Livelihood Improvement in Tribal Rainfed Region:

Experiences from Participatory On-farm Interventions in Nalgonda District, Andhra Pradesh

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Citation

Srinivasarao, Ch., Veeraiah, R., Rammohan, S., Dixit, S., Sanjeeva Reddy, B., Rao, K.V., Ramana, D.B.V., Nagasree, K., Dastagiri, S., Sumanta Kundu., Vijay S. Jakkula., Anuradha, B. and Venkateswarlu, B. 2013. Livelihood Improvement in Tribal Rainfed Region: Experiences from Participatory On-farm Interventions in Nalgonda District, Andhra Pradesh. Central Research Institute for Dryland Agriculture, Hyderabad, Andhra Pradesh. 142 p.

Copies: 500

ISBN No: 978-93-80883-21-2

Published by
The Director
Central Research Institute for Dryland Agriculture
Santoshnagar, Hyderabad - 500 059
Ph: 040-24530177 Fax: 040-24531802
Website: http://www.crida.in
E-mail: director@crida.in

Printed at :
Sree Ramana Process Pvt. Ltd., Secunderabad. Ph : 040-27811750

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FOREWORD

Livelihood options are shrinking in rural areas in general and more so in the fragile eco-regions. Various strategies have been adopted to improve livelihoods from time to time. These include productivity and profitability enhancement, building support systems and institutions, and converging on development agenda of different agencies. With climate change coming to be another formidable challenge it is anticipated that rainfed farming will be adversely affected by drought and water shortages. These, in turn, will impact food security and livelihoods of millions of rainfed farmers.

The dry tropical and tribal districts of Andhra Pradesh have always been the focus of development research. Agricultural intensification, adoption of diversified farming for higher profitability, migration to mining activities are some of the responses of rural communities in drought situation. The objectives of the NAIP project "Sustainable Rural Livelihoods for Enhanced Farming Systems Productivity and Efficient Support Systems in Rainfed Areas" were therefore designed keeping in mind the problems faced in rainfed farming, especially in areas where there is little or no support system. Against such a backdrop, this project could implement resource conservation related; crop, livestock and horticulture related; value addition and market linkages related interventions with special focus on innovative institution.

This publication is an excellent effort by the project team in documenting the entire process of livelihood interventions through farmers' participation. The interventions were designed to address each of the five capitals i.e. human, natural, financial, social and physical to bring about improvement in the livelihoods of the people in the selected disadvantaged cluster of Dupahad of Nalgonda district, Andhra Pradesh. I hope that this publication will pave way to enhance crop and livestock productivity and profitability, provide means to harvest rainwater through innovative means and capacity building of farmers through innovative community based institutions.

Alok K Sikka

New Delhi
October, 2013

Acknowledgements

The publication entitled "***On-Farm Participatory Livelihood Interventions in Rainfed Tribal Regions of Nalgonda District in Andhra Pradesh***" is an outcome of natural resource management and livelihoods interventions of National Agricultural Innovation Project (NAIP) of the ICAR funded by World Bank. This book deals with identifying the appropriate participatory livelihood interventions in rainfed agriculture, analyzing relationships between relevant factors at micro, intermediate and macro levels, and prioritizing interventions.

We are highly thankful to Dr. S. Ayyappan, Secretary, Department of Agricultural Research and Education (DARE) and Director General, Indian Council of Agricultural Research (ICAR), New Delhi for highlighting the importance of holistic analysis of livelihoods which is vital for understanding how to increase sustainability of rural livelihoods interventions. We thank the National Director (NAIP), Dr. D. Rama Rao for his keen interest in bringing out this publication. We also thank Drs. Mruthyunjaya and Bangali Baboo ex-National Directors (NAIP), Dr. A.P. Srivastava, National Coordinator, NAIP (Component - 3), for their support and encouragement during this study. We thank all the scientists, technical staff, project staff, RAs and SRFs, who have directly or indirectly contributed to the project. Most importantly, we thank all the participating farmers in the district, without their active involvements impacts could not have been to this extent.

We believe that this publication will be useful for extension workers, policy makers, planners, researchers, academicians and students in offering valuable insight into the livelihood interventions in tribal backward regions. Further, this publication will help policy makers in building framework, institutional mechanisms and support systems for scaling up of the successful livelihood approaches.

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Chapter 1

Introduction

A livelihood is a means of making a living. It encompasses people's capabilities, assets, income and activities required to secure the necessities of life. A livelihood is sustainable when it enables people to cope with and recover from shocks and stresses (such as natural disasters and economic or social upheavals) and enhance their well-being and that of future generations without undermining the natural environment or resource base. Livelihoods options are shrinking in rural areas in general and more so in fragile eco-regions, such as drought, desert prone, hilly areas and other under developed /backward districts. Various strategies were adopted to improve livelihoods including sustainable natural resource management, productivity and profitability enhancement, building support systems and institutions, and converging development agenda of different development agencies. The sustainable livelihoods approach (SLA) is a way to improve understanding of the livelihoods of poor people. It draws on the main factors that affect poor people's livelihoods and the typical relationships between these factors. It can be used in planning new development activities and in assessing the contribution that existing activities have made to sustaining livelihoods.

The worsening state of dryland agriculture created by drought, recurring crop failures and a lack of livelihood diversification in rainfed backward regions leads to distress and survival migration. There is a decrease in agricultural productivity because of inherent risk involved in the crop farming due to uncertainty of rainfall and occurrence of recurrent droughts. Livelihood strategies in rural areas can be classified into three categories: agricultural intensification and diversification, farm productivity and profitability and addressing migration. Agricultural production is only one sub-set of activities within the broader set of livelihood activities of agricultural producers. Agricultural producers often have additional ways of making a living: as labourers, artisans, processors, traders, money lenders, etc. In addition, remittances of money from migrated family members in town or abroad, or from the rent of land or houses are other sources of income.

Agriculture labourer and self-employed agriculture are the main occupations of household heads of the rural poor in Andhra Pradesh (AP) with over 75% of the lowest income quartile falling in these two categories. The rural poor therefore depend primarily on agriculture and allied activities (e.g. non-timber forest products, livestock, etc.) for their livelihood. The poor have limited access to economic activities, in part because of limited ownership of land and lack of formal credit. The majority of households below the poverty line are landless. Marginal farmers often own land only in degraded areas. Uncertain tenancy relations and rigid leasing regulations have also affected the livelihood options accessible to the poorest (World Bank, 2003). Sixteen percent of India's population is classified as scheduled caste, and 8% as scheduled tribe. These groups are dominantly poor and rural and face particular socio-cultural barriers to development.

In the rainfed tribal regions, as the natural resources are dwindling day by day, dependence on one particular commodity is not possible; therefore diversification is the only solution. Diversification of livelihood strategies by the rural poor specifically refers to the addition of new activities to complement existing ones, to safeguard or augment household income. An important implication of livelihood diversification is that natural resource-based activities may become part-time and this could have negative consequences particularly for participatory resource management such as watershed and community forestry programmes. Crop diversification, recharge of open wells, farm mechanization, livestock interventions, and community biogas cum vermicomposting, market linkages and ICT interventions are some of the alternatives that increase economic stability. The rural poor pursue diverse livelihoods in order to put together enough to survive, as a tribal family needs additional sources of income to ensure the food security of the household.

In the past, projects run by the Department for International Development (DFID) has made a substantial contribution to improving rural livelihoods in India. This has been mainly achieved by supporting programmes led by state governments in Andhra Pradesh, Orissa, Madhya Pradesh and West Bengal. These programmes have adopted different approaches – from 'watershed plus' in Andhra Pradesh and western Orissa to supporting Panchayat Raj institutions in Madhya Pradesh and West Bengal and Integrated Tribal Development Agencies in southern Orissa. The watershed plus approach developed and piloted in 5 districts by the Andhra Pradesh Rural Livelihoods Programme (APRLP), has now been scaled up to all 22 districts of the State. However, these projects focused only on one particular aspect of livelihood; therefore there was a need to diversify options available for improving livelihood in rainfed tribal regions of Andhra Pradesh.

To meet these objectives, National Agricultural Innovation Project (NAIP) Component-3 sub project "***Sustainable Rural Livelihoods through Enhanced Farming Systems Productivity and Efficient Support Systems in Rainfed Areas***" was therefore launched in September, 2007 in 49 villages belonging to 8 rainfed and tribal districts of Andhra Pradesh and was led by a consortium of ten organizations with Central Research Institute for Dryland Agriculture (CRIDA) as the lead centre. Nalgonda was one among the eight districts (besides Adilabad, Anantapur, Kadapa, Khammam, Mahabubnagar, Rangareddy and Warangal). Dupahad cluster is located in Nalgonda district, which is one of the backward districts of Telangana region in Andhra Pradesh. There are large tracts of unproductive wastelands in the district, which can be broadly classified into barren hillocks devoid of any vegetation except the thorny bushes and xerophytes and with severe soil erosion; vast stretches of undulating lands with ravines; sizeable stretches of plain land that is kept fallow and used only for grazing. Poor vegetative cover, harsh climatic conditions, low productivity and depletion of ground water, frequent droughts are important features of the cluster. Dupahad cluster was therefore selected for studying the on-farm participatory livelihood interventions for farmers benefit. The majority of populations in Dupahad cluster of AP were landless, majority of the villages were tribal (SC and ST population) with low farmer investment capacity, low household income, poor infrastructure and low overall productivity.

Unlike irrigated agriculture, the productivity of rainfed crops in Nalgonda district has not shown significant growth as there are constraints in rainfed production systems. Some of these constraints are uncertainty in rainfall, degraded lands, low input application, untapped water-nutrient synergy, poor crop management, lack of focused extension programme, lack of appropriate policy support. And also, farmers grow rainfed crops on marginal or sub-marginal lands and, very little attention is given to application of manures and fertilizers. These result in low fertility, nutrient deficiency and complete crop failure due to water stress. The objectives of this NAIP project were therefore designed keeping in mind the problems faced in rainfed farming, i.e. the economic status of farmers and their land holding capacity. The project was conceived with the overall objective of addressing rural livelihoods holistically in Nalgonda district. The specific objectives were:

- Efficient management of natural resources and increased productivity, profitability and diversity of the farming system.
- To facilitate agro processing, value addition and market linkages for enhanced on farm and off-farm income and employment generation.
- Capacity building and skill development of primary and secondary stakeholders through knowledge sharing, collective action and use of modern ICTs.
- To build a policy framework, institutional mechanisms and support systems for scaling up of the successful approaches.

The project followed the sustainable livelihoods framework adopted by Department for International Development (DFID), which is based on five capitals i.e. human, natural, financial, social and physical capital. Some of the key interventions of this project were resource conservation related; crop, livestock and horticulture related; value addition and market linkages related, institutional innovations and capacity building. The interventions were designed to address each of the capitals to bring about improvement in the livelihoods of the people in the selected disadvantaged cluster such as Dupahad. These interventions were participatory livelihood interventions and were different from the previous interventions by Andhra Pradesh Rural Livelihood Programme (DFID-APRLP). By using participatory approach, critical analysis of livelihood related problems was addressed by identifying the specific constraints and preparing a problem-intervention matrix. By these interventions the main emphasis in a cluster was laid on one or two interventions, which will address the key livelihood issue of the cluster by having a maximum impact at the household level. The project promoted sustainable natural resource management through an innovative process of enabling and empowering rural communities, and in accordance with Participatory Action Research (PAR) philosophy the project began with a series of consultations with the stakeholder communities by employing focused group discussions and brainstorming sessions. A consortium of partners {(I-Kisan, International Crops Research Institute for the Semiarid Tropics (ICRISAT) and Sri Aurobindo Institute of Rural Development (SAIRD)} were associated with CRIDA in implementing NAIP project (Fig. 1).

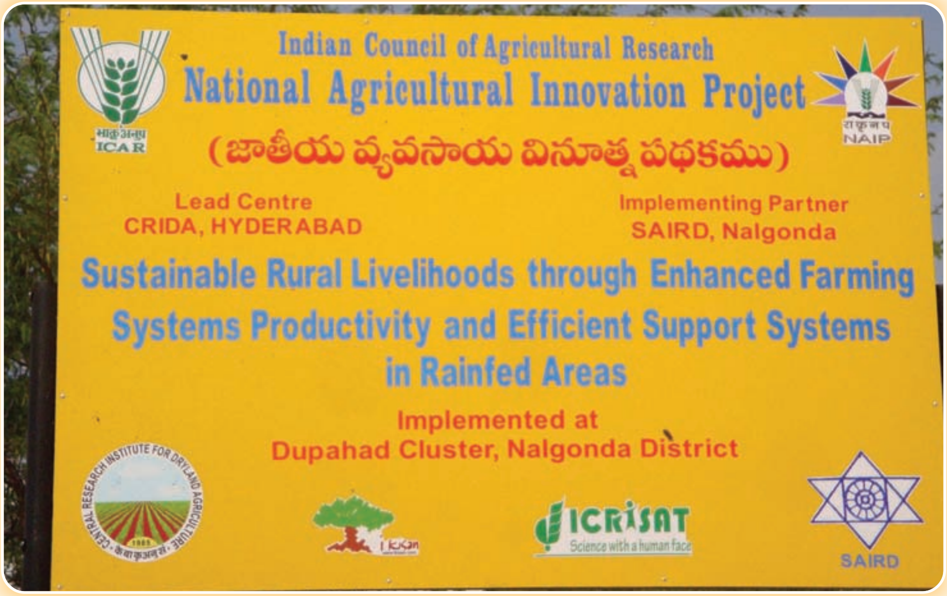


Fig. 1 : NAIP project implementation and its consortium partners

The output of these exercises helped in understanding the livelihood options across the clusters and design appropriate interventions. Some of the interventions listed below were implemented to address productivity, profitability and livelihood issues besides improving environmental services.

- Farm ponds
- Use of crop residue as mulch and livestock feed
- Intercroppping
- Establishment of horti-pasture system on marginal lands
- Introduction of new crop varieties
- Community shade net
- Crop diversification
- Vegetable production
- Small ruminant enterprise for the landless women
- Recharging the open wells
- Community biogas cum vermicompost unit
- Promotion of compost production
- Revival of local seed systems
- Tapping potential for harvesting water resources
- Upscalling of zero till maize
- Market linkages

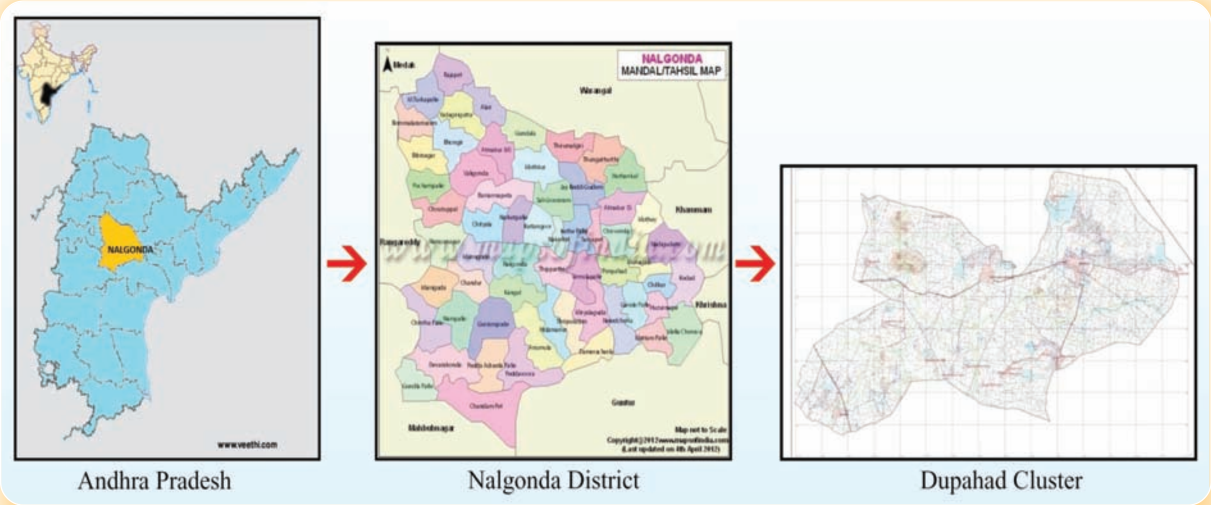
The project invested initially in setting up biogas cum vermicompost unit, building percolation tank, introducing site specific nutrient management, participatory soil sampling and analysis, encouraging farmers to grow green manure crops by providing with seeds of *gliricidia*, introducing new crop varieties, establishment of milk collection center, introduction of improved breeds, introducing contingency crops such as sorghum and horsegram during severe drought year of 2009, ICT interventions, market linkages for mango and watermelon. Even after the termination of the project in the year 2012, these interventions are still helping the farmers in continued adoption of resource conservation technologies. Farmers are benefitting from increase in household income as a result of these interventions. The new ventures are helping the rural community in sustaining their livelihood.

Chapter

2

Dupahad Cluster: Baseline Survey and Socio-Economic Conditions

Dupahad cluster, in Nalgonda district has geographical area of 800 ha, spread over in 9 thandas (New banjara hills, Jamal kunta thanda, Seetamma thanda, Yellapa kunta thanda, Chinnagore kunta thanda, Pedagore kunta thanda, Peda seetharam thanda, China Seetharam thanda, Lalsingh thanda), which are predominantly tribal populated and rainfed. The cluster is located 160 km away from Hyderabad on National Highway No. 65. The route is diverted from National Highway No. 9 at Durachapally village, 6 km after Suryapet towards Garedepally Road. The distance from Durajpally village to Dupahad is 18 km. The location of the cluster is depicted in Fig. 1.



Andhra Pradesh

Nalgonda District

Dupahad Cluster

Fig. 1 : Location of Dupahad cluster of Nalgonda district

The entire population in this cluster are tribal and out of 621 tribal households, 22% are landless labourers, 27% are small farmers, 26% marginal farmers, 25% medium farmers (Fig. 2). In the cluster, rainfed area (82%) is more than irrigated area (18%). The average rainfall is 715 mm during the year 2006 and slightly increased to 735 mm in the year 2007.

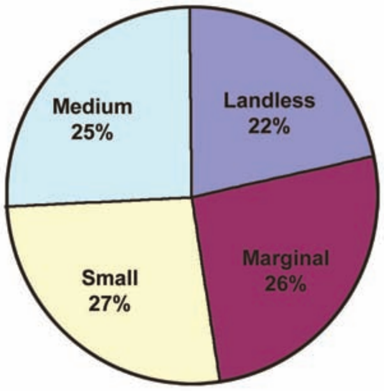


Fig. 2 : Composition of tribal households in the cluster of villages

Population and Literacy

The total population of the cluster is 2326 out of which 649 are male, 681 are female and 996 are children. Around 92% of the population is living below poverty line. The literacy rate of the cluster is 45% (1279 literates out of 2326 population). The composition of the literates was; 465 educated up to primary level, 349 middle level and 465 up to high school level. The composition of the institutions in the cluster indicates that there are 6 Self Help Groups (SHGs) and 3 Rytu-Mitra groups. No other institutions are present in the cluster. Education status of heads of households up to primary level was as follows backward caste 5% and schedule tribe 2%.

Family size and land holdings

The average family size was 3.95 with large farmers leading. The proportion of men was higher than women across different categories (Table 1). The average land holding per household worked out to be 1.18 ha, and was highest in larger farmers (6.48 ha) followed by medium farmers (2.63 ha) and small farmers (1.42 ha) (Table 2). The area operated was concentrated with medium farmers (54%) followed by small farmers (31%), and marginal farmers (13%). The least area operated per household was in the case of large farmers (2%). The number of household was concentrated with small farmers dominating (26%) followed by landless, marginal and medium farmers (25%).

Table 1 : Average family size in Dupahad cluster, Nalgonda district

Category	Men	Women	Children	HH Size
Landless	2.13	1.15	1.13	3.96
Marginal	1.57	1.13	1.43	3.99
Small	1.45	1.11	1.55	3.90
Medium	1.45	1.05	1.61	3.93
Large	2.00	1.00	1.00	4.00
Overall	**1.65**	**1.11**	**1.45**	**3.95**

HH: Households

Table 2 : Land holding pattern of tribal population in Dupahad cluster

Category	Number of Households	Area operated (ha)	Average holding size (ha)
Landless	76(25)	0(0)	0.00
Marginal	77(25)	47(13)	0.61
Small	80(26)	113.8(31)	1.42
Medium	76(25)	200(54)	2.63
Large	1(0)	6.5(2)	6.48
Total	**310(100)**	**367.2(100)**	**1.18**

Figures in parentheses are %

Land use in target villages

The total geographical area is 800 ha, out of which 600 ha belongs to cultivable area. The land use pattern indicates that 600 ha are net sown area, 74 ha are permanent fallows and 13.5 ha are under miscellaneous trees and groves. Among cultivable area rainfed area is 492 ha and irrigated area is 108 ha. There are 126 hectares degraded soils and rocks and hills in the cluster. The estimated soil loss per annum per ha was around 4 tons and 16% of the geographical area is reported as degraded and 14% of the total geographical area is covered under soil and moisture conservation measures.

Soils and cropping pattern

The cluster consists of 97% red soils while 3% are occupied by the mixed soils. The red soils are basically sandy loams which are poor in organic matter content and deficient in major and micro nutrient status. The water holding capacity of the soils is very low and thereby the productivity of the soil is very low. The soils are sloppy as a result erosion of soil and run off are very high.

Fig. 3 : Degraded soils of Dupahad cluster villages

Soil degradation is also one of the major problems of this cluster (Fig. 3). Mostly sole crop is being grown under rainfed condition during *kharif* (June-October). Dominant crops grown are: 63% under pulses, 18% cereals, 11% oilseeds and 8% under vegetables (Table 3). The major source of irrigation is wells, and there are a total 232 wells in the cluster.

Livestock Status

The average livestock holding per household in the cluster ranged from 0.46 to 2.77. Across the farm categories, landless labourers had the higher number of livestock (9%) followed by large farmers (8%) and small and medium farmers (7% each). Poultry birds dominated in number, per household (2.77) followed by milch animals (1.92) and draught animals (1.22) (Table 4).

Table 3 : Major crops/horticulture crops grown in tribal villages of Dupahad cluster (Area in ha)

Crop	Marginal		Small		Medium		Large		Total
Paddy	54.1	(73)	63.6	(58)	117	(62)	11.8	(67)	246.5
Greengram	0	(0)	45.6	(32)	39.1	(15)	0.8	(33)	85.6
Pigeonpea	12.8	(5)	10.9	(10)	53.3	(23)	0	(0)	57.1
Tomato	10.5	(18)	12.2	(0)	7.8	(0)	0	(0)	30.5
Soybean	12.0	(3)	10	(0)	0	(0)	0	(0)	22.0
Groundnut	22.1		20.6		36.9		51.2		130.8
Other Crops	10.7	(1)	8.3	(0)	8.5	(0)	0	(0)	27.5
Total	60.1	(100)	110.1	(100)	189.5	(100)	2.4	(100)	600.0

Figures in parentheses are %

Table 4 : Average livestock ownership of the households

Type	Landless	Marginal	Small	Medium	Large	Others	Total
Draught animals	0.07	1.01	1.85	1.92	2.00	0.00	1.22
Milch animals	1.47	2.04	1.96	2.18	2.00	0.00	1.92
Sheep	3.17	0.08	0.43	0.26	0.00	0.00	0.97
Goat	1.74	0.08	0.06	0.00	0.00	0.00	0.46
Poultry birds	2.83	2.42	2.93	2.88	4.00	0.00	2.77

Crop productivity

The average productivity of paddy in the cluster was 48.6 q ha^{-1}. Similarly the greengram productivity was 7.7 q ha^{-1}. The productivity of tomato which is an important crop of the area was 107 q ha^{-1} (Table 5).

Table 5 : Productivity of major crops grown by tribal farmers in Nalgonda (q ha^{-1})

Crops	Marginal	Small	Medium	Large	Overall
Paddy	50.2	48.0	47.3	48.5	48.6
Pigeonpea	-	-	3.5	8.6	5.5
Greengram	-	9.9	8.9	6.5	7.7
Tomato	154.4	92.3	98.8	76.0	107.4
Groundnut	12.1	10.6	26.9	41.2	90.8
Pigeonpea	-	-	10.6	23.5	34.1

Cropping intensity

Cropping intensity was lower in larger farmers and gradually increased in medium/small and highest was noticed in marginal farmers (Fig. 4). Tomato, Bhindi, green leafy vegetables are grown with limited irrigation by marginal to small farmers thus showing higher cropping intensity.

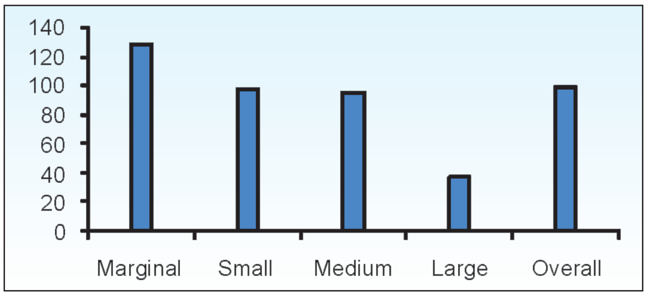


Fig. 4 : Cropping intensity in cluster of tribal villages

Livestock productivity

The productivity of milch animals was 1.54, 1.49 and 1.54 l/day/animal during the three stages of lactation, viz., first 3 months, and 4-6 months and beyond (Table 6).

Table 6 : Productivity of milch animals (in lit day^{-1})

Livestock	Stage of Lactation		
	First 3 Months	4-6 months	After 6 months
Cows	1.32	1.32	1.18
Buffaloes	1.79	1.66	1.88
Overall	1.54	1.49	1.54

Cost of cultivation

The average cost of cultivation per ha of paddy in the cluster worked out to be at Rs. 17345**.** The labour wages accounted for 63% of the total cost followed by fertilizer cost (27%) and seed cost (10%). The cost of cultivation of green gram per ha was Rs.5311 out of which 82% was the labour cost, 10% was the chemicals cost and 8% was the seed cost. The cost of cultivation per ha of red gram was Rs.6028 out which the labour component was to the extent of 62% followed by 16% for fertilizers, 13% for chemicals and 8% was the cost of seed (Fig. 5, 6 and 7 respectively). Not much of the variation was observed across the land holding categories in cost pattern of all the three crops

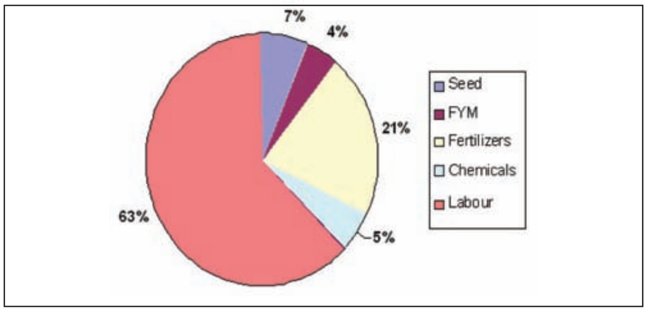


Fig. 5 : Cost of cultivation of paddy (average in cluster)

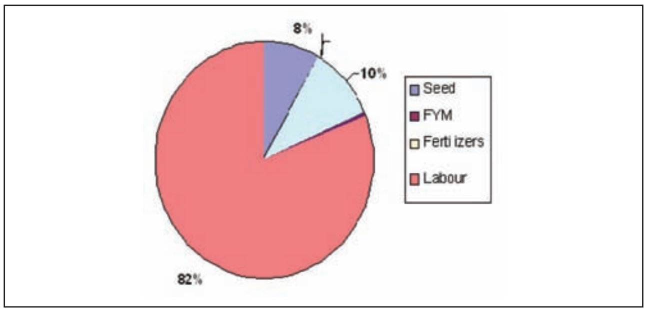


Fig. 6 : Cost of cultivation of paddy (average in cluster)

except in case of green gram wherein the large farmers spent more (around Rs. 7500 ha^{-1}).

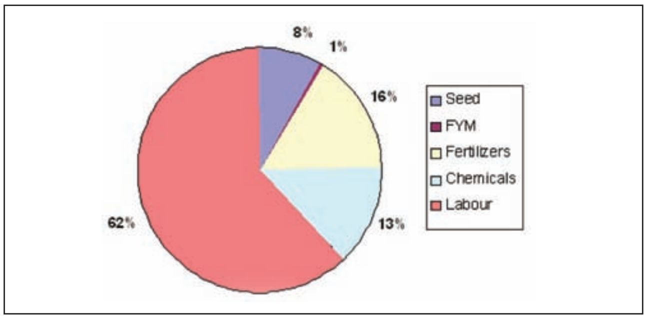


Fig. 7 : Cost of cultivation of pigeonpea (average in cluster)

Marketing pattern

The sampled farmers of the cluster had a marketable surplus of 44% of the grain and 30% of the fodder produced by them. All the farmers marketed the surplus on the farm itself (Table 7). Large farmers marketed their produce more than the others i.e. (100% of their produce), followed by medium farmers (49%) and small farmers (44%). Lowest marketing was done by marginal farmers (37%) of their produce.

Table 7 : Marketing pattern of farm produce of the cluster

Particulars	Marginal	Small	Medium	Large	Total	
Grain	Production (q)	102	67	208	92	117
	Produce marketed as % of production	37	44	49	100	57

Farm mechanization

Tractor was the popular farm equipment used mostly by the marginal and small category farmers (less than 50%). Among the other types, mould board plough was more popular with 43% of small and medium farmers and 40% of the marginal farmers. Other equipment usage was limited to less than 30% in all categories of farmers (Table 8).

Table 8 : Farm mechanization status in the cluster

Farm implement/ Machine	% farmers using			
	Marginal	Small	Medium	Total
Tractor	48	46	38	44
Mould board plough	40	43	43	42
Cultivators	32	32	31	32
Weeders	19	30	27	25
Sprayers	23	18	32	24
Dusters	15	20	17	17
Threshers	14	21	22	19
Winnowers	28	25	22	25
Motor pump	22	21	19	20

Agricultural extension

Only marginal farmers had higher % of contacts with all four categories of agencies mentioned in the table. When total sample was considered the Agricultural officer (AO) of the State department was contacted by 15% of the sampled farmers. Other agencies contacted were limited to less than 10% (Table 9).

Table 9 : Contacts made by the farmers with extension agencies among different categories of farmers

Agencies	Marginal	Small	Medium	Large	Total
Agril. officer of state dept.	31	4	11	0	15
Extension wing of agril. university	22	3	8	0	11
Extension personnel input organizations	16	3	11	0	9
NGOs	16	0	9	0	8

Gender in decision making

All the decisions in agriculture and financial management were mostly taken jointly (97 to 100%) by all the categories of households. Whereas, in case of large farmers, decisions related to child marriage were taken by men and regarding child education by women. In case of other categories the decisions were taken jointly in these two cases (Table 10).

Membership in organizations

Membership in cooperative society was common (more than 50%) among marginal, small and medium farmers. The lone large farmer of the sample was member in Rytu-Mitra group. The membership in village welfare association in case of marginal, small and medium farmers was to the tune of 30%. Likewise the membership in school committees of these groups was limited to less than 10%.

Economic Status

The average number of wage earners per household was 1.50. The share of wage earners in the family ranged between 25% (large and medium farmers) to 52% in case of landless labourers. The

Table 10 : Gender equality in decision making (%) among farm holdings

Activity	Marginal			Small			Medium			Large			Total		
	M	W	J	M	W	J	M	W	J	M	W	J	M	W	J
A) Agricultural operations															
i) Variety to be grown	1	1	97	0	0	100	0	0	100	0	0	100	0	0	100
ii) Purchase of inputs	0	1	99	0	0	100	0	0	100	0	0	100	0	0	100
iii) Employing labour	0	1	99	0	0	100	0	0	100	0	0	100	0	0	100
iv) Sale of produce	1	0	99	0	0	100	0	0	100	0	0	100	0	0	100
B) Financial Management															
i) Purchase of household materials	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100
ii) Purchase of clothes	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100
iii) Purchase of ornaments	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100
iv) Obtaining / payment of loans	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100
v) Spending during festivals	0	1	99	0	0	100	0	0	100	0	0	100	0	0	100
vi) Payments to labour	0	1	99	1	1	97	1	0	99	0	0	100	1	1	98
C) Children education	3	43	55	6	23	71	8	32	60	0	100	0	6	33	62
D) Children marriages	28	41	31	5	49	46	12	48	40	100	0	0	15	46	39

M= Men; W= Women; J= Jointly

Table 11 : Wage earners and wage income status in the tribal cluster

Category of households	No. of wage earners (No. per household)	% of wage earners / family	Wage income (Rs/year/household)	
			On-farm	Off-farm
Landless	2.05	52	19817	19585
Marginal	1.76	44	16420	17237
Small	1.14	29	11275	11483
Medium	1.00	25	10057	10235
Large	1.00	25	10000	10000
Total	1.49	38	14356	14601

average on farm wage income earned was Rs.14356/ household/year compared to off farm earnings of Rs.14601. Both on and off farm wage income decreased with the increase in land holding size of the wage seekers (Table 11).

The employment opportunities obtained by an average labour in Nalgonda cluster were 66 days in on-farm, 5 days in off-farm and another 10 days outside the cluster.

Migration

Over one-third of the cluster families were involved in migration. Among the migrating families, the average migration duration was 61 days for each migrating person and the income earned in the process was Rs.6046 per capita with an average migration income of 2172. Out of the total 35.9 families migrating on average, 1.54 persons from a family migrated (Table 12).

Family income

The annual average income of Nalgonda cluster households worked out to Rs.52382. More than three-fourths of the income came from agriculture. Migration income was to the tune of 39% in the case of landless (Fig. 8). Livestock and other sources contributed to minimal family income. However, income through wages was considerably higher for landless labours followed by marginal, small, medium and large farmers.

Table 12 : Features of labour migration in Nalgonda cluster

Particulars	Project
Percent families migrating	35.90
Average no. of persons migrating / HH	0.55
Average migration income / HH	2172
Average no. of persons migrating in migrating families	1.54
Average income from migration in migrating families	6046
Duration of migration per migrating person	61.0
Average income from migration per migrating member in the year	3925

HH – Household

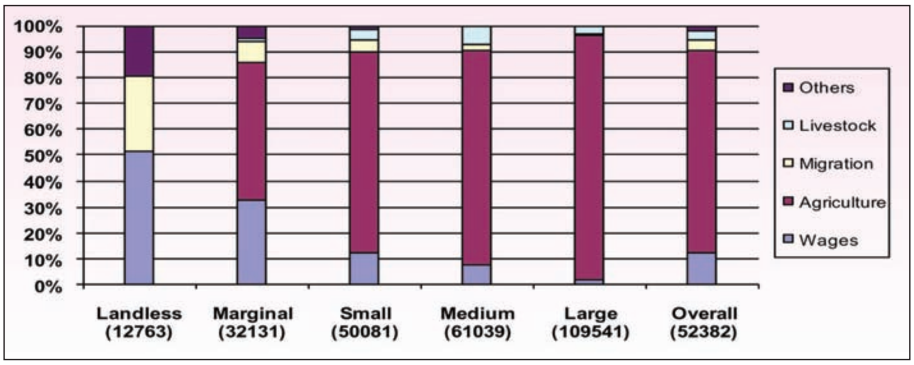


Fig. 8 : Average annual household income in Dupahad cluster

Family expenditure

The range of annual expenditure for household maintenance of the respondent families in the cluster was from Rs. 33881 to Rs. 40513. The expenditure was observed to be high in case of landless labourers (Rs. 40513) and least in large farmers. The share of expenditure was mainly high in case of food (80%), and in all other areas it was limited to less than 10% (Table 13 and Fig.9).

The important features of Dupahad cluster are illustrated in Table 14. The table gives summary of the cluster pertaining to geographical location, climate, annual rainfall, land holdings, education, household income, crops grown, banking system, healthcare system. The data presented in the table is critically evaluated based on the information provided by farmers and government officials. The table covers data on each and every aspect of the cluster and summarizes the information in relation to livelihood aspects of the farmers.

Table 13 : Average family expenditure scenario in tribal dominant Dupahad cluster

Household category	% in different items of expenditure							Total family expenditure (Rs/year)
	Food	Clothing	Education	Health / medicines	Festivals / ceremonies	Travel	Entertainment	
Landless	73	11	1	2	3	1	8	40513
Marginal	86	3	0	2	4	1	4	33881
Small	83	6	0	2	4	1	4	36387
Medium	77	5	2	2	3	2	10	36710
Large	85	3	0	2	3	1	6	35016
Total	80	6	1	2	3	1	7	36854

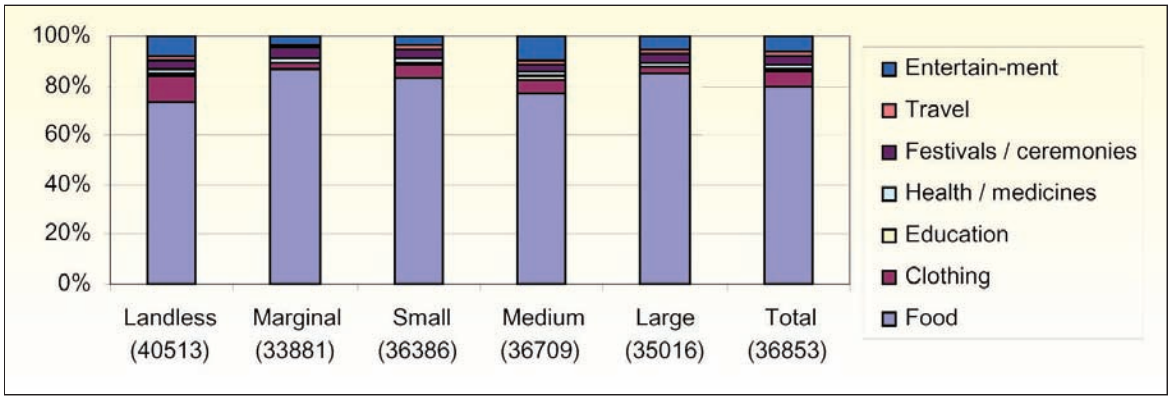


Fig. 9. Average family expenditure of household in Dupahad cluster

Table 14 : Features of Dupahad cluster in Nalgonda district of Andhra Pradesh (Summary)

S. No.	Parameters	Value
1)	Number of villages in the cluster	9
2)	Total geographical area of the cluster (ha)	800
3)	Total cultivable area (ha)	600
	a) Wet (irrigated)	108
	b) Dry (rainfed)	492
4)	Average rainfall (in mm)	
	a) During 2006	715
	b) During 2007	735
	c) During 2008	NA
	d) During 2009	NA
	e) During 2010	599
	f) During 2011	645
5)	Number of households by size of farm holding (No)	
	a) Landless households	88
	b) Small & marginal farm households	225
	c) Medium farm households	229
	d) Large farm households	52
	e) Other households	27
	f) Total households	621
6)	Population of the cluster (Number)	
	a) Men	1130
	b) Women	1141
	c) Children	55
	d) Total population of the cluster	2326
7)	Literacy rate of the cluster (Number)	
	a) Illiterates	1047
	b) Primary school	465
	c) Middle school	349
	d) High school / Intermediate	465
	e) Degree	—
	f) Total population	2326
8)	Presence of village Institutions	
	a) Self-Help Groups (SHGs) / DWACRA	6
	b) Rytu Mitras (RMs)	3
	c) Watershed Committees	—
9)	Number of village Institutions per 100 population	
	a) SHGs / DWACRA	0.3
	b) RMs	0.1
	c) WSCs	
10)	Number of Credit Organizations	
	a) Banks	1
	b) Primary Agril. Credit Societies (PACS)	—
11)	Number of Credit Organizations per 100 households	
	a) Banks	0.2
	b) PACS	—
12)	Number of Primary Village Health Centers	1
13)	Number of Veterinary Health Centers	—
14)	Number of Villages having Market Yard within 10 kms	—
15)	Land Use Pattern (ha)	
	a) Forests	86
	b) Non-Agril. Use / Barren Land	26.5
	c) Permanent pastures / grazing land	—
	d) Land use pattern under miscellaneous trees / grooves	13.5
	e) Uncultivable waste lands	—
	f) Permanent fallows	74
	g) Current fallows	—
	h) Other cultivable lands	—
	i) Net sown	600
16)	%age of households Below Poverty Line (BPL)	92
17)	Share of different types of soils	
	a) Red chalka	97
	b) Black soils	3
	c) Others	—
18)	Soil loss (thousand tons/ha)	4
19)	Extent of land degraded (as % to the geographical area of the cluster)	15.8
20)	Area treated with soil & water conservation measures (as % to the geographical area)	14
21)	Area under NDVI / green cover (ha)	NA

S. No.	Parameters		Value
22)	Area under cultivation of different crops (ha)		
	a)	Cereals	108
	b)	Pulses	375.2
	c)	Oilseeds	68.2
	d)	Vegetables	50.4
	e)	Fruits	—
	f)	Commercial crops	—
	g)	Fodder crops	—
	h)	Plantation crops	—
	i)	Others	—
23)	%age of area under cultivation of diff crops to the Gross Cropped Area		
	a)	Cereals	18
	b)	Pulses	62.5
	c)	Oilseeds	11.3
	d)	Vegetables	8.2
	e)	Fruits	—
	f)	Commercial crops	—

S. No.	Parameters		Value
	g)	Fodder crops	—
	h)	Plantation crops	—
	i)	Others	—
24)	Sources of Irrigation		
	a)	Open Wells	165
	b)	Tube/Bore Wells	67
	c)	Tanks	1
25)	Total number of wells (Open,tube,bore)		232
26)	Total number of functional wells		212
27)	% age of functional wells to Total		91
28)	Number of Processing units in the Cluster		1
29)	Transport facilities to the villages of Cluster		Bus
30)	Number of Villages having drinking water facility in the cluster		
	a)	All the Households	—
	b)	50% of Households	—
	c)	Only few Households	1
	d)	Not even to one Household	8

Chapter 3

Water based Interventions

National Agricultural Innovation Project was launched at Duphad cluster and another seven hamlets in Penpahad Mandal, 160 km away from Hyderabad. The population of nine Schedule Tribe (ST) thandas was 2,326. Around 92% populations are living below poverty line. The major source of irrigation in the cluster was open wells (165) and tube wells (67). Farmers preferred to grow paddy with support of open wells and tube wells during *kharif* and, paddy and vegetables depending on water availability during *rabi* season. Greengram, redgram, groundnut and vegetables were mostly grown in rainfed area while paddy was practiced under open wells and bore wells. The vegetables were cultivated under rainfed during *kharif* season, while they are grown with the support of irrigation during *Rabi* and summer seasons.

