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PARTICIPATORY RURAL APPRAISAL IN DRYLANDS: A HOLISTIC APPROACH FOR GETTING INSIGHT INTO AN AGRO-ECOSYSTEM ANALYSIS

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ABSTRACT

Participatory Rural Appraisal (PRA) is an effective tool to understand the technology adoption profile in a cropping system, to get first-hand information about their needs, resources available, identify location-specific problems and researchable issues and ultimately to come up with tangible possible solutions drawn as an action plan. The present study was undertaken in Zamistapur (16.69N, 77.95E), Chowdarpally (16.71N, 77.94E), Telugu Gudem (16.68N, 77.94E) and Kodur Thanda (16.68N, 77.93E) villages of Mahabubnagar district, Telangana State. The PRA tools used include transect walk, agro-ecological mapping, social mapping, seasonal calendar, gender analysis, livelihood analysis, technology mapping, consequence diagram, problem-solving tree, etc. The major constraints identified were frequent droughts, soil salinity, water scarcity/groundwater availability at high depth, drinking water quality, erratic electricity supply, non-availability of labourers for agricultural activities, lack of quality germplasm of livestock, wild boar damage to crops, etc. Based on the problems identified, suitable solutions were arrived in consultation with subject matter experts and progressive farmers. There is need to address the problem of water scarcity, frequent droughts, insect and pest problems by the use of integrated watershed development, resource prioritisation and

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utilisation efficiency, use of IPM technologies, capacity building of farmers about relevant technologies, etc. This would certainly result in upliftment of the social status of the people as well as overall development of agriculture and rural livelihood as a whole. The researchable issues focused on the means to develop soil and water conservation plan trials on different cropping patterns/systems including rice/sorghum as main crop and short duration pulse and other vegetables so as to break the mono-cropping of rice and sorghum. Moreover, suitable extension programmes may be formulated and implemented with a problem solving approach considering the local resources and skill available within the farming community.

Introduction

Agriculture sector in India is passing through new millennium challenges that are quite different from those faced in the previous decades. The enormous pressure to produce more food from less land (due to land stratification and alternate usage) with shrinking natural resources and climate change related events, is a mammoth task for the farmers as well as agricultural research scientists. To gear up the momentum of growth as well as maintaining the livelihood security of farmers, a careful analysis into the agro-ecological situation and economic evaluation of inputs like seeds, fertilisers, pests and diseases, irrigation sources, etc., are of considerable importance. In this context, Participatory Rural Appraisal (PRA) is an important tested tool to understand the technology adoption profile in a cropping system, to get first-hand information about their needs, resources available, identify location-specific problems and researchable issues and ultimately to come up with tangible possible solutions drawn as an action plan (Rajula Shanthy et al., 2004).

PRA is a term that has been widely advocated and increasingly used in development circles. The stress on 'farmer participation' has arisen from a realisation that earlier approaches to on-farm research recognised the importance of farmers, but was not able to effectively incorporate farmers' skills and experimental practices into the research process. The purpose of PRA is to enable development practitioners, government officials and local people to work together to plan context-appropriate programmes. It is an approach for shared learning between local people and outsiders. This process will also help to understand the technology dissemination process, rural development activities, linkage

mechanisms existing among research, training and extension, credit and input supply systems (Jones, 1995; Mathialagan, 2000). The present work was carried out as a part of *Mera Gaon Mera Gaurav* Scheme (My Village My Pride), launched by Indian Council of Agricultural Research, New Delhi during September-October, 2015 with the following objectives:

1. To understand the agro-ecological setting in a holistic approach
2. To explore the agriculture related problems in the study area and
3. To find solutions for the prioritised problems for the upliftment of farmers

Methodology

The present study was undertaken in Zamistapur (16.69N, 77.95E), Chowdarpally (16.71N, 77.94E), Telugu Gudem (16.68N, 77.94E) and Kodur Thanda (16.68N, 77.93E) villages of Mahabubnagar district, situated in Southern Telangana Agro-climatic zone of Telangana State.

The PRA tools used include transect walk, agro-ecological mapping, social mapping, seasonal calendar, gender analysis, livelihood analysis, technology mapping, consequence diagram, problem-solving tree, etc.

The study was conducted in four villages of Mahabubnagar district of Telangana with a population of almost 1800 households. The major occupation in this village is agriculture and 60 per cent of the farmers have a landholding ranging from 5-10 acres. Despite being a progressive village with a wide range of crops and animal husbandry, there are some problems like water scarcity, unavailability of labour, intrusion of wild animals, etc., which are extensively affecting the livelihood.

Rapport Building: The Assistant Director of Agriculture and concerned Agricultural Officers were consulted before survey work. Reconnaissance survey was conducted for selecting the village with the assistance of the local development officers of the block. Informal meeting was organised in the village along with sarpanches to get acquainted with their mode of functioning. PRA was finally conducted with full cooperation of selected people from the villages and facilitators.

PRA Tools Used : The PRA tools used include transect walk, agro-ecological mapping, social mapping, time trend, seasonal calendar, gender analysis, time line, livelihood analysis, technology mapping, consequence diagram, problem – solving tree, etc.

The research team made transect walks in the cross section of the villages accompanied by several local informants who were knowledgeable about the natural resource issues. Observations were made on different micro-ecological niches and discussed issues of mutual interest. Data were recorded to assess the topography, soil type, land use pattern, major crops, trees, livestock, cropping pattern, technologies adopted, socio-economic and cultural settings and agricultural

problems. Based on the observations of transect walk, agro-ecological data were compiled depicting the climatic and environmental conditions in relation to agricultural practices prevalent in the village.

Data were also collected for crop yield and price trend over the respective years to identify the fluctuations that had occurred during the last five years and how it had influenced village life.

Problem Identification: The major problems identified in the villages were listed and Rank Based Quotient (RBQ) of the problems was calculated based on the ranking done by 20 farmers of each village. Rank Based Quotient was calculated using following formula as given by Sabarathnam (1988):

$$RBQ = \frac{\sum f_i (n+1-i) \times 100}{N \times n}$$

Where, i = Concerned ranks

N = Numbers of farmers

n = Numbers of ranks

f_i = Frequency of farmers for ith rank of the technological need

Based on the agriculture-related problems identified, a problem-solution tree was constructed to highlight the possibilities to overcome the identified problems.

Results And Discussion

Transect and agro-ecological details : Chowdarpally is located at the latitude between 16.70 to 16.71 N and longitude between 77.94 to 77.95 E. Kodur Thanda and Telugu Gudem is located at the latitude of 16.68 N and longitude between 77.92 to 77.93 E and at 77.94 E, respectively. Zamistapur is located at the latitude between 16.70 to 16.71 N and longitude between 77.95 to 77.96 E. Table-1 details the features identified during the transect walk. On an average, the area receives 692 mm of rainfall in a year with major share from South-West Monsoon (June-September).

