Empowering smallholder bitter gourd farmers in Rizal, Laguna, Philippines towards sustainable and safe farming practices

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Abstract. Excessive use of pesticides in high-value crops proves detrimental to both health and the environment. This action research aims to evaluate farmers' food safety practices as basis in introducing interventions to empower them toward the adoption of good agricultural practices for safe and sustainable farming. In this study, bitter gourd farmers (n=30) from Rizal, Laguna, Philippines were randomly sampled and surveyed. Current agricultural practices of the farmer participants and sustainability gaps in production were determined to assess the factors that contribute to their existing knowledge. Based on the results, socio-economic variables such as age, income, poverty, years of farming, and tenancy arrangement were found to be associated with GAP-related practices. Most of the farmers were aware of the importance of reading the product label of pesticides before application, wearing protective equipment, and routine monitoring. Moreover, a training intervention that focused on the identified sustainability gaps was provided. Farmers were trained in integrated pest management, internal control system on pesticide use, and keeping records to equip them towards safe and sustainable farming. Training, monitoring, and other extension activities should be provided occasionally to the farmers for continuous adherence to these sustainable practices.

1 Introduction

The vegetable industry in the Philippines has a great potential for success. However, based on the data [1], vegetable production in the country is rising by over 2% annually, and vegetable growing space is expanding by 1.7%. The percent increase in vegetable production is not enough to satisfy local demand. As a result, even if the local farmers could provide consumers with more than USD 3 million worth of vegetables, the country would still opt to import other produce.

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Ampalaya is the most common name for the bitter gourd (*Momordica charantia L.*) in the Philippines. Due to its nutritional and therapeutic benefits, bitter gourd is among the top 10 most consumed vegetables in the country [2]. Bitter gourd is a good source of iron, folic acid, calcium, phosphorus, and vitamins A, B, and C. Aside from being nutritious, bitter gourd has long been used as a folk remedy, but recent research has shown that it is also a potent herbal remedy for a variety of illnesses [3]. Since pharmaceutical companies have started using bitter gourd as one of the main components in health supplements, production of it has significantly increased. Bitter gourd is only grown in *tumana*, or fertile mountainous upland locations; as a result, output is restricted. Most farmers use direct seeding as a method of planting to avoid the hassle of having to plant seeds in seed boxes and the tedious work of transplanting. However, during the rainy season wherein waterlogged soils can drown and retard the growth of seeds, farmers choose to grow seeds up to two weeks in a seedling tray and transplant them once the seedlings are grown enough to withstand heavy rains and adapt to climate changes in the fields. Growing bitter gourds can take up to 3-4 months depending on the variety planted.

In December 2022, the bitter gourd production in the Philippines was reported to be 984.000 PHP million. The previous figure for September 2022 was 880.000 PHP million, therefore this represents an increase. The statistics peaked at 1,501.000 PHP million in June 2022 and hit a record low of 130.000 PHP million in September 2000 [2]. Production of bitter gourds increased 2.7 percent to 20,134.70 MT, with the biggest output coming from Calabarzon at 7,371.21 MT, or 36.6 percent [4].

1.1 Conventional production and pesticide misuse

Conventional farming does not involve biotechnology applications and organic methods but instead uses traditional breeding techniques to produce faster growing crops of high yield, quality fruits and resistance to pests and diseases. To satisfy market demands, conventional crops would require specific nutrients and chemicals to achieve competitive quality for premium price. [6]

However, pesticide misuse and overuse frequently result in consequences. Studies have documented the negative impacts of pesticide to human health particularly on the farmer applicators and excessive usage of pesticides led to the contamination of the environment and food systems [7, 8]. Farmers exposed to pesticides working-by-hand face safety risk from residues in crops and soil and spray drift contact through skin and inhalation. Personal protection through proper handling and use of personal protective equipment (PPE) significantly decreases pesticide entry into biological system [9]. Effect of pesticide use on farmer health and productivity using production data from farm-level survey and health data from the same population of farmers in two rice producing regions in the Philippines then subjected to simulation analysis confirmed the negative impact on farmer health whereas a positive impact on productivity [10]. Reduction in insecticide usage in Philippine rice production is likely associated with positive social impact.