Rainfall situation in the cluster

Duphad cluster falls under Penphad mandal which is the nearest rain gauge station for the study area. Rainfall data was collected analyzed and compared with normal rainfall. Normal rainfall of the mandal is about 609 mm which is lower than district average (753 mm). Eleven years annual rainfall was plotted and compared with normal rainfall (Fig.1). Study area received deficit rainfall in eight years out of eleven years. Lowest rainfall was received in 2002 with deficit of 68%. There was continuous deficit in rainfall from year 2001 to 2004 with deficit of 44 to 68%. In year 2010, study area received 908 mm of rainfall with excess rainfall of 49%.

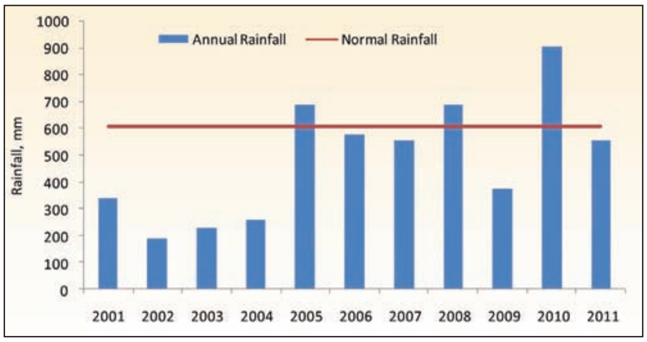


Fig. 1 : Rainfall scenario during year 2001-2011in the cluster

Ground water status in the cluster

Depth to groundwater levels data was accessed from Central Ground Water Board (CGWB) web site. The data was plotted against seasonal rainfall. Maximum seasonal fluctuation in Ground Water Level (GWL) of +11.37 m was found in 2010 where the annual rainfall was recorded about 906 mm. During the five years period, depth to groundwater level reduced to as low as 14.3 m in pre monsoon of 2010. Depth to groundwater level was raised to close to as 2 m during post monsoon season in year 2007 and 2011. The average depth to groundwater level during pre monsoon season was about 6 m and during post monsoon season it was about 2.9 m (Fig. 2).

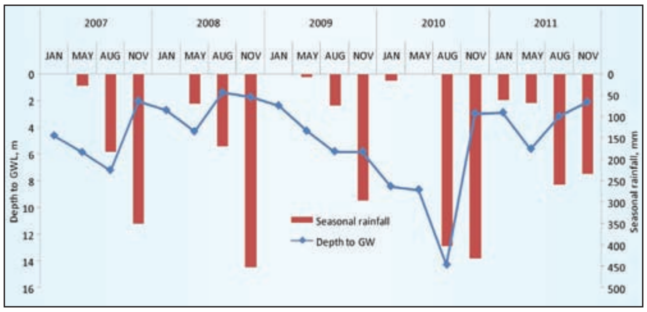


Fig. 2 : Seasonal groundwater fluctuations and rainfall in the cluster

Table 1 : Summary of Participatory Rural Appraisal (PRA) output in natural resource management for tribal dominant Duphad cluster, Nalgonda district, Andhra Pradesh

Problem/Issue identified	Proposed Intervention	Innovation employed
Ineffective of existing structures for rainwater harvesting	Renovation of existing percolation tanks for rain water harvesting and groundwater recharge	NREGS funds were mobilized for renovation of Jalamalkunta percolation tank and partly shared by project
Indiscriminate digging of tube wells Low success rate of tube wells	Recharge the open wells and defunct wells with rainwater for groundwater recharge	Adopted this intervention to 40 open wells across the cluster
Monitoring of groundwater resource use	Installation of water meters for monitoring pumping water from bore wells	Installed water meters on delivery system of pump sets and quantifying the water used for crops.
Depletion of groundwater levels	Periodical monitoring of groundwater levels	Investigation is being carried out
Excess soil erosion and runoff	Monitoring of runoff and sediment loss from farmers fields under mono crop system	Tipping bucket assembly was installed at field to monitor runoff and sediment loss for each of the rainfall event

Approach

A) Renovation work of Jalamalakunta percolation tank

Estimation: Jalamalakunta tank is situated at N 17° 0' 26.6" and E 79° 42' 53.3" between Jalamalakunta Thanda and New Banjara Hills Thanda in Dupahad cluster of Nalgonda district. The tank was constructed two decades ago to harvest the runoff from the catchment area of 15 ha. The present tank does not have enough capacity to accommodate all the runoff from the catchment. After discussion with the farmers it was proposed to enhance the storage capacity by increasing the height of bund and surplus weir (Fig.3). With the provision, there would be a significant increase of groundwater level at surrounding area. The tank is surrounded by 15 open wells and bore wells some of them are defunct. If the tank is renovated, all the wells would get recharged and will enhance cropping intensity. The technical details of the proposed bund are presented in Table 2.

Location	:	Between Jalmal Kunta and New Banjara Hills Thands
Total Catchment Area to tank	:	15 hectares
Water spread area of tank	:	1.178 Hectares
Annual average rainfall	:	650 mm
Max. Expected water yield	:	4.14 ha – m
Existing storage capacity	:	1.3 ha – m
Designed storage capacity	:	1.87 ha – m

(To achieve the designed capacity the following works needed to be carried out)

1. Deepening the tank bed and strengthening bund
2. Construction of surplus weir at designed height (South – West Corner near hillock)

I) Total earth work involved to achieve design storage capacity: 3695 cum

At the middle of the water spread area of tank (an extent of 0.75 ha), the soil needs to be excavated to a depth of 0.5 m and heaped on the bund uniformly to achieve required dimensions of the bund.

II) To construct surplus weir of 6 m length.

Excavation required:

a) Crest – 9 m X 1.5 m X 2 m —— 27 cum

b) Wing wall on both sides –
3 m x 1.5 x 2 m x 4 Nos —— 36 cum

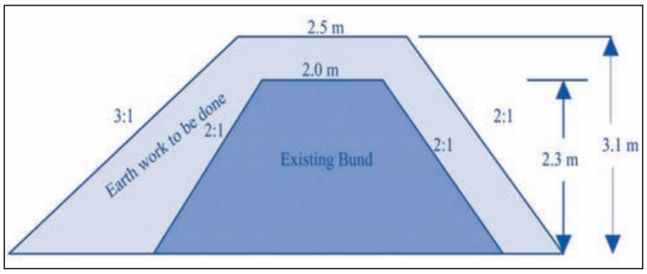


Fig. 3 : Cross section of the existing bund and dimensions for the proposed bund

Table 2 : Technical details of bund proposed for improved capacity

S.No	Particulars	Existing Bund	Proposed Bund
1	Bund width	2.0 m	2.5 m
2	Bund height	2.3 m	3.1 m
3	U/S slope	2:1	3:1
4	D/S slope	2:1	2:1

Impact of Intervention

The above work was included in “Shelf of Works” of NREGS programme in year 2009. Budget (Rs. 2,50,000) was sanctioned for deepening and bund strengthening based on the estimate submitted to the department. The work was carried out through labour as per the norms of NREGS. Construction of surplus weir was taken up by project funds and it was also constructed in April that year. The very same year rainfall was very distributive and catchment area of the tank received good amount of rainfall, percolation tank filled with designed excess volume 3695 cum.

Impact on groundwater recharge nearby open well

The percolation tank has a good significant impact on water table in nearby open wells (Fig. 4). The below Google image is showing location of percolation tank and open wells under observation

Fig. 4 : A team of experts visit to percolation tank before renovation, view of tank with full capacity after renovation (clock wise direction)

in downstream side of the tank (Fig.5). Depth to groundwater levels (GWL) of six open wells were plotted, the results show that there was tremendous increase in recharge of groundwater (8 to10 m) and depth to groundwater increased from 15 m to 5 m in five bore wells. Bore well 3 got recharged by 15 m and depth to groundwater was reached from 27 m to 8 m (Fig.6).

In downstream of the tank there are 21 farmers having open/bore wells. All the groundwater resources got recharged by the percolation tank. Before the intervention, the paddy grown areas under all the wells were about 11 ha with an average of 0.52 ha per open well. After this intervention, the areas under all wells have gone to 16.4 ha with an increase of 50% additional area under irrigation facility. The corresponding yields have also increased from 50 t to 92.6 t with a yield growth of 83%. The production per unit area was increased from 4.5 t ha^{-1} to 5.6 t ha^{-1} with an increase of 25% (Fig.7).

Fig. 5 : Google image depicting percolation tank and observed open wells

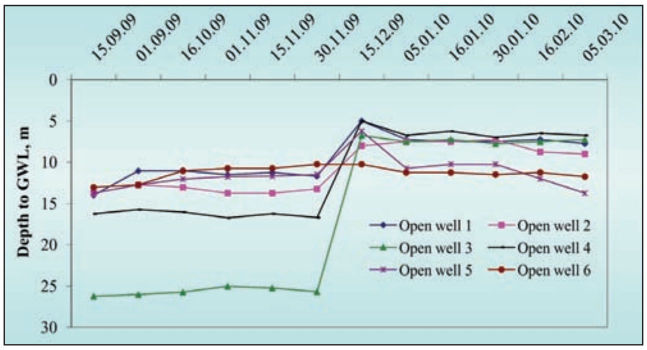


Fig. 6 : Improved depth to groundwater levels in open wells due to tank renovation

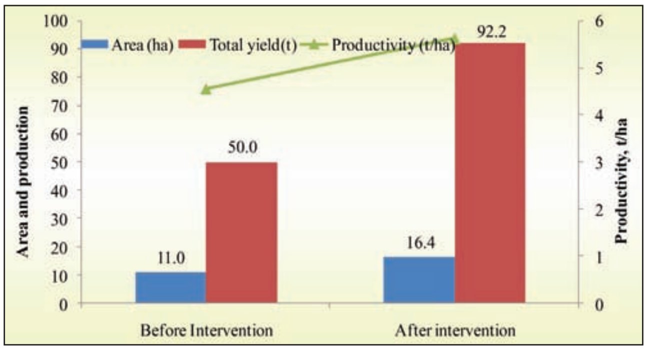


Fig. 7 : Effect of the renovation of tank on area, production and productivity

B) An economic design for recharging dug wells with rainwater

Design and estimate

In initial PRA and baseline survey, it was observed that groundwater level was declining season by season and some of the open wells and bore wells were defunct. Even crops under irrigation got affected due to this. In initial period of monsoon season, after sowing operation, if any dry spell occurred, crops suffered from moisture stress even under open wells because it required some time to recharge naturally. In the cluster of villages, open wells which have either gone dry or whose water levels have declined considerably, could be recharged directly with surface run-off. Rainwater that was collected from surrounding area was diverted by approach channel to a settlement or silt trap, from which it was diverted by conduit into the open well. Open wells were thus recharged with runoff water from nearby water ways or surrounding catchment area. This initiative met immediate water requirement of crops as well as improved groundwater levels. In areas where considerable de-saturation of aquifer have already taken place due to over-exploitation of groundwater resources, it resulted in the drying up of dug wells and lowering of piezometric heads in bore/tube wells, therefore an alternative simplified and economic design was made to recharge dug wells with rainwater.

Keeping in view the large number of defunct open wells in Dupahad cluster, a massive campaign was undertaken to recharge the open wells. Of the 45 defunct wells, over 30 wells were recharged by diverting the runoff after trapping the silt to the open wells. The technique involved diverting the runoff from a nearby water way into a silt trap and then leading the clear water into the open well through a PVC duct (Fig. 8). With the help of

Fig. 8 : Open well recharge through runoff water harvesting: silt traps, silt tap being arrange by farmer, Recharging open well with runoff water from the fields (top left, top right, bottom)

this additional water the area under protective irrigation increased from 4 ha to 26 ha. Besides this, 4 farm ponds were dug leading to recharging of 4 bore wells in the farmers field. With this, an additional 13 ha was brought under protective irrigation.

Design and operational guidelines to be followed:

1. Selection of dug wells in such a way that, the catchment area should be agricultural land or forest land which yields lesser siltation. On other hand, if the catchment is a barren land that results in more silt in the runoff water, the designed silt trap may not work efficiently.
2. Wells with higher yields before getting dried up due to the de-saturation of aquifers should be selected for recharge as they prove to be more suitable for ground water recharge when compared to low yielding wells.
3. Wells with larger diameter are more suitable than smaller ones as the designed system has problem with silt
4. The approach channel to the silt trap should be of enough capacity to accommodate the runoff from catchment area or a water way.
5. Stone pitching should be provided to sides of silt trap.
6. Stone pack should be provided at conduit inlet.
7. Silt trap should be de-silted after every runoff event occurred.
8. Most of the wells are unlined so, PVC conduit at one end should be enough length to carry the runoff water in to well without causing erosion of walls of the dug well.
9. Periodical de-silting of well should be carried out as the silt trap could not trap the suspended silt.

A schematic diagram of open well recharge and cost estimation is given below (Fig. 9 & Table 3).

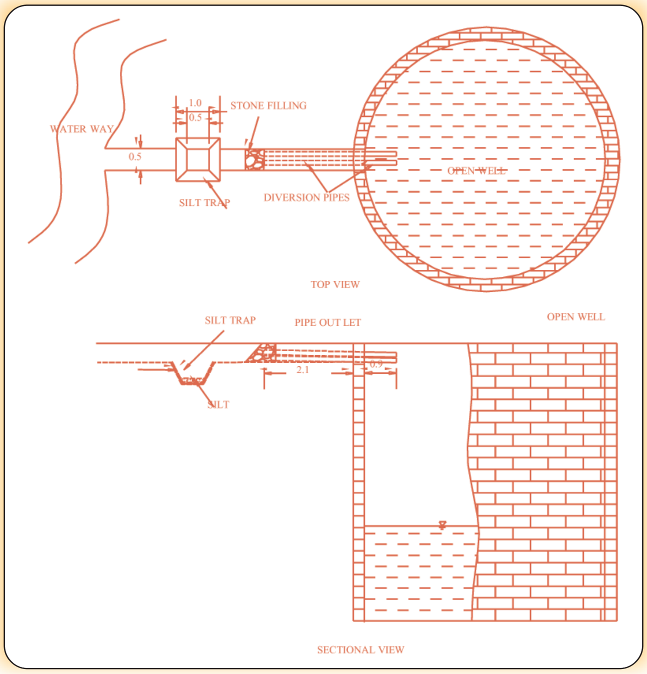


Fig. 9 : A schematic diagram of open well recharge through runoff water

Table 3 : Cost estimation for dug well recharge with rainwater (runoff) in the cluster

Particulars		Length	Width	Depth	Volume	Unit	Price (Rs)	Total
Approach channel		6.0	0.5	0.45	1.35	m³		
Silt trap	Top	1.0	1.0		0.56	m³		
	Bottom	0.5	0.5	1.0				
Earth work involved					1.91		100	191
RR stones		0.5	0.5	0.45	0.11	m³	100	11
PVC pipe 3" dia		one length of 20ft or 6 m			m	70	420	
Total								622

Table 4 : List of open well farmers adopted artificial recharge through runoff water rainwater

Village	No of open well recharge units	volume of water harvested (m³)
Chinna Garakunta Thanda	9	11700
Jalmala Kunta Thanda	14	18200
New Banjara Hills	7	9100
Peda Seetharam Thanda	6	7800
Seethamma Thanda	5	6500
Yallappa Kunta Thanda	6	7800
Total	47	61100

Table 5 : Estimated or projected silt deposition against catchment area and runoff volume for a runoff event with some assumptions

Catchment area (ha)	Runoff volume harvested (m³)	Silt deposited (kg)	Volume of silt deposited (m³)
0.5	325	390	0.28
1	650	780	0.56
1.5	975	1170	0.84
2	1300	1560	1.11

Impact

Dupahad cluster of NAIP project comes under black zone in terms of groundwater department encyclopedia, as the groundwater is depleted year by year because of high density of bore wells and open wells. These open wells may not be yielding enough water to meet the requirements of farm operation during early monsoon. The percolated water from rainfall requires a few weeks time to bring the water level up or recharge the open wells. Farmers cannot store runoff water separately in the field itself. In these circumstances the idea of artificial recharge of dug wells was introduced. This technique not only helps recharge of open wells but also contributes groundwater development.

Mean time, farmers can use the water collected from rainfall for their immediate need for agriculture. This technique was adopted for 47 bore wells covering six villages in Dupahad cluster of NAIP (comp 3) project (Table 4). Volume of water recharged or collected on individual open well basis was not calculated as it required detailed catchment area/contributing area. Based on some assumptions (10% runoff against rainfall and contributing area of 2 ha) the system has the potential of recharging volume of 1300 m^3 for each of open well. The overall rainwater trapped among the 47 open wells around 61100 m^3. Silt deposited through runoff water (sediment load 1.2g l^{-1}) is 780 kg that can be removed periodically (Table 5).

C) Monitoring of groundwater resource use through water meters

Water meters were fixed to two pump sets in the cluster in order to monitor or quantify the water used by a farmer for a particular crop in a season (Fig.10). Daily water pumping from a bore well was monitored by taking the initial and final reading of the water meter. This study indicates whether farmer is over irrigating or under irrigating his field in a season. Water pumping in rice fields and tomato fields was monitored.

Irrigation application in paddy fields

It was observed that total pumping of water was around 2075 m^3 to irrigate 0.5 ac of paddy crop (Fig. 11). Irrigation application is estimated as 1066 mm in addition to contributed rainfall of 628 mm in *kharif* season. Water productivity of rice is estimated at 2.92 kg ha^{-1} mm^{-1} with water use of 1694 mm and productivity of 5 t ha^{-1}.

Application of irrigation water in tomato field

Daily pumping of water was plotted (Fig. 12). Total pumping of water in m^3 was recorded for the entire crop period which was observed to be

Fig. 10 : Water meter reading being observed by field staff (Water Meter: Close up) : Direct impact on percolation tank

1853 m^3 for 0.5 ac of tomato crop. Application of irrigation water for whole crop period was estimated at 923 mm in *rabi* season.

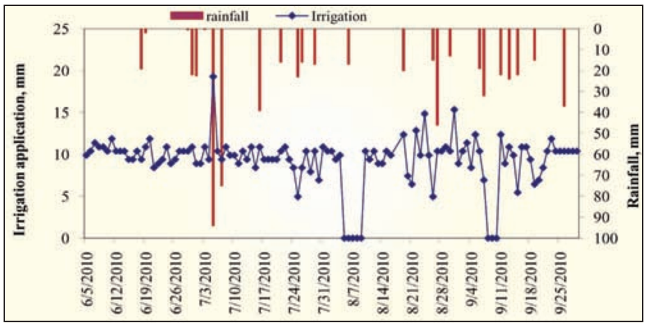


Fig. 11 : Application of irrigation water for 0.5 ac of paddy

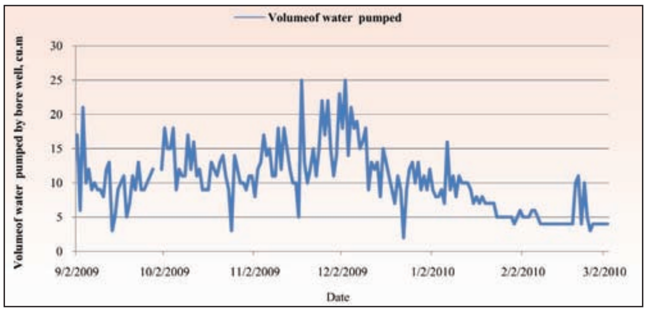


Fig. 12 : Daily bore well pumping (cu. m) during crop period

D) Efficient use of water sources through micro irrigation

Micro irrigation system (drip) was installed in water melon field which was inaugurated by the horticulture minister, Govt. of AP (Fig. 13a). This system was introduced for demonstration purpose which influenced the farmers to adopt micro irrigation techniques. Drip irrigated field was compared with controlled field where conventional irrigation system was adopted. The results were found to be significant (Fig. 13b & Fig. 13c).

Effect of irrigation application method was studied in watermelon crop with conventional method and drip irrigation method. Under this study one hectare of watermelon crop was considered. Observations like irrigation application, period, and irrigation interval, area covered in day, production and gross income were noted down. It was found that the productivity increased by 16%

in drip irrigation when compared to conventional irrigation (Table 6). Drip irrigation system could cover one hectare area with 6 mm of irrigation application with pump discharge of 3 LPs for 6 hours pumping. Whereas, conventional irrigation method could cover only one tenth of hectare per day with same discharge and operating hours.

Table 6 : Comparison of watermelon crop under drip and conventional method of irrigation

S.No	Particulars	Drip irrigation	Conventional irrigation
1	Name of the crop	Watermelon	Watermelon
2	Area (ha)	1	1
3	Irrigation application	6 mm/day	60mm/10 days
4	Irrigation period (days)	1	10
5	Irrigation interval (days)	1	10
6	Pumping duration (per day/h)	6	6
7	Area covered in a day (ha)	1	0.1
8	Production (t ha^{-1})	31	36
9	Income (Rs)	95000	110000

Fig. 13a : Drip irrigation system being inaugurated Horticulture Minister, Govt. of AP

Fig. 13b : Comparison of drip irrigated and conventional irrigated fields

Fig. 13c : Drip irrigation system in tomato fields : water saving interventions

E) In-situ rainwater harvesting through furrows

In-situ conservation is the key intervention to enhance moisture availability to plants through retention of rainfall in low to medium rainfall zones. Presently, conservation measures are mostly taken up during crop growing season after weeding that result in loss of precious rainfall as runoff, as there is less crop cover on the surface. Ridger planter is developed to make deep furrow (25 cm) of 60 cm width with paired row planting and fertilizer application simultaneously. This system can store about 250 cu.m of water to the field per hectare. Combined operations such as furrow making, sowing and fertilizer application also result in lower cost of cultivation. Threshold rainfall for initiation of runoff is also higher with this practice. The in-situ conservation paired row furrow system was found to enhance the crop productivity by 15-20%. The different *in-situ* water conservation interventions followed in the cluster are illustrated in (Fig. 14).

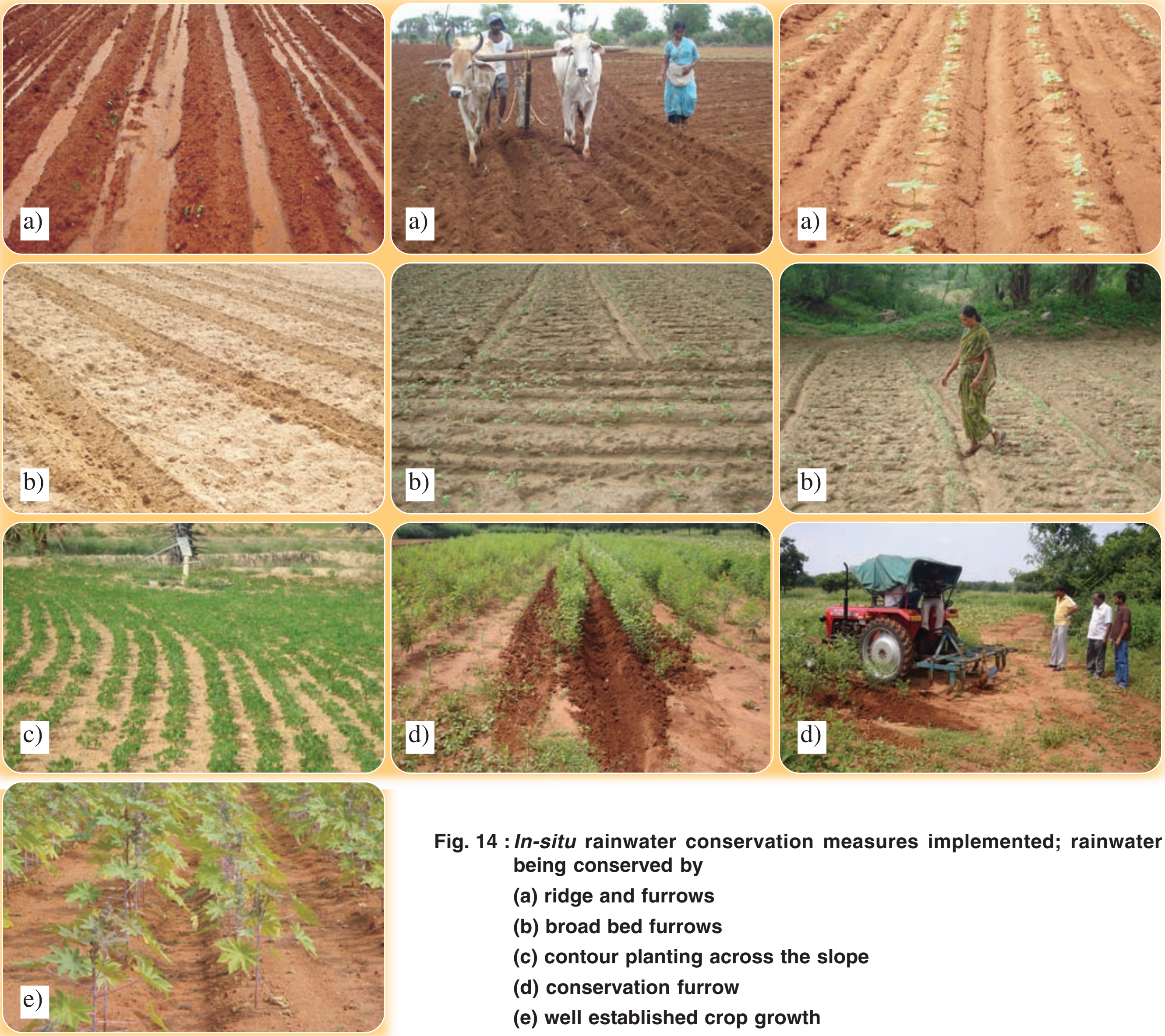


Fig. 14 : ***In-situ*** **rainwater conservation measures implemented; rainwater being conserved by**

(a) ridge and furrows
(b) broad bed furrows
(c) contour planting across the slope
(d) conservation furrow
(e) well established crop growth

F) Water productivity of crops

Water productivity of crops was calculated based on the area, production and water used in growing period. This was worked out for farmers who were benefited by the project. Water productivity of tomato was found to be 19.9 kg ha^{-1} mm^{-1} with productivity of 13.91 t ha^{-1} during 2008 *kharif* season which is higher than that of earlier season (2007) with water productivity of 17.0 - 19.9 kg ha^{-1} mm^{-1} (Fig. 15). Water productivity of Bhendi was found about 8.2 kg ha^{-1} mm^{-1} during *kharif* season of 2008 which was 67% higher than the earlier season (*kharif* 2007). Groundnut water productivity was found to be 14.1 kg ha^{-1} mm^{-1} with production of 8.47 t ha^{-1}. Jowar water productivity was about 9.1 kg ha^{-1} mm^{-1}. Water productivity of green gram was about 10.4 kg ha^{-1} mm^{-1} (Table 7).

Table 7 : Water productivity of important crops grown in the cluster.

Year	Crop	Area (ha)	Yield (t ha^{-1})	Productivity (t ha^{-1})	Water productivity (kg ha^{-1} mm^{-1})
2007-2008	Tomato	3.40	40.45	11.90	17.0
	Bhindi	0.40	1.4	3.46	4.9
2008-2009	Tomato	8.98	125	13.91	19.9
	Bhindi	0.36	2.1	5.77	8.2
	Groundnut	2.83	24	8.47	14.1
	Sorghum	74.06	370.1	5.00	9.1
2009-2010	Greengram	51.40	294.6	5.73	10.4

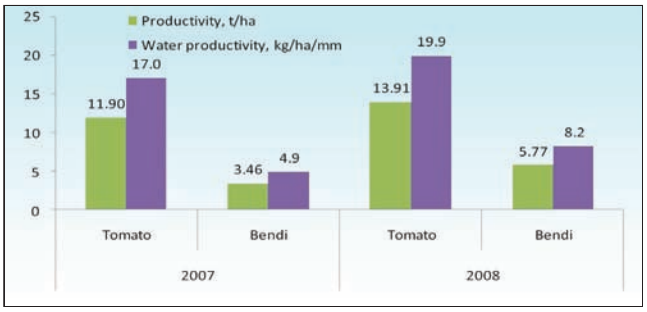


Fig. 15 : Comparison of water productivity of crops during kharif seasons of 2007 and 2008

Name of the farmer : D DEVALA

Village : JAMALKUNTA THANDA

I am benefited by the renovation of existing percolation tanks taken up by CRIDA under NAIP program for rainwater harvesting and groundwater recharge. Installation of water meters for monitoring pumping water from bore wells has also helped me to check if I am over irrigating my field.

Chapter

4

Participatory Soil Testing and Balanced Nutrition

Soil fertility requires nutrients to exist not only in sufficient quantities, but also in balanced form. Balancing soils and achieving optimal soil nutrition will create more favorable soil conditions for better utilization of applied fertilizers and for a greater effect from organic/microbial based products. Too much of one nutrient may lock up or interfere with the absorption of another. The soils of the rainfed regions are not only thirsty but are also hungry. Soil erosion with depletion of nutrients under continuous cropping without adequate additions of nutrients and organic matter over the years has resulted in the degradation of soils and its fertility. Wide-spread deficiencies of macro, micro and secondary nutrients have been reported in the rainfed areas (Srinivasarao et al. 2008), and these must be overcome through balanced nutrition of crops. While much attention has been paid to correcting S and micronutrient deficiencies in irrigated systems, little efforts are made to diagnose secondary and micronutrients deficiencies in the rainfed regions of India. Participatory soil sampling and testing in rainfed regions will therefore be a key step in administering balanced nutrition for soil health management.

In Dupahad cluster of Nalgonda district, soils are low to medium in organic carbon, and are coarse to medium in texture, and low in biological activity. The predominant crops grown are rice, sorghum, maize, groundnut, pulses, and cotton, vegetables, and fruits crops in the district mostly with imbalanced nutrient application. The modest quantity of organic and crop residues added are rapidly oxidized due to high temperature prevailing in the arid and semi-arid regions, allowing little humification of the added organic matter. The general belief that soils in the tribal regions are rich in organic carbon and fertility status as a result of less intensive cropping with low yield was found to be untrue. The tribal regions are intensively cultivated for the last two decades without much input with highly exhaustive crops like vegetables. Thus, soils showed multiple nutrient deficiencies. The nutrient requirements per tonne of production of rainfed crops grown in Nalgonda district, and the average uptake of micronutrients by rainfed crops are illustrated in Tables 1 and 2. Through Site Specific Nutrient Management (SSNM), the extent of nutritional constraints on productivity enhancement and livelihood improvement in tribal dominated area of Andhra Pradesh are addressed.

Table 1 : Nutrient requirement per tonne of production in important rainfed crops grown in Nalgonda district

Crop	Produce	kg nutrient/tonne produce		
		N	P_2O_5	K_2O
Sorghum	Grain	22.4	13.3	34.0
Pearl millet	Grain	42.3	22.6	90.8
Rice	Grain	20.1	11.2	30.0
Groundnut	Grain	58.1	9.6	30.1
Sunflower	Grain	56.8	25.9	105.0
Cotton	Grain	44.5	28.3	74.7

Table 2 : Average uptake of micronutrients by some rainfed crops grown in tribal villages in Nalgonda district, Andhra Pradesh

Crop	Economic yield (t ha^{-1})	Total uptake (g ha^{-1})					
		Zn	Fe	Mn	Cu	B	Mo
Maize	1.0	130	1200	320	130	—	—
Sorghum	1.0	72	720	54	6	54	2
Pigeonpea	1.2	38	1440	128	31	—	—
Groundnut	1.9	208	4340	176	68	—	—
Sunflower	0.6	28	645	109	23	—	—
Sesamum	1.2	202	952	138	140	—	—

By using participatory soil sampling and balanced nutrition this NAIP (componet 3) project aimed at improving the livelihoods of rural poor by improving the overall system productivity through adoption of good agricultural practices.

SSNM nutrient deficiency symptoms

Soils of Nalgonda are slightly acidic to alkaline. Among major nutrients N and P deficiency are very common to the extent of 76 and 29% respectively. Sulphur, B and Zn deficiencies are to the extent of 61 and 51%, respectively, and Fe and Zn deficiencies were observed in 4% and 9% fields respectively. General description of the study sites are given in Table 3.

All the crops grown in the cluster are associated with nutrient deficiencies both macro and micro. For optimal crop yield, producers need to recognize the symptoms of nutrient deficiency, the lack of plant available nutrients or nutrient toxicity and excess nutrient uptake. Crops are affected by immediate factors such as weather conditions or injury, excess fertilizer, pesticide drift or insect infestations which may appear to be nutrient deficiencies. It is critical therefore to perform regular soil testing to determine nutrient levels and monitor changes in soil nutrient status. The deficiency symptoms of N, P, K, S, Zn, Fe, and B for major crops grown in Dupahad cluster are discussed below.

Table 3 : Details of study sites/villages and soil types in Dupahad cluster in Nalgonda district

District/Cluster Villages	No of villages	No. of households	Area (ha)	Characteristics of the cluster	Soil Type	Crops
New Banjara Hills, Jamal Kunta Thanda, Seetamma Thanda, Yellapa Kunta Thanda, Chinagore Kunta Thanda, Pedagore Kunta Thanda, Peda Seetharam Thanda, China Seetharam Thanda, Lalsingh Thanda	9+9*	621	500	Highly drought prone area, off season employment and high migration rates, small hamlets/ thandas with more than 80% tribes.	Red and black mix	Groundnut, pigeonpea, greengram, sorghum, vegetables

*Extended villages

Nitrogen (N)

The most common visual symptom of nitrogen deficiency is poor plant growth. Leaves become pale green or yellow because they are unable to make sufficient chlorophyll. Leaves in this state are said to be chlorotic. Lower leaves (older leaves) show symptoms first, since the plant will move nitrogen from older tissues to more important younger ones. Nitrogen content was low in all of the farmer's fields in Dupahad cluster. Most of the rainfed crops grown in Dupahad cluster, on average remove 80 to 100 kg N ha^{-1}. Details of nutrient deficiencies in individual farmer's fields in this cluster indicated severe nitrogen deficiency in soils and were clearly visible in the plants (Fig.1).

Phosphorus (P)

Symptoms include poor growth, and leaves that turn blue/green but not yellow, oldest leaves are affected first. Undersides of tomato plant leaves, and the veins and stems, may turn purple. In general black soils are highly deficient in P. However, in red soils, due to high P applications and less P fixation soil P build up has increased. In individual farmer's fields of Dupahad cluster, some of the fields showed available P status as high as 80 kg ha^{-1}. The status of P in soils of this cluster can be classified as low to medium, and crops like maize do show P deficiency (Fig.2).

Fig. 1 : Nitrogen deficiency in Sorghum and Tomato

Fig. 2 : Phosphorus deficiency in Maize in Dupahad cluster, Nalgonda

Potassium (K)

Typical symptoms of potassium deficiency in plants include brown scorching and curling of leaf tips as well as chlorosis (yellowing) between leaf veins (Fig. 3). Purple spots may also appear on the leaf undersides. Plant growth, root development, and seed and fruit development are usually reduced in potassium-deficient plants. Often, potassium deficiency symptoms first appear on older (lower) leaves because potassium is a mobile nutrient, meaning that a plant can allocate potassium to younger leaves when it is K deficient. The K status of soils in Dupahad cluster is low to medium. In this cluster out of the 20 farmer's fields tested during pre *kharif*, 2010 for site specific nutrient management in groundnut, greengram and vegetable crops, 12 fields needed K application.

Fig. 3 : Potassium deficiency in Maize, Tomato and Custard apple in light-textured soils

Sulphur (S)

Whenever the S status of growing plants drops below the critical level required, visual symptoms of S deficiency start appearing on the plant. Sulphur deficiency symptoms in many ways resemble those of N - that is, the leaves become pale-yellow or light-green (Fig. 4). Unlike N, S-deficiency symptoms appear first on the younger leaves, and persist even after N application. Plants deficient in S are small and spindly with short and slender stalks, their growth is retarded, maturity in cereals is delayed, nodulation in legumes may be poor and N-fixation reduced, fruits often do not mature fully and remain light-green in color, forages contain undesirably wide N:S ratio and thus have lower nutritive value. The S content of Dupahad cluster ranged from low to high, however S deficiency was widespread in this cluster with 30 percent of farmer's field's deficit in S.

Fig. 4 : Sulphur deficiency in Groundnut in red soils

Calcium (Ca)

Calcium deficiency symptoms appear initially as localized tissue necrosis leading to stunted plant growth, necrotic leaf margins on young leaves or curling of the leaves, and eventual death of terminal buds and root tips. In Dupahad cluster tomato crop was affected by calcium deficiency in soils

Fig. 5 : Calcium deficiency in tomato : Emerging constraint in light-textured red soils

(Fig. 5). Symptoms start as sunken, dry decaying areas at the bottom end of the fruit, furthest away from the stem, not all fruit on a truss is necessarily affected.

Zinc (Zn)

In a mild deficiency, pale green stripes appear on either side of the mid-rib of young leaf blades. On middle-aged leaves, these stripes become necrotic and the colour of the central leaf changes to a muddy grey-green. In severe deficiencies, leaves turn yellow and the plants are stunted. Dead patches on the leaf cause it to bend or collapse. Both mild and severe zinc deficiencies will reduce grain yield. The Zn content of Dupahad cluster was high in majority of farmer's fields, however Zn deficiency was seen in one or two villages where citrus crops were grown (Fig. 6).

Iron (Fe)

The symptoms of iron deficiency appear on the youngest, newest leaves. The area between the leaf veins becomes pale yellow or white (this is called interveinal chlorosis). Usually, no noticeable physical deformity occurs, but in severe cases the youngest leaves may be entirely white and stunted (Fig. 7). It may be difficult to distinguish iron

Fig. 6 : Zinc deficiency in citrus and Jasmine in degraded soils of Dupahad cluster

Fig. 7 : Iron deficiency in Groundnut and citrus crops in Dupahad cluster

deficiency symptoms from those of other nutrients, particularly zinc, which has similar symptoms in many plants. In iron deficient leaves, interveinal chlorotic lesions are angular and outlined by the leaf veins, whereas the chlorotic lesions in zinc deficient leaves are more rounded and the edges less sharp. In Dupahad cluster Fe deficiency was sufficient in most of the villages except in 2 villages where it was deficient and sufficient. For instance, deficiency and sufficiency ranges of Fe in some villages of Dupahad cluster indicated that Fe concentrations below 66 mg kg^{-1} were Fe deficient, and above were sufficient. Citrus crops grown in this cluster showed Fe deficiency.

Boron (B)

The symptoms of boron deficiency reflect the several functions boron fulfills in the plant, but symptoms differ greatly among plant species. The symptoms can often be confused with other deficiencies or disorders (such as virus disease, frost or hormone damage) that cause distorted growth. They also vary depending on the severity of the deficiency. Boron does not easily move around the plant, and therefore a deficiency is most likely to be seen in the younger tissues first. Boron deficiency was badly seen in vegetable crops grown in Dupahad cluster. Boron was deficient in soils of all the villages in the cluster. Tomato crop showed boron deficiency to a larger extent (Fig. 8).

Participatory soil sampling

Soil samples from 286 farmers' fields covering 9 thandas in Dupahad cluster of Nalgonda districts were collected during 2009 with farmer participation in soil sampling (Fig. 9). After conducting farmers' meeting in each village and depending upon soil type, crop, slope and management, about 30% of farmers' fields were selected for sampling using stratified random methodology. The identified farmers were made into groups for demonstration of soil sampling procedure. Collected soil samples were labeled with cluster name, village name and farmer's name. In most of the clusters, village sarpanch or village head was involved in participatory soil sampling. Collected soil samples were analyzed in the soil chemistry laboratory at Gaddipally and CRIDA (Fig. 10a, 10b).

