cost (Rs)	Gross return(Rs)	Net profit (Rs)	Cost : Benefit ratio
Kitchen garden	10.07	260	76996.00	195451.00	118455.00	1:1.53
Potato	17.68	109	173000.0	318746.00	145746.00.	1:0.84
Backyard poultry	650 nos	80	76800.00	162500.00	85700.00	1:1.1

Table 3 Production/Productivity/Area

Activities	Area (ha)	Production (t)	Productivity (t/ha)
Kitchen garden	10.07	14.19	0.94
Potato	17.68	16.69	1.40
Backyard poultry	580 nos.	1.30	2.24 kg/bird

The above results indicate that, though the farmers are practicing agriculture as main profession since time immemorial, they did not know about cultivating those crops for their nutrition and to generate extra income. Also, they were keeping poultry birds at their homes which did not give them any economic benefit due to smallness in size. The outcome of the project clearly shows that through the project they become aware of cultivating the right variety of vegetables and also learned to use the space near their houses for growing vegetables including the fallow jhum land by cultivating potato after harvest and getting nutritional value as well as generate small income in the family. Through this, they learned entrepreneurial activities which were never practiced in the village as the production was not sufficient even to feed their family. In potato, the study revealed less benefit (1:0.84). This is because of high transportation charges for carrying seeds and stealing by children who roamed in and out of the village while babysitting their younger brothers and sisters. Potato is a new crop to them which develops curiosity in them and majority of the tubers are taken out by the children before maturity. This causes heavy crop losses every year in case of potato. However, it is hope that when the crop become popular, they will become use to it and stop this kind of activity. Besides, the project had trained them for seed storage which will lessen the cost expenditure.

Conclusion

For those people who were completely ignorant and their food sufficiency was not achieved even at house hold level, it is imperative to mention that NAIP had given them the breakthrough agricultural technologies which are very encouraging and will bring a lasting sustainability to this disadvantaged area.

Indigenous Technical Knowledge (ITKs) in Agriculture

Indigenous traps for the management of rodent outbreak in north eastern hill region of India

N.S. Azad Thakur, D.M. Firake, D. Kumar, G.T. Behere and Kanchan Saikia
ICAR Research Complex for North Eastern Hill Region, Umiam, Meghalaya

Introduction

Rodents are the most notorious vertebrate pest and frequently cause severe damage to almost all standing agricultural crops, stored food grains, grasses, fodder crops and other useful commodities. Annual losses caused by rodent's in commonly cultivated agricultural crops are in the range of 2 to 15% and sometimes up to 100% damage during outbreak situations (Islam et al., 1993). In general, bamboo flowering is considered as a harbinger of famine in North-East India. The popular belief is that the gregarious flowering of bamboo produces large quantities of seeds, resulting in a population explosion of rats which feed upon other food commodities, thus damaging stored produce leading to famine (John and Nadgauda, 2002). Lesser Indian mole rat (*Bandicota bengalenis*), common house rat (*Rattus rattus*), himalayan rat (*Rattus nitidu*) and house mouse (*Mus musculus*) are the predominant rodent species of North-East India (Anonymous, 2008).Tribal communities of the region have been using various methods of rodent management since longer time. Among all, rat traps are the most important tool of rodent management. Trapping rat is an age old method which is ecologically sound and environment friendly. Moreover, different chemical baits are available in the market and are also been provided by the government agencies during outbreak period; where they play additional role in rodent management. However, frequent rainfall situations in the region not only destroy the baits and its effectiveness but also increase the chances of poisoning to the non target organisms. Under such circumstances, locally made bait stations/containers play significant role by protecting the bait from heavy rain as well as weathering, and ultimately improve their efficacy. Additionally, it also reduces the chances of non target poisoning. Thus, attempts were made to collect information on different indigenous traps and bait stations and also to evaluate their effectiveness at different locations in the region.

Methodology

All eight districts of Mizoram state were surveyed during 2004 to 2008 (during recent bamboo flowering). Further, indigenous traps and bait stations were collected from the region and brought to the laboratory. As per farmer's perception, most popular and effective traps (viz., *Vaithang* and *Chepthang*) were selected for their evaluation along with conventional traps (Sherman's and Snap traps) at different locations in Mizoram. Different bait stations/ bait container were also evaluated for their efficacy. Three most widely used

rodenticides viz., Bromadiolone, Coumatetralyl and Zinc phosphide were selected for the study. Common baits (consisting boiled rice+ jaggery+ mustard oil + rodenticide) were kept inside the indigenous bait containers as well as in bare conditions (on plant leaves) during night time.

Results

Survey on identification of different indigenous rat traps in Mizoram

Indigenous traps, *Vaithang* and *Chepthang* or *Thangchep* were observed to be common and widely used by the farmers in different agro-ecological systems. In addition to that, two more traps, *Hnawhtawt* and *Chehrap* or *Kharkhip* or *Kawlper* were also used by farmers. However, later two rat traps were not found popular and efficient during outbreak period. Therefore, their use was limited and mostly during dearth period of rodents.

Evaluation of indigenous traps at different locations of Mizoram

Among all, the *Vaithang* trap was found to be highly efficient (70 to 90 %) at different places followed by *Chepthang* trap (50 to 80%); whereas the Sherman's traps (10 to 20%) and Snap traps (10 to 30 %) were observed to be far inferior in comparison with indigenous traps (Table 1).

Table 1 Evaluation of conventional and indigenous traps in Mizoram

Name of trap	Per cent rat trapping (Mean±SE) in different villages			
	Tawipui south	Theiriat	Thualthu	Chengoui
Vaithang trap	85±2.89[a]	70±5.77[a]	90±2.89[a]	80±5.77[a]
Chepthang trap	70±5.77[a]	50±5.77[a]	80±2.89[a]	70±5.77[a]
Snap Trap	30±5.77[b]	20±5.77[b]	20±5.77[b]	10±0.00[b]
Shermans Trap	20±5.77[b]	20±5.77[b]	10±5.77[b]	20±5.77[b]
F Value	35.92	18.00	80.00	49.33
P value	<0.001	<0.001	<0.001	<0.001

Note: Figures with different letters are significantly different (Tukey's HSD test, P=0.05)

Survey on identification of different indigenous rat bait stations /bait containers of Mizoram

Local people were found to use indigenously available items like hollow bamboo pieces, broken pitchers and coconut shells etc. for the purpose of bait containers. Normally, the size of different bait stations was about 1 to 1.5 feet long and 6-11 cm in diameter.

Evaluation of different bait stations under field conditions

Consumption of rodenticides using bamboo bait station was significantly higher compared to bait on plant leaves (common method) (Table 2). Consumption of bromadiolone

and coumatetralyl by using bamboo bait station was found to be highest (46.17% and 54.14%, respectively); while it was lowest in case of placement on plant leaves (38.05% and 43.00%, respectively). Similar trend was also observed in zinc phosphide bait.

Table 2 Evaluation of different bait stations under field conditions

Treatment	Bait consumption (%)		
	Bromadiolone bait	Coumatetralyl bait	Zinc phosphide bait
Bait inside bamboo bait station	46.17	54.14	29.08
Bait on plant leaves	38.05	43.00	17.23
'T' value	79.37	9.62	21.64
P value	<0.001	<0.001	<0.001

Conclusion

Present study concludes that the tribal communities of North East India have developed most efficient rodent traps and bait stations based on their longstanding experiences. Therefore, basic idea and design behind these indigenous creations could be utilized in future to formulate new improved traps, which can be further commercialized.

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Zabo and *Panikheti*- resource conserving farming systems for optimal utilization of water and land resources for livelihood improvement in Nagaland

A.K. Tripathi, A. Roy, Seeralan, S. and N. Uttam Singh
ICAR Research Complex for NEH Region, Umiam, Meghalaya.

Introduction

In the last two decades, the emphasis has been given in agriculture policy to increase the productivity of rainfed are through the optimum use of water. Watershed approach major programme implemented by various development agencies had little impacts. In spite of that huge amount has been spent by various development agencies. Desired results could not be obtained due to absence of appropriate extension strategies and technologies. The programme could not reach to masses mainly because of lack of participation of the people. As agriculture production system in rainfed area is very complex in nature and subsistence level, there is a need to design appropriate strategy. A suitable strategy for this area could be evolved with the involvement of the people by incorporating their wisdom and practices in the programme, which was developed after a long informal experimentation and every farmers would accept the innovative ideas. Several knowledge and practices are available throughout the country developed by the farmers over the period found more suitable as appropriate technology could be integrated as extension tools. North Eastern Region where agriculture is mostly rainfed and mono cropped, this strategy could be more beneficial, for utilizing natural resources for optimal use of water for diversifying agriculture.

Features of *Zabo* Production System

Zabo an indigenous farming system practiced in Phek district of Nagaland which had tried to combine land and water management in such a manner that it take care of forest, agriculture and animal husbandry simultaneously. The main factors which affects the success of the system is guided by the demand driven forces as its location is coming under rain-shadow zone. To meet the altogether requirement from human being to livestock, they adopted a suitable method of water conservation through informal institutional setup. It helps not only the food security of the farm households but also reduces dependence on external inputs to sustain their food requirement. This system include all important scientific component of natural resources management and deals with social and economical issues, which have great relevance to develop need-based strategy for increasing food production in Nagaland. The systems maintain the soil fertility through azolla culture and incorporation of legumes at the time of puddling. It directly helps to minimize the dependency on external inputs such as fertilizer. Another unique feature of the system is that helps them to settle

their cultivation and meet all kinds of food requirement through mixed farming thereby minimizes the farmer's risk. This system is found to be eco-friendly and meet the local requirement, hence there is urgent need to give more impetus to popularize these system in other part of the country having same location specificity. It is clear from case study that the system is based on the local knowledge that will have greater relevance for solving food security crisis through the optimum use of water resources.

Features of *Panikheti* Production System

First to scrap and make the *heap* of the topsoil on various places in the plots followed by ploughing in the rest area. Farmers believe that *Albizia tree* in the bund of the paddy fields helps to build up the fertility in their field. Collection of first runoff water, which carries humus, is the prime desire of every farmer. The farmers through the community participation check the loss of water due to seepage or leaching in terrace. The farmers maintain the fertility by incorporating the legume crop during time of puddling. The farmers are not using any external inputs (fertilizers, insecticides) and maintain fertility through locally available plant biomass and with their innovative ideas like growing alder trees, which provide the nitrogen to the field crop. Protected forest is playing a vital role around the valley that produces large quantity of biomass and increasing the efficiency of soil for retention of moisture resulting to boost up the ground water level towards surface. In the less fertile land, the indigenous method of fertilizer application technique is to use the dung ball, which is generally prepared by mixing paddy husk with animal excreta before/after transplanting (30-40days). In the absence of dung, black soil is used for dung ball preparation. Paddy is major crop grown during *kharif* season; most of the variety is local yielding 1.5-2.0 t/ha.

Nutritional Status and Food Security

The per capita consumption of rice in *Panikheti* system (Khonama) village was recorded as high as 600 g/ day whereas, in *Zabo* system (Kikruma village) it was worked out to be only 359-g/ day. Similarly the average per capita consumption of meat per day in *Panikheti* (Khonama village) was estimated to be 60 g against 17 g in *Zabo* system. In contrary, consumption of vegetable was quite high (577 g) in *Zabo* system compared to *Panikheti* system (115 g/day). It is interesting to observe that fish consumption was 3.6 kg/ year in *Zabo* system mainly because the availability of fish within the system. In *Panikheti* system the fish consumption found to be negligible. However, the farmers of this system compensate their nutritional requirement taking egg, which was estimated to be 60 no/year. The average per capita investment on food in *Zabo* system estimated to be Rs. 2675/year, whereas, the investment on food in *Panikheti* system was recorded to be Rs. 5777/year. The per capita investment of food items in *Zabo* system was Rs. 2615, in which 55.5 % spent on rice followed 20.57 % on meat, egg, fish and 7.78 % on vegetables. In *Panikheti* share of food items was less than *Zabo* system (51.76). But in this system the farmers spent one-

third percentages on meat and egg. Consumption of vegetables was found to be negligible in *Panikheti* system compared to the *Zabo* system were the farmers spent sufficient amount on vegetables. Though the per capita investment on food was higher in *Panikheti* but the *Zabo* system is found to be more balanced since their consumption pattern found to be nearer to balanced diet.

Conclusion

Study on economic assessment of indigenous farming systems, conducted in Nagaland indicated that all the existing farming systems are economically viable and operating at subsistence level. The *Zabo* system in Nagaland was considered as the most resource conserving farming system that utilizes natural resources in an efficient manner. Adoption of *Zabo* system in the study area indicates that village institutions have played better role in afforestation, sharing of water resources and reducing jhum area. The system can be replicated with certain modifications by integrating with the improved technologies for sustainable livelihood.