In Chowdarpally, the land is sloping towards east with west side having higher elevation (463.3-472.4 m) compared to east side (442-448 m). In Kodur Thanda and Telugu Gudem, such slope was missing and almost whole area was lying at an elevation of 475.5-484.6 m and 442-448 m, respectively. In Zamistapur, the land is sloping towards south with northern side having higher elevation (487.7-497 m) compared to southern side (442-454.2 m) (Table-1). Major source of irrigation in the selected villages are bore and open wells. There is severe water problem in all the villages and water level is almost at 122 m. Drip irrigation has not been widely adopted to save water. The village has red soil and sandy loam soil texture suited for growing a wide range of crops.

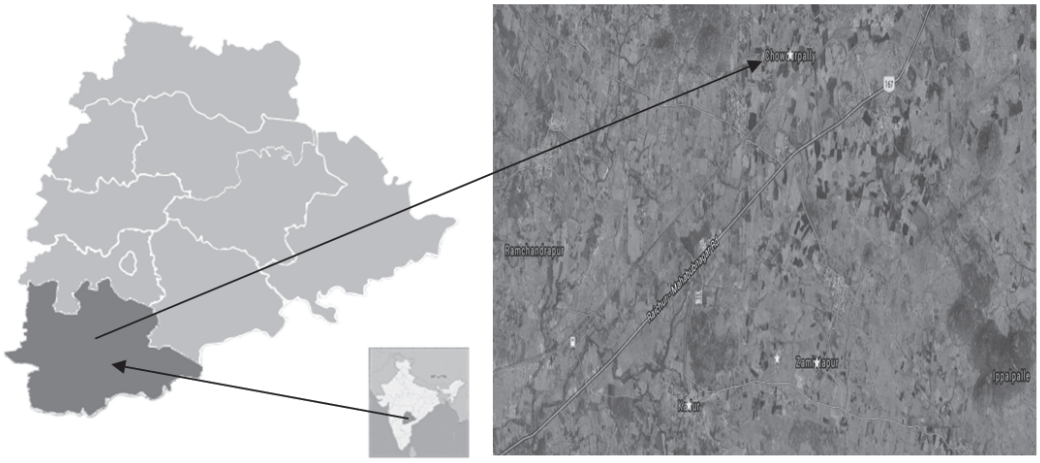

Fig. 1 : Study Area Location in Mahabubnagar District of Telangana

Table 1 : General Transect Analysis of Villages

Particulars	Upland	Lowland
Altitude	470-485 m	439-445 m
Soil type	Red soil	Sandy Loam
Land usage	Farm land and habitat	Farm land mostly
Major crops	Castor, Maize, Sorghum, Groundnut, Redgram, Sunflower	Maize, Rice, Cotton, Sunflower, Ragi, Redgram
Vegetables	Okra, Tomato, Chilli, Flower, Cauliflower	Coconut
Fruit trees	Mango, Acacia, Neem, Tamarind	Tamarind, Neem, Mango, Custard apple, Sitaphal and Ramphal
Weeds	Parthenium, Lantana camara, Argemonemexicana	Parthenium, Tridoxprocumbens, Trianthemaportulacastrum
Cropping pattern	Rice-GN-Rice Jowar-GN-Rice Cotton-GN-Rice	Rice-Rice-Rice Rice-GN-Rice

(Contd...)

Table 1 ***(Contd...)***

Particulars	Upland	Lowland
Water Resources	Bore well, open well, tank	Bore well, open well, tank
Pests	Maize-stem borer; Okra-fruit borer, whitefly; Cauliflower-diamond back moth; Chilli-aphids, mites	Rice-BPH, false smut, panicle mite; Cotton-leaf spots, blackarm, grey mildew, micro-nutrient deficiencies, sucking pest; Groundnut-stem necrosis; Redgram-sterility mosaic, maruca pod borer, wilt/maruca; Castor-wilt; Maize-shoot borer
Diseases	Bhendi : Powdery mildew Chilli : Anthracnose	Mango-stem borer
Technologies	Wild boar fencing Soil testing Rice thresher	Soil testing
Problems	Underground water depletion, land degradation Low soil fertility, soil salinity	Demanding of high wages by agricultural labourers, high cost of fertilisers and agro-chemicals, labour shortage during harvesting period, pest and diseases problems, fluctuating market price
Opportunities	Soil and Water conservation measures (Percolation pond, check dam and farm ponds) Crop diversification, inter-cultivation, green mulching	Drip irrigation, integrated pest and disease management, promoting use of bio-fertilisers

Agro-ecological Mapping: Agro-ecological map depicts the climatic and environmental conditions in relation to agricultural practices prevalent in the village. It helps in better understanding of the topography, land use, soil type, variation in main climatic parameters, irrigation system prevalent in the village, dominant crops, trees, shrubs, weeds and other agro-ecological conditions of the village. Majority of the land area are plains (89 per cent), rest is undulating and hilly track (11 per cent) (Table 2). Villages have both red and sandy loam soil types with pockets of saline soils. Problematic soils are saline soils.

Table 2 : Topography and Soil Types of Adopted Villages

Village	Undulating (ha)	Plain land (ha)	Red soil acreage & % of total	Black soil acreage & % of total	Other (problematic saline soils) in ha
Zamistapur	46	335	333, 87.4	48, 12.6	6
Chowdarpally	21	188.6	185.6, 88.5	24, 11.5	4
Telugu Gudem	10	85	83, 87.3	12, 12.7	4
Kodur Thanda	9	93	91, 89.2	11, 10.8	3
Total	86	701.6	692.6, 87.9	95, 12.1	17

Sowing window for four major field crops (start and end of normal sowing period) were observed to be 2nd fortnight of June to 1st fortnight of July for castor, 2nd week of June to end of June for jowar, 2nd fortnight of June to 1st fortnight of July for redgram and 1st week of June to last week of July for rice.

Intensive agriculture is followed in these villages, namely, Zamistapur, Chowdarpally, Telugu Gudem and Kodur Thanda. Important crops grown are kitchen garden vegetables and fruits. Tomato is the major vegetable crop in the kharif season. In rabi season, chilli, and okra are grown. The summer season crops are cauliflower and okra. Fruit crops like mango, guava, papaya, custard apple, and drumstick are grown in the backyard. The major tree crops are tamarind, neem and Acacia. Parthenium, Argemone mexicana, bermuda grass, Lantana camara, Tridox procumbens, Trianthema portulacastrum are the commonly found weeds in the village. The common shrubs in the village are Calotrophis sp, Lantana camara, Abutilon sp. Cassia auriculata, Nerium, Opuntia sp. and Euphorbia sp.

Social Mapping: Social mapping is one of the visual PRA techniques which involves direct participation of villagers. It is used to analyse the social structure, stratification and availability of social facilities including spatial distribution of castes, information regarding occupational pattern, location of households, social institutions, groups, leadership patterns, value systems, social gatherings, norms, customs, social evils existing in the village, etc. In short, the social map enables us to understand and analyse the existing social scenario of the village.

