AJSTR ASEAN JOURNAL OF SCIENTIFIC AND TECHNOLOGICAL REPORTS
ONLINE ISSN: 2773-8752

Research article

Increasing Sweet Potato (Ipomoea batatas) Root Crop Yield Based Scientific Participatory Research

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Citation:
Lacaba, M.; Villanueva, R.; Tadios, L.; Tan, N. Increasing sweet potato (Ipomoea batatas) Root Crops Yield based participatory scientific Research. *ASEAN J. Sci. Tech. Report.* **2023**, *26*(3), 24-35. https://doi.org/10.55164/ajstr.v26i3.249375.

Article history:
Received: May 3, 2023
Revised: June 16, 2023
Accepted: June 22, 2023
Available online: June 28, 2023

Abstract: This study aims to improve sweet potato production in the Philippines by identifying the challenges facing sweet potato farmers and providing effective interventions to address these issues. Participatory Action Research (PAR) was used to foster community participation and action and to establish a baseline profile of farmers, assess participation rates, evaluate interventions using high-yield varieties and proper training on the use of the stem-cutting system and staggered planting, and identify challenges after the intervention. The mean age of the participants was 52.44 years old, indicating that they belong to the marginalized adult group, and their average monthly income from sweet potato production was relatively low. In addition to sweet potato farming, the key informants are also engaged in other crop production, such as rice (100%), banana (89%), cassava (67%), corn (67%), taro (67%) and potato (22%). Regarding fertilizer use in sweet potato farming, key informants use urea and complete 14-14-14 fertilizers. Using NSIC Sp-36 and UPL Sp-17 varieties combined with staggered planting and stem-cutting techniques effectively increases sweet potato yield per hectare. The total yield from the scientific interventions was 8,000 kilograms or 8 tons, twice the target yield of 4,000 kilograms or 4 tons. While the adaptation of the farming strategy effectively increased to 160% actual yield, there is a low market demand due to the lack of production takers, which constrained the success of this intervention. Moreover, some farmers could not attend the activity, which is essential to note. These interventions can potentially improve the productivity of sweet potato farming and increase food security and income for small-scale farmers. However, there is a need to intensify the marketing strategy.

Keywords: New variety; percent of yield loss; staggered planting; sweet potato

1. Introduction

Sweet potato (SP) is the seventh most important crop globally and the fifth most important food crop produced annually [1]. The world consumption of the said crop reached up to 130 million metric tons in 2017. China is the top global producer, with approximately 7.2 million metric tons, followed by Malawi at about 5.4 million metric tons. The same year, the Philippines ranked

22nd among the countries producing sweet potatoes with only 537,303 metric tons [2].

Based on the aforecited data, there is an excellent opportunity for sweet potato farmers/producers. In the 2017 International Potato Center (IPC) data, the Philippines has made few contributions to overcoming the global market's challenges. The center has reported that the Philippines' sweet potato production has been declining. It used to be 250,000 hectares in 1980, and in 2017 it is less than 80,000 hectares. There is a gap of 170,000 hectares over the three decades. The IPC has suggested that the government's best way to fill this gap is to link the farmers to the market through science and technology intervention.

In 2017, the volume of sweet potato production was contributed mainly by Bicol Region at 44,958 metric tons, followed by central Luzon at 31,459 metric tons. The third-largest contributor was Eastern Visayas at 25,363 metric tons. Sweet potato recorded a 1.7 percent gain from 133.94 thousand metric tons in 2016 to 136.25 thousand metric tons. This was explained by the increase in area planted in Caraga due to adequate rainfall during planting time and the bigger tubers harvested in Eastern Visayas because of sufficient soil moisture [3]. However, in June 2018, the production volume in Eastern Visayas decreased to 24,676 metric tons, with almost 960 metric tons of production loss in just a year. Samar, one of the provinces in Eastern Visayas, recorded a decrease of about 14% from 3,647 ha planted/harvested in 2012 to 3,135.10 ha grown/harvested in 2018 [3]. This problem is due to a lack of clean planting materials, the type of sweet potato varieties used by the farmers, and the traditional planting strategy.

