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Rainwater harvesting for enhancing upland agriculture: Lessons and experiences in selected upland farming communities in Albay Province, Philippines

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ABSTRACT

The upland farming communities in the Philippines are among the vulnerable sectors to climate change impacts. Their agricultural production is generally rainfed, and their farms are in marginal upland areas with steep slopes prone to soil erosion. Water scarcity is a common and perennial problem. To address the need expressed by the smallholder farmers, 11 rainwater harvesting facilities (RWHFs) were established in three upland farming communities in Albay Province, Philippines. The project team facilitated the establishment of RWHFs from two state universities, three local government units, and farming communities. Capacity development and participatory project planning and implementation were the important project approaches. This project generated several lessons. These include the essence of multisectoral collaboration, comprised of local government units, farming communities, and state colleges and universities; the value of collective action of farmers; effectiveness of cross-farm visits and on-site training; tapping locals for project monitoring; integration of sustainable land use management system to sustain RWHFs; and, the importance of resource sharing in carrying out project activities. The project experiences and lessons could be used as a reference by other development programmes in replicating this initiative in other upland farming communities in the country.

KEYWORDS

Smallholder farmers, agroforestry, cross-farm visits, collective action, resource sharing

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HIGHLIGHTS

- The lack of irrigation water limits the agricultural production of upland farmers in the three upland farming communities in Albay Province.
- Eleven (11) RWHFs, aimed at maximizing the agricultural production of small-holder farmers, were established.
- RWHF establishment served as a mechanism to expand farmer-cooperator's agricultural production areas and enabled the upland farmers to cultivate rice in two cropping seasons.
- Harnessing active engagement of local communities and tapping local experts facilitated the project implementation amid the pandemic.

1. INTRODUCTION

Smallholder farmers dominate the agriculture sector worldwide. Lowder, Skoet, and Singh (2014) reported that 85% of the 525 million farms worldwide are less than two hectares. Many of these smallholder farmers are poor, food insecure and have limited access to market and basic services (Rapsomanikis, 2015). Fortenbacher and Alave (2014) highlighted that the upland settlers are the poorest among the rural population because of low farm productivity, limited access to rural advisory services, alternative employment opportunities, and basic social services. Furthermore, most upland farmers cultivate in marginal lands, with generally steep slopes that are prone to soil erosion and are rainfed or dependent on rainfall as a source of irrigation (Landicho et al., 2015). Hence, they are also vulnerable to climate change impacts and other weather and natural disturbances.

In their research, (Landicho, Van, & Ximenes, 2018) emphasized that the low level of adaptive capacity for climate change adaptation among the upland farmers in Southeast Asia, particularly in the Philippines, Viet Nam and East Timor, is brought about by the low level of farmers' knowledge and awareness about the climate change adaptation strategies, low level of assets, and weak leadership or governance in natural resources management. These results suggest the need for capacity development programmes, particularly on climate change adaptation strategies. Specifically, the upland farming communities in Albay Province have been experiencing climate change impacts such as unavailability of water during the dry season and long dry spell, stunted crop growth, low crop productivity and yield, and increased farm inputs (Landicho et al., 2018).

The need for a water source for crop irrigation was on the top list of upland farmers for them to adapt to climate change impacts. Han (2006) argues the need for a new paradigm in rainwater management as the weather becomes more severe and unpredictable due to climate change. The new paradigm involves developing small-scale detention ponds or rainwater storage facilities instead of large remote projects. Each small-scale facility promotes multi-purpose rainwater management rather than single-purpose watershed management (Contreras, Sandoval, & Tejada, 2013). Rainwater harvesting through small water impounding projects (SWIPs) addresses the unbalanced rainfall distribution by collecting and storing direct rainfall and surface runoff for future use (Contreras et al., 2013). SWIPs which serve as rainwater harvesting and storage structures consist

