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Participatory problem prioritization for agriculture development in a semi-arid tropical region of south India

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Abstract
India is a developing country and its roots are strengthened by agriculture as India is a dominantly agrarian country. The economic development of the country largely depends upon the development of agriculture sector. 70 percent of rural population in India belongs to the farming community. But the agriculture in the rural poor faces numbers of problems, biotic, abiotic or policy related in origin. To address the problem of the rural agriculture sector is the key to development in true sense. Hence the study was an attempt to identify and prioritize the problems by means of Participatory Rural Appraisal (PRA) in a village named Managundi in South India. Snowball sampling was used to identify the 30 Respondent Farmers (RFs) who represent the different categories of farmers in the village through three Key Informants (KIs). The problem ranking was done by RFs and KIs. Rank Based Quotient (RBQ) was calculated based on the ranking. It was found that water scarcity was the most prior problem in the study area based on economic terms, using value-based index (VBI) derived through RBQ. Also, a perfect spearman's rank correlation between VBI based ranking given by the RFs and KIs showed the importance of snowball sampling in village problem identification. And subsequently the solutions were suggested based on the physiography and availability of resources in the village.

Keywords: Participatory problem prioritization, ranking quotient, key informants, snow ball sampling, Value based index

Introduction
The economy of India largely depends upon its agriculture and allied sector as it is the largest source of livelihood in the country. 70 percent of rural households in India depend primarily on agriculture to earn a living, among them 82 percent of farmers are small and marginal (Anonymous). The agriculture and allied sectors shared 16.5% to the Gross Value Added (GVA) of the country, which is lesser than that in the year 2014-15 (18.2%). This might have resulted due to relatively higher growth performance of non-agricultural sectors owing to structural changes taking place in the economy (Anonymous, 2020). This is indeed necessary for a developing country that few members of a farming family should be diverted towards earning income from non-agricultural sector and this idea is also one among the various ideas behind achieving Government of India's target of doubling farmers' income by 2022. But this also includes simultaneous development of agricultural sector so as to increase per capita production. While, the Government of India's target of doubling farmers' income by 2022 focuses on income support schemes, crop insurance, water conservation, waste management techniques and agricultural marketing reforms, many of the rural poor are still untouched of all these schemes and benefits due to the over bursting population and majority of residence in villages. But the development in true sense means rural development in case of India, which can only be addressed by solving the agricultural problems at village level. To address the agricultural problems at grass root level, the participatory rural appraisal method has been proved to be very much fruitful (Ghimire, 2009) [9]. With this background, the present study was conducted in Managundi village of Karnataka in south India.

Managundi village is situated between 15°21'52.55"N to 15°23'26.41"N latitude and 74°58'24.62"E to 74°58'33.53"E longitude in Dharwad district of Karnataka and belongs to hot semi-arid ecoregion having annual rainfall of 600 to 1000 mm with an undulating topography, surrounded by low altitudinal hills. The village has a total population of around 3300 with 830 farm families. The village economy is agrarian and also a significant population of youth is involved in working as daily wagers in brick manufacturing units. In the present scenario, as per the elderly population of village, the youth is more attracted towards earning by daily

wages and getting detached from agriculture due to prevailing problems and related losses leading to low income.

Keeping this in view the status of agriculture development, an attempt was made to do the identification and prioritization of problems related to agriculture sector by participatory rural appraisal (PRA) method and statistical methods.

Material and Methods

The problem identification technique was used to identify and prioritize the problems prevailing in agricultural sector in the village. For selection of respondents or more literally, the selection of samples for collecting information was done by snowball sampling technique (Goodman, 1961) [3]. Hence, first three key informants were selected from three different backgrounds, who were leading in the village in each sector i.e., a progressive dairy farmer, a progressive crop farmer, and an agriculture field worker (Government employee) who can represent each sector. First, they were asked for the major problems related to agriculture sector. After that they were asked to nominate another 30 farmers representing all sections of the village. From the three key informants, major problems in different crops/ animal husbandry sectors were selected. Other 30 farmers were individually asked to rank the problems based upon the severity and percentage of loss they are personally facing by the problem. Since selected farmers represented all the sectors varying from small to large farmers, ranking pattern were also diverse. The information about the extent of damage (per acreage) to affected crops due to particular problem in the village was obtained by the farmers.