Bamboo based household products used in agri-allied sectors in Dhalai, Tripura

Ratan K. Saha and Dilip Nath
College of Fisheries, Central Agricultural University, Lembucherra, Agartala, Tripura

Introduction

Indigenous knowledge is the knowledge of the indigenous people inhabiting different geographical regions of the world with their own language, culture, tradition, belief, folklore, rites and rituals. As such, scientist in this knowledge base economy who are in research of new ideas and innovations expect that indigenous knowledge may hold significant message which may be of use to remedy the deficiencies in modern agricultural and environment related issues. There is a need for studying and documenting traditional knowledge in different ecological and cultural environments. Several researchers are working on ITK in different fields of agriculture and allied sectors. Keeping the above statements in view the present paper has emphasized on some indigenous knowledge based products of the rural people of Dhalai district of Tripura. The study was carried out during 2009-2011.

Methodology

The study was conducted in the selected villages of two clusters of, *viz.* Balaram and Maracherra in Dhalai district of Tripura. Participatory Rural Appraisal (PRA) methodology was adopted to identify and description about the traditional practices of fish farmers that are prevalent in the selected villages. Questionnaire was made in local language to communicate with the villagers after the direct observation in field. Secondary data on this traditional knowledge based practice were also collected through focused group discussion. By contracting the discussion methods the indigenous practices of bamboo based household products used by the farmers were documented.

Results

Indigenous methods practiced by villagers on bamboo based household products of Dhalai district were identified and described below:

Kula (Bamboo winnower)

It is used in cleaning and winnowing pulse grains. Highly preferred for its shape and varied utilities in crops such as pulses, cereals, millets and oilseeds. It is made up of bamboo stick and cane which is coated with cow dung paste to fill up the holes/gaps. It is U-shaped and has a length, breadth and depth is 50 cm, 40 cm and 3.5 cm respectively. Operated generally by household women, its average life span is 2 years and cost is Rs.50/unit.

Chalni (Bamboo sieve)

It is used in cleaning and sieving the rice and pulses. The tool is used for separating the unsplitted full grains from the spitted pulse grains. Also removes stones and other wastes.

The base area is 100- 110 cm in diameter and height 3.5 cm. The base has numerous rectangular grids of 4 mm diameter. Operated generally by household women, its average life span is 10 years and cost is Rs.80 /unit.

Tukri (Bamboo pan)

It is made up of bamboo cane and the open mouth is bonded tightly by bamboo stick. The base is rectangular in shape and 80 cm in diameter whereas the mouth is open, round shaped and 180 cm in diameter. Sometimes it is coated with cow dung paste to fill up the holes/gaps. It is mainly used for the collection of plant products and broadcasting of seeds. Another type of *tukri* which is used to carry soil by the earth worker after the soil excavation by manually. Two hard bamboo stick is fitted tightly at open mouth in opposite direction. It has depth of 90 cm. Both men and women operate it. Handling and transportation of FYM and grains are made easier and quicker with help of the tool. Average life span is 1- 2 years and costs Rs. 50-80 /unit.

Hukka (Smoking tool)

It is made by two bamboo pipe- one is comparatively large and broad in size and another one is small and short. The broader bamboo pipe is used as base whose lower portion is closed and upper portion is being opened. One hole is made on the lower half part of the larger bamboo pipe were the smaller pipe is inserted which is fixed tightly. Water is filled at the lower portion of the main bamboo pipe and another tool locally known as chilim which is filled with the paste of tobacco and jiggery mixture. The ash made tablet called tikki is kept above tobacco paste which is burned. The smokers used to smoke on the open mouth of the larger bamboo pipe. Its life span is 5 to 10 years and not made for sale.

Khara (bamboo bucket)

It is made up of bamboo cane and the open mouth is bonded tightly by bamboo stick. The base is rectangular in shape and 80 cm in diameter whereas the mouth is open, round shaped and 120 cm in diameter. It is mainly used for the collection of plant products, vegetable, fruits, rice straw, etc. Both men and women rural villagers of all the tribal communities of Tripura operate it. One jute belt is fitted with it for easy operation. The belt is fitted with head and the bucket is hanged on backae. Handling and transportation of FYM and grains are made easier and quicker with help of the tool. Average life span is 1- 2 years and costs Rs. 100-120 /unit.

Conclusion

The above findings may be helpful for the researcher as well as the local farmers in different ways. It will help the researcher to make database on indigenous technical knowledge on bamboo based household products. It can also help to categorize the available bio-resources in local area. It may also help for the preparation of people's biodiversity register which can protect the IPR issues for future uses. Furthermore, the study may help the improvement of livelihood of the rural farmers of this district, if it would be encouraged in a scientific manner. These traditional knowledge based practices of this area are low cost, more profitable and eco-friendly sustainable.

Studies on ethno-veterinary plants used by Lepcha community in Sikkim

A.K. Mohanty, Ashok Kumar, B.G. Nath, B. Lepcha and P.K. Pathak
ICAR Research Complex for NEH Region, Sikkim Centre, Sikkim

Introduction

The documentation and scientific validation of indigenous traditional knowledge on ethno-medicinal use of various locally available plant resources has been realized to be very important to make the way for discovery of drugs for veterinary usage (Rana *et al*, 2010). The tiny state Sikkim, nestled in the lap of eastern Himalayan region, a hotspot of rich biodiversity with a total geographical area of 7096 km^2, is considered to be a rich repository of medicinal plants nurturing several distinct ethno-medicinal practices through ages. The state of Sikkim is inhabited by various ethnic tribes like *Bhutias, Lepchas, Nimbus, Nepalese,* mainly dependent upon agriculture and animal husbandry for their livelihood sustenance. *Lepchas* are considered as very autochthones of Sikkim. *Lepchas* of Dzongu are known for their rich cultural heritage. Animal rearing is the integral part of subsistence economy in this Himalayan region and the dependency on livestock is increasing with increase in altitude. But due to high cost and non-availability of veterinary facility, the *Lepchas* use some locally available native plants for their livestock treatment, which are based on their traditional know-how and cultural heritage. Besides over the ages, Sikkim has developed rich traditional practices of folk medicines. The traditional knowledge of Himalayan ethnic groups about the ethno-medicine is very ancient and had always played pivotal role in discovery of novel products. Hence it is urgent need to explore the ethnoveterinary plant resources used by the *Lepcha* community of Dzongu biosphere reserve through identification, scientific validation and testing the reliability of the traditional knowledge for better farming.

Methodology

Initially a PRA survey was conducted in the *Lepcha* dominated area to know about the prevailing ITKs of the region through ITK mapping and to assess the availability of local indigenous ethno-veterinary plants. A base line survey was conducted in the villages of Dzongu area through a tailor made interview schedule to collect information about traditional knowledge regrading use of plants resources and their products for veterinary treatment. The respondents were comprised of local herbalists, farmers, village headman, and elderly person of the villages between 25- 75 age groups. The respondents were selected on the basis of their recognition having knowledge concerning folk medicines used for livestock treatment. With the prior consent of respondents for recording the information, they were asked about the plant parts used for livestock treatment, mode of preparation of

folk remedies and the dose and time of administering the folk medicines that have been acquired through parental heritage. The information on ethnoveterinary therauptics collected by use of interview schedule were identified and validated through review of literature. Information thus rcorded were verified through visit to the study sites.

Results

The study documented a total of 23 ethno-medicinal plants as veterinary therapeutics mostly used by *Lepcha* tribe of Dzongu area (Table 1). A precise account of the ethno-medicinal plants is enumerated with their local name, scientific name, family, parts used and their utility in veterinary practices. In terms of number of species used, *Solanaceae* appeared as the most prominent family (3 nos.) followed by *Poaceae* family (2nos.) whereas rest 18 nos. of ethno-medicinal plants are from different families. Regarding the plant parts used for ethno- medicinal property, *Lepcha* tribe of North Sikkim use maximum number of leaf parts (7 nos.) as folk medicines followed by roots (6 nos.) and fruits (2 nos.). The total 23 medicinal plants recorded in North Sikkim, are used to control 16 different ailments, out of which 4 plants are used for treatment of poisoning, 3 plants for diarrhoea and 2 plants for treatment of reproductive disorder.

Some of the ethnoveterinary plants have been validated through review studies and local enquiry. The study documented that the people of Dzongu biosphere reserve used tender leaves and floral parts of *Urtica dioica* (Sisno) plant after boiling for controlling the blood pressure. This similar treatment is also used in Eastern Nepal (Rai, 2003), South Sikkim (Idrisi *et al*, 2010) and Darjeeling (Bantwa and Rai, 2009). In the poultry house, ferns and tobacco powder are used to reduce the infestation of poultry lice. Farmers of Tamer, Arki and Angara blocks of Ranchi district of Jharkhand state also use tobacco shoot with kerosene oil for controlling ectoparasite (Kumar and Singh, 2011). Freshly crush leaves of *Artemisia vulgaris* (Titepathi) are kept in nose to prevent bleeding is a treatment practice used by *Lepcha* community of Dzongu area and the same therauptic practice also reported earlier in South Sikkim (Idrisi *et al*, 2010). Shoots of *Artemisia vulgaris* are consumed in case of mouth ulcer and leaves are crushed and applied externally on forehead during dizziness and headache (Bantwa and Rai, 2009). The raw seed of *Dhatura metal* (Dhatura) is used as a medicine of dog bite which is also practiced by the *Lepcha* community of South Sikkim (Rai, 2003). Besides the treatment of dog bite, dhatura is also used for the treatment of nervousness, nausea, and hysteria. Extract of *Rhus semialata* (Bhakimlo) fruit is used as treatment for stomach poisoning in the study area. Many plant species are used for treatment in various disorders. Such indigenous knowledge indicates that local communities in study area have been able to carry this ancient wisdom. Due to poor road connectivity and inadequate facilities in veterinary health service sector the people of this area faced problem during treatment of animal. For this reason, the *Lepcha* communities still depend on various medicinal plants for treatment in most of the diseases.

Table 1 Ethno-veterinary uses of plant resources of Sikkim Himalayan regions

Local name	Scientific Name	Part used	Disease/ ailments cured or treated
Titepathi	*Artemisia vulgaris*	Leaf	It is used to prevent bleeding from nose
Phul tarul	*Canna* spp.	Rhizome	It is fed to pig after boiling properly during lean period (Dec – May)
Gaza	*Canabis indica*	Leaf	Chopped and dried leaves along with mineral feeds are fed to animals to treat non specific diarrhea.
Dalley khursani	*Capsicum frutescens* L.	Fruit	Dried dalley chilli and spider after grinding fed to poultry chicks to minimize swelling in the body.
Bhui champa	*Clematis* spp	Root	Crushed roots are tied on the fractured bones for curing the fractured parts
Dhatura	*Dhatura metal* L.	Seed	Used as a medicine on dog bite
Angeri	*Lyonia avalifolia*	Leaf	It is fed with sugar syrup when cattle poisoned by consumption of tender leaves of certain plants such as tapioca (*Manihot sp.).* Tender leaves are crushed and applied locally to treat scabies in animal
Kurkus	*Millettia pachycarpa* Bentham	Root	The juice extracted from the crushed roots of kurkus is used in fishing (Its effect is drowsiness in fishes)
Bhakimlo	*Rhus semialata* Murr.	Fruit	The diluted extract of this local fruit after boiling in copper utensil is used to control stomach poisoning which is developed due to feeding of the tender leaves of Siris plant and tapioca plant.
Sisno	*Urtica dioica* Linn.	Leaf, shoot	Tender leaves and floral parts of this plant consume after boiling to reduce high blood pressure
Maize	*Zea mays*	Cob	Animals affected with oral poisoning are get cured if they are fed with burnt ashes of green maize cob.
Tobacco	*Nicotiana tabacum* L.	Leaf	Spreading the ferns and tobacco powder in the poultry house to reduce the infestation of poultry lice (Ectoparasite).
Ukhu-ko patta	*Saccharum officinarum*	Leaf	Uncut long leaves of sugarcane are used for placental removal in livestock
Pharsi/Kadu	*Cucurbita maxima*	Stem	Paste of pumkin stem are applied over udder to treat early stage of mastitis
Pyaja	*Allium cepa*	Bulb	50 g of black salt and 50 g of onion paste mixture is fed twice a day to prevent non specific diarrhea in animal
Tamarke	*Stephania glabra*	Tuber	Tamakre used as a water trough to improve immune system of animal
Abhijalo	*Drymaria sp.*	Root	Used for treatment for herb poisoning
Aselu/Tolu	*Rubus ellipticus*	Branch	It combats common cold and infectious fever
Seto saro	*Hedychium spicatum*	Root	Used against blood coagulation in the blood vessels that hinder the flow of blood
Hokling	*Phytolacca acinosa*	Root	Beneficial for treating fever and pain
Dhupi	*Juniperus squamata*	Leaf	Used against the diseases of the kidneys
Kutki	*Picrorhiza kurroa*	Leaf	Used for the treatment of diarrhoea
Hathijara/ Panchaunle	*Dactylorhiza hetegirea*	Root	Used for the treatment of infertility and impotence or reproductive tract

Conclusion

The rich diversity of phytoresources used by the *Lepcha* community in Sikkim Himalayan biosphere needs to be scanned judiciously for their health and sustenance. Since exploitation of plant diversity resources in entire Sikkim Himalayan region has gone up to alarming level and many of the medicinally useful local plant species have been depleted drastically, their conservation has become utmost concern. The present study of ethno-medicinal plants used as traditional method of veterinary treatment deals with 23 plant species from 20 families having 17 different ethno-veterinary uses, which indicate the ethno-veterinary wealth of Sikkim. The present study suggests for an urgent need to explore ethnomedicinal plants of the area, extensively, covering additional villages, to identify more plants of pharmaceutical value, to make scientific evaluation of these folk medicine plants and to study their pharmacodynamics. Further, more research efforts are required to strengthen community based conservation as well as community based commercial ventures, which would not only provide income to local communities of the area but also help in conservation of these valuable bio-resources.