Caste and Settlement: Total farm families are 635 in Zamistapur, 800 in Chowderpally, 135 in Telugu Gudem and 45 in Kodur Thanda villages (Table 3). Most of the farmers in Kodur Thanda are ST category whereas 10 per cent in Telugu Gudem, 3 per cent in Zamistapur and Nil in Chowdarpally. SC farmers form major category in Zamistapur and Chowdarpally villages, with

small per cent of BC farmers found in these villages. In Telugu Gudem, most of the families belong to Goud community and only few OBCs and STs are also there. It was nice to see that all the houses of Telugu Gudem were almost pucca with the support of government schemes. It was interesting to note that the households belonging to different castes/ categories were scattered in the village, but followed a specific pattern. The existence of social stratification based upon caste and community was noticed.

Table 3 : Farm-households' Classification

Villages	Total No. of farmers in the village	No. of women-headed households	No. of SC households	No. of ST households
Zamistapur	635	15	100	15
Chowdarpally	800	32	200	0
Telugu Gudem	135	5	0	11
Kodur Thanda	45	3	0	30

Leadership Pattern and Other Social Information: Leadership pattern was not observed in this village because it was predominated by same community people. However, a progressive farmer and the precision farming farmer association leader influenced the villagers in decision making process and also intervene in social activities. People are generally harmonious and due respect was given to elders by the children and youth, clearly representing the existence of a strong value system in the village. People participate in social gatherings like Bonalu, Bathukamma festival and other local festivals.

Social Evils: Social evils are the unconstructive elements in any rural sector of the country that hampers its progressive development and growth. Dowry system was found to be prevalent in the village. The other social evil observed was consumption of local liquor leading to unrest in homes.

Farming Situation: Total cultivable area ranged between 95 - 381 hectares in these villages. Lowest cultivable acreage was seen in Kodur Thanda and Telugu Gudem villages and highest of 381 ha situated in Zamistapur village (Table 4). However, the net sown area is between 74-286 ha. Major percentage of cultivable land is rainfed (70.5 per cent) and only 29.5 per cent is irrigated in all villages.

Table 4 : Farming Situation of Adopted Villages

Villages	Rainfed area (ha)	Irrigated area (ha)	Total cultivable land (ha)	Net sown land (ha)	% of total cultivable land
1. Zamistapur	296	85	381	286	75
2. Chowdarpally	140	69.6	209.6	169.8	81
3. Telugu Gudem	60	35	95	74.1	78
4. Kodur Thanda	59	43	102	83.64	82
Total	555	232.6	787.6	613.54	77.9 (Average)

Cropping System, Soil Type and Yield: Various types of farming system were observed which included Paddy-Groundnut-Paddy, Jowar-Groundnut-Paddy, Cotton-Groundnut-Paddy, Paddy-Paddy-Paddy coupled with few vegetables, fruit trees and livestock too (Table 5). Sorghum, groundnut and castor were the major crops grown in the field. Yield (q/ha) of sorghum was 4.0, castor-7, redgram-4.5, cotton-2.5. Majority of soil type was red and sandy loam.

Table 5 : Cropping System in the Study Area

Village	Crops/cropping systems	Area covered (ha)	Varieties	Yield q/ha	Major problems
Zamistapur	Rice-GN-Rice	11	BPT-5204	21	BPH, False smut,
	Jowar-GN-Rice		of rice	4.3	Panicle mite
	Cotton-GN-Rice			2.5	
	Sorghum	102	CSV-23	4	Wild boar
	Castor	41	GCH-4	7.2	Wilt
Chowdarpally	Rice-Rice-Rice	28	BPT-5204	26	BPH, False smut,
	Rice-GN-Rice		of rice	23	Panicle mite
	Castor	33	GCH-4	7.1	Wilt
	Groundnut	12	K-6	20	Stem necrosis
	Red Gram	5	LRG-41, PRG-158	4.6	Wilt/Maruca

(Contd...)

Table 5 *(Contd...)*

Village	Crops/cropping systems	Area covered (ha)	Varieties	Yield q/ha	Major problems
Telugu Gudem	Jowar-GN-Rice	10	BPT-5204	4.1	BPH, False smut,
	Rice-GN-Rice		of rice	23	Panicle mite
	Castor	26	GCH-4	6.9	Wilt
	Groundnut	12	K-6	19	Necrosis
	Redgram	5	LRG-41	4.5	Sterility mosaic, Maruca pod borer
Kodur Thanda	Rice-GN-Rice	15	BPT-5204	21	BPH, False smut,
	Jowar-GN-Rice		of rice	4.2	Panicle mite
	Castor	29	GCH-4	7	Wilt
	Cotton	15	Bt	2.5	Leaf spots, Grey mildew, Sucking pest

Farmers' Classification: Majority of farmers in all the villages are small and landless (>90 per cent) except Zamistapur (25.8 per cent), it has majority of marginal farmers (73.15 per cent) (Table 6). Only one large farmer was found in Zamistapur, otherwise no large farmer was observed in any of these villages.

Table 6 : Farmer Categories in Adopted Villages

Villages	Small and Landless		Marginal		Medium		Large	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Zamistapur	164	25.8	464	73.1	5	0.9	1	0.2
Chowdarpally	760	95	0	0	40	5	0	0
Telugu Gudem	121	90	0	0	14	10	0	0
Kodur Thanda	40	90	0	0	5	10	0	0

Major Problems Identified in These Villages: The major problems observed in the villages were underground water depletion, soil fertility degradation, soil salinity, demanding of high wages by agricultural labourers, high cost of fertilisers and agro-chemicals, labour shortage during harvesting period, pest and diseases problems, fluctuating market price,

drinking water problem, severe drought, malnutrition, etc.

Seasonal Calendar and Analysis: Seasonal calendar indicated month-wise information about all the aspects related to cultivation of crops and livestock rearing. In this village, most of the farmers are not well educated and hence are mostly devoid of government schemes related to agriculture and animal husbandry. The animal husbandry enterprise included dairy, goat rearing, sheep farming and backyard poultry. Seasonal analysis helps in identifying the period which are critical with respect to labour demand, pest and disease problems and availability of fodder.

In rice, BPH, false smut, panicle mite are the major threats faced by the farmers. In cotton, leaf spots, blackarm, grey mildew, micro-nutrient deficiencies, sucking pest; in groundnut, stem necrosis; in redgram, there was incidence of sterility mosaic, maruca pod borer, wilt/maruca; in castor, wilts were common; and in seasonal vegetables (okra, chilli, tomato) sucking pests like thrips and whiteflies are the common pests.

Cropping Events: Sorghum and groundnut have lost area to maize, castor, rice, and redgram since 2000. Despite this, sorghum constitutes majority of the area under cropping in the surveyed area. Area under horticulture crops in these villages has increased many folds over a period of five years. Area under vegetables has seen a slight increase while that under spices has almost remained constant during last five years.