Problem prioritization was done by using rankings given by the key informants and respondent farmers. These ranks along with the monetary loss percentage caused by a particular problem, were used to calculate two parameters Rank Based Quotient (Sabarathanam, 1988) [5] and Value Based Index to finally arrive at the problem prioritization. The average monetary losses for the village were calculated for each problem based on the selling cost of the particular crop per unit. Frequencies of each rank for a problem were calculated and tabulated in rank frequency table. The rank frequency table indicates the number of persons giving a particular rank to a particular problem. The percentage monetary loss due to the problem *viz*. "water scarcity" was calculated using the information by farmers that whenever there is a seasonal drought, any crop faces around 50% of loss. Hence without taking monetary numbers, directly 50% was taken in to consideration. Rank Based Quotient (RBQ) was then calculated using following formulae.

Rank Based Quotient

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

Where

i = Concerned ranks (1 to 9)

N = Total numbers of farmers (30)

n = Numbers of rank

f_i = Frequency (Number of farmers reporting that particular problem)

Value based index is the parameter for prioritizing the prevailing problems on the basis of economic loss witnessed due to a particular problem or the monetary value of a problem. It is calculated as:

VBI = RBQ x Total economic loss percentage per annum experienced due to the problem at village level.

While calculating total economic loss percentage, average loss percentage per annum of both main and bi-products are multiplied with standard price. The problem that has the highest VBI is the most important problem to be tackled as it is causing highest economic loss to maximum number of farmers. The VBI calculated for each problem has been mentioned in table no. and the problems prioritized based on the VBI has been shown in table. Spearman's rank correlation (Spearman, 1904) between the ranks given by KI(s) and respondent farmers, based on RBQ and VBI were determined. This was done to establish the importance of choosing the key informants wisely which will lead to a concrete problem prioritization. Because in the snowball technique of sampling, the selection of higher number of respondents solely relies on the lesser population which nominates them.

Result and Discussion

Problems identified in the village

Based on the information of key informants and respondent farmers, 9 major problems were identified in the village which is depicted in Table 1. The problems were of researchable, extension and development type. The division of problems in to these types are based on the type of input that is required to address a particular problem. For example, the problem of water scarcity needs some research to be done that what kind of storage structure and what kind of irrigation will be required for the crops and based on that, the structures will be developed. Hence it is categorized as researchable and development problem. Similarly, the other problems were classified.

Table 1: Problems identified in the village

S. No.	Problems	Type
1	Water scarcity for all crops due to uneven distribution of rain	Researchable and development
2	Yield loss in Soybean due to pest and diseases (Yellow Mosaic virus)	Extension
3	Yield reduction in Maize due to improper nutrient management and pest and diseases (downy mildew, stem borer)	Researchable And extension
4	Blast of paddy	Extension
5	Wild boar menace and pest and diseases of Sugarcane (early shoot borer, grassy shoot, red rot)	Extension and Development
6	Sucking pests in Cotton (Thrips, Aphids)	Extension
7	Shoot borer of Jowar	Extension
8	Terminal drought and pod borer of Chickpea	Extension
9	Mastitis in cattle	Researchable

Problem prioritization

Problem prioritization is important in order to make decisions regarding, which problems are needed to be addressed first while undertaking an agricultural development planning. The

problem ranking was done by both the respondent 30 farmers (Table 2) as well as the key informants (Table 3). Based on the rankings, the RBQ were calculated separately for both RF and KI (Table 4). The ranking based on RBQ was different in both the cases, which is depicted in table 5. Based on RBQ, the ranks up to number 4 was same for both RF and KI. Afterwards there was a little disagreement in rankings was observed, which may be due to the diverse group of farmers in RF category.

