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Problem Tree Analysis for Farm Communities along Bicol River, Camarines Sur, Philippines

Ricky P. Laureta[1], Diomerl Edward B. Baldo[1,2]*, Kier P. Gasga[1]
Maria Petra O. Ebron[1], and Jessica Dione R. Nunag[1]

[1]Partido State University, San Juan Bautista St. Goa Camarines Sur 4422, Philippines
[2]Applied Biological Sciences Program, Chulabhorn Graduate Institute, 54 Kamphaeng Phet 6 Road, Lak Si, Bangkok 10210, Thailand

**Corresponding author's E-mail address: debbaldo@parsu.edu.ph*

Abstract— In the past decades, climate change has contributed an evident impact in agriculture. Understanding the current status of agricultural farmlands are pivotal in addressing agricultural adaptation in exposed areas. This paper aimed to survey insights into the dynamics of agriculture-based problems of farm communities along the Bicol River Basin, and to identify priorities needed for the improvement of farm productivity. Six barangays from initially identified vulnerable municipalities were assessed on their respective agricultural problems. Two barangays from each of the municipality in Baao, Canaman and Minalabac, were targeted as participating sites in the participatory rural appraisal. A problem tree analysis revealed that 67% of the sites' root cause was the absence of water source for efficient farming irrigation. Oppositely, 33% of the participating communities pinpointed the base problems to prolonged flooding that threatens the ideal farm yield. Other problems mentioned included unavailability of advanced farming technologies, low harvest rates due to climate shift, high cost of farming inputs such as fertilizers and labor, access to farm to market roads, low farm gate price of harvested products and lack of trees to aid in flood prevention. The study further revealed that either water scarcity or effects of rainfall intensities are the key problems faced by agricultural communities along climate-risk prone areas. Public investments on rehabilitation and maintenance of farming irrigation facilities must be given a greater degree of attention in these areas.

***Keywords*— Problem tree analysis, agricultural development, vulnerable communities, Bicol River Basin, climate change**

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INTRODUCTION

Philippines, as a country rich in natural resources is expected with high agricultural productivity. Over the years, agriculture becomes a major component in the country's gross domestic product (GDP). According to the report of Philippine Statistics Authority (2018), the production performance of the country's agricultural gross output recorded 3.96% expansion from 2017. Agriculture also plays an important source of livelihood to Filipinos. Brown and colleagues (2018) reported that close to 30 % of the country's labor force is provided by agriculture. Each region in the country comes up with various interventions in the aim of maximizing the agricultural capacity. As such, Philippine Statistics Authority (2004) reported that Bicol is among the regions that contribute to effective programs in the goal of advancing the country's agronomy. The number of farms in Bicol Region increased by 1.9% from 377.8 thousand in 1991 to 348.4 thousand in 2002. Also, concerned national agencies continuously launch and support the advent of innovative farming technologies in the Bicol region (Baldo and Laureta, 2022). However, there is still a need for research-based strategies to increase agricultural outputs, especially today where major problems such as increased global population and farm labor shortage are directly observed.

The government has extended its support in the development and construction of water system irrigations. The country has established the Republic Act 3601 creating the National Irrigation Administration (NIA) in 1963 (Inocencio and Briones, 2021). Two major roles were confronted by NIA in its early operation, guiding the financing and construction of large multi-purpose dams and strengthening the role of irrigation associations for the sustainable operations and maintenance of the irrigation system (Inocencio and Barker, 2018). From year 2000, emerging challenges were faced by the national agency, including but not limited to the shift in global climate. Important recommendations during this time was adoption of cropping and water management practices that would mitigate the effects of climate change.

Participatory rural approach (PRA) is the process of involving local residents of a certain community in the analysis and interpretation of their own situation at a given rural area. The participants are the ones who lead in the collection, analysis, interpretation and presentation of information. This process requires the participants to partake in the knowledge and development processing, with the project team members as facilitators (Nigussie and Tesfaye, 2019). PRA emphasizes the significance of empowering local people to assume an active role in analyzing their own living conditions, problems and potentials in order to seek for a change of their situation. This aids in problem identification and prioritization which enables proper formulation of action plan for a specific rural area.

MATERIALS AND METHODS

Participatory rural approach (PRA) workshop

The study was conducted from July to September 2019. Six communities were identified as target participants of the PRA. These barangay communities comprise the nominated areas of the local government units (LGU) of three vulnerable municipalities of Camarines Sur namely Baao (Sta. Eulalia and San Francisco), Canaman (Mangayawan and San Francisco) and Minalabac (Taban and Del Carmen-Del Rosario) (Laureta and de la Vega, 2020) (Figure 1). These communities were categorically chosen as vulnerable because of their close proximity to the BRB. Specific number (Table 1) of key informants represented the different sectors of the community namely youths, fisherfolks, barangay health workers (BHW), senior citizens, and farmers who were led by their top barangay officials. They were asked to enumerate agriculture-based problems in their communities. Each problem cited or listed is written down on a separate metacard (de Zeeuw and Wibers, 2004). The cards were ranked according to priority. The key questions for ranking were:

i. Which of the problems is the root cause?
ii. Which are the problems that create many other problems?
iii. Which of these problems has the most important effects on the farm output?