Gender Disaggregated Activities: Women in this village contribute mainly to agriculture, home management and livestock management. They do weeding, sowing/ planting, harvesting and apply fertilisers as and when required in field. They also feed the livestock, clean the shed and the animals. Some of them take the animals to the fallow land for grazing. Landless women and women from poor families work as agricultural labourers within the village. Men are mainly involved in field activities like land preparation, earthing up, etc., and also take the livestock for feeding, fodder collection and grazing (sheep and goat). Landless farmers also engage themselves in agricultural activities within their village during the peak period. Both men and women feed animals, do milking, take them for grazing and collect fodder, whereas only women clean the shed. Women do all kinds of household work along with agricultural activities.

Timeline : Timeline is a PRA tool used to know the history of major remembered events in the village and community and their significance with the social development. It indicates the causal link between past and present. The purpose of this tool is to obtain historical account of changes in demography, socio-economic condition, communication, social relationship and interaction, technology diffusion and adoption. Timeline of major events in all the villages under study shows more or less similar pattern as what is generally indicated by the majority of the Indian villages, viz. construction of temple, primary school, open well, electrification, anganwadi, bus-

stand, handpump, drinking water supply system, direct to home (DTH), high school, etc.

From the timeline of agriculture, it is evident that farmers grew a number of crops. It indicates that farmers used to follow conventional agriculture earlier with very less farm mechanisation and used to rear local breeds of cattle and buffalo. There is a gradual increase in use of communication technologies like use of landline (in 2000), mobiles (in 2006) to use of internet and broadband (in 2013).

Matrix Ranking: Matrix ranking technique is applied to know the relative importance of technologies or varieties of crops or breeds of cattle over the others based on key informants (KI). The villagers have adopted and discontinued several varieties of sorghum, cotton, redgram, castor and groundnut over the years, but recently they are using Kadiri-6 (K-6) variety of groundnut, GCH-4 variety of castor, LRG-41 and PRG-158 variety of redgram, CSV-23 variety of sorghum and Bt cotton varieties (Table 7).

Indigenous breed of cattle has disease resistance and produces better quality milk. But the farmers of village prefer Jersey cross breed because of high milk production and early age of maturity, which gives them more income. Even they prefer buffalo over crossbreds due to higher fat% which fetch more price in the market (Table 8).

Table 7 : Matrix Ranking for Redgram Varieties

Indicator	KI	Varieties					
		LRG-41		PRG-158		Maruthi	
		Rank	Score	Rank	Score	Rank	Score
Yield	KI-1	B	2	A	3	C	1
	KI-2	B	2	A	3	C	1
	KI-3	B	2	A	3	C	1
	Sub-total		6		9		3
Wilt resistant	KI-1	C	1	A	3	B	2
	KI-2	B	2	A	3	C	1
	KI-3	B	2	A	3	C	1
	Sub-total		5		9		4

(Contd...)

Table 7 *(Contd...)*

Indicator	KI	Varieties					
		LRG-41		PRG-158		Maruthi	
		Rank	Score	Rank	Score	Rank	Score
Drought	KI-1	A	3	C	1	B	2
tolerance	KI-2	A	3	C	1	B	2
	KI-3	A	3	B	2	C	1
	Sub-total		9		4		5
Sole and	KI-1	A	3	B	2	C	1
inter-cropping	KI-2	A	3	B	2	C	1
both	KI-3	A	3	B	2	C	1
	Sub-total		9		6		3
Grand total			29		28		15

(KI-Key Informants)

Table 8 : Matrix Ranking for Dairy Animals

Indicator	KI	Varieties					
		Jersey crossbred		Indigenous		Buffalo	
		Rank	Score	Rank	Score	Rank	Score
Milk Yield	KI-1	B	2	C	1	A	3
	KI-2	B	2	C	1	A	3
	KI-3	A	3	C	1	B	2
	Sub-total		7		3		8
Fat%	KI-1	C	1	B	2	A	3
	KI-2	B	2	C	1	A	3
	KI-3	C	1	B	2	A	3
	Sub-total		4		5		9
Early maturity	KI-1	A	3	B	2	C	1
	KI-2	A	3	C	1	B	2
	KI-3	A	3	B	2	C	1
	Sub-total		9		5		4

(Contd...)

Table 8 *(Contd...)*

Indicator	KI	Varieties					
		Jersey crossbred		Indigenous		Buffalo	
		Rank	Score	Rank	Score	Rank	Score
Disease resistance	KI-1	C	1	A	3	B	2
	KI-2	C	1	A	3	B	2
	KI-3	C	1	A	3	B	2
	Sub-total		3		9		6
Monetary value	KI-1	B	2	C	1	A	3
	KI-2	B	2	C	1	A	3
	KI-3	B	2	C	1	A	3
	Sub-total		6		3		9
Grand total			29		25		36

(KI-Key Informants)

Livestock Farming System: Mahabubnagar has the highest livestock population (1833245 ACU as per 2003 Census) among the different MGMG villages adopted by ICAR-CRIDA, Hyderabad. The district also has the highest number of cattle (7,03,754) next only to Adilabad. The district boasts of the highest number of sheep / goats (7,73,222). The grazing pressure, however, is 10.7 ACU/ha grazing area.

Zamistapur had predominantly buffalo population, whereas, sheep population was good enough in all the four villages (Table 9). Few farmers in all villages were keeping cattle and goat. Milk yield (lites/day) in buffaloes varied from 5-10, whereas in cows varied from 2-5. Small ruminants were able to achieve 15-16 kg in one year.

Table 9 : Details of Livestock Production System in the Adopted Villages

S.No.	Particulars	Zamistapur	Chowdarpally	Telugu Gudem	Kodur Thanda
1.	Buffalo	400	50	30	10
2.	Cattle	25	15	10	5
3.	Sheep	150	950	100	100
4.	Goat	55	150	15	20

(Contd...)

Table 9 *(Contd...)*

S.No.	Particulars	Zamistapur	Chowdarpally	Telugu Gudem	Kodur Thanda
5.	Fisheries	Nil	Nil	Nil	Nil
6.	Milk yield (L)				
	Cows	2-5	4-5	3-4	4-5
	Buffaloes	7-10	5-7	6-8	6-7
7.	Milk rate (₹/L)				
	Cows	27.0	30.0	25.00	40.00
	Buffaloes	40	40.0	45.00	50.00
8.	Utilisation of milk	Home consumption and selling to milk collection booth	Home consumption and selling to milk collection booth	Selling to milk collection booth	Mostly home consumption
9.	Mutton rate (₹/kg)	400	400	400	400

In Kodur Thanda, people are keeping sheep and goat, but they don't prefer kid selling. Only adult one at the age of one to one and half years of age having less than 25 kg body weight (based on visual observation) are sold @ ₹ 5000-6000 per unit. They make this selling on special occasions like Ramzan or Dussehra to make more profits. Earlier they were keeping buffaloes, but now it is very less due to non-availability of feed resources. Same reason was attributed to the decreasing population of cows also. They don't rear poultry, but the youth are interested in poultry rearing and need chicks. The only disease known to them was FMD.