Fig. 8 : Boron deficiency in guava and tomato : Emerging nutritional constraint in vegetable and fruit crops in Dupahad cluster, Nalgonda

Fig. 9 : Participatory soil sampling untertaken from farmer fields

Soils analysis

The soil pH was measured by glass electrode using a soil to water ratio of 1:2; electrical conductivity (EC) was determined by an EC meter using a soil to water ratio of 1:2. Organic carbon was determined using the Walkley-Black method (Nelson and Sommers 1996). Available N was determined by alkaline permanganate method (Subbiah and Asija 1956). Available P was determined by Olsen (Olsen and Sommers 1982) and Bray methods, respectively in neutral to alkaline and acidic soils, K by neutral normal ammonium acetate method (Hanway and Heidel 1952), available S was measured using 0.15% calcium chloride ($CaCl_2$) solution as an extractant (Tabatabai 1996), available micronutrients (Zn, Fe, Cu and Mn) were extracted by DTPA reagent (Lindsay and Norvell 1978) and available B was extracted by hot water (Keren 1996). A fertility status report for all the villages under the cluster was prepared based on these analyses (Table 4)

Fertility status of the soils of Dupahad cluster

Soil fertility of the cluster of villages was carried out with farmer participation. Soil reaction, electrical conductivity and fertility status of soils of different villages in the cluster are presented in Table 4. Soils of Dupahad cluster in Nalgonda district showed pH ranging from acidic to the alkaline range. From the analysis of several samples collected from 9 hamlets it was found that some of the soils in hamlets like Jalmal Kunta Thanda, Pedagore Kunta Thanda, Peda Seetharam Thanda are slightly acidic. However, no salinity problems were observed.

Fig. 10a : Soil testing of farmers field samples done at KVK, Gaddipally

However, mean EC of soil samples in all clusters was normal. Organic carbon content of different clusters varied widely among villages. Mean values of organic carbon ranged from 0.46% in Dupahad cluster to 0.70% in Tummalacheruvu cluster. Organic carbon status was low to medium, with low available N, and low to high available P. Among the micronutrients, most of the soils were deficient of available B and in some villages Zn deficiency was also found (Srinivasarao et al. 2006, 2008). Based on the critical limits considered for low content, soils of these villages were labeled as normal, low, medium, high, deficient and sufficient (Table 5).

Fig. 10b : Soil analysis being done at CRIDA, Hyderabad

Name of the farmer : A. LAGUPATHI

Village : PEDA SEETHARAM THANDA

I have been applying fertilizers in excess in particular Urea and DAP. With soil health card based balanced nutrition in particular SSNM as recommended by CRIDA under NAIP programme higher yields of groundnut were recorded in my fields.

Table 4 : Village-wise soil fertility status in different farmer's fields of Dupahad cluster in Nalgonda district of Andhra Pradesh.

Name of the village		PH	EC dS/m	SOC %	Av. P mg kg^{-1}	Av. K	Av S	Av. B	Av.Zn
New Banjara Hills (11)*	Range	6.8-8.4	0.19-0.52	0.25-0.61	2.8-50.4	58-186	4.2-20.4	0.12-0.72	0.22-0.86
	Mean	7.7	0.27	0.43	13.3	101	8.1	0.32	0.53
	%deficient farmers' field			**64**	**18**	**0**	**82**	**91**	**82**
Jamal Kunta Thanda (33)	Range	6.1-8.5	0.04-0.73	0.14-0.92	0.6-36.8	34-247	2.8-61.4	0.06-1.00	0.30-6.58
	Mean	7.7	0.24	0.45	9.1	98	12.6	0.32	0.99
	%deficient farmers' field			**70**	**39**	**9**	**70**	**91**	**61**
Seetamma Thanda (7)	Range	6.3-8.1	0.03-0.68	0.31-0.96	0.2-18.2	36-131	2.1-139.0	0.04-0.60	0.30-4.96
	Mean	7.6	0.29	0.62	12.6	82.0	27.9	0.32	1.31
	%deficient farmers' field			**29**	**14**	**14**	**57**	**86**	**57**
Yellapa Kunta Thanda (13)	Range	6.2-8.2	0.08-0.66	0.35-1.13	5.3-22.1	21-116	2.8-45.9	0.06-0.74	0.34-1.78
	Mean	7.7	0.28	0.69	11.6	63	13.5	0.37	0.84
	%deficient farmers' field			**46**	**0**	**38**	**69**	**85**	**38**
Chinagore Kunta Thanda (24)	Range	6.7-9.0	0.05-1.60	0.16-0.69	4.0-18.0	51-346	3.0-140.3	0.10-1.20	0.22-1.18
	Mean	7.9	0.43	0.44	8.4	131	27.1	0.44	0.7
	%deficient farmers' field			**73**	**13**	**0**	**46**	**75**	**54**
Pedagore Kunta Thanda (16)	Range	5.5-8.5	0.03-0.57	0.19-0.94	1.0-31.2	34-102	3.8-43.8	0.04-0.78	0.22-2.64
	Mean	7.5	0.21	0.34	7.0	62	12.5	0.25	0.74
	%deficient farmers' field			**93**	**44**	**31**	**63**	**94**	**69**
Peda Seetharam Thanda (17)	Range	5.8-8.3	0.03-0.43	0.21-0.48	1.4-25.4	41-139	3.2-16.6	0.06-0.50	0.42-1.42
	Mean	6.8	0.15	0.34	6.70	78	5.9	0.18	0.77
	%deficient farmers' field			**100**	**53**	**12**	**94**	**100**	**53**
China Seetharam Thanda (15)	Range								
	Mean	6.6-8.6	0.07-0.62	0.30-0.67	1.6-12.2	39-105	3.5-60.5	0.12-0.80	0.62-4.88
	%deficient farmers' field	8.1	0.37	0.50	7.4	68	25.3	0.46	1.95
				53	**33**	**7**	**20**	**67**	**7**
Lalsingh Thanda (7)	Range	7.2-8.3	0.18-0.72	0.26-0.82	4.0-16.4	29-196	4.6-120.8	0.22-0.58	0.58-4.90
	Mean	8.0	0.34	0.56	9.2	73	30.2	0.40	2.28
	%deficient farmers' field			**29**	**29**	**43**	**29**	**86**	**14**
Cluster summery (143)	Range	5.5-9.0	0.03-1.60	0.14-1.13	0.2-50.4	21-346	2.1-140.3	0.04-1.20	0.22-6.58
	Mean	7.6	0.29	0.46	9.0	89	17.0	0.34	1.02
	%deficient farmers' field			**68**	**29**	**14**	**61**	**86**	**51**

NB: Critical limits considered for low content: OC< 0.5, Av. N<280 kg ha^{-1}, Av. P<12 kg ha^{-1}, Av. K<120 kg ha^{-1}, Av. S<22.4 kg ha^{-1}, Zn<0.75 mg kg^{-1}, Cu<0.5 mg kg^{-1}, Fe < 6 mg kg^{-1}, Mn <1.0 mg kg^{-1}, B<0.58 mg kg^{-1}. * indicates number of farmers fields.

Table 5 : Summary of soil fertility status in tribal farmer's fields in Dupahad cluster, Nalgonda District (Total of 256 farmer's fields)

Name of the village	pH	EC	SOC	N	P	K	S	B	Zn	Fe	Cu	Mn
		dS/m	%	kg ha^{-1}				mg kg^{-1}				
New Banjara hills	Normal	N	L-M	L	L-H	L-M	L-H	D	D	S	S	S
Jamal Kunta Thanda	Slightly acidic-Normal	N	L-M	L	L-H	L-M	L-H	D	S	S	S	S
Seetamma Thanda	Normal	N	L-M	L	L-M	L-M	L-H	D	S	D-S	S	S
Yellapa Kunta Thanda	Normal	N	L-M	L	L-M	L	L-H	D	S	S	S	S
Chinagore Kunta Thanda	Normal to Alkaline	N	L-M	L	L-M	L-H	L-H	D	D	D-S	S	S
Pedagore Kunta Thanda	Slightly acidic to Normal	N	L-M	L	L-H	L	L-H	D	S	S	S	S
Peda Seetharam Thanda	Slightly acidic to Normal	N	L	L	L-H	L-M	L-M	D	S	S	S	S
China Seetharam Thanda	Normal	N	L-M	L	L	L	L-H	D	S	S	S	S
Lalsingh Thanda	Normal	N	L-M	L	L-M	L-M	L-H	D	S	S	S	S

NB: N = Normal; L= Low; M = Medium; H = High; D = Deficient; S = Sufficient

Soil Health Card (SHC)

The soil health card evaluates the health or quality of a soil as a function of its characteristics, water, plant and other biological properties. Based on in-depth studies, soil health cards list the vital components of a particular patch of land. They provide detailed information on various minerals present in the land, suitable crops, fertilizers to be used, and also whether the land is acidic or alkaline. The card is a tool to help the farmer to monitor and improve soil health based on their own field experience and working knowledge of their soils. Regular use will allow them to record long term trends in soil health and to assess the effects of different soil management practices. This card is most effective when filled out consistently by the same person over time. It provides a qualitative assessment of soil health and evaluation ratings do not represent any absolute measures or value. The purpose is not to compare one soil type against another, but rather to use indicators that assess each soil's ability to support crop production within its capabilities and site limitations.

Central Research Institute for Dryland Agriculture (CRIDA) has evolved a new model of issuing SHCs based on farmer's participatory soil analysis. Before collecting soil samples in the village, meetings were organized to create awareness and farmers were trained to collect soil samples in their own field. A team of experts analyze samples of soil from farmer's fields for pH, EC, organic carbon, available NPK and micro nutrients (Table 6). Thus farmers realized the value of soil testing and applying the nutrients according to recommendations (Table 7).

Based on these recommendations soil health cards were prepared. First the cards were developed in English language, but due to the language barrier, cards were translated into local language "Telugu" (Fig. 11). More than 1800 farmers were given soil health cards in local languages "Telugu" by indicating district, mandal, village, farmer's name, survey number of the field, nutrient deficiencies, crop wise fertilizer doses and details of manure and fertilizers with nutrient contents etc. Soil health cards development based on this model was done in Dupahad cluster of Nalgonda district. Based on soil health cards, Site Specific Nutrient Management (SSNM), balanced nutrition and Integrated Nutrient Management (INM) options were implemented in Dupahad cluster by suitable crop and nutrient management interventions.

Table 6 : Soil test report of selected tribal farmer's fields of Dupahad cluster of Nalgonda district, AP

Name of the village	Crop	N	P	K	S	Zn	Cu	Fe	Mn
		(kg ha^{-1})				(mg kg^{-1})			
Jamalkunta tanda	Greengram	136	80.3	104	90.6	2.72	1.20	6.4	3.5
Jamalkunta tanda	Groundnut	192	23.4	74	43.8	0.38	0.60	12.5	8.4
New Banjarahills	Greengram	297	38.8	152	5.5	0.58	0.70	6.4	7.6
Jamalkunta tanda	Greengram	188	57.6	399	41.6	0.90	1.40	6.4	6.1
Jamalkunta tanda	Greengram	212	24.9	116	16.1	0.44	0.90	2.0	7.6
Seetamma tanda	Greengram	249	41.7	97	31.0	0.37	0.90	10.6	20.3
Jamalkunta tanda	Greengram	171	35.9	308	22.5	0.41	0.70	1.7	5.8
New Banjarahills	Greengram	288	28.7	217	5.5	0.22	1.20	2.6	6.7
Peddagarakunta tanda	Greengram	291	42.2	70	7.6	0.51	1.30	5.5	4.5
Jamalkunta tanda	Greengram	202	21.0	305	37.4	0.46	0.60	1.0	8.0
Jamalkunta tanda	Greengram	188	9.9	83	67.2	0.53	0.90	9.9	6.4
Jamalkunta tanda	Greengram	299	28.7	198	41.6	0.55	1.30	3.9	4.2
Jamalkunta tanda	Greengram	166	21.5	118	7.6	0.51	0.90	10.4	11.6
Jamalkunta tanda	Greengram	242	14.7	193	9.8	0.39	1.00	3.2	5.2
Jamalkunta tanda	Greengram	302	14.7	283	7.6	0.47	1.60	6.2	8.3
Jamalkunta tanda	Greengram	231	18.1	170	41.6	0.89	1.50	6.6	3.8
Jamalkunta tanda	Greengram	212	38.8	284	52.3	0.41	0.50	1.3	4.8
Jamalkunta tanda	Greengram	235	32.6	114	33.1	0.39	0.60	5.1	1.5
Jamalkunta tanda	Bhendi	162	11.4	77	35.3	0.41	1.20	8.0	2.7
Peddagarakunta tanda	Greengram	299	35.5	151	26.8	0.79	1.10	5.6	3.1

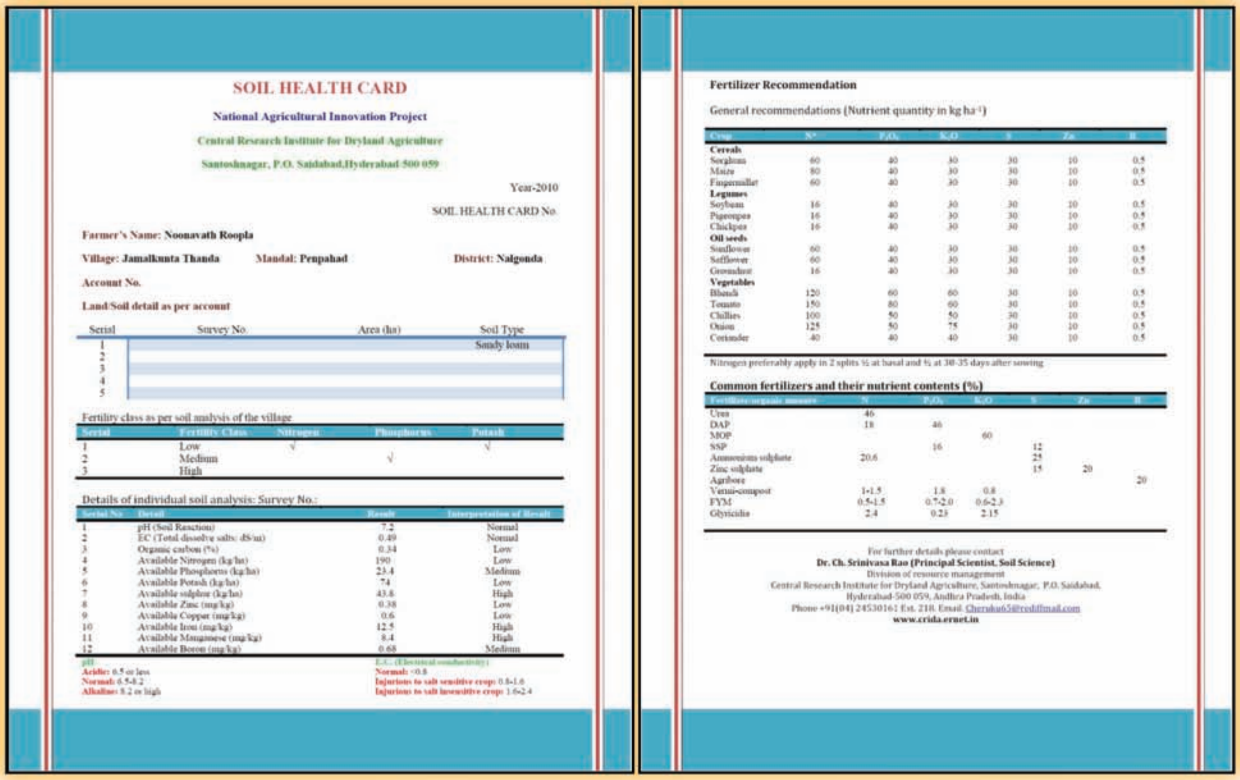
Table 7 : Farmer field specific fertilizer recommendation developed for oilseed/pulse crop (viz. groundnut, green gram, vegetable crops (tomato and ladies finger) as on soil test value for Dupahad cluster of Nalgonda district, AP

Farmer No.	Tribal village	Crop	Fertilizer requirement (kg ha^{-1})				
			Urea	DAP	MOP	Gypsum	ZnSO4
1	Jalmakunta tanda	Green gram	50	-	90	-	-
2	Jalmakunta tanda	Groundnut	-	125	90	-	50
3	New Banjarahills	Groundnut	50	-	65	150	50
4	Jalmakunta tanda	Green gram	50	-	-	-	25
5	Jalmakunta tanda	Green gram	-	125	90	150	50
6	Seetamma tanda	Groundnut	50	-	90	-	50
7	Jalmakunta tanda	Green gram	50	-	-	-	50
8	New Banjarahills	Groundnut	-	125	65	150	50
9	Peddagarakunta tanda	Green gram	50	-	90	150	50
10	Jalmakunta tanda	Green gram	-	125	-	-	50
11	Jalmakunta tanda	Green gram	-	125	90	-	50
12	Jalmakunta tanda	Green gram	50	-	65	-	50
13	Jalmakunta tanda	Green gram	-	125	90	150	50
14	Jalmakunta tanda	Green gram	-	125	65	150	50
15	Jalmakunta tanda	Groundnut	-	125	65	150	50
16	Jalmakunta tanda	Groundnut	-	125	65	-	25
17	Jalmakunta tanda	Green gram	50	-	65	-	50
18	Jalmakunta tanda	Tomato	50	-	90	-	50
19	Jalmakunta tanda	Bhendi	-	125	90	-	50
20	Peddagarakunta tanda	Tomato	50	-	65	-	25

Name of the farmer : D. SAMYA

Village : JAMALKUNTA THANDA

Soil health cards issued by CRIDA under NAIP programme have benefited me in increasing the crop yield. I have now realized the value of soil testing and applying the nutrients according to recommendations. I can now check my input cost on fertilizer inputs and apply only need based.



SOIL HEALTH CARD

National Agricultural Innovation Project

Central Research Institute for Dryland Agriculture

Santoshnagar, P.O. Saidabad,Hyderabad 500 059

Year-2010

SOIL HEALTH CARD No.

Farmer's Name: Noonavath Roopla

Village: Jamalkunta Thanda **Mandal:** Penpahad **District:** Nalgonda

Account No.

Land/Soil detail as per account

Serial	Survey No.	Area (ha)	Soil Type
1			Sandy loam
2			
3			
4			
5			

Fertility class as per soil analysis of the village

Serial	Fertility Class	Nitrogen	Phosphorus	Potash
1	Low	√		√
2	Medium		√	
3	High			

Details of individual soil analysis: Survey No.:

Serial No	Detail	Result	Interpretation of Result
1	pH (Soil Reaction)	7.2	Normal
2	EC (Total dissolve salts: dS/m)	0.49	Normal
3	Organic carbon (%)	0.34	Low
4	Available Nitrogen (kg/ha)	190	Low
5	Available Phosphorus (kg/ha)	23.4	Medium
6	Available Potash (kg/ha)	74	Low
7	Available sulphur (kg/ha)	43.8	High
8	Available Zinc (mg/kg)	0.38	Low
9	Available Copper (mg/kg)	0.6	Low
10	Available Iron (mg/kg)	12.5	High
11	Available Manganese (mg/kg)	8.4	High
12	Available Boron (mg/kg)	0.68	Medium

pH:
Acidic: 6.5 or less
Normal: 6.5-8.2
Alkaline: 8.2 or high

E.C. (Electrical conductivity):
Normal: <0.8
Injurious to salt sensitive crop: 0.8-1.6
Injurious to salt insensitive crop: 1.6-2.4

Fertilizer Recommendation

General recommendations (Nutrient quantity in kg ha⁻¹)

Crop	N*	P_2O_5	K_2O	S	Zn	B
Cereals						
Sorghum	60	40	30	30	10	0.5
Maize	80	40	30	30	10	0.5
Fingermillet	60	40	30	30	10	0.5
Legumes						
Soybean	16	40	30	30	10	0.5
Pigeonpea	16	40	30	30	10	0.5
Chickpea	16	40	30	30	10	0.5
Oil seeds						
Sunflower	60	40	30	30	10	0.5
Safflower	60	40	30	30	10	0.5
Groundnut	16	40	30	30	10	0.5
Vegetables						
Bhendi	120	60	60	30	10	0.5
Tomato	150	80	60	30	10	0.5
Chillies	100	50	50	30	10	0.5
Onion	125	50	75	30	10	0.5
Coriander	40	40	40	30	10	0.5

Nitrogen preferably apply in 2 splits ½ at basal and ½ at 30-35 days after sowing

Common fertilizers and their nutrient contents (%)

Fertilizer/organic manure	N	P_2O_5	K_2O	S	Zn	B
Urea	46					
DAP	18	46				
MOP			60			
SSP		16		12		
Ammonium sulphate	20.6			25		
Zinc sulphate				15	20	
Agribore						20
Vermi-compost	1-1.5	1.8	0.8			
FYM	0.5-1.5	0.7-2.0	0.6-2.3			
Glyricidia	2.4	0.23	2.15			

For further details please contact
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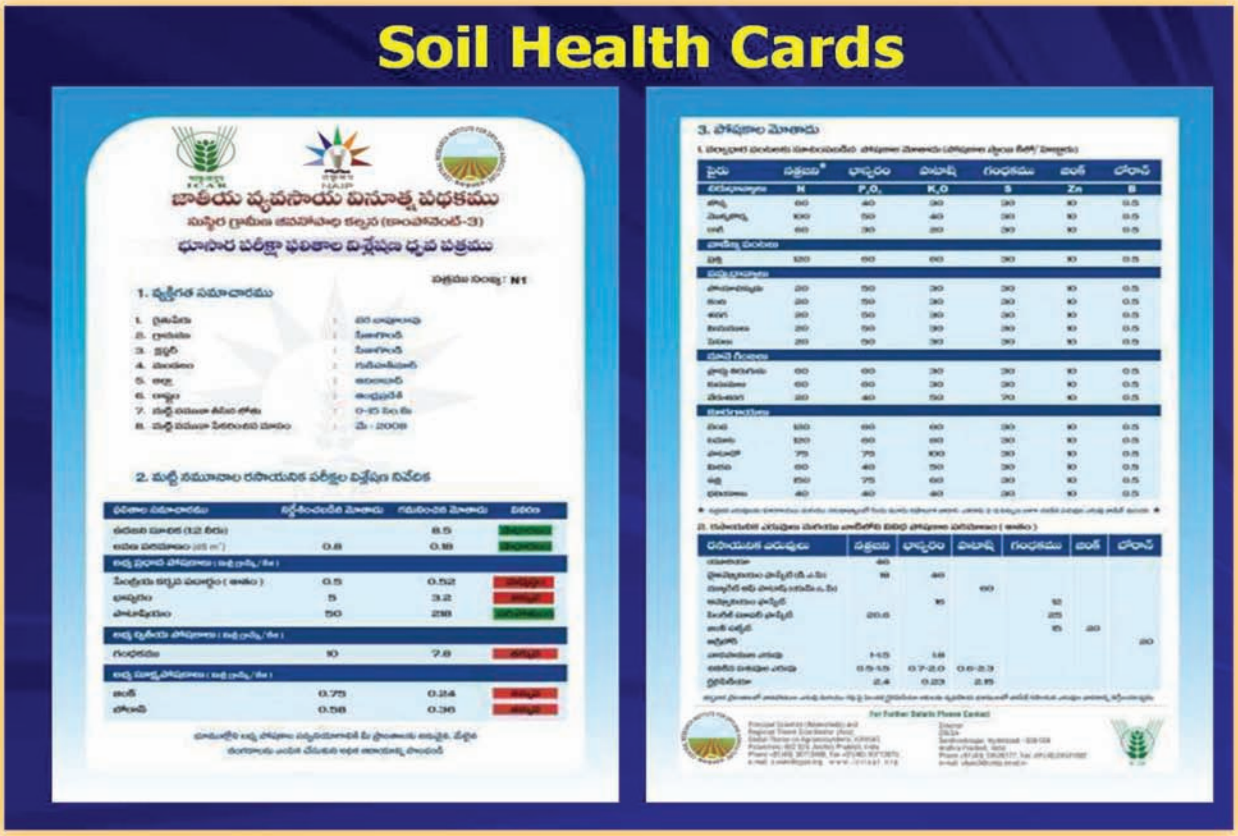


Fig. 11 : Model soil health cards developed and distributed among the farmers in 9 villages in the cluster initially and extended to other adjoining villages later.

Group discussions, fertilizer recommendation, and field demonstrations

On-farm SSNM demonstrations based on 50:50 percent cost sharing was initiated in Dupahad cluster of Nalgonda district. As per recommendations made for each farmer, fertilizers were applied to each selected farmer's field. Before this intervention meetings were organized in these villages (Fig. 12), and demonstration plots were measured for 0.5 acre as SSNM (improved practice based on soil testing) to compare with farmer's practice of blanket application without soil testing. Before the start of on-farm trials fertilizer recommendations based on soil health card were given to farmers for SSNM demonstrations (Fig. 13).

Fig. 12 : Organizing Gram Sabha and discussions on soil test data with tribal farmers and field visits on proposed intervention

Fig. 13 : Need based fertilizer to farmers for on farm trails in groundnut (based on soil testing farmer's fields; 50% cost basis)

On farm trials

During 2009-12, a total of 89 on-farm trials were conducted with different test crops (groundnut, greengram, cotton, sorghum and vegetable crops like tomato and Bhindi) in 9 tribal villages of Dupahad cluster with the objective to demonstrate the comparative evaluation of SSNM and balanced nutrition and farmers practice (Fig. 14-16). Crops were grown on selected farmers' fields with known fertility status and SSNM based nutrient application. Balanced nutrition was compared with the farmers' practice in an area of half acre in each of the farmers' fields. The balanced nutrition included a recommended dose of fertilizers (90 kg N and 50

Fig. 14 : Impact of balanced nutrition on groundnut in Dupahad cluster

kg P_2O_5 for cotton, 20 kg N and 40 kg P_2O_5 for groundnut and green gram, 150 kg N and 80 kg P_2O_5 for tomato and 120 kg N and 60 kg P_2O_5 for Bhindi) along with basal application of micro-nutrient mixture of 2.5 kg agribor/5 kg borax (0.5 kg B ha^{-1}), 50 kg zinc sulphate (10 kg Zn ha^{-1}) and 200 kg gypsum/elemental sulphur (30 kg S ha^{-1}). Farmer's practice in each trial was documented, which included suboptimal dose of N and P. Entire dose of N and P was applied as basal. Besides, other crop management practices like weeding and pest and disease control measures were followed. The data on crop yield and economic returns were analyzed considering farmers as replications using one way ANOVA with randomized blocks on GenStat.

Fig. 15 : Impact of balanced nutrition on greengram and yield recording in Dupahad Cluster

Fig. 16 : Impact of balanced nutrition on spinach in Dupahad cluster

Yield advantage by implementing balanced nutrition

Before the introduction of balanced nutrition, farmers of Dupahad cluster used fertilizers without soil test based, and mostly blanket recommendation on a large scale. In crops like groundnut and green gram in Dupahad cluster of Nalgonda district, mean seed/pod yield increased from 1.08 to 1.41 t ha^{-1} and from 0.54 t ha^{-1} to 0.75 t ha^{-1}, respectively due to balanced nutrition registering 31.1 and 39.6% yield increase. Similarly, greengram and groundnut response also varied from 33% to 47% and 18% to 44%, respectively. In Dupahad cluster of Nalgonda, balanced nutrition improved groundnut, greengram, tomato and bhindi yield significantly in many farmers' fields (Fig. 18, 19, 20 & 21). In some of the farmer's fields, groundnut yield reached to 1.5 t ha^{-1} with balanced nutrition registering the increase in yields from 30-40 percent over farmer's practice. There was increase in the yield of vegetable crops particularly leafy vegetables (i.e. Spinach, *Hibiscus Cannabinus* and *Basella alba*) through balanced nutrition (Fig. 17).

Fig. 17 : Leafy vegetables (Spinach, Hibiscus Cannabinus and Basella alba) grown with balanced nutrition

Similarly greengram yield reached to 0.85 t ha^{-1} with balanced nutrition registering the increase in yields from 25-45 percent over farmer's practice. For tomato, yield reached to 33 t ha^{-1} with balanced nutrition registering the increase in yields from 25-50 percent over farmer's practice. And for bhindi, yield reached to 13 t ha^{-1} with balanced nutrition registering the increase in yields from 25-40 percent over farmer's practice.

In all the crops (oilseed, food legume and vegetables) groundnut, green gram, tomato and bhindi, showed much wider gaps at higher productivity level in yields between farmer's practice and SSNM. Among vegetable crops, tomato and Bhindi mean yield increased from 21.6 t ha^{-1} to 30.4 t ha^{-1} and 8.7 t ha^{-1} to 11.6 t ha^{-1} registering 41% and 33% increase in yield, respectively in Nalgonda district (Fig. 22, 23, 24 & 25).

In groundnut, SSNM treated soils showed a significant increase in yield over farmer's practice with the highest yield of 1.5 t ha^{-1} as compared to 1.2 t ha^{-1} in one of the farmer's field. The increase in yield was consistent in all the farmer's fields. The increase in yield was more than 1.2 t ha^{-1} with a mean value of 1.4 t ha^{-1} through SSNM.

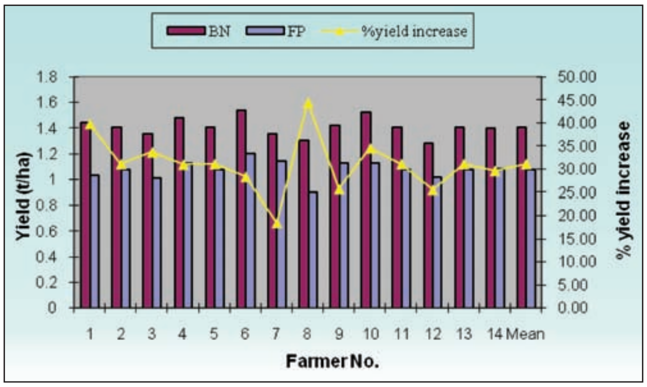


Fig. 18 : Effects of balanced fertilization on groundnut yield in farmers' fields of Dupahad cluster, Nalgonda district, Andhra Pradesh, 2009-2010. (CD (P=0.05) 0.08).

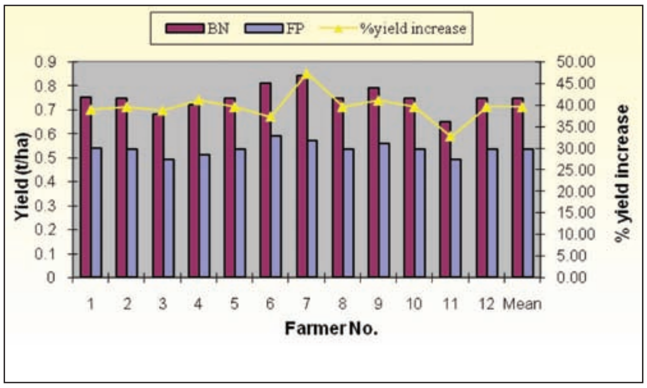


Fig. 19 : Effects of balanced fertilization on green gram yield in farmers' fields of Dupahad cluster, Nalgonda district, Andhra Pradesh, 2009-2010. (CD (P=0.05) 0.07)

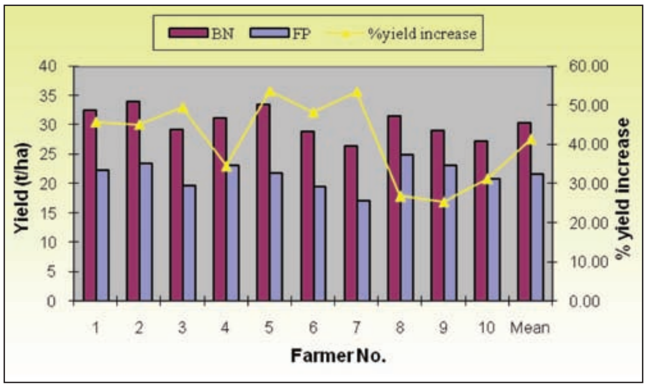


Fig. 20 : Effects of balanced fertilization on tomato yield in farmers' fields of Dupahad cluster, Nalgonda district, Andhra Pradesh, 2009-2010. (CD (P=0.05) 0.9).

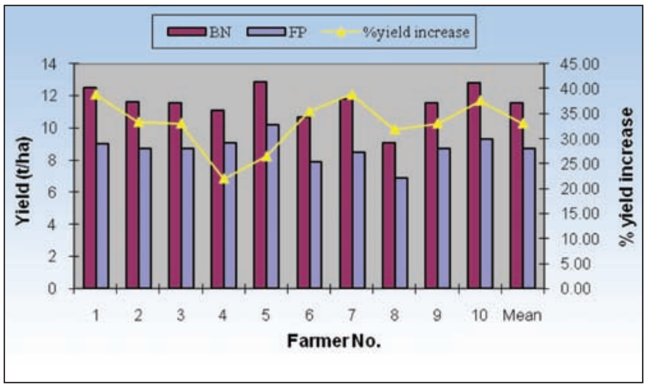


Fig. 21 : Effects of balanced fertilization on Bhindi yield in farmers' fields of Dupahad cluster, Nalgonda district, Andhra Pradesh, 2009-2010. (CD (P=0.05) 0.4).

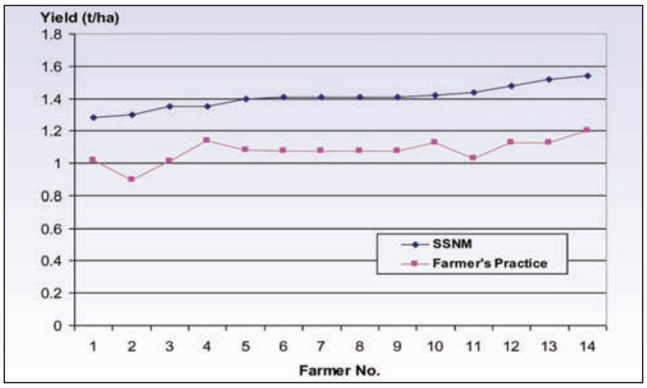


Fig. 22 : Response pattern in groundnut to SSNM over farmer's practice in Dupahad cluster, Nalgonda district.

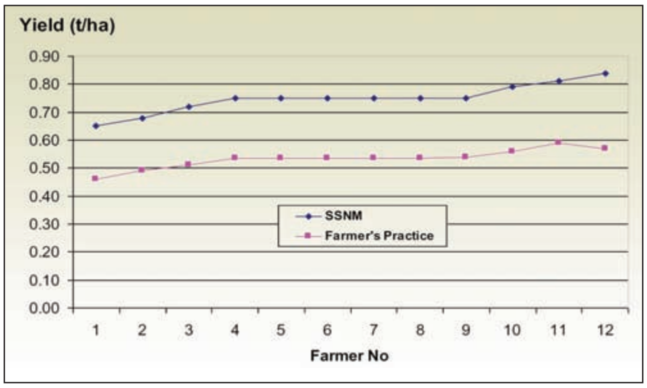


Fig. 23 : Response pattern in greengram to SSNM over farmer's practice in Dupahad cluster, Nalgonda district.

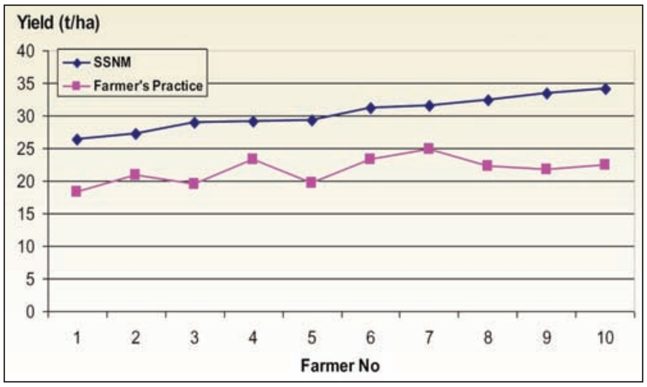


Fig. 24 : Response pattern in tomato to SSNM over farmer's practice in Dupahad cluster, Nalgonda district.

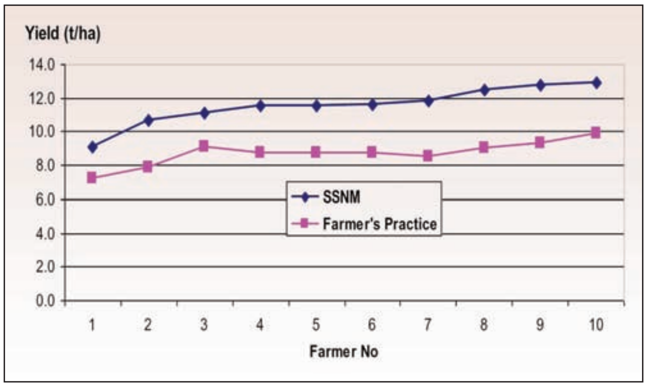


Fig. 25 : Response pattern in bhindi to SSNM over farmer's practice in Dupahad cluster, Nalgonda district.

In greengram, SSNM treated soils showed a significant increase in yield over farmer's practice with the highest yield of 0.85 t ha^{-1} as compared to 0.6 t ha^{-1} in one of the farmer's field. The increase in yield was consistent in all the farmer's fields. The increase in yield was more than the farmer's practice yield of 0.6 t ha^{-1} with a mean value of 0.75 t ha^{-1} through SSNM.

It was found that the magnitude of yield increase due to balanced nutrient management was greater in tomato compared to other vegetables. In tomato SSNM treated soils showed a significant increase in yield over farmer's practice with the highest yield of 34 t ha^{-1} as compared to 25 t ha^{-1} in one of the farmer's field. The increase in yield was consistent in all the farmers' fields. The increase in yield was more than the farmer's practice yield of 25 t ha^{-1} with a mean value of 30 t ha^{-1} through SSNM.

In bhindi, SSNM treated soils showed a significant increase in yield over farmer's practice with the highest yield of 13 t ha^{-1} as compared to 10 t ha^{-1} in one of the farmer's field. The increase in yield was consistent in all the farmer's fields. The increase in yield was more than the farmer's practice yield of 10 t ha^{-1} with a mean value of 12 t ha^{-1} through SSNM.

Name of the farmer : B. LINGA

Village : YELLAPAKUNTA THANDA

SSNM has been a true revelation in increasing my crop yield. I was getting 1.2 t ha^{-1} of groundnut before I started practicing SSNM. Now I am able to get 1.5 t ha^{-1}. I apply only needed fertilizers now.

Impact of balanced nutrition on farm income

Addition of deficient nutrients increased yield and benefits to farmers in a spectacular manner. In Dupahad cluster, by adopting SSNM and balanced nutrition approach over the farmer's practice, yield levels were improved from 18-44% in groundnut, 33-47% in green gram; and in vegetable crops from 25 to 54% in tomato and 7-10% in Bhindi. Net income and return per rupee investment also improved substantially through balanced nutrition. These results clearly bring out the potential of SSNM and balanced nutrition in enhancing household income of tribal farmers. The economic viability of balanced nutrition over the farmers' practice was calculated depending on prevailing prices of input and output costs. The additional cost incurred in the balanced nutrition as compared to farmers' practice was mainly due to micro and secondary nutrients and additional N and P. Net income and return per reinvestment improved substantially through balanced nutrition. In groundnut crop net income obtained was Rs. 8380-13840 ha^{-1} in Nalgonda, through balanced nutrition. Similarly in other crops of Dupahad cluster, net returns obtained Rs. 4207-8995 ha^{-1} in greengram, Rs. 47526-78329 ha^{-1} in tomato and Rs. 15570-38370 ha^{-1} in Bhindi through balanced nutrition in comparison Rs. 2600-8900 ha^{-1} in groundnut, Rs. 2375-4895 ha^{-1} in greengram, Rs. 12926-43726 ha^{-1} in tomato and Rs. 4570-24370 ha^{-1} in Bhindi through farmer's practice (Table 8). This additional income could substantially benefit the resource poor farmers and improve their livelihoods in the low fertile tribal dominated districts of Andhra Pradesh. Mean value of return per rupee investment was 1.60, 1.55, 2.09 and 1.78 in groundnut, greengram, tomato and Bhindi respectively through balanced nutrition compared to 1.39, 1.35, 1.55 and 1.42 in farmer's practice. Srinivasarao et al. (2010) reported higher B:C ratio in case of tomato (11.4) followed by green chilies (4.26) bitter gourd (2.71) and ridge gourd (1.87). Impact of balanced fertilization in gross return and additional income realized by farmer through vegetable cultivation in Dupahad cluster and net return and benefit: cost ratio of greengram cultivation is presented in Figs 26 and 27.

Table 8 : Economic advantage due to Site Specific Nutrient Management and balanced nutrition followed in different crops in the cluster of villages in tribal dominated district of Andhra Pradesh.

