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Typology of agroforestry practices, perceived benefits, and challenges: The case of Kapit-Bisig Farmer's Association Inc., Barangay Sta. Catalina, Atimonan, Quezon, Philippines

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ABSTRACT. This study examined the perceived benefits and challenges of agroforestry technologies adopted by the Kapit-Bisig Farmer's Association Incorporated (KBFAI) members in Barangay Sta. Catalina, Atimonan, Quezon. The association was established in 1989 and became a partner organization of the Department of Environment and Natural Resources (DENR) to implement the Community-Based Forest Management (CBFM) program, including agroforestry, in 1997. In 2018, the KBFAI was awarded the Best CBFM Model in the CALABARZON region. All 50 active members interviewed adopted the multi-storey agroforestry system, which provided farmers with economic benefits, such as a variety of produce, better yield, and regular monthly income. Some respondents' farmers integrated forest/fruit trees and crops, poultry, livestock, and apiculture into their farms. Socially, the KBFAI encouraged members to participate in various organizational, technical, and life skills training initiated by linked government agencies. Livelihood skills augmented members' income through the "*coprahan*" venture, selling seedlings from their nursery, rattan basket weaving, and tiger grass broom making, where raw materials were sourced from the CBFMA area. The training also sensitized them to avoid traditional livelihood activities, such as *kaingin* and charcoal making. Members likewise enjoyed the environmental benefits of their agroforestry farms through soil improvement, shade to crops, sustained water supply, and reduced soil erosion in steep slopes. Despite these benefits and improved well-being, findings showed that farmers' continued adoption of agroforestry was uncertain as most members became senior citizens and had difficulty maintaining their agroforestry farms. Their children were hardly interested in farming. This study recommends that the DENR and support organizations incentivize agroforestry farming to attract and engage the young generation and sustain the beneficial agroforestry systems in Barangay Sta. Catalina and in all uplands nationwide.

Keywords: Aging farmers, agroforestry technologies, community-based forest management, ecologically sustainable, upland farming

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INTRODUCTION

Kaingin and charcoal production are the major threats to the last remaining patches of the Philippines rainforest (Meeteren, 2012). Most residents of Barangay Sta. Catalina, Atimonan, Quezon practiced such activities in the 1980s as their traditional means of livelihood. The government encouraged the residents to adopt agroforestry technologies to supplant their

destructive activities when the former introduced the Integrated Social Forestry (ISF) Program in 1984. Members of the Samahang Pangkaunlaran ng Bantakay, the precursor of the Kapit-Bisig Farmer's Association Incorporated (KBFAI), participated in the ISF Program and became recipients of the Certificate of Stewardship Contract (CSC). Individual farmers were recognized as potential government partners in sustainable upland farming. They were given 4 to 7 ha of timberland, which they could use as food production areas, provided that 20% of the stewarded area be planted to timber species or fruit trees. The contract has 25 years term, renewable for another 25 years upon agreeable land use.

In 1989, the KBFAI was established and registered on August 7, 1991, with the Securities and Exchange Commission. KBFAI became a recipient of the Community-Based Forest Management (CBFM) program of the Department of Environment and Natural Resources (DENR) on June 27, 1997. As DENR's partner in managing, improving, protecting, and wise utilization of natural resources, KBFAI was awarded 2,207.30 ha of timberland in Barangay Sta. Catalina, Atimonan, Quezon. The timberland is under a CBFM Agreement good for 25 years but may be renewed if KBFAI proves to be a trustworthy partner of the DENR. The concept underlying CBFM is that communities participating in decision-making are in the best position to manage and protect forests sustainably (Duthy & Bolo-Duthy, 2003).

Initially, there were 331 legitimate members of KBFAI. Membership sharply decreased before 2000 and stabilized at slightly less than 100 by 2010. KBFAI was a well-known CBFM Agreement holder in the Philippines engaged in different DENR-supported activities to conserve timberlands. Through agroforestry adoption, it trains other communities to strengthen their organization and improve their upland farms. In 2012, it was recognized by the DENR for its "Good CBFM Practice," and in 2018, it was awarded the "Best CBFM Model in the CALABARZON region."

Agroforestry is a concept that has been introduced in the Philippines. Members of KBFAI adopted agroforestry systems that could alleviate their well-being. Since the 1960s, smallholder farmers have traditionally raised trees, crops, and animals. However, their integrated farming system was abandoned as they shifted to modern agriculture focused on monocropping using commodity crops for exports, such as coconut, rice, and banana. Before adopting agroforestry, upland farmers in the study area had cultivated rice. However, using expensive external farm inputs, such as fertilizer, seeds, and pesticides, was difficult to sustain because of meager capital resources. Continuous application of fertilizer led to soil acidity. Growing a single crop increases the risk of failure due to unproductive soil and increasing pest and disease occurrences. Intensive farming, declining farm productivity, and increasing indebtedness posed a disturbing challenge to the upland farmers of Sta. Catalina. Some farmers have yet to know about sustainable upland farming, like agroforestry.

After being introduced to agroforestry technologies in the early 1980s, KBFAI farmers continued to practice agroforestry. After being introduced to agroforestry technologies in the early 1980s, KBFAI farmers continued to practice agroforestry. However, there was a pressing need for comprehensive documentation regarding the specific agroforestry technologies adopted, context, benefits of agroforestry to the farmers, and the various challenges they faced that constrained the continuity of the farming practice. This study examined the types of agroforestry practices of KBFAI farmers, the characteristics of these farmers, and their perceived economic, social, and environmental benefits in agroforestry technology adoption. The constraining and enabling factors in agroforestry technology adoption among the KBFAI farmers were also explored.