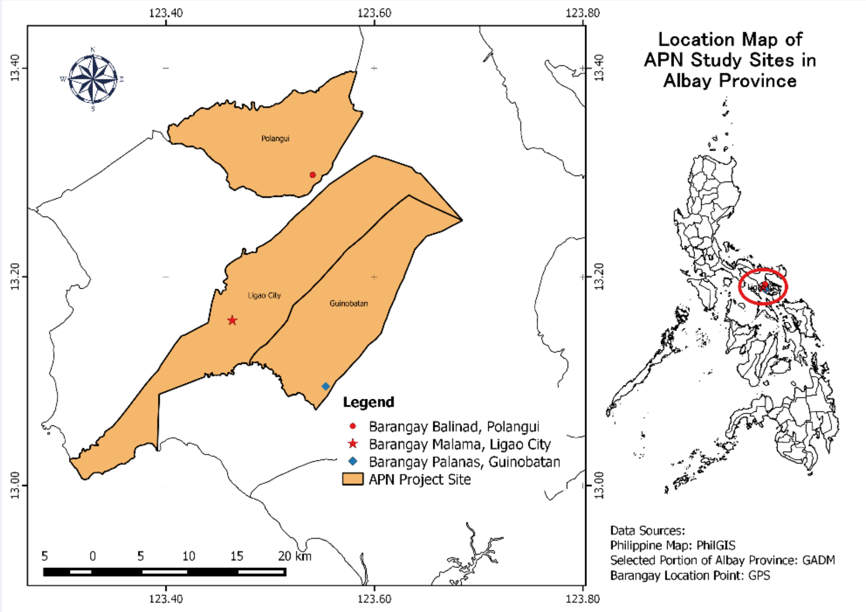

FIGURE 1. Location map of the project sites.

of an earth embankment, spillway, outlet works and canal facilities. Aside from economic benefits, SWIPs have an important role in enhancing the multi-functionality of agriculture, particularly in the uplands (Concepcion et al., 2006). Socio-economic benefits from SWIPs can be seen at the farm and community levels (Monsalud, Montesur, & Abucay, 2003; Naval, 2016) .

Given the potential of rainwater harvesting ponds and SWIPs in addressing the impacts of climate change on agricultural production of smallholder farmers, a capacity development project was implemented in Albay Province, Philippines, in 2019, which centred on the establishment of rainwater harvesting ponds, using the principles of multisectoral collaboration and engagement. Multisectoral collaboration means that multiple sectors and stakeholders collaborate in a managed process to achieve shared outcomes and common goals (Kuruvilla et al., 2018) and enhance technology promotion and adoption (Landicho, Cabahug, & De Luna, 2009; Cruz, Carandang, Galapia, Carandang, & De Luna, 2014).

This article highlights the lessons and experiences of establishing rainwater harvesting ponds in the three upland farming communities in Albay Province, Philippines, using the multisectoral collaboration as an approach.

2. METHODOLOGY

The project was implemented in three upland farming communities: Barangay Malama in Ligao City; Barangay Palanas in Guinobatan, and Barangay Balinad in Polangui (Figure 1). The project was managed by the four research collaborators representing the University of the Philippines Los Baños-Institute of Agroforestry (UPLB-IAF) and the Bicol University College of Agriculture and Forestry (BUCAF). The local government units of Ligao City, Polangui and Guinobatan, Albay Province were also tapped as local partners through their respective Offices of City/Municipal Agriculturists and are represented by the concerned agricultural technicians. The key leader of each of the three upland farming communities and the agricultural technicians of the three LGUs comprise the Local Project Facilitating Team. Technical experts from the Department of Agriculture-Regional Field Unit in Bicol were tapped to provide technical advice and assistance in establishing and maintaining the rainwater harvesting ponds. Eleven (11) farmer-cooperators were selected, and their respective farms showcased the rainwater

FIGURE 2. Sites of cross-farm visits showcasing rainwater harvesting facility, andsoil and water conservation measures.

harvesting ponds. Meanwhile, other upland farmers in each of the three project sites were also actively engaged in establishing the rainwater harvesting ponds.

Capacity-building activities were organized to enhance the knowledge and skills of farmer-cooperators and other volunteer upland farmers on rainwater harvesting, soil and water conservation measures, and agroforestry. These activities include cross-farm visits and on-site training on rainwater harvesting, soil and water conservation and management, and agroforestry. The farmer-to-farmer training approach was utilized to ensure a more effective transfer of learning.

Participatory planning and establishment of rainwater harvesting ponds were employed, utilizing the smallholder farmers' collective action (Bayanihan). The local community members (i.e. young members of the community) did periodic monitoring of rainwater harvesting ponds to assess their performance (in terms of water retention), durability, and utilization and distribution among the farmers.