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Indigenous Technical Knowledge on Ethno-veterinary Medicine and Soil and Water Conservation in Saiha, Mizoaram

Y. Ramakrishna, S.B. Singh, M. Chinlampianga, B.K. Singh, T. Boopathi, K. Rajasekar, A.K.R. Singh, S.K. Dutta and K.A. Pathak
ICAR Research Complex for NEH Region, Mizoram Centre, Mizoram

Introduction

The Farmers of Mizoram have been practicing various ethno-veterinary medicine and indigenous technical knowledge for soil and water conservation from centuries. Such knowledge needs to be documented and evaluated for their validation for further fine tuning and up-scaling. Under NAIP-3, an effort was made to collect such ITKs for their validation and up-scaling.

Methodology

Information on various ethno-veterinary medicine and indigenous technical knowledge for soil and water conservation were collected through extensive field visit and interaction with the farmers using a semi-structured questionnaire.

Results

Ethno-veterinary medicine practiced by Paihte community in Mizoram

1. Scientific name : *Hystrix indica* Kerr., Common Name: Indian porcupine, Local (Mizo) Name: Sa-kuh.

Part used: Intestine & Rectum

Mode of use and application: About 2-5 g of intestine & rectum (dried) make into powder form and mixed with water (about 30 ml). The mixture is given orally to poultry for prevention as well as treatment of any diseases associated with poultry. It was reported to be effective in curing common bird flu. The drug is given twice or thrice daily depending upon severity and may be continued for 3 consecutive days from the first day. The same drug is also used for treating diarrhea and swine fever.

2. Scientific name: *Manis crassicaudata* Gray, Common name: Indian Pangolin, Local (Mizo) name: Saphu,

Part used: scale/feathers

Mode of use and Application: Inhaling the burning smoke of scale/feathers (1 no at a time) given for those pig not taking food properly and lacking appetite. The drug is given twice a day and may continue for 3 days. It was reported to be effective in recovering the pig which did not take any food from 2-3 days back.

Note: Any aquatic animals like crab, fish, etc are not given to swine during pregnancy. As it is believed to cause abortion or death of piglets before delivery.

3. Scientific name: *Python molursus Linn.*Common Name: Python,Local (Mizo) Name: Sa-phai

Part used: Fatty substance/ fatty oil

Mode of use and Application: The fatty oil is smear on the cut or wound portion on any domestic animals to prevent from housefly attack (which lay egg/maggot) as well as antiseptic. It is more effective than Himax.

4. Scientific name: *Calotes sp.* Common name: LizardLocal (Mizo) name: Laiking

Part used: Whole body

Mode of use and application: The live or death body after fire or without putting over fire is given to pig having cough. There is no limit in nos. and dose

Indigenous Soil Water Conservation Practices

Bamboo irrigation system

Perennial spring water sources in hill of Mizoram are available in few places only, these water are diverted for irrigation or house hold purpose. Bamboos are used to divert perennial springs on the hilltops to the lower reaches through gravitational force. The channel sections made of bamboo divert and convey water to desire field or collected in tank for redistribution. Conveyance of water through bamboos was done first by selecting similar width/size bamboos. The preferred spices are phulra (*Dendrocalamus hamiltonii*) and Mautak (M*elocanna baccifera*). Conveyance systems are formed in two ways, first in semi circle and other in circle format.

For making semi circle type, Phulrua (*Dendrocalamus hamiltonii) and* Mautak (*Melocanna baccifera)* types bamboo are mostly preferred as it is easy to split open and amendable. The bamboo is cut horizontally along the length and split open into two equal half. Nodes are removed with help of (tuikawa) local implement and smoothening was done for uninterrupted flow of water. The bamboo channels were place on the 'X' mark frame. The base of the frame (X shape) are firmly planted/ placed on the ground and channels are placed on the interception point and tied firmly with help of bamboo rope/stripe. The lower node side of the frames is used as starting/collecting point. The boarder end of second bamboo is tied first fallow towards narrow side. The subsequent boarder ends are tied to the previous bamboo's narrow ends. The elevation difference between two points of the single frame channels should be around 20-30cm, if more than 45 cm water, will spill out and if slope is less then there will be possibility of back flow. To change the direction of the channel or for distribution of channels the frames are separated and water will be pass through a permanent or temporary bamboo channels based upon the requirement. The total unit last for 2-3 year and can be easily repairable at any level.

In circle format, bamboos are made to pipe like structure. For this purpose well developed uniformed diameter near stem node of D*endrocalamus longispathus* and D*endrocalamus manipureanus* are generally use. A 3-5 cm hole is made on the node area

first with the help of hand saw by making two small cut, the cord length of the cut will be of 3-5 cm, then with chisel node area will be cut open and later smoothen the node area. Similarly all the node of the bamboo, it will like a pipe with hole on the node area and in one direction of bamboo.

Leaf pruning and mulching

During the month of July and august month, when the rainfall is high, the old leaves are pruned and spread over the field. Removal of old leaves allow more aeration, help to grow fresh leaves and fruiting parts. In banana and sugarcane crops old leaves are removed and placed near the root zone during the month of December and January. It act as mulch and later improve fertility of soil.

Measuring soil moisture

Knowledge of soil moisture to optimize the water requirement at various stages crop growth period and other activity is important. Though the rainfall occurrence is high for five months but crop production during the rabi season is very difficult due to scarcity of soil moisture. Local people know the soil moisture content by lifting any rock with size of 15-10 cm in dimension. The moisture content of soil is directly correlated with the moisture content of the root zone. This also helps in scheduling irrigation in field crops and plantation crops.

Dead furrow

Dead furrows were formed at an interval of 10-15 metres depending upon the slope. This reduces the velocity of runoff, safe disposal through one end of the field and safe accumulation of eroded soil.

Rice-fish-livestock-vegetable farming systems of north east India: rich heritage for resource conservation and livelihood improvement

Anup Das, M. Datta, I.M. Singh, Ramkrushna G.I., Krishnappa R., Jayanta Layek and *Supriya Das

ICAR Research Complex for NEH Region, Umiam, Meghalaya

*Government Degree College, Dharmanagar, Tripura

Introduction

Rice is the major staple food of the people of north eastern part of India. Almost all social and cultural activities are directly or indirectly related to rice and rice season. Almost 100% farmers grow rice and rice is cultivated in about 80% of gross cultivated area. They cultivate rice by wisdom and tradition for subsistence. Entire livelihood is dependent on rice based farming systems. A good rice crop brings smile to the family and locality and a poor crop brings misery and makes farmers debt ridden. Each and every part of rice plant is having economical and social significance. Grain is the staple food for human, husk, and bran as livestock feeds, straw is used for making the roof, bedding materials for livestocks and main cattle feed during dry season, straw is used for cooking, used as binding materials and mud plastering of houses and so on. Practically rice and rice products are the main food items during breakfast, lunch as well as dinner. Needless to say that majority of the population takes 3 meals of rice a day. Rice beer and delicious rice products (locally called *Pitha*) during New Year and *Makar Shakranti* are other significant use of rice in the region. There is wide diversity of rice such as sticky, aromatic, colorful, short, long etc. and each one of them is having a particular use. Some of the important local rice varieties are *kalikhasa*, *harinarayan* (Tripura), purple and sticky rice (Manipur), *Joha* (Assam), *Attey* (Sikkim) etc. At least 10% of available land area is given for water harvesting for life saving irrigation during dry season and most importantly for growing fish and domestic use. The pond may be in one corner, in one side or even in the middle of rice field. It is again a common practice to have one or two ponds either at the front or any side of the home yard. A meal of 'rice with fish' is the most cherished food of the people of the region. Low land rice fields are major ecosystem for growth of indigenous fish and it is an accepted fact that the demand and taste of indigenous fish are much better than the improved fishes. Rice ecosystem is also the major habitant for edible snails, roots etc. that sustains the lives of millions in the region. Woman buy daily food items (popped rice, parched rice, fermented fish, other edible), domestic items (utensils, cloths), toys for children, etc. in exchange of rice grain from vendors.

Methodology

Extensive field visits were undertaken for collection of basic information from farmers field. Wherever required, soil/plant samples were collected. In the plains of Tripura, Assam,

Manipur, parts of Garo Hills, Megghalaya etc, it is a common practice of following rice-fallow or rice-rice systems from centuries. The first rice is grown during May to August (*Aus* Season) and the second one during August to November (*Sali* rice). Boro rice (Nov/ Dec to Feb/March) is also practiced by farmers having irrigation facilities. It is a common practice to leave at least 50 to 60% residues/standing stubbles in the field. The field is immediately ploughed and the straw is incorporated and second rice is transplanted. During following years, the field is ploughed immediately after receiving first rain during March-April incorporating all the residues and manures into the soil. It is a common practice to apply some FYM/manure/oil cakes etc. once in 2-3 years in rice fields, as per the availability. The final ploughing is done about 20 to 30 days after first ploughing, providing sufficient time to decompose the entire weed and crop biomass along with organic manure. In this way, the problem of weeds also managed to a great extent especially during initial growth period of rice.

It is an added advantages that all the farmers' rear livestocks like local breeds of cow (2-3 nos), goats (3-4 Nos.) and ducks (5-8 Nos). Some farmers keep buffalo (1-2 nos), poultry (4-5 nos), pigeon etc. All these livestock contributes to the organic manure stock of the farmers. Vegetables like colocasia, *bhindi*, amaranthus, brinjal, cucurbits, etc. grown during rainy season and potato, sweet gourd, *pai sag*, cole crops etc are grown during winter season in uplands (about 15-20% of the land). Bottle gourd, lablab bean, sweet gourd etc are grown on pond dyke and over the water bodies with support provided with locally available materials like bamboo, tree branches etc**.** On the other hand some farmers grow ash gourd, lablab bean, pumpkin, etc. near the main house, allow the vines to climb and spread over the roof of the houses**.** Kitchen gardening is also very common and nutrient requirement of kitchen gardens are met from the wastage of kitchen and litters/ washings from animal sheds.

Results

Nutrient cycling in traditional rice farming

The recycling of straw in the field (about 5t/ha dry matter/ rice season on dry weight basis) contributes about 40 kg N, 11 kg P_2O_5 and 80 kg K_2O/ha considering N: P_2O_5: K_2O content of 0.63, 0.19 and 1.38%, respectively. Similarly, from recycling of weed biomass (about 3t/ha/rice season on dry weight basis) it is possible to supply about 45 kg N, 6 kg P_2O_5 and 37 kg K_2O/ha kg /ha considering N: P_2O_5: K_2O content of weed biomass 1.50, 0.19 and 1.22%, respectively. Thus, in a single rice growing season of about 130 days, it is possible to recycle about 80 kg N, 17 kg P_2O_5 and 117 kg K_2O/ha (Das et al. 2008). Besides, it is a common practice to let leave livestocks viz., cows, buffaloes, goats and sheeps in the paddy field during dry season where a lot of dung is deposited in the field and contributes to soil fertility. The amount of animal excreta may vary from 1 to 5 t/ha depending upon the location, type of animal grazed in the field and duration for which animal is allowed to graze in the field. The amount of N, P and K added through such animal grazing is about 20-25 kg/ha. Thus, the amount of nutrient available in rice field is almost sufficient for a good

rice crop. The urine of animals is collected in-*situ* in the field, which is very rich in nitrogen (0.40%) and potassium (1.35%) (Das et al, 2012). The biological activities in natural soils are much higher than that of conventionally fertilized plots (Das et al, 2008). Again, depending upon the availability of organic manure, the framers apply FYM/Composts @ 5-10t/ha at least once in three years. The local varieties in general requires less inputs and better adapted to the specific agro-ecosystem, less prone to pest and diseases and therefore, provides resilience against changing climate.