The core problem is placed at the bottom part of the board. Subsequently, the participants were asked, if each word on the metacards are causes of the core problem or more of consequences or effects. By doing so, the problem

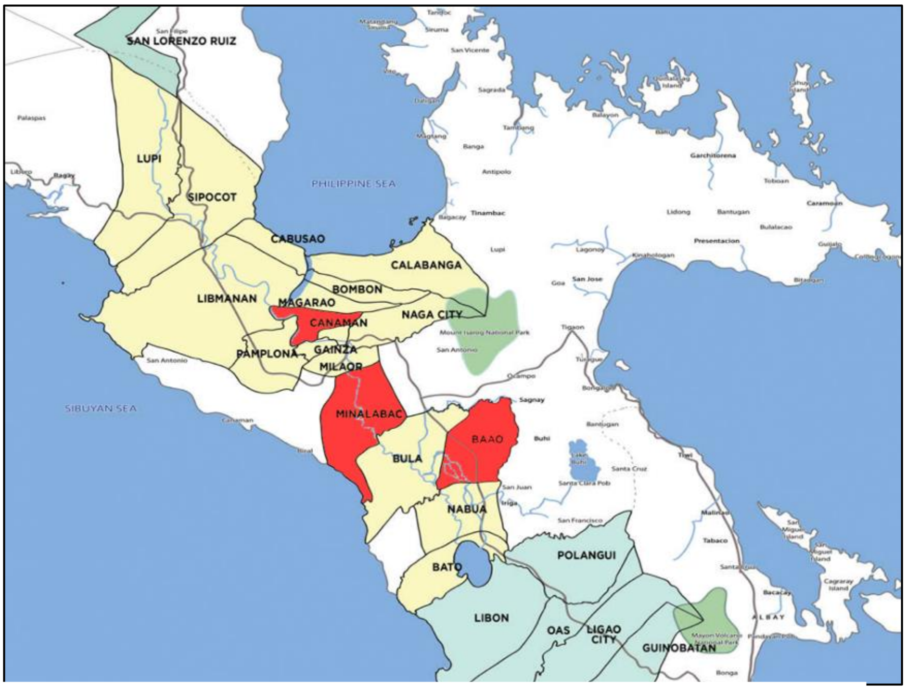

Fig. 1. Bicol river territorial map showing study sites from the Municipalities of Baao, Canaman and Minalabac. (Google Maps)

Problem tree analysis was utilized in this study. A problem tree is used to deduce information and assess relationship among problems, their causes and effects. This is an effective tool in supporting project planners to identify clear and manageable goals and in the identification of strategies on how to achieve them. The value of this type of assessment is maximized if it is carried out in workshop with the stakeholders giving the opportunity to establish a shared view of the situation (Veselý, 2008). Problem tree analysis is widely used for prioritization strategies in agriculture.

The study aims to gain insights into the dynamics of agriculture-based challenges in the localities alongside the Bicol River Basin (BRB). Specifically, it aims to enumerate the community's problems that hinder sustainable farm yield, and recommend prioritizations in the improvement of farm productivity.

cards arranged in the form of a tree, with consequences of the core problems at the right part and the causes placed at the left portion of the board.

For triangulation, a key informant interview (KII) was conducted with an official of the Camarines Sur Irrigation Management Office as representative of NIA's regional office.

Table 1. Breakdown of PRA participants

Municipality	**Community**	**Number of Participants**
Baao	Sta Eulalia	42
	San Francisco	40
Canaman	Mangayawan	31
	San Francisco	34
Minalabac	Taban	32
	Del Carmen-Del Rosario	31
Total		**210**

Results and Discussions

Learning the present scenario of major problems from farmers of vulnerable communities such as the municipalities of Baao, Canaman and Minalabac in Camarines Sur, triggered by its close proximity to the BRB, will help agricultural researchers working throughout the country to carry out a need-based outputs. There is a need for special established instrument to report and gather information from local farmers and PRA is used to satisfy this objective. Problem tree analysis is used as a tool to elicit the most common struggles of local farmers. Each of these problems are tabulated (Tables 2) in each of the sampling barangay sites and is reported according to their ranking, as perceived by the community.