3. RESULTS AND DISCUSSION

The one-year capacity development project has generated significant lessons and experiences. These are as follows:

a) The cross-farm visits and on-site training on agroforestry and soil and water conservation organized by the team served as a mechanism for the farmers in the three project sites to appreciate and recognize the importance of soil and water conservation rainwater harvesting in upland farming. A cross-farm visit to the selected model farms of the Conservation Farming Villages (CFV) programme in Barangay Oma-oma, Ligao City, enabled the 30 farmers from the three project sites to observe the agroforestry farms showcasing the integration of annual and perennial crops, and soil and water conservation measures. On the other hand, the farmer-cooperator of the Rainwater Harvesting Project in Barangay La Medalla, Polangui, Albay, talked about the community's efforts in the establishment of the rainwater harvesting pond through the assistance of the Office of the Municipal Agriculturist in Polangui and other project partners (Figure 2). This activity promoted the farmer-to-farmer training and knowledge sharing. According to Millar, Photakoun, and Connet (2005), cross-farm visits greatly impacted farmer awareness, confidence and problem-solving. It was also the farmers' preferred approach for learning new technologies. The authors added that cross-farm visits offer opportunities for farmers to see the actual field situation, talk and discuss with their fellow farmers, and share experiences and lessons directly. Moreover, farmers tend to recall the strategies and methods much better when they have seen them in the field. Building from previous capacity building projects (Landicho et al., 2009), the project collaborators believed that farmers learn

FIGURE 3. (L-R) (a) 10m x 30m pond in Barangay Palanas; (b) 8m x 10m pond in BarangayMalama; and (c) 5m x 7m pond in Barangay Balinad

from other farmers, as they share similar symbols and experiences. Farmers find it much easier to apply the technologies to their farms through cross-farm visits.

b) The establishment of rainwater harvesting facilities is site-specific. There is no standard size, type, and even process in establishing rainwater harvesting facilities in upland farming communities. The size and type of rainwater harvesting ponds depend on the existing local conditions, particularly the size of the farms being cultivated by the farmers, the type of crops being cultivated, the geographical conditions of the community and farms therein, the number of farmer-beneficiaries that would use the resource; and, the willingness and commitment of the community members to engage in the establishment and maintenance of the facility. In the case of Barangay Palanas, Guinobatan, where the dominant crop is rice—a water-demanding crop; and, where a number of adjoining farms were considered as among the farmer-beneficiaries, the size of the pond that was constructed was about three times the size of the ponds in the two other project sites (Figure 3). In this way, water collection, storage and distribution would be more effective and efficient. Other studies have also explored the use of different criteria in determining suitable rainwater harvesting facilities (Ammar, Riksen, Ouessar, & Ritsema, 2016; Martínez-Acosta, López-Lambraño, & López-Ramos, 2019) .

c) The spirit of collective action or the "Bayanihan system" is essential in a more efficient establishment of rainwater harvesting facilities. Barrameda and Barrameda (2011) define Bayanihan as any voluntary communal effort to achieve a common goal. It is a common practice in Philippine towns that community members help their neighbours move to a new place, repair homes or build communal infrastructures. As in other community-based development projects, the cooperation and spirit of "working together" played a key role in completing the RWHF establishment in the three project sites. This element is essential, particularly for development projects in the "pilot stage" and have limited funding support. The establishment of rainwater harvesting ponds is a tedious process. Through their collective action, the smallholder farmers were able to establish 11 rainwater harvesting ponds: (i) Two (2) in Barangay Palanas with a dimension of 30m x 10m x 2m; (ii) Four (4) in Barangay Malama with a dimension of 10m x 8m x 2m; and Five (5) in Barangay Balinad with a dimension of 5m x 7m x 2m (Figure 4).

d) Resource sharing is an important ingredient in any community development project and serves as a mechanism to develop a sense of project ownership among the stakeholders. Unlike the traditional projects where everything is given out by the project implementors and funding agencies, and local organizations and farming communities are merely considered as "beneficiaries", this capacity development project showed the relevance of counterparts from the local government units and the three partner communities. For instance, the LGUs provided vegetable seeds for establishing agroforestry systems/models and engaged the agricul-

FIGURE 4. Farmer-volunteers join thefarmer-cooperators in the establishment of rainwater harvesting ponds in thethree project sites through their "bayanihan" system.

tural technicians in the project without additional compensation. On the other hand, the farming communities provided labour in the establishment of RWHFs and agroforestry systems as their counterpart (Figure 5). Sharing of resources and efforts enables the local stakeholders to value the project, develop a sense of project ownership, and pave the way for the sustainability of the project initiatives.