Productivity and income

By adopting above practices, the farmers in plains of Tripura, Manipur and Assam harvests about 3 to 4 tone rice/ha with minimal external inputs. The productivity of fish is about a ton/ha, where as vegetable productivity ranges between 8-10 t/ha. Milk productivity is about 2 l/day/cow due to adoption of local breeds. Every year at least one kindling is achieved from goat with litter size of 2 kids/kindling. About 60-70 eggs are received from each duck in a year. Besides, farmers harvest fish from rice field (20-50 kg/ha), irrigation channels, small streams, etc. for their subsistence. The small and marginal farmers having about 0.5 ha land earns about Rs.50,000 from rice based farming systems. Due to favourable climatic conditions, good soil quality and rich knowledge base in managing rice based systems; the farmers of the region are sustaining their livelihood on agriculture for centuries without a single case of suicide or famine death and thus, showcasing the strength of the traditional farming systems.

However, with the increase in population pressure and decrease in per capita land holding, the pressure on land is increasing tremendously. In about 25% area of the region, especially in plains the farmers started applying fertilizer and chemicals and using high yielding varieties for enhancing productivity. The irony is that still the region is in deficit of about 1.77 million ton of rice, in-spite of its rich natural resource base and potential in improving the productivity substantially. Under such condition, scientific nutrient cycling, appropriate integration of various enterprises, selection of improved varieties/breeds and judicious blending of traditional knowledge with modern scientific tools and technologies will have to be undertaken for sustaining the fragile ecosystem of the region and conserve the rich traditional knowledge base in agriculture. Considering such needs, large scale farmers participatory demonstrations have been undertaken for promotion of rice based integrated farming system in all the NEH states under NAIP, FPARP, TSP etc. for improving livelihood of the farmers.

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Marketing and Socio-economic Aspects

Impact of agricultural modernization on sustainable livelihood among the tribal and non-tribal farmers

Mayur Prajapati, K.D. Solanki, K.A.Thakkar and B.H. Prajapati
S.D. Agricultural University, Sardarkrushinagar, Gujarat

Introduction

Indian society has been undergoing far reaching changes over the last two hundred years and if some of these changes can be subsumed under modernization. India provides a vast and fascinating laboratory for research into modernization. The differential level of modernization in one area with others areas need to be studied carefully. The main factor in the modernization process is represented by the levels of functional achievement attainable as a result of rapid and continuing growth of knowledge and technology. In India, small and marginal farmers constitute a major portion of the rural agriculture sector. The Indian industry is also largely reliant on agriculture for both inputs and end-user applications. However, the limited availability of land, the limited cash returns, and agriculture being confined to one or two seasons in the year, have made the villagers look for other livelihood support systems for their sustenance. A large number of tribal communities are bereft of stable livelihoods and thus they fall in the category of the vulnerable section of Indian Society. Therefore, it is essential to provide the latest information regarding the agricultural modernization to sharpen their knowledge in terms of assets and activities required for a means of living, not only living but have been lead to formalization of the Sustainable Livelihood approach. Considering this fact, the study was carried out to evaluate the impact of agricultural modernization on sustainable livelihood of tribal and non tribal farmers.

Methodology

The present study was conducted in Sabarkantha district of North Gujarat region of Gujarat state as the economy of the district is basically dependent on agriculture as 62.8% workers are engaged in primary sector and the farmers of Sabarkantha district are innovative as well as enthusiastic in modern agriculture. Secondly the district ranks first with respect to tribal population amongst the districts of North Gujarat region. Considering the highest tribal population, multistage random sampling technique was used to select the respondents. According to the Census-2001, proportion of scheduled tribes population to total population in villages are categorized in 9 different percentage ranges at district level, i.e., zero percentage range of scheduled tribes population to 76 and above percentage range. It is seen that only 14 villages out of 1,372 were having percentage range of scheduled tribes population of 41-50; covered in Khedbrahma, Vijaynagar, Bhiloda, and Meghraj talukas of the district. Among these four talukas considering the numbers of villages Meghraj and Bhiloda talukas were selected purposively. Looking to the common situation of the inhabited villages for the

tribal and non-tribal farmers, 11 villages of Bhiloda and Meghraj talukas, having scheduled tribes population of 41-50 range of percentage were selected purposively. Total 220 farmers were selected. For measuring the agricultural modernization and sustainable livelihood teacher made test were developed. The test of agricultural modernization was consisted of the major thirteen criteria. The criteria were discussed with the experts and total 200 score of agricultural modernization was determined by conference method. For standardizing the score, the agricultural modernization index (A.M.I.) was calculated, for each individual respondent and grouped into three categories viz., low, medium and high A.M.I. The test of sustainable livelihood was also developed with the help of three main indicators and 12 sub indicators were included after discussion with experts and total 300 score of sustainable livelihood was determined. For standardizing the score, the Sustainable Livelihood Index (S.L.I.) was calculated for each individual respondent.

Results

Relationship between selected criteria for agricultural modernization index and the sustainable livelihood of tribal and non-tribal respondents

To evaluate the impact of agricultural modernization on sustainable livelihood the relationship between selected criteria for agricultural modernization index and the sustainable livelihood of tribal and non-tribal respondents, the correlation coefficient was calculated.

Table 1 Correlation coefficient of criteria of agricultural modernization with sustainable livelihood of tribal and non-tribal respondents (n = 220)

Name of Criteria for Agricultural modernization	"r" value	
	Tribal farmers	Non-tribal farmers
Farming pattern (X1)	0.1892*	0.3045**
Seed selection (X2)	0.1907*	0.3660**
Use of irrigation system (X3)	0.1795 NS	0.2024*
Use of underground pipeline for irrigation (X4)	0.1670 NS	0.2130*
Use of transportation facility for marketing of agricultural production (X5)	0.1589 NS	0.5779**
Available modern machinery and implements (X6)	0.1633 NS	0.2385*
Available modern sources energy equipments (X7)	0.1924*	0.2289*
Extent of use of chemical fertilizers (X8)	0.2012*	0.3263**
Extent of use of organic fertilizers (X9)	0.2823**	0.2095*
Extent of use of storage facility (X10)	0.1562 NS	0.2125*
Use of Plant protection measures (X11)	0.2023*	0.4657**
Extent of use of harvesting structures (X12)	0.1724 NS	0.2384*
Extent of use of Improved dairy practices (X13)	0.2182*	0.3230**

* significant at 0.05 level of probability; ** significant at 0.01 level of probability ; NS = Non significant

It is clear from table 1 that out of 13 criteria of the AMI among the tribal respondents the correlation coefficient of one criteria viz., " extent of use of organic fertilizers" (0.2823) was statistically found to be positively and significantly related with sustainable livelihood at 0.01 level of significance, whereas 6 criteria viz., farming pattern (0.1892), seed selection (0.1907), available modern sources of energy equipments (0.1924), extent of use of chemical fertilizers (0.2012), use of plant protection measures (0.2023) and extent of use of improved dairy practices (0.2812) were statistically found to be positively and significantly related with sustainable livelihood index of tribal respondents at 0.05 level of significance.

As far as the criteria " use of irrigation system ", "use of underground pipeline for irrigation", "use of transportation facility for marketing agricultural production", "available modern machinery and implements", "extent of use of storage facility" and "extent of use of harvesting structures" were concerned, the computed correlation coefficient were found to be positive but non-significant. The above discussion leads to be concluded that criteria of agricultural modernization viz., farming pattern, seed selection, Available modern sources energy equipments, extent of use of chemical fertilizers, use of plant protection measures, extent of use of improved dairy practices affected significantly and positively correlated with the extent of sustainable livelihood of tribal farmers. While the criteria viz., extent of use of organic fertilizers was affected highly significantly and positively correlated with the extent of improve sustainable livelihood of tribal respondents. The probable reason might be that the tribal farmers have somewhat changed their traditional farming to scientific farming and more attention towards the dairy practices and obtain the advantage of communication system as well as marketing and input supply and services & facilities. The animals are the source of organic manure and also subsidiary income might have gave courage to take risk to adopt such a new concept of organic farming, which was directly or indirectly influenced and extent of sustainable livelihood. While in case of non-tribal respondents, out of 13 criteria of the AMI the correlation coefficient of six criteria viz., farming pattern (0.3045), seed selection (0.3660), use of transportation facility for marketing agricultural production (0.5779), extent of use of chemical fertilizers (0.3263), use of plant protection measures (0.4657) and extent of use of improved dairy practices were statistically found to be positively and significantly related with sustainable livelihood at 0.01 level of significance, while remaining seven criteria viz., use of irrigation system (0.2024), use of underground pipeline for irrigation (0.2130), available modern machinery and implements (0.2385), available modern sources of energy equipments (0.2289), extent of use of organic fertilizers (0.2095), extent of use of storage facility (0.2125) and extent of use of harvesting structures (0.2384) were statistically found to be positively and significantly related with sustainable livelihood at 0.05 level of significance.

The above discussion leads to be concluded that all selected criteria for agricultural modernization were significantly and positively correlated with sustainable livelihood of non-tribal respondents. It is interesting that all criteria for agricultural modernization were applied by the non-tribal respondents and changed their traditional ways of livelihood. It was indicated the impact of the agricultural modernization on the extent of sustainable

livelihood among the non-tribal respondents. The probable reasons might be that the non-tribal respondents have changed their ways of living owing to distinguishes changes of assests viz., natural, social, human, physical and financial.

Table 2 Association between the agricultural modernization of the tribal and non-tribal respondents and their sustainable livelihood

Consequent variable	Correlation coefficient 'r' value	
	Tribal	Non-tribal
Agricultural Modernization	0.1527^{NS}	0.3613^{**}

** Significant at 0.01 level of probability; NS: Non significant

It is clear from Table 2 the agricultural modernization (0.1527) was statistically found to be positively but non-significantly related with sustainable livelihood of tribal respondents. While the agricultural modernization (0.3613) was statistically found to be positively and significantly related with sustainable livelihood of non-tribal respondents at 0.01 level of significance. It can be concluded that the agricultural modernization was more affecting the sustainable livelihood of non-tribal respondents in comparison of tribal respondents. The probable reason might be that sustainable livelihood index is the function of many indicators. All the identified indicators of sustainable livelihood are leading the farmers to apply the agricultural modernization, in order to live sustainable livelihood the farmers may have adopted the agricultural modernization, however, it was observed very low in tribal respondent.

Conclusion

It can be concluded that the impact of agriculture modernization was more affecting the sustainable livelihood of non tribal respondents in comparison of tribal respondents. It indicates that the non tribal respondents have changed their ways of living owing to distinguishes changes of assets viz., natural, social, human, physical and financial and leading them to apply the agricultural modernization. However it was observed very low in tribal respondents.

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Groundnut seed production through producer company in rainfed agriculture zone of West Bengal

A.K. Roy, S. Chakraborty, H. Chudali, B. C. Mahato and G. Mukherjee*
Bidhan Chandra Krishi Viswavidyalaya, West Bengal
*Department of Agriculture Marketing, Government of West Bengal

Introduction

Producers' organizations – which range from the local and national to the regional and global – provide a mechanism for creating and articulating demand and improving the bargaining power of their members. The institutional capacity of such organizations varies immensely, and in many contexts there are legitimate questions to be posed about their governance, accountability and representation (notably of women, as well as of agricultural workers). Organizations of rural producers are often not represented in the overall governance of research organizations, and rarely are they engaged in budget allocation and priority setting. On the other hand, there are numerous successful examples of engagement of producers' organizations on various scales in agricultural innovation programmes, advisory services and research. For instance, in Senegal, rural producers' organizations have been involved in the reform of agriculture advisory services from the national through the local level, in setting the research agenda and the governance of service delivery. There is a need to engage these organizations and to build their capacity and voice so they can better represent the interests of their members as clients and partners of research and service institutions .The involvement of smallholder farmers as partners in agricultural research and advisory services is necessary which presuppose favourable policy environment. Effective partnership needs building coalitions, sharing responsibilities and creating synergies among governments, civil society, the private sector – and above all –farmers and their organizations. NAIP through its unique project implementation design gave such opportunity to link various stakeholders and synergise capabilities of respective stakeholders for the benefit of small holders in 'Disadvantage Agriculture'. The Producer Company as Farmers' Institution was formed under the aegis of NAIP component-3 subproject. Producer Company undertook two activities; seed production and marketing through product aggregation in Groundnut. The technology transfer paradigm in NAIP was characterized by involvement of civil society organizations in project implementation with equal partnership as consortium partners. The consortium was represented by public sector research institution emerging as lead agency and civil society organizations with grassroots presence as delivery agency dealing with developing Farmers' Institution. The multiplicity of problems so inherent in rainfed farming was addressed through collective effort of Farmers' Institution and public sector research institution acting as technology supplier. In the sub project of NAIP Component-3 under

discussion, Bidhan Chandra Krishi Viswavidyalaya (BCKV) is playing as public sector research institution while Access Development Services (ADS), Indian Gramin Services (IGS) acted as social mobilization agency engaged in institution building. In *Lodhashuli* Cluster, the consortium partners were BCKV, WBUFAS and Access Development Service.