METHODOLOGY

Location of the study

The study was conducted in Barangay Sta. Catalina, Atimonan, Quezon, in the mid-southern part of Luzon (**Figure 1**), with a latitude of

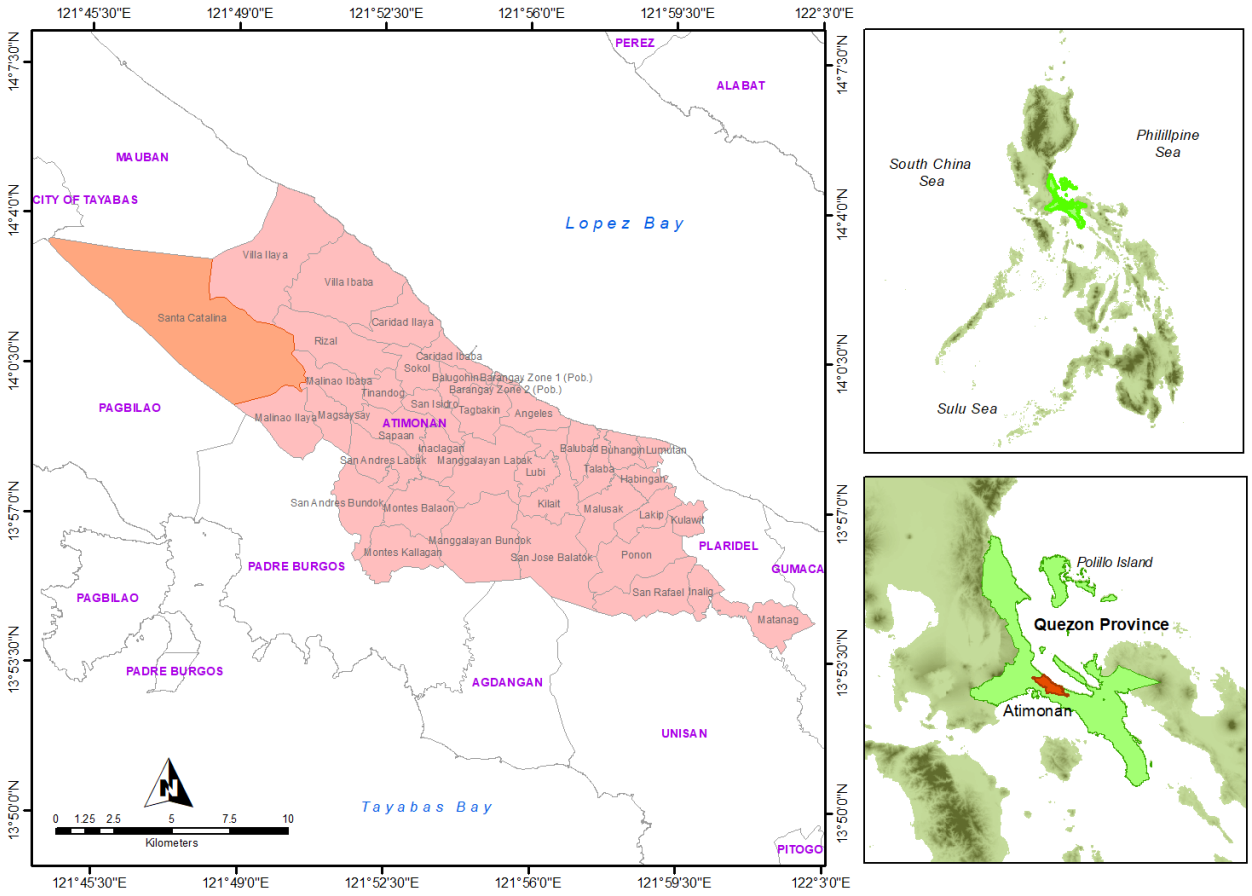

Figure 1. Study location showing Barangay Sta. Catalina.

14°1' N, a longitude of 121°48' E, and an altitude of 64 m or 121.97 ft above mean sea level (m asl). In 2020, the barangay had a population of 2,723, representing 4.24% of Atimonan (PSA, 2020). The majority of the KBFAI members resided in Sta. Catalina, particularly in Sitios Kailogan, Bantakay, Banabahan, Hubilyuhan, Gitna, and Sapinit. Some members resided in the Municipality of Pagbilao, an adjacent town of Atimonan.

KBFAI has been a recipient of various programs and projects since the 1980s. In 2004, a Regional Training Center (RTC) was constructed in Sitio Bantakay with the support of the DENR. This now serves as the venue for community training of the DENR, with KBFAI officers serving as resource persons. This center also serves as the office of KBFAI.

Research design and conceptual framework

This case study generates a thorough description of the agroforestry practices of KBFAI members through qualitative research. To collect primary data and understand agroforestry farming practices, immersion in the study site was done from June to July 2019 for continuous observation, farm visits, interviews, interaction with farmers, farm sketching, transect walk, and photo documentation. Continued stay in the area facilitated focus group discussion (FGD) with farmers and survey using a semi-structured interview schedule. Additional data was collected in September and October 2022 for validation with KBFAI leaders and photo documentation. Secondary data (mostly maps and reports) were also secured from local government units and the DENR. KBFAI was selected as the study organization since it has practiced agroforestry for over three decades. Moreover, the organization has been a long-term partner of the DENR and was recognized for its successful CBFM project implementation in 2012 and 2018.

Informed consent and permission to stay in the study site were first secured by consulting the officers of KBFAI. Other formal requests to stay in the area were sent to the concerned local government units. Field visits were made for site familiarization and to finalize the checklist of questions for the FGD and survey instrument using a semi-structured interview schedule. These visits also helped determine the type of secondary data needed. The survey interviewed 50 KBFAI members. In the FGD, all nine participants were officers of KBFAI. Data gathered were analyzed using descriptive statistics.

Agroforestry technology adoption by KBFAI members is influenced primarily by their perceived economic, social, and environmental benefits of the technology (**Figure 2**). However, this techno-adoption process is not a linear engagement. Other factors are at play in agroforestry adoption: the characteristics of the adopters, characteristics of the agroforestry system and variant technology, and the continuing challenges and enabling factors encountered during the technology adoption process.

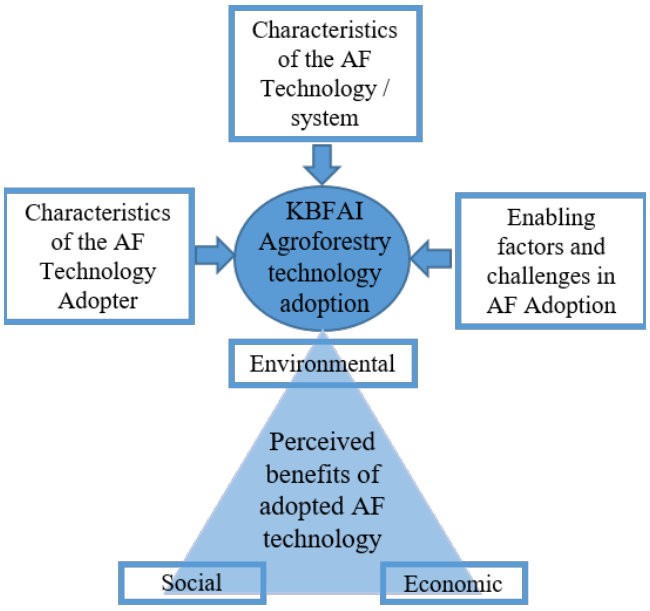

Figure 2. Conceptual framework of the study.