Crop/No. of trials	Cost of cultivation (Rs. ha^{-1})		Net return (Rs. ha^{-1})		Return per Rupee investment	
	BN	FP	BN	FP	BN	FP
Groundnut (14)	18500	16300	8380-13840 (11068)	2600-8900 (6317)	1.45-1.75 (1.60)	1.16-1.55 (1.39)
Greengram (12)	12173	9973	4207-8995 (6691)	2375-4895 (3527)	1.35-1.74 (1.55)	1.24-1.49 (1.35)
Tomato (10)	58074	55874	47526-78326 (63486)	12926-43726 (30526)	1.82-2.35 (2.09)	1.23-1.78 (1.55)
Bhendi (10)	39030	36830	15570-38370 (30345)	4570-24370 (15370)	1.40-1.98 (1.78)	1.12-1.66 (1.42)

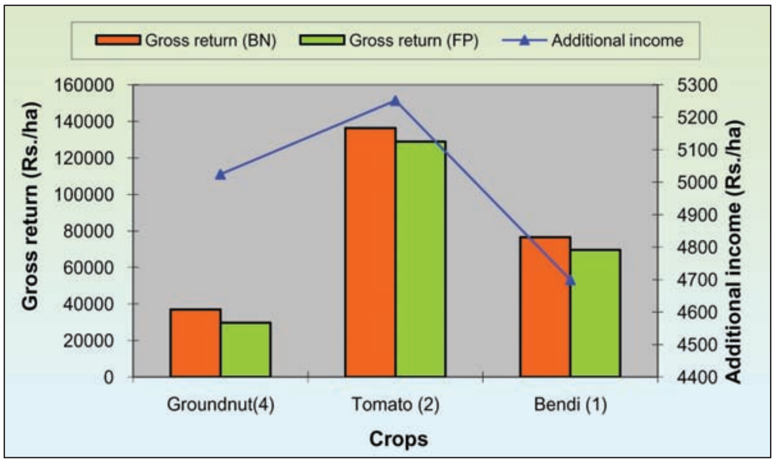


Fig. 26 : Impact of balanced fertilization in gross return and additional income realized by farmer through vegetable cultivation in Dupahad cluster of Nalgonda district, A.P.

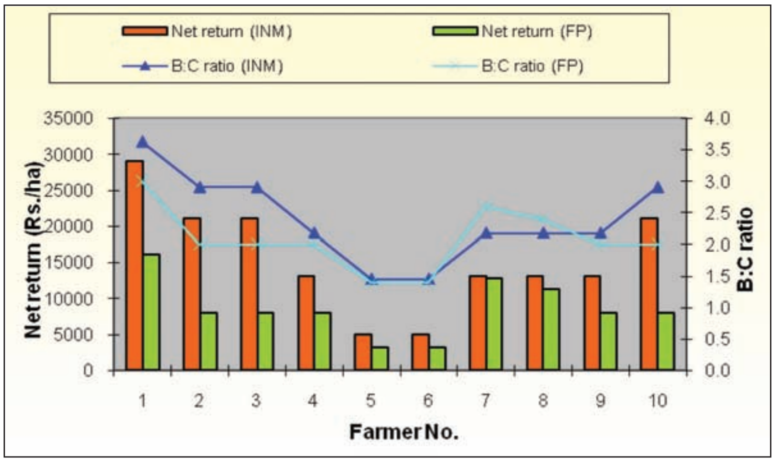


Fig. 27 : Impact of INM in net return and benefit: cost ratio of greengram cultivation in some selected farmer's field of Dupahad cluster of Nalgonda district, A.P.

Impact of SSNM on livelihood

Increasing crop productivity by application of improved technologies was one of the strategies for enhancing the livelihood security of the rural poor in the project. Thus a systematic effort was made to assess the native nutrient status of soil and supplement the same with application of appropriate nutrients in required quantity. Enhancing crop productivity and household income has been adopted by the project as a short term measure towards improving rural livelihoods. It was observed in many cases in the project area that the additional income generated due to higher productivity and profitability was mostly ploughed back into farming as additional capital. Increased vegetable productivity enhanced cash flow in the family in short intervals. The families that participated in SSNM trials have shown higher consumption of vegetables at household level leading to better nutritional security as well.

Many farmers, who realized higher profits due to better nutrient management, used their additional income for improving housing, buying animals, educating children, meeting social obligation etc. In Dupahad cluster of Nalgonda the impact of SSNM was observed mainly in vegetables like tomatoes, Bhindi, leafy vegetables like palak and flower crops such as marigold. Though these did not translate in large gains like in the case of cotton, the additional income contributed to purchasing of household articles, better clothing and additional investment in purchasing better quality inputs for agriculture.

Chapter

5

On Farm Generation of Organic Matter and Soil Health Improvement

There are several strategies to improve soil organic carbon through which soil health can be improved. Better management practices (BMPs) that enhance soil health and allow sustained agricultural productivity need to be promoted in dryland areas. Activities that promote the accumulation and supply of organic matter, such as the use of cover crops, refraining from burning, and those that reduce decomposition rates such as reduced and zero tillage, lead to an increase in the organic matter content in the soil (Sampson and Scholes, 2000). Growing cover crops is one of the best practices for improving organic matter levels and, hence, soil quality. The term green manure is often used to indicate the same plant species that are used as cover crops. However, green manure refers specifically to a crop in the rotation grown for incorporation of the non-decomposed vegetative matter in the soil (Venkateswarlu et al. 2007). Though, horsegram which is a cover crop is not an assured crop for grain production in *rabi* season in deficit rainfall year, it is an assured crop for biomass production (Srinivasarao et al. 2011).

Crop residue recycling, inclusion of legumes in the cropping sequence or as intercrops, green manure crops, green leaf manuring, tank silt addition, farm yard manure, biofertilizers, vermicomposting along with fertilizers and integrated nutrient-water management are some of the important options to improve soil health and crop productivity in rainfed-dryland areas (Srinivasarao et al. 2011a). Green manuring is a key step forward to reduce the use of chemical fertilizers and thus improving soil health. Soil health cards are another means by which soil health can be improved. The soil health cards are prepared based on soil analysis data along with nutrient recommendations to different predominant crops. In most of the semi-arid regions of Andhra Pradesh, a single crop is grown during the rainy or post rainy season with the land remaining fallow for the rest of the period. Legumes can be grown with this rainfall for off season fodder or for incorporation into the soil *in situ*, to improve soil organic carbon and partially meet the nutrient requirement of rainy season crops. Cover crops improve soil by speeding infiltration of excess surface water; relieving compaction and improving structure of overtilled soil, adding organic matter that encourages beneficial soil microbial life and enhancing nutrient cycling.

Gliricidia green leaf manuring

For seed propagation, *Gliricidia* seeds are soaked in water for 8-10 h, preferably overnight (Fig. 1). The soaked seeds are sown in small polythene bags filled with a mixture of red soil, sand, and farmyard manure (1:1:1) and watered regularly. Generally, 3 to 4 month-old seedlings can be planted on bunds in the rainy season. Seed propagation method is more convenient for establishing a large number of plants.

Growing *gliricidia* plants on farm bunds serves dual purpose of producing green leaf manure rich

Fig. 1 : *Gliricidia* seed propagation and nursery in tribal dominated Dupahad cluster, Nalgonda district of A.P.

in N and also helps in conserving soil through reduced soil erosion (Srinivasarao et al. 2009 a, b, c). The *Gliricidia* green leaf manuring technology was promoted in light soils of rainfed tribal and backward districts of Andhra Pradesh, such as Nalgonda district and Operational Research Project (ORP) villages in different regions across the country. Leaf material was applied on the surface of ploughed soil and mixed into soil before crop planting. *Gliricidia* leaf manuring improves organic matter content in the soil, improves soil physical properties, allows the water to infiltrate into the soil more quickly rather than run off the surface, increases water holding capacity of the soil, reduces soil erosion, restores and improves the soil quality and increases crop yields (Srinivasarao et al. 2011). Use of *Gliricidia* as green manure minimizes the usage of chemical fertilizers that are very expensive and also environmentally unfriendly. Initially about 120 farmers were trained in on-farm generation of *gliricidia* leaf manuring in terms of selecting good seed material, soaking, filling of polythene bags with soil and vermicompost, sowing the seed, planting of seedlings. Training was also given on propagation through stem cuttings. Planting was taken up on the field boundaries, common lands, around water harvesting ponds and also as live fencing.

Nutrient additions through Gliricidia

Amount of *Gliricidia* leaf manure application depends upon the growth of boundary plantations. Usually, about 1 to 2 t ha^{-1} leaf manures can be applied. Application of 1 t ha^{-1} *gliricidia* leaf manure provides 21 kg N, 2.5 kg P, 18 kg K, 85 g Zn, 164 g Mn, 365 g Cu, 728 g Fe besides considerable

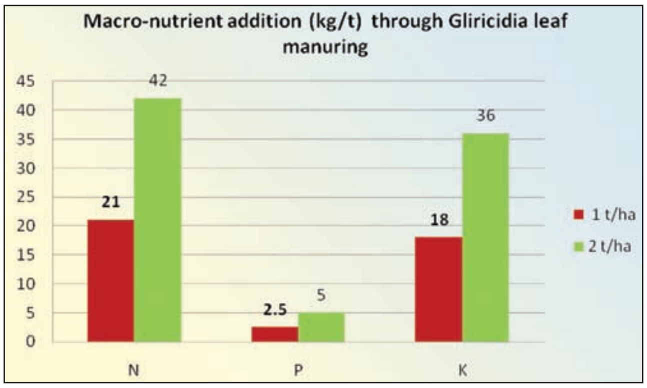


Fig. 2 : Macro nutrient addition through *Gliricidia* leaf manuring at different levels of manure application

quantities of S, Ca, Mg, B, Mo etc. The amounts of nutrients added through 2 t gliricidia ha^{-1} are N (42 kg), P (5 kg), K (36 kg), Zn (170 g), Mn (328g), Cu (730 g) and Fe (1456 g) (Fig. 2 & 3).

Addition of *gliricidia* improves mobilization of native soil nutrients in the soil due to production of carbon dioxide and organic acids during decomposition of the plant material, adds valuable nutrients such as N, P, K, Ca, and Mg to the soil. *Gliricidia* plants grown on 700-m long bunds can provide about 30 kg N ha^{-1}yr^{-1} under rainfed systems with 700-800 mm annual rainfall (Wani, 2010). The major requirement of rainfed crop nutrient needs can be met through 2 t *gliricidia* leaf manuring, if properly added. Remaining nutrient needs of crops can be supplied through chemical fertilizers. Legume crops like chickpea, soybean, groundnut, blackgram, greengram, pigeonpea do not need any additional N application, if 2 t *gliricidia* leaf manure per ha is applied. Similarly, P and K needs in most of the dryland crops like sorghum, pearlmillet, upland rice, chickpea, groundnut, soybean, sunflower and cotton can be supplied if crops are grown in soils with medium to high nutrient soils. Micronutrient requirement is mostly met through addition of 2 t *gliricidia* ha^{-1} for major rainfed crops.

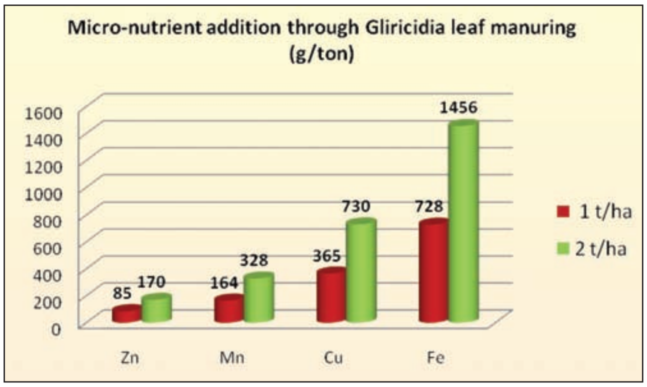


Fig. 3 : Micro-nutrient addition through *Gliricidia* leaf manuring at different levels of manuring

Soil health improvement using Gliricidia

Gliricidia leaf manuring improves organic matter content in the soil. Use of *Gliricidia* as green manure minimizes the usage of chemical fertilizers that are very expensive and also environmentally unfriendly. *Gliricidia* roots stabilize lands with high slopes. *Gliricidia* root rhizosphere soil samples showed improved organic carbon content in different depths of soil profiles (Fig. 4). Similarly biological health of soil improved considerably in terms of population of fungi, bacteria, actinomycetes, total microbial count, microbial biomass carbon and nitrogen. Improvement of soil environment in the *gliricidia* rhizosphere in the field bund soil could be due to improvement of organic carbon and root activity and rhizodeposition (Srinivasarao et al. 2011).

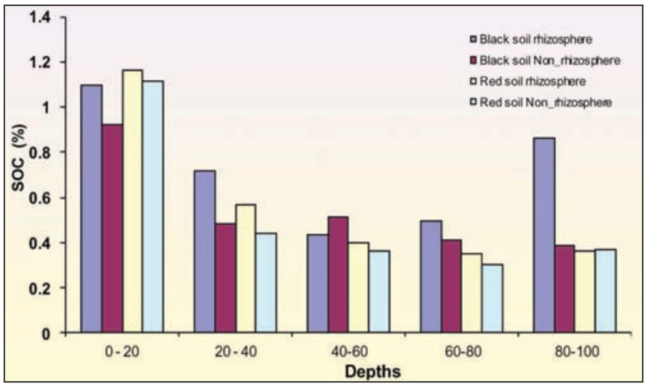


Fig. 4 : Organic carbon content in the soil from gliricidia root rhizosphere in black and red soils

Cover crops as green manuring (Horsegram and Dhaincha)

On farm generation of horsegram biomass or dhaincha (Fig. 5) by using off-season rainfall showed the production of 3.03-4.28 t ha^{-1} yr^{-1} for soil incorporation (Srinivasarao et al. 2011b). Horsegram is a legume crop with a low requirement for water that quickly produces N-rich foliage. Horsegram as a cover crop was introduced in the rainfed dryland district of Nalgonda to improve soil health and water retention. Horsegram incorporation in rainfed sorghum-sunflower and sunflower-sorghum rotations during rainy season demonstrated the restoration of degraded soils and improved crop yields. In general, mean monthly rainfall distribution at the experimental site during 1994-2003 was as follows: total annual rainfall (738mm); crop season (516mm); off season (144mm); fallow period (78mm). After harvest, *kharif* crop horsegram was grown by utilizing off-season rainfall received to the extent of 20%, and incorporated at the flowering stage. Due to improved organic matter and nutrient supplementation the succeeding crops in the system were benefitted.

Tank Silt

Tank silt possesses high water retention capacity and acts as good source of nutrients. Analysis conducted in several tanks in Nalgonda district of Andhra Pradesh showed the potential of tank silt in supplying organic carbon and several nutrients. As tank silt provides all of the nutrients in adequate quantities (Table 1), and also improves soil health and water holding capacity essential for drought proofing in rainfed areas, it can be considered as an alternative for fertilizers, thereby contributing

Table 1 : Organic carbon and nutrient contents in tank silt collected from some tanks of Nalgonda district of Andhra Pradesh

Parameter/Nutrient		Content (Range)
Organic carbon (%)	:	0.4-0.5
Mineral nitrogen (mg kg^{-1})	:	163-200
Available P (mg kg^{-1})	:	1.78-2.00
Available K (mg kg^{-1})	:	560-600
Available S (mg kg^{-1})	:	12-20
Available Zn (mg kg^{-1})	:	13-15
Available B (mg kg^{-1})	:	0.3-1.0

Fig. 5 : Horsegram and Dhaincha grown in rainfed regions of AP

towards climate change mitigation. Tank silt amended at the rate of 30 t ha^{-1} in alternate years improved water retention capacity, carbon and nutrient status, and protected rainfed crops during intermittent droughts.

De-silting of tanks in Nalgonda indicated the presence of all the valuable nutrients required for plant growth in adequate quantities. Recycling of tank silt will overcome the deficiency of nutrients observed in many soils particularly that of zinc, boron and sulphur, and will also improve organic carbon of soil resulting in improved soil physical properties. Desilting of minor irrigation tanks for increasing storage and improving soil fertility was carried out under NAIP. Seven tanks were desilted in Dupahad cluster of Nalgonda district. A total of 202 farmers participated in this programme by contributing to lifting of the tank silt and applying the same to their castor fields (Fig. 6). A total of 18800 tons (approximately) of silt material was dug out from the 7 tanks and it was transported in 9374 tractor loads to the farmers' fields. Desilting was organized tank-wise with sufficient advance information to the farmers of the villages served by the respective tanks.

Legume intercrops

Cereal-legume intercropping facilitates to maintain and improve soil fertility (Andrew, 1979). In this context, re- introduction of long-term rotations intercrops and grain legumes play an important role (Karlen 1994). Cereal-legume intercropping is practiced in tropical regions (Hauggaard-Nielsen et al. 2001) and rain-fed tracts of the globe (Dhima et al. 2007). Intercropping is advocated due to its benefits for yield increase, conserving soil, control of weeds, control legume root parasite infections and high quality fodder (Fenandez-Aparicio et al. 2007).

Fig. 6 : Impacts of tank silt application on soil health and crop productivity

Zero till maize

Interventions like zero till maize improved yields by 13% over conventional method besides savings on water and labour (Fig. 7). The zero till maize introduced during *rabi* 2007 was upscaled within the cluster and outscaled beyond the cluster during the year. This was systematically attempted through well designed training and exposure visits for the farmers of the cluster. *Rabi* 2008 saw the zero till maize spreading to 20 farmers in Dupahad cluster.

Fig. 7 : Zero till maize interventions in farmers fields

FYM compost pits promotion

Farm Yard Manure (FYM) can be prepared by cow dung, cow urine, and waste straw and dairy waste. Cow manure is rich in humus, the bulky and fibrous material that comes from undigested plant matter. Cow manure is composted by putting it into a bin or pile and letting it decompose. It contains about 2.0% nitrogen, 0.5% phosphorous, and 1.5% potassium (Table 2). FYM compost pits were introduced in Dupahad cluster of Nalgonda district. A pit was dug (4×6×10 ft) near cattle shed above the level of soil. The excavated soil was spread on the surface. The pit was then filled with grass and soil up to 10-15cm. Cow dung manure was then spread up to 15-20 cm and left for one to two month (Fig. 8).

Crop residues recycling

As part of integrated nutrient management, raising of glyricidia on the bunds, vermicomposting, composting, and incorporation of crop residue in soil were promoted in this cluster. Rice, sorghum, groundnut shells, pigeonpea residue were available in Dupahad cluster. The NPK content of these residues is listed in Table 3.

Table 2 : Organic carbon and nutrient contents of FYM from Nalgonda district of Andhra Pradesh

Parameter/Nutrient		Content (Range)
Total carbon (%)	:	20-22
Total nitrogen (%)	:	1.20-1.80
Total P (%)	:	0.40-0.60
Total K (%)	:	1.10-1.90
Total S (mg kg^{-1})	:	0.34-0.50
Total Zn (mg kg^{-1})	:	83-128
Total B (mg kg^{-1})	:	12-27

Table 3 : NPK content (kg t^{-1}) of some crop residues of rainfed crops

Crop residues	N	P_2O_5	K_2O	Total
Rice	6.1	1.8	13.8	21.7
Sorghum	5.2	2.3	13.4	20.9
Groundnut	16.0	2.3	13.7	32.0
Pulses	12.9	3.6	16.4	32.9

Fig. 8 : FYM compost pits promoted in the villages

In Dupahad cluster, on adding crop residues soil health parameters like organic carbon, microbial biomass carbon and particulate organic carbon were improved. The soil organic carbon increased from 0.31 to almost 0.50 percent after rice-wheat crop cycles, where the residue was either retained or incorporated. In addition to organic carbon, crop residues also cover large part of nutrient requirements of crop plants. Finally, in order to refurbish soil productivity and increase the efficiency of inorganic fertilizer efficient crop residue management plays a vital role.

Name of the farmer : D. SAMYA

Village : JAMALKUNTA THANDA

I have been growing gliricidia on my field bunds and also practicing crop residue recycling in my fields. This has improved my crop yields. I have been applying tank silt and farm yard manure along with chemical fertilizers since CRIDA intervention which has enhanced crop productivity. Interventions like zero till maize improved crop yields by 13% over conventional method.

Chapter 6

Community Based Biogas Plant Linked Vermicomposting

In Rural India, most of the families depend on wood and kerosene to satisfy their daily energy needs. Families in remote tribal villages of the Nalgonda District of Andhra Pradesh mainly depend on wood as fuel for cooking. As forests become depleted, villagers have to go further and further to collect wood, taking time and energy that could be put to more productive use. Those who have to buy wood pay high prices, which strains household budgets. Wood is collected several times a week by both women and children, leading to the reduction of wood resources. And, apart from the time, effort and money spent in obtaining wood, cooking fires cause indoor pollution which is harmful for infants. The use of traditional cooking stoves leads to a high chance of respiratory/ lung infections among users. In India, use of huge amounts of chemical fertilizers is reducing soil fertility and crop yields; therefore the construction and distribution of biogas digesters and the production of vermicompost are available options which might provide a real solution to these various problems.

Biogas is produced by anaerobic digestion of animal wastes, which is used for domestic purposes. In agriculture-based countries around the world, biogas is produced in household reactors known as biogas digesters to provide energy for lighting and cooking. Millions of people, especially farmers, have benefited from this technology and its popularity is ever growing (Gautam et al. 2009). According to a rough estimation there are thought to be about 2.5 million household and community biogas plants installed around India (Suthar 2010). Biogas slurry may be a potential source of earthworm culture as it contains easy digestible and assimilated carbohydrates and proteins. Nevertheless, the biogas slurry needs to be mixed with some plant nutrient-rich materials prior to using as substrate for vermiculture/ vermicomposting. Crop residues appeared as potential source of earthworm feed and quality vermicompost production (Suthar 2007, 2009).

Some of the environmental and social benefits of biogas linked vermicompost are:

- Reduced pressure on forests and fossil energy sources
- Reduction in the greenhouse gas emissions (CO_2, CH_4)
- Reduction in poverty (fewer expenses related to energy and fertilizer)
- Improved access to energy, more time for beneficiaries
- Less in-door air pollution (reduction in the respiratory and lung infections)
- Better quality of soil which is enriched by the use of organic material through vermicompost

The Government of India provides small grants, through the Ministry of New and Renewable Energy, to encourage the installation of biogas plants as part of a drive to speed rural development and reduce poverty. Supporting this initiative, the NAIP

Comp-3 Project, working with Gram Sabhas (village assemblies) is helping villagers in Nalgonda District switch to biogas. The enthusiastic response and growing demand show that biogas can be a viable alternative to wood as a fuel for cooking. One of the major interventions taken up in Dupahad cluster was community biogas cum vermicompost unit through convergence with the Non Conventional Energy Development Corporation of Andhra Pradesh (NEDCAP). This intervention was implemented as a model for offering solution to the rural energy problems besides generating employment through production of good quality vermicompost. The biogas plant was constructed as per the approved designs for 85 cu m, by availing technical and financial assistance of NEDCAP. Capacity (Flouting drum type/KVIC Model) was constructed according to standards and designs approved by ministry of new and renewable energy (MNRE), Govt of India.

Biogas: clean, renewable fuel for rural homes

The potential for biogas is enormous. It can be generated from cattle dung, which is readily available, as most villagers own cattle. Unlike wood whereby the smoke from wood fires can lead to asthma, lung cancer and bronchitis, biogas is a clean and smokeless fuel. Switching to biogas stoves means cleaner, healthier homes, particularly benefiting women and children. Biogas stoves are also more efficient, whereby women have better control over gas stoves than wood stoves and food can be prepared more quickly. They can start cooking as soon as they turn on the gas and turn it off immediately when they finish without the effort involved in lighting wood fires, an especially difficult task when wood is wet. Much time and effort is also saved as the women no longer have to gather wood and stockpile it for the rainy season. They are also relieved of the heavy work of carrying loads of wood back home on their heads. A Schematic representation of a typical biogas unit is illustrated in Fig. 1.

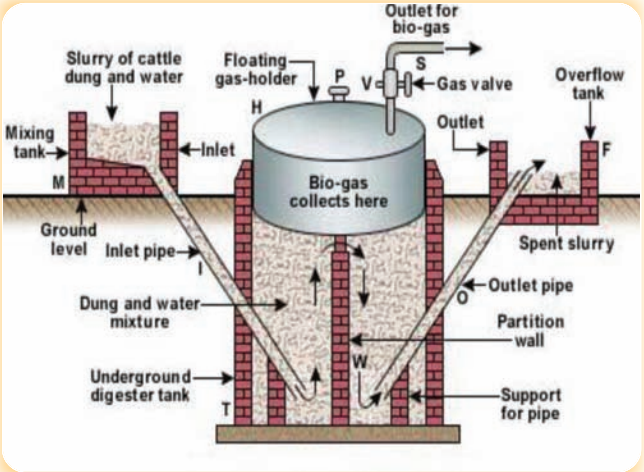


Fig. 1 : Schematic representation of a typical biogas unit

It is a composite unit consisting of digester and gas holder. The digester is a chamber containing the animal waste in the form of slum. It is normally situated below the ground level. It is made of masonry work. There is a partition wall in the middle of the digester which divides the digester into semi-circular compartments. There is one inlet opening to recover digested material and another outlet opening to feed the system. Outlet opening is lower than the inlet opening. The gas holder is a drum like structure, it is a like cap on the mouth of the digester where it dips in the slurry and rests on suitable base inside the digester.

The community biogas unit set up at Jalmalkunta village, Duphad cluster has an 85 cubic meter capacity digester having a diameter of 6.8 m (Fig. 2). It requires about 940 kg of dung every day with which it can produce about 52 cubic meter of gas per day. So, nearly about 30 kg of dung per day per family is required to feed in to the biogas unit. Present gas consumption pattern

Fig. 2 : Biogas unit at tribal Dupahad cluster (Nalgonda) : First ever community biogas plant established in A.P.

Fig. 3 : Biogas genset of 15KVA : to lift water in the tribal village Jalmalkunta

for a family of 4 members is 1.0 m^3 per day for cooking needs. Hence, 32 households have been given biogas supply connections, which required 32 cubic meter gas. The remaining, approximately 20 cu. m gas was allocated for running biogas genset of 15KVA (Fig. 3), to energize 2 bore wells of 5hp each or 5, 3 and 3 hp capacity bore wells for 2 hrs every day.

The energy generated by the genset is highly useful to draw water from the bore wells when line supply is unavailable to irrigate high value crops like vegetables and mulberry, adopting efficient irrigation practices like drip and sprinklers systems, which are already available in the cluster or to augment the drinking water supply needs of Jalmalkunta thanda. A Schematic view of connection of biogas genset is illustrated in Fig. 4.

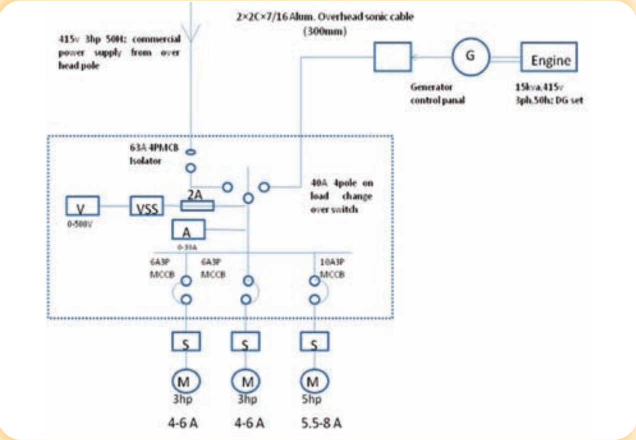


Fig. 4 : Schematic view of connection of biogas genset

Benefits of Biogas

- Biogas is a clean fuel. It produces no smoke and cuts down on pollution, especially indoors.
- Biogas is almost twice as efficient as wood in producing energy and, biogas stoves are five times more efficient than traditional stoves. Biogas stoves light instantly in all weathers, making cooking quicker by using less fuel.
- Families save money as their dependence on wood is reduced.
- Biogas reduces the work load; women are freed from the chore of gathering wood.
- Biogas is sustainable. The raw materials to produce biogas (cattle dung and water) are readily available renewable resources.
- Biogas produces manure as a by-product; Waste slurry from biogas plans is an excellent starting material for vermicompost preparation.
- Biogas helps conserve forests by replacing wood as a fuel, thereby reducing pressure on forests.

Beneficiary women's group of community biogas plant

Women in Dupahad cluster were benefited by the community biogas plant. The drudgery of bringing wood, choking whilst cooking and kid's safety was addressed through this intervention. The scheme has the following advantages:

a) Reduction in the consumption of conventional energy sources such as kerosene, firewood, cow-dung cakes and LPG.

b) Encouraging people in villages to use dung for generation of gas and slurry from bio-gas plant as a source of vermicompost.

c) Providing the rural women clean source of cooking fuel thereby discouraging use of firewood, dung cakes.

d) Successful continuation after project termination by Banjara society.

The figure below (Fig. 5), illustrates individual household biogas connections and its beneficiaries.

Fig. 5 : Women beneficiary group utilizing community biogas : DDG (NRM), ICAR interacting with tribal women members

Crop residue burning

Crop residues like paddy straw/green manures are vital resources for sustaining soil productivity. They not only replenish soil organic matter, which is a key indicator of soil quality, but also supply essential nutrients upon mineralization (N, P, S and Si) and even on soaking (K) and improve physical properties (Surekha et al. 2003). It has been estimated that in India alone, burning of crop residues releases CO_2, CO, CH_4, N_2O and SO_2 gases, equivalent to 6606 thousand tones of CO_2 annually (INCCA, 2007). Improving the management of crop residues as animal feed and restricting its wastage through burning, should be one of the main priorities. Thus, there is an urgent need to optimize the use of the limited feed resources, especially straws for ruminant feeding. Burning of crop residues is quite common in tribal districts of Andhra Pradesh (Fig. 6). In Dupahad cluster of Nalgonda district, crop management practices encouraged crop residue to be efficiently utilized for vermicompost preparation.

Vermicomposting: recycling residues and wastes into valuable organic fertilizer

Environmental degradation is a major threat confronting the world, and the rampant use of chemical fertilizers contributes largely to the deterioration of the environment through depletion of fossil fuels, generation of carbon dioxide (CO_2) and contamination of water resources. It leads to loss of soil fertility due to imbalanced use of fertilizers that has adversely impacted agricultural productivity and causes soil degradation. Now there is a growing realization that the adoption of ecological and sustainable farming practices can only reverse the declining trend in the global productivity and environment protection. Vermicomposting is a simple biotechnological process of composting, in which certain species of

Fig. 6 : Cotton and Maize crop residue burning in Nalgonda district

African earthworm *(Eudrillus euginiae)* Tiger worm or Red wrinkle *Eisenia foetida* Asian worms *(Perinonyx excavatus)*

Fig. 7 : Prominent earthworm types used for vermicomposting (Source: TNAU Agric-Portal)

earthworms are used to enhance the process of waste conversion (crop residue, vegetable and fruit market wastes, biogas slurry) to produce a better end product. Composting with worms or vermicomposting, converts food waste to worm manure. It is generally known that epigeic species have a greater potential as waste decomposers than anecics and endogeics. This is due to predominantly humus consuming surface dwelling nature of the epigeics. The commonly used epigeic species are *E. eugeniae*, *Eisenia foetida* and *Perionyx excavatus* (Fig. 7).

Vermicompost plays a major role in improving growth and yield of different field crops, vegetables, and flower and fruit crops. Its benefits to home gardeners include its simplicity, low cost and ability to compost indoors year round. For farmers, vermicomposting provides an economical means of achieving high agricultural yields while repurposing animal waste. Municipal vermicomposting reclaims organic material to reduce waste streams by 20-40%. Vermicomposting's benefits include reducing organic wastes in landfills, creating soil supplements with impressive nitrogen and mineral levels, and enhancing soil texture and agricultural production.

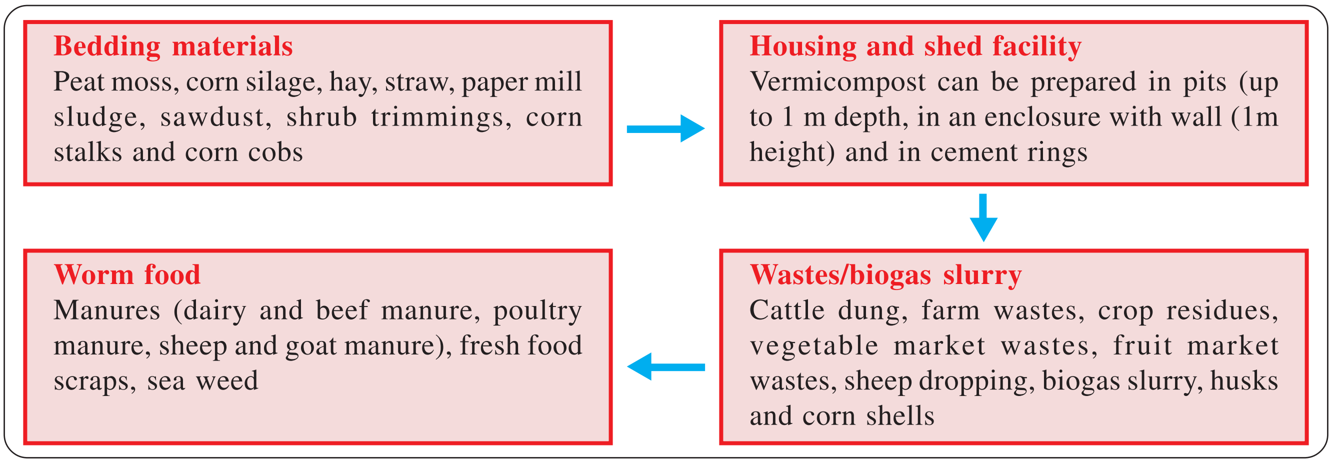
Why vermicomposting?

Vermicompost is an important source of organic manure. It has the following useful attributes

- helpful in recycling any organic wastes into a useful biofertilizer and leaves no chance of environmental pollution.
- a eco-friendly, non-toxic product, consumes low energy input while processing.
- a preferred balanced nutrient source.
- Improves physical, chemical and biological properties of soil without any residual toxicity.
- Reduces the incidences of pests and diseases in crop production.
- Improves quality of agricultural produce.

Vermicomposting preparation and its nutrient value

A range of agricultural residues, all dry wastes, for example, sorghum straw and rice straw (after feeding cattle), dry leaves of crops and trees, pigeon pea (*Cajanus cajan*) stalks, groundnut (*Arachishypogaea*) husk, soybean residues, vegetable wastes, weed (*Parthenium*) plants before flowering, fiber from coconut (*Cocos nucifera*) trees and sugarcane (*Saccharum officinarum*) trash can be converted into vermicompost. In addition, animal



Bedding materials
Peat moss, corn silage, hay, straw, paper mill sludge, sawdust, shrub trimmings, corn stalks and corn cobs

Housing and shed facility
Vermicompost can be prepared in pits (up to 1 m depth, in an enclosure with wall (1m height) and in cement rings

Wastes/biogas slurry
Cattle dung, farm wastes, crop residues, vegetable market wastes, fruit market wastes, sheep dropping, biogas slurry, husks and corn shells

Worm food
Manures (dairy and beef manure, poultry manure, sheep and goat manure), fresh food scraps, sea weed

Fig. 8 : Materials required for vermicompost preparation

Steps in Vermicomposting

Collection of wastes and processing including shredding and separation of non-degradable material.

Preparation of earthworm bed. A concrete base is required to put the waste for vermicompost preparation. Loose soil will allow the worms to go into soil and also while watering; all the dissolvable nutrients go into the soil along with water.

Collection of earthworm after vermicompost collection. Sieving the composted material to separate fully composted material. The partially composted material will be again put into vermicompost bed.

Storing the vermicompost in proper place to maintain moisture and allow the beneficial microorganisms to grow.

Fig. 9 : The various steps in the preparation of vermicompost prepared from community biogas slurry in the cluster

manures, dairy and poultry wastes, food industry wastes, municipal solid wastes, biogas slurry and bagasse from sugarcane factories also serve as good raw materials for vermicomposting. Figs 8 and 9 show schematic representation of materials required and steps for vermicompost preparation.

Vermicomposting unit should be in a cool, moist and shady site. Biogas slurry and chopped dried leafy materials are mixed in the proportion of 3: 1 and are kept for partial decomposition for 15 – 20 days. A layer of 15-20cm of chopped dried leaves/ grasses should be kept as bedding material at the bottom of the bed. Each bed should contain 1.5-2.0q of raw material and the number of beds can be increased as per raw material availability and requirement. Selected earthworm (500-700) should be released on the upper layer of bed. Water should be sprinkled immediately after the release of worms. Beds should be kept moist by sprinkling of water every three days to maintain adequate moisture and body temperature of the earth worms. Bed should be turned once after 30 days for maintaining aeration and for proper decomposition. Compost gets ready in 45-50 days if agriculture waste is used. The processed vermicompost is black, light

Fig. 10 : Mechanical and manual separation of earthworms in Dupahad cluster

in weight and free from bad odor. Pile the compost in small heaps and leave under ambient conditions for a couple of hours when all the worms move down the heap in the bed. Separate upper portion of the manure and sieve the lower portion to separate the earthworms from the manure (Fig.10).

Table 1 : Nutrient composition of vermicompost and compost

Nutrient element	Vermicompost (%)	Compost (%)
Organic carbon	10-14	12
Nitrogen	0.51–1.6	0.8
Phosphorus	0.19-1.02	0.4
Potassium	0.15-0.73	0.5
Calcium	1.18-7.61	2.2
Magnesium	0.093-0.568	0.5
Sodium	0.06–0.16	< 0.01
Zinc	0.0042–0.011	0.0012
Copper	0.0026–0.0048	0.0017
Iron	0.2050–1.3313	1.1690
Manganese	0.0105–0.2038	0.0414

The nutrient content of vermicompost varies depending upon the waste materials that are being used for compost preparation. Suthar (2006) demonstrated that during the vermicomposting of some crop residues mixed with cattle dung, there is an increase in total N (91-144%), available P (63-105%), and exchangeable K (45-90%) content of it. The nutrient composition of vermicompost and ordinary compost is given in Table 1.

Benefits of vermicompost

The utilization of vermicompost results in several benefits to farmers, industries, environment and overall national economy (Fig. 11). As the nutrient inputs required will be minimized due to the use of vermicompost, it will lead to lower cost of production. The soil quality will be improved leading to increased soil productivity and better quantity and quality of crops. Wastes create no pollution, as they become valuable raw materials for enhancing soil fertility and less wasteland formation.

Farmers

- Enhancement of soil productivity
- Increase in yields with less irrigation
- Less risk of crop loss during intermittent dry spells
- Vermi wash for plant protection
- Crop produce has better taste, luster, keeping quality without toxic residues and fetches a higher price

Industry

- Cost-effective pollution abatement technology

Environment

- More groundwater recharge and lesser depletion of groundwater
- Reduces soil salinization and lesser soil erosion
- Less pollution as chemicals need not be purchased and used

National Economy

- Lesser imports of agrochemicals, saving valuable foreign exchange
- Boost to rural economy
- More export of agricultural produce with lower pesticide residues
- Less expenditure on water supply and pollution control
- Lesser wasteland formation

Fig. 11 : Several benefits of vermicompost prepared from biogas slurry

Process: vermicomposting from biogas slurry

Biogas slurry and farm waste was used for preparation of vermicompost at Jalmalkunta Thanda of Dupahad cluster. The slurry coming out of the biogas unit is used as input to a large scale vermicomposting unit in which weed biomass and crop residue is turned into useful manure. To effectively utilize the digested slurry coming out from the plant, which contains nitrogen, phosphorus and potassium, two vermin-compost sheds with 20 beds of 0.75 x 6 m size were allocated exclusively to produce quality vermiculture. The slurry coming out of the plant was dried in vats like structure to optimum moisture content and later shifted to beds. This process advanced the vermicompost generation process by 15 days and completely avoided water application over the beds in rainy and winter seasons, and decreased to bear minimum in summer season. Every week, around 5 tons of slurry comes out of the biogas unit which is fed to the vermin-compost unit. After 40-45 days, this slurry turns into about 3 t of excellent vermicompost. In Dupahad cluster of Nalgonda district, on average 0.5 tons of vermicompost is produced per month by the community biogas cum vermicompost unit. For effective functioning of plant, and utilization and monitoring of biogas energy and vermicompost generated from the plant, a user group was formed at the thanda. Two persons on wage basis were engaged to collect the dung from the households, feeding the biogas unit and generate the vermicompost (Fig. 12a & 12b). The unit has a great potential for recycling the animal waste into useful manure and save fuel wood for cooking purpose and improving the livelihoods of the rural poor.

Name of the farmer : D. SARITHA

Village : JAMAKUNTA THANDA

I have been benefited by the community biogas plant introduced by CRIDA. The biogas has addressed drudgery of bringing wood, choking whilst cooking and also my kid's safety. It also helped me in reduction in the consumption of conventional energy sources such as kerosene, firewood, cow-dung cakes and LPG.

