Participatory Rural Appraisal: A Holistic Approach for Getting Insight into an Agro-ecosystem Analysis

T. Rajula Shanthy[1], Monika Singh[2], Nisha Sahu[3], Surekha[4], M. Balaji Rajkumar[5], S. GopalaSundara Raj[6], Kalyan De[7] and S. Ramachandran[8]

1. Principal Scientist and Head, Extension Section, 2 to 8. Scientist (Trainees) on FET, Sugarcane Breeding Institute, Coimbatore, Tamil Nadu (India)

Corresponding author e-mail: rajula.sbi@gmail.com

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 Pullagoundanpudur village of Coimbatore district, Tamil Nadu state. 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 major constraints identified were market price fluctuation, water scarcity/ground water availability at high depth, erratic electricity supply, non-availability of labourers for agricultural activities, rhizome rot of turmeric, wilt in chilli and tomato, banana lodging and uneven maturity. Based on the problems identified, suitable solutions were arrived in consultation with subject matter experts and progressive farmers.

Key words: *Participatory rural appraisal; Participatory approach; Agro-ecosystem analysis;*

The new millennium poses challenges in Indian agricultural sector that are quite different from those faced in the previous decades. The enormous pressure to produce more and more food from less land with shrinking natural resources is a tough task for the farmers as well as agricultural research scientists. To scale up the momentum of growth, a careful analysis into the agro-ecological situation and economic evaluation of inputs like seeds, fertilizers, irrigation sources etc. are of considerable importance.In this context, Participatory Rural Appraisal (PRA) is an important 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 realization that earlier approaches to on farm research recognized 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 programs. 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 the field Experience Training of the trainee Scientists at Sugarcane Breeding Institute, Coimbatore during 2012 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 prioritized problems for the upliftment of farmers

METHODOLOGY

The study was conducted at Pullagoundanpudur village; it is a small village under the administrative control of the revenue village Devarayapuram of Thondamuthur block in Coimbatore district of Tamil Nadu state with a population of 680 with 262 households. The major occupation in this village is agriculture and 60 per cent of the farmers have a land holding ranging from 5-10 acres. Major crops are turmeric, banana, onion, cauliflower, okra, chilly, maize, sugarcane and coconut. 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, Assistant Director of Horticulture, concerned Agricultural Officers, Cane Development Manager and the Assistant Veterinary Surgeon were consulted before selecting the block. Reconnaissance survey was conducted for selecting the village with the assistance of the local development officers of the block. Several informal meetings were organized in the village 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 walksin the cross section of the village 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 datawere 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 of turmeric and onion 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 village Pullagoundanpudurwere listed and Rank Based Quotient (RBQ) of the problems was calculated based on the ranking done by 20 farmers of the village. Rank Based Quotient was calculated using following formula as given by *Sabarathnam (1988):*

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

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 : Pullagoundanpudur is located at the latitude between 10°59’30” and 11°01’02’’ N and longitude between 76°48’00’’ and 76°48’44’’E. Table 1 detailsthe features identifiedduring the transect walk. On an average, the area receives 716 mm of rainfall in a year with major share from North-East Monsoon. The mean annual maximum temperature is 34.4°C and the mean annual minimum temperature is 18.6°C. The relative humidity varies from 72 - 83%.

The land is sloping towards south with northern side having higher elevation (1600-1680 ft) compared to southern side (1540-1590 ft). The upland part is bordered by mountains and reserve forest in the northern side and has a perfect setting of a rain shadow region of the Western Ghats. Major source of irrigation in the village is bore well and open well. Drip irrigation is widely adopted to save water. The village has red soil and black soil with sandy clay loam texture suited for growing a wide range of crops.

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.

Intensive agriculture is followed in this village. Important crops grown are turmeric, banana, onion,