Table 2. Agricultural problems identified in the study sites

Study Site	Rank	Identified Problem	Functional Category
Baao			
San Francisco	1	Prolonged period of flood	Infrastructural
	2	No proper drainage	Infrastructural
	3	Geographical location	Distribution Channels
	4	Catch basin	Infrastructural
	5	Garbage	Innovation resources
Sta. Eulalia	1	Geographical Location	Distribution Channels
	2	Overflow of Bicol River Basin	Infrastructural
	3	Lack of trees	Innovation resources
Canaman			
Mangayawan	1	High cost farm inputs *ie* fertilizers and labor	Suppliers
	2	Low buying price of farm harvest	Suppliers
	3	Low quality of soil due to application of synthetic fertilizers	Innovation resources
	4	Saline intrusion	Natural environment
San Francisco	1	Limited access to "Farm to Market Road"	Distribution channel
	2	Wrongly-planned irrigation system	Managerial
	3	Distance from the fresh water source to start the rice cropping	Innovation resources
	4	Near distance to seawater which affects to saline intrusion	Innovation resources
Minalabac			
Del-Rosario-Del Carmen	1	Low season harvest	Innovation resources
	2	No capacity to make use of advance farming technologies	Innovation resources
	3	Lack of Capital	Innovation resources
Taban	1	Low season harvest	Innovation resources
	2	No capacity to make use of advance farming technologies	Innovation resources

Table 3 shows the summary of problems ranked by the number of times they were mentioned in the PRA session. Listed is the top ten dilemmas as identified unanimously among the participants of the activity.

Table 3: Summary of identified problems in the Communities

Ranking	Identified Problem	Functional Category
1	No source of farming irrigation system	Infrastructural
2	Prolonged flood	Infrastructural
3	Saline intrusion in the farmlands	Infrastructural
4	Unavailability of advanced farming technologies	Innovation resources
5	Established Farming irrigation systems are not well planned	Managerial resources
6	Low harvest rates due to climate change	Distribution channels
7	High Cost of Farming inputs i*e* fertilizers and labor	Suppliers
8	Limited access to “Farm to Market Road”	Infrastructural
9	Low farm gate price buying price of harvested products	Distribution channels
10	Inadequate trees to aide in flood prevention	Natural environment

The components of an internal analysis of the identified problems are categorized functionally as infrastructural, managerial, suppliers, distribution channels, and innovation process with few modifications (Sammut-Bonnici and Galea, 2015). Infrastructure is the backbone of the industry allowing operations to run efficiently while providing information to improve the current process. On the other hand, managerial resources create the competencies in relation to the planning, control, and the leading functions. The suppliers and the nature of their products and services will have a bearing on the competitive advantage of the farming industry. Distribution channels can be analyzed to seek the strengths and weaknesses of distribution chain management. Areas of assessment are the motivation of channel members, product, pricing and motivation issues in the marketing channels. Innovation resources encourages a climate for new ideas and technological capabilities and has the capacity to innovate. Lastly, the natural environment is placed as an important functional category because of its significance in classifying factors associated with the effects brought about by natural phenomena or climate shift.

Table 4: Summary of NIA-constructed irrigation in the Communities

Municipality	Community	Number
Baao	Sta Eulalia	1
	San Francisco	1
Canaman	Mangayawan	0
	San Francisco	3
Minalabac	Taban	0
	Del Carmen-Del Rosario	0
Total		**5**

NIA is the government agency which is tasked in the management of construction and operation and maintenance (O&M) of the water facilities across the country. Table 4 summarizes the known projects of NIA in the surveyed communities. It was revealed that three out of the six communities had the opportunity to be provided by water facility. However, In San Francisco, Canaman, two out of three water systems are unusable because of “faulty” construction plans, as understood by the participants.

Successful research initiatives can be proposed and implemented after understanding the grassroot problems faced by the farmers for which participatory rural approach paves way. Most experiences with PRA take place in rural setting. Major sectors in which PRA applies are in fields such as natural resources management, health and nutrition, poverty alleviation programs, village level and urban planning and ultimately, agriculture (Muralikrishnan et al., 2021). In all study sites of this problem analysis, common ordeal of community is the incidence of poverty. Among these, 67% of the community pinpointed the root cause of agricultural dilemmas to lack of or if there is any, ineffective source of water irrigation. The remaining 33% of surveyed communities mentioned that if persistent flooding, does not occur in their respective areas, high agricultural productivity will be gained. These problems inevitably affect rice production. Despite abundant land resources, and availability of sufficient human resources, the community’s agriculture is not yet developed to its full potential primarily because of these identified challenges.

Most of the problems cited are functionally categorized as infrastructural. This is unanticipated because irrigation continues to be the largest public agricultural expense in the Philippines. In the 1970s and 1980s, public expenditure on irrigation represented about 45% of all agricultural spending. In 2015, 12% of total public expenditures for irrigation reached 22 billion pesos. Ninety percent (90%) of which was allocated to capital investments and the remainder was shared to corporate expenditures. From 1976 to 2015, capital investments averaged 85% of total public expenditures for irrigation. These huge investment does not exactly answer the present agricultural dilemmas. Public investment levels respond to short-term changes on

Figure 2. Detached irrigation facility established by NIA in Mangayawan, Canaman

international rice production process because these changes on international rice production affect the marginal rate of return to irrigation investment and the adoption of rice self-sufficiency rather that a consideration of the long-term costs and benefits (Kikuchi et al., 2003).