Name of the farmer : D. VACHAYA

Village : NEW BANJARA HILLS THANDA

By using vermicompost in my field, there was an enhancement of soil productivity and increase in crop yield. The watermelon crop showed an enormous increase in size of fruit, with better taste and luster. I also made a net profit compared to previous years, as vermicompost applied fields produced better quality watermelon.

Fig. 12a : Community biogas plant : Collection of dung and its preparation to add into biogas inlet tank

Fig. 12b : Schematic representation of vermicompost preparation from biogas slurry : Biogas slurry, vermicopost beds and final product

Promotion of community vermicompost units

In Dupahad cluster (Nalgonda), backyard vermicomposting was encouraged. Backyard vermicomposting can be replaced by enterprise model of vermicomposting by training and capacity building of farmers and women self helps groups. Discussions were carried out with gram sabhas and gram panchayats on promoting vermicompost, and it was decided to establish self help groups. Self help groups of women were encouraged to take up vermicomposting as income generation activity and make the vermicompost available for different agricultural crops within the cluster. This was successfully done, and the women were trained and helped to access to premises either in a private property regime or in the public property regime.

Application of vermicompost to crops

Vermicompost can be used for all crops such as agricultural, horticultural, ornamental, and vegetable etc. But generally, vermicompost is recommended for high value vegetables and fruit crops. Vermicompost was applied to most of the horticulture crops in this cluster (i.e. marigold, chrysanthemum, watermelon, mango, palm tree, tomato, bhindi) (Fig. 13). Application needs to be done around root zone in the opened ring and covered by the soil.

- **For general use in agriculture:** 3-4 t ha^{-1}. For agricultural crops, apply vermicompost by placement beside crop row when the seedlings are 12-15 cm is height.
- **For fruit trees:** 5-10 kg per tree around the base of the tree, cover with soil and water regularly
- **For vegetables:** 3-4 t ha^{-1} around the base of the plant, cover with soil and water regularly
- **For flowers:** 500-750 kg ha^{-1} around the base of the plant, cover with soil and water regularly

Bhindi Watermelon Capsicum

Mango Tomato Marigold

Fig. 13 : Vegetable and fruit crops raised by applying biogas slurry based vermicompost in tribal farmers fields

Vermicompost field impacts and farm income

Vermicompost generates income for landless farmers, due to their nutritional value. Farmers are choosing vermicompost for several reasons. Some need an environmentally-beneficial alternative for manure management, while others want to produce vermicompost to increase their crop yields and reduce their use of fertilizers, herbicides and pesticides. And some farmers choose vermicomposting to increase their income from sales of worms or vermicompost. In Dupahad cluster over 10 tons of vermicompost has been produced from inception. All participants produced good vermicompost but the only "market" appeared to be use of vermicompost on their own land for horticulture and vegetable crops. However, at the time of fertilizer price escalations vermicompost was sold at Rs. 5 kg^{-1} to the neighboring fruit and vegetable farmers forming another source of revenue for these farmers. Through vermicompost sale the farmer's profited, as it served as on additional source of income. In the famer's fields, watermelon was grown with improved nutrition by addition of micronutrients along with vermicompost, which resulted in the improved quality in form of size, flesh colour and brix reading. Some of the crops grown in the cluster using Vermicompost are illustrated in (Fig. 14.)

Fig. 14 : Farm productivity and profitability with vermicompost application in tribal villages

Chapter

7

Farm Mechanization (Impacts on Productivity, Livelihoods and Drudgery)

The issue of rural population livelihood is complex, and intimately linked with the performance of agriculture and allied sectors. Inadequate credit availability for agriculture, weather related risks and uncertain market support are forcing the farmers to leave agriculture slowly and go searching for alternate employment generation activities in rural and urban areas. The agriculture sector performance in rural areas not only affects the farming community but also seriously the landless laborers, small scale agro-processing industries and rural artisans alike. This effect is more clearly visible in case of rainfed areas which are prone for greater risks as such; the farmers of these areas are resource poor and unable to invest more in new technologies and inputs. Sixty six % of the cultivable area in the country is under rainfed area which influences the livelihood of nearly 40% of the country's population. The major problems faced by the people in these regions include recurrent droughts, crop failures, degraded natural resource base and inadequate institutional and market support besides poor socio economic status. Considering the importance of need to develop natural resource development in rural areas, government of India gave significant focus on land and water resources improvement, agriculture implements assets provision and livestock production to have better chance to contribute to poverty reduction, besides creation of non-farm livelihood options to have good supplementary effect.

Thus, goal of improving rural livelihoods has now become a major research agenda in the country more so in the highly vulnerable rainfed areas. This vulnerability has to be addressed through giving new skills to the poor along with doubling technologies and building of durable income generating activities and capacity to adapt to rapidly changing markets. Against this background, the project on "Sustainable Rural Livelihoods through enhanced Farming Systems Productivity and efficient Support Systems in Rainfed areas" has been formulated as an action research pilot project in selected village clusters of the Nalgonda district involving a consortium of institutions from public, private and NGO sectors. The long-term goal of the NAIP – SRLP project sub theme is to make a positive contribution towards improved livelihoods of the rural poor through facilitating increased access to more effective and efficient farm power machineries used by small farm and rural systems in backward districts. The most important issue we encountered was the affordability by small farmers and justification of possessing them based on the size of the farms. This was mainly due to the misconception that mechanization means tractorisation.

This chapter enumerates the farm power availability status in the Dupahad cluster of Nalgonda district at entry level of this project, various small farm mechanizations interventions selected and implemented to reduce drudgery and enhance livelihoods of farmers during the project implementation period. The major occupation of Dupahad cluster are; farming (89%) followed by landless (5.30%) and agriculture labour (5.20%). Among the farmers, small farmers are more in number followed by medium and large farmers. Pigeonpea is the most popularly grown crop followed by Paddy and Groundnut and very less percent of area is under vegetable production. However, majority of the farmers grow vegetables in two seasons under supplemental irrigation. Most of the field crops are raised in *kharif* and some extent in *rabi* but no crops are raised in summer season. Traditional agriculture has been the backbone of Dupahad cluster primarily in terms of subsistence food supply and livelihood security.

In developed countries, agricultural mechanization is viewed as an important component for increasing agricultural production. But, in rainfed areas and in socially back ward regions it can also be viewed as better livelihood generation component besides reducing drudgery of farmers by replacing traditional tools with improved ones and, small capacity selected machines to complete farming operations with a minimum use of draft animal and manpower, within a short time, at a low cost and with increasing quality. However, farming is not only a question of labour and machinery but also a system determined by many factors, such as kind of crops, weather, soil type, capital etc. to obtain benefits from utilization of agricultural machinery, it is also essential to have knowledge about management, operations, maintenance and cost of operation.

Major constraints observed in farm mechanization in the cluster

- The presence of rocks just below the soil surface in majority of the thandas and shallow soil depth and low moisture holding capacity of soil.
- The cultural system, such as cattle rearing which promotes animal draft power with traditional implements and customary land ownership inhibits commercial type farming up to some extent.
- High cost of farm machinery like improved implements, mechanically powered machines.
- Traditionally small land holdings, lack of awareness campaign to apprise farmers about the various machinery and equipment, proper maintenance and the benefits gained from using such machinery.
- Industrial skills dwindling due to better opportunities to acquire education, knowledge and develop mechanical / literary related skills to work in other service sectors.
- Lack of entrepreneurial skills to start metal working enterprises to produce simple tools and implements, for example, blacksmithing could be initiated at least by those who have been exposed to metal working.

The household social assets (Table 1) available in the cluster play a vital role in enabling rural households to address their farm-power constraints in general. Though in the cluster adequate numbers of tractors are available, it could not be perceived that the area is progressive in agriculture front. Because, for this community soft loans are available under various government schemes. Some of the households tackle farm-power shortages on an individual basis through reciprocal labour or by pooling their draught animals and implements which are inadequate in number in the cluster. Others draw up farming operations by working in groups to improve their work capacity. Majority of households in the cluster relying on family labour

Table 1 : Social assets in farming operations in the cluster

Parameter	Units	Parameter	Units
No. of Adult population	1525 Nos	Tractors	7 Nos
Agricultural workers	1358 Nos	Cage wheels	3 Nos
Area under cultivation	1712 acres	T D Cultivators	7 Nos
Rainfed area Irrigated area	82% 18%	Manual Sprayers	49 Nos
Draft animal pairs	275 Nos	Borewell pump sets	234 Nos (5 hp)
Country ploughs	275 Nos	Open well pump sets	257 Nos (3hp)
Soil leveling planks	270 Nos	-	-
Hand hoes	100 Nos	-	-

for all their farming needs, survive at the margin of subsistence. Many do not have even enough essential hand tools for all household members to carry various farming operations. They race against time from the initial preparation of their land through to harvest. The timeliness of their operations is often compromised by the need to hire out their labour to others at the busiest times of the cropping season. The most common implements used by the farmers of this cluster in land preparation activity are animal drawn country plough and tractor operated cultivator. Other common equipment used by the farmers are sprayer and hand hoe. Almost all the land holding households have irrigation water pumping sets. However, the water table is very deep, whatever ground water available with them in bore/open wells being used for raising food and cash crops like paddy, different types of vegetables and groundnut.

The livelihood outcomes for households owning draught animals or tractors for various crop production operations in arable cropping systems are more food secure than those relying on family labour and the hoe. While hoe households typically cultivate up to 1.5 acre per year, draught-animal-owning households able to cultivate up to 7 acres per year, and households owning tractors more than 25 acres per year. The farmers having draught animals or tractors follow more diversified cropping patterns and there is greater emphasis on cash crops production like groundnut, more area under vegetables and pigeonpea. Households hiring farm power do not enjoy the same level of security as owners of farm power. They have less certainty of when the hire services will be available as Draught Animal Pair (DAP) and tractor owners meet their own needs first, and the hire services may be monopolized by more influential farmers and close relatives. The areas cultivated tend to be smaller than that of owners; DAP hirers typically cultivate 2 acres and tractor hirers up to 5 acres in the cluster. As the farm operations wages and working pattern is concerned, it is needless to say that man was getting highest wages than woman in all categories of farmers. The data in table 2 show that, men and women were working equal amount of time in all the categories of farmers. In case of number of hours spent per day, women were spending more time in farm activities than the family activities in all the categories of farmers. Women work 9 hours a day in both of these activities together with traditional tools and methods, which possibly result in physical fatigue and drudgery in various operations.

Table 2 : Working pattern of farmers in various activities in Dupahad cluster

Parameter	Marginal farmers		Small farmers		Medium farmers		Large farmers		Landless	
Working hours / day	Hrs	%	Hrs	%	Hrs	%	Hrs	%	Hrs	%
Men	6	50.0	6	50.0	6	50.0	0	0.0	6	50.0
Women	6	50.0	6	50.0	6	50.0	0	0.0	6	50.0
Drudgery of women	Hrs	%	Hrs	%	Hrs	%	Hrs	%	Hrs	%
Family activities	4.2	47.7	4.4	50.6	4.5	51.7	0	0.00	4.37	48.8
Farm activities	4.6	52.3	4.3	49.4	4.2	48.3	0	0.00	4.59	51.2

There is no doubt that farm implements and machinery technologies other than a country plough and hand hoe, offer considerable advantages in terms of area cultivated, total yields achieved, levels of drudgery reduction, opportunities to redeploy family labour, and household food security. After careful study of cropping pattern in the cluster and various hand tools, farm operations implements available with the farmers and agriculture workers, to improve household livelihoods; farm implements and machinery technological intervention package action plan as listed in table 3 was drawn up. Items were procured under the project and supplied to the farmers on custom hiring basis at a nominal rental fee for landholding households and on free of rent for landless and agricultural workers. Along with provision of farm implements, skill development and gender awareness training for men and women have been key parts of the programme.

Table 3 : Technological gaps identified and Improved Implements suggested for the cluster

Operation	Implements being used	Crops	Improved Implements suggested
Field preparation	Country plough, Leveling plank	Groundnut, Pigeonpea Vegetables, Paddy Sorghum	2, 3 Tyne cultivators, Blade harrow
Sowing	Broadcasting, Seed dropping behind country plough	Groundnut, Pigeonpea, Sorghum	Pora tube attachment to country plough, 2 Tyne gorru with Pora tube, 2 Row mechanical planter
Vegetables Transplanting	Sickle	Tomato, Brinjal, Green chilli, Water melon	Pick axe
Weeding and Intercultural operation	Spade and Sickle	Groundnut, Pigeonpea, Vegetables, Sorghum	Hand hoe, Manual weeder, Animal drawn blade harrow
Plant protection equipments	Hand Compression Sprayer	Groundnut, Pigeonpea, Vegetables	Lever operated sprayer Power Sprayer
Harvesting and Threshing	Sickles, Manually beating Animal treading, Manually	Paddy, Groundnut, Pigeonpea	Serrated sickle, Beating on drums, Groundnut stripping device
Fodder preparation	Sickles and Axe	Sorghum, Maize, Grass, Groundnut	Manual Chaff cutter Chipper Shredder

NAIP – SRLP programme has tested a range of implements which have met with varying degree of acceptance among the farmers. For example, women took the seed and fertilizer application with pora tube, weeding with wheel hoe, groundnut stripping device whereas other technologies, such as 2/3 tyne cultivators for ploughing, blade harrow, pick axe use for transplanting of vegetable seedlings, beating drums for paddy threshing , power sprayers proved more popular among men farmers. The other farm implements introduced in the cluster are: chaff cutter, cono weeder, groundnut stripper, groundnut shelling, improved leveler and two-row planter (Fig. 1). The programme has created a demand for these tools within the community. Benefits of adoption include reduced drudgery and


Chaff cutter **Cono weeder**


Groundnut stripper **Groundnut shelling**

Improved leveler **Two-row planter**

Fig. 1 : Various farm implements introduced in Dupahad cluster : Benefitted tribal farmers

time saving for women, development of skilled and more productive labour. In themselves, the tools helped to empower women. With the availability of more hand hoes and weeding wheel hoes, women were slightly relieved from weeding tasks that traditionally were a 'woman's task. More time availability offered real opportunities for diversification options such as increasing area under leafy vegetables, water melons, poultry farming or on-farm sales of produce. The main impact of improved tools like 2/3 tyne cultivators, which are designed for primary, secondary tillage operations is to increase the area under cultivation. In turn, this created a demand for additional labour for subsequent crop production operations.

The study explored the potential of farm power, implements and machinery as a labour saving practice. The labour inputs in various agricultural operations could be reduced by 40% when the animal drawn 2/3 tyned cultivator was used compared to country plough. In the draught animal powers category, the blade harrowing method of intercultural and weeding system, the labour reduction was 75% (Table 4). The labour saving with manual push – pull weeder was upto an extent of 29% besides reduction of drudgery due to postural change in the operation when compared with traditional tools like, sickle, khurpa and pawada. Farming using improved tools like these indeed also mitigate the labour shortages which majorly affects small-scale farmers in the cluster. A long term study of small scale farmers at manual or draft animal mechanization level in their farming practices will definitely bring significant changes in the farmers' livelihoods. Majority of farmers reported increase in crop yields after they changed to adoption of improved tools and implements due to the saving in labour and improvements in timeliness of operations over the conventional practices. In addition to this most farmers switched over to new crop varieties and diversified their crop rotations. These effects lead to increased farm income which combined with the reduced production costs resulting in significantly higher net income. Depending on the farmer's choice of the production system and the location, the increases in net income over the period of observation ranged from 50 to more than 200%. Further as a result of the saved time and labour, most of the farms introduced

Table 4 : Advantages of various farm implements when compared with traditional practices/ tools.

Implement	Farm operation	Field capacity acres / day	Labour saving%	Cost saving%
Hand hoe	Weeding	160 m^2/hr	35	25
Pick axe	Vegetables trans planting	—	20	15
2, 3-Tine cultivator / Blade harrow	Field preparation Intercultural and weeding operation	0.65 - 0.90 1.5	40 75	30 40
2–Tyne Cultivator with pora tube	Sowing operation	1.5	50	33
2 Row planter	Sowing operation	1.2	65	45
Manual weeder	Weeding operation	210 m^2/hr	29	25
Groundnut stripping devices	Pods separation	—	30	20

Table 5 : Various farm hand tools and implements kept at Dupahad cluster for custom hiring services.

Tool / Farm Implements	Nos available on custom-hiring	Type of crop / Operation	Area covered acres	Man days used
Hand hoe	100	Land preparation, Vegetables nursery bed preparation, Weeding and Miscellaneous farm works	200	700
Pick axe	45	Sowing of crops, Vegetables transplanting and Miscellaneous farm works	95	375
2, 3-Tine cultivator/ Blade harrow	200	Land preparation, Intercultural operation in row crops	6000	10000
2–Tyne Cultivator with pora tube	22	Sowing of crop, Top dressing operation	660	330
2 Row planter	1	Groundnut sorghum, pigeonpea	20	20
Manual weeder	6	Weeding in row crops	120	1000
LOK Sprayers Power Sprayers	130 25	Crop protection operation	4075	2000
Groundnut stripping devices	3	Groundnut	75	780
Manual chaff cutter	1	Fodder chaffing	-	300
Shredder	1	Fodder and biomass chaffing	-	50

other alternative sources of income such as poultry, goat and sheep rearing, vermicompost preparation and vegetable production and the related value adding activities. The school age kids attended school at a regular base since their work input was not anymore required on the farms.

The total use of power sources and implements provided on custom-hiring service for 3 years period for different field operations is listed in Table 5. The total use of 3/ 2 tyne cultivator using drought animal power was 10000 man days. This implement impact is such that, because of its suitability to all dryland crops, the country plough usage restricted to wet land ploughing only for paddy cultivation in the cluster. Another alternative use found for this implement is intercultural and weeding just by replacing the shovel with more length blades to suite to various crop row spacing's, which was readily accepted by the farmers with few field demonstrations. The one implement that was readily accepted by the women farmers of the cluster is manual weeder. Since, the number is small in quantity; its use was (1000 man days) confined to inter row weeding operation of vegetables crops in majority of the cases. Similar is the case with groundnut stripping device, the use is restricted to *rabi* season where few farmers cultivate in small acreage as cash crop. This has given a clear message that operations on small farms can also be mechanized as well with some beneficial effects.

Perceptions of the farmers on farm power and machinery

Farmers of the cluster were of the opinion that farm mechanization had played an important role in drudgery reduction and cost saving, and there has been an increase in overall on-farm employment and livelihoods. It was interesting to note that over 60% of the farmers in the study area reported that all their adult family members were fully employed in their own farms. However, majority of the farmers who owned neither tractors nor draught animals expressed that they were not getting full employment in their own farms for all adult members of their family. On the other hand, few draught animal pair owned farmers created new economic activity by using their spare time and resources like farm animals, implements etc. to add extra income to their own total agricultural income by renting their services to other farmers within the village. Due to availability of small hand tools like hand hoe and pick axe on nominal rental rate through custom-hiring, another employment opportunity got by the farmers in the cluster is to work easily under National Rural Employment Guarantee Scheme (NREGS) implemented by the state government on natural resources development and management activities. There is also demand within the community for more sophisticated and expensive implements and machinery. Other studies in this area of work also supported these findings, that failure of cooperative institutional arrangements for farm mechanization stimulated local rural entrepreneurs to establish their own custom hiring ploughing and other entrepreneurial service delivery systems through farm machineries. From these interventions, evidence is emerging that this new way of working has tangible impacts on the livelihoods of the poor. Among the most impressive and unexpected are to do with increasing poor people's access to farm power, and information on new farm implements and machinery. Many of these activities to promote and develop mechanization can be taken up in public and private partnership mode or in the private sector supported by government funding. The main role of this sector is to facilitate the delivery of inputs and services. Other roles will include providing necessary information and training and participating in networking activities to achieve an efficient balance between supply and demand. Efforts are required to ensure that this sector can function effectively, supported by appropriate training, extension, favorable fiscal policies and research.

Name of the farmer : NUNAVAT BALAKOTI

Village : JALMALKUNTA THANDA

I was using age old country plough to carry various land preparation activities. Under NAIP - SRLP program, I was advised to go for two in one two tyne gorru and blade harrow with the same draft animal pair. With the same efforts, now, I am able to carry 40 - 50% more land preparation work with the help of improved implement. Manual push - pull type weeder is highly suitable for inter row weeding, reduced labour efforts considerable extent and liked very much by vegetable growers, who don't have draught animal power and whose hiring costs are high for this particular operation

Chapter
8
Crop Based Interventions

Crop production is the major source of livelihood for farmers and agricultural labourers. In Dupahad cluster rural community depended on agriculture based livelihoods. Therefore, there was considerable emphasis for enhancing income from increasing crop productivity and cropping intensity. This was achieved through various types of interventions involving switching over to improved varieties, adopting crop diversity and better crop management including nutrient and moisture management practices. Besides, the project implemented interventions promote better seed replacement ratio (groundnut and pulses), like seed multiplication for farmer's fields, contingency crop planning during weather aberrations, and nursery raising for better establishment of different crops.

Variety replacement

Varietal replacement was also considered as one of the interventions whereby, farmers could maximize their profits. Existing low yielding local varieties were replaced with drought tolerant improved cultivars such as sorghum, groundnut, pigeonpea, greengram, watermelon, tomato, bhendi and leafy vegetables. The cluster is near to national highway, therefore replacement of vegetables, fruit and flower crops was given due emphasis. Sugar Queen variety (Syngenta Seeds) of watermelon was introduced in place of large size green colour varieties which has good demand with retailers/buyers. The variety weighs 2 to 3 kg with duration of 55-60 days (Fig. 1). This variety was preferred by many consumers because it is easy to carry, store and can be consumed in single go by 3 to 4 member family. Initial year, seed was supplied on subsidy to encourage the new variety in the watermelon growing area. In Dupahad cluster, watermelon was grown with improved nutrition by addition of micronutrients along with other limiting factors to the soil besides, addition of vermicompost generated from community based biogas plant, resulted in the improved quality in form of size, flesh colour and brix reading. A participatory process was adopted to choose varieties preferred by farmers keeping in view their preference for various attributes. Initially, a few were supplied with the seeds of watermelon taste improved variety. Other farmers were encouraged to visit the fields while the crop was under cultivation and at the time of harvest. Once the farmers were impressed with the quality of the produce, availability of seeds of improved variety was facilitated so that the variety could spread across a larger area. During 2010 tomato, horsegram, groundnut and green gram local cultivars were replaced by improved varieties. The results are shown in Tables 1, 2 and 3.

Fig. 1 : Increase in water melon yield after varietal replacement in tribal farmers fields

Tomato

The local variety was replaced with Annapurna and Meenakshi variety (Fig. 2), and there was a 15% increase in the yield from 24.25 to 27.50 (Table 1).

Greengram

For greengram, local variety was replaced with two other varieties LGG 407 and LGG 460 (Fig. 3). Both the varieties showed a significant increase in crop yield. The increase was 30% and 20% respectively (Table 2).

Fig. 2 : Tomato crop (Meenakshi variety) showing increased yield

Fig. 3 : Greengram crop (LGG 460) showing increased yield

Table 1 : Varietal replacement in tomato and impacts on productivity in 8 tribal villages

Crop	Variety	No of farmers	Area (ha)	Low yield recorded (t ha^{-1})	Highest yield recorded (t ha^{-1})	Average (t ha^{-1})
Tomato	Local	50	5	23.25	25.50	24.25
Tomato	Annapurna	50	5	25.00	30.00	27.50

Table 2 : Varietal replacement in greengram and impacts on productivity in 8 tribal villages

Crop	Variety	No of farmers	Area (ha)	Low yield recorded (t ha^{-1})	Highest yield recorded (t ha^{-1})	Average (t ha^{-1})
Greengram	Local	50	10	7.00	8.75	7.88
Greengram	LGG 407	100	40	9.75	13.25	11.00
Greengram	LGG 460	02	0.2	8.40	9.00	9.20

Horsegram and Groundnut

Horsegram was replaced with 18-R (Fig. 4a) variety and groundnut with Narayani and K6 varieties (Fig. 4b). There was a two-fold increase in yield for both these crops, and also farmers benefited with additional income (Table 3).

Fig. 4a : Horsegram crop (18-R variety) showing increased yield

Fig. 4b : Groundnut crop (K6 variety) showing increased yield

Table 3 : Introduction of drought tolerant horsegram and high yielding groundnut varieties

Crop	Variety	No of farmers	Area (ha)	Conventional yield (kg ha^{-1})	Improved yield (Kg ha^{-1})	Additional income (Rs ha^{-1})
Horse gram	18-R	10	0.20	870	1520	5200
Groundnut	Narayani	4	0.20	750	875	6250
Groundnut	K 6	5	0.20	3257	6272	8000

Village level seed production

While the importance of improved varieties in enhancing the farmer's income is proven, timely availability of seeds of HYVs continues to be a problem due to constraints in organizing the seed chain on a sustainable basis. This is more so in the case of groundnut where the seed cost is high due to high seed rate. To address this issue, interventions were made both from technology and institutional arrangements to organize village-level seed production for meeting the seed self-sufficiency. To start with, the local seed requirement was assessed through participatory methods and farmers with protective irrigation facility were short-listed for taking up seed production. Greengram and Groundnut seed production were initiated in the cluster (Fig. 5 & 6). While developing village seed concept, total village requirement were considered (Table 4). Therefore besides rainfed crops, paddy was also included keeping in view the cropping system, productivity, farm income and livelihoods (Table 5).

Table 4 : Details of village seed production of some crops in the cluster

Season and year	Crop	Variety	No. of farmers involved	Area covered (ha)	Quantity of seed produced (q)	Remarks
Rabi-2007	Paddy	MTU-1010	60	24	1421	Marketed by farmers group
Kharif-2008	Paddy	BPT-5204	100	40	2200	Marketed by farmers group
Kharif-2008	Pigeonpea	LRG-41	5	2	15	Used for next season
Kharif-2008	Pigeonpea	PRG-158	5	2	20	Used for next season
Rabi 2008	Green gram	WGG-460	15	6	46	Used for next season

Table 5 : Per acre economics of improved seed interventions

	Hybrid seed production				Normal paddy cultivation		
	Wt (kg)	Price (Rs. kg^{-1})	Amount (Rs.)		Wt (kg)	Price (Rs. kg^{-1})	Amount (Rs.)
Female seed	750	75	56250		3000	10	30000
Male seed	750	10	7500				
Total/ acre	1500		63750		3000	10	30000
Avg. price obtained (Rs. Per kg)			**43**	Avg. price obtained (Rs. per kg)			**10**
Benefit from the intervention			113%				
Total farmers			21				
Total acreage			35				
Total income from the acreage			22,31,250				

Fig. 5 : Greengram seed production

Fig. 6 : Groundnut seed production

Vegetable seed distribution

In view of the income generation potential of horticulture, interventions were focused on improved vegetable cultivation, organic vegetable production with a group approach and quality improvement of fruits from existing orchards through better management and harvesting practices. In Dupahad cluster, tribal farmers from the Banjara society are already cultivating vegetables on large area (Fig. 7). The project interventions included making available seeds of improved varieties with better shelf life, balanced nutrition and micro irrigation. Besides farmers were trained in various farm operations, harvesting, clearing of vegetables, harvesting bozes, safe transport etc.

In addition to this vegetable seed kits were distributed to small and marginal farmers during 2009-10 for growing kitchen garden. Yield and economics of farmers practice and improved management for vegetable cultivation in Dupahad cluster during the first year are given in Table 6.

Water melon seed distribution

As it was proposed to subsidize the seed, it was decided to procure the best variety and distribute it to the proposed farmers. Out of the total cultivars of the area, fifteen farmers showed interest to this intervention. Sugar Queen Variety was purchased by Ikisan Ltd. and distributed to the farmers in the first week of March 2011. Total seed procured is 1.5 kilograms for 7 acres of land. Two packets, 50 grams each, were distributed per plot (half acre land) to the fifteen farmers keeping in view for developing market linkages of this produce (Table 7).

Fig. 7 : Tomato harvest being recorded; Group of farmers with their harvest (Dupahad cluster, Nalgonda)

Table 6 : Yield and economics of farmers practice and improved management for vegetable cultivation in Dupahad cluster

Crop	No. of farmers	Yield (kg ha^{-1})		Additional income due to improved practice (Rs.ha^{-1})
		Farmers' practice	Improved package	
Bhindi (Ankur 10)	2	2600	3750	6900
Tomato (Desi)	2	10225	11275	10500
Onion	12	10100	13125	9375

Table 7 : Production and marketed produce of watermelon with varietal intervention

S.No	Date	Beneficiary	Weight (kg)	Rate (Rs. kg^{-1})	Payment (Rs.)	Retailer/ Buyer/ Institute
1	17-Apr	Mr. Srinu	4174	8	33392	Aditya Birla Retail
3	21-Apr	Mr. Lumba	700	6	4200	ITC Choupal Fresh
2	22-Apr	Mr. Lumba	700	6	4200	Arunodaya Enterprises
4	22-Apr	Mr. Chandiya	400	7.2	2870	Nagarjuna Group
5	23-Apr	Mr. Saidulu	6000	6.5	39000	Spencer's Retail
6	27-Apr	Mr. Lumba	876	6	5256	ITC Choupal Fresh
7	29-Apr	Mr. Tirumala	1600	6.5	10400	Nagarjuna Group
8	30-Apr	Mr. Baloji	1100	7.3	8000	CRIDA
9	30-Apr	Mr. Baloji	500	5	2500	ITC Choupal Fresh
10	30-Apr	Mr. Baloji	300	5.6	1700	Suryapet market
11	3-May	Mr. Baloji	1115	5	5575	ITC Choupal Fresh
12	3-May	Mr. Buba	1163	5	5815	Aditya Birla Retail
13	3-May	Mr. Hamu	1611	5	8055	Aditya Birla Retail
14	4-May	Mr. Bhagavaniya	2462	6	14775	Reliance India Ltd.
15	4-May	Mr. Baloji	204	6	1224	Reliance India Ltd.
16	4-May	Mr. Baloji	600	5	3000	ZC office
17	4-May	Mr. Shankar	1310	6	7860	Reliance India Ltd.
18	4-May	Mr. Chandiya	300	6	1800	Reliance India Ltd.
	Total		**25,115**	**6.36**	**1,59,622**	

Name of the farmer : N. BHEEKYA

Village : JAMALKUNTA THANDA

I changed the variety of groundnut which had a great impact on crop yield and additional income. The two varieties Narayani and K6 gave me an additional income of Rs. 6250 and Rs. 8000 respectively.

Chapter 9

Nursery Based Interventions and Impacts

A nursery is a place where plants are propagated and grown to usable size. Although the popular image of a nursery is that of a supplier of garden plants, the range of nursery functions is far wider, and is of vital importance to many branches of agriculture, forestry and conservation biology. Most nurseries remain highly labor-intensive. Although some processes have been mechanized and automated, others have not. In Dupahad cluster, nursery based interventions had a greater impact on farming community. As cluster experienced weather aberrations like delay in on-set of monsoon, nursery based seedlings with protected irrigation resulted in establishment of successful vegetable crops and other boundary plants. The various types of nurseries established included social forest nursery, vegetable nursery and kitchen gardens (Fig. 1). Among the various nurseries *gliricidia* nursery is the predominant one in Dupahad cluster. In some of the village's, community nursery of *gliricidia* was taken under shade net facility provided under NAIP project led by CRIDA, Hyderabad (Fig. 2).

Fig. 1 : Various nurseries in Dupahad cluster

Community shade net

A shade net house is a building in which different vegetable, floral nurseries are grown. These structures range in size from small sheds to industrial-sized buildings. It is a structural building with different colours (green, black, white, pink) of covering materials. Shade nets have various agriculture application like it is used for cultivation of cut flowers, vegetables and tissue plants in green house; to protect ornamental plants, flowers, foliage, indoor plants in shade house; to protect young plants from windy conditions; to prevent hail from reaching the plants; and protection from birds and insects. "Presently shade nets are used in floriculture, tissue culture, olericulture etc, but the main crops are grapes, tomatoes, flowers like

Fig. 2 : *Gliricidia* grown under the shade net at Dupahad cluster

Fig. 3 : Vegetable crops grown in community shade net nursery

anthurium, vanilla beans, carnation, gerbera etc and plantation crops like tea, coffee, and spices (Fig. 3). Shade nets give the option of low-cost with low growth which is very much feasible for farmers of India to try new crops at low-cost options when compared to green house. In view of the above benefits shade net house was constructed in Dupahad cluster of Nalgonda district to grow some of the crops like tomatoes, forest species etc. Social forest nursery was established to raise gliricidia and pongamia plants. Around 10,000 plants were distributed to schools in Dupahad cluster. Subabul was also raised in the nursery and distributed to 10 farmers.

Community vegetable nursery was raised for promoting vegetable cultivation. Tomato US618 variety and Annapurna variety were grown in this nursery. Around 5000 (US618 variety) were distributed to 20 farmers which gave a yield of 20t/acre, and around 40000 (Annapurna variety) were distributed to 40 farmers which gave a yield of 16t/acre. Yield of both these varieties was higher than the traditional variety (8-10 t/acre). Besides, mango, oranges and other fruit crop seedlings are also grown in community nursery and individual nursery. Kitchen gardens were also promoted in Dupahad cluster with drumsticks and papaya as the major crops; these were distributed to 600 farmers in the cluster. Teak plants (5) were also distributed to 600 households (Fig. 4).

Fig. 4 : Teak plantations

Name of the farmer : DOODIYA

Village : PEDA SEETHARAM THANDA

I have grown gliricidia seedlings in the nursery and once grown planted them in the field bunds. The incorporation of gliricidia in soil has helped me to increase soil health and I reduced the use of urea in fields.

Chapter

10

Contingency Crop Planning Impacts Livelihoods during Drought Years

Contingency planning is a plan of action for dealing with contingencies that arise in the wake of natural calamities. Because of the large geographical size of the country, India often faces natural calamities like floods, cyclones and droughts occurring fairly frequently in different parts of the country. While not all natural calamities can be predicted and prevented, a state of preparedness and ability to respond quickly to a natural calamity can considerably mitigate loss of life and property and the human suffering and restore normalcy at the earliest. Dryland agriculture is largely rainfall-dependent, especially in India where the quantity and distribution of monsoon rain decides the crop production.

In Dupahad cluster of Nalgonda district, a predominant tribal inhabitation, intermittent long dry spells are quite common. At times, the same area is subjected to delayed onset of monsoon or crop failure in case of mid season drought/ intermittent long dry spell in successive seasons or years. The land use pattern of this cluster indicates that 600 ha are net sown area, 74 ha are permanent fallows and 13.5 ha are under miscellaneous trees and groves. About 62% of the cultivated area was occupied by paddy as sole crop under normal rainfall years followed by pulses (both red and greengram which together account for 34%) (Table 1). However, during sub normal rainfall years groundnut is cultivated in place of paddy. The productivity of paddy in the cluster was 48.6 q ha^{-1}, while that of greengram was 7.7 q ha^{-1}. The productivity of tomato which is an important vegetable crop of the area was 107 q ha^{-1}. The average cost of cultivation per ha of paddy in the cluster worked out to Rs. 17345. The labour wages accounted for 63% of the total cost followed by fertilizer cost (21%) and seed cost (7%). The cost of cultivation of green gram per ha was Rs. 5311 out of which 82% was labour cost, 10%

Table 1 : Major crops grown in Dupahad Cluster in normal rainfall year (Area in ha)

Crop	Marginal	Small	Medium	Large	Total
Paddy	44.1(73)	63.6(58)	117(62)	1.6(67)	226.3(62)
Greengram	0(0)	35.6(32)	29.1(15)	0.8(33)	65.6(18)
Red gram	2.8(5)	10.9(10)	43.3(23)	0(0)	57.1(16)
Groundnut	22.2 (31)	0(0)	0(0)	0(0)	0(0)
Tomato	10.5(18)	0(0)	0(0)	0(0)	10.5(3)
Soybean	2(3)	0(0)	0(0)	0(0)	2(0.6)
Other Crops	0.6(1)	0(0)	0(0)	0(0)	0.6(0.2)
Total	60.1(100)	110.1(100)	189.5(100)	2.4(100)	362.1(100)

NB: Figures in parentheses are percentages was chemicals cost and 8% was the seed cost. The cost of cultivation per ha of red gram was Rs.6028 out which the labour component was to the extent of 62% followed by cost of fertilizers (16%), chemicals (13%) and seed (8%). The annual average income of Nalgonda cluster households worked out to Rs. 52,382. More than three-fourths of the income came from agriculture. Migration income was to tune of 39% in the case of the landless.

The long term average annual rainfall of Dupahad cluster is 835 mm. During the seven year period from 2003-2009, four years (2003, 2004, 2006 and 2009) received rainfall below 75% of the normal rainfall. i.e., drought occurred once every two years in this region, this lead to widespread distress among tribal farmers who, by and large, practice subsistence farming. It is, therefore, of paramount importance that contingency crop planning is formulated and periodically updated in this region to meet this adverse season.

Contingency planning for agriculture in Dupahad cluster was needed to address the following needs:

- Crop life saving measures.
- The alternative cropping strategy.
- Compensatory cropping programme.
- Supply of inputs.
- Provision for irrigation.
- Supply of power.

Contingency planning

Since *kharif* cropping is a primary activity in the rainfed areas, where monsoon variability plays a crucial role in production, contingency crop planning will require a greater attention in these areas. Though, there is much talk about the significance of contingency planning, literature regarding systematic studies on yield and economics of alternative crops/cropping systems followed as contingency crop planning is meager.

In 2009 *kharif*, this region suffered from severe drought, onset of monsoon was delayed by two months and the total amount of rainfall received was about 200 mm as against the normal of about 850 mm. Many farmers migrated to nearby cities for work as a daily wage labourer. Severe shortage of food and fodder was expected due to delay in sufficient rainfall up to the month of August.

The annual rainfall was considerably lower than the previous years (Fig. 1) and drought was declared. All the major crops grown in the cluster suffered as a result, 500 acres of groundnut sowings dried up due to low rainfall and drought like conditions.

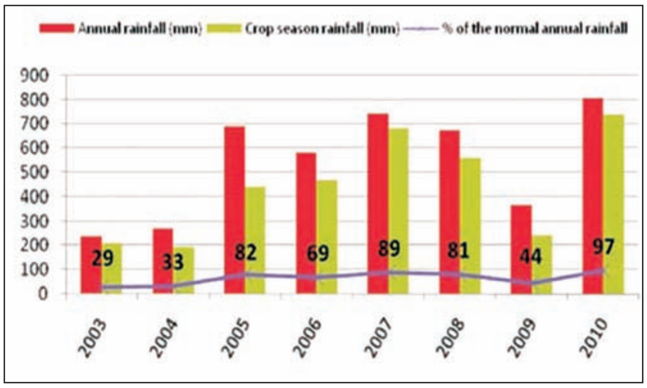


Fig. 1 : Rainfall pattern of Dupahad cluster (Source: Srinivasarao *et al.* 2010)

Therefore, in Dupahad cluster, as part of the contingency measures two drought tolerant and short duration crops (sorghum and horsegram) were introduced in several tribal villages (Fig. 2). The impacts of contingency crop planning on the livelihood of poor families inhabiting 9 tribal hamlets in Dupahad cluster of villages in Penpahad mandal, Nalgonda district were studied. Seeds of local varieties of these two crops were purchased from the local market and sown through broadcasting method after land preparation with meager quantities of fertilizers (10-20 kg N in sorghum and no nutrients to horsegram) to reduce the risk factor further. Some quantity of farmyard manure was also added as a nutrient source (0.5 to 1.0 t ha^{-1}), which helped in the retention of more water between large gaps of rain spells (Srinivasarao et al. 2010).

Sorghum

During kharif 2009, 500 acres of ground nut sowing was done in Dupahad cluster, due to low rainfall and drought conditions ground nut crop dried up. Under contingency plan, 1800 kg of Jowar (Sorghum) seed was then supplied to 120 farmers covering 200 acres. The highest yield recorded was 1.3 t ha^{-1} and lowest recorded was 0.88 t ha^{-1}. Total Sorghum grain production was 84 t and fodder production was 500 tones.

Horsegram

During 2009 as the drought situation was still prevalent in the cluster during *Rabi*, horsegram CRIDA 18 R was introduced in some of the farmers' fields as a contingency crop.

The details on sowing and harvesting dates of the crops, previous crops grown during normal rainfall years, soil type are presented village wise along with grain and fodder yields in Tables 2-7.

Fig. 2 : Sorghum grown as a contingency crop in Nalgonda district in severe drought year 2009 : Source of food for tribal farmers

Table 2 : Biomass and grain yield of sorghum taken up as contingency crop in Jalmalkunta Thanda during the severe drought year of 2009.