Methodology

The present paper owes its methodology to collection and analysis of secondary and primary information about the producer organizations being experimented worldwide for the benefit of small holder farming. Participatory tools mainly the Focused Group Discussion (FGD) was used to track the process involved in shaping out the activities of Producer Company. Semi Structured Questionnaire was used to elicit the farmers and other stakeholders' response about the programs of Producer Company. The information was analyzed and presented in the matrix according to the nature of information emanated from the stakeholders.

Results

Cluster Committee

The farmers' groups were formed through the discussion with the farmers in each village. Village Committee was formed at the village level to organize extension services in more integrated manner. Village Committee was federated in to Cluster Committee at the cluster level. The cluster committee acted as extension service provider. The project was being implemented in 7 villages and therefore seven Village Committees (VC) were formed. The institution building through federative process is depicted in Fig 1. Farmers' Groups discussed the capacity building issues and undertook crop oriented group activities. The field level project staff acted in tandem with the cluster committee and village committee**.** The field staff of the project, Cluster-in charge, proactive members of the cluster committee and village committee created core activity groups which implemented the project in the grassroots. The major project activities included organizing technology demonstration, organizing training programme, distribution of inputs, collection of farmers' contribution from distribution of inputs and discussion about the crop development in the meeting of Village Committee and Cluster Committee.

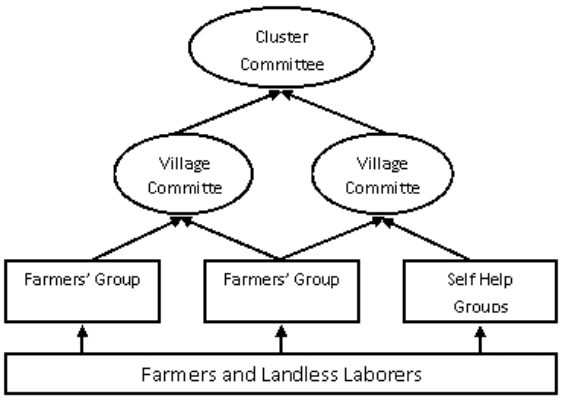

Fig 1. Institution building process

Formation of Producer Company

The Cluster Committee was federated into the Producers' Company named as "*Grameen Agro Producer*

Company". The incorporation of Grameen Agro Producer Company (GAPC) was on 3rd January 2012. Farmers' groups (FG) which were the base of Village Committee were used as Farmers' Group (FGs) working as base level foundation of Producer Company. Producer Company acted as apex body of Farmers' Group (FG). The farmers were trained to nurture FGs and to negotiate with external resource institutions such as government, financial institutions and markets. Producer Company activists as chosen from the village committee and cluster committee were trained in undertaking output marketing and organizing seed production program.

Legality of Producer Company

Any ten or more individuals, each of them being a producer, that is, any person engaged in any activity connected with primary produce, any two or more producer institutions, that is, producer companies or any other institution having only producers or producer companies as its members or a combination of ten or more individuals and producer institutions, can get a producer company incorporated under the Act. The companies shall be termed as limited and the liability of the members will be limited to the amount, if any, unpaid on the shares. As such, "producer companies would not be vulnerable to takeover by other companies or by MNCs.'' Producer Company incorporated under the Companies Act, 1956 (No.1 of 1956) on 10th day of September, 2004 within the meaning of Section 581A (1) of the Act. The Company is deemed to be a private Company within the meaning of Section 581C (5) of the Companies Act, 1956. Shares of the Company shall be issued only to individual producers or producer institutions. Producer Company, which has got all the trappings of a cooperative and flexibility of a public limited company, is the ideal model to succeed in the marketing of agriculture produces. The Board of directors will be chosen among the producers through voting procedure.

Initial Offer: 10 equity Shares; Face Value: Rs.10; Issue Price: at par

Patronage: Rs.2, 00,000 (Rupees two lakhs only) (Patronage is the use of services offered by the company to the members)

Nature of Equity Share: The equity share of a producer company cannot be traded on the stock exchange. Shares are transferable to active members at par value with the previous approval of the Board.

Surrender of Membership: The Board shall direct the surrender of membership together with shares at par value in case of any member ceasing to be a producer/ otherwise failing to retain his qualifications to be a member as per Articles.

Transmission: In the case of death of a member and if the nominee is not a producer, the Board shall direct the nominee to surrender the shares of the deceased member to the company at par value.

Distribution of profit: Subject to limit. There is dividend not amounting to more than 20% of the net profit of the Company (statutory) and as determined by the Board. Patronage Bonus will be paid out of the surplus arising out of the operations of the Company, after certain provisions, in proportion to the patronage only.

Voting Right: One member - one vote irrespective of the number of shares held.

Technology Transfer in Groundnut

The technology adoption in precise was: Introduction of *kharif* groundnut and improvement of production technology in *rabi* groundnut. The project identified some critical gaps in the farming system. Among the critical gaps, absence of viable second crop in *kharif* was identified as major bottlenecks in farming system productivity. Farmers used to take *Aman paddy* as major crop in *kharif* season. Most of the uplands were current fallow in nature. The groundnut used to be cultivated in *rabi* but with non-descript degenerated variety which was consistently low yielder (1.0 to 1.5 t/ha). The seed replacement rate was quite low and farmers cared less for the crop. Through NAIP the variety named TAG-24 was introduced in the first year (2008) with specific package of practices (POP). The yield jumped to 2.0-2.5 t/ha with good quality kernel having uniform maturity. The productivity enhancement in NAIP village area was quite obvious. The difference was quite higher indicating the superiority of the technology. The production in NAIP village was 2.5 ton/ha, 40% higher than the Non-NAIP village (Table 1). The agro-ecological practices were improved through line sowing, nutrient application along with gypsum and irrigation scheduling. The farmers were trained intensively and total coverage under the project was 100 ha involving 800 farmers. Input was subsidized 75% in the first year, 50% in the second year and in the third year the subsidy was reversed and farmers made 100% contribution. The ownership of farmers in input procurement justifies the technology acceptance and subsequent continuance in groundnut.

Table 1 Area-Production data of groundnut Intervention in NAIP

Season	Year	Number of Farmers	Area (ha)	Yield (ton/ha) in NAIP	Yield (ton/ha) in Non NAIP Village
Kharif	2009	1420	185.04	2.0	1.2
Rabi	2009	802	90	2.5	1.9
Kharif	2010	1500	43.60	2.0	1.12
Rabi	2010	750	38	2.5	2.0
Kharif	2011	1500	77	2.0	1.4
Rabi	2011	750	16.8	2.40	2

The cost of cultivation in groundnut and the profit comparison between seed groundnut and raw groundnut clearly exhibits the profitability of seed production enterprise. The profit in seed production enterprise is more than Rs. 26000/ha. In product aggregation the gain over grain is around Rs. 1600/ha**.** The implication is that through transfer of technology farmers gained quite considerably through increased yield. Product aggregation and seed production ensured further gain. Therefore, overall gain as compared to Non-NAIP area is tempting enough to persist with the technology adoption and Producer Company engineered market based intervention.

Groundnut Value Chain

The groundnut value chain includes input supply, production, traders, local processing, wholesaling, mixture factory, retailing and processing or oil extraction. Final processing and oil extraction happens outside the state while retailers operate at the nearest town level. At the village level against 1000 farmers on an average 5 village level traders operate**.** Small traders operate across villages and sell it to wholesale traders. Wholesale trader sells the unprocessed shell to the retailer at the town level which ultimately is sold to big retailer outside state. Farmers in normal situation are dependent on input suppliers, seed suppliers and credit providers for starting cultivation. The problems they face at this level are uncertainty in timely supply of quality seed or desired level of variety. Through the project intervention to start with the Cluster Committee and later Producer Company integrated all value-chain based activities. The activities included the responsibility of quality input supply on time, and market related support for the aggregated and value added product that fetched better price.

Activity Profile in Seed Production Process

Interaction between stakeholders: The stakeholders in the seed production program were BCKV, SFCI, Producer Company and Farmers Group. BCKV was the technology supplier while SFCI was involved in supply of foundation seed, registration of farmers as seed growers and buying back of seed from the Producer Company (Fig 2). Before undertaking seed production program the stakeholders had interacted through meeting, cross-visits, regular interaction through telephone and e-mail. Each of the activities in the seed production was chalked out and deliberated upon. The who-does-what table was prepared and BCKV as lead agency monitored that table and any deviation would have been reported to all stakeholders to avoid confusion and misunderstanding.

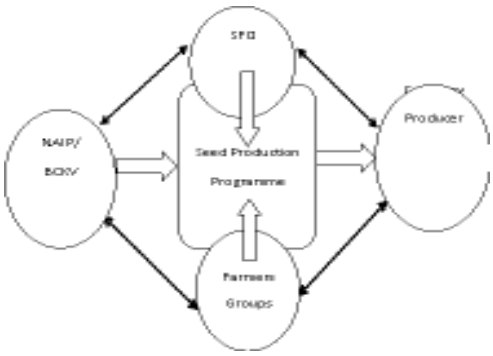

Fig 2. Stakeholders in the seed programme

Activity

The activities for seed production program broadly included following activities: meeting with Farmers' Group, requisition to the SFCI for Foundation Seed, training on Package of Practices, field demonstration on line sowing on groundnut, field inspection by the SFCI official, registration of seed growers with farmers, training on harvesting, processing and packaging, training on collection procedure of seeds from seed growers, collection & storage of the produce in local warehouse and handover of the produce to the SFCI. Each of the activities demanded special skill training module and Producer Company hired external consultants to give organizational and management related hand holding support. The technicalities involved in seed production were handled by the NAIP project staff in

association with program manager of the Producer Company. The activity wise description will help to understand the process involved in implementation of the program.

Meeting with Farmers' Group

Farmers were initially circumspective as earlier occasion they were misled by the input dealers or market intermediaries. They expressed concern about the ability of the Producer Company to negotiate with SFCI. To them SFCI was as good as any other unknown input dealers or market intermediaries. Another hesitation was how they will refuse the market intermediaries who have constant communication with them and market intermediaries collect the material from the doorstep of farmers. Sensing the initial hesitation Producer Company official in the Farmers' Group meeting advised the farmers to allocate part of their land for seed production to minimize the risk. Farmers therefore could retain their old contact with the market intermediaries while embarking on new venture. The risk minimization strategy helped to persuade the farmers in undertaking seed production entrepreneurship.

Requisition to the SFCI for Foundation Seed

After selection of farmers and their respective area, the certified seed was requisitioned to SFCI and farmers paid 50% advance money to make payment to the SFCI. SFCI charged Rs. 54 per Kg of seed which was quite higher than the price of normal seed. Persuasion and thread bare discussion in the FG meeting convinced the farmers to pay the higher price for seed. To them the idea of 'Certified Seed' was quite new.

Conclusion

Producer Company could complete the seed production exercise through the verbal contracts brokered between Producer Company and Farmers Groups. Verbal contracts often include embedded services such as discounted bulk input supply, access to credit (usually in kind), supply of capital equipment and technical support to the production process. For both the producer and the agribusiness, formal contracts can help manage risk, reduce transaction costs and, over time, build trust. They can bring advantages to smallholders, including increased productivity (made possible by the inputs and technical support) and a stable, assured market with guaranteed prices that often exceed the market going rate and that are less prone to volatility. By improving capacity and providing the stability of assured income, contracts over the longer term can enable and create the incentives for producers to invest underutilized resources in increasing production levels and quality.

Impact of NAIP in tribal district of Gujarat

K.A.Thakkar
SDAU, Sardarkrushinagar, Gujarat

Introduction

National Agricultural Innovation Project-3 has completed four years of operation in Gujarat State. The project is aimed at achieving livelihood security of the tribal people. The major emphasis was therefore, given to increase the agriculture productivity, milk productivity and creating employment opportunities through value addition and agro processing and to conserve natural resources. The major interventions identified for increase in the income of the farmers were; promotion of high yielding varieties, seed production, crop diversification, scientific animal husbandry, land leveling and terracing, promotion of MIS, vermi-composting, goat husbandry and poultry.After implementation of the project, four interventions were proved to be high pay off namely, crop diversification, scientific animal husbandry, seed production and goat husbandry. All the above interventions were considered for impact analysis.

Methodology

There are two clusters each of three villages in all three districts of Gujarat state making a total of six clusters. Of six clusters, Vagadadi cluster of Banaskantha district was purposively selected as NAIP head quarter is in the district and all three villages of Vagadadi cluster is nearer to head quarter. Further, the researcher is working for last four years in Vagadadi cluster and is familiar with the farming system and local language. All the farmers of these three villages were selected for the study. The selected farmers were then grouped into four categories based on the technological interventions they adopted in their field during last year. The intervention-wise farmers selected from different villages are as under.