Table 2: Problem ranking by respondent farmers

S. No.	Problems	Ranks									
		1	2	3	4	5	6	7	8	9	Total
1	Water scarcity for all crops due to uneven distribution of rain	15	5	8	-	2	-	-	-	-	30
2	Mastitis in cattle	10	8	-	9	3	-	-	-	-	30
3	Yield reduction in Maize due to improper nutrient management and pest and diseases	3	12	-	-	7	3	5	-	-	30
4	Wild boar menace and pest and diseases of Sugarcane	-	-	13	7	5	-	-	-	5	30
5	Shoot borer of Jowar	2	3	-	10	6	-	5	4	-	30
6	Blast of Paddy	-	2	9	4	7	2	-	6	-	30
7	Sucking pests in Cotton	-	-	-	-	-	10	7	11	2	30
8	Terminal drought and pod borer of Chickpea	-	0	-	-	-	5	11	9	5	30
9	Yield loss in Soybean due to pest and diseases	-	-	-	-	-	10	2	-	18	30
		30	30	30	30	30	30	30	30	30	

Table 3: Problem ranking by Key Informants (KI)

S. No.	Problems	KI 1	KI 2	KI 3
1	Water scarcity for all crops due to uneven distribution of rain	1	2	1
2	Mastitis in cattle	4	1	2
3	Yield reduction in Maize due to improper nutrient management and pest and diseases	2	3	3
4	Wild boar menace and pest and diseases of Sugarcane	3	4	4
5	Shoot borer of Jowar	5	5	6
6	Blast of Paddy	7	7	5
7	Sucking pests in Cotton	6	8	7
8	Terminal drought and pod borer of Chickpea	8	6	8
9	Yield loss in Soybean due to pest and diseases	9	9	9

To calculate the VBI, first the economic loss percentage was carried out for each problem (Table 3). The data collected from farmers were used to calculate the economic loss percentage. While calculating total economic loss percentage, average loss percentage per annum of both main and by products is multiplied with standard price.

Table 4: Calculation of economic loss (%) from data collected by Farmers

Problem	Yield loss & Economic loss	Total yield and income without problem	Economic loss % per annum
Water scarcity for all crops due to uneven distribution of rain	Around 50% of yield is lost in all crops in the *kharif* season due to seasonal drought. If there is a good rain in a particular year, there is no yield loss related to drought.		50%
Yield loss in Soybean due to pest and diseases	1.5 q/ha Selling price =Rs 3600/q Loss = Rs 5400/ac	12 q /ha, Income =3600 × 12=Rs. 43,200/ac	Economic loss per annum / total income per annum without problem x 100 Rs .5400 /43,200 x 100 = 12.5%
Yield reduction in Maize due to improper nutrient management and pest and diseases	7q/ha. Selling price =Rs 1300/q Loss = Rs 9100/ha	20 q /ha, Income = 1300 × 20= Rs. 26,000/ha	Economic loss per annum / total income per annum without problem x 100 Rs .9100 /26,000 x 100 = 35%
Blast of Paddy	5q/ha. Selling price =Rs 1550/q Loss = Rs 7750/ha	20 q /ha, Income =1550 × 20= Rs. 31,000/ha	Economic loss per annum / total income per annum without problem x 100 Rs .7750 /31,000 x 100 = 25%
Wild boar menaces and pest and diseases of Sugarcane	10 t/ha. Selling price = Rs .2500/t Loss = Rs. 25000/ha	30 t/ha, Income = 2500 × 30= Rs. 75,000/ha	Economic loss per annum / total income per annum without problem x 100 Rs.25000/75,000 x 100 = 33.3%
Shoot borer of Jowar	4 q/ha Selling price = Rs .4000/q Loss = Rs. 16000/ha	12 q/ha Income = 4000 × 12= Rs. 48,000/ha	Economic loss per annum / total income per annum without problem x 100 Rs.16000/48,000 x 100 = 33.3%
Sucking pests in Cotton	2 q/ha. Selling price =Rs 4600/q Loss = Rs 9200/ha	10 q /ha, Income = 4600 × 10= Rs. 46,000/ha	Economic loss per annum / total income per annum without problem x 100 Rs .9200 /46,000 x 100 = 20%
Yield reduction in Terminal drought and pod borer of Chickpea	1q/ha. Selling price =Rs 4300/q Loss = Rs 4300/ha	7 q /ha, Income = 4300 × 7= Rs. 30,100/ha	Economic loss per annum / total income per annum without problem x 100 Rs.4300 /30,100 x 100 =14.28%
Mastitis in cattle	3 L/day Selling price =Rs 27/L Loss = Rs 81/day	6 l /day, Income = 27 × 6 = Rs. 162/day	Economic loss per annum / total income per annum without problem x 100 Rs .81/162x 100 = 50%