Name of the farmer	Date of sowing	Date of harvesting	Previous crop grown	Soil type	Rainfed/ Irrigated*	Fodder (t ha^{-1})	Grains (t ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
B. Ramulu	19/09/09	7/1/2010	Green gram	Chalaka soil	Rainfed	2.5	0.95	29500	21900	3.9
B. Bodiya	17/9/09	9/1/2010	Paddy	Red soil	Rainfed	2.5	0.85	26500	18900	3.5
B. Bhasya	17/9/09	8/1/2010	Greengram Paddy	Red soil	Rainfed	2.5	0.88	27250	19650	3.6
D. Somla	15/9/09	8/1/2010	Groundnut Greengram	Red soil	Rainfed	2.5	0.88	27250	19650	3.6
B. Thavuriya	16/10/09	10/1/2010	Paddy, Groundnut	Chalaka soil	Irrigated	2.5	1.03	31750	24150	4.2
B. Ramakoti	20/9/09	20/1/2010	Groundnut	Chalaka soil	Rainfed	2.9	0.85	26660	19060	3.5
D. Hussion	16/9/09	10/1/2010	Greengram Tomato	Chalka soil	Rainfed	2.0	0.73	22562	14962	3.0
N. Bheemla	16/9/09	20/1/2010	Greengram	Chalaka soil	Rainfed	2.1	0.73	22590	14990	3.0
N. Rajya	19/9/09	9/1/2010	Pigeonpea	Red soil	Rainfed	2.0	0.98	30066	22466	4.0
B. Balakoti	20/9/09	10/1/2010	Groundnut	Red soil	Rainfed	2.0	0.35	11300	3700	1.5
L. Ramulu	23/9/09	20/1/2010	Groundnut	Red soil	Rainfed	2.3	0.98	30170	22570	4.0
D. Rama	16/9/09	5/1/2010	Tomato	Red soil	Rainfed	2.4	0.95	29460	21860	3.9
D. Bixam	18/9/09	7/1/2010	Paddy	Chalaka soil	Rainfed	3.0	0.40	13200	5600	1.7
D. Eeru	19/9/09	12/1/2010	Greengram	Chalaka soil	Rainfed	2.0	0.33	10550	2950	1.4
Range						2.0-3.0	0.33-1.03	10550-31750	2950-24150	1.4-4.2
Mean						2.4	0.78	24201	16601	3.2

* Life saving irrigation

Table 3 : Biomass and grain yield of sorghum taken up as contingency crop in Seethamma Thanda in the severe drought year of 2009.

Name of the farmer	Date of sowing	Date of harvesting	Previous crop grown	Soil type	Rainfed/ Irrigated*	Fodder (t ha^{-1})	Grains (t ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
V. Sanjiva	15/9/09	13/1/2010	Groundnut	Black soil	Rainfed	2.50	0.30	11500	3900	1.5
B. Srinu	16/9/09	19/1/2010	Greengram	Chalaka soil	Rainfed	1.50	0.80	25500	17900	3.4
V. Srinu	19/9/09	8/1/2010	Groundnut	Red soil	Irrigated	2.50	0.95	31000	23400	4.1
V. Esthari	20/9/09	11/1/2010	Groundnut	Red soil	Rainfed	2.50	0.85	28000	20400	3.7
V. Shankar	17/09/09	13/1/2010	Tomato	Chalaka soil	Rainfed	1.50	0.25	9000	1400	1.2
Range						1.5-2.5	0.25-0.95	8100-29500	500-21900	1.1-3.9
Mean						2.1	0.63	19740	12140	2.6

Table 4 : Biomass and grain yield of sorghum taken up as contingency crop in Peda Gara Kunta Thanda in the severe drought year of 2009.

Name of the farmer	Date of sowing	Date of harvesting	Previous crop grown	Soil type	Rainfed/ Irrigated*	Fodder (t ha^{-1})	Grains (t ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
B. Srinu	15/9/09	20/1/2010	Greengram	Block soil	Rainfed	2.3	0.78	25550	17950	3.4
G. Shankar	16/9/09	12/1/2010	Pigeonpea	Black soil	Rainfed	1.5	0.35	12000	4400	1.6
B. Soni	17/9/09	15/1/2010	Greengram	Red soil	Irrigated	3.2	1.05	34700	27100	4.6
B. Huniya	18/9/09	20/1/2010	Redgram	Red soil	Rainfed	1.6	0.25	9100	1500	1.2
B. Changar	20/9/09	23/1/2010	Greengram	Chalaka soil	Rainfed	1.7	0.25	9200	1600	1.2
B. Bignna	15/9/09	15/1/2010	Groundnut	Chalaka soil	Rainfed	2.1	0.85	27610	20010	3.6
B. Ramoji	17/9/09	14/1/2010	Greengram	Block soil	Rainfed	1.6	0.23	8350	750	1.1
B. Sreenu	21/9/09	16/1/2010	Pigeonpea	Red soil	Rainfed	1.7	0.25	9200	1600	1.2
Range						1.5-3.2	0.25-1.05	8140-32780	540-25180	1.1-4.3
Mean						2.0	0.51	15954	8354	2.1

* Life saving irrigation

Table 5 : Biomass and grain yield of sorghum taken up as contingency crop in Banjara Hills in the severe drought year of 2009.

Name of the farmer	Date of sowing	Date of harvesting	Previous crop grown	Soil type	Rainfed/ Irrigated*	Fodder (t ha^{-1})	Grains (t ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
D. Nandiya	16/9/09	5/1/2010	Paddy	Chalaka soil	Rainfed	2.5	0.76	25375	17775	3.3
D. Pakeera	15/9/09	6/1/2010	Paddy	Chalaka soil	Rainfed	2.9	0.77	26075	18475	3.4
N. Bhasya	15/9/09	23/1/2010	Cowpea	Red soil	Irrigated	2.6	1.05	34050	26450	4.5
D. Bixam	16/9/09	20/1/2010	Paddy	Block soil	Irrigated	2.9	0.98	32150	24550	4.2
D. Hussain	17/9/09	19/1/2010	Paddy	Block soil	Irrigated	2.9	1.03	33650	26050	4.4
D. Keemya	18/9/09	14/1/2010	Paddy	Block soil	Rainfed	1.5	0.50	16500	8900	2.2
D. Ramulu	19/9/09	25/1/2010	Paddy	Chalaka soil	Rainfed	2.0	0.88	28250	20650	3.7
Range						1.5-2.9	0.50-1.05	15600-32520	8000-24920	2.1-4.3
Mean						2.5	0.85	26529	18929	3.5

Table 6 : Biomass and grain yield of sorghum taken up as contingency crop in Peda Seetharam Thanda in the severe drought year of 2009.

Name of the farmer	Date of sowing	Date of harvesting	Previous crop grown	Soil type	Rainfed/ Irrigated*	Fodder (t ha^{-1})	Grains (t ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
B. Lakpathi	19/9/09	20/1/2010	Paddy	Chalaka soil	Rainfed	1.2	0.85	26700	19100	3.5
B. Rama	20/9/09	9/1/2010	Paddy	Chalaka soil	Irrigated	2.5	0.77	25625	18025	3.4
B. Patthi	21/9/09	13/1/2010	Paddy	Red soil	Rainfed	1.0	0.23	7750	150	1.0
Range						1.0-2.5	0.25-0.85	7900-25980	300-18380	1.0-3.4
Mean						1.6	0.62	19345	11745	2.5

* Life saving irrigation

Table 7 : Grain and fodder yield of horsegram taken up as contingency crop in Dupahad cluster of Nalgonda district in the severe drought year of 2009.

Name of the farmer	Village	Area cultivated	Date of sowing	Date of harvesting	Grains (t ha^{-1})	Fodder (t ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
E. Kotaiah	Jalmalkunta	1	28/809	30/12/09	0.64	2.2	19415	14365	3.8
E. Bheekya	Jalmalkunta	1	29/08/09	28/12/09	0.67	2.4	20484	15434	4.1
B. Bodamna	Jalmalkunta	1	1/8/2009	30/12/09	0.67	2.4	20381	15331	4.0
B. Ramulu	Jalmalkunta	1	28/08/09	29/12/09	0.69	2.3	20983	15933	4.2
D. Takirya	Jalmalkunta	1	28/08/09	3/1/2010	0.70	2.8	21539	16489	4.3
D. pakeera	N.B. Hills	0.5	28/8/09	2/1/2009	0.35	1.2	10655	5605	2.1
E. Bixam	N.B. Hills	1	3/8/2009	2/1/2010	0.64	1.9	19308	14258	3.8
D. Hari	N.B. Hills	1	2/8/2009	4/1/2010	0.66	2.3	20001	14951	4.0
D. Ameena	N.B. Hills	1	2/8/2009	4/1/2010	0.68	2.3	20569	15519	4.1
D. Vasram	N.B. Hills	1	3/8/2009	5/1/2010	0.64	2.1	19448	14398	3.9
B. Shivla	N.B. Hills	1	5/8/2009	30/12/09	0.66	2.6	20314	15264	4.0
N. Nadya	N.B. Hills	0.5	27/08/09	3/1/2010	0.32	1.1	9811	4761	1.9
D. Dasu	N.B. Hills	1	18/8/09	19/1/10	0.67	2.3	20456	15406	4.1
D. Somya	N.B. Hills	1	19/08/09	30/12/09	0.64	2.3	19640	14590	3.9
G. Hemla	N.B. Hills	1	22/08/09	27/12/09	0.55	2.0	16743	11693	3.3
D. Gopi	N.B. Hills	1	29/08/09	2/1/2010	0.60	1.8	18101	13051	3.6
D. Motya	N.B. Hills	1	28/08/09	3/1/2010	0.57	1.7	17153	12103	3.4
E. Ramulu	N.B. Hills	1	18/08/09	1/1/2010	0.70	2.4	21259	16209	4.2
V. Srinu	Seetamma Thanda	1	28/8/09	30/12/09	0.67	2.5	20554	15504	4.1
V. Bodiya	Seetamma Thanda	1	29/08/09	2/1/2010	0.65	1.8	19599	14549	3.9
B. Lagupathi	PedaSeetharamThanda	0.5	28/8/09	30/12/09	0.31	1.1	9552	4502	1.9
G. Venkamla	Yellapa Kunta Thanda	1	28/08/09	26/12/09	0.68	2.8	20919	15869	4.1
Range					0.31-0.70	1.1-2.8	9552-21539	4502-16489	1.9-4.3
Mean					0.61	2.1	18495	13445	3.7

Grain and fodder yield of sorghum and horsegram

Grain yield of sorghum varied from 0.33 to 1.03 t ha^{-1} in Jalmalkunta thanda, 0.25-0.95 t ha^{-1} in Seethamma thanda and 0.25-1.05, 0.50-1.05 and 0.25-0.85 t ha^{-1} in Peda Gara Kunta Thanda, Banjara Hills, Peda Seetharam Thanda respectively. Similarly fodder yield also varied from 1.0-3.2 t ha^{-1}. Horsegram seed yield varied from 0.31-0.70 t ha^{-1} and fodder yield varied from 1.1-2.8 t ha^{-1}. In some cases harvest index of sorghum was as low as 16% due to dry spell during grain filling and grain development stages.

Livelihood Impacts of Contingency Crop Planning in Dupahad cluster

Gross return, net return and B: C ratio varied significantly among the farmers and villages. Gross return, net return and B: C ratio varied from Rs. 7900-32780 ha^{-1}, Rs. 300-25180 ha^{-1} and 1.1-4.3 respectively in sorghum cultivation. Similarly in horsegram, gross return, net return and B:C ratio varied from Rs. 9552-21539 ha^{-1}, 4502-16489 ha^{-1} and 1.9-4.3 respectively. Higher returns and benefit cost ratio was obtained due to lower cost of cultivation and higher selling prices of grain and fodder of sorghum and horsegram. Cost of cultivation of sorghum and horsegram was Rs. 7600 ha^{-1} and Rs. 5050 ha^{-1} respectively. Selling price of sorghum and horsegram grain was Rs. 30 and 28 per kg respectively. The entire tribal dominant population in the Dupahad cluster (9 hamlets) used grain of sorghum for *roti* and cooked sorghum and horse gram as source of energy and protein throughout the year during 2009-2010. Similarly, fodder of sorghum and horse gram was used for livestock as large number of livestock exists in the cluster (Buffalo, sheep, goat etc). Through contingency planning food security of all 8 villages were addressed along with protein security in the form of horsegram, and fodder security for livestock through sorghum.

Conclusions

Yield and economics data of sorghum and horsegram sown in the month of August and September as contingency crop shows that these two crops were a viable option for the degraded red soils with low fertility status. In case of delayed monsoon, general practice in this area is to keep their land fallow. In that situation, it is a better option for the farmers to get up to 1 t ha^{-1} sorghum grain and 0.7 t ha^{-1} horsegram for ensuring family food security besides availing fodder security for livestock.

Name of the farmer : L. MANCHA

Village : JAMALKUNTA THANDA

The contingency crop planning during the severe drought helped me in growing alternate crop such as sorghum and horsegram. Both these crops increased my net return.

Chapter

11

Livestock Based Interventions

Livestock plays an important role in the rural economy and contributes significantly to livelihoods of rural poor in rainfed areas of the state. Smallholder livestock is crucial to the sustainability of drought-prone rainfed districts like Nalgonda, as it complements and supplements the family income and provides crucial resilience for the poor families to cope with uncertainty of rainfall and occurrence of recurrent droughts (Reddy et al. 2005). The productivity of livestock is greatly constrained by the lack of green fodder and good quality feed. Reduction in milk production and weight loss in animals, during the dry season, are common features in these areas.

Technologies to improve livestock productivity and its contribution to the livelihoods of the rural poor do exist; however, the rate of adoption of livestock-related technologies in small-holder mixed farming systems, worldwide, is consistently low. This is largely due to the in-adequacies of the existing research and extension systems to meet the needs and aspirations of farmers (Norman and Collinson, 1985; Francis and Sibanda, 2001; Parthasarthy Rao et al. 2005). The major reason for this shortcoming is that the researchers and development planners do not have proper perspective of the resources, environment, problems and needs of resource-poor farmers. In order to solve this problem, approaches that ensure effective linkages among researchers, extension workers, decision-makers and farmers are needed (Conner et al. 1998). Unfortunately, the extension services in the livestock sector are very poor. Problems related to livestock need to be addressed with appropriate technological interventions. Delivery of such solutions need service providers who can catalyze technology adoption. Attempts were made to understand the diverse micro-farming situations and evolve appropriate package of technological options in association with the farmers. The objectives of project were to identify the constraints for improving the small-holder livestock farming systems in rainfed areas by implementing interventions to address them and to evaluate their impact on productivity and profitability.

Livestock holdings among different categories of farmers in Dupahad cluster

In Duphad cluster, 79% of the families are dependent on livestock farming (Table 1). Cattle and buffaloes constitute 74.7 and 25.3% of the total dairy animals in the village. Among the dairy animals, 72.0% are of non-descriptive cattle and 2.6% is crossbred cattle. Graded Murrah buffalo population is 13.1% of the total dairy animals. Majority of small ruminants are with small (39%), marginal (31%) and medium (27%) farmers. Similarly most of the backyard poultry was also owned by marginal (38%), small (36%) and medium (23%) farmers. The livestock holding (ACU/ha) was highest in marginal farmers (1.0) followed by small (0.9), medium (0.7) and large (0.3) farmers. Medium and small farmers are more dependent on livestock farming than other categories of farmers (Table 2).

Table 1 : Livestock holdings among different categories of farmers in tribal Dupahad cluster

Type of Farmer	No. of Farmers	Average Land Holding (ha)	Livestock Holdings (Nos)			Poultry holdings (Nos)
			Cattle	Buffaloes	Small Ruminants	
Large	17	12.36	34	14	32	76
Medium	85	6.03	196	85	381	788
Small	191	3.50	341	120	548	1264
Marginal	271	1.43	225	51	435	1307
Landless	26	0.00	0	0	5	29

Table 2 : Livestock dependence among different categories of farmers

Type of Farmer	Dependence on Livestock and Poultry (%)			
	Cattle	Buffaloes	Small Ruminants	Poultry
Large	52.94	41.18	23.53	47.06
Medium	80.00	55.29	38.82	63.53
Small	71.73	38.22	31.41	73.82
Marginal	39.48	14.76	20.66	61.62
Landless	0	0	3.87	15.39

Status of livestock production

The livestock production systems in the cluster villages of Nalgonda were found to be complex and generally based on traditional and socio-economic considerations, mainly guided by available feed resources. High disease incidence, low technology uptake, insufficient market facilities and infrastructure and inability of the livestock holder to invest were common in the locale of the study. Predominantly local breeds of cattle, buffaloes, sheep, goat and poultry were kept for production of milk, meat and eggs for either direct consumption or sale at nearby peri-urban areas. The agro-eco system analysis of the cluster villages revealed that the productivity of livestock was being affected adversely by a number of causes. Most of the farmers in cluster villages are used to take their dairy animals for grazing on available grazing / forest/waste lands. Few farmers kept their animals stall fed either at home or at farm nearby their cultivated lands. Paddy straw was the most common basal feed, followed by stovers of jowar and maize. The sorghum especially SSG-59-3 variety was most cultivated green fodder followed by para grass, hybrid napier (Co1) and lucerne and local mixed grasses by very few farmers. The usage of concentrate ingredients viz., rice bran, cottonseed cake, wheat bran, ground nut cake, gram chuni, maize grain, horse gram being practiced by few farmers and restricted to productive animals only and maximum 1kg per head irrespective of milk yield. The farmers supplemented rarely mineral mixture. Further, repeat breeding is the major problem in high yielders. Low energy and protein intake was observed in most of the dairy animals.

Most of the problems associated with productivity of livestock in general and small ruminants in particular were non- availability of feed and fodder both quantitatively and qualitatively. Poor management of available feed and fodder resources along with non-adoption of chopping practice were responsible for aggravating the situation especially under drought conditions leading to distress sale of livestock. Further, outbreaks of foot and mouth disease (FMD), haemorrhagic septicaemia (HS), *peste des petits ruminants* (PPR), entero toxemia, blue tongue, sheep and goat pox were causing heavy losses. Lack of awareness among the livestock keepers about prophylaxis and control measures and inadequate veterinary and animal health care personnel were among the major reasons for this dubious distinction. Besides these, constraints in timely supply of vaccines/deworming medicines were other bottlenecks. Lack of institutional support and community support has been major deterrents for livestock development activities. Thus, low productivity of large ruminants (cattle and buffaloes) could be mainly attributed to the factors like imbalanced feeding, poor genetic potential, high incidence of preventable diseases and improper breeding management.

Small ruminants, particularly goat are an important means of livelihoods. However, inadequate availability and poor quality of feed and fodder, high incidence of diseases, heavy worm infestation, and lack of knowledge on scientific management practices were major constraints leading to low productivity. High incidence of inbreeding, indiscriminate crossbreeding and no supplementation during lean period caused further losses. There was also high mortality rate in newborn kids and lambs owing to poor management. Backyard poultry, an age-old livelihood activity of rural women has been facing constraints like low egg production and poor weight gain, higher disease incidence though preventable. Absence of access to vaccination services and health care and no networked markets when there is surplus production together compounded for the containment of this sector from further progress.

Assessment of problems and opportunities in livestock production

Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) were carried (Table 3) out to understand the status of livestock related problems and opportunities in cluster villages. Focused group discussions (FGDs) were conducted to understand specific problems of different livestock owning households (Table 4). The project adopted a participatory action research approach for developing innovative livestock production technologies with farmers. The approach takes advantage of indigenous knowledge systems as well as advanced livestock management practices. Besides, attempts were made to build the capacity of farmers to experiment and solve their own livestock health, feeding and management problems. It used many of the principles of Participatory Rural Appraisal, but extended the active participation of farmers well beyond the initial stage of appraisal to technology development and adaptation to new area of action research, where in actual research took place to find out an immediate solution to a problem.

Table 3 : Summary of PRA output for Duphad cluster, Nalgonda district

Problem identified	Causative factor	Innovation employed
Low milk yields in dairy animals	Non-descriptive breeds and lack of feed and green fodder resources	Promotion of artificial insemination to upgrade the local breeds Increasing the feed and fodder resources Supplementation of nutrients
Poor marketing facilities	No milk collection center and value addition to the produce	Establishment of milk collection center Capacity building of stakeholders with respect to value addition to milk
Non profitability & high mortality of backyard poultry	Local breeds and frequent epidemics of Ranikhet disease	Introduction of improved breeds Streamlining Animal Health Services
Low body weight gain and high morbidity and mortality in small ruminants (goat & sheep)	Non-descriptive breeds and epidemics of PPR, ET and Blue tongue Over exploitation of grazing resources and no supplementation	Promotion of Nellore ram lambs Faecal examination based deworming Streamlining Animal Health Services Supplementation of nutrients especially during lean period

Table 4 : Matrix ranking for low productivity of livestock in cluster villages

Problems	Severity of problem*
Non-availability of quality feed and fodder	4
Lack of green fodder	5
Poor feed-fodder management	3
Low yield potential of native breeds	4
Inbreeding	3
Disease outbreaks	3
Lack of veterinary services	5

*Ranking based on 1-5 scale

Most of the straws and stovers available in Duphad cluster contained Ca above critical level (>0.3%). Among the cultivated green fodders, the Ca content was marginally deficient in sorghum green, while the para grass, hybrid napier were moderate in Ca and *lucerne* was rich in Ca. Among the concentrate ingredients, the available horse gram was good source of Ca (0.77%) and others like maize grain, groundnut cake, gram chuni, rice bran were marginally sufficient (0.18–0.38%). Although the Ca content of most of the straws appeared to be above critical level, the bio-availability to the animals may be less due to presence of substantial amounts of oxalates and high silica. The P in most of the dry and green roughages was lower than the critical level of 0.21%. Most of the straws and stovers contained Zn well below the critical level (<30ppm). Among the concentrate ingredients, except horse gram and maize, other ingredients like rice bran, wheat bran, groundnut cake and cotton seed were good sources of Zn. The average Mg in dry and green roughages ranged from 0.24 to 0.36 and 0.22 to 0.41%, respectively. Green forages and other concentrate ingredients were quite rich in Fe compared to roughages. Most of the green and dry roughages except sorghum green, stovers of maize and Jowar offered to the animals contained good amounts of Mn. Cobalt content in most of the feeds and fodders was found to be above the critical level of 0.1 ppm (Co content of straws (0.16–0.28 ppm) and green fodder (0.20-0.47 ppm).

The feed intake seems to be optimum from July to December months. The feed (DM) intake irrespective of milk yield, type of the animal was lower in all the cases from January to June months and the extent of deficiency for high and low yielding buffaloes ranged from 23.54 to 46.22% and 27.36 and 67.25%, respectively and in cows it was in the range of 18.62 to 32.12% and 26.56 to 58.74%, respectively. The intake of nutrients calculated for different categories of dairy animals indicated that majority of farmers were marginally under feeding their animals and few were moderately over feeding. The TDN intake was marginal to moderately low (8.84-32.16%). The DCP intake irrespective of milk yield, type of the animal was lower in all the cases and the extent of deficiency for high and low yielding buffaloes ranged from 22.36 to 30.14% and 18.22 and 28.98%, respectively and in cows it was in the range of 9.62 to 18.78% and 22.46 to 30.16%, respectively. In general, low energy (deficit ranged from 23-41% of the maintenance requirement) and protein (deficit ranged from 41-73% of the maintenance requirement) intake was observed in most of the dairy animals. Low blood plasma protein and glucose and higher ketone bodies reflecting malnutrition with respect to energy and protein in dairy animals.

Repeat breeding is the major problem (62%) in crossbred cattle, where as anoestrus (28%) and suboetrus (32%) in non-descript cattle. Non-exhibition of oestrus (silent heat) symptoms is the major problem (65%), followed by abortion (27%) in graded buffaloes, where as anoetrus (57%) and long calving intervals (39%) are the major problems in non-descriptive buffaloes. Apart from these, timely availability of AI at the farmers door step otherwise leaser time for the farmer to take the animal to the nearby veterinary hospital for AI seems to be the actual problem in most of the cases of long calving interval.

After identifying the major problems, various innovative livestock production practices in the form of capacity building; verification trials-cum-demonstrations to address the problems were planned and discussed in meetings with the stakeholders. Several interventions were brought to the doorsteps of stakeholders in the form of a 'basket of technologies' in order to help them to select need-based interventions depending on their own resources. Then, a comprehensive schedule for implementing technical interventions was discussed and finalized in the meetings and finally implemented at community level. Such plans were discussed with the district and sub-district officials of the State Department of Animal Husbandry for further refinement. The evaluation process was monitored and assessed by the "Peer Review Team members "of NAIP and necessary changes were made as and when needed. The core principle of the process was active involvement of the community in decision-making process with technical support by the project staff.

Innovative interventions

Capacity building of the rural youth as livestock service providers (paravets)

In order to address the day-to-day minute health problems in livestock and poultry, a participatory approach was adopted in the cluster villages. Two local youth from the cluster of villages were selected and trained at office of the Joint Director of Animal Husbandry, Mahaboobnagar for about 45 days as Para worker (Fig. 1).

The methodology involved more of hands on training in first aid, animal hygiene, feed and fodder management, deworming, common diseases and vaccination schedule, etc. The para-vets were provided with a simple veterinary kit along with necessary literature after the programme so that they can be provide simple veterinary services in their native village on nominal payment charges (Rs 1 and Rs 2 for treating each small and large ruminant, respectively) with the help of local veterinary doctor whenever required. This way they are expected to serve the local farmers and also earn a livelihood for themselves. The previous attempts to develop a cadre of para-vets to aid the on-going development programmes have not produced the desired results. Studies indicate that lack of post-training handholding support has resulted in many trained Para-vets losing interest. In order to prevent this, CRIDA has been implemented the following measures like assuring a minimum monthly income and incentives for better performance to the para-vets and also provide the required support and time for them to settle down as useful resource persons for the community.

Fig. 1 : Capacity building of the rural youth

Streamlining of animal health services as community activity

Animal health services were streamlined in the cluster villages through the trained Para workers. Strong integration and linkage (both forward and backward) among the stakeholders, animal husbandry (AH) professionals and service providers (para workers) was established in reporting any epidemics and timely implementation of prophylaxis measures with community cooperation. Livestock owners were organized into common interest groups (CIG) like milch animal rearers, goat rearers etc. Meetings with local Veterinary Assistant Surgeon (VAS), Para workers, sheep/goat/milch animal CIG groups were held at monthly intervals to discuss their problems and finalize vaccination/deworming schedule. The CIGs were encouraged to procure enmass all the required vaccines and deworming drugs well in advance by utilizing the revolving fund available with the community. Based on consultations, schedules were drawn for vaccinations and deworming in cooperation with Village Organizations (VO). The Para workers were deployed to carry out periodical vaccination and deworming in livestock under the guidance of the local Veterinary Assistant Surgeon.

Improving feed and fodder base in the village

The necessity for green fodder arises during *rabi* (post-rainy season) when the green fodder availability ceases. Hence, the idea of participatory evaluation of perennial and annual fodder species on farmers' fields was introduced to sustain productivity of livestock even during *rabi* and summer. It aimed at increasing fodder supply through identifying and disseminating new varieties of fodder or dual-purpose crops in addition to conservation and efficient utilization of available feed and fodder resources. This involved participatory selection of fodder options with an emphasis on genetically improved varieties and newer supplementary feed resources. Small fodder banks were established with the surplus fodder collected at monthly intervals from the common lands during rainy season. Encouraged to cultivate fodder crops like maize, lucerne, cowpea, horsegram, sunhemp etc., on tank bed areas at the end of winter season. *Stylo hamata* was sown on the available bunds in the village for strengthening of bund and also as leguminous fodder source for livestock.

Increasing feed and fodder base at household level

Azolla, a blue green algae which is having more than 25% CP and can be doubled in quantity within 5-7 days was encouraged to establish in pits at backyard depending on the number of milch animals of the farmer (Table 5). Large-scale production trials were taken up across the cluster villages to demonstrate the *Azolla* as alternative nutritious supplementary green fodder for livestock (Fig. 2). Azolla yield is much more than the perennial fodder varieties like APBN-1/CO-3 etc and is around 1000 MT ha^{-1} at the rate of 300 gm/sq.m/day even after taking into account wastage space between two Azolla beds. It is more nutritious than the leguminous fodder crops like lucerne, cowpea, berseem etc and can be fed to cattle, buffalo, sheep, goat and also poultry after mixing with concentrate mixture at the ratio of 1:1.

Table 5 : Production potential of Azolla

No. of milch animals	Pit size (m)	Azolla productivity (kg/day)
1	2.0 X 1.5	0.75-1.05
2	4.0 X 3.0	1.50-2.10
3	6.0 X 4.5	2.25-3.15
4	8.0 X 6.0	3.00-4.20

Fig. 2 : Azolla cultivation

Efficient utilization of available feed resources

Efficient utilization mechanism was strengthened through supply of chop-cutters to the custom hiring centers. Custom hiring centers are promoted in the cluster of villages to encourage mechanization of agricultural-operations. Farmers hire the implement by paying user charges. Experimental learning exercises were organized on the need of chopping feed/fodder especially the sorghum stover, which is the major rainfed crop residue available to feed livestock in most of the villages under study. Further stakeholders were encouraged on urea molasses treatment of paddy straw and preservation of surplus green fodder as silage.

Enabling institutional mechanisms

One member from each community was selected and formed as Salaha Samithi after taking consensus in grama sabha. The local line department officer i.e., Veterinary Assistant Surgeon (VAS) and Village Organization (VO) were also included as officiating members in Salaha Samithi. The Salaha Samithi discusses about all the issues once on last Thursday of every month. With the help of local NGO and scientific staff of the CRIDA, the Salaha Samithi prioritizes the activities to be implemented in their villages and also suggests the members for involving in the interventions. Similarly common interest group (CIG) of small ruminants was formed and made responsible for all production enhancement activities of sheep and goat in that cluster.

Capacity building of livestock keepers

A participatory evaluation methodology was tailored to strengthen the capacity of livestock rearers. The CIG members, who are interested in livestock rearing, were selected. Training programmes were organized to educate them on scientific management practices of different species of livestock and poultry, essentially about the advantage of regular deworming, timely vaccination against endemic diseases and supplementation of mineral and concentrate mixture during lean period. The group members including small ruminant rearers do exist in the cluster village were trained through specially designed training programmes and demonstrations related to ram lamb rearing, fodder production, preservation and its efficient utilization and also urea molasses mineral bricks (UMMB) preparation (Table 6, Fig. 3). All the small and large ruminant rearers were enabled to mark different activities like deworming, vaccination, shearing, and supplementation etc., on the monthly calendar for ready reminder. Every second Thursday in a month, CIG members along with the para worker met the VAS and finalize the activities to be taken for control of various diseases and or improvement of productivity. Further, the para worker and shepherds were imparted with the skills of using drenching gun for deworming and shearing machine for wool cutting.

Table 6 : Urea molasses mineral blocks composition and nutrient content

Ingredient quantity	(kg)
Urea	10
Molasses	38
Wheat Bran	40
Cement	10
Mineral Mixture	01
Salt	01
Vitamin A, B_2, D_3 and K supplement	0.02
Chemical composition	**(%)**
Dry Matter	93.89
Crude Protein	36.40
Crude Fat	0.92
Crude Fiber	2.70
N.F.E.	38.78
Total Ash	21.20

1 kg UMMB provides DCP for 400 kg Body Weight Animal for Maintenance, which can replace 1.5 kg of Concentrate Mixture.

Fig. 3 : Urea molasses mineral brick (UMMB)

Provision of revolving fund

Revolving fund of about Rs.200000 (Rupees two lakhs only) was made available from the project fund to the Salaha Samithi for providing loans to the selected members for purchase of livestock/ vaccines/feed/fodder seed etc well in advance through CIG.

Regular screening of faecal samples of different flocks

Faecal matter from each flock was collected by one CIG member on rotational basis at monthly interval and got examined the same at district animal husbandry department.

Judicious use of deworming drugs

Para worker undertakes mass deworming of a particular flock depending on the faecal examination report. Deworming will be carried with the help of drenching gun, which prevents wastage of valuable drugs (Fig 4).

Timely immunization

In every cluster village, the CIG was made responsible for indenting well in advance for required quantity of vaccines and deworming drugs in consultation with the local VAS, which was facilitated by the project staff. This resulted in timely availability of vaccines and vaccination of large (HS, BQ and FMD) and small ruminants (BT, PPR and FMD) and also poultry (Ranikhet disease) against endemic diseases.

Access to cost effective concentrate mixture

During the crops harvesting season, one SHG was encouraged and trained to procure the locally available feed ingredients and prepare concentrate mixture sufficient to supplement small ruminants in their village during lean period by making use of revolving fund. The SHG sells the same in the village during lean period after charging one rupee extra on cost to cover preparation of the mixture.

Intensification of small ruminant-based livestock production systems

Initially women from SHGs who are otherwise engaged as daily labour were selected and trained through specially designed programme on ram lamb rearing or production as livelihood activity. Nellore ram lambs aged 3-4 months were procured from nearby villages, insured under *Jeevarakshanidhi* a state sponsored scheme and distributed to the women on 50: 50 cost sharing basis. The agreement was that the women would return the remaining 50% share when they dispose of the animals. All the small ruminant rearers were enabled to mark different activities like deworming, vaccination,

Fig. 4 : Deworming of small ruminants

Fig. 5 : Ram lamb rearing as livelihood activity

Fig. 6 : Concentrate mixture supplementation to rams

shearing, and supplementation etc., on the monthly calendar for ready reminder. Faecal matter from each flock was collected by one UG member on rotational basis at monthly interval and got examined the same at district animal husbandry department. Para worker undertakes deworming depending on the faecal examination report. The ram lambs were reared for about 6 months on semi-intensive system of management with supplementation of concentrate mixture as per the recommendation of the project staff and VAS (Fig. 5 & 6). An agreement was made within the group that only one member on rotational basis should take all the animals for grazing every day. The SHGs were closely monitored by the project staff with respect to feeding and health management practices from time to time. Effect of supplementation of concentrate mixture on daily average gain and final weight gain in Nellore ram lambs was evaluated under village situation to demonstrate the advantage of supplementation especially during lean period.

Empowerment of rural women through backyard poultry with improved breeds

A participatory action research was conducted with proven high producing backyard poultry breeds like *Vanaraja, Rajasree, Grama Priya* etc., in cluster villages (Fig. 7). It was designed to create additional employment opportunities and income generation for empowerment of rural women besides aiding family nutritional security. Identified one or two interested self help group (SHG) members as an entrepreneur for chick rearing in each village and organized training program on chick rearing including vaccination. SHG members established chick rearing centers in one cluster villages to rear day old chicks for 6 weeks. Vaccination against all the major endemic diseases was completed during this period either by trained women or para worker with the help of VAS. The chick rearing SHG members agreed to charge a minimum Rs.5 per chick over and above the maintenance (feed, medicines, vaccination etc.,) expenditure towards the services they offered during the 6 weeks period. The 6 weeks old chicks were sold to the trained women farmers in the same village and performance of the chicks was regularly monitored. Some of the fertile eggs produced from these birds were hatched with *Desi* (local non-descript type) hen. Further, vaccination and day to day health care services were streamlined through the para worker under the guidance of the local VAS.

Exploitation of genetic potential in milch animals through supplementation

After assessing the nutrient intake at individual farmer level and depending on the production potential of the animal, supplementation was provided in the form of mineral and concentrates mixture/*Azolla* especially during the lean period when there is no green fodder available for feeding. Some of the crossbred cows and graded Murrah buffaloes are fed increasing quantity of feed and challenging them to produce at their maximum potential. It is starting the concentrate mix (about

Fig. 7 : Back yard poultry production with rural women

500 gm) feeding before 2 weeks expected date of calving (EDC) and increase it gradually to a level of 500 -1000 g for every 100 kg body weight. This challenge feeding will condition her digestive system for the increased quantity of feed to provide sufficient nutrients to initiate lactation on a higher plane. This effect has been found to have higher total milk yield in the lactation. Dairy animals with low energy and protein intake were offered with at least 2-3 kg green fodder and 1-3 kg concentrate mixture for a period of 5-6 months depending on the breed. Reproductive camps were conducted to create awareness about identification of silent heat in buffaloes especially in summer and importance of timely insemination. Farmers were educated in managing heat stress by providing proper housing to the animals and early morning and late evening grazing during summer and feeding roughages during night etc. Supplementation of mineral mixture and regular deworming practice was encouraged by making available with subsidized products from AH department. Synchronization of oestrus (with PGF_2 alpha hormonal injections) was implemented in anoestrus and repeat breeders. Further the impact of mineral supplementation in mitigating anoestrus problem in dairy animals was demonstrated.

Exploitation of available dung for biogas production

It is estimated that around 3000kg of dung from large ruminants (cattle and buffalo) and 300 kg from small ruminants (goat and sheep) is available in the cluster villages per day for biogas production. Community biogas plant was established in villages in order to exploit the available dung. About two cubic foot of gas may be generated from one kg of dung at a temperature 28°C. This biogas consists of 55-65% methane, 30-35% carbon dioxide, with some hydrogen, nitrogen and other traces. This gas is enough to cook a day's meals for 4-6 people in India. Its heating value is around 600 B.T.U. per cubic foot. After biogas this slurry can be used as organic fertilizer (vermicompost) which contains 1.8-2.4% nitrogen (N_2), 1.0-1.2% phosphorus (P_2O_5), 0.6-0.8% potassium (K_2O) and 50-75% organic humus. Exploitation of dung not only provides the bio-energy, but also prevents the GHGs accumulation in the atmosphere.

Outcome of innovations in livestock production practices implemented

About 3246 and 4114 large and small ruminants were vaccinated against HS, BQ & FMD and PPR, ET & FMD, respectively and about 4905 small ruminants and calves were dewormed in the cluster villages over the three years (Fig. 8). As a result no single outbreak of any disease was reported during the 3 year period. Capacity building of local youth and involvement of farmers proved effective in streamlining the animal health services and control of animal diseases in rural areas.

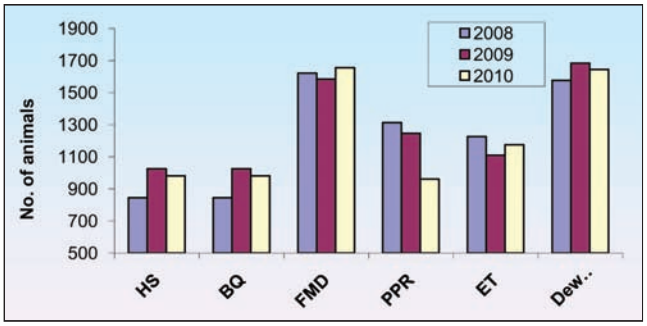


Fig. 8 : Number of animals treated in animal health camps in Dupahad clusters villages during the year 2008-10

Regular screening of faecal samples for worm dynamics and worm burden in selected flocks revealed highest worm infestation from May to July followed by August to October. The learning's

Table 7 : Live weight of Nellore ram lamb flocks under different treatments

Parameter	Control Flock (No Dewormer Drenched + No Supplementation)	Dewormer Drenched Flock	
		No Supplementation	Concentrate mixture supplemented
No. of rams in Study	96	74	128
Initial Live weight (kg)	14.3^{a} ± 0.86	13.9^{a} ± 0.78	14.1^{a} ± 0.92
Final Live weight (kg)	25.3^{a} ± 0.96	31.3^{b} ± 0.92	36.3^{c} ± 0.68
Weight gain (kg)	11.0^{a} ± 0.23	17.4^{b} ± 0.48	22.2^{c} ± 0.34
Average Daily Gain (g)	61.3^{a} ± 3.22	96.8^{b} ± 4.18	123.2^{c} ± 2.88

from the study indicated that drenching of deworming drug according to the worm dynamics and worm burden along with appropriate management practices helps in achieving higher weight gain in small ruminants (Table 7). Further, supplementation of concentrate mixture resulted higher daily average gain and final weight gain in Nellore ram lambs and improved the overall profit (Fig. 9). This resulted in change of stakeholders mind set and practice of supplementation to small ruminants along with drenching of appropriate deworming drug.

Regular vaccination (Table 8) substantially reduced the morbidity and mortality in backyard poultry. The average weights of 4 weeks old improved and *Desi* chicks ranged from 338 -365 and 120-155 g, respectively. The average age (days) and weight (kg) at laying 1st egg was 192.6 ± 2.4 & 2.06 ± 0.08 and 227.0 ± 3.9 & 1.32 ± 0.08, whereas weight of egg (g) at 40 weeks age was 58 ± 0.7 and 49 ± 0.6, respectively in improved and *Desi* birds. Number of eggs lay per bird till 40 weeks age was 73 ± 1.4 and 16 ± 1.2 in improved and *Desi* birds. Thus, the results indicated that the improved birds are better alternative for *Desi* birds under backyard as dual purpose (chicken and eggs) bird for getting higher profits. Vaccination for risk aversion is essential for success of backyard poultry in rural areas, however, new insights in prophylaxis of backyard poultry (local birds as disease carriers) should be considered seriously before introduction of improved breed. Further, regular deworming seems to be also very important in backyard poultry due to unhygienic surroundings.