Sr. No.	**Villages**	**No. of farmers selected**				
		Crop diversification	**Seed production**	**Scientific animal husbandry**	**Goatry**	**Total**
1	Vagadadi	36	18	33	52	139
2	Khemrajiya	27	23	26	39	115
3	Mandaliya	07	09	11	19	46
	Total	**70**	**50**	**70**	**110**	**300**

A key tool for data collection was intervention-wise four interview schedules separately developed. The schedule for collecting data on personal attributes was common for all four categories of the farmers. The survey data were supplemented by participatory rural appraisal, participatory observation by researcher and research assistants working in the community for nearly three years.

Results

Increased income

At the entry point of the project, PRA of all villages and house hold survey of all the farmers was made where the average annual income of an individual farmer through particular intervention was recorded. Then, the income of the selected farmers after adoption of intervention was again collected and finally difference was worked out to know the increase in the income. The results in this regard are depicted in Table-1.

Table 1 Increased income of the respondents

Sr. No.	Stage	Intervention-wise average income/ha (Rs)			
		Crop diversification	Seed production	Scientific animal husbandry	Goatry
1	Baseline	26031.00*	24146.00**	8230.00***	2383.00****
2	After intervention	35122.00	37531.00	10918.00	5092.00
3	% increase	34.92	55.43	32.66	113.68

* Income through traditional crop cultivation has been considered as baseline income,**Income through non-seed crop cultivation has been considered as baseline income; ***Income/ animal/ year ****Income through local bread of goat

Data presented in Table 1 indicate that out of four major technological interventions, goatry was found to be the most beneficial activity which almost doubled (113.68 %) the income of the farmers. Seed production was another important intervention which has increased 55.43 per cent income of the farmers. Through crop diversification (vegetables), 34.92 per cent average increase in farmers' income was noticed. Through adoption of scientific animal husbandry 32.66 per cent increase in income of the respondents was observed.

Relational analysis

Attempt was also made to ascertain the relationship between personal attributes of the farmers and their income enhancement. The results are included in Table-2.The co-efficient of co-relation show that three variables, namely; education (0.378), land holding (0.518) and irrigation facility (0.613) established positively significant relation with income

enhancement through crop diversification. Whereas, age established negatively significant relationship with income enhancement indicating that young farmers are generally adopt new crops faster even if risky. In case of seed production, three variables viz. education (0.343) and holding (0.383) and irrigation facility (0.498) again established significant and positive relation with income enhancement. In case of Scientific Animal Husbandry, herd size only established significantly positive relationship with income enhancement.

With regard to goat husbandry, all the variables selected have failed to establish significant relationship with income enhancement.

Table 2 Relationship of personal attributes with income enhancement

Sr. No.	Attribute	Correlation of Co-efficient(r)			
		Crop diversification	Seed production	Scientific animal husbandry	Goatry
1	Age	-0.423**	0.113	0.098	0.132
2	Education	0.378**	0.343**	0.103	0.078
3	Land holding	0.518**	0.383**	0.118	0.082
4	Herd size	0.073	1.002	0.382**	1.008
5	Irrigation facility	0.613**	0.498**	0.092	1.021
6	Extension contact	0.212	0.163	0.132	0.091
7	Training received	0.132	0.113	0.121	0.085

** Significant at 0.01 level of significance

Conclusions

It can be concluded that goatry is the most remunerative enterprise for income enhancement followed by seed production, crop diversification and scientific animal husbandry. Three variables namely; Education, Land holding and Irrigation facility were emerged as important variables establishing positively significant relationship with income enhancement through crop diversification and seed production.

Cognition and adoption of technologies related to climate resilient agriculture among farmers of Meghalaya

Seeralan S., A.K. Tripathi, D. J. Rajkhowa, A. Venkatesh, Anup Das, Aniruddha Roy, N. Uttam Singh and S.V. Ngachan
ICAR Research Complex for NEH Region, Umiam, Meghalaya

Introduction

The emerging issues of climate change are metamorphosing into great threat to sustainable development and food production. Over a period of time, farmers had refined and retuned agricultural practices and production systems to the changing socio-economic, climatic conditions. This has been attained by adopting new technologies, crop mixtures and the institutional mechanisms devised. Changes in temperature and rainfall pattern as well as increase in CO_2 level are expected to have great influence on agriculture. Such changes may manifest in the reduction in land quality and low productivity. In an analysis of adaptation to climate change in the drought prone areas of Bangladesh, Selvaraju *et al.*(2006) found that the major adaptation strategies practiced by small scale farmers were in the form of modification of agronomic practices and the choice of crop varieties that tolerate the changed climate regime. In Meghalaya, the changing climate scenario has given a way out for materializing new agronomic practices, *Insitu* conservation technologies, farming systems etc, to better suit to the local climatic conditions. Temperature here is ranging from 4^{o}C to 30^{o}C and annual rainfall on an average of 2000-4000 mm. Altitude varies from 450-1300 m above mean sea level. Soils are slightly acidic, rich in organic 'C'. In general, topography is hilly terrain, fragile, excessive sloping with rolling topography. Adaptation to climate change refers to the adjustment in ecological, social, and economic systems in response to climatic conditions and their effects and farmers' awareness about climate change has great capacity to drive farmers into improvising local technologies which can help in adaptation (Tol, 1998). Keeping this in view, this study was designed to analyze the cognition and adoption of farming technologies related to climate resilience.

Methodology

The study was conducted in Ri-Bhoi and East Khasi hills districts of Meghalaya. Multiple random sampling was used to select the respondents. From each district, four villages and thirty farmers from each village were selected and sample size of 240 was attained. Both descriptive and inferential statistics were used to analyze the data by using SPSS.

Results

The study sought the level of awareness about the climate change among the respondents. Results are given in table 1. Results revealed that majority (78.33%) of the

respondents were aware of changing climate. Out of this, 42.58% of the respondents got the information from extension agents, 24.56% from NGOs and voluntary organizations, 22.24% from mass media and 10.62% from fellow farmers.

Table 1 Source of awareness about climate change and climate resilient technologies

Source	Frequency (n=198)	Percentage
Extension agents	80	42.58
NGOs and Voluntary organizations	46	24.56
Mass media	42	22.24
Fellow farmers	20	10.62

Perceived causes of climate change

Table 2 shows the perception of the respondents about the causes of climate change. The results revealed that majority (81.21%) of the respondents assigned the cause of climate change to deforestation and *jhuming*. This was followed by Carbon emission out of different activities as claimed by 64.56% of the respondents while 30% of the respondents reasoned it to natural process i.e. change is inevitable.

Table 2 Perceived causes of climate change

Source	Frequency (n=198)	Percentage
Deforestation and jhuming	195	81.21
Carbon emission	155	64.56
Natural processes	72	30.00

Adaptation measures

Table 3 represents the results of adaptation measures practiced by the respondents to combat climate change. It showed that the majority (95.83%) of the respondents followed reduced chemical use and more organic supplementation. It also revealed that about 92.50% of the respondents planting the crops tolerant to climate attached vagaries. Mulching and cover cropping were also practiced by 65.41% of the respondents. The rationale was to

Table 3 Adaptation measures to climate change

Source	Frequency (n=198)	Percentage
Reduced chemical use	230	42.58
Planting crops tolerant to climate attached vagaries	222	92.50
Mulching and cover cropping	157	22.24
Integrated Farming System	153	10.62

reduce evaporation and also to add organic matter to soil. About 63.75% of the respondents reported that they take up integrated farming system comprising different suitable enterprises for improving resource use efficiency.

Factors influencing the adoption of climate resilient technologies

Table 4 represents the factors influencing the adoption of climate resilient farming technologies by the farmers. The technologies included were improved short duration varieties, polyhouse vegetable production and nursery management, zero tillage of pea, *in-situ* soil and water conservation, contour cropping, diversification, integrated nutrient management etc. The more the number of technologies adopted by a respondent, the more he ranks in adaptation status. The results depicted that the level of education of the respondents, extension contact, risk taking ability and trialability of the technology were highly significant. These variables were significant at 0.01. This implies that the positive increase in these variables led to the corresponding increase in the capacity to use the adaptation strategies. In a study of factors affecting the adoption of piggery related technologies in Meghalaya, Seeralan *et al* (2011) found that level of education, risk taking ability were significant in influencing the likelihood of adoption of the piggery technologies. Age was also significant in adoption of these technologies by the respondents and it was significant at 0.05 level. The sign of the co-efficient of age was negative implying that the younger respondents used more of the adaptation measures compared to the older ones. This is in line with Adesina & Zinnah (1993) who postulated that younger farmers have greater affinity to improvise and adopt new technologies because they are relatively more knowledgeable, more willing to take risk. In addition, access and control over assets was also significant at 0.05 level in influencing the use of adaptation measures. Some of the adaptation measures such as increased use of organic manures and diversification of farming system etc, are labour intensive. This may explain why the capacity of the farmers to use these adaptation measures depends on availability of labour and main source of labour in subsistent agriculture is family.

Table 4 Tobit regression for adoption of climate resilient technologies

Factors	Co-efficient	Standard error	Z	P>|z|
Age	-0.572821	0.28742	-2.56	0.020**
Level of education	13.28491	1.98428	6.72	0.000***
Extension contact	8.798462	1.54829	3.83	0.000***
Access and control over assets	3.72192	0.69249	3.48	0.019**
Risk taking ability	8.12352	1.23824	3.59	0.000***
Trialability of the technology	6.94423	1.85299	3.70	0.000***
Constant	2.82321	1.01893	2.72	0.004

Conclusion

There is no doubt that rural and remote communities are going through a rapid period of change. While this process has been ongoing, the impact of climate events and the uncertainty this creates has eroded the resilience and well being of farming communities. This paper has outlined the social factors that indicate that rural people of Meghalaya are aware of climate resilient technologies and the factors which may give a fillip towards likelihood of adoption of technologies. Some areas will be increasingly unviable and we need to manage this change carefully and with deep respect for those most affected. This requires co-operation and respect from farmers' organizations, women groups, environmental bodies and NGOs. Without this, agriculture and rural communities will change in ways that may be divisive and adaptation may be negative and unsustainable.

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Measurement of the existing sustainable livelihood of the tribal and non-tribal farmers

Mayur Prajapati, K.D. Solanki and K.A. Thakkar
S.D. Agricultural University, Sardarkrushinagar, Gujarat

Introduction

Agriculture and agro-based industries play an important role in the improvement of the rural economy in India. At present, about 70 percent of Indians depend on agriculture for their livelihoods. It is a major constituent of the Indian economy that accounts as the main source of income to the rural population as well as a decisive say in all economic policies of India. Small and marginal farmers constitute a major portion of the rural agriculture sectors. The Indian industry is also largely reliant on agriculture for both inputs and end-user applications. However, the limited availability of land, the limited cash returns, and agriculture being confined to one or two seasons in a year, have made the villagers look for other livelihood support systems for their sustenance. A large number of tribal communities are bereft of stable livelihoods and thus they fall in the category of the vulnerable section of Indian Society. Therefore, it is essential to provide the latest information regarding the agricultural modernization to sharpen their knowledge in terms of assets and activities required for a means of living by formulating a Sustainable livelihood approach. Considering this fact, the study was conducted with following objectives.

Methodology

The present study was conducted in Sabarkantha district of North Gujarat region of Gujarat state as the economy of the district is basically dependent on agriculture as 62.8% workers are engaged in primary sector. Secondly, the district ranks first with respect to tribal population amongst the districts of North Gujarat region. According to the Census-2001, proportion of scheduled tribes population to total population in villages are categorized in 9 different percentage ranges at district level, i.e. Zero percentage range of scheduled tribes population to 76 and above percentage range. It is seen that only 14 villages out of 1,372 were having percentage range of scheduled tribes population of 41-50; covered in Khedbrahma, Vijaynagar, Bhiloda, and Meghraj talukas of the district. Among these four talukas considering the numbers of villages Meghraj and Bhiloda talukas were selected purposively. Looking to the common situation of the inhabited villages for the tribal and non-tribal farmers, all 11 villages of Bhiloda and Meghraj talukas, having scheduled tribes population of 41-50 range of percentage were selected purposively. Ten tribal farmers and Ten non-tribal farmers from each village were selected. Thus, total 220 farmers were selected. Sustainable livelihood was measured through three different indicators viz., Social, Economic

& Environmental indicators. To measure these indicators, a teacher made test was developed. The test was consisted of major six sub indicators of social attributes *viz*., education of family, training & special skills, cultural event, tradition, health services and market services. Five sub indicators of economic attributes *viz*., production system, financial system, employment pattern, cropping intensity and consumption pattern and one sub indicator *viz*., farming system of environmental indicator was involved. Total 12 sub-indicators were determined for measuring Sustainable Livelihood. Such major indicators and sub indicators were discussed with the extension educationists and Agricultural economists and then finally they were included in the test of sustainable livelihood. To measure the education of family, average family education maximum 4 score was determined while remaining eleven sub indicators of sustainable livelihood were given score by organizing conference method of the teachers. The total 300 maximum score of SLI was determined. Sustainable livelihood was calculated for each indicator for each individual respondent. All indicators score were summed up to get the sustainable livelihood index of individual respondent. The index of sustainable livelihood was calculated for each individual respondent with the help of the following formula:

$$\text{Sustainable Livelihood Index (SLI)} = \frac{\text{Sum of scores of all indicators rated by Individual}}{\text{Maximum score attributes to the all indicators rated.}} \times 100$$

Results

Indicators of Sustainable Livelihood

Sustainable livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living; a livelihood is sustainable which can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets. DFID distinguishes five categories of assets (or capital)-natural, social, human, physical and financial. Considering the above concept, sustainable livelihood measured from three different indicators of respondents. The Indicator which were Social indicator, Economic indicator & Environmental indicator. Sustainable livelihood index was calculated for each indicator for each individual respondent. All Indicator score were summed up to get individual respondent livelihood index.