Table 1. General transect analysis of Pullagoundanpudur village

Particulars	Upland	Lowland
Altitude	1600-1680 ft	1540-1590 ft
Soil Type	Red Soil	Black Soil
Land Use	Farm land	Farm land and Habitat
Major Crops	Okra, Cauliflower, Tomato, Chilli, Maize, Turmeric, Onion, Banana	Banana, Turmeric, Onion, Sugarcane, Coconut
Trees	Mango, Acacia, Neem, Tamarind, Pungam, Prosopis	Tamarind, Neem, Mango, Sacred fig, Silk cotton
Weeds	*Parthenium, Lantana camara , Argemonemexicana*, Nut grass, Bermuda grass	*Parthenium, Tridoxprocumbens, Trianthemaportulacastrum*
Cropping pattern	Turmeric - Maize Bhendi - Onion Cauliflower – Onion – Maize Intercropping: Turmeric + Onion, Turmeric + Chilli, Turmeric + Bhendi Coconut + Banana Banana + Lab lab	Turmeric - Banana Intercropping: Turmeric + Onion Banana + Onion
Water Resources	Bore Well, Open Well	Bore Well, Open Well
Pests	Chilli: Aphids, Mites Turmeric: Thrips, Shoot borer Onion: Thrips Maize : Stem borer Bhendi : Fruit borer, Whitefly Cauliflower : Diamond back moth	Turmeric: Thrips, Shoot borer Onion: Thrips
Diseases	Turmeric: Rhizome rot Onion: Wilt Banana: Panama wilt Bhendi : Powdery mildew Chilli : Anthracnose	Turmeric: Rhizome rot Onion: Wilt Banana: Panama wilt
Technologies	Electric fencing Drip irrigation and Fertigation Turmeric steam boiler Turmeric Polisher - Trolley Attached Soil testing	Drip irrigation and Fertigation Turmeric steam boiler Turmeric Polisher - Trolley Attached Soil testing
Problems	Elephant and wild pig menace Underground water depletion	Soil fertility degradation Lodging of banana
	Demanding of high wages by agricultural labours High cost of fertilizers 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)	Crop diversification, Inter-cultivation of green manure crops like sunhemp
	Mechanization of operations like turmeric harvesting, boiling and drying Setting up of turmeric processing unit (Cooperative/ Private) Creating awareness regarding tissue culture banana Integrated Pest and Disease Management Promoting use of biofertilizers	

cauliflower, okra, chilli, maize, and coconut. Tomato is the major crop in the kharif season. In rabi season, maize, chilli, onion, bhendi are grown. The summer season crops are cauliflower and bhendi. Fruit crops like mango, guava, papaya, custard apple, and drumstick are grown in the backyard. The major tree crops are tamarind, neem, *Acacia* and silk cotton. *Parthenium,Argemone mexicana*, nut grass, bermuda grass, *Lantana camara, Tridox procumbens, Trianthema portulacastrum* are the common weeds found 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 analyze 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 analyze the existing social scenario of the village.

Caste and settlement: Majority of people in this village belong to OBC (84%) followed by Adidravidar communities (16%). It was interesting to note that the households belonging to different castes/categories were scattered in the village, but followed a specific pattern. Ring settlement was seen with houses at the entry and farms attached. The existence of social stratification based up on caste and community was noticed.

Leadership pattern and other social information: Leadership pattern was not observed in this village because it was predominated by samecommunity 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 *Kaliamman kovil* festival and other local festivals.

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

Time trend of turmeric and onion : It is a simple PRA technique, usually depicted in the form of graph (bar/ line) to show the trend of crop/animal production, commodity prices, human/cattle population etc. Trend analysis indicated a gradual decrease during the last 5 years, *i.e.*, from 2008 to 2012. In turmeric, this is mainly due to the shift in adoption of local variety Erode, which they use to grow earlier to the presently grown local variety Salem, because of preference in local market and traders. Price trend analysis indicated the gradual decrease in price of turmeric from Rs 18000/q during 2011 to Rs 3000/q in 2012 and in onion from Rs 25/kg during 2009-10 to Rs. 4/kg during 2012. This is mainly due to the increase in area under both these crops thereby increased production than the local market demand leading to glut in market.

Seasonal calendar and analysis: Seasonal calendar indicates monthwise information about all the aspects related to cultivation of crops and livestock rearing. In this village most of the farmers are well educated and hence with the assistance from TNAU and State Department of Horticulture / Agriculture they get technical guidance and follow year round cropping system. The animal husbandry enterprise includes piggery, dairy, goat rearing, emu farms 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 turmeric, thrips, leafblotch, and rhizome rot are the major threats faced by the farmers.In banana there was incidence of leaf spot, fusarium and panama wilt; In onion,thrips and flies were common;In maize, stem borer was prevalent, and inseasonal vegetables (bhendi, chilli, tomato) sucking pests like thrips and whitefliesare the common pests.

Gender disaggregated activities : Women in this village contribute mainly to agriculture, home management and livestock management. They do weeding, sowing/planting, harvesting and apply fertilizers 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, polishing of turmeric 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 kind of household work along with agricultural activities.