FIGURE 5. The community members provide labour as their project counterpart.

e) Addressing the expressed/felt need of the communities guarantee their commitment and engagement in the project activities. Since agriculture is their main livelihood, the three farming communities were in dire need of water sources that would provide irrigation to sustain their agricultural production even during the dry season. This need was expressed in 2018 when a study was conducted in the three farming communities (Landicho et al., 2018) . Since the project's inception, the farmers and the local leaders have extended their support and active engagement in the project activities. Despite the pandemic and natural disasters brought about by typhoons in 2020, the farmers persisted in completing the establishment of RWHFs (Figure 6).

f) The establishment of rainwater harvesting ponds enabled the farmers to enhance their agricultural production. For instance, in Barangay Palanas, the farmers used to cultivate rice in one cropping season only. However, they started cultivating rice for two cropping seasons because of the good retention of the rainwater collected in the rainwater harvesting ponds (Figure 7). In Barangay Balinad, on the other hand, the farmers did not cultivate the sloping areas surrounding their coconut farms because of the lack of water. However, with the establishment of rainwater harvesting ponds, these farmers started cultivating these idle lands with agricultural crops. In Barangay Malama, the land area allocated for rice production was increased by the farmer-cooperators because of the availability of irrigation water.

g) The establishment of rainwater harvesting ponds gave way for adopting agroforestry systems and technologies in the sloping agricultural production areas of the upland farmers.

Given the marginal conditions of the upland farming communities, agroforestry is considered an appropriate land use management system. Agroforestry is a dynamic, ecologically-based natural resource management system that deliberately combines woody perennials with herbaceous crops and/or animals either in some

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FIGURE 6. Functional ponds in the three project sites.

form of spatial arrangements or temporal sequence on the same land to diversify and sustain production for increased social, economic and environmental benefits (Leakey, Temu, Melnyk, & Vantomme, 1996). A number of studies have shown that agroforestry offers potential in enhancing the socio-economic productivity of the farmers because of the diverse crop components (Landicho et al., 2016; Tolentino, Landicho, De Luna, & Cabahug, 2010; Cunningham, Nicholson, Yaou, & Rinaudo, 2008) while at the same time addresses the ecological dimension (Baliton et al., 2020; Palma & Carandang, 2014; Casas, Marin, Toledo-Bruno, Lacandula, & Aguinsatan, 2014).

In Barangay Palanas, the upland farmers, through the technical assistance of the agricultural technician, have established an agroforestry system, integrating mulberry (*Moros alba*) as hedgerow species, and dragon fruit (*Hylocereus undatus*) as alley crops, in the alley/hedgerow cropping system (Figure 8a). Being a woody

FIGURE 7. Farmers in Barangay Palanas, Guinobatan can now produce rice in two cropping seasons because of water availability.

perennial, mulberry serves as the permanent crop and is planted as contour hedgerows. On the other hand, the dragon fruit, which is a medium-term crop, is planted along the alleys and annual vegetable crops. Besides their suitability to the site, mulberry and dragon fruit provides economic potentials, being high-value crops. Furthermore, mulberry wine is being produced in Bicol Region, and therefore, Barangay Palanas could be a potential supplier of raw materials to the processors. The vegetable crops would serve as a food source for the upland farmers.

In Barangay Malama, the sloping farms around the ponds were developed into contour farms, where kakawate (*Gliricidia sepium*) serves as the hedgerow, and lemon (*Citrus limon*), cacao (*Theobroma cacao*), turmeric (*Curcuma longa*) and vegetable crops serve as the alley crops (Figure 8b). Lemon, cacao and turmeric are among the high-value crop species in Albay. Lemon is integrated into farms with open areas, as this species is light-demanding, while cacao is integrated into farm areas with coconut. Vegetable crops are a source of food for the household and other community members. *Gliricidia sepium* offers a number of potentials, including soil fertility restoration, being a nitrogen-fixing tree species, a source of fuelwood, particularly the prunings, and, as a source of feeds for the livestock, particularly the leaves. The leaves could also be used as botanical pesticides. In Barangay Balinad, the steep areas around the ponds were developed into contour farms with *Gliricidia sepium* as the hedgerow crop and corn as the alley crop (Figure 8c).

Integrating soil and water conservation measures such as the contour hedgerows is an appro-

FIGURE 8. (L-R) (a) mulberry-dragon fruit integration in Barangay Palanas; (b) integration of citrus, cacao and yellow ginger with *Gliricidia sepium* as contour hedgerows in Barangay Malama; and, c) integration of *Gliricidia sepium* as contour hedgerows in the corn production area in Barangay Balinad.

priate strategy to prevent soil erosion in the sloping areas, which are oftentimes the sites that smallholder farmers cultivate. Integrating soil and water conservation measures in upland farming does not only control soil erosion in the sloping areas and conserve soil nutrients needed by the crops but, more importantly, helps protect the ponds from being damaged by the soil and debris from the sloping areas around them.