In Samar, the challenges sweet potato farmers face in relation to variety selection and traditional planting strategies significantly impact sweet potato production. The limited variety selection, primarily yellow and purple, poses several limitations. These dominant varieties may not fully meet the dynamic market demands for sweet potatoes, potentially resulting in missed opportunities to maximize yields, improve resistance to pests and diseases, and enhance market competitiveness. The lack of diversity in varieties restricts the potential for farmers to adapt to varying market preferences and exploit the full range of benefits offered by different sweet potato cultivars [4]. Moreover, the reliance on traditional planting strategies in Samar poses an additional hurdle to sweet potato production. These conventional methods, often passed down through generations, may no longer be aligned with modern agricultural practices and advancements. Consequently, these outdated techniques fail to optimize productivity and efficiently utilize land and resources. Farmers adhering to traditional planting strategies may miss opportunities to increase yields, improve resource efficiency, and overcome challenges associated with climate variability and other environmental factors [5].

The limited variety selection and traditional planting strategies in Samar exacerbate the difficulties faced by sweet potato farmers, hindering their ability to achieve optimal productivity and compete effectively in the market. To address these challenges, interventions are needed to broaden the selection of sweet potato varieties and introduce modern farming techniques that align with current agricultural knowledge and best practices. By doing so, farmers in Samar can unlock the full potential of their land, increase their yields, enhance pest and disease resistance, and improve their overall market competitiveness. Farmers in Samar, Philippines, are small landholders with an average farm size of approximately one to two hectares. The sweet potato varieties grown in the said areas are the yellow and purple ones. Basey is one of the municipalities in Samar with high market demand for sweet potatoes. There are associations in the said place that strengthen the farming and production of sweet potato commodities, such as the Balante Agricultural Farmers' Association and Women's Association. However, during the conduct of the project Support Systems for Sweetpotato Value Chain Development and Establishment of SP Value Chains in Leyte and Samar implemented by the Visayas State University-Philippine Rootcrops Research and Training Center (VSU-PhilRootcrops), the municipality of Basey was not one of the beneficiaries [6].

The challenge now is to train Balante Agricultural farmers on the propagation techniques through the stem-cutting system and staggered planting so that they produce high-quality and disease-free planting materials to increase sweet potato production eventually. The stem-cutting system used UPL Sp-17 and NSIC SP-36 varieties. According to the National Seed Industry Council [7], aside from being a high-yielding crop, these are also more resistant to pests, particularly from scab and weevil, which attack sweet potatoes. Generally, these varieties grow in all regions in the Philippines. To address these problems, this study aims to

improve the livelihoods and well-being of sweet potato farmers by identifying their challenges related to sweet potato production and providing effective interventions to address these issues. It specifically aims to: (1) establish a baseline profile of the key informants involved in the research study, including their demographics, income, and crop planting practices, to gain an understanding of the context of the study; (2) provide information on the participation rate of sweet potato farmers in the activity or program being conducted, and assess the impact of the interventions; (3) provide evidence of their effectiveness in improving sweet potato production from 4 tons to 6 tons through the introduction of new varieties and scientific ways of farming, and (4) identify the challenges faced by sweet potato farmers in terms of selling their products and the lack of cooperation among members of the farmer association.

2. Materials and Methods

2.1 Research design

The study adopted a Participatory Action Research (PAR) approach, which is well-suited to the objectives of this research. PAR is an approach that emphasizes community participation and action. In line with the first objective, the study aimed to establish a baseline profile of the farmers involved, including their demographics, income, and crop planting practices [8]. This would provide an understanding of the context of the study and the needs and challenges facing the farmers in sweet potato production. In line with the second objective, the study aimed to provide information on the participation rate of sweet potato farmers in the activity or program being conducted. This would help measure the interventions' impact and assess their effectiveness. The PAR approach used in the study would facilitate the participation of the farmers in the research activities, allowing for more accurate data collection and analysis.