Timeline : Time line 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. Time line of major events in Pullagoundenpudur village 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, hand-pump, drinking water supply system, direct to home (DTH), high school etc.

From the time line 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 mechanization and used to rear local breeds of cattle. There is a gradual increase in use of communication technologies like use of landline (in 1996), mobiles (in 2006) to use of internet and broadband (in 2012).

Matrix ranking : Matrix ranking technique is appliedto 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 turmeric over the years, but recently they are using Salem, Erode and Orissa varieties. Among these three varieties, Salem variety is most preferred because of high price and curcumin content (Table 2).Erode variety gives the highest yield and Orissa variety has bigger rhizomes and hence, handling is easy. Among the two varieties of banana, *i.e.,Kadhali* and *Karpuravalli*, the farmers of this village prefer mostly *kadhali* variety because of its resistance to lodging and have high market demand from other states. Regarding sugarcane, they prefer Co 86032

Table 2. Matrix ranking for turmeric

Indicator	KI	Varieties					
		Salem		Erode		Orissa	
		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*
Rhizome size	KI-1	B	2	C	1	A	3
	KI-2	A	3	C	1	B	2
	KI-3	B	2	C	1	A	3
Sub-total			*7*		*3*		*8*
Curcumin content	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*
Handling of rhizome	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*
Monetary value	KI-1	A	3	C	1	B	2
	KI-2	A	3	B	2	C	1
	KI-3	A	3	C	1	B	2
Sub-total			*9*		*4*		*5*
Grand total			38		24		28

(KI – Key Informants)

Table 3. Matrix ranking for sugarcane

Indicator		KI Varieties					
		CoC 671		CoSi 95077		Co 86032	
		Rank	Score	Rank	Score	Rank	Score
Sugar content	KI-1	C	1	B	2	A	3
	KI-2	C	1	B	2	A	3
	KI-3	C	1	A	3	B	2
Sub-total			3		7		8
Drought tolerance	KI-1	B	2	C	1	A	3
	KI-2	B	2	C	1	A	3
	KI-3	C	1	B	2	A	3
Sub-total			5		4		9
Cane weight	KI-1	C	1	B	2	A	3
	KI-2	C	1	B	2	A	3
	KI-3	C	1	A	3	B	2
Sub-total			3		7		8
Total			11		18		25

(KI – Key Informants)

Table 4. Matrix ranking for cow breeds

Indicator	KI	Cow Breeds					
		Holstein Freshien		Jersey		Kangyam*	
		Rank	Score	Rank	Score	Rank	Score
Milk Yield	KI-1	A	3	B	2	C	1
	KI-2	A	3	B	2	C	1
	KI-3	A	3	B	2	C	1
Sub-total			9		6		3
Milk Quality	KI-1	B	2	B	2	A	3
	KI-2	C	1	A	3	B	2
	KI-3	B	2	B	2	A	3
Sub-total			5		7		8
Early maturity	KI-1	A	3	B	2	C	1
	KI-2	B	2	A	3	C	1
	KI-3	A	3	B	2	C	1
Sub-total			8		7		3
Disease resistance	KI-1	B	2	B	2	A	3
	KI-2	C	1	B	2	A	3
	KI-3	B	2	B	2	A	3
Sub-total			5		6		9
Grand total			27		26		23

(KI – Key Informants) *Indigenous

variety over the other varieties (Table 3) as it has higher sugar content, more drought resistance and higher cane weight than CoC 671 and CoSi 95077.

Indigenous kangyam breed has disease resistance and produces better quality milk. But the farmers of Pullagoundenpudur village prefer Holstein-Freshien cross breed (Table 4) because of high milk production and early age of maturity, which gives them more income.

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 5). 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.

Table 5. Livelihood analysis of small, medium and large farmers (annual income & expenditure in Rs)

Items	Small	Medium	Large
Sources of Income			
Agriculture	125000	240000	1000000
Livestock	27000	27000	84000
Others	100000	-	-
Expenditure			
Agriculture	75000	107000	500000
Education	100000	130000	50000
Food	50000	72000	60000
Clothing	16000	15000	20000
Medical	20000	5000	8000
Vehicle	24000	28000	36000
Entertainment	1500	2000	1500
Tours & Travels	12000	3000	6000
Mobile	2400	2400	6000
Livestock	7000	8000	45000
Electricity	5000	6000	6000
Savings	-	-	200000