A perusal of data presented in Table 1 indicate that indicators of sustainable livelihood among selected social indicator changes were found in tribal respondents, like health services with a mean score of 5.49, cultural events with a mean score of 5.06, tradition (mean score 4.86) and market services (mean score 2.20) were ranked 1st,2nd,3rd and 7th, respectively. While among the selected economic indicator changes to be appeared in sub indicators viz., financial system (mean score 3.82), consumption pattern (mean score 3.54) and production

system (mean score 2.29) and were ranked 4th, 5th and 6th, respectively. While among the environmental indicator the sub indicator viz., farming system had 1.79 mean score and was ranked on eighth number. Remaining sub indicators of economical and social indicator viz., employment pattern, cropping intensity, education of family and training and special skill were appeared with too much less average mean score, which is indicating that these sub indicators had not changed their status for sustainable livelihood, among tribal respondents.

It is evident from the data presented in above Table 1 in the case of non tribal respondents particularly in social indicator most affected sub indicators which on their sustainable livelihood were viz., tradition (10.36 mean score), health services (9.32 mean score), cultural events (8.41 mean score) and market services (2.86 mean score) and were ranked 2nd, 4th, 5th and 7th, respectively. While in economic indicator the sub indicators were most affected viz., consumption pattern (11.59 mean score), financial system (9.85 mean score), production system (4.30 mean score) and employment pattern (2.74 mean score) and were ranked 1st, 3rd, 6th and 8th, respectively.

Table 1 Overall rank order of indicators of sustainable livelihood possessed by tribal and non-tribal farmers. (n = 220)

Sr. No.	Name of Indicators of Sustainable Livelihood	Tribal Farmers		Non-tribal Farmers	
		Av. Mean Score	Over all Rank	Av. Mean Score	Over all Rank
A) *Social Indicator*					
1.	Education of Family	0.83	XI	1.40	X
2.	Training & Special skill	0.11	XII	0.26	XI
3.	Cultural events	5.06	II	8.41	V
4.	Tradition	4.86	III	10.36	II
5.	Health services	5.49	I	9.32	IV
6.	Market services	2.20	VII	2.86	VII
B) *Economic Indicator*					
1.	Production system	2.29	VI	4.30	VI
2.	Financial system	3.82	IV	9.85	III
3.	Employment pattern	1.19	IX	2.74	VIII
4.	Cropping Intensity	1.12	X	1.40	X
5.	Consumption pattern	3.54	V	11.59	I
C) *Environmental Indicator*					
1.	Farming system	1.79	VIII	2.65	IX

The data presented in the Table 1, also clearly show that the average mean score of all the selected sub indicators of sustainable livelihood of non-tribal respondents were found higher than the average mean score of the selected sub indicators of sustainable livelihood

of tribal respondents. The above discussion leads to be concluded that indicators of sustainable livelihood in both groups of farmers which differentiate with some specific indicators viz., consumption pattern, cultural events, tradition, health services and financial system which were indicated the standard and the gap of sustainable livelihood between the tribal and non-tribal respondents.

The probable reasons for such type of results might be that the traditional way of living and customs of the tribal community are directly affected to their sustainable livelihood.

Extent of sustainable livelihood index

The data presented in Table 2 reveal that the above two-thirds (67.27 per cent) of tribal respondents were having medium extent of sustainable livelihood, while 23.64 per cent of them had low extent of sustainable livelihood index, whereas only 9.09 per cent of them had high extent of sustainable livelihood. In the case of non-tribal respondents two-thirds (66.36 per cent) of the respondents were having medium extent of sustainable livelihood, while 12.73 per cent of them had low extent of sustainable livelihood, whereas only 20.91 per cent of them had high extent of sustainable livelihood.

Table 2 Distribution of the respondents according to their extent of sustainable livelihood index (n=220)

Sr. No.	Sustainable Livelihood Index	Tribal farmers		Sr. No.	Sustainable Livelihood Index	Non-tribal farmer		'Z' value
		Number	Percent			Number	Percent	
1.	Low (Below 18.95)	26	23.64	1.	Low (Below 51.92)	14	12.73	2.1372*
2.	Medium (18.95 to 32.17)	74	67.27	2.	Medium (51.92 to 81.56)	73	66.36	
3.	High (Above 32.17)	10	09.09	3.	High (Above 81.56)	23	20.91	
	Total	110	100.00			110	100.00	

Mean: 25.56; S.D: 6.61 Mean: 66.74, S.D: 14.82; *Significant at 0.05 level of significance

It could be concluded that majority (90.91%) of the tribal respondents were having low to medium extent of sustainable livelihood, although in the case of non-tribal respondents 87.27 per cent were having medium to high extent of sustainable livelihood. The 'Z' value was found significant (2.1312*) which implies that tribal farmers differ significantly from non tribal farmers with respect to their sustainable livelihood. It is also observed from the data presented in Table 2 that the high extent of sustainable livelihood index score among the tribal respondents was started above 32.18 while in case of non-tribal respondents the low and high category of extent of S.L.I. score were reported below 51.91 and 81.57, respectively. It is also interesting noted that the majority of the tribal respondents were

having low to medium extent of S.L.I. whereas in case of non-tribal respondents were having medium to high extent of S.L.I.

Relationship between the personal, social, economical, situational, communicational attributes of the tribal and non tribal farmers and their Sustainable livelihood.

To explore the associationship between independent variables and Sustainable livelihood, zero order correlation method was applied and the values of correlation coefficient (r) were estimated. These values have been given in Table 3.

Table 3 Correlation coefficient of selected independent variables with Sustainable livelihood (n=220)

Sr.No.	Variables 'r' value	Non-tribal farmers	Tribal farmers
[1]	Personal variables		
	i Age -0.0299 NS	0.1994*	
	ii Education	0.1587 NS	0.2365*
[II]	Social variables		
	i Size of family	0.1895*	0.2390*
	ii Social participation	0.1528 NS	0.2072*
[III]	Economic variables		
	i Land holding	0.1776 NS	0.2820**
	ii Annual income	0.1927*	0.2532**
[IV]	Situational variables		
	i Source of irrigation	0.1123 NS	0.1945*
	ii Livestock possession	0.1982*	0.1728 NS
[V]	Communication variables		
	i Sources of information	0.1791 NS	0.3028**
	ii Cosmopoliteness	0.1923*	0.2927**

* Significant at 0.05 level of probability; ** significant at 0.01 level of probability; NS = Non significant

It is critically observed from table 3 that out of 10 independent variables, the correlation of four variables *viz*., size of family (0.1895), annual income (0.1927), livestock possession (0.1982), and cosmopoliteness (0.1923), were statistically established positively and significantly association with sustainable livelihood index of tribal farmers at 0.05 level of significance.

The variable 'Age' was concerned the computed correlation coefficient was found to be negative and non-significant, while remaining variable viz., education, social participation, land holding, source of irrigation and source of information did not establish any associationship with sustainable livelihood index of tribal farmer. It can be conducted that size of family, annual income, livestock possession and cosmopoliteness were the important variable affectively the S.L.I. among the tribal farmers.

In the case of non-tribal respondent, out of ten independent variables, the correlation of four variable viz., Land holding (0.2820), annual income (0.2532), source of information

(0.3028) and cosmopoliteness (0.2927) were statically found to be positively and significantly associated with sustainable livelihood index at 0.01 level of significance. While the independent variable viz., age (0.1994), education (0.2365), size of family (0.2390), social participation (0.2072), source of irrigation (0.1945) were statically found to be positively and significantly related with sustainable livelihood at 0.05 level of significant. The variable "livestock possession" was concerned the computed correlation coefficient was to be found non-significantly.

It can be concluded that all the independent variables, except livestock possession were important variable affecting the S.L.I. among the non-tribal farmers. Therefore, to improve the standard of sustainable livelihood index of the rural people, they should be weighted by the planner and extension agencies. The probable reason might be that there is direct influence of agricultural modernization on the S.L.I. of non tribal farmers and they have taken the advantages of the AMI for improving the S.L.I.

Conclusions

It can be concluded that the average mean score of all the selected sub indicators of sustainable livelihood of non-tribal respondents were found higher than the average mean score of the selected sub indicators of sustainable livelihood of tribal respondents. Which were indicated the standard and the gap of sustainable livelihood between the tribal and non-tribal respondents.

The majority (90.91%) of the tribal respondents were having low to medium extent of Sustainable livelihood, although in the case of non-tribal respondents 87.27 percent were having medium to high extent of Sustainable livelihood. The size of family, annual income, livestock possession and cosmopoliteness were statistically established positively and significantly association with S.L.I of tribal farmers at 0.05 level of significance while in the case of non-tribal respondents, all the independent variables, except livestock possession were important variables affecting the S.L.I. It indicates that, there is a direct influence of agricultural modernization on the S.L.I. of non-tribal farmers and they have taken the advantages of agricultural modernization for improving their S.L.I.

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Impact of seed replacement in major field crops on livelihood security of tribal dominated areas of Southern Rajasthan

T. Singh[1], R.L. Soni[2] and R. Dave[2]
[1]RRLRRS, Gerua, Hajo, Assam
[2]Krishi Vigyan Kendra, Banswara, MPUAT, Udaipur

Introduction

About 8.08 % of the country's population is constituted of tribals which makes India the second largest concentration of tribal communities in the world (Census 1991). These are 635 tribes in India located in five major tribal belts across the country. The main concentration of tribal farmers is in the central tribal belt in the middle part of the country which includes southern Rajasthan, Madhya Pradesh, North eastern Gujarat, Vidharwa region of Maharashtra and Chhatishgarh. The prominent areas of tribal constitute about 15 % of the total geographical area of the country and correspond largely to under developed areas of the country. They live in geographical isolation mostly in remote and inaccessible hilly areas. They are referred to as backward due to their incapability to utilize the opportunities of development offered to them. They are illiterate, have traditional beliefs and constitute the poorest of the poor segment of the society. These tribals are generally characterized by (i) primitive traits (ii) relative isolation (iii) distinctive culture (iv) shyness from outside environment and people (v) socio-economically most backward (vi) predominance of illiteracy (vii) ill health (viii) no commercial outlook.

The goal of attaining social equity and inclusive growth can't be achieved without providing livelihood and nutritional security to the most vulnerable sections of the Indian population which consist of mostly scheduled tribes and scheduled caste. Ensuring equity, good quality of life and its sustainability and economic empowerment of the weaker section is an important policy goal of our development plans. The planning Commission has identified 150 disadvantaged districts largely inhabited by small and marginal farmers belonged to SC and ST community who have not yet reaped full benefits of recent advancement in agriculture science and technology. Banswara district of Southern Rajasthan is one of them which having more than 70 % tribal population. The agriculture in the district is largely characterized by low productivity due to low seed replacement rate, poor adoption of production technologies and traditional way agriculture resulting poor livelihood. Despite sustained Government efforts and initiations in agriculture, major economic gains have not percolated to small and marginal tribal farmers because of lack of access to knowledge of agriculture technology, poor resource base and limited capacity to take risk. Cereal-cereal crop rotation is the prevalent cropping system followed by the tribal farmers for their subsistence. Maize-wheat is the major cropping system in the region. One of the major requirements of any agricultural operation is seed. Seeds of high quality can go a long way in improving the

productivity of crops. Considering the importance of seeds in improving the productivity of different crops, focused efforts are essential to ensure their timely availability as also increasing the Seed Replacement Rate (GoI, 2012). Seed replacement rate is low in wheat at the national level. It was only 13 per cent in wheat, against 19 per cent in paddy, 24 per cent in maize and 27 per cent in sorghum in 2003-04 (GoI, 2005). Since there is exist dearth of firms for the supply of certified seeds, the seed replacement ratio (SRR) is often low in the region. Therefore, major emphasis was given to improve the seed replacement rate in the major field crops in the adopted villages.