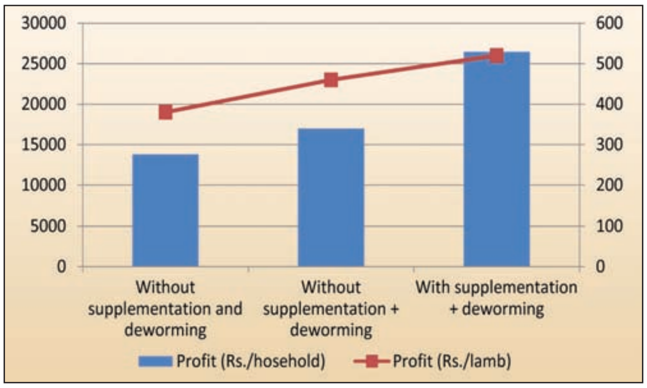


Fig. 9 : Economics of Nellore ram lamb flocks under different treatments

Improved cultivars augmented fodder resources substantially. Usage of chop-cutter, reduced wastage of the fodder up to 50 per cent. Chopping of fodder prevented the selective consumption of fodder and enhanced the intake and utilization of feed. Farmers observed that cutting of the fodder into small pieces was a laborious task, albeit it proved to be a good feed for the animals. Thus, chopping of fodder and

Table 8 : Vaccination schedule followed in improved backyard poultry breeds

Age (days)	Name of the Vaccine	Dosage	Route
1	Marek's Disease	0.20 ml	Subcutaneous
7	*Ranikhet* Disease (Lasota)	One drop	Eye drop
18	*Ranikhet* Disease (Lasota)	One drop	Eye drop
28	*Ranikhet* Disease (R_2B)	0.50 ml	Subcutaneous

*Repeated R_2B at every 6 months interval.

Fig. 10 : High yielding fodder cultivar (Co-3)

fodder cultivation on bunds/fields has resulted in increased production including quality of the milk. Increasing fodder supply improved the livestock production. Milch animals gave more milk (average increase of 1-2 liters/day) as a result of overall increase in availability of palatable and nutrient rich fodder including green fodder during lean period.

This higher milk production resulted in generation of an extra income of Rs.15-30 per day per milch animal. Similarly Azolla also yielded immediate results and farmers are very happy about the outcome as feeding *Azolla* on an average, increased milk yield by 0.5-1.5 liter per day with an increase of 1-3% of milk fat (Table 9). Feeding of Azolla at 1:1 with concentrate mixture reduced 30 per cent production costs in milch animals. However, issues like declining *Azolla* production after 6-8 weeks of introduction was addressed through training farmers. After the implementation of different need based Nutritional /Animal / Housing Management/Hormonal interventions improved conception rate and decreased calving interval and also postpartum reproductive disorders in dairy animals. In majority of the cases the

Table 9 : Milk yield in graded murrah buffaloes with or without Azolla supplementation in Dupahad cluster

Parameter	Control (No Concentrate mixture Supplementation)	Supplemented*	
		100% Concentrate mixture	50% Concentrate mixture + 50% Azolla
No. of animals in Study	6	6	6
Initial milk yield (l/d)	6.5 ± 0.32	12.0 ± 0.42	12.8 ± 0.50
Peak milk yield (l/d)	8.1 ± 0.54	15.8± 0.61	16.1 ± 0.48
Lactation milk yield (305 days) (l)	1746± 2.50	2686 ± 2.60	2936 ± 2.82
Average Daily milk yield (l)	5.73 ± 0.22	8.81 ± 0.36	9.63 ± 0.42
Average butter fat %	6.23 ± 0.09	6.18 ± 0.12	6.58 ± 0.08

* Supplementation was provided 2 weeks before expected date of calving

calving interval reduced from an average of 20 months to 15 months in graded buffaloes and 19 months to 15 months in crossbred cattle.

Conclusions

The project experiences suggest that that capacity building and participatory involvement of farmers while streamlining of animal health services as community activity would facilitate containment of animal diseases in rural areas. Further, adoption of improved livestock management practices with augmentation of feed and fodder resources would help in providing healthier livelihoods and income from large and small ruminants. Improved cultivars in addition to conservation and efficient utilization of available feed resources would augment fodder resources substantially in rural areas and reduced distress sale of animals during lean season. Animal health camps and on-farm trials created awareness among farmers regarding the adoption of better livestock practices like supplementation of mineral mixture, chopping of crop-residues, backyard Azolla cultivation, etc. Through farmer-farmer interaction, many farmers realized the economic benefits of better livestock practices and came forward to adopt them. The project interventions had an ample impact not only on the farming community, but also on landless and women farmers.

Name of the farmer : B. BHEEMLA

Village : JAMALKUNTA THANDA

Earlier we did not have much green fodder to feed our milch animals especially during summer. With the establishment of azolla at backyard we could able to give nutritive feed supplement throughout the year and that improved milk yield and fat per cent in milk. Now, I am getting more remunerative price to the milk and earning more money.

Chapter

12

Market Linkages and Livelihood Impacts

Market Linkages is one of the important as well as challenging responsibilities under NAIP. There is always learning from linkages every season which acts as a hold up for the next. Apart from creating retail links, linkages extended to providing technical knowhow, recommendation of profitable variety as well as providing subsidy for the same. A comparative study to analyze benefits from linkages with corporate retailers is illustrated in Table 1.

Table 1 : Comparative study to analyze benefits from linkages with corporate retailers

	Attribute	Corporate retailers	Marketyard
1	Price	Always higher than the local market	Comparatively less
2	Price fixation	Fixed a day or two before procurement	No predictability of price. The price would be fixed only after approaching the yard. The farmer has no option except to sell it to the price fixed in the auction.
3	Hassle free transactions	Payment through cheque/ DD/ money transfer in less than 7 days	Cash payment at market yard. Installments on the field
4	Secure	Full security to the produce	No security of the produce. Theft cases are more at nights
5	Commission	Nil	Commission to agents ranges between 10-15%
6	Hamali charges Chute (%)	Nil Nil	Hamali charges of 3-4% 10%
7	Maintenance charges	None	Has to pay maintenance. Also called as market cess
8	Open auction	No auction system. The price is fixed in advance.	System of open auction prevails. The genuineness involved is always a doubt.
9	Dormitory facility	A dormitory facility for proper rest and freshening up	No facilities
10	Transport	Depending on the trust and relationship the retailers often picks up the produce at the farmer's orchard. Even if it is not done a fair price is fixed up including transport cost.	There is no separate consideration for transportation.
11	Weighment	Perfect measurement of weight using electronic scales.	Electronic scale measurement is seldom noticed. Generally lots (of mangos) are auctioned by many vendors.

Market Linkages in tribal villages

I kisan was one among eight consortium partners in the project with the responsibility of establishing market linkages, and establishment and strengthening of village resource centres.

With specific reference to Market Linkages, Ikisan is focused on the following activities:

- Identification of companies/ corporate retailers like Reliance, Heritage etc for retail links
- Identification of demanded farm produce, study requirements of primary processing / value addition
- Establish standards of acceptance, price premium and rejects
- Formulate price discovery mechanism
- Describe payment and delivery terms
- Create mutually beneficial contracts

Hence it was decided by the consortium partners CRIDA, I-Kisan and KVK-SAIRD to pilot the introduction of varieties that are comparatively in higher demand. Capacity building activities were also undertaken by CRIDA. The intention of organizing capacity building was to extend linkage activities to activities like empowering farmer with sound technical knowledge. Major learning in market linkages is the need to work out activities well in advance before the season. Quality of the society's technical knowledge is directly proportional to the quality of produce which is one of the main criteria for a successful market linkage. Keeping in view the need to strengthen the society with technical and managerial skills a workshop was organized on 18th Feb at KVK, Gaddipalli. Technical staff from CRIDA, KVK and Ikisan participated in the programme. To improvise on the efficiency of market linkages, it was decided to push technical advisory through Sasyavani to farmers' mobiles along with the regular market information.

Dupahad cluster in Nalgonda district and its surrounding villages cultivate paddy, cotton and groundnut. This region is also known for vegetable and fruit crop cultivation. However yields were low for tomato, bhindi, leafy vegetables, fruit crops, water melon and mango majorly due to low yielding varieties, improper water management and deficiency of major nutrients. These constraints were addressed by CRIDA and SAIRD in the Nalgonda Dupahad cluster with the help of Consortium partner IKisan. A basic research was conducted especially on fruit and vegetable category business. Based on this understanding it was felt that Dupahad area has a good potential for watermelon linkages. China Gorekunta, one of the villages of the cluster cultivates this crop for the last few years. Hence it was decided by the consortium partners CRIDA, I-Kisan and KVK-SAIRD to pilot the introduction of varieties that are comparatively in higher demand. Subsequently based on the results, the activity could be scaled up to other villages. Mango linkage which is almost established in the cluster could be used as a back up to work on water melon linkages.

Mango linkages

Dupahad cluster of Nalgonda district is one of the areas in Andhra Pradesh with high potential for mango cultivation. Almost 200 acres of land is under mango cultivation in this area. The place is occupied by a large number of vendors and commission agents. These agents offer some money to the farmers well before the season and take the orchards for lease. These offers by the agents are way too low than the market prices in local market.

Other farmers who sell the produce at the local markets have concerns as well, in terms of genuine pricing, correct weighing, commission and cess charges, etc, that almost pools up to a loss of 20 to 30 percent on the market price.

Market linkages concept by Ikisan has aimed at breaking this chain by creating a channel that directly linked the farmers to retail chains and corporate buyers in the cities. Market linkages activity for mango which was carried out effectively in 2009 has brought about much learning. One of the most important learning was the need to 'group up'. This idea was drawn out from the experience of previous transactions made with the retail chains (NFCL, 2012).

One of the inferences drawn from the activities done under NAIP was that a significant amount of time would be consumed for an intervention to stabilize and become self sustainable. Mango market linkages serve as classic example in support of this statement. During the first year of mango linkages a visit was made to Gaddiannaram market, Hyderabad along with one of the farmers of the Dupahad cluster. This is done to study the procedures in the local markets and to make a comparative study.

Key findings of the visit are listed below:

- The price for the produce is not fixed in advance. It is only decide after an open auction.
- The produce is dumped in heaps in the yard with the farmer having to guard till it is auctioned.
- Parties (vendors) gather at the heaps with a person announcing the price quoted with an accountant noting down the details once the deal is done.
- Commission for the produce taken by agent's ranges from 10% to 12% of the total auctioned value.
- The hamali charges are between 3% to 4%
- Chute is fixed at 10%

It was observed that on a whole the farmer is exploited here in these markets. The total loss to the farmer all the deductions put together is around 23% to 29% (commission- 10% to 15%; hamali – 3% to 4% and chute – 10%).

Season 2011 witnessed huge transactions of Rs 24 Lakh and tonnage of around 164. Increase in the tonnage was 300% from previous season that has contribution from more farmers and retailers. Tonnage transacted with the buyers/ retailers kept showing an increasing trend through the years. It kept doubling from 2008 to 2010 and increased four times in 2011. The doubling during the first 3 seasons was due to gradual increase in awareness among farmers about the profitability. The intervention made a great impact in terms of sustainability which is the major objective of the project. Though there was a stagger at the outset to stabilize the activity owing to the remoteness, the progress evened out subsequently through the years. Every season was a great learning that helped focus the efforts in the next. This steady progress made up a strong foundation by 2010 which is the third season for mango linkages. The year was a spectator of major events like formation of mango society, pooling up produce, value addition etc. Despite the huge rise in quantities and amount, all the consignments took place evenly compared to previous seasons. The 2011 season, which is the fourth since the inception of Market Linkages, showed a great deal of support from the society

Fig. 1 : Heavy tonnage of mangoes obtained during 2011 season in cluster villages

that led to heavy tonnage and transactions (Fig. 1 & Fig. 2). This could be regarded as an indication to the level of establishment of linkage activities under the project.

The phenomenal increase in 2011 was because of coordination among the farmers of the society. Most tonnage has been transacted through market linkages than the local market. It has been four seasons since activities under mango market linkages component of SRLS begun under the project. In the year 2011, linkages activities went smoothly because of the catalytic effect of the previous. A great deal of effort was not required at the cluster level in 2011, instead it was focused on the other facet i.e. retailers/ buyers.

Fig. 2 : Mangoes loaded into trucks at tribal villages of Dupahad cluster and transported to retailers

Table 2 : Total consolidated data of mango market linkages under NAIP in 9 villages of Dupahad cluster

Parameters	2008	2009	2010	2011	Average	Total
No. of buyers	1	2	2	5	-	
No. of beneficiaries	1	2	6	9	-	12
Total tonnage	8	20	41	164		233
Retailer net price	11	14	15	13	13	-
Local net price	9	11	11	11	11	-
Total transaction (Rs.)	96000	3,77,000	6,49,956	2,40,5388		35,28,344
Benefit %	16.67	23.67	30.41	24.51	23.81%	-

The result was an increase in the number of retailers that directly boosted the farmers' negotiating power and hence a better price. The development was gradual but for sure effective. Most transactions took place over telephonic conversation. Physical presence of Ikisan staff was not required except during the initial transactions done with new retailers; instead the time was dedicated to bringing in new retailers to the cluster as well as establishing the existing contacts. There is a mutual exchange of concern between the parties many times through 'farmer-retailer interaction meetings'. Also the society members kept interacting with the procurement team at the collection points each time they had a consignment.

Watermelon linkages

Watermelon is a traditional crop in Dupahad cluster. Farmers cultivated only regular watermelon varieties (large oval to oblong), until Ikisan Ltd. intervened under the stewardship of Central Research Institute for Dryland Agriculture (CRIDA). The objective was to introduce small (icebox type) varieties like Sugar Queen, Kiran etc. (Fig. 3) that have more demand among corporate retailers / buyers and hence a better profitability, and built in the farmer capacity to market his produce to profitable and reliable sources rather than resorting to local vendors/ agents. Regular variety large oval to oblong type (Namdhari 295) is very prominent in the area right from the beginning. Every season during commencement of fruiting, local vendors buy the produce from farmers at their farm. Generally the whole plot is negotiated for certain amount (lease system). The harvest quantity is taken by the buyer irrespective of the tonnage (weight) as well as quality of the fruit. The second type of buyer fixes a certain price per ton. With time, few farmers have ventured to take a step ahead and sell the produce in the local markets learning that the profitability would be high. The average price offered by the vendors based on the information provided by farmers is Rs.3000 per ton of watermelons prior to NAIP interventions.

This particular intervention of market linkages works on backward integration strategy. Apart from providing a platform to link up/ market the produce, suitable variety that has a greater demand and good price is recommended. This was done keeping in view the demand of particular varieties with the buyers/ retailers. Icebox type varieties have better demand and were proposed for introduction in the cluster area. Sugar Queen Variety that falls under ice-box variety was recommended for the area. Average price obtained per kg was Rs. 6.35 with five major retailers of Hyderabad city through

Fig. 3 : Sugar Queen and Kiran varieties of watermelon introdduced in Dupahad cluster for higher yields and farm income

linkages. Highest price was Rs.8 by MORE at the beginning of the season and Rs.5 mid season and Rs.6 at the end of the season. The general observation made was that the prices were at their peak both during the onset as well as at the end of the season. Transactions from the cluster begun in the middle of the season and ended before the season due to which the average price per kilo restricted to Rs.6.32. Retailers contacted for supply in the 1st and 2nd week of May and showed willingness to pay premium prices for the produce. But by that time the produce at the cluster exhausted. The minimum profit through the intervention is around 95% more than that obtained in the local market and around 100% more than that comes from leasing the crop to vendors**.** Seed costs were considered in the economics as there is a significant difference between the two varieties's cost of cultivation. Oval to round large varieties cost around Rs. 5000 to 10000 and Sugar Queen costs Rs. 26000 per kilo of seed. From the retailer's perspective icebox type varieties are most sought after, for reasons like easy to carry, high sugar content etc. It was decided to take the activity on pilot and later scale it up based on the results and also to provide seed at 50% subsidy.

Costs that incur and the risk involved in local market are almost negligible. But then, due to lack of negotiation power, farmers would have no option but to oblige to the price fixed up by the vendors. This creates a major difference in the profitability for the farmer. Intervention by NAIP in this particular case not only emphasized on educating farmers about profitability through market linkages but also on customization of the cultivation/ cropping patterns based on market demand. Customization in this case is replacement of the crop with a much sought after and demanded variety.

The produce supplied from the cluster made a mark among retailers with its high sweet content, colour and shelf life. Due to the association with almost ten major retailers/ buyers hopefully there is a good scope for increasing intake of produce from the cluster season after season. A planned technical advisory from technical staff is required right from the beginning of the season starting with sowing calendar. Content regarding best management practices for watermelon should be disseminated through the touch-screen kiosk.

Table 3 : Costs and profitability in traditional systems and market linkages in Dupahad cluster

	Traditional System		
	Farm Gate	Local Market	With Market Linkages
Costs (Rs.)			
1. Seed (per kg of harvest)	0.05	0.05	0.15
2. Transport	-	0.50	1.20
3. Commission (10%)	-	0.40	-
4. All other costs	1.00	1.00	1.00
Total	**1.05**	**1.95**	**2.35**
Price (Rs.)			
1. Gross	3.00	4.00	6.35
2. Net	1.95	2.05	4.01

Tomato linkages

Tomato was one of the major vegetable crops being cultivated in Dupahad cluster. However, yields of this crop were considerably low. With NAIP intervention tomato seeds of the variety (UF 618) were procured from Nalgonda Horticulture Department and distributed amongst the farmers. Farmers were encouraged to broadcast these seeds instead of the local variety. Yields doubled by this intervention (Fig. 4), thereby encouraging the farmers to link up with retailers to sell the product.

Seed production

Market linkages as such need not necessarily be output marketing to corporate retailers but it can also be input marketing like seed production. This is as well, marketing to major seed companies along with buy back and formal agreements on price. It could be useful to the farmer as a business model. A number of private seed companies and a few NGOs have already begun to produce hybrid rice seed as huge revenue generating business models. In fact, many villages across India have started producing hybrid seed by grouping up as farmer's organizations either individually or by partnering with private companies. These developments and farmers' interest from the clusters had encouraged Ikisan to facilitate for seed production activity initially in Jaffergudem cluster.

Awareness and knowledge about corporate buyers' procuring and marketing styles

The ultimate aim of the intervention is sustainability which can be achieved by imparting sufficient knowledge about businesses at different markets and at different levels in the marketing channel. Such awareness would build up in the farmers, the capacity to market his produce without an external intervention in the long run. Cluster farmers were always encouraged to participate during linkages at the retailer's distribution points to know more about them. In the season 2009 a study was conducted to make a comparative analysis of the retailer market and local market.

Fig. 4 : Tomato crop showing yield increase with better management

The results of the analysis were produced before the farmers to show the profitability or rather the losses incurred at local markets. Targeting a big farmer has served easy word of mouth spread of the benefit to other farmers of the society.

Exposure of the area's potential to the corporate retailers/ buyers

There was a constant effort to organize field level meetings and farmer interaction meetings under market linkages activities. Number of retailers increased gradually from 2008 to 2011. Season 2011 was pre planned such a way that retailers and farmers have direct face to face interactions with each other in the form of interaction meetings (Fig. 5). This encouraged farmers to have direct discussions and fixed up terms and conditions on mutual consent right on the spot. All major retailers of Hyderabad city by now are aware and acquainted of 'Sri Aurobindo Mango Growers Society' and its capacity to supply over 250 tons of produce every season.

Settle in the retailers' supplier database

Corporate retailers rely on organized groups for their requirements rather than individuals. They also take into regard the continuity in supply and a quality. This forms the basis for any supplier to settle in the retailer's permanent supplier database. There was always a good supply from the cluster in terms of quality and commitment. In 2011 the supply was very consistent which impressed retailers. Heritage Foods India Ltd. is the first retailers to recognize the cluster's potential and has been a regular procurer every year. Reliance India Ltd., has issued a vendor code for the society in 2011. This indicates acceptance to the society to be one of their permanent suppliers in the long run.

Tonnage

Transactions with the buyers/ retailers kept showing an increasing trend through the years. It doubled from 2008 to 2010 every year and quadrupled in 2011. The doubling during the first

Fig. 5 : Group meetings with tribal farmers and retailers

3 seasons was due to gradual increase in awareness among farmers about profitability through linkages. The phenomenal increase in 2011 was due to coordination among the farmers of the society and their support and trust developed in the previous years. Most tonnage of the cluster was transacted through market linkages than the local market.

Marketing

Market linkage activity focuses on linking up the farmer's produce to a reliable, profitable and sustainable source. Ikisan Ltd., has been working on the concept during the project period under NAIP. Working for the task involved a constant association with two entities viz 1) Farming Community and 2) Corporate retailers/ buyers. There is a mutual exchange of concern between the parties many times through 'farmer-retailer interaction meetings'. This has developed awareness about each other. Also the society members kept interacting with the retailer procurement teams at the collection points each time a consignment was done.

The criteria to judge an intervention like market linkage for it's efficiently may not exclusively be the tonnage lifted to buyers/retailers. Market linkages aims at bringing about profitability through effective marketing. Agricultural markets are always complex and the constant price fluctuation adds more to it. If a local market serves the aim it is always encouraged to stick to that particular market. From the learning and observations from the last four seasons, the criteria for efficient market linkages may be awareness in the cultivars about the corporate buyers' procuring and marketing styles. The ultimate aim of the intervention is sustainability which can be achieved by imparting sufficient knowledge about businesses at different markets. Training on value addition to compete in these markets is essential as well. Such awareness would build up in the farmer's capacity to market his produce without an external intervention in the long run. The cluster farmers were always encouraged to participate during linkages at the retailer's distribution points to know more about them.

In the season 2009, a study was conducted to make a comparative analysis of the retailer market and local market. A big farmer Mr. Mamidi Somaiah had assisted and participated in the study. The results of the analysis were produced before the farmers to show the profitability or rather the losses that incur at local markets. Targeting a big farmer has served, easy word of mouth spread of the benefit to other farmers of the society. There was always a good supply from the cluster in terms of quality and commitment. In 2011 the supply was very consistent which impressed the retailers. Heritage Foods India Ltd. is the first retailers to recognize the cluster's potential and has been a procurer every year. Reliance India Ltd. has issued a vendor code in the year 2011, indicating an acceptance for the society to be as one of their suppliers in the long run.

Name of the farmer : D. TAKEERYA

Village : JAMALKUNTA THANDA

The initiative of CRIDA-IKISAN to establish market linkages worked in my favour, as I was able to market my produce to big retail supermarket chains such as MORE and HERITAGE foods. The market linkages brought profitability through effective marketing, and I was able to increase my sales and income.

Chapter 13

Technology Demonstration and ICT Based Interventions for Effective Outreach in Dupanad Cluster, Nalgonda District

Planning, Implementation and Impacts

Information Communication Technology (ICT)

For sustainable agricultural development access to information, knowledge about interventions, technology that is accessible and available at farmer's doorstep, ICT is prerequisite. But prior to that all that we need to know is what to do and how to do it. At this juncture IT applications play a crucial role to support learning and method of application through which more sustainable management of information and knowledge resources could be done. In this backdrop the formation of KSC "Knowledge sharing center" at grass roots level envisages the access to value added information services on latest tools and technologies of agriculture for improving the rural livelihoods. It also facilitates the sharing of data, information and the collective knowledge gleaned from research, experiences and interaction with cluster partners. From KSC it is expected to increase the ability of individuals to take decision for immediate action, which needs priority. It would be ensured that the information which is disseminated through extension approaches, caters the real need of farmers, is easily accessible, and contributes to a fuller understanding of the development issues farmers are facing. At this juncture use of Information and Communication Technology (ICT) as an extension tool in knowledge management exhibits multifaceted dimensions and multifarious roles for technology access.

With this background, ICT's component was included in the CRIDA's NAIP project on "Sustainable rural livelihoods through enhanced farming systems productivity and efficient support systems in rainfed areas" which was an action research pilot project in selected village clusters of the 8 backward districts of Andhra Pradesh i.e. Anantapur, Adilabad, Mahabubnagar, Warangal, Rangareddy, Nalgonda, Kadapa & Khammam involving a consortium of institutions from public, private and NGO sectors.

Location

In Nalgonda the KSC was centrally placed at New Banjara Hills of Dupahad with the support of cluster anchor to cater the information and technology needs of the nine thandas of the cluster covering 621 households and 800 ha geographical area. The KSC was inaugurated on September 12, 2008 and the functioning of the technology dissemination services was formally launched.

Fig. 1 : Knowledge share centre, New Banjara Hills, Dupahad cluster, Nalgonda and contact details (Inset)

The broad objectives in establishing KSC are

- To enhance access and sharing the useful knowledge resources in agriculture & allied sectors
- To supplement experts advisory services
- To strengthen the capacity of farmers, local institutions and CBOs etc in terms of knowledge resources utilization
- To support extension and outreach activities of CRIDA

Situation analysis of tribal villages

Before introducing ICT interventions in the Nalgonda district an analysis was made about the villages situation in terms of the resource availability, infrastructure, ICT tools exposure and socio economic variables using participatory approaches like participatory rural appraisal, focus group discussions, etc. The situation analysis revealed the cluster of villages under Nalgonda district are typically rainfed areas with predominant crops as rice, castor, and cotton which are the major crops and horticultural crops in few pockets of the cluster. The area is drought prone and the villager's main occupation was agriculture.

Information Needs Assessment (INA)

After the situation analysis of the cluster an information needs assessment was carried out in the village to ascertain the information priorities and needs among the villagers with the structured interview schedule developed for the study.

Fig. 2 : INA with farmers, women and rural youth groups in Dupahad cluster

The data was analyzed to assess the information needs of the cluster which further incorporated in the customization of the content suitable to the priorities of the villagers in the cluster. The overall information needs data from the nine villages of the Dupahad cluster of Penpahad Mandal in Nalgonda district revealed that 94% of the respondents preferred market information as the essential need followed by the information management of pests and diseases (89%) (Table1).

Table 1 : Priority information needs of the farmers, Dupahad cluster (no: of farmers = 40)

Information need	Frequency	Percentage
Pest, disease, weed management	36	89
Market based information	38	94
Weather alerts	29	73
Govt schemes	17	42
Inputs information	10	26
Crop management	22	55
Improved varieties & hybrids	24	61

ICT infrastructure deployment in the cluster through Knowledge Share Centers (KSCs)

After several consultations with knowledge management experts, consortium partners, field level extension functionaries, farming community representatives, special ICT partner I-Kisan and specialists of CRIDA knowledge resource centre planned deployment of various ICT tools to have effective outreach and dissemination of needful technologies.

Fig. 3 : Orientation & INA with gathering at VRC, New Banjara Hills, Dupahad cluster

The ICT services are designed using multi-channel, multi-user and multi-nodal approach and the tools identified were

- touch screen information kiosks
- display announcement package
- interactive voice response systems (IVRS)
- internet
- Sasyavani: mobile based agro-advisory

Content design and development

The Dupahad cluster with nine villages and geographical area of 800 hectares with 621 households in the project is a unique cluster representing progressive farmers who were enthusiastic, co-operative and keen to use the ICT tools deployed in the cluster. The content was localized to the needs of the villagers. As most of the villagers prioritized the need for market information it was decided to float market prices on all the ICT tools. For the information need on plant protection separate software on crop diagnostic kit with voice over in local and English language was developed which mainly functions through touch screen information kiosks. Further various DVDs on pest management strategies were screened on display announcement system. The content was customized to users' needs in the Dupahad cluster on the location specific crops.

The information on ten rainfed crops in the farm of management time table (MTT) crop diagnostic kit (CDK), package of practices (POP) user friendly softwares were developed for the benefit of villagers. Besides, brief information on management practices of 53 other vegetable crops, horticultural crops, annual crops cereals, pulses, oilseeds and cash crops were also maintained for creating the awareness among the farming community. DVDs and CDs are procured from different educational and research institutions for screening purpose on DAP at suitable timings convenient to farmers, farm women and rural youth. Pre recorded voice files were developed for the IVRS facility which would guide the user to avail the information in a step wise manner when the options were given. The content for the Sasyavani service was classified into three categories i.e. (i) general information (ii) marketing information and (iii) weather based advisories. General information on high yielding varieties, seed treatment and spacing, pest and disease alerts, etc. were given during the cropping season. Whereas marketing information was provided during harvesting season while weather information with suitable advisories were given on daily basis. The content was formatted in the two forms i.e. text based messages through SMS and voice alerts in local language.

Institutionalization of the ICT based extension services

For the penetration of ICT services at grass root level stake holders suitable three tire institutional structure was implemented in the project. The three levels were:

i) Knowledge resource centers (KRS) where the knowledge resources were generated using farmers feedback. Customization of the content to the local needs digitization of the content, modifying the content according to ICT channels usage were the main activities of KRCs located at CRIDA and I-Kisan

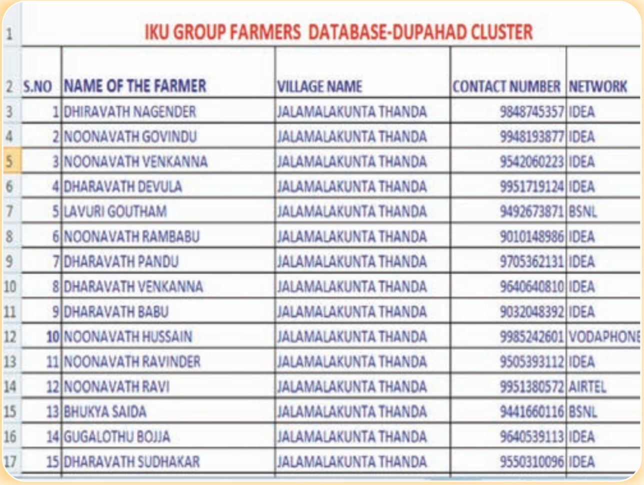
ii) Knowledge sharing centers (KSCs) where the knowledge is shared with the villagers by placing the content in the various ICT tools deployed at the village KSCs. Sharing and dissemination for the main activities of the KSCs.

The trained village level operator coordinates the activities and serves as a liasion, media between KRCs and IKU groups. The village level operator Mr. D. Nagaiah who prevails in the same village played a pivotal role in successful functioning of the KSCs. Towards this, the KSC Operator is expected to do the following activities adhering to a rigorous schedule that is designed to ensure tractability.

- Field work (Permanent Journey Plan) geared towards market linkage and agri risk management
- KSC Operations consisting of price and weather updates, agriadvisories to farmers, maintenance of the centre etc
- Group Meetings during the evenings to impart knowledge as well as inculcate the habit of visiting the KSC
- Video screening of informative media on various subjects such as governance, health, literacy, agriculture etc.

The entire infrastructure was established and operations were stabilized as envisaged in the project design of ICT Component. Different methods of information capture were developed to track the use of ICT Module at cluster level

iii) Information knowledge utilization groups (IKUGroups) for facilitation of knowledge sharing and usage of the ICT services in the KSC. Around 356 farmer's database was maintained based on the IKU members group details from all the eight villages in the Dupahad cluster.



IKU GROUP FARMERS DATABASE-DUPAHAD CLUSTER

S.NO	NAME OF THE FARMER	VILLAGE NAME	CONTACT NUMBER	NETWORK
1	DHIRAVATH NAGENDER	JALAMALAKUNTA THANDA	9848745357	IDEA
2	NOONAVATH GOVINDU	JALAMALAKUNTA THANDA	9948193877	IDEA
3	NOONAVATH VENKANNA	JALAMALAKUNTA THANDA	9542060223	IDEA
4	DHARAVATH DEVULA	JALAMALAKUNTA THANDA	9951719124	IDEA
5	LAVURI GOUTHAM	JALAMALAKUNTA THANDA	9492673871	BSNL
6	NOONAVATH RAMBABU	JALAMALAKUNTA THANDA	9010148986	IDEA
7	DHARAVATH PANDU	JALAMALAKUNTA THANDA	9705362131	IDEA
8	DHARAVATH VENKANNA	JALAMALAKUNTA THANDA	9640640810	IDEA
9	DHARAVATH BABU	JALAMALAKUNTA THANDA	9032048392	IDEA
10	NOONAVATH HUSSAIN	JALAMALAKUNTA THANDA	9985242601	VODAPHONE
11	NOONAVATH RAVINDER	JALAMALAKUNTA THANDA	9505393112	IDEA
12	NOONAVATH RAVI	JALAMALAKUNTA THANDA	9951380572	AIRTEL
13	BHUKYA SAIDA	JALAMALAKUNTA THANDA	9441660116	BSNL
14	GUGALOTHU BOJJA	JALAMALAKUNTA THANDA	9640539113	IDEA
15	DHARAVATH SUDHAKAR	JALAMALAKUNTA THANDA	9550310096	IDEA

Fig. 4 : Screen shot of IKU group database in Dupahad cluster

Capacity building on usages of ICT based extension services

Large scale stake holders participation especially from the rural communities play crucial role in the success of technology adoption i.e. usage of ICT based extension services. Sensitization exercises like awareness camps, exposure visits are conducted to create the awareness towards the ICT services developed in the knowledge share centers. The farmer was made aware about the comparative advantages and the best mix of extension services available through the use of ICT tools. The IKU Group members were suitably trained to make use of ICT based services through touch screen kiosk, DAP, IVRS and internet, etc.

Fig. 5 : Training session on ICT's and exposure visit to CDAC for rainfed tribal farmers

Skills were developed and ICT readiness was gained through capacity development programmes like trainings, skill development programmes, quiz exercises, etc. Farmers are empowered through capacity enhancement programmes for usage of the services provided which further supports the farming community in effective decision making. The interactive sessions through farmers' field schools at their door step provided the room to stimulate learning and accessing advisories and technical services through the knowledge share centre.

Table 2 : Capacity development activities carried out in Nalgonda, Dupahad cluster (2008 - 2012)

Activity	No. of farmers attended	Conducted at
Awareness camps(2)	92	New Banjara Hills, Dupahad
Quiz exercises	55	New Banjara Hills, Dupahad
Kharif orientation campaign(1)	64	Suryapet, July 8, 2010
IKU Members drive (2)	89	All eight villages of Dupahad cluster
Farmers' field schools/ Interactive sessions (5)	78	New Banjara Hills, Dupahad
Training/Exposure visits(3)	42	CDAC, KVK CRIDA, MANAGE KCC, NRSC
Review meetings for feedback (26)	563	All eight villages of Dupahad cluster

Fig. 6 : Community mobilization activities in tribal villages of Dupahad cluster

Usage of the ICT based services

The ICT based services are made accessible to the farmer's door step which provides instant access to the important technological resources and latest updates on crop cultivation, package of practices, varieties and hybrids information and the market information. The features of the services are timely provision, easy accessibility, location specific crop information, accuracy of communication and cast effective. The ICT frame work adopted in the Nalgonda district offered a unique opportunity to bridge the gap between scientists, experts, field level extension professionals and farmers. The following data and feedback from the farmers/ users provide the gists of usage of ICT tool wise extension services.

Touch Screen Information Kiosk (TSIK)

Touch screen information kiosk version is set up in a stand-alone system equipped with content containing appropriate images and voice backup files of different topics on crop information like package of practices. Touch screen kiosk allows users to navigate for information on crop cultivation practices, plant protection measures and market information etc, with a finger touch facilitating user-friendly interaction like ATMs. Farmer wise soil health card information was put in Information Communication Technology (ICT)–Kiosk in district resource centers which can be accessed by Touch Screen Interactive system in local language (Telugu) to know about various crop and soil management practices for predominant crops grown in the region (Fig. 7).

Fig. 7 : Farmer's awareness on nutrient application in local language Telugu through ICT-Touch Screen Kiosk established by CRIDA

Fig. 8 : Screen shots of the content (in local language) placed in kiosk

Touch screen, the unique interactive tools for one stop access to information to cater the needs of individual or very small group of farmers with minimum literacy standards. Even though voice over facility is provided, the data reveals that the usage of touch screen kiosk was mostly confined to people with minimum educational qualifications. At present the location specific information on ten crops i.e. groundnut, cotton, castor, red gram, blackgram, paddy, chillies, maize, greengram and bengalgram is available in the kiosk. The content for livestock, horticultural crops is under preparation which would be available to clientele in the couple of the months. So far the content of cotton crop is accessed more (15.05% of clientele) followed by the paddy (10.88%) and pigeonpea (10.84%) crops during the current year (2009-2010) among the

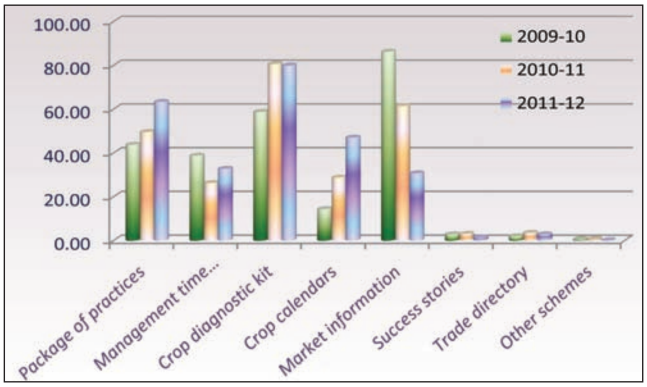


Fig. 9 : Pictorial representation on usage of TSIK services

Table 3 : Distribution of the users based on the usage of services of TSIK (2009-2012)

Name of the software/ DSS/ Expert System/Service	No. of users(frequency)		
	2009-10	2010-11	2011-12
Package of practices	382 (43.8)	1127(49.7)	1566(63.4)
Management time table	339(38.9)	598(26.4)	812(32.9)
Crop diagnostic kit	513(58.8)	1831(80.7)	1976(80.0)
Crop calendars	126(14.5)	655(28.9)	1164(47.1)
Market information	753(86.3)	1396(61.6)	761(30.8)
Success stories	26(2.9)	72(3.2)	36(1.5)
Trade directory	18(2.06)	83(3.7)	72(2.9)
Other schemes	6(0.69)	17(0.8)	5(0.2)

content of ten crops paddy, cotton, chillies, pigeonpea, blackgram, bengalgram, greengram, maize, castor and groundnut placed in kiosk for accessing information.

Display Announcement Package (DAP)

The DAP approach involves the use of videos in the form of screening DVDs/CDs for technology transfer so that farmer can easily gain understanding and adopt a field level to increase the crop productivity. It works on the traditional extension principle 'seeing is believing'. The ICT services created an iterative and interactive platform where the technologies are screened based on the farmers needs and interest.

Table 4 : Visitor statistics for DAP services in Dupahad cluster

Year	No. of CDs' screened		No of farmers attended	
2009-10	172 (Common)		414	
2010-11	Screening for farmers women 221	Screening for farm 197	Male 981	Female 321
2011-12	346	253	1126	447

So far 1189 no. of screenings were conducted with 3289 no. of farmers attended where the number indicates the repeated attendance from certain farmers who were convinced about the service. Advance monthly DAP calendar with screening details would be prepared in consultation with IKU group members, operator and local organizations in the periodical monthly review and feedback meetings.

Internet

Another important ICT tool internet was introduced to explore an opportunity wide spread technology outreach and access to information. A detailed survey was made for connectivity, and an idea based internet network was introduced in the village. Besides the power problems and poor connectivity the internet proved to have deeper penetration among the rural communities. The internet facility was used mostly for e-mails and internet browsing followed by educational opportunities, job search and examination results (Table. 5).

Fig. 10 : Internet facility in the Dupahad cluster of Nalgonda

Table 5 : Distribution of the users according to services availed through internet (2009-12)

Services utilized through internet	2009-10	2010-11	2011-12
Examination results/ marks sheets	35(28.93)	53(10.37)	78(12.85)
Job search	28(23.14)	136(26.61)	162(26.69)
Educational opportunities	52(42.98)	187(36.59)	336(55.35)
e-mails and internet browsing	86(71.07)	373(72.99)	526(86.66)
Bus/train ticket reservations	0(0.00)	46(9.00)	93(15.32)
Utility bills payment	0(0.00)	49(9.59)	89(14.66)
Others	2(1.65)	16(3.13)	21(3.46)

The average internet usage 521/month was low in the inception year as the people were hesitating to use the service (Fig. 11). After frequent interactions and community mobilization exercises the usage was improved in the second year, but was limited due to poor connectivity and power problems. The internet usage was almost regular and sometimes exceeded one GB / month also due to considerable hike in usage for various services as well as stabilization of the tool.