h) Support of the local government units at various levels helps facilitate the smooth project implementation in the three project sites. The active involvement of the Office of the Municipal/City Agriculturist, through their agricultural technicians in the three project sites, helped mobilize the farmers in all stages of project implementation and closely monitored the status of project implementation (Figure 9). Furthermore, mobilizing the Local Multisectoral Team through the leadership of the agricultural technicians representing the Office of the Municipal/City Agriculturists in the three local government units. Constant communication and close coordination are being done regarding the field activities, and these are being relayed to the key leaders of the partner communities. Literature has pointed out the crucial role of the LGUs in promoting sustainable natural resource management in the Philippines (Landicho & Dizon, 2020; Cruz et al., 2016; Luna, 2018; Landicho et al., 2018).

i) Regular communication of the project collaborators via electronic mail and other forms of social media is a key to sustaining the project implementation despite the travel restrictions and face-to-face interactions brought about by the pandemic. The diverse means of communication ensured that the project implementation is on track and issues and problems arising from the project implementation are immediately being addressed (Figure 10).

j) Tapping the locals as the Local or On-Site Monitors is both capacity development and a project facilitating opportunity. These on-site monitors served as the link between the farmers and the collaborators since the agricultural technicians, whose municipalities were also on lockdown, were restricted to fieldwork. The local/on-site monitors organized the field activities, coordinated with the collaborators for logistics and technical concerns, and monitored the progress of RWHF establishment (Figure 11). These local/on-site monitors were also tapped to conduct periodic monitoring using the monitoring tool that the project collaborators developed. Engaging youth in-field monitoring did facilitate project implementation and provided an opportunity to enhance their capacities coordinating and monitoring projects and enhancing their communication skills. In Barangay Balinad, the local/on-site monitor was the President of the 4H-Youth Club, while the Barangay Secretary was tapped as the local monitor in Barangay Malama. In Barangay Palanas, the President of Sangguniang Kabataan (Youth Organization) was also engaged as the local monitor.

4. CONCLUSION

Water availability is the primary factor influencing the agricultural production of smallholder

FIGURE 9. The LGUs at the municipal and village (barangay)-level are actively engaged in facilitating project implementation.

FIGURE 10. Despite the pandemic, the project collaborators are able to maintain regular communications and updating via Zoom meetings.

farmers in the rainfed areas. This article concludes the viability of establishing rainwater harvesting facilities in the upland farming communities in Albay Province, Philippines. While the establishment of rainwater harvesting facilities is complex and multidimensional, the lessons and experiences generated by this project suggest that certain mechanisms can facilitate the establishment and sustained management of these facilities. These include the multisectoral collaboration—of the LGUs, farming communities and other assisting institutions such as the state colleges and universities; collective action of the farming communities; capacity development through cross-farm visits and training, and tapping the locals as part of the monitoring team; integration of sustainable land use management and other supporting technologies such as agroforestry and soil and water conservation and management; and resource sharing. These lessons could be used by the other development organizations and LGUs to implement similar initiatives in other upland farming communities in the country.

FIGURE 11. The locals managed to conduct regular monitoring of the rainwater harvesting ponds.

As the rainwater harvesting ponds are still in their first two years of being operational, further studies can be undertaken regarding the efficiency of the water utilization and distribution of the ponds to the cropped fields. Studies on the evapotranspiration rate and underground seepage of the 11 rainwater harvesting ponds could also be investigated to further improve water collection and storage effectiveness and efficiency. Finally, an impact assessment can be conducted after three years of the pond establishment and utilization to assess how these facilities contribute to the agricultural production of the farming communities and analyze the strengths and weaknesses of the facilities, including the mechanisms of maintenance, utilization and distribution of the rainwater to farmer-beneficiaries.

5. POLICY IMPLICATIONS

The lessons and experiences of this capacity development project proved the workability of establishing rainwater harvesting ponds in the upland farming communities in the country. Hence, the local government units, through the Office of the Municipal Agriculturists and other concerned offices, could work together towards the establishment of at least one rainwater harvesting pond in each of the clusters of the upland farming communities. This will ensure the availability of water for use in the irrigation of their crops. The establishment of rainwater harvesting ponds could be mainstreamed in their local development programmes to facilitate the allocation of a budget for the sustainable management of these ponds. This is also consistent with the Republic Act 6716, also known as the Rainwater Collector and Springs Development Act of 1989, which requires the construction of rainwater collection in every "barangay" or village to prevent flooding and ensure the continuous provision of clean water during the dry season.

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