Third, the study aimed to assess the impact of the interventions and provide evidence of their effectiveness in improving sweet potato production. Using staggered planting and the stem-cutting system was expected to increase sweet potato production. The PAR approach used in the study would enable the farmers to evaluate the interventions actively, ensuring that their perspectives and experiences were considered. Finally, to achieve the last objective, the study sought to identify the challenges faced by sweet potato farmers regarding the sale of their products and the lack of cooperation among members of the farmer association. To address this issue, the PAR approach was used to foster collective inquiry and experimentation. The researcher-agriculturist trained the farmers on staggered planting and the stem-cutting system, which was participatory, allowing the farmers to share knowledge and learn together. This was intended to facilitate the development of collaborative efforts through community empowerment. Overall, the PAR approach was highly suitable for this study, as it allowed for community participation, collaboration, and action. Through this approach, the study aimed to improve sweetpotato production by addressing farmers' challenges in selling their products and promoting cooperation within the farmer association.

2.2 Data collection method

2.2.1 Social preparations for a participatory approach

The researchers conducted social preparations to achieve the first three objectives of the study. This was carried out in a two-day session that included baseline assessments and focused group discussions (FGD) for the challenges of engaging in sweet potato farming. *Survey questionnaire:* The baseline profile of key informants was collected using a survey questionnaire. The questionnaire included questions about key demographic information, such as age and average monthly family income. It also had questions about sweet potato production, such as average monthly family income from sweet potato farming, other crops planted, and fertilizer use. The survey questionnaire was administered using a face-to-face approach with a guided approach. The researchers presented the questions orally during the first day of social preparation activities for the participatory research. This approach ensured that key informants clearly understood the questionnaire and could provide accurate responses. *Attendance sheet:* The researchers used an attendance sheet or register to monitor the attendance of study participants in participatory research. This involved creating a physical document or spreadsheet that allowed researchers to record the names of study participants, the dates and times of scheduled activities or meetings, and whether or not each participant attended. For several reasons,

collecting attendance data during the research process among sweetpotato farming interventions is important. Firstly, it allows researchers to track participant engagement and ensure they are actively involved in the intervention activities. By monitoring attendance, researchers can identify participants struggling to attend or engage with the program and provide additional support or resources as needed. Secondly, attendance data can be used to assess the effectiveness of the intervention. If attendance rates are consistently high, it may suggest that participants find the program valuable and motivated to continue participating [9]. On the other hand, low attendance rates may indicate that the program needs to be adjusted, or additional support must be provided to help participants engage more effectively. Finally, attendance data can be used to evaluate the overall success of the intervention. By tracking attendance over time, researchers can assess whether the program meets its goals and objectives and make adjustments to ensure that the intervention effectively improves sweet potato farming practices and outcomes.

2.2.2 Focused Group Discussion (FGD):

After the scientific farming intervention, an FGD was conducted. This aimed to identify the various challenges faced by farmers in sweet potato farming. The FGD involved 32 farmer participants divided into four groups of eight members each. The groups discussed the challenges existing farmers' organizations encountered in sweet potato farming and provided reasons why training interventions were needed. This approach allowed for a deeper understanding of the challenges faced by farmers in sweet potato farming, as well as the specific needs of farmers' organizations in terms of training and support. By conducting the FGD during the first day of the participatory research training, participants could establish a strong foundation for future research and interventions based on a shared understanding of the challenges and needs of the community.

2.2.3 Experimental process

The researchers trained the 32 farmers and followed these Philippine Rootcrop [4] standards for sweet potato farming: *Use of clean planting materials:* The clean planting materials were acquired from Philippine Rootcrops, Baybay Leyte, and after 2 months, the demo farms became the source of SP clean planting materials through stem cutting. The demo farms are located adjacent to Samar State University-Basey Campus, a one-hectare agricultural land. In the first demo farm UPL Sp-17 was planted and NSIC Sp-36 in the second demo farm. The planting materials per hectare were approximately 40,000 cuttings (1,800 kg). Since there are two farms or the equivalent of 2 hectares to serve as nurseries and sources of planting materials for other farmers, the needed planting materials were approximately 80,000 cuttings (3,600 kg).