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 type of technology behaviour. This technique is used as feedback mechanisms which help 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 *kathali* variety of banana, Salem and Erode variety of turmeric, Co 86032 variety of sugarcane and Co 1 variety of onion. However, due to wilt problem they have discontinued *nendran* variety of banana and CoC 671 variety of sugarcane due to red rot. Seed treatment of vegetables, application of farm yard manure, the popular sugarcane variety Co86032 and drip fertigation are 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 this village are using

Table 6. Rank Based Quotient of the major problems identified in the village

Problems	1	2	3	4	5	6	7	RBQ	Rank
Water scarcity / ground water available at high depth	13	6	1	-	-	-	-	93.3	2
Non availability of labour for agricultural activities	2	10	8	-	-	-	-	40.7	4
Discontinuous electricity and quality power supply	4	3	4	9	-	-	-	68.3	3
Rhizome rot of turmeric	-	-	1	3	16	-	-	37.49	5
Chilli and Tomato wilt	-	-	-	-	2	15	3	18.33	6
Market price fluctuation (turmeric, onion)	18	2	-	-	-	-	-	98.33	1
Banana lodging and uneven maturity	-	-	-	-	-	2	18	16.66	7

precision farming, drip irrigation and cross breeding. These technologies have both positive and negative effects which are analyzed using consequence diagram. Consequence analysis of drip irrigationindicated 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 the crop yield. Cross breeding was mostly practiced by the villagers as they get high milk yield which in turn provide high income. The major drawback was increased disease incidence.

Rank based quotient and problem-solution tree : In spite of being a progressive village, there are some problems such as market price fluctuation, water scarcity/ground water availability at high depth, interrupted power supply, non-availability of labourers for agricultural activities, rhizome rot of turmeric, chilli and tomato wilt, banana lodging and uneven maturity affecting agriculture productivity and profit.

Based on RBQ (Table 6), the three major problems identified were market price fluctuation, water scarcity/ ground water availability at high depth and discontinuous electricity and quality power supply. The possible solution for three major problems is given in problem solution trees (Fig. 1-3). The price fluctuation in turmeric is a