Methodology

The present participatory research programme based on IFS models was done four consecutive years from 2007-08 to 2010-11 by KVK, Banswara in Southern humid agro-ecosystem of Rajasthan under NAIP component 3. Ten villages of district were selected in two clusters for ensuring livelihood security. The soils of the region were loamy clay with soil pH ranging 7.5 to 8.1. These soils were low in organic carbon, available phosphorus and medium to high in available potassium. The crop production technologies were demonstrated at farmer's field. Each demonstrations were allotted 0.2 ha area. Before demonstration of technologies, all selected farmers were provided proper trainings and exposure visits so that they can easily adopt the scientific package and practices. During the course of investigation farmers participation was ensured through federation of interested farmers into business group and ultimately formation of Farmers Producer Company. Improved variety seeds of major crops were provided as critical input to the farmers with 25 to 50 % share basis. The farmer's share was deposited in the Bank account to create a Sustainability Fund for sustaining the activities after completion of the research programme. The yield and economics were calculated at end of the season.

Results

Seed Replacement in Maize

Seed replacement in maize increased productivity ranging from 35.5 % to 60 % over local practices during *Kharif* season while in *Rabi* season it ranged from 16.6 % to 46.6 %. The productivity level of maize was low during *Kharif* season due to use of local seed, very high seed rate, erratic rainfall pattern, weed infestation and terminal drought. Maize variety All Rounder recorded highest yield (36.0 q/ha) followed by MRM 3838 (35.7 q/ha) and Bio 9681 (32.5) while in *Rabi* season MRM 3838 recorded highest yield (52.0 q/ha) followed by All Rounder (48.5 q/ha) and Bio 9681 (45.0 q/ha). Singh and Morris (1997) also found that SRR in maize increased the productivity.

Seed replacement in wheat, barley and rice

During Rabi season wheat is the major cereal grown by the farmers. Productivity of wheat is low due to use of grain as seed with very high seed rate and temperature fluctuations

Table 1 Effect of seed replacement in maize on productivity and income (4 years data pooled)

Season	Variety	Average yield (q/ha)		Increase in yield over District Average (%)	Gross return (Rs)	Increase in area under HYVs (%)
		Demonstration	District			
Kharif	MRM 3765	30.5	22.5	35.5	30500	85
	MRM 3838	35.7		55.5	35700	
	Bio 9681	32.5		44.4	32500	
	All Rounder	36.0		60.0	36000	
Rabi	MRM 3765	45.0	35.5	26.8	45000	100
	MRM 3838	41.4		16.6	41400	
	Bio 9681	48.5		36.6	48500	
	All Rounder	52.0		46.5	52000	

during crop growth period. During the project period over 2000 field demonstrations were conducted to improve seed replacement and yield. Results revealed that both varieties (Raj 3765 and Raj 4037) were less affected by temperature anomalies and superior in terms of yield over district average. Raj 3765 and Raj 4037 recorded 30 % to 40 % increment in yield over district average yield. Use of quality seeds enhances wheat yield by 25-30 per cent (*GoI* 2006). Barley varieties (RD 2052 and RD 2035) also found superior over district average yield ranging from 22.2 % to 28.4 %. Hybrid and non-hybrid rice varieties resulted 43.2 % to 91.1 % yield advantage over district average yield.

Table 2 Effect of seed replacement in wheat, barley and rice on productivity and income (4 years data pooled)

Crop	Variety	Average yield (q/ha)		Increase in yield over District Average (%)	Gross return (Rs)	Increase in area under HYVs (%)
		Demonstration	District			
Wheat	Raj 3765	32.5	25.0	30.0	39000	70-80
	Raj 4037	35.0		40.0	42000	
	WR 544	32.0		28.0	38400	
Barley	RD 2052	28.9	22.5	28.4	28900	25
	RD 2035	27.5		22.2	27500	
Rice	P 1460	31.5	22.0	43.2	63000	30
	PRH 10	42.5	22.0	91.1	78750	-

Seed replacement in oilseeds and pulses

It was observed that seed replacement in oilseeds and pulses was very low. Results of summer green gram variety K 851/ SML 668 demonstrations revealed that farmers increased their income Rs. 32500 per ha after wheat crop. Cultivation of gram with limited irrigation

found more beneficial than wheat crop with gross return of Rs 47000 per ha. Demonstrations on soybean variety JS 335 increased yield by 26.1 %.

Table 3 Effect of seed replacement in oilseeds and pulses on productivity and income (4 years data pooled)

Crop	Variety	Average yield (q/ha)		Increase in yield over District Average (%)	Gross return (Rs)	Increase in area under HYVs (%)
		Demonstration	District			
Summer Green gram	K 851/ SML 668	5.5	4.0	37.5	32500	60
Soybean	JS 335	14.5	11.5	26.1	31100	25
Gram	GNG 469	14.0	10.5	33.3	45000	50
	BGM 372	15.0	10.5	42.8	47000	

Federation of farmers and creation of sustainability fund

Under NAIP project, farmers were further tied up with the market by providing adequate facilities and roping in a private sector to help them to get better prices for their produce. Farmers were grouped into farmers business groups (FBGs) on the basis of self help principles and ultimately forming farmer's producer marketing company. In the adopted ten villages 61 FBGs were formed with help of Access Development Services. These 61 FBGs were further federated into producer company namely "Jhambu Khand Agro Producer Company Limited (JKPCL)" and registered under company Act, 1956. The company has stared collective procurement and marketing of agricultural inputs like seeds, fertilizers, pesticides etc. The annual turnover of JKPCL was Rs. 28.5 lacs during the year 2010-11 and targeted one crore for the year 2011-12. Further, the concept of FBGs and Producer Company has developed a number of leaders in the form of Board of Director, President, Secretary and members associated with this endeavour. These trained personnel can serve as technology agent and acting as bridge between Institutes like KVK, State Agriculture Department and other private companies for knowledge and skill empowerment. The critical inputs such as seeds, fertilizers, implements, storage bins etc. were provided to the farmers with 25 to 50 % share basis. The farmer's share was deposited in the Bank account to create a Sustainability Fund for sustaining the activities after completion of the research programme. Banswara district has collected more than Rs. 40.0 lacs as sustainability fund to keep alive the activities. The Rural Technology Centre has been opened in two clusters of five villages for providing technical support to the farmers.

Thus, seed replacement in major crops brought remarkable changes in improving livelihood tribal small and marginal farmers. Based on the success of the programme Government of Rajasthan brought a mega programme on seed replacement of all major

field crops of the region. The programme as a whole not only enhanced income of household but also provided on and off farm employment opportunities for small and marginal farmers, thereby reducing migration.

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Linking farmers to markets through refrigerated van: an in-depth analysis on forward linkage in West Bengal

S. Chakraborty, A.K. Roy, H. Chudali, B.C. Mahato and G. Mukherjee[#]
BCKV, West Bengal
[#]Department of Agriculture Marketing, Government of West Bengal

Introduction

National Agriculture Innovation Project (NAIP) had technology to improve the productivity of rainfed farming situation. The identified farm technology had potentials to enhance livelihood security of farming community. The technology transfer paradigm in NAIP was characterized by involvement of civil society organizations in project implementation with equal partnership as consortium partners. The consortium was represented by public sector research institution emerging as lead agency and civil society organizations with grassroots presence as delivery agency dealing with developing Farmers' Institution. Cluster Committee acted as Farmers' Institution. The Cluster Committee was the federated structure of Village Committee/Producer Group comprising farmers**.** The Farmers' Institution was the building block for technology demonstration, technology testing and technology transfer. The village committee was the starting point which was later federated in to cluster committee which acted as apex body of Farmers' Institution in respective cluster.

Methodology

The cluster under discussion was at at Borjora Gram Panchayat in Borjora Block of Bankura district. The cluster is about 27 km from district head quarter Bankura. The objective of Cluster Committee was to trigger entrepreneurship among small holders' women community and landless laborers who lease-in land for vegetables cultivation**.** The project area was nearer to Industrial town of Durgapur (steel city of West Bengal). Farmers have inherent incentive in vegetable production as urban markets are fast expanding. Farmers have to go though competitive pricing as fresh vegetables from neighboring areas also crowding in the urban industrial market. Around 1689 farmers were trained and they cultivated vegetables in 227.23 hectare following Package of Practices (POP) as supplied by the Bidhan Chandra Krishi Viswavidyalaya (BCKV)**.** Farmers overwhelmingly worked on improving and refining their method of Vegetable cultivation. The Package of Practices (POP) included replacement of variety, application of organic manure like vermicompost, balanced application of fertilizers, need based application of pesticide and staggered harvesting responding to demand in market fluctuations through analysis of market intelligence. The net profit in 3.5 bighas of land through the cultivation of vegetables like ladies finger,

cauliflower, palak, coriander, fenugreek (green) stands to be more than 12000/. The hike in net profit was Rs.10000-13000**.** Net Return analysis projected different kind of profitability scenario. The diversified profitability scenario reflects the farming situation diversity within the same geography.

Convergence Programs- triggered by success in vegetable cultivation

The BCKV led NAIP componernt-3 has successfully roped in fund from the Department of Agriculture Marketing, Government of West Bengal for formation of Producers' Company and procurement of a Refrigerated Van. Project has already procured Refrigerated Van to carry vegetables in distant market. The convergence fund boosted the project activity at Barjora Cluster.

Formation of Producers' Company

A Producers' Company named "*Grameen Agro Producers' Company*" under the Companies Act, 1956 was formed in 2011.

Purchasing Refer Van

With the convergence fund from the Dept. of Agril marketing, Govt of West Bengal, through RKVY, through the project entitled "Development of Business Model of Refrigerated Van in Different Production Situations of West Bengal**",** a refer van of one MT Capacity (1000 kg) for fruits and vegetables, with a temperature range of 3-10 °C (as per product requirement), was purchased by BCKV in October, 2011. The objective was to meet the demand of cool chain management for Post Harvest related forward linkage to offset constraints arising out of product perishability. Refrigerated Van was a proposed intervention which would be operated by the Common Interest Groups of beneficiaries on commercial basis. The hypothesis was that the refrigerated van would ensure linking product to the distant market to capture the niche buyers who were prepared to pay premium price. The enhanced income out of this reaching out of commodities in different markets would give a push in productivity enhancement with increased market signal being sent to the growers as incentive for quality production.

Results

The ground reality was different from the business model hypothesized earlier. After placing the refer van at Borjora Cluster, Producers' Groups (PG) were formed with producer company at apex body to sell vegetables nearby urban markets like *Durgapur, Assansole and Panagarh*. The markets were mushroomed by small traders with each of their business size being small with little daily level variation on quantity requirement. These markets were not properly segmented to absorb the quality and quantity of product we offered. Not a single vegetable retailer operating in these markets wanted to receive high amount of product at one go. The individual order size for each retailer was small in quantity and therefore, the quantity collected from the farmers has to be divided in many parcels which

were eating in to profitability. The benefit of product aggregation through the Producers Company initiative was thus lost. It was then decided that Producer Company first needs to standardize the forward linkage issues; like finding appropriate market where forward linkage will realize the appropriate value. Producer Company decided to find the market of organized retail and landed up with the opportunity of working with *Switz food Pvt. Ltd.*, retail chain *Monginis* groups. The other retails still under consideration for forging business partnership are Relience, Aditya Birla and Spencers.

Initially it was decided that The *Switz Food* (*Monginis*) group will tally the price quotation of Producer Company with their rate for a period of 15 days on daily basis. The rate comparison in reality continued for one month. Initially they gave Producer Company the 'start-up advantage'. They accepted the rate of the Producer Company and agreed to take the vegetables for 15 days uninterrupted. The rate comparison revealed that *Switz Food.* is making losses as they accept the Producer Company rate. There was a open discussion with the managers of *Switz Food* and Producer Company representative. It was decided thast Producer Company will supply according to the rate quoted by *Switz Food.* Initially Producer Company lifted vegetables from Barjora and supplied it to the *Switz Food.*. Fortnight analysis revealed that the Producer company is incurring losses because transportation cost from Barjora to Kolkata (200 km) is pushing up the final price**.** With intense urge to complete the business cycle of supplying vegetables through refrigerated van, instead of giving up, the project started searching for nearest peri-urban vegetable zone which can meet the demand of *Switz Food*. Nadia (Agriculture Export zone, AEZ of Vegetables 50 km from Kolkata, and adjacent to BCKV campus) and Baruipur (30 km away from Kolkata,) came up as next options, between which Baruipur was better in terms of price of vegetables and product variations. Nearness to Kolkata assured further collection from other local *haats* without pushing up the transportation and overhead cost. Factoring in all these facts, the operation site was shifted to *Baruipur.* From February, 2012 fresh vegetables were supplied to *Swits Food India* in the refrigerated van on regular basis after making contact with the group of farmers who are based at *Baruipur.* For the last 6 months the Producer Company is supplying vegetables from the group of farmers from *Baruipur.* Working on forward linkage with *Swits Food India* gave two advantages to Producer Company: Producer Company has established itself as reliable vendor. Producer Company has developed the credentials which can be used for emerging as vendor with other established company like Reliance, Spencers etc. Now the task is to send back the market signals to barjora Cluster of NAIP to relink the farmers with *Swits Food India.*