Misuse of pesticides was often attributed to prevalent misinformation of retailers with 88% not following recommendation standards that is, either excessive or inadequate dosages. A thorough investigation also revealed 79.2% suggested products related to just 6 mechanisms of action raising the dangers of pest resistance with all highly toxic pesticides could be substituted with less-toxic ones. [11]

In the Philippines, pesticide poisoning is a growing issue, and because vegetable farmers utilize mostly manual techniques, they are exposed to pesticides to a far greater amount than rice or maize growers. The exposure of young children, who are frequently involved in vegetable production from a young age, is especially concerning. In a study conducted in the Philippines' north-east Luzon Island, it was shown that schoolchildren begin working on vegetable patches as young as 6 to 9 years old. Their responsibilities included applying and preparing pesticides in addition to watering and other duties. After using chemicals, children had health problems such as headaches, skin rashes, and gastrointestinal pain [12]. Moreover, pesticide resistance in pests is caused by the frequent use of these compounds. However, farmers have used insecticides carelessly, doubling the recommended dosage. Similar to this, they commonly use chemical pesticides without taking into account the residues the chemicals leave behind or how they might affect customers. Selling vegetables exposed to too many pesticides poses a risk due to the potential high concentrations of pesticide residues [13].

Pesticide residues left from excessive application affect the crop itself, the soil, and the water. According to one study conducted in Sta. Maria, Pangasinan, insecticide residues were detected in soil tests from 42% of eggplant farms, and some of the detected pesticides exceeded the maximum allowable limit in eggplant. Profenofos, triazophos, chlorpyrifos, cypermethrin, and malathion were among the pesticides left behind in the soil, while cypermethrin and chlorpyrifos remained on one fifth of the crop samples [11].

1.2 Good Agricultural Practices (GAP) and Integrated Pest Management (IPM)

According to the Food and Agriculture Organization (FAO), food safety has become more and more crucial over time due to its effect on consumer health and the expansion of domestic and international food trade. To safeguard consumers from the risks of foodborne illnesses, safe food must be produced. Additionally, food safety is essential to food security and helps to boost export markets' competitiveness. At several points along the food chain, including primary production, secondary and tertiary processing, storage and distribution, and packaging, there may be risks to food safety. Therefore, it is crucial to start addressing food safety at the farm level. To guarantee a secure food supply, effective production techniques must be implemented both during production on farms and afterward. The term "Good Agricultural Practices" (GAP) refers to a set of guidelines for on-farm production and post-production procedures, according to the Food and Agriculture Organization (FAO) [14]. By taking into account aspects of economic viability, social well-being, and environmental sustainability, these principles seek to assure the development of nutritious, safe, and non-food agricultural goods. There is currently a growing emphasis on installing such systems because many importing nations as well as domestic customers, notably organized merchants, now demand manufacturers to implement GAP as a prerequisite for procurement to ensure the quality and safety of their produce.

In the Philippines, the Department of Agriculture [15] provided a set of guidelines and principles for GAP which include site selection and management, planting material and selection, water source, pest and animal control, fertilizers, and pesticides, harvesting, transportation, lastly, traceability and recall. The Regulatory Division of the Department of Agriculture is promoting and facilitating the Good Agricultural Practice Certification program to guarantee food safety and agricultural product quality while maintaining a high regard for environmental protection and worker health, safety, and welfare. It also aims to make it easier for Philippine agricultural products to access markets abroad and in ASEAN adjacent countries.

In a study conducted by Kharel et. al. [16], the unsystematic use of agrochemicals for commercializing output has recently put the sustainability of the vegetable business at risk. Adopting GAP may help commercial vegetable production use fewer agrochemicals. Using the mixed-method approach of farmers' surveys, key informant interviews, and in-depth interviews, the findings demonstrated that farmers were implementing a variety of good practices, including integrated pest management techniques, soil fertility management techniques, and cropping methods. The study concluded that adopting GAP encourages farmers to practice safe and sustainable vegetable production by lowering the usage of agrochemicals. The results suggested market-based approaches for making GAP-based production profitable, such as raising consumer knowledge among the public, guaranteeing premium prices using quality assurance systems, and encouraging its wider use. This can be supported by making government subsidies, pricing incentives, and insurance services more accessible to farmers and by expanding access to GAP inputs. This study intends to produce data on a sustainable and safe vegetable production model, which will be essential for Nepal to institutionalize GAP.

Meanwhile, several practices contributing to the sustainability of one agricultural system can be named such as the practice of crop rotation, at the same time, increasing the diversity of planted crops in a field. Numerous advantages, such as developing healthier soil and better pest control, can result from planting a variety of crops. Most sustainable agriculture practices involve the use of Integrated Pest Management (IPM). FAO [14] defined IPM as the means of carefully weighing all available pest control methods before integrating the necessary controls that prevent the spread of pest populations, limit the use of pesticides and other interventions to what is necessary economically, and minimize or eliminate risks to human health and the environment. The regular application of a variety of techniques, such as mechanical and biological controls, can keep pest populations under control while reducing the need for chemical pesticides. The sustainable and all-encompassing method known as IPM combines techniques for the cost-effective prevention and control of pests and diseases in crops. Pesticides (chemicals used to control pests) are only used when other approaches fail to achieve the desired outcome. IPM emphasizes healthy crop growth while causing the least amount of harm to agro-ecosystems and supports organic pest management techniques.