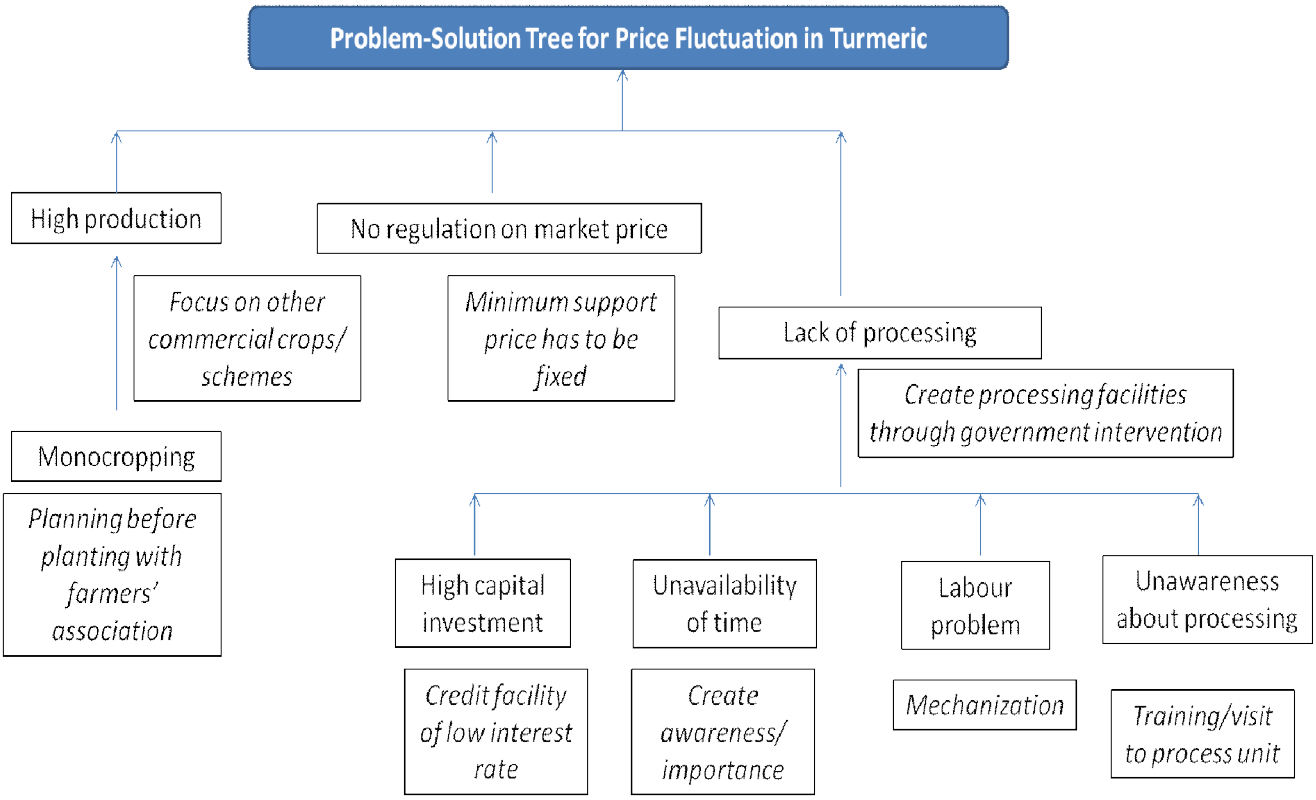

Fig. 1. Problem solution tree for price fluctuation in turmeric Problem (normal font); Solution (in italics)

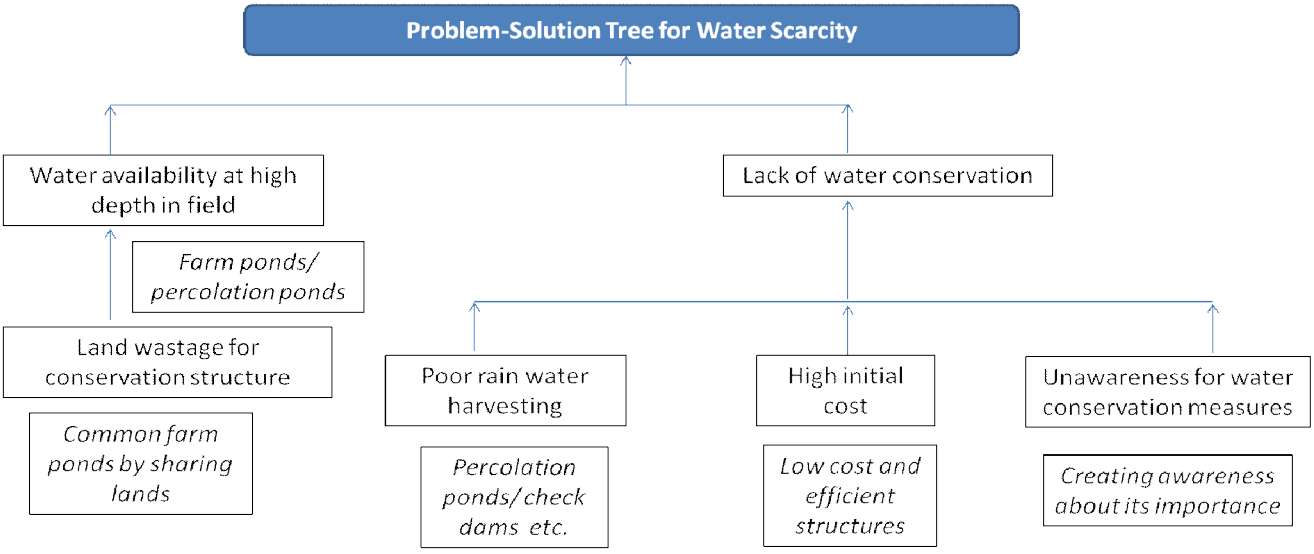

Fig. 2. Problem solution tree for water scarcity Problem (normal font); Solution (in italics)