Sampling method

In the conduct of the survey, purposive sampling was employed. The sampling method was applied to members of KBFAI practicing agroforestry. Official membership of KBFAI was listed at 331 in 2019, but less than 10% (only 31 members) were actively participating (DENR-CENRO-Calauag, 2019). In 2020, the CBFM Compliance Monitoring Report for KBFAI of the CENRO showed the active participation of 67 members only (26 males and 41 females), approximately 20% of the total members listed (DENR-CENRO Calauag, 2020). Given the variability of active membership, it was decided to interview 50 KBFAI members, representing 70% of those in the 2020 active list or 15% of the outdated KBFAI members list. The selection was based on active membership in KBFAI and agroforestry adoption.

RESULTS AND DISCUSSION

Characteristics of KBFAI agroforestry technology adopters

Demographic characteristics

Men and women equally represented the respondents. Of the 50 active KBFAI members interviewed, the majority (40%) were middle-aged, with the range of 45-59 years, followed by senior members, 60-80 years (32%). Those between 18-25 and 26-44 years totaled 28% of respondents.

The senior members were mostly active in CBFM activities since they had ample time to attend meetings. Among the adult, active members were those who lived near the KBFAI office or in areas where the officers resided. In Sitio Hubilyuhan, the remotest village from the KBFAI office, only the president of the People's Organization (PO) attended meetings. Instead, members living far from the office preferred to wait for announcements or updates. Of the 50 respondents, 38% (19) lived in Sitio Bantakay, where the KBFAI office is located. Their proximity allowed them early and easy access to useful information, especially on income-generating opportunities. Those from two villages close to the KBFAI office – Sitio Kailogan and Sitio Sapinit – constituted 28% and 24%, respectively.

Most KBFAI respondents (28%) have five family members, and the average family size is 5.2. This is higher compared to the population census of the Philippine Statistic Authority (PSA) on the average household size in 2015 and 2020, which were 4.4 and 4.1, respectively. Such family size is considered small for an agricultural community in the Philippines, where households are usually large, owing to a greater number of children and accommodation of close relatives expected to help in the farm and livelihood activities, house chores, or errands. In terms of educational attainment, more than half of the respondents (53%) completed elementary education. Some (21%) finished high school, and only three were college graduates. Farmer respondents could read and write despite their low educational attainment, traced to the absence of schools in the area and their exposure to farming activities. Only one elementary school was found in the area; barangay high schools and colleges were absent. Poor households would be heavily indebted to put up the travel and lodging allowance if their schooling children push for higher educational pursuits. Without a scholarship or outside support, school-age children had to be content with an elementary diploma. Some children also believed that it was their duty to help their parents (this is common among the eldest child) so the family would survive. Older children may forego their dream of higher education to take care of younger siblings, especially when the family is large and secondary or tertiary schools are located several kilometers away from the house.

Each family member, whether in nuclear or extended type, was socialized to perform a function needed to maintain harmony and the structural integrity of the family as an institution. Most senior respondents mentioned that the family's survival matters most, so they spend more time producing or finding food than being educated. In Sta. Catalina uplands, farming requires adaptive skills and long experience dealing with poor soil conditions. Many were engaged in farming since childhood because this was an expected role. Farm parcels were small since the land tilled by KBFAI members was classified as timberland. Before the DENR intervention, local farmers mostly used the slash-and-burn or *kaingin* system to clear the forest vegetation. Income derived from cash crops raised on the small farm was augmented by charcoal making, a quicker way to earn cash every 15-20 days. Branches and tree trunks for charcoal production were removed from the upper slopes of Sta. Catalina and other timberlands, far from the farms. This clearing activity eventually provided additional farm parcels. So, the bigger the family, the more workers were utilized to engage in labor-intensive *kaingin* and charcoal making. More males in the family may entail higher charcoal production and, thus, higher cash income. These livelihood strategies were destructive to the forest cover of Atimonan and nearby coastal plains. Therefore, the government had to introduce agroforestry technologies and other livelihood training to help the farmers and save the forests.

Farm decisions and stewardships by gender

Regarding decision-making on farming activities, men (66%) usually decide since they are more capable of performing labor-intensive activities such as land preparation, plowing, and harrowing. The farm was the domain of married men, who were expected to be present to make the farm yield produce that may be sold for income generation. They managed and solved problems related to the farm. Women (14%) involved in farm decision-making were widows and single parents. Only seven respondents (20%) indicated that males and females managed farms together. This result is consistent with the findings of Torreta (1992) in the study site, claiming that both husbands and wives jointly made farm decisions. However, husbands did most of the strenuous activities in land and farm preparation, harvesting, and post-harvesting, livestock raising, charcoal making, and fuel wood gathering.

For land stewardship, 45 respondents (90%) have been long-time KBFAI members and were CSC recipients handed out in the early 1980s. Five were new members who applied for stewardship but had yet to obtain the stewardship tenure. Some couples, both KBFAI members, applied for separate stewardship but were given only one CSC. Torreta (1992) indicated that in 1990, 47 women were awarded the CSC in Sta. Catalina

under the FAO-UNDP-ISFP, and most recipients were KBFAI members.

Livelihood and income sources

More than half of the respondents (27 farmers) planted coconuts as a major component of their agroforestry farms. Copra making ranks high because of a ready market and ease in generating copra. This livelihood activity does not require sophisticated skills, and when the price of copra goes up, the copra farmer earns well. The widespred growth of coconut in the area is due to the wide adaptability of the crop, available folk knowledge on coconut production and farm maintenance, and the steady supply of income every 45 days once the coconut is mature for harvest. Accessibility of the copra market is another reason. Copra buying stations are found within a 5 km radius of Sta. Catalina. Copra buyers in Atimonan and the adjacent towns of Pagbilao and Lucena City can readily pick up copra if the farmer cannot deliver it to the station.

Fourteen farmers raised forest and fruit tree seedlings in family nurseries as part of the KBFAI-CBFM program. This enterprise's high number of respondents indicates that the PO has a thriving business selling timber tree seedlings to different clients. KBFAI's good standing as a CBFM partner of the DENR made the latter patronize the seedlings needed for reforestation and disseminate to other organizations about KBFAI's collection. Some farmers were also engaged in off-farm work to augment income. These included operating a sundry or "sari-sari" store and engaging in construction work, particularly for young male members. Some senior citizens derived additional income from monthly pensions and financial support from relatives.