The highest percentage economic loss (50%) was reported in water scarcity and mastitis of cattle. The reasons behind this are discussed later in the genesis and solution section. Afterwards, the VBI were calculated as described in the methodology section, separately for both RF and KI.

Table 5: RBQ and VBI calculated for KIs and RFs

S. No.	Problems	Average economic loss per annum (%) due to the problem	RBQ (KI)	Rank	RBQ (RF)	Rank	VBI (KI)	Rank	VBI (RF)	Rank
1	Water scarcity for all crops due to uneven distribution of rain	50	96.29	1	89.25	1	4814.81	1	4462.50	1
2	Mastitis in cattle	50	85.18	2	82.59	2	4259.25	2	4129.50	2
3	Yield reduction in Maize due to improper nutrient management and pest and diseases	35	81.48	3	68.51	3	2851.85	3	2397.85	3
4	Wild boar menace and pest and diseases of Sugarcane	33.3	70.37	4	60.37	4	2343.33	4	2010.30	4
5	Shoot borer of Jowar	33.3	51.85	5	57.50	6	1726.66	5	1914.75	5
6	Blast of Paddy	25	40.74	6	58.51	5	1018.51	6	1462.75	6
7	Sucking pests in Cotton	20	33.33	8	31.48	7	666.66	7	629.60	7
8	Terminal drought and pod borer of Chickpea	14.28	37.03	7	28.14	8	528.88	8	401.83	8
9	Yield loss in Soybean due to pest and diseases	12.5	11.11	9	23.7	9	138.88	9	296.25	9

Importance of key informants in snowball sampling

The spearman's rank correlation was determined between the ranks given by the KIs and the villagers based on both RBQ and VBI. The ranks based on RBQ showed a correlation coefficient of +0.95 whereas the VBI based ranks were perfectly correlated with coefficient of +1. This shows that there is a significant role of the KI(s)'s opinion in identifying the village problem. Similar results were reported by Suchiang *et al.* (2017) [7] in constraint analysis of rearing Niang Megha pigs by the tribal farmers of Meghalaya. Hence the selection of KIs should be done carefully. Like in any field experiment, when we draw representative samples carefully to get best inference, similarly, the selection of key informants is most important in a village problem identification.

Importance of prioritization based on economic terms

The perfect positive correlation between ranks given by KI and respondents also signifies that prioritization based on economic terms is more appropriate. Hence, the VBI based ranking was finalized for prioritizing the problems. As the VBI based ranks by both KI and RF were exactly same, there was no need to do average of both VBI. Otherwise it is recommended that the average VBI of both the KI(s) and RF should be taken for finalization.

Genesis and Solution of problems

Here, we have discussed the problem and solution for the first four prior problems which cause the maximum loss. As, the action plans were given in the village based on these major four problems.