The stem cutting system (SCS) was the stage of planted SP from five to six leaves, and stems were cut from the plantlets with a sterile surgical blade. The stem cutting consisted of at least one axial bud and two leaves. *Fertilizer, nutrient, and water management.* In terms of nutrient content, fertilizers were applied two weeks after planting. For vegetative growth, a complete fertilizer (14-14-14). Then one and half months after planting, another set of fertilizers using a combination of nitrogen and potassium for a bulking period. The amount of fertilizer for each sweet potato hill was approximately 0.5 grams. The depth typically varies for water management from two (2) to six (6) inches. After five to 10 days, root depth can range from four (4) to eight (8) inches depending on moisture uniformity and the presence of a hard pan. The varieties introduced to the farmers are considered 'sun-loving' and do not necessarily require to be watered daily. *Pest and disease management.* There was crop sanitation to prevent or eradicate sources and vectors of pests and diseases. Planting materials should be healthy and pest and disease-free. Old plant materials, weeds, or volunteer plants that could act as an infestation source for the new crop were removed. Crop rotation prevents the build-up of crop-specific pests and diseases in one field area. Cultural control also included using pest and disease-free planting materials, growing the crop in ways that increase its resistance against pests and diseases by ensuring it is not suffering from soil nutrient deficiencies or water stress, and growing it in a climate it is well suited to. If any of the growth factors are sub-optimal, the crop will become stressed, and when plants are stressed, they have less resistance to pests and diseases. A healthy plant may be more resistant to attack by pests or diseases. *Harvesting period.* A specific schedule of activities prepared by the research team was given to the farmer-

cooperators to ensure the timely execution of technology interventions. Part of the research team is an agriculturist who handles training and discussion of root crop safety handling from planting to post-harvesting. The agriculturist was around during the demo farm applications.

3. Results and Discussion

3.1 Data analysis

For the survey questionnaire, demographic data such as age, average monthly family income, sweet potato production, other crops planted, and fertilizer were analyzed using descriptive statistics such as percentages and mean. The attendance data collected through the attendance sheet were analyzed using descriptive statistics to calculate the attendance rate for all the training conducted in social preparations. The total yield is calculated by adding the actual yields for each variety to evaluate the effectiveness of the scientific interventions. The target yield is then determined by dividing the actual yield by the percentage actual yield. This allows for a comparison between the target yield and the actual yield, providing insight into the success of scientific interventions in increasing yield production. For the FGD, a thematic analysis was conducted to identify common themes and patterns in the challenges faced by farmers in sweet potato farming. The study was performed manually or using the software NVivo. The identified themes were presented in a narrative presentation.

3.2 Baseline Profile of the Study Samples

The findings presented in Table 1 offer a valuable baseline profile of the 18 key informants involved in the study. The mean age of the participants is 52.44 years, indicating that they belong to the marginalized adult group, highlighting the importance of addressing their specific needs and challenges. The average monthly income of the participants, excluding their earnings from sweet potato farming, is Php 6,883.33. This figure sheds light on the economic circumstances of the informants, providing insights into their financial situation beyond their involvement in sweet potato production. Regarding income derived explicitly from sweet potato farming, the participants' average monthly earnings amounted to Php 1,116.67. This figure is relatively low compared to the estimated family income of Php 22,000.00 in 2015, as reported by the Philippines Statistics survey [10]. This suggests room for improvement and potential for increasing revenue through interventions to enhance sweet potato production and marketing strategies. The profile of the research participants also includes their educational background. The findings indicate that among the participants, 16.67% have had no schooling, 38.89% have reached elementary level education, 16.67% have graduated from elementary school, 11.11% have earned high school level education, 5.55% have graduated from high school, and 11.11% have pursued college-level education.

Furthermore, the key informants are involved in other crop production alongside sweet potato farming. They all cultivate rice, while 89% are also in banana production. Additionally, 67% of the participants grow cassava, corn, and taro, showcasing their diverse agricultural activities. A smaller percentage, 22%, cultivate potatoes as well. Regarding fertilizer use in sweet potato farming, the data reveals that 22% of the informants utilize urea only, while 27.78% apply a combination of urea and complete 14-14-14 fertilizers. These findings highlight the prevailing practices in fertilizer application among the participants and can inform future interventions and recommendations regarding appropriate fertilizer usage for optimal sweet potato production.