For many KBFAI members, more than on-farm income was needed to meet the needs and aspirations of family members. They augmented their income with off-farm work, especially when the agricultural work demand was low. Off-farm work provided immediate cash regularly. More regular income was derived from store operations, remittances, paid work in the barangay, transport service, and contractual work in construction. Household members helped generate additional income through off-farm work, whether their contribution was high or low. For instance, they helped produce handicrafts (rattan baskets, tiger-grass brooms, and bracelets from discarded tree parts), which the KBFAI initiated and put on sale. These crafts were not generating substantial income as they needed to be better promoted outside the barangay, and that product display within the RTC was intermittent.

Typology and characteristics of agroforestry technologies adopted

Nair (1993) classified agroforestry based on the type of components: agrisilviculture (trees + crops), silvopastoral (trees + animals/pasture), agrosilvopastoral (trees + crops + pasture/ animal), and others (*i.e.*, multipurpose tree lots, apiculture with trees, and aquaculture with trees). In the study site, farmers practiced variations in agroforestry technologies adopted as they acquired experience and understanding of their circumstances and their relation to what farming practices are suitable.

Out of 50 respondents, 46 adopted the agrisilviculture agroforestry system using multistorey mixed cropping (**Table 1**). Under this system, more than half of the respondents (27) adopted a coconut-based multistorey mixed-cropping type. According to ICRAF (2021), a multistorey agroforestry system has at least three "storey" or "layers" of intercropped plants of different heights. The multistorey agroforestry cropping design of respondent adopters was also composed of different layers depending on the height of the crops. The upper layer included the large trees that produce timber for construction or furniture; the middle layer comprised the smaller trees (*e.g.*, many fruit trees and coconut palms), followed by bananas and coffee. There were cassava and herbaceous crops for the lower layers, like leafy green vegetables (*e.g.*, pechay and mustard).

Mixed cropping (2-3 crops) was commonly observed in the coconut-based multistorey agroforestry system. The understorey crops (mostly fruit trees) were randomly planted in

spaces not covered by upper-layer plants, utilizing the sunlight penetrating the ground. Unlike intercropping or alley cropping, mixed cropping follows no definite pattern of crop configuration except for the plants in the upper canopy layer (for optimal growth and yield, coconut spacing is maintained at 7 m x 7 m at the very least). Many farmers find this most convenient in areas with steep slopes. Some farmers divided their land into parcels: some were intended for mixed cropping using fruit trees as understorey crops, while others were devoted to annual cash crops for optimal growth, easier maintenance, and management.

Other agroforestry farming systems were also observed. Four members practiced the agrosilvopastoral system. Aside from trees, the farmers tended livestock, did apiculture (raised bees for honey), or grew ornamentals, including the high-valued anahaw (*Livistona rotundifolia*) palm, as part of their agroforestry practice, with timber trees at the upper canopy layer serving as the animals' shelter against heat. Livestock included bees, chickens, and pigs, although some pigs became threats to young timber or fruit tree plantations, especially those that were not fenced. Economic benefits were visibly derived from apiculture and poultry. Harvested honey was marketed, as well as chicken meat. In addition, chicken dung was utilized as fertilizer in the agroforestry system. Livestock needed high maintenance in matters of feed and sanitation. Thus, the contribution of livestock to farmers' overall income could have been higher. Furthermore, seven members planted trees in farm boundaries to serve as windbreaks.

Table 1. Typology of agroforestry technology and their variants (crop/tree and animal components) adopted by the respondents.

Type of agroforestry based on component and system	Agroforestry component		
	Woody/Perennial/Palm	Annual	Animal
Agrisilvicultural	1. Anahaw, rambutan, langka, chico, santol	Pechay, mustasa	
(Multistorey)	2. Avocado, lanzones, mangga, cacao, gmelina, ipil-ipil, lanete, makaasim		
	3. Avocado, lanzones, mangga, cacao, mahogany, gmelina, ipil-ipil, lanete, makaasim	Banana, pineapple, taro, cassava	
	4. Avocado, lanzones, mangga, cacao, mahogany	Banana, pineapple	
	5. Avocado, rambutan, langka	Banana, pineapple, gabi	
	6. Avocado, rambutan, langka	Banana, pineapple, taro	
	7. Avocado, rambutan, langka, mahogany, narra	Banana, pineapple, gabi	
	8. Avocado, rambutan, mangga, mahogany, batino, narra, kalantas	Pineapple, taro, sili	
	9. Avocado, rambutan, mangga, mahogany, batino, narra, kalantas	Pineapple, taro	
	10. Avocado, rambutan, mangga, mahogany, batino, narra, kalantas	Pineapple, taro	
	11. Avocado, rambutan, mangga, mahogany, batino, narra, kalantas	Pineapple, taro, sili	
	12. Batino, narra, kalantas, bagtikan, guayabano, durian, dalungyan	Taro, cassava	
	13. Coconut	Banana, pineapple, taro, cassava	
	14. Coconut	Banana, taro, cassava	
	15. Coconut, avocado, lanzones, mango, cacao	Banana	
	16. Coconut, avocado, lanzones, mangga, cacao, mahogany	Banana, pineapple, taro	
	17. Coconut, avocado, lanzones, mangga, cacao, mahogany	Banana, pineapple, taro, cassava	
	18. Coconut, avocado, lanzones, mangga, cacao, white lauan, red lauan, mabolo, molave	Banana, pineapple, taro	
	19. Coconut, cassava, calamansi, mahogany, batino, narra, kalantas	Pechay, ginger	
	20. Coconut, gmelina, ipil, lanete, makaasim	Banana, taro, cassava	

Table 1. (Con't)