In Telugu Gudem, all varieties of livestock are reared, but buffaloes are preferred more owing to milk collection booth centre from where they get money every week. The milk rate varied from ₹ 25 to 45 per litre depending on the fat %. Villagers anticipated of almost 50 litres of milk sent by them on daily basis. In the village, there are two poultry farms keeping 5000 birds each. They are keeping only broilers and sell them locally @ ₹ 100 each. They don't sell birds outside the village. Nobody was keeping layers in the village.

In all villages, small ruminants are sold on average to middleman based on visual observation which suggests their profitability

can be improved using weighing balance. The people of all the villages under study are unaware of the government schemes for supporting livestock enterprise in the State.

Livelihood Analysis: Livelihood analysis shows the percentage distribution of income and expenditure pattern of small, medium and large farmers. In large and medium farmers, the major source of income is agriculture followed by livestock. Small farmers apart from agriculture and livestock, work as labourers for earning their bread. The major expenditure of large farmers goes on agricultural inputs and paying labourers (Table 10). They also spend considerable amount in food items as compared to other expenditures, like health, education, etc., and they do maximum percentage of saving. It was observed that education was given importance by all class of people. The medium and small farmers spend maximum for good education and their annual saving was observed to be very less or almost negligible. Some small farmers don't save anything for their future because their total income is also insufficient for them throughout the year. Rather, when they are in need of money, they take loan from banks or borrow money from rich farmers.

In drought years, all categories of farmers are affected and small farmers are worst affected as their resilience capacity is very less. During drought years, livestock component is giving resilience; otherwise there is a great loss in agricultural activities.

Table 10 : Livelihood Analysis of Small, Medium and Large Farmers (Annual Income & Expenditure in ₹) During Normal and Drought Years

Items	Small		Medium		Large	
	Normal rainfall	Drought	Normal rainfall	Drought	Normal rainfall	Drought
Sources of Income						
Agriculture	25000	5000	100000	20000	400000	50000
Livestock	15000	10000	50000	40000	84000	64000
Others	15000	15000	15000	20000	30000	45000
Expenditure						
Agriculture	20000	15000	30000	25000	200000	150000
Education	5000	5000	20000	20000	30000	30000
Food	12000	12000	30000	30000	60000	60000

(Contd...)

Table 10 *(Contd...)*

Items	Small		Medium		Large	
	Normal rainfall	Drought	Normal rainfall	Drought	Normal rainfall	Drought
Clothing	5500	5500	15000	15000	35000	35000
Medical	2500	2500	7000	7000	15000	15000
Vehicle	2000	2000	15000	15000	36000	36000
Entertainment	1500	500	5000	3000	15000	10000
Tours & Travels	3000	3000	10000	10000	20000	20000
Mobile	1500	1000	3000	2000	6000	5000
Livestock	5000	6000	8000	10000	35000	40000
Electricity	2000	2000	4000	4000	6000	6000
Savings	-5000	-24500	18000	-61000	56000	-248000

Technology Map: Technology map is used to know the different types of technology present in the village and behavioural pattern of the villagers towards technology adoption (Chambers et al., 1989). Adoption type, discontinuance, rejection and over-adoption are the different types of technology behaviour. This technique is used as feedback mechanism which helps to identify the problems of the farmers by scientist and extension personnel. Among the several varieties/ technologies introduced in the village, some of them are discontinued and others are being adopted. The farmers have adopted Kadiri-6 (K-6) variety of groundnut, GCH-4 variety of castor, LRG-41 and PRG-158 variety of redgram, CSV-23 variety of sorghum and Bt cotton varieties. Seed treatment of vegetables, application of farm yard manure are some of the technologies adopted by the farmers of the village.

Consequence Diagram: Consequence diagrams are drawn to know the impact of adoption of technology (Kar et al., 2002). The farmers of these villages are using precision farming, drip irrigation and cross breeding. These technologies have both positive and negative effects which are analysed using consequence diagram. Consequence analysis of drip irrigation indicated that subsurface hardening, less aerobic micro-organism, nutrient leaching because of presence of sandy clay loam soil and frequent clogging of dripper with salt are the negative consequences of drip irrigation; still the villagers are using drip irrigation profusely as it increases water use efficiency, uniform distribution, application of

pesticide and increased crop yield. Cross breeding was mostly practised by the villagers as they get high milk yield which in turn provides high income. The major drawback was increased disease incidence. Also, farmers are preferring buffaloes over cattle due to higher returns owing to more fat % in milk. The major drawback of this preference led to less resilience as buffaloes are more susceptible to heat stress.

Table 11 : Rank Based Quotient (RBQ) of the Major Problems Identified in the Village (N=20)

Problems	1	2	3	4	5	6	7	RBQ	Rank
Underground water depletion/water scarcity	17	2	1	-	-	-	-	97.14	I
Land degradation	15	1	1	1	1	1	-	89.29	VII
Soil salinity	10	5	3	1	1	-	-	95.48	II
Fluctuating market price	13	4	1	1	1	-	-	90.71	V
Wild boar menace	11	5	3	1	-	-	-	90.00	VI
Insect/pests of rice	16	1	2	1	-	-	-	94.29	IV
Frequent droughts	15	3	2	-	-	-	-	95.00	III

Rank Based Quotient and Problem-solution Tree: Based on the responses of farmers, the rank of problem was calculated using RBQ (Table 11). The data provided by the villagers were further validated by the Agriculture Officer of Agriculture Department, Mahabubnagar. In spite of being a progressive village, there are some problems such as underground water depletion, land degradation, soil salinity, fluctuating market price, demanding of high wages by agricultural labourers, pest and diseases problems, high cost of fertilisers and agro-chemical, frequent droughts, etc. The possible solution for these major problems is given in problem-solution trees (Fig. 1-4). Water scarcity was categorised as the biggest problem affecting the villages. This problem is not only with these villages, but also affecting other rainfed areas of India. According to the response of the farmers, water was the most valuable and critical input in the region which is supported by the livelihood analysis too. In the event of climate change this problem may further be aggravated if not attended properly. Possible solutions, which are feasible in the area, have been listed in the Fig. 2. These can be addressed by creating awareness about water footprint, farm pond, rainwater harvesting structures and proper selection of crop. Promoting less water intensive crops

and low water requiring varieties need to be identified specific for the region and popularised later on. Focus need to be made more on rain water harvesting which need to be utilised for groundwater recharging as well as irrigation purposes and less exploitation of groundwater which need to be preserved for drinking purpose only.

Soil salinity was next problem (Fig. 3) according to the rankings and is the main reason for chemical drought where a crop does not easily respond to the input application. Farmers need to be made aware of its consequences and suitable measures. Farmers in the area mostly go for rice cultivation if water is there, otherwise they leave the land barren which make the soil saline. There should be crop rotation, inter-cropping and use of conservation agriculture for soil reclamation. Standard agronomic practices for removing soil salinity should be adopted and promoted in the village.