The baseline profile of the research participants provides valuable insights into their demographic characteristics, income levels, educational backgrounds, and engagement in other crop production. Understanding these aspects is crucial for designing interventions that address the specific needs and challenges sweet potato farmers face. The income, educational background, and crop diversification findings can guide efforts to enhance income generation, improve agricultural practices, and support sustainable livelihoods in the study area.

Table 1. Profile of the Research Participants as Baseline Data

Profile (n=18)	Result
Mean Age	52.44-year-old
Educational Background	No Schooling (3 or 16.67%) Elementary Level (7 or 38.89%) Elementary Graduate (3 or 16.67%) High School Level (2 or 11.11%) High School Graduate (1 or 5.55%) College Levels (2 or 11.11%)
Average Monthly Income (Other than engagement in sweet potato farming)	Php 6, 883.33
Average Monthly Income on Sweetpotato Production	Php 1, 116.67
Planted crops other than Sweet potato	Rice (18 or 100%) Banana(16 or 89%) Cassava (12 or 67%) Corn(12or67%) Taro(12or67%) Potato (4 or 22%)
Fertilizer Used	Urea only (4 or 22%) Urea and Complete 14-14-14 Combination (5 or 27.78%)

3.3 Participation Rate of Sweetpotato Farmers

The high participation rate of sweet potato farmers (91%), as shown in Table 3, indicates that they are willing to attend activities related to their farming practices. This result is significant as it implies that the farmers are interested in improving their sweet potato production and are willing to invest their time and effort to attend related activities.

However, despite the high participation rate, it is essential to note that there are still farmers who could not attend the activity, as shown in the average number of absences (3) and percentage of absences (9%). The in-depth interviews conducted by the researchers revealed that the lack of participation of other informants is a common challenge the farmers face. Identifying the reasons behind their absence and addressing them accordingly is essential to improve their participation rate.

Table 2. Participation Rate of Sweetpotato Farmers

Number of participants	Average number of attendees	% of participation	Average number of absences	% of absences
32	29	91%	3	9%

3.4 Yield per Hectare through Scientific Interventions

The table presents data on sweet potato yield per hectare through scientific interventions for two different varieties of sweet potato: NSIC Sp-36 and UPL Sp-17. The data shows the number of cuttings used, the cutting losses (20%), the cutting survival (80%), the theoretical yield (in kilograms) [11], and the actual yield (in kilograms) for each variety.

Table 3. Sweet potato Yield per Hectare through Scientific Interventions

Variety	Number of Cuttings	Cuttings losses (20%)	Cuttings Survival (80%)	Target (Theoretical) Yield (kilograms)	Actual Yield (kilograms)
NSIC Sp-36	33,000	2760	18,400	2,300	4,600
UPL Sp-17	7,000	2040	13,600	1,700	3,400
TOTAL	40,000	4,800	32,000	4,000	8,000
% actual yield= actual yield/theoretical yield*100					200%

For NSIC Sp-36, 33,000 cuttings were used, 20% of which were lost, leaving 26,400 surviving cuttings. The target theoretical yield was 2,300 kilograms per hectare, but the actual yield was 4,600 kilograms per hectare. For UPL Sp-17, 7,000 cuttings were used, 20% of which were lost, leaving 5,600 surviving cuttings. The target theoretical yield was 1,700 kilograms per hectare, but the actual yield was 3,400 kilograms per hectare. The total number of cuttings used for both varieties was 40,000, with 4,800 cuttings lost and 32,000 surviving. The theoretical yield for both varieties combined was 4,000 kilograms per hectare, but the actual yield was 8,000 kilograms per hectare. The percentage of actual yield achieved compared to the theoretical yield is 200%, indicating that the real yield exceeded the target yield by two times. The data suggests that the scientific interventions used in sweet potato cultivation using staggered planting successfully increased the yield for both sweet potato varieties. The high yield obtained from the scientific interventions indicates that these interventions can improve the productivity of sweet potato farming. Using NSIC Sp-36 and UPL Sp-17 varieties combined with staggered planting and stem-cutting techniques effectively increased the yield per hectare. However, it is essential to note that there were yield losses of 20%, which is not negligible. This could be due to several factors, such as pest infestation, disease, or other environmental factors. Future studies could further investigate ways to reduce these yield losses and improve overall yield per hectare.