Type of agroforestry based on component and system	Agroforestry component		
	Woody/Perennial/Palm	Annual	Animal
	21. Coconut, gmelina, ipil-ipil, lanete, makaasim	Banana, pineapple, taro, cassava	
	22. Coconut, gmelina, ipil-ipil, lanete, makaasim	Banana, pineapple, taro	
	23. Coconut, gmelina, ipil-ipil, lanete, makaasim	Banana	
	24. Coconut, mahogany	Banana, pineapple, taro, cassava	
	25. Coconut, mahogany, batino, narra, kalantas	Banana, pineapple, taro	
	26. Coconut, mahogany, batino, narra, kalantas	Banana, pineapple, taro, cassava	
	27. Coconut, mahogany, gmelina, ipil-ipil, lanete, makaasim	Banana, pineapple, taro, cassava	
	28. Coconut, mahogany, batino, narra, kalantas	Papaya, taro, cassava	
	29. Coconut, mahogany, batino, narra, kalantas	Banana, cassava	
	30. Coconut, rambutan, langka	Banana, taro, cassava	
	31. Coconut, rambutan, langka	Banana, taro, cassava	
	32. Coconut, rambutan, langka	Banana, pineapple, taro, cassava	
	33. Coconut, white lauan, red lauan, mabolo, molave	Banana	
	34. Coconut, white lauan, red lauan, mabolo, molave, calamansi	Pineapple, banana	
	35. Mahogany, batino, narra, kalantas	Banana	
	36. Mahogany, mahogany, batino, narra, kalantas	Banana, cassava	
	37. Mahogany, narra, gmelina, ipil-ipil, lanete, makaasim, calamansi	Banana, taro	
	38. Mahogany, narra, gmelina, ipil-ipil, lanete, makaasim, calamansi	Banana, taro	
	39. Malunggay, guayabano, gmelina, ipil, lanete, makaasim	Cassava, taro, ginger, sili, tomato	
	40. White lauan, red lauan, mabolo, molave	Banana, sili, taro	
	41. White lauan, red lauan, mabolo, molave	Banana, sili, taro	
	42. White lauan, red lauan, mabolo, molave	Banana, sili, taro	
	43. White lauan, red lauan, mabolo, molave	Banana, sili, taro	
	44. White lauan, red lauan, mabolo, molave	Banana, sili, taro	
Agrisilvicultural	1. Coconut, anahaw, mahogany, coffee, mangachapoi, bagtikan	Pineapple	
(Multistorey and alley cropping			
Agrosilvopastoral	1. Coconut, anahaw, mahogany, coffee, mangachapoi, bagtikan	Pineapple	Bee, pig, chicken/ turkey
(Multistorey)	2. Coconut, avocado, lanzones, mangga cacao, mahogany, gmelina, ipil-ipil, lanete, makaasim	Banana, pineapple, taro, cassava	Pig
	3. Coconut, calamansi, white lauan, red lauan, mabolo, molave	Banana, pineapple, ginger, taro	Chicken, pig
	4. Coconut, malunggay	Banana, pineapple, taro, cassava	Bee

One farmer member adopted an alley cropping system type of agroforestry. The alley cropping system was regularly promoted during the KBFAI training on agroforestry, as this was widely adopted in upland farms in Mindanao in the 1980s. When the ISFP was launched in 1982, the Community Forestry Program (CFP) in 1989, and the implementation of the Center for People's Empowerment in the Uplands in 1992 (a highly selective program based on the potential and desirable characteristics of the PO), the prospective recipient-partner of the Stewardship Agreement had to undergo training in agroforestry, land management, enterprise development, and forest conservation. Given the slopes' steepness of many upland farms in Sta. Catalina, alley cropping was promoted to secure the farms' long-term productivity and protect soil, water, and biodiversity.

One respondent continuously practiced alley cropping, integrating pineapple and other cash crops in the narrow alleys developed through contoured hedges of leguminous shrubs. This system is one of the most labor-intensive agroforestry designs, especially in establishing contours and the consequent alleys. The steeper slopes can accommodate narrow alleys, while the lower areas can have wider alleys. All except one farmer discontinued the alley cropping practice due to aging and high maintenance of the alleys. To be successful in alley cropping, there is a need to rearrange the timberland to allow sunlight penetration, slow down the erosion of topsoil through the establishment of choice hedges, and constant intervention to maximize the complementation of the nutrient-rich hedges to the cash crops in the alleys. Given the labor demand and attention needed, alley cropping appears to work well when farms are nearby, with young farmers, or with those households having many adult males.

With the advancing age of KBFAI farmers, many favor the coconut-based mixed cropping agrisilviculture. Coconut is highly preferred as it grows easily and with low maintenance requirements while allowing farmers to grow other crops in between. Through the years of embracing different DENR-initiated programs, KBFAI members learned to integrate fruit trees into their coconut farms and to secure cash income. While waiting for the season of harvest and wages, they also planted short-term annuals – vegetables and root crops of different kinds and ornamentals. The respondents prefer a coconut-based multistorey mixed-cropping agroforestry system since they want a stable monthly income from coconuts. Coconut growing fits well with the aging population who have less energy for intensive farming while allowing them modest income every 45 days, the interval of coconut harvest. Once established, coconut requires less maintenance, and wide spacing allows fruit trees to grow without close management. Many respondents owned *coprahan* facilities for processing. Besides selling coconut in whole, they also processed the coconut meat into copra for sale to Quezon traders.

The coconut-based multistorey cropping system is one of the highly successful systems since this accommodates crops of different heights, canopy patterns, and root systems to maximize the use of sunlight, water, and nutrients (Sharma *et al.*, 2020). This promotes efficient cycling, ecological balance, and, subsequently, sustainable land use and maintains an ecological balance. In multistorey cropping, the existing planted trees are managed as an overstorey with an understorey of the woody or non-woody plants grown for various products. It allows simultaneously growing diverse plants of different heights in the same field (USDA, 2008). A multistorey cropping system is a very effective technique to counter degrading land use under farming, promoting sustainable productivity and profitability (Dutta & Gogoi, 2020).

KBFAI members knew they could not cut naturally growing timber trees in their farmlands because they are in timberlands. As DENR partners, they planted timber tree species on farm boundaries and steeper slopes as shelterbelts or windbreaks in compliance with their stewardship contract's 20% timber tree retention requirement. The less steep areas were planted with coconut, fruit trees, and short-term agronomic crops.

Table 2 shows the species planted by the respondents on their farms. The timber trees mostly planted by farmers were Mahogany and Falcata, both are fast-growing species. These trees were promoted during the CFP launched by the DENR in the early 1990s. Avocado, dalanghita or native orange, pineapple, and banana were the common fruits integrated into the coconut-based agroforestry system. Only a few farmers incorporated livestock, poultry, piggery, and apiculture in their upland farms. Farmers who could incorporate livestock in their agroforestry system have farms on less steep slopes than the majority that had a different favorable condition.

Forest trees were spaced at 2 m x 2 m or 3 m x 3 m apart for optimal growth. Tree strips also serve as windbreaks to protect the smaller crops from being easily damaged by strong winds and rainfall commonly occurring in the study site. The same system is applied to fruit plantations commonly intercropped with coconut palms. In areas with agronomic crops, the coconut palms were widely spaced, at 7 m x 7 m, to allow enough sunlight to

Table 2. Typology of agroforestry technology and their variants (crop/tree and animal components) adopted by the respondents.