Frequent droughts was the next ranked problem where majorly water availability to root zone is compromised severely causing productivity losses as well as mortality (Fig. 4). This is one of the biggest challenges in climate change scenario. Proper water management system is the long term solution to this problem. Frequent drought need to be addressed by installation of rainwater harvesting structures, use of contingency planning measures, soil cover, mulching. Excessive evapo-transpirative losses need to be checked by use of tree covers, shading of plots, azolla cultivation in farm ponds, etc. The farming policy of farmers needs to be strategised in order to include drought resistant components in their farming systems like livestock, horticulture, agri-processing, etc.

The belt dealing with rainfed rice crop, insect/pest of *rice* is the next ranked problem (Fig. 5). Proper training and use of integrated nutrient and pest management is the key solution to the problem. Sowing window of farmers should be scientifically planned rather than one or two rainfall dependent system coupled with efficient water management strategies. Suitable agronomic practices depending on agro-climatic conditions of the village will be the viable option to the problem-solving agenda.

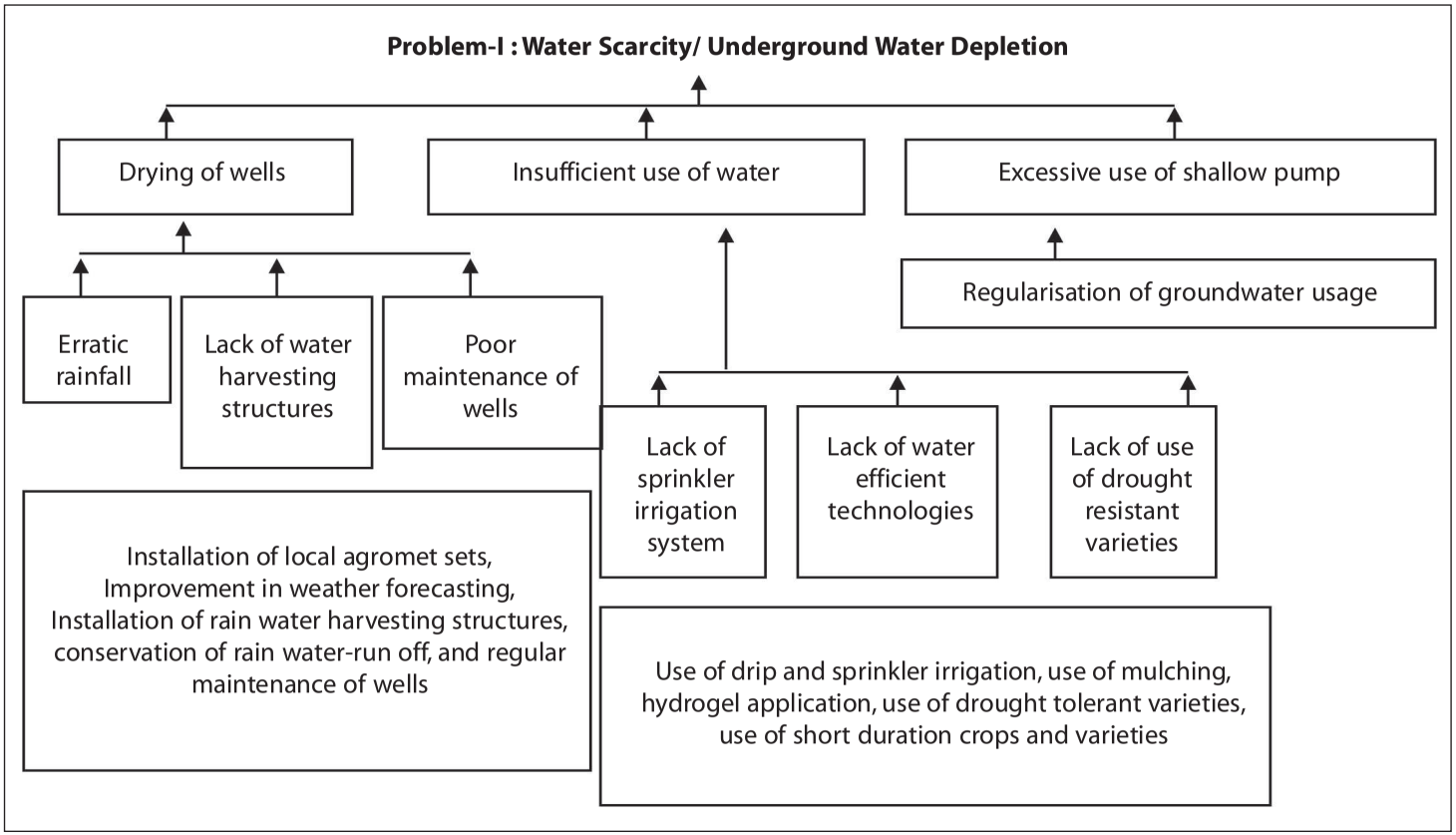

Fig. 2 : Problem-Solution Tree for Underground Water Depletion, Problem (normal font); Solution (in italics)