Adopting new sweet potato varieties and improved farming techniques has significantly increased yield per hectare. Research studies support the use of NSIC Sp-36 and UPL Sp-17 varieties. A study by Aikpokpodion and Osaigbovo [12] found that the NSIC Sp-36 variety had a high yield potential and was suitable for cultivation in other countries like Nigeria. Another study by Khan et al. [13] reported that UPL Sp-17 exhibited good resistance to pests and diseases and had a high yield potential in India. Moreover, staggered planting and stem-cutting techniques have improved sweet potato yields. A study by Adal and Abraha [14] found that staggered planting increased the number of vines per hectare and yielded a higher product than traditional planting methods. Additionally, stem-cutting techniques have been reported to increase the number of plants per hectare, resulting in higher yields [15]. The statement further indicates that the total yield from the scientific interventions was 8,000 kilograms (8 tons), twice the target yield of 4,000 kilograms (4 tons). This demonstrates the potential of these interventions to improve the productivity of sweet potato farming significantly. Using NSIC Sp-36 and UPL Sp-17 varieties combined with staggered planting and stem-cutting techniques effectively increases sweet potato yield per hectare. These interventions can potentially improve the productivity of sweet potato farming and increase food security and income for small-scale farmers.

3.4 Challenges

3.4.1 Lack of Production Takers

According to the participants, some of them take it negatively because of low market demand due to a lack of production takers, as presented in the following utterances. *"waray namon nababaligyaan kay adi manla kami nagbabaligya* (we have no place to sell the commodity because we are selling it here in the locale)"- Key Informant 3. "*waray namon ginbabaligyaan, han hani ginsusudoy nam dinhi* (we have no place to sell the commodity, we just sell it by roaming around the community)"- Key Informant 4. "*it am baligya waray nam permanente nga ginbabaligyaan tapos nagbabaligya ngani kami diri nauubos* (We have no permanent location to sell

the commodity, and even if we tried selling it, it remained unsold)"- Key Informant 8. "*it problema an pagbaligya namun kay waray man nam naabaligyaan kay nasusumo na ginbabaligyaan nasusumo nala kay adlaw-adlaw* (the problem is we have no other targets to whom we can sell the commodity, buyers tend to refuse since it is regularly done)"- Key Informant 9. *"Diri gud naiimod, magbaligya man kami ha bungto kulang napalit* (we cannot sell them all, even we sell it in thetown proper of Basey there are few buyers)"- Key Informant 11.

The study's results showed that using the two new sweet potato varieties introduced to the key informants increased yield per harvest. However, the success of this intervention is constrained by the low market demand due to the lack of production takers, as mentioned by some of the key informants in the study. The inability to sell their sweet potato crops in a permanent location or to find enough buyers affects their motivation to continue planting and selling sweet potatoes. The key informants reported that they only sell their crops within the community or by roaming around the locality (Key Informants 3 & 4). Some also expressed that they have no permanent location to sell their products, and even if they tried selling them, they remained unsold (Key Informant 8). Moreover, Key Informant 9 stated that they have no other targets to sell their sweet potato, and buyers tend to refuse since it is regularly done. This means buyers are already accustomed to periodically buying from the same group of farmers and may not have enough demand for more sweet potatoes from other sources. Key Informant 11 added that even selling the sweet potatoes in the town proper of Basey resulted in few buyers, making it challenging for them to sell their products.