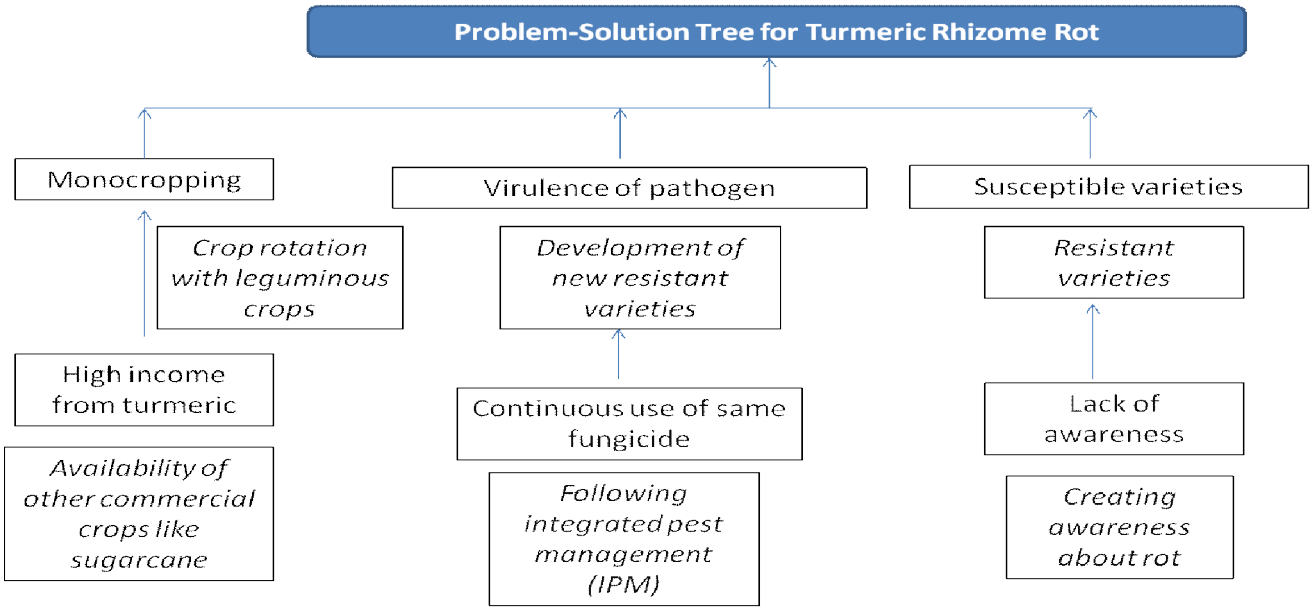

Fig. 3. Problem solution tree for turmeric rhizome rot Problem (normal font); Solution (in italics)

major problem which can be overcome to a certain extent by setting upsmall-scale turmeric and vegetables processing facilities and value addition unit by farmer cooperatives; and following multiple cropping patterns so as to draw profit from other crops also. Water scarcity is another problem which is due to the unavailability of ground water or poor rain water harvesting. Construction of farm ponds, percolation ponds, and check dams is being suggested to conserve water. Rhizome rot is the major disease affecting yield and productivity of the turmeric. This can be reduced by integrated pest management, crop rotation and use of resistant varieties.

CONCLUSION

The social scenario as evidenced through the rural appraisal techniques in this village calls for improvement in many sectors. Development needs to be done in many aspects, especially in providing amenities for health care,lavatory facilities, veterinary aids etc. There is no primary health centre in the village and people are not even aware about proper health care. The lack of a veterinary dispensary is also a major drawback. Problems like infertility among cattle need to be addressed with due priority. 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 both *in situ* and *ex situ* conservation practices, trials on different cropping patterns/systems including sugarcane as main crop and short duration pulse and other vegetables so as to break the mono cropping of turmeric and banana, characterization and mapping of rhizome rot resistance gene in turmeric, micro propagation of turmeric and banana for mass scale production of biotic/ abiotic resistant varieties, integrated pest management for turmeric, onion and chillies under drip irrigated condition. Moreover, suitable extension programs may be formulated and implemented witha problem solving approach considering the local resources and skill available within the farming community.

Paper received on : March 01, 2013
Accepted on : March 23, 2013

REFERENCES

Chambers, R., P. Arnold and L.A. Thrupp. (1989). Farmer – first innovation and agricultural technology (eds). Intermediate Technology Publications, London.

Jones Carolyn. (1995). PRA Training Handouts. Edinburgh University, UK.

Kar, G., G.P. Reddy and K. Kannan (2002). PRA for natural resources management and research prioritization to improve productivity of rainfed upland ecosystem. *J. of Ext. Edu.*, **12** (4) : 3241-3248

Mathialagan, P. (2000). Problems of poultry farmers as perceived by the farmers, extension personnel and technology development in Tamil Nadu. *Indian J. of Animal Research.* **34** (10) : 52-55.

Rajula Shanthy,T., R. Thiagarajan, J. Vasantha Kumar and Santha Ravichandran. (2004). Participatory Rural Appraisal for improving sugarcane productivity. *J. of Ext. Edu.*, **15** (2&3) : 3639 – 3644.

Rajula Shanthy,T. and R. Thiagarajan. (2008). Participatory rural appraisal in sugarcane based agro-ecosystem analysis. *Indian J. of Ext. Edu.*,**1** (1) : 97-101.

Sabarathnam, V.E. (1988). Manual of Field Experience Training for ARS Scientists, NAARM, Hyderabad.

• • • • •