Water scarcity for all crops due to uneven distribution of rain

In Managundi village there is uneven distribution of rainfall. For last three to four years the villagers are facing the problem of drought due to scarce rain. The agricultural crops in *kharif*, *viz*., Soybean, Cotton, Maize, and Rice are grown rainfed in the village. So, whenever there is a scarce rain, the crop loss is around 50%. The main reasons for this are drying of the existing storage structures due to erratic rainfall. This problem can be solved by interventions such as, proper weather forecasting and contingent crop planning for farmers. Also, another problem is the unavailability of water to the crops at peak period of their growth. The origin of this problem comes from lack of rain water harvesting structures in the hilly regions of the village. As the superfluous water of rain flows downward the hill mostly, so the hill slopes are best scope for interventions. Another problem is the lack of any ground water recharge techniques. Third reason is the farmers are not aware of water efficient technologies. Hence in solution, the construction of water harvesting structures, construction of ground water recharge structures, mulching and drought resistant variety introduction should be taken up.

Mastitis of cattle

In the village the major problem prevailing for cattle is mastitis. Mastitis leads to around 50% of reduction in milk yield and based on VBI it was found to be second most prior problem. The reasons found were the lack of hygiene leading to poor quality milk, improper milking method, lack of early diagnosis, antibiotic resistance and lack of proper treatment. The possible solutions are, using machine for milking, keeping the udder and hands clean, providing full course of medication to prevent development of antibiotic resistance, introduction of new range of antibiotics and proper mastitis test.

Yield reduction in Maize

The yield reduction in maize was found to be the third prior issue in the village. Maize is one of the most widely grown crops in the village. Every year, the farmers are facing yield loss in maize about 35% due to pest and diseases and also due to improper nutrient management. In pest and diseases, downy mildew is most prevalent and in pests, stem borer is most prevalent. To overcome these problems, the farmers should go for integrated pest and disease management rather than going for individual chemical treatments. The IPM and IDM starts with clean cultivation and sanitation, also includes seed treatment, using botanicals and baits like fishmeal bait. But the most serious problem in maize is nutrient management. The farmers in Managundi are exclusively practicing the monocropping in maize. As maize is a very much nutrient intensive crop, it should be taken in intercropping with legumes. Also, the farmers are not focusing on micronutrients like Zn and B, which are very much important for maize. Hence the best possible solution would be intercropping with legumes and also Integrated Nutrient Management.

Yield reduction in Sugarcane

Sugarcane is one of the major crops grown in village. Farmers face about 20% of yield loss every year due to many reasons. Most important reason is the wild boar attack. As the fields are adjacent to hilly forest areas, the wild boars often run into their fields destroying the standing crop. The small farmers tie cheap sarees around their fields to prevent it, but it is not economically feasible for farmers with large fields. There is no awareness among the farmers about the solar fencing. Also, the irrigation is not assured as there is no canals constructed in the village and the drips and bore wells are left unattended after the completion of period of government subsidy provision. Other causes of yield loss are red rot, early seedling borer and grassy shoot disease. The pest and diseases can be overcome by Integrated Pest and Disease Management. That includes, deep summer ploughing, earthing up, set treatment and releasing tricho-cards (cards containing eggs of *Trichogramma chilonis*). To overcome the wild boar menace, there is a requirement of government intervention. The farmers should be provided with subsidized solar fencing. Also, the focus on micro irrigation systems should be increased.

Conclusion

Agriculture being the most important source of income in the village, the development of agriculture sector is most crucial. Villages in the rural India are usually undertaken in an umbrella of programme being operated at state or central level but it is not a site specific treatment of problems. To address the problems, identification of problems at grass root level is need of the hour. Particiaptory problem appraisal enables the researcher to get a keen observation of real problems as the problems are reported by the villagers themselves. In this study, nine major problems were identified for Managundi village and prioritized with the help of the farmers themselves in an effective manner. The village being situated in a semi-arid region with scanty rainfall, the water scarcity was found to be the most prevalent problem causing 50 percent crop loss. Apart from water scarcity, mastitis of cattle, pest and diseases of maize, sugarcane, jowar, soyabean and related yield losses, wild boar invasion, lack of transport facility, lack of technology dissemination were found to be other major problems causing 12 to 50 percent of crop yield loss every year. After the identification and prioritization of problems, suitable measures to overcome the constraints have been suggested to the village administration. However, implementation was beyond the scope of the researchers. The study also establishes the importance of choosing key informants wisely and proper sampling is the key to a successful PRA study.

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