3.4.2 Presence of Conflict Among Farmer Association Members

Another identified problem contributing to the percentage of absences is the lack of cooperation among association members, as provided in the following responses of Key Informants. They are looking forward to the organization's unity such as *"Magka-urusa diri mag inaragway* (united and with no conflict)"- Key Informant 1, *"Magburubligay, mag-iristorya hin maupay para waray samok, mag-urusa* (Helping each other, discuss things in good ways to avoid conflict, unity)" - Key Informant 5, *"magburublig kami hit am grupo, para maupay it amon pagkaurusa, magburubligay* (help each other in the association so we can work together)"-Key Informant 6, "*An akon la han amon asosayon han amon bug-os nga magburublig kami* (For me, the members of association must work together)" - Key Informant 10, *"Kada miyembro magburublig ngan mayda nakatoka nga trabahuon* (each member must help and must have assignment of work)" - Key informant 12, "*Angay nga magburubligay ada pagtrabaho para diri makuri* (everyone must help so work will be easier)" -Key Informant 15, and *"bublig nga umunlad ito baga asosasyon, ngan magkamayda miyembro nga upayon gud, urusa kay maginaragway kit ano man it mahihimo? (everyone must help in the association, a member who is willing for the improvement of the association, as one, if we are more into conflict will it contribute to the association*)" - Key Informant 16.

The results indicate that lack of cooperation among association members is a significant factor contributing to absenteeism, and the key informants recognize this as a problem. They emphasize the importance of unity, teamwork, and communication in overcoming this problem. Key Informants 1, 5, and 16 all mention conflict as a hindrance to the association's progress and stress the need for resolving it. Key Informants 5, 6, 10, 12, 15, and 16 all emphasize the importance of working together, helping one another, and having assigned tasks to ensure the smooth functioning of the association. It is evident from the responses that the key informants understand the value of teamwork and its effect on the association's progress. They recognize that the lack of cooperation and conflicts can affect the association's functioning and, in turn, result in absenteeism. The key informants' responses suggest that the association needs to foster a sense of unity, trust, and cooperation among its members to address the absenteeism problem effectively. This can be achieved by promoting open communication channels, developing a culture of teamwork and collaboration, and establishing a clear hierarchy of tasks and responsibilities.

The participatory approach was central to this study, ensuring the active involvement of the key informants, sweet potato farmers, in every research stage. The study recognized the farmers as experts in their own right, valuing their knowledge, experiences, and perspectives. The participatory approach empowered the farmers through collaborative decision-making and problem-solving and allowed their voices to shape the study's design and implementation. This inclusive approach promoted a sense of ownership among the

farmers, fostering their commitment and motivation to improve sweet potato production. By actively engaging the key informants, the study aimed to enhance the interventions' relevance, effectiveness, and sustainability, ultimately benefiting the farmers and their communities.

The findings, including the participants' age, income, educational background, and farming practices, are a testament to the participatory nature of the study. The insights gained through this approach will help guide future interventions and recommendations, ensuring they are tailored to the specific needs and aspirations of the farmers and ultimately contributing to the overall success and impact of the study. The mean age of the participants is 52.44 years old, indicating that they belong to the marginalized adult group. This finding is consistent with previous research on rural communities in the Philippines, which shows that older adults often face challenges related to poverty and limited access to resources [16]. The average monthly income of the participants, other than from engagement in sweet potato farming, is Php 6,883.33, which is lower than the estimated family income in 2015 of Php 22,000.00 based on the Philippines Statistics survey results [3]. This suggests that the key informants may face economic challenges that could impact their ability to invest in their farming practices and improve their yields. Furthermore, the key informants are engaged in various crop production, including rice, banana, cassava, corn, taro, and potato. This finding is consistent with previous research on small-scale farming communities in the Philippines, which shows that farmers often engage in multiple crop production to diversify their income sources and reduce risks [17]. Regarding fertilizer use in sweet potato farming, most key informants (73%) do not use complete 14-14-14 fertilizers. Instead, only 4 out of 18 key informants (22%) use urea only, while 5 (28%) apply a combination of urea and complete 14-14-14 fertilizers. This suggests that there may be room for intervention in providing education and resources to key informants to improve their fertilizer use practices and ultimately increase their yields.