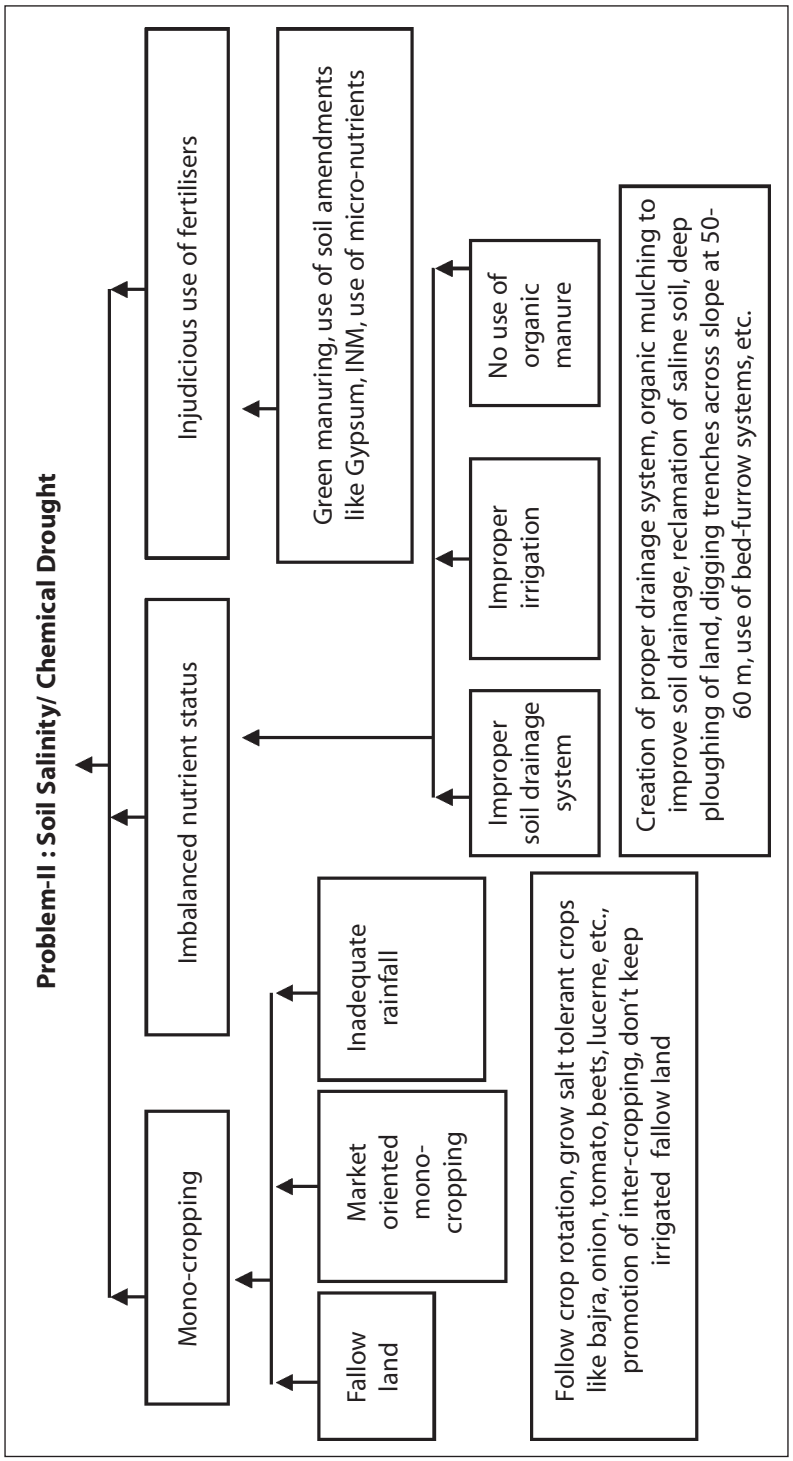

Fig. 3 : Problem-Solution Tree for Soil Salinity, Problem (normal font); Solution (in italics)

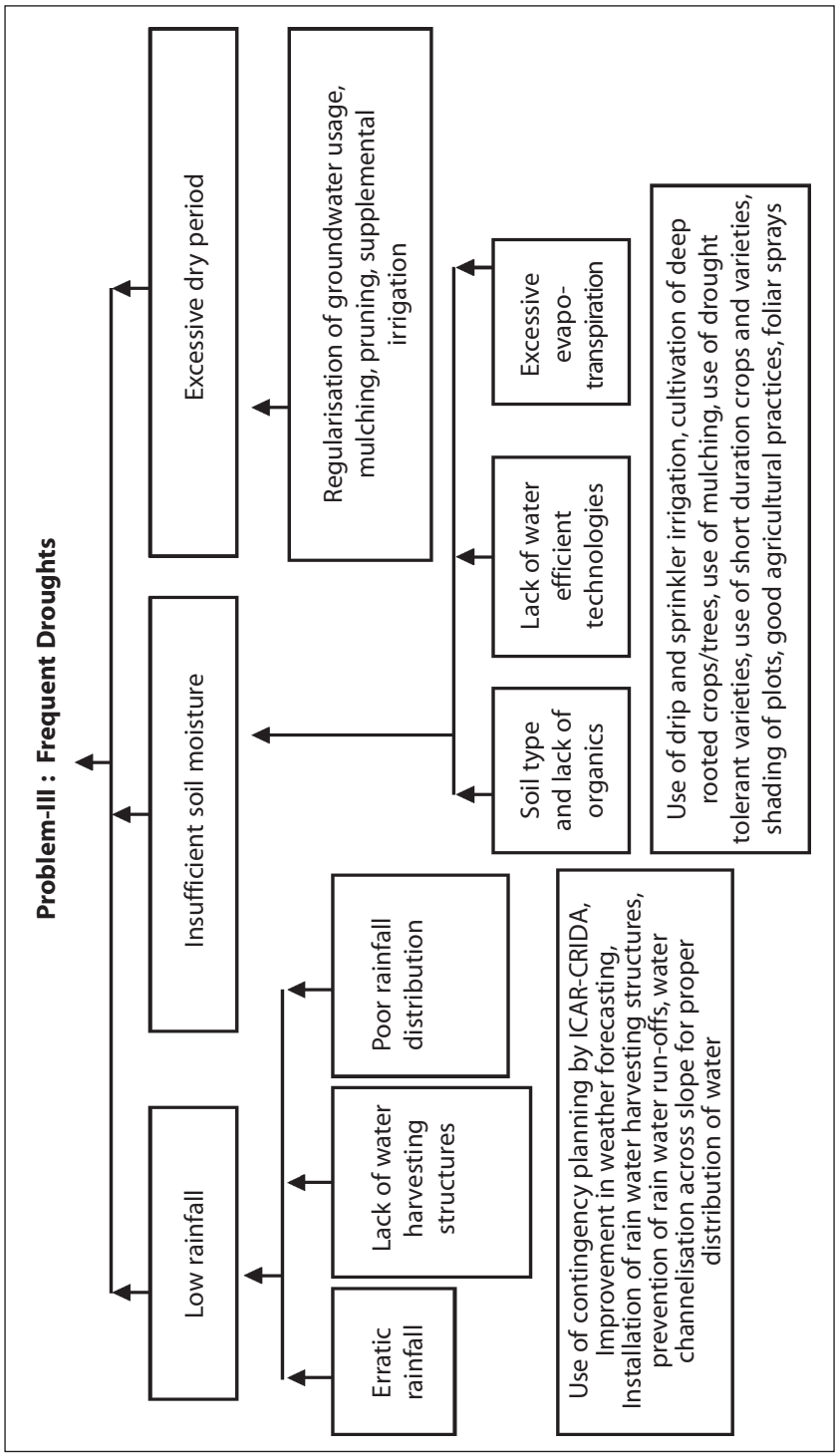

Fig. 4 : Problem-Solution Tree for Frequent Droughts, Problem (normal font); Solution (in italics)