Local name	Scientific name	Local name	Scientific name	Local name	Scientific name
Timber tree		Fruit tree/palm		Crop species and others	
Mahogany	*Swietenia macrophylla* King	Avocado	*Persea gratissima* Gaertn.	Banana	*Musa sapientum* L.
Batino	*Alstonia macrophylla* Wall. ex DC.	Lanzones	*Lansium domesticum* Correa	Pineapple	*Ananas comosus* (L.) Merr.
Narra	*Pterocarpus indicus Willd. forma indicus*	Mangga	*Mangifera indica* L.	Gabi	*Colocaisa esculenta* (L.) Schott
Kalantas	*Toona calantas Merr. & Rolfe*	Cacao	*Theobroma cacao* L.	Balinghoy	*Manihott esculenta* (Crantz)
Bagtikan	*Parashorea malaanonan* (Blanco) Merr	Dalanghita	*Citrus reticulata* Blanco	Malunggay	*Moringa oleifera* Lamk
White Lauan	*Shorea contorta* Vidal	Rambutan	*Nephelium lappaceum* L.	Ginger	*Zingiber officinale* Rosc.
Red Lauan	*Shorea negrosensis* Foxw.	Langka	*Artocarpus heterophyllus* Lam.	Sili	*Capsicum fructescens* L.
Kamagong	*Diospyros discolor* Willd.	Chico	*Manilkara sapota* (L.) Royer.	Tomato	*Solanum lycopersicum* L.
Molave	*Vitex parviflora* Juss.	Durian	*Durio zibethinus* Murr.	Tiger grass	*Thysanolaena latifolia* (Roxb. ex Hornem.) Honda
Gmelina	*Gmelina arborea* Roxb.	Dalungyan	*Artocarpus altilis* (Park.) Fosb.	Ube	*Dioscorea alata* L.
Ipil	*Instia bijuga* (Colebr.) O. Ktze.	Mangosteen	*Garcinia mangostana* L.	Palay	*Oryza sativa* Linn.
Lanete	*Wrightia pubescens* R. Br. subsp. *laniti* (Blanco) Ngan	Coffee	*Coffea arabica* L.	Pechay	*Brassica rapa subsp. chinensis* (L.) Hanelt
Makaasim	*Syzygium nitidum* Benth.	Guayabano	*Annona muricata* L.	Mustasa	*Brassica juncea* (L.)
Narig	*Vatica mangachapoi Blanco*	Santol	*Sandoricum koetjape* (Burm. f.) Merr.	Apiculture	
Gakakan	*Drypetes falcata* (Merr.) Pax & K. Hoffm	Coconut	*Cocos nucifera* L.	Poultry	
Palosapis	*Anisoptera thurifera* (Blanco) Blume	Anahaw	*Livistona rotundifolia* (Lam.) Mart.	Piggery	

herbaceous crops underneath while allowing the coconuts to spread well under their canopy. This configuration supports complementary relations and efficient space utilization.

Perceived benefits from the adoption of agroforestry

Respondents' decisions to adopt an agroforestry system depend on their perceived environmental, economic, and social benefits. The study by Jha *et al.* (2021) indicated that adopting agroforestry improves the adaptive capacity of farmers, the resilience of local farming systems, and the provision of diversified livelihood benefits. Likewise, Gebru *et al.* (2019) emphasized that agroforestry improves socioeconomic conditions and environmental health. Improving farmers' resilience is an outcome of improved livelihood that agroforestry affords. This leads to better access to fuelwood, fodder, timber, non-timber forest products, employment, and income opportunities.

Environmental benefit

Agroforestry benefits farmers and the environment (Mwase *et al.*, 2015) as this can improve agronomic productivity, enhance carbon sequestration, nutrient cycling, soil biodiversity, water retention, pollination, and reduce soil erosion (Sollen-Norrlin *et al.*, 2020). During the FGD, participants relayed that adopting agroforestry reduced soil erosion in their farms because planted trees protected the soil from the battering impact of heavy rains. In addition, the trees also protected the vegetable crops and livestock during strong winds and heavy rainfall. This was also the case with the coconut-based mixed cropping systems, the fruit tree mixed cropping with timber trees, and the agrosilvopastoral systems adopted by the KBFAI farmers. Planting different crops made the development of root matrices possible, allowing for the absorption and adsorption of nutrients and water storage. The primary roots of timber and fruit trees improved water absorption, while the lateral roots developed by coconut, trees, and annuals obstructed surface water flow and erosion of topsoil. The canopy layers slowed down the flow of rainwater through interception and prevented heavy splashing on the surface, thus, reducing soil erosion. According to Sharma *et al.* (2020), soil erosion is minimized if farmers grow more than one crop in the same field. In addition, it helps store water for the survival of other crops and lessens the risk of pests and diseases brought by diversification. Gebru *et al.* (2019) also claimed that agroforestry minimized soil erosion, helped decrease the incidence of natural hazards and floods, and ameliorated the microclimate.

Moreover, FGD participants shared that there was a significant change in farm productivity since they shifted to the mixed cropping system. Soil texture changed because of the presence of high biomass contributing to soil fertility and, at the same time, the filtering effect of the roots and debris on the floor, slowing down the surface flow along the slopes. Diversification of plants or crops and the proper selection and spacing of plant mixtures resulted in sustainable farming.

Economic benefit

Farming is the main source of income in the upland areas. Through the adoption of agroforestry, KBFAI farmers have generated substantial income without resorting to the previously practiced *kaingin* system. Makundente *et al.* (2020) highlighted the importance of relevant government agencies in encouraging farmers to practice agroforestry to benefit from crop yields and additional income from the sale of tree products. The economic benefits of agroforestry technology adoption validate the suitability of agroforestry as an upland production strategy. Its continued practice further proves the income position of KBFAI farmers.

The majority of KBFAI farmers adopted the coconut-based multistorey agroforestry system. Before agroforestry adoption, the members relied on selling fresh coconut harvest or extracted coconut oil, which was sold at a low price. With agroforestry, KBFAI members were no longer dependent on coconut income alone. They derived income from harvested fruit trees or agronomic crops planted along with coconut and timber trees and sales of tree seedlings. The short-term crops, seasonal fruit harvests, and seedling sales

provided economic relief and freedom from being cashless for a long time.

Active members of KBFAI maintained the PO-owned nursery by weeding or removing unwanted sprouts regularly to maintain the seedling quality. In 2019, as part of the CBFM program, the KBFAI members sold guayabano seedlings in the community from their nurseries. Raising seedlings for sale was still in its infancy. Members are in the trial-and-error stage of the germination process, learning more about soil suitability, preparation, and pest and insect attack prevention.