The high participation rate of sweet potato farmers in the study (91%) is a positive finding attributed to their interest in improving their production. However, the study also revealed that some farmers could not attend the activity, as indicated by the average number of absences (3) and percentage of absences (9%). To address this challenge, it is important to identify the reasons behind the farmers' lack and address them accordingly. For example, providing incentives such as transportation allowances, refreshments, or training certificates may motivate farmers to attend the activity [18]. Additionally, organizing the action at a convenient time and location may increase participation rates [19]. Adopting new sweet potato varieties and improved farming techniques has increased yield per hectare dramatically. Research studies support the use of NSIC Sp-36 and UPL Sp-17 varieties. A study by Aikpokpodion and Osaigbovo [12] found that the NSIC Sp-36 variety had a high yield potential and was suitable for cultivation in other countries like Nigeria. Another study by Khan et al. [18] reported that UPL Sp-17 exhibited good resistance to pests and diseases and had a high yield potential in India. Moreover, staggered planting and stem-cutting techniques have improved sweet potato yields. A study by Adal and Abraha[1] found that staggered planting increased the number of vines per hectare and yielded a higher yield than traditional planting methods.

Additionally, stem-cutting techniques have been reported to increase the number of plants per hectare, resulting in higher yields [19]. The statement further indicates that the total yield from the scientific interventions was 8,000 tons, twice the target yield of 4,000 tons. This demonstrates the potential of these interventions to improve the productivity of sweet potato farming significantly. Using NSIC Sp-36 and UPL Sp-17 varieties combined with staggered planting and stem-cutting techniques effectively increases sweet potato yield per hectare. These interventions can potentially improve the productivity of sweet potato farming and increase food security and income for small-scale farmers. However, while improved sweet potato varieties can increase yield, the lack of a stable market for smallholder farmers remains a significant challenge. Developing market linkages and promoting value addition can help smallholder farmers improve their income and livelihoods. This finding is consistent with previous studies that have identified the absence of a stable market as a significant barrier to increasing the revenue and productivity of smallholder farmers [20,21]. Further, the lack of cooperation and conflict among members of farmer associations has been identified as a common problem in many smallholder farming communities. This issue can significantly impact the success of collective action for community development and agricultural productivity [22]. Therefore, addressing the

lack of cooperation and conflict among the association members is essential to improve their productivity and livelihoods. One possible solution is to facilitate regular meetings and forums for the members to discuss their concerns and develop a shared vision for their association [23]. Additionally, capacity-building programs on leadership, communication, and conflict resolution can be conducted to promote effective collaboration among the members [22].

4. Conclusions

In conclusion, this study sheds light on various aspects of sweet potato farming practices among small-scale farmers in rural communities in the Philippines. The findings underscore these farmers' marginalized status, economic struggles, and engagement in diverse crop productions. The study emphasizes the need for targeted interventions to enhance fertilizer use practices and address absenteeism issues during farming activities.

Furthermore, the study highlights the potential of adopting new sweet potato varieties and improved farming techniques to increase yield per hectare significantly. This increase in productivity can positively impact food security and income generation for small-scale farmers. However, challenges such as the absence of a stable market and cooperation conflicts among farmer associations must be effectively tackled. To address these challenges and improve the livelihoods of small-scale farmers, it is crucial to develop market linkages, promote value addition, and conduct capacity-building programs focused on leadership, communication, and conflict resolution. These interventions can be pivotal in facilitating the sustainable development of small-scale farming communities in rural areas. In summary, this study underscores the importance of ongoing research and targeted interventions to support the sustainable growth of small-scale farming communities. By addressing the identified challenges and leveraging the opportunities highlighted in this study, it is possible to empower small-scale farmers, enhance their resilience, and contribute to the overall development of rural areas.

5. Acknowledgements

The authors acknowledge the active participation of the farmers during the data collection, which significantly helped in the data-gathering process.

Author Contributions: M.-L, M.M., lead researcher, ensured the quality and integrity of the research process, from data collection to analysis, to interpretation of data; V., R.B., lead agriculturist, provided valuable insights and guidance on various aspects of agriculture, including crop cultivation, soil management, pest, and disease control, and irrigation systems; T., N.T., field in-charge, coordinated logistics, such as transportation, equipment, and supplies, to facilitate field activities; and T., L.A., English Language Expert, tasked to effectively communicate the research findings and insights to a broader audience, and ensured that the research paper is well-written, coherent, and engaging.

Funding: This research was funded by the Technology Transfer and Promotion Division (TTPD) of the Department of Science and Technology – Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (DOST-PCAARRD) and Center for Engineering Science and Technology Innovation (CESTI of the Samar State University, Samar, Philippines.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results".

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