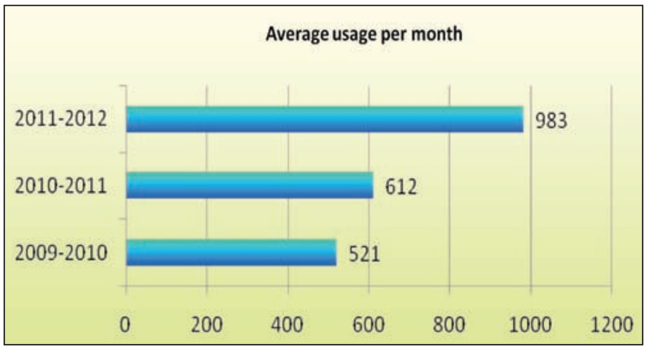


Fig. 11 : Internet usage in the Dupahad cluster of Nalgonda

Interactive Voice Responses System (IVRS)

When the farmer is out of station / away from KSC / at remotely held distant place the farmer can avail this IVRS facility making a call to initial payable service and cluster specific IVRS number 9966918427 and later IVRS toll free number 1800 4252 436. Pre recorded voice files guide the user to avail the information on market prices, weather information and pest management measures, etc. With regard to IVRS application where telephone connection is mandatory which again depends on the phone line availability, the advanced technology of fixed cellular Terminal (FCT) was used innovatively in which a mobile SIM card is inserted which could be used as a phone connection for running of IVRS application. The voice information was provided in local language (Telugu) and as well as in English. By using this service farmer can directly get the current price information, weather information, best management practices for agriculture and allied information by a call from his mobile or from any pay phone. The total crops covered under IVRS service are thirteen.

Table 6 : User's statistics for IVRS facility

IVRS	No.of. Calls	Duration (Min)	Avg Time/ Call (Min)
2010-11	398	856	2.15
2011-12	623	1291	2.07

Sasyavani: Mobile based agro-advisory

Under the project an attempt was made to exploit an opportunity and making the useful information available to farmers using the mobile phones considering it vast net work and enhanced penetration among the rural communities. The information was disseminated through text based SMS messages and voice alerts.

Table 7 : Distribution of the respondents on voice alerts usage %

Sasyavani	No. of. attended calls/ voice alerts (%)	No. of missed calls/ voice alerts (%)
2010-11	40	60
2011-12	51	49

Sustainability and Scaling up

Feedback was collected from the farmers regarding withdrawal strategy and sustainability of the knowledge share centre. Most of the farmers opined that the facility should be hand over to field level NGO unlike in other clusters that opted mostly for gram panchayats, here the respondents felt efficient functioning of the knowledge share centre could be made by the field level NGO only. Majority of the farmers are willing to pay for usage

Table 8 : Response of the farmers towards withdrawal strategies N=40

Withdrawal Option	Frequ-ency	Percentage (%)*
Gram panchayat	11	27.5
GBOs / RMGs/UGs	9	22.5
Government Departments	12	30
Field level NGOs	26	65
IKU Groups	18	45
Others	4	10

*Indicates multiple response

of internet services for uploads and downloads as well as scan facility. The perception by the villages indicated that substantial and increased reach of technology is possible with ICT interventions as a source of information and technology access.

Conclusions and lessons learnt

CRIDA experiences in the Nalgonda cluster reveals ICT based extension services play a crucial role of creating awareness and enhanced knowledge about the latest technologies such as new high yield varieties, hybrids, pest management, crop practices, timely harvesting, market facilities and value addition. But the services provision to the farmer has its own reservations due to the limitations of ICT based extension services. Often the services suffer with bottle necks like connectivity problems, power failure, repairs and maintenance of the ICT tools. However, as the number of media choices evolves through ICT approaches parallel usage of different ICT channels paves the path for effective dissemination of the technologies. ICTs if properly deployed with specific advice to village level the location specific advisories offer an apt solution for the problems faced by the farmers. The experience of knowledge share centers functioning at field level reveals the need for trained manpower with expertise to tackle repairs of ICT tools, solutions to sustainability challenges and reduction in the operation cost without compromising on the quality of the services.

Name of the farmer : LAKPATHY

Village : PEDDA SEETHARAM THANDA

The KSC provides timely market information which enabled us to support our decisions in marketing the crop produce among the different marketing channels available and also for realizing the good price for the products. The advice from the knowledge share centers helped us to give information on pests and diseases of the crop and also timely measures to control the pests. It served us to reduce the crop losses and providing more yield.

Chapter 14

Training and Capacity Building

Capacity building of the farmers is considered critical for the success of interventions in the project area, thereby contribution to improved livelihoods. A series of innovative capacity building efforts were initiated which included exposure visits, hands-on training to the farmers, the landless, village artisans and the project staff. The details are given below in Table 1.

Table 1 : Capacity Building Activities undertaken for tribal farmers in Dupahad cluster, Nalgonda district

Name of the cluster and training course	No. of Trainees	Date
Dupahad, Nalgonda		
2008		
Computer Training at SRTRI	2	06.02.08-13.05.08
Motor winding training in SRTRI	3	21.04.08-20.06.08
Livestock para-veterinary training	2	19.03.08-05.05.08
Training programme on Organic farming with Panchagavya	15	16.5.08-25.5.08
Vermicompost Training	30	03.11.08-04.11.08
Exposure visit to Thirupathi for Mulberry Gardens	15	1.8.08-3.8.08
Exposure visit to Gunagal Farm CRIDA	30	16.10.08
2009		
Training programme on Zero tillage maize demonstration	10	10.11.2009
Demonstration On Azolla production	03	26.11.09
Demo on Zero tillage maize demonstration	10	12.03. 09
2010		
Pre *kharif* Workshop	59	13.05.10
Method demonstration on seed Treatment and green manure	17	06.06.10
Field demonstration of ridge furrow method	12	23.06.10
Awareness camp on weather based crop insurance	20	06.07.10
Training on Hybrid rice seed production	50	08.09.10
Animal Health camp cum fertility camp	40	24.09.10
Pre Rabi work shop	70	30.10.10
2011		
Market linkages	45	09.03.11
Vegetable production	25	21.05.11
Soil health programme	52	13.06.11
Participatory soil sampling	34	19.09.11

Training for tribal youth in water level measurement in open wells

Training on soil health management for productivity enhancement in light textured degraded soils in tribal villages

Training on market linkages for vegetables and fruits for tribal farmers

Farmer's day organized at tribal village Jalmalkunta in Dupahad cluster, Nalgonda district

Chapter

15

Lessons and Way Forward

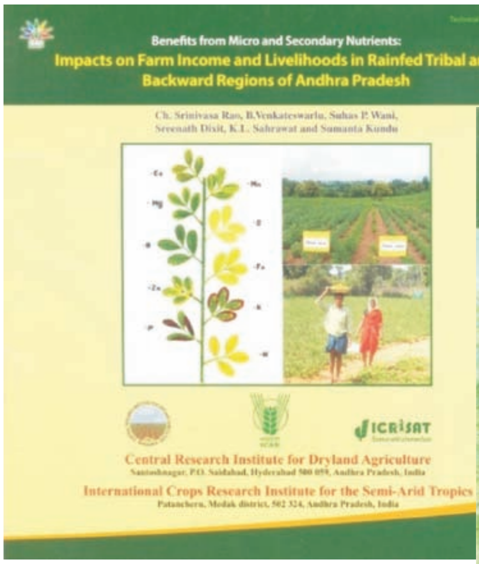
The success of many livelihood interventions created many leads for future research initiatives. Experiences from various on-farm interventions in the villages of Dupahad cluster of Nalgonda district established that they are useful for sustainable livelihood development, i.e., socially (improve quality of life), economically (provide financial returns) and environmentally (reduce GHG emissions and pressure on the local environment). During the past four and half years of its implementation, various interventions through NAIP project brought out many significant outcomes that have a bearing on future course of development of rainfed areas in our country. The learning's of the project have led to many insights; which have significant policy implications, especially in rainwater harvesting, promotion of balanced nutrition, promotion of small farm mechanization, livestock interventions, and promotion of community biogas cum vermicomposting and finally market linkages and ICT interventions. The project tried to build institutions and processes around interventions so that these could be practiced by the community and the changes brought in by the project interventions could be sustained even after the termination of the project.

In it's strive to improve governance and reduce poverty in Dupahad cluster of Nalgonda district, the set up of a biogas cum vermicompost support programme is a valuable intervention. Through this intervention, there was an increase in farmer's income and also it contributed towards creating employment. Renewable energy services can help improve rural livelihoods to raise income levels through enterprise activities. The balanced use of fertilizers and the introduction of soil health card were also valuable in increasing soil fertility, at the same time helping farmer's of the cluster to reduce fertilizer inputs. The construction of water harvesting structures helped in storage of water to be used at times of intermittent droughts. Introducing farm machinery encouraged farmers in saving time and effort. Livestock interventions were also valuable in promoting new breed of animals which would give more income through their outputs. A Contingency planning was another important intervention, especially at times of intermittent droughts whereby farmers had the option to change their cropping sequence. This will pave way for any such future calamities whereby farmers can decide on which crop to sow depending on the onset and withdrawal of the monsoon. Marketing of produce was the most important lesson learnt by the farmers, which enabled them to sell their produce at a higher rate than previous years. This intervention also helped farmers in the cluster to increase their income. Finally, educating farmers through ICTs and helping them in understanding the importance of their crops through ICT kiosks, will pave way for future development. Livelihood activities that capitalize on existing capabilities in a community, for instance, by converting a labour-intensive activity into an energy-intensive one, stand a greater chance of succeeding as they allow the community to concentrate on acquiring new skills on only one side of the technology equation.

The project was successful in establishing the role of the support systems in enhancing rural livelihoods through these interventions, based on the ability of the community and existing institutional infrastructure. However, there is a large variation in the ability of the communities to participate in the project, absorb the project assistance and build further on the project outcomes. Thus able facilitation is required for making the community self reliant, whereby farmers understand livelihood issues and come up with their own ideas and solutions to tackle these issues. The interventions under the project are going to address basically the crop security and thus it would definitely be a sustainable model and they could be replicated in deprived areas to enhance livelihood. The various innovation interventions at farm level would provide better perspective in near future with more skill development. The various interventions in Dupahad cluster could act as a catalyst for neighboring clusters. Farmer's can adopt successful interventions in their respective clusters and scale it up for sustaining livelihoods. The process of linking farmers with administration will aid in developing linkages across various market sectors. The external market linkages would result in more commercial production of profitable crops. For effective way forward, the traditional livelihoods and culture needs are to be taken into consideration when development plans are being created. Well-planned and implemented methods of adaptation, and assistance in the creation of new sustainable livelihoods in the form of interventions should be provided to project affected people. A longer-term perspective is required to successfully assist communities to adapt in the face of development projects. Many communities may become dangerously dependent on outside sources for assistance, especially the local and national government, if their methods of livelihood are no longer viable. Therefore viable interventions such as the ones in this project should be the need of the hour.

Publications

Bulletins and Books



Technical Bulletin No.1/2011

Benefits from Micro and Secondary Nutrients:
Impacts on Farm Income and Livelihoods in Rainfed Tribal and
Backward Regions of Andhra Pradesh

Ch. Srinivasa Rao, B.Venkateswarlu, Suhas P. Wani,
Sreenath Dixit, K.L. Sahrawat and Sumanta Kundu

Central Research Institute for Dryland Agriculture
Santoshnagar, P.O. Saidabad, Hyderabad 500 059, Andhra Pradesh, India

International Crops Research Institute for the Semi-Arid Tropics
Patancheru, Medak district, 502 324, Andhra Pradesh, India

Technical Bulletin No.2/2011

Soil Health Improvement with *Gliricidia*
Green Leaf Manuring in Rainfed Agriculture
On Farm Experiences

Ch. Srinivasa Rao, B.Venkateswarlu, M. Dinesh Babu, Suhas P. Wani,
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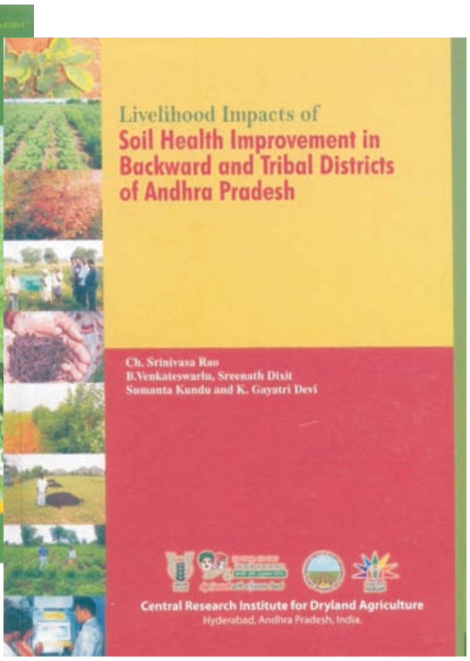

Livelihood Impacts of
Soil Health Improvement in
Backward and Tribal Districts
of Andhra Pradesh

Ch. Srinivasa Rao
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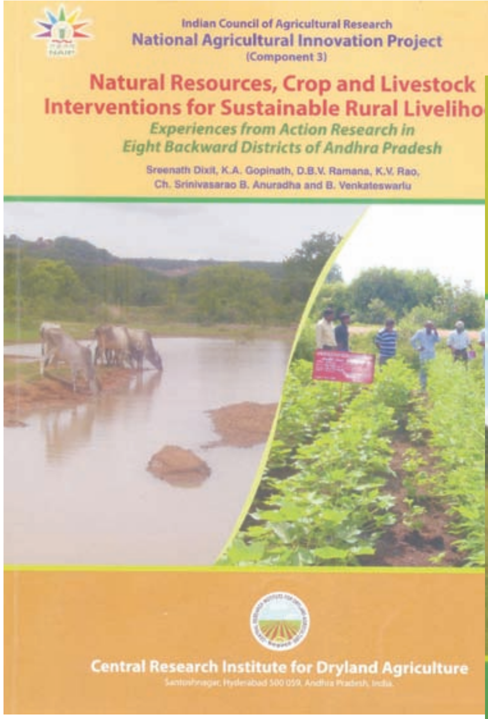
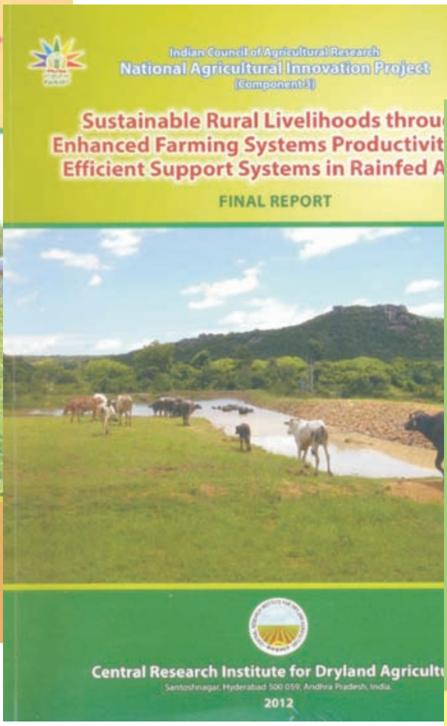


Indian Council of Agricultural Research
National Agricultural Innovation Project
(Component 3)

Natural Resources, Crop and Livestock
Interventions for Sustainable Rural Liveliho
Experiences from Action Research in
Eight Backward Districts of Andhra Pradesh

Sreenath Dixit, K.A. Gopinath, D.B.V. Ramana, K.V. Rao,
Ch. Srinivasarao B. Anuradha and B. Venkateswarlu

Central Research Institute for Dryland Agriculture
Santoshnagar, Hyderabad 500 059, Andhra Pradesh, India.

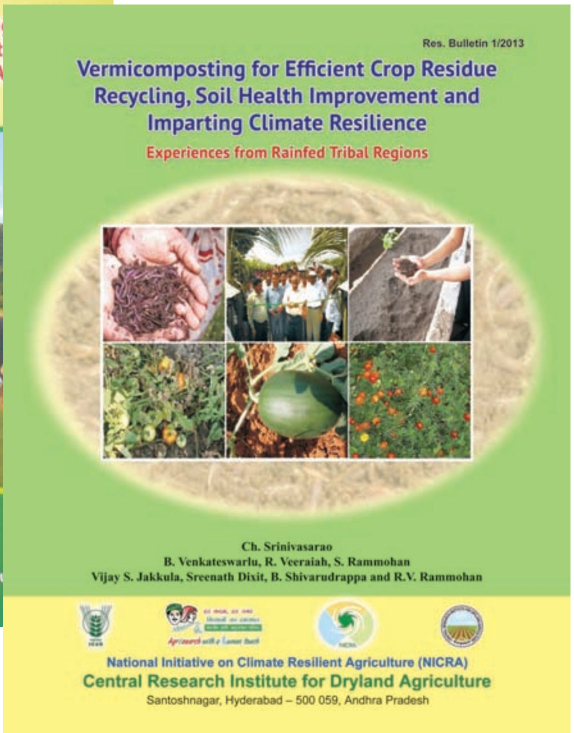


Indian Council of Agricultural Research
National Agricultural Innovation Project
(Component 3)

Sustainable Rural Livelihoods throu
Enhanced Farming Systems Productivit
Efficient Support Systems in Rainfed A

FINAL REPORT

Central Research Institute for Dryland Agricult
Santoshnagar, Hyderabad 500 059, Andhra Pradesh, India.
2012



Res. Bulletin 1/2013

Vermicomposting for Efficient Crop Residue
Recycling, Soil Health Improvement and
Imparting Climate Resilience
Experiences from Rainfed Tribal Regions

Ch. Srinivasarao
B. Venkateswarlu, R. Veeraiah, S. Rammohan
Vijay S. Jakkula, Sreenath Dixit, B. Shivarudrappa and R.V. Rammohan

National Initiative on Climate Resilient Agriculture (NICRA)
Central Research Institute for Dryland Agriculture
Santoshnagar, Hyderabad – 500 059, Andhra Pradesh

Press Coverage

ఆదివారం
ఆదివారం
ఆదివారం

ఆటవిడుపు

హైటెక్ సాగు

నెట్‌వద్ద బ్రౌజింగ్ చేస్తున్న విద్యార్థులు

న్యూ బంజారా హిల్స్‌తండాలో నూతన సాగు పద్ధతి

నెట్ సౌకర్యం

లాభదాయకంగా ఉంది

వ్యవసాయ పద్ధతులు తెలుస్తున్నాయి

డ్రిప్ ఇరిగేషన్ సిస్టమ్‌ను ప్రారంభిస్తున్న మంత్రి దామోదర్‌రెడ్డి, ఎమ్మెల్యే వేదాసు వెంకయ్య అనంతరం జరిగిన సభలో ప్రసంగిస్తున్న మంత్రి

గిరిజనులు బలపడితేనే దేశాభివృద్ధి

బంజార అభివృద్ధి కార్యక్రమాల్లో మంత్రి దామోదర్‌రెడ్డి

సాక్షి సూర్యాపేట

పోలరాజు, సలిగంటి బ్రహ్మం, క.వెంకన్న, ఏనురాజు కనకయ్య ఎన్నికయ్యారు.

పోషక ఎరువులపై అవగాహన ఉండాలి

పెన్‌పహాడ్, న్యూస్‌లైన్ : పోషక విలువలు తక్కువగా ఉండి వర్షాధారపంటల భూములపై రైతులకు తగిన అవగాహన ఉండాలని హైద్రాబాద్ క్రీడా సంస్థ ప్రిన్సిపాల్ డాక్టర్ సీహెచ్. శ్రీనివాసరావు అన్నారు. కేవీకే,క్రీడా సంయుక్తంగా మండలంలోని దూపాడ్ క్లస్టర్‌లోని జల్మాలకుంట, న్యూబంజారాహిల్స్‌తండాల్లో ఏర్పాటు చేసిన ప్రాజెక్టు పనులను బుధవారం పరిశీలించారు. భూసార విలువలు పెంచుట, పెంచుతున్న మొక్కలు, బయోగ్యాస్, వానపాముల పెంపకం,సమగ్ర పోషక పద్ధతులు తదితర అంశాలపై అవగాహన కల్పించారు. ఈ భూసార పరీక్షలు నిర్వహించి ఏయే పంటలకు అవసరమైన పోషక విలువలు భూమిలో ఉన్నాయో గుర్తించేందుకు రైతులకు భూసార పరీక్ష కార్డులను శిక్షణ ఇచ్చారు. ఖరీఫ్ 2010లో పెసర, వేరుశనగ, కూరగాయల పంటలకు సంబంధించిన విత్తనాలను పంపిణీ చేసి ఎప్పటికప్పుడూ రైతులకు సూచనలిస్తున్నట్లు తెలిపారు. ఈ కార్యక్రమంలో డాక్టర్ వీరయ్య, ఎస్. రాంమోహన్, సుందరి

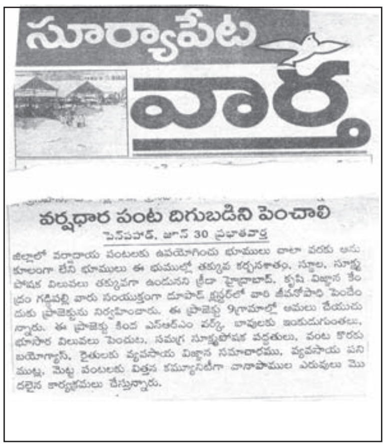
ఆంధ్రజ్యోతి

నల్లగొండ | ఆదివారం 23 అక్టోబర్ 2011

బయోగ్యాస్‌తో పెరగనున్న జీవనోపాధి

ఐసీడీఆర్ డిప్యూటీ డైరెక్టర్ డా.అనిల్‌కుమార్‌సింగ్

బయోగ్యాస్ యూనిట్‌ను ప్రారంభిస్తున్న అనిల్‌కుమార్ సింగ్

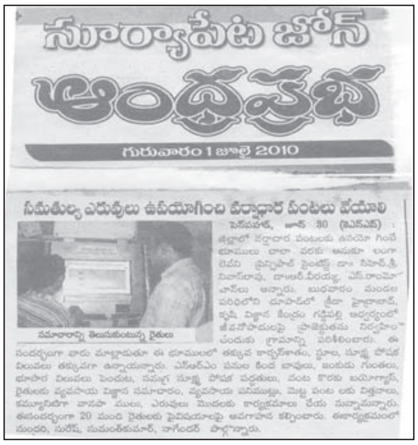


సూర్యాపేట వార్త

వర్షధార పంట దిగుబడిని పెంచాలి

పెన్‌పహాడ్, జూన్ 30 ప్రభాతవార్త

జిల్లాలో వర్షాధార పంటలకు ఉపయోగించు భూములు చాలా వరకు అనుకూలంగా లేని భూములు ఈ భూముల్లో తక్కువ కర్బనశాతం, స్థూల, సూక్ష్మ పోషక విలువలు తక్కువగా ఉండునని క్రీడా హైద్రాబాద్, కృషి విజ్ఞాన కేంద్రం గడ్డిపల్లి వారు సంయుక్తంగా దూపాడ్ క్లస్టర్‌లో వారి జీవనోపాధి పెంచేందుకు ప్రాజెక్టును నిర్వహించారు. ఈ ప్రాజెక్టు 9గ్రామాల్లో అమలు చేయుచున్నారు. ఈ ప్రాజెక్టు కింద ఎస్ఆర్ఎం వర్క్, బావులకు ఇంకుడుగుంతలు, భూసార విలువలు పెంచుట, సమగ్ర సూక్ష్మపోషక పద్ధతులు, పంట కొరకు బయోగ్యాస్, రైతులకు వ్యవసాయ విజ్ఞాన సమాచారము, వ్యవసాయ పని ముట్లు, మెట్ట పంటలకు విత్తన కమ్యూనిటీగా వానాపాముల ఎరువులు మొదలైన కార్యక్రమములు చేస్తున్నారు.



సూర్యాపేట జోన్

ఆంధ్రప్రభ

గురువారం 1 జూలై 2010

సమతుల్య ఎరువులు ఉపయోగించి వర్షాధార పంటలు వేయాలి

సమాచారాన్ని తెలుసుకుంటున్న రైతులు

ఈనాడు
నల్గొండ

గురువారం 1 జులై 2010 16 పేజీలు

రైతుల అభివృద్ధికి కృషిచేయాలి

పెన్‌పహాడ్, న్యూస్‌టుడే : భూసార పరీక్షలు నిర్వహించి సమతుల్య ఎరువుల వాడకంతో రైతులు అధిక దిగుబడులు సాధించవచ్చని హైదరాబాద్ క్రీడా ప్రిన్సిపల్ సైంటిస్టు డాక్టర్ సిహెచ్.శ్రీనివాసరావు అన్నారు. జాతీయ వ్యవసాయ నవకల్పనా పథకంతో గడ్డిపల్లి అరవింద కృషి విజ్ఞానకేంద్రం వారు వివిధ తండాల్లో పనులను తనిఖీ చేశారు. ఎన్ఏపీ పథకాన్ని సమర్థంగా అమలు చేసి రైతుల అభివృద్ధికి కృషి చేయాలన్నారు. జల్మాల్‌కుంట తండాలో షెడ్ నెట్ హౌస్‌లో నర్సరీ పెంపకం, చెర్వు అలుగు నూతన నిర్మాణం, తండాలో ఏర్పాటు చేసిన బయోగ్యాస్ ప్లాంట్ ద్వారా ఇళ్లలో వంట కోసం ఇంధనం సరఫరా చేసే విధానాన్ని ఆయన పరిశీలించారు. 20 మంది రైతులకు భూసార పరీక్ష పరికరాలను అందజేశారు. డాక్టర్ వీరయ్య ఎన్ఏపీ నిర్వాహకులు రామ్మోహన్, సైంటిస్టు సుందరిసురేష్, నాగేందర్, సుమంత్, కెవికె సిబ్బంది, రైతులు పాల్గొన్నారు.

నల్గొండ 7

వ్యవసాయ రంగంలో ఆధునిక పద్ధతులు పాటించాలి :వెంకటేశ్వర్లు

(ప్రజాశక్తి విలేకరి – పెన్‌పహాడ్)
వ్యవసాయ రంగంలో శాస్త్రసాంకేతిక పరిజ్ఞానాన్ని ఉపయోగించి అనుబంధ పరిశ్రమలకు చేయూతనిచ్చేందుకు నవ కల్పన పథకం(ఎన్ఏఐపి) నూతన ఒరవడి సృష్టిస్తుందని ప్రాథమిక వ్యవసాయ మెట్ట పంటల క్రీడా డైరెక్టర్ బి. వెంకటేశ్వర్లు అన్నారు. మంగళవారం మండల పరిధిలోని దూపాడు ఆవాస గ్రామమైన న్యూ బంజారాహిల్స్‌లో జాతీయ వర్మికంపోస్టు షెడ్డును ప్రారంభించారు. ఈ సందర్భంగా ఏర్పాటు చేసిన రైతుల బంజారా సొసైటీ సంఘం సభ్యుల సమావేశాన్ని ఉద్దేశించి ఆయన మాట్లాడారు. ఈ కార్యక్రమంలో ఎన్ఏఐపి డైరెక్టర్ సీనియర్ శాస్త్రవేత్త శ్రీనివాస్ దీక్షిత్, కెవికె సెక్రటరీ గంటా గోపాల్ రెడ్డి, సంజీవ రెడ్డి, పిఆర్ రెడ్డి, రవి శంకర్, కెవికె డైరెక్టర్ వల్లబోలు వెంకట్ రెడ్డి, కెవికె ప్రిన్సిపల్ వీరయ్య, కెవికె శాస్త్రవేత్తలు రాంమోహన్, కిసాన్ ప్రాజెక్టు మేనేజర్ రవికుమార్, బంజారా సొసైటి ఎండి నాగేందర్, అధ్యక్షులు రవీంద్ర నాయక్, స్థానిక సర్పంచ్ భద్రయ్య, ఎంపిటిసి దేవులా పాల్గొన్నారు.

వర్మికంపోస్టు షెడ్డును ప్రారంభిస్తున్న దృశ్యం

ప్రజాశక్తి సోమవారం 25-02-2008

మౌళిక సదుపాయాల కల్పనే ప్రభుత్వ ధ్యేయం : ఆర్డీఆర్

(ప్రజాశక్తి విలేకరి-పెన్‌పహాడ్)

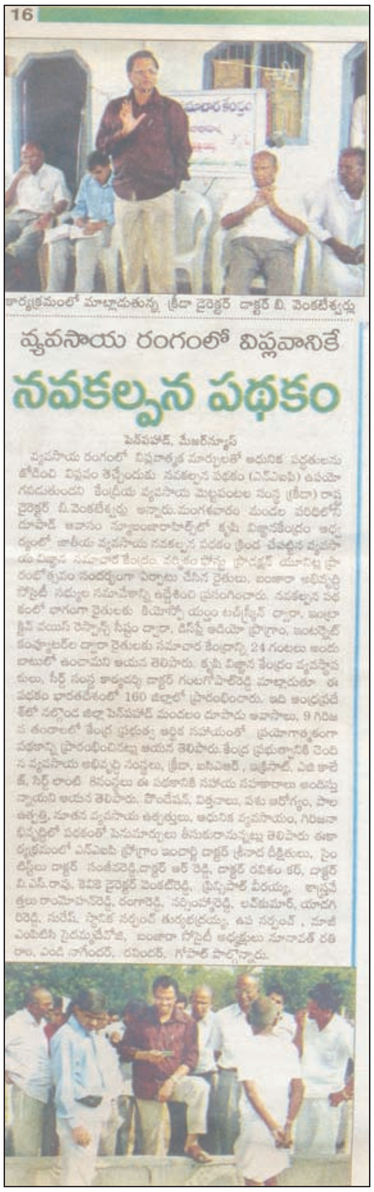
పైప్‌లైను ప్రారంభిస్తున్న మంత్రి ఆర్డీఆర్

భానుపురి జో
ఆంధ్రజ్యోతి
గురువారం 1-7-2010

సమతుల్య ఎరువులు ఉపయోగించాలి

పెన్‌పహాడ్, జూన్ 30(ఆన్ - లైన్): సమతుల్య ఎరువులు ఉపయోగించి వర్షాధార పంటల దిగుబడి పెంచుకోవాలని డాక్టర్ సీహెచ్.శ్రీనివాసరావు అన్నారు. బుధవారం కృషి విజ్ఞాన కేంద్రం ఆధ్వర్యంలో దూపహాడ్ క్లస్టర్‌లో ప్రాజెక్టును నిర్వహించారు. ఈ ప్రాజెక్టు కింద ఎన్ఆర్ఎం వర్క్స్, బావులకు ఇంకుడు గుంతలు, భూసార విలువలు పెంచడం తదితర కార్యక్రమాలు చేస్తారు. గ్రూపు శాస్త్రవేత్తలు 20మంది రైతుల భూముల్లో సమగ్ర పోషక పద్ధతులను ఎలా చేయాలో నేర్పించారు. కార్యక్రమంలో డాక్టర్ ఆర్.వీరయ్య, ఎస్.రాంమోహన్, సుందరి, సురేష్, సుమంత్ కుంద్, నాగేందర్ పాల్గొన్నారు.

పంటలను పరిశీలిస్తున్న అధికారులు



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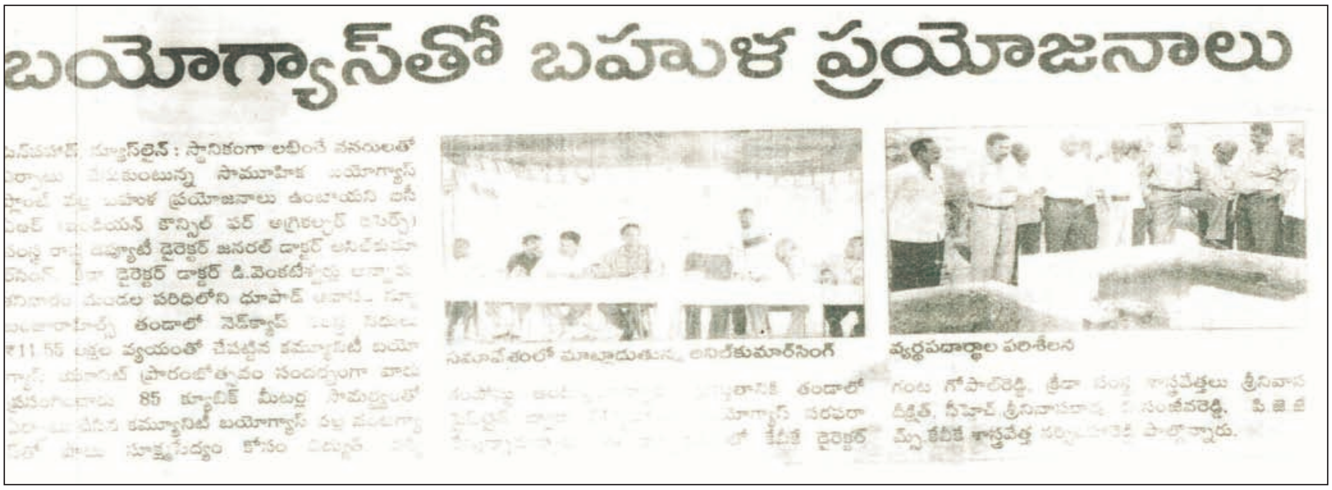
కార్యక్రమంలో మాట్లాడుతున్న క్రీడా డైరెక్టర్ డాక్టర్ బి. వెంకటేశ్వర్లు

వ్యవసాయ రంగంలో విప్లవానికే
నవకల్పన పథకం

పెన్‌పహాడ్, మేజర్‌న్యూస్

వ్యవసాయ రంగంలో విప్లవాత్మక మార్పులతో ఆధునిక పద్ధతులను జోడించి విప్లవం తెచ్చేందుకు నవకల్పన పథకం (ఎన్ఏఐపీ) ఉపయోగపడుతుందని కేంద్రీయ వ్యవసాయ మెట్టపంటల సంస్థ (క్రీడా) రాష్ట్ర డైరెక్టర్ బి.వెంకటేశ్వర్లు అన్నారు. మంగళవారం మండల పరిధిలోని దూపాడ్ ఆవాసం న్యూబంజారాహిల్స్‌లో కృషి విజ్ఞానకేంద్రం ఆధ్వర్యంలో జాతీయ వ్యవసాయ నవకల్పన పథకం క్రింద చేపట్టిన వ్యవసాయ విజ్ఞాన సమాచార కేంద్రం, వర్మికంపోస్టు ప్రాజెక్ట్ యూనిట్ల ప్రారంభోత్సవం సందర్భంగా ఏర్పాటు చేసిన రైతులు, బంజారా అభివృద్ధి సొసైటీ సభ్యుల సమావేశాన్ని ఉద్దేశించి ప్రసంగించారు. నవకల్పన పథకంలో భాగంగా రైతులకు కియోస్క్ యంత్రం టచ్‌స్క్రీన్ ద్వారా, ఇంటరాక్టివ్ వాయిస్ రెస్పాన్స్ సిస్టం ద్వారా, డిస్క్ ఆడియో ప్రోగ్రాం, ఇంటర్నెట్ కంప్యూటర్‌ల ద్వారా రైతులకు సమాచార కేంద్రాన్ని 24 గంటలు అందుబాటులో ఉంచామని ఆయన తెలిపారు. కృషి విజ్ఞాన కేంద్రం వ్యవస్థాపకులు, సీర్డ్ సంస్థ కార్యదర్శి డాక్టర్ గంటగోపాల్‌రెడ్డి మాట్లాడుతూ ఈ పథకం భారతదేశంలో 160 జిల్లాల్లో ప్రారంభించారు. ఇది ఆంధ్రప్రదేశ్‌లో నల్గొండ జిల్లా పెన్‌పహాడ్ మండలం దూపాడు ఆవాసాలు, 9 గిరిజన తండాలలో కేంద్ర ప్రభుత్వ ఆర్థిక సహాయంతో ప్రయోగాత్మకంగా పథకాన్ని ప్రారంభించినట్లు ఆయన తెలిపారు. కేంద్ర ప్రభుత్వానికి చెందిన వ్యవసాయ అభివృద్ధి సంస్థలు, క్రీడా, ఐసిఏఆర్, ఇక్రిశాట్, ఎచ్ కాలేజ్, సీర్డ్ లాంటి సంస్థలు ఈ పథకానికి సహాయ సహకారాలు అందిస్తున్నాయని ఆయన తెలిపారు. పౌండేషన్, విత్తనాలు, పశు ఆరోగ్యం, పాల ఉత్పత్తి, నూతన వ్యవసాయ ఉత్పత్తులు, ఆధునిక వ్యవసాయం, గిరిజనాభివృద్ధిలో పథకంతో పెనుమార్పులు తీసుకురానున్నట్లు తెలిపారు ఈ కార్యక్రమంలో ఎన్ఏఐపీ ప్రోగ్రాం ఇంచార్జి డాక్టర్ శ్రీనాథ దీక్షితులు, సైంటిస్టులు డాక్టర్ సంజీవరెడ్డి,డాక్టర్ ఆర్ రెడ్డి, డాక్టర్ రవిశంకర్, డాక్టర్ వి.ఎస్.రావు, కెవికె డైరెక్టర్ వెంకటరెడ్డి, ప్రిన్సిపాల్ వీరయ్య, శాస్త్రవేత్తలు రాంమోహన్‌రెడ్డి, రంగారెడ్డి, నర్సింహారెడ్డి, లవకుమార్, యాదగిరిరెడ్డి, సురేష్, స్థానిక సర్పంచ్ తుర్కభద్రయ్య, ఉప సర్పంచ్ , మాజీ ఎంపిటిసి సైదమ్మకేసోజీ, బంజారా సొసైటీ అధ్యక్షులు సూనావత్ రతిరాం, ఎండి నాగేందర్, రవీందర్, గోపాల్ పాల్గొన్నారు.



బయోగ్యాస్‌తో బహుళ ప్రయోజనాలు

పహాడ్, న్యూస్‌లైన్ : స్థానికంగా లభించే వనరులతో ర్పాటు చేసుకుంటున్న సామూహిక బయోగ్యాస్ ప్లాంట్ వల్ల బహుళ ప్రయోజనాలు ఉంటాయని ఐసీఏఆర్ (ఇండియన్ కౌన్సిల్ ఫర్ అగ్రికల్చర్ రిసెర్చ్) సంస్థ డిప్యూటీ డైరెక్టర్ జనరల్ డాక్టర్ అనిల్‌కుమార్ సింగ్, క్రీడా డైరెక్టర్ డాక్టర్ డి.వెంకటేశ్వర్లు అన్నారు. మంగళవారం మండల పరిధిలోని ధూపాడ్ ఆవాస న్యూ బంజారాహిల్స్ తండాలో నెడ్‌క్యాప్ [illegible] రూ.11.55 లక్షల వ్యయంతో చేపట్టిన కమ్యూనిటీ బయోగ్యాస్ యూనిట్ ప్రారంభోత్సవం సందర్భంగా వారు ప్రసంగించారు. 85 క్యూబిక్ మీటర్ల సామర్థ్యంతో ఏర్పాటు చేసిన కమ్యూనిటీ బయోగ్యాస్ వల్ల వంటగ్యాస్‌తో పాటు సూక్ష్మసేద్యం కోసం విద్యుత్ [illegible]

సమావేశంలో మాట్లాడుతున్న అనిల్‌కుమార్‌సింగ్

[illegible] తండాలో [illegible] బయోగ్యాస్ సరఫరా [illegible] కేవీకే డైరెక్టర్

వ్యర్థపదార్థాల పరిశీలన

గంట గోపాల్‌రెడ్డి, క్రీడా సంస్థ శాస్త్రవేత్తలు శ్రీనివాస దీక్షిత్, సీహెచ్.శ్రీనివాసరావు, [illegible] సంజీవరెడ్డి, పి.జె.జె మ్స్, కేవీకే శాస్త్రవేత్త [illegible] పాల్గొన్నారు.

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List of Acronyms

AH	Animal Husbandry
APRLP	Andhra Pradesh Rural Livelihood Project
BMP	Better Management Practice
CDK	Crop Diagnostic Kit
CGWB	Central Ground Water Board
CIG	Community Interest Group
CRIDA	Central Research Institute for Dryland Agriculture
DAP	Display Announcement Package
DAP	Drought Animal Pair
DFID	Department for International Development
EDC	Expected date of Calving
FMD	Foot and Mouth Disease
FYM	Farm Yard Manure
GWL	Ground Water Level
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technology
IKU	Information and Knowledge Utilization
INA	Information Needs Assessment
INM	Integrated Nutrient Management
IVRS	Interactive Voice Response Systems
KRS	Knowledge Resource Centers
KSC	Knowledge Sharing Centre
KVK	Krishi Vigyan Kendra
MNRE	Ministry of New & Renewable Energy
MTT	Management Time Table
NAIP	National Agricultural Innovation Project
NEDCAP	Non Conventional Energy Development Corporation of Andhra Pradesh
NGO	Non Governmental Organization
NREGS	National Rural Employment Guarantee Scheme
ORP	Operational Research Project
PAR	Participatory Action Research
POP	Package of Practices
PRA	Participatory Rural Appraisal
RRA	Rapid Rural Appraisal
SAIRD	Sri Aurobindo Institute for Rural Development
SHC	Soil Health Card
SHG	Self Help Group
SLA	Sustainable Livelihood Approach
SRLP	Sustainable Rural Livelihoods Project
SRLS	Sustainable Rural Livelihood Security Project
SSNM	Site Specific Nutrient Management
TSIK	Touch Screen Information Kiosk
UMMB	Urea Molasses mineral bricks
VAS	Veterinary Assistant Surgeon
VO	Village Organization

भाकृअनुप
ICAR

हर कदम, हर डगर
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