People in upland areas engaged in different ways to earn. The agroforestry system provided food and non-food forest products. Aside from selling fruits and working in *coprahan*, basket and bag weaving, tiger broom making, and bracelet making (out of rolled paper) were also practiced by the members. These crafts were made mostly by female members during their free time while having casual conversations with other KBFAI members.

The products served as a source of additional income. Attractive designs for baskets, bags, and bracelets made them saleable at a reasonable price. These products were displayed in the RTC and the public market. Residents of Atimonan have been encouraged by their local government to patronize hometown-made products. Sales started to pick up but dipped low during the pandemic period.

The monthly income (**Table 3**) indicates the average income derived by the respondents from theiron-farm and off-farm livelihood. On average, farmers earned PHP 1,800 from selling *copra*. This amount needs to be improved to meet the basic needs of farmers in 2018. Income was augmented through other livelihood options adopted as part of the agroforestry system design. One member shared that in 2018, his family earned around PHP 100,000 from tending 13 heads of pigs. From this revenue, that member was able to build a house with two rooms for his family. Other agroforestry farm produce helped meet the farm-household daily needs (*i.e.*, fuelwood and fruits).

Some financially challenged members, particularly middle-aged farmers, sought alternative income sources. They took off-farm work in either construction, transport service, or operating a small neighborhood sundry store (sari-sari store) that may fetch around PHP 6000-8000 mo-1 extra income. Other additional income may be derived from the KBFAI-initiated livelihood for its members, such as basket weaving, bracelet making, and nursery maintenance.

Social benefit

For most KBFAI members, as relayed during FGD and interviews, the training on agroforestry helped them revisit their traditional way of farming prior to the modernization of agriculture in the 1960s and 1970s, which made farmers shift to monocropping, use of early maturing, high-yielding plant variety, and application of chemical and fertilizer inputs to obtain a high yield from planted rice, and short-term crops. The expected high yield was short-lived, and less than a decade after adoption; the farmer was saddled with debts due to increasing production requirements and the rising cost of fertilizer and pesticides. Due to modernization, many were forced to sell their farms in the lowland and move to timberlands. Recognizing that the government owned these lands and banned tree cutting without a permit, the informal settlers had to implement a quick way of earning money – through the adoption of the *kaingin* system and charcoal making (during timberland clearing, the trees or branches cut were made into charcoal for sale). Kaingin making was the easiest way to acquire additional farm parcels in forestlands. The clearing allowed them to raise short-term crops and make available cash income at the expense of the environment. With declining soil fertility and farm productivity through continued land use, the KBFAI farmers realized the unsustainability of the practice. This pushed them towards deeper poverty condition.

The formal training on agroforestry revitalized upland farming in Barangay. Sta. Catalina. The training helped them re-imagine the techniques of their ancestors and the attendant cultural values and beliefs. Re-integration of trees and other farm components was compatible with their early beliefs on land use; hence, the formal training

Table 3. Estimated average monthly on-farm & off-farm income of the KBFAI member respondents.

Type of livelihood sources	Specific livelihood income sources	Frequency	%	Estimated average monthly income by respondents (PHP)	Remarks
On-farm sources					
	Coprahan	27	54	1,800.00	
	Piggery (13 heads farmer-1)	3	6	833.00*	Experience from a single farmer
	Charcoal making	2	4	600	
	Selling crops	5	10	400	
	Poultry	1	2	2000	
	KBFAI: Nursery maintenance	14	28	400	
Off-farm sources					
	Construction work	2	4	800	
	Truck and tricycle driving service	2		5,000.00	
	Sari-sari store operation	7	14	6,000.00	
	Pension/ support from relatives	7	14	6,000.00	
	Barangay. wage work	2	4	2,600.00	
Under KBFAI					
	Bracelet making	5	10	100	
	Basket weaving	4	8	1,000.00	

easily found its application in many KBFAI members' farms

Oduniyi & Tekana (2019) concluded that membership in the farmers' association is a significant variable in adopting agroforestry practices. The KBFAI became a channel of new knowledge about agroforestry, increasing the PO's trustworthiness to its members. Members who saw and experienced the able and sincere leadership of KBFAI made them confident to adopt agroforestry technologies and maintain their membership in the organization.

KBFAI members' training from the various government and non-government agencies helped them improve their social and technical skills. Aside from agroforestry training conducted by the DENR from 2010-2012, members participated in the Forest Products Research and Development Institute (FPRDI) training through its project funded by the International Tropical Timber Organization (ITTO). This training included organizational development and management, basic handicraft skills, craftsmanship development (advanced handicraft skills), product development training, product costing, product trading and documentation process, product quality and quality management, product storekeeping, and booth fair management (FPRDI-ITTO, 2012). During these two years, the members were given a package to develop and market forest-based products and the PO capacity to handle business. On the other hand, the members' social capital developed through friendships, camaraderie, connections, and linkages with government agencies to voice their concerns without fear during public fora and conferences, to which the PO leaders were consistently invited. Individual members were also encouraged to share their experience and knowledge about agroforestry farming, particularly on planting

and maintenance. Jara-Rojas *et al.* (2020) claimed that social capital and networking could be crucial in spreading agroforestry as a sustainable land use practice. Oduniyi & Tekana (2019) suggested strengthening farmers. The presence of farmer associations, particularly in rural areas, significantly contributes to the diffusion of agroforestry technologies.

The agroforestry system adopted by the KBFAI members was beneficial due to the multiple products it provided. Although agroforestry was earlier practiced, knowledge and skills were not widely disseminated nor homogenized, and the benefits mainly accrued to individual farmers only. The social capital that allowed for greater interaction and connectivity did not improve because not all members actively participated in PO-led activities. This also did not deter upland residents from continuing its *kaingin* and charcoal making that destroyed many upland zones, especially in Barangay. Sta. Catalina, the fragile uplands and watershed connecting to Lamon Bay, bordering many Atimonan and Quezon coastal communities.

Past experiences were given due consideration in the current agroforestry technology diffusion process, which emphasized collective development, the conservation of the upland environment, the maturing of the KBFAI so that it can continue to deliver the services needed by the members, and the continued development of members' knowledge on organization and management, technical skills, and life skills. The benefits of the latter agroforestry training accrued to individual members and the KBFAI organization.

Disabling and enabling factors in the adoption of agroforestry

Sollen-Norrlin *et al.* (2020) raised several challenges in adopting agroforestry technologies. High costs of implementation, lack of financial incentives, limited agroforestry product marketing, and lack of education, awareness, and field demonstrations are some lingering concerns in agroforestry technology adoption.