The present solution regarding the problems on water system can be classified into four major headings (Barker and Molle, 2004), namely conservation of real water saving, supply augmentation; resistance to abiotic stresses such as salinity, drought and flood and reallocation to higher valued uses and crop diversification. The ideas are applicable to the surveyed communities especially in Canaman where drought and saline intrusion is much of concern. In the dry season, from March to May, close to no yield of rice was recorded in the saline intruded communities of Barangays Mangayawan and San Francisco, leading to disenfranchised investments from agricultural inputs. Another problem that has surfaced is the unusable irrigation systems constructed by NIA. Moya (2014) reported case studies on the causes of their poor performance. Many of these findings can be traced to flawed economic and technical decisions during the construction phase of the irrigation systems. This is also reflected in the water irrigation systems established in Mangayawan Canaman, where only one of the three is utilized and the others are unusable (Figure 2). Based on the consecutive reports of NIA, budget was allocated for the repair and completion of this facility (NIA, 2018; NIA, 2019). This finding corroborates with the notion communicated by David & Inocencio (2012). Gaps have been found between design assumptions and operational realities causing systems to underperform. The situation is worsened when natural disasters or higher rainfall intensities occur. According to the recent report of PAGASA (2022), the average annual rainfall in BRB is approximately 2000-3600 mm, which varies among sections. These figures mirror an intense effect in the agricultural communities alongside the river. Geospatial modelling reveals that typhoons are direct contributor to the vulnerability of communities along the Bicol river (Laureta et al., 2021). Similarly, simulation of these natural phenomena is shown to impact production by destroying farming inputs and infrastructures in nearby province, Laguna (Balela et al., 2019). In this study, facilities are found to be poorly designed, misaligned and constructed inappropriately to function in such scenarios. In 2019, Briones and co-workers reported that the Philippine government has allotted 2.9 billion pesos for the improvement of irrigation facilities nationwide.

NIA-Bicol as represented by the acting head of the Camarines Sur Irrigation Management Office Head Office, clarified some of the issues raised by the barangay participants through another KII session. The first issue was the failure of two of the three irrigation system to operate and be utilized by the farmers. According to the key informant, geographically, there is only one established irrigation facility in the barangay Mangayawan. Perhaps, the residents had misunderstood the way they their facilities are fixed. The officer mentioned that there is a creek connecting to the rice field and they installed check gate, though irrigation check valves which are used in landscaping and irrigation to prevent backflow. Further, the It was emphasized that an invitation is provided to the residents regarding the planning of the water facility establishment. However, according to him, residents were passive and did not share insights during the discussion, bringing assumption that they agree on the engineering plan. It was added that the problem of flooding beyond the scope of the agency's jurisdiction and exclaimed that this task should be a project of the Department of Public Works and Highways (DPWH).

The community has provided sensible solutions to problems identified during the inducted PRA. In the absence of irrigation system in the surveyed areas, the local government unit in the barangay level shall be tapped to draft a resolution that will forward the concern to national agencies such as the NIA for the assessment, design criteria consideration, project cost estimation, design of overall project and final construction of accessible irrigation system. Monitoring and maintenance plan should also be deliberately discussed in the planning phase. For this to be translated into fruition, it is important that a representative from the agricultural sector be present in the barangay council hearings and relay the problems to lead officials. Consistent follow up on this resolution request will be done to ensure the development of this plan. It should be noted that appropriate solutions are very site specific, depending on both the physical and socio-economic environment of the community. This idea conforms with the report made by Lucas & Chhajed (2004) highlighting the pronounced gap between theories and practices in local agriculture development.

CONCLUSIONS

The problem of Philippine agriculture on water systems is shown to persist over time. This dilemma is clearly observed in the rural farmlands of vulnerable municipalities in the province of Caramarines Sur along the Bicol river, Baao, Canaman and Minalabac. Water resources development and management should be of prime priority in the planning and targeting for rice self-sufficiency. However, climate change has become an emerging challenge to policy makers, agriculture leaders and the farmers. The future of rice industry that has fed the country's economy and populace for the longest time rely on suitable research-driven policies and reasonably toned-down bureaucratic government processes. If remain unaddressed, the country will continuously embark in short-term solutions such as rice imports, which will eventually lead to threat in the livelihood of our local farmers and subsequent increase in struggles of food security, economic loses and national income. Application of research-based techniques and innovations should be intended specifically for the need of every farm site.

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