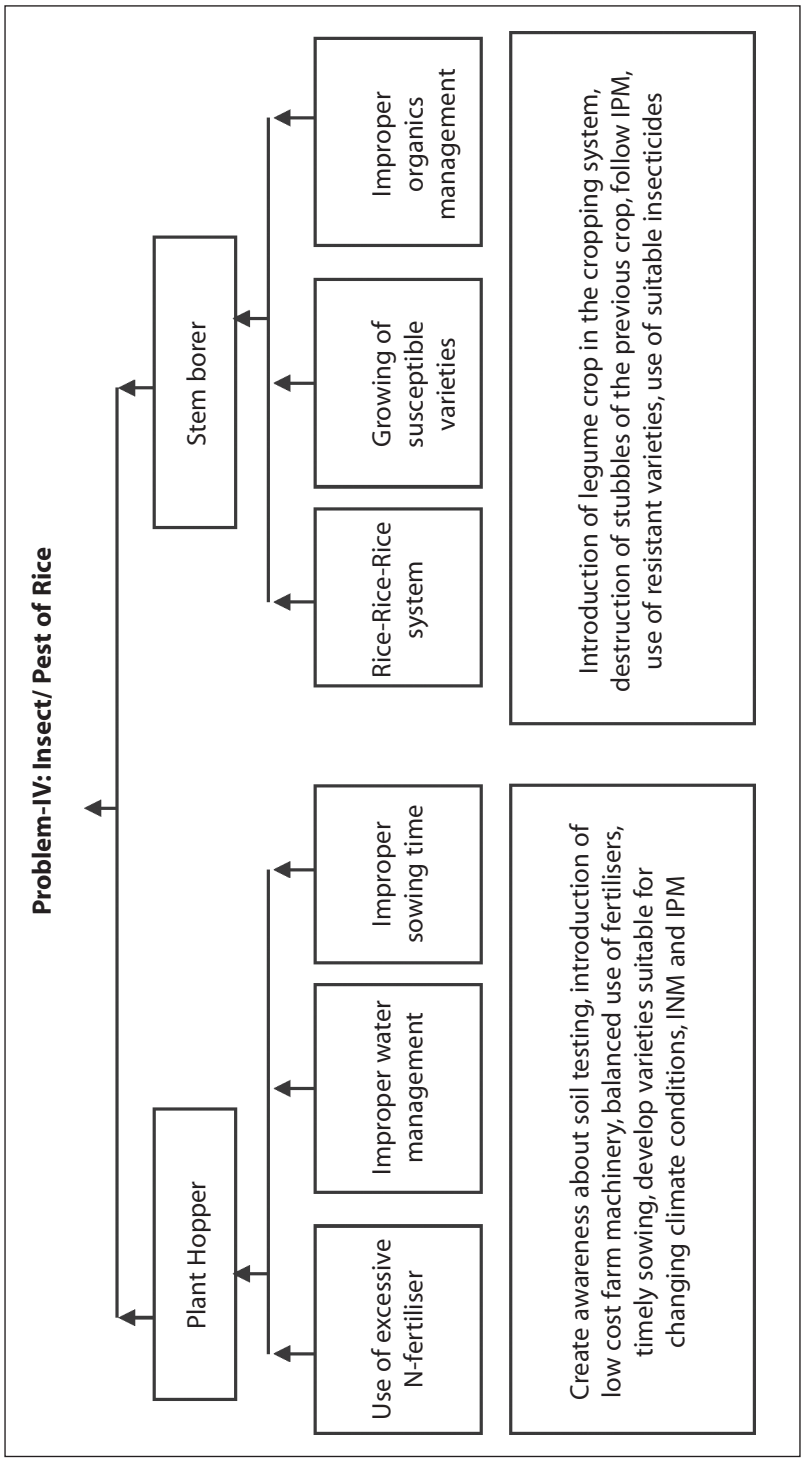

Fig. 5 : Problem-Solution Tree for Insects/Pests of Rice, Problem (normal font); Solution (in italics)

Apart from this, construction of farm ponds, percolation ponds, and check dams is being suggested to conserve water and for recharging wells. Wild boar problem was rampant in all the villages under study which they were avoiding using nets beside their agricultural plots.

Major policy related areas identified in the villages are as follows:

1. Awareness about rain water management system and proper use of water in agricultural operations was an important intervention which needs to be addressed in the study area. Use of drip irrigation, sprinklers, mulching technologies, etc., have to be demonstrated to the farmers. As the area come under dryland and water deficit is a prominent feature of the region, water saving and efficient practices will lead to agricultural sustainability of the study area.

2. Farmers are still using the old varieties of rice. There is need to create awareness among farmers about the drought and pest resistant varieties for the area, its availability and agronomic practices for improved profitability of the farmers.

3. Farmers need to be made aware of the Integrated Pest Management (IPM) technologies and proper knowledge need to be developed as and when required.

4. Soil testing and recommended use of fertilisers will make the area free from soil salinity and other micro-nutrient deficiencies.

5. Awareness needs to be created about the benefits of integrated farming system which has the potential of increasing profitability, improved nutrient management, drought tolerance capacity by the use of livestock, etc.

Major researchable areas identified in the villages are as follows:

1. Improved health management of the farmers in the area can be addressed by using community nutrient garden concept for localised availability of all the nutrients and less dependency on the outside resources.

2. As severe drought is quite common in the region, drought tolerant varieties need to be developed for all popular crops with respect to specific agro-climatic conditions of the area. Assessment of water footprint of the villages is necessary for proper planning, development and efficient utilisation in different systems.

3. There is need to study wild boar menace by multi-disciplinary research team to control the problem in a biological and cost-effective means.

4. In the climate change era, there is need for area-specific crop-weather forecasting intervention through modeling for crop yield forecasting as well as weather based crop insurance and index based livestock insurance to reduce the risk of farmers.

5. Soil testing needs to be customised to farmer's field basis rather than area basis to suggest individual use of fertiliser and micro-nutrients.

Conclusion

The PRA tool in the present study enabled the researchers to understand the cropping profile, resources available, identify location-specific problems and researchable issues and ultimately to come up with tangible possible solutions drawn as an action plan in Zamistapur, Chowdarpally, Telugu Gudem and Kodur Thanda villages of Mahabubnagar district, Telangana State. Agro-ecosystem analysis helps in planning and prioritising research and development activities in agriculture and natural resource management through inter-disciplinary interaction. The major constraints identified were underground water depletion, soil fertility degradation, soil salinity, demanding of high wages by agricultural labourers, high cost of fertilisers and agro-chemicals, labour shortage during harvesting period, pest and diseases problems, fluctuating market price, drinking water problem, severe drought, malnutrition, etc. Water scarcity was categorised as the biggest problem affecting the villages which need to be addressed by rain water harvesting for groundwater recharging as well as irrigation purposes and less exploitation of groundwater which need to be preserved for drinking purpose only. Soil salinity was the main reason for chemical drought which can be tackled by crop rotation, inter-cropping and use of conservation agriculture for soil reclamation. Frequent drought need to be addressed by installation of rainwater harvesting structures, use of contingency planning measures, soil cover, mulching. Suitable agronomic practices depending on agro-climatic conditions of the village will be the viable option to the insect/pest management. Thus, policy briefs related areas identified included awareness about rain water management, use of drought and pest resistant varieties for the area, Integrated Pest Management (IPM) technologies, soil testing and recommended use of fertilisers and awareness about the benefits of integrated farming system. Major researchable areas identified in the villages were development of community nutrient garden, drought tolerant varieties, multi-disciplinary research team to control the problem in a biological and cost-effective means, crop-weather forecasting intervention, etc. Thus, present PRA technique was able to address all the components of Agro-Eco-System Analysis (AESA) like farming system analysis, sociology issues, economics, and politics like agro-ecosystem based strategies by involving farmers for betterment of region and nation overall.

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