In the case of KBFAI, most members belonged to the senior citizen category; thus, the farmers' time to manage and maintain their agroforestry system needed to be improved. In many agroforestry farms, there was overshading due to the DENR-funded National Greening Project (NGP) that the PO implemented. The project required participating KBFAI members to plant indigenous timber tree species in the area covered by the CBFM Agreement, where the farmers already maintained their agroforestry practice. After the DENR monitoring and payment, the senior KBFAI members were forced to cut the younger indigenous trees to remove competition posed by these trees to the fruit trees and cash crops established as components of their agroforestry practice.

Another challenge or disabling factor pertains to the DENR's changing policy regarding timber trees planted by KBFAI members in keeping with the 20% tree retention requirement of their stewardship contract since 1984. Those who planted timber species earlier in response to the ISFP in the early 1980s and the CFP in the 1990s wished to cut the mature trees ready for harvest. However, DENR implemented the logging ban (supposedly applicable only to natural stands) as stated in Executive Order 23, series of 2011. As relayed by the participants, the DENR suspended the tree harvesting permit. It dampened the spirit of KBFAI members and made them suspect the DENR's programs overall. Harvested timber of high-value tree crops planted by KBFAI members could transform their economic condition due to the country's high demand for construction and furniture wood. Climate change impacts such as typhoons also challenged their agroforestry farming system and livelihood sources. The vulnerability of the agroforestry farms diminished but not substantially reduced.

Finally, quarrying in the upper part of Sta. Catalina affected the farms of agroforestry practitioners as big stones cascaded into their farms and disturbed wild animals, particularly the wild pigs. The pigs now frequented their farms and devoured crops.

Enabling factors in agroforestry technology adoption

Participants in the FGD mentioned that agroforestry technology adoption made farmers more innovative and drawn to voluntary engagement to contribute to environmental restoration. Many respondents in the past were involved in *kaingin* and charcoal making, two livelihood practices that degraded their environment. Although the KBFAI prohibited *kaingin*-making, a few continued this practice due to perceived benefits and socio-economic reasons. After attending training and seminars, negative behaviors had been reduced substantially, with only a few KBFAI members continuing the environment-destructive practices (purportedly to improve the quality of acidic soil from the ashes produced in forest debris burning).

The rocky areas on the upper slopes of Sta. Catalina also prevented some farmers from improving their agroforestry farms due to limited space to grow agricultural and forest crops. Some members did not manage their areas before because they believed they could not plant their preferred crops according to their desired arrangement due to rocky surfaces. Some farmers, however, did not see the rocks as a deterrent. They became innovative and utilized the rocks for fencing purposes. Rocks stood out aesthetically and protected the crops threatened by livestock or wild animals.

The lack of concrete plans about tree harvesting permits for planted trees created confusion as to whether the farmer could harvest the timber species planted in past programs as promised. Although the approved Community Resource Management Framework (the operational plan facilitated by the DENR-CENRO) was formulated by the KBFAI, members have yet to enjoy income from harvested trees. This is the primary reason some farmers were discouraged from sustaining agroforestry practices, alongside the delayed returns to investment because tree farming has a 20- to 30-year gestation period for slow-growing species. The only thing that KBFAI members thoroughly enjoy is the tenure that guarantees access and control over the timberland covered by their stewardship contract or CBFMA.

Despite the challenges, KBFAI members continued to practice agroforestry because the benefits far outweighed the costs and burdens. As shown in **Table 4**, there are enabling factors in adopting the agroforestry system. KBFAI membership enabled upland farmers to value the ecological services of the surrounding timberland, contribute meaningfully to protecting the environment, and help individual members through training

Table 4. Identified enabling and disabling factors in the adoption of agroforestry during FGD.

	Enabling factor	Disabling factor
Social	Build connections/linkages with the government and non-government agencies	Lack of concrete plans for tree resource harvesting/utilization
	Devoted leaders; trustworthy leadership	Aging farmers
	Training and seminars improved competencies	
Environment	KBFAI has good and well-equipped facilities	Water supply problems and some rocky road areas
	Have a strong CBFM	
	Provision of land stewardship (CSC)	
Economic	AF products provide continued income	Need for more marketing outlets for AF products and handicrafts
	KBFAI projects helped members to generate more income	

to build their competencies, enhance soil productivity, and provide the means to improve their way of life and social status. Once permitted, economic rewards from timber harvesting would tilt the balance in favor of sustained agroforestry practice.

CONCLUSION

Adopting agroforestry technologies provided the KBFAI members with multiple benefits from the multiple products and services that the technology provides, encompassing environmental, economic, and social benefits. Most (46 out of 50) of the KBFAI member respondents adopted the agrisilviculture (trees + crops) type of agroforestry system in Barangay Sta. Catalina, Atimonan, Quezon. Under this system, more than half of the KBFAI members adopted a coconut-based multistorey mixed cropping agroforestry system that entails less maintenance, especially for aging KBFAI members. The agroforestry system is the primary income source for all KBFAI members. It helps members in creating livelihood programs through food or non-food products. Non-food product livelihood includes bag and basket weaving, broom and bracelet making, while food products produce fresh and dried fruits and chips.

Membership in KBFAI serves as a vehicle for social capital and human capital development. Individual members became technically and psychologically skilled, while the KBFAI increased in quality leadership and improved its networks and physical assets. Empowered leaders led the association to seek support from government agencies to strengthen environmental protection and rehabilitation in the area. Soil erosion and *kaingin* making were no longer widely observed in the area with the adoption of agroforestry technologies by almost all members. Trees on farms protected crops from strong winds and heavy rains.

Sustainability issues on agroforestry are still raised since the younger generation was not interested in farming. Most KBFAI members reached 60 to 80 years old, an age range of less agility. Senior members needed to be more successful in encouraging their young to engage in agroforestry farming. Despite their awareness of agroforestry benefits, the youth mostly preferred to work in white-collar jobs. The restrictions on timber harvesting also dissuaded many KBFAI members from tree-growing or adopting tree-based multi-cropping system. Respondents practiced multistorey mixed cropping because it was hard to apply preferred agroforestry designs in spaces planted to timber as required by their new project with the DENR (NGP site) and filled with rocks. They adopted a multistorey agroforestry system with coconuts, bananas, and other crops requiring less maintenance and with an established market.

This study provided insights into the different species combinations of the woody perennials and non-perennial agroforestry components. Sources of off-farm income that augment farmers' household income are also revealed in this study, along with the social, economic, and environmental enabling and disabling factors in adopting the agroforestry system.

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