1.3 Empowerment of smallholder farmers

Farmers are at the center of the change of the food system. Smallholder farmers are at the vanguard of the change we need to see, from the sustainable management of the environment to cultivating more nutrient-dense food. They generate a significant amount of the world's food supply. Smallholders should be given the tools they need to participate actively in the agenda for the reform of the food system as producers and recipients [17].

Farmers play a crucial part in accelerating the transformation of the food system. Smallholder farmers in particular stand out as crucial players in enacting the necessary reforms, including sustainable environmental management and the production of nutrient-rich food. Their efforts have a significant impact on the world's food output. As a result, it is crucial to give smallholders the tools and skills they need to fully participate in the food system reform agenda as both producers and recipients [17].

Agriculture empowerment is crucial for enhancing food and nutrition security. Improving the targeting of important indicators that matter for policy and practice requires an understanding of the factors that influence farmer empowerment in agriculture. The majority of current research focuses on female empowerment, ignoring the equally significant factor of male empowerment. According to econometric findings of Mwololo et. al. [18] gender and empowerment in agriculture were positively and significantly associated, and even the same drivers had different effects on male and female farmers [18]. Therefore, empowerment programs should focus on both male and female farmers in order to make up for these discrepancies. Additionally, commercialization, accessibility to government extension services, and asset value were positively and substantially linked with empowerment in agriculture, pointing to additional avenues for enhancing empowerment in this sector.

However, farmers are able to overcome this obstacle. Their creativity and ingenuity are already having an influence, but if we want to succeed as a group, that impact must grow.

The article also made the case that farmers could decide to grow food that is suitable for the local ecosystem, for instance by relying on indigenous and traditional crops, particularly those with superior nutritional value. Groups of farmers are reviving millet cultivation in parts of Africa like Senegal and Niger, revealing its many advantages as a staple grain. In one Nigerian project, this local crop was produced on a modest scale and distributed to nearly 20,000 people in 28 villages, providing them with wholesome food. When such projects are scaled across nations, regions, and continents, their beneficial effects can exponentially increase.

2 Methodology

The study was conducted in the municipality of Rizal, Laguna, Philippines involving thirty (30) random smallholder farmers who represented various farmer groups. This study adopted a research methodology characterized by a descriptive and correlation research approach. The variables examined encompassed farm practices related to Good Agricultural Practices (GAP) and food safety, alongside the demographic and farming profiles of the participating farmers. To address identified gaps and constraints related to safety and sustainability, the study utilized baseline databases and data analysis as a foundation for designing and executing targeted interventions. These interventions were meticulously tailored to augment the technical skills and knowledge of the farmers, with a particular emphasis on fostering sustainable and safe approaches to insect, pest, and disease management, cultural and nutrient management, post-harvest handling, and the processing of bitter gourd. Notably, the interventions placed a significant emphasis on inculcating practices associated with safe pesticide management and the meticulous adherence to good agricultural practices (GAP).

To make a start on the study, comprehensive data collection efforts were initiated. These initiatives included a broad range of data, including farmer demographics, farming profiles, and the specifics of their existing agricultural methods, particularly with relation to the concepts of Good Agricultural methods (GAP) and food safety. Most likely, a variety of techniques, including surveys, interviews, and thorough record-keeping, were used in this data collection procedure. The next step entailed data analysis after this collection of data had been effectively assembled. The goal of this analytical method was to pinpoint significant weaknesses and limitations that threatened the viability and safety of these farmers' bitter gourd production. The study then proceeded to the design and planning of particular interventions after obtaining these findings. These interventions were meticulously designed, taking into consideration the particular requirements and circumstances of the participating farmers, to address the gaps that were identified and limitations. This degree of individualization made sure that the treatments were both ultimately effective and appropriate. The area of training and capacity-building was at the center of these developed interventions. A lot of work went into improving the farmers' technical expertise and understanding. The variety of subjects covered in the training sessions included cultural and nutritional management strategies, sustainable and safe procedures in insect, pest, and disease control, and the nuances of post-harvest handling. To assure food safety and advance sustainable farming, it was crucial to place a strong focus on safe pesticide control and strict adherence to good agricultural practices (GAP).

An important stage in the process was putting these interventions into action. They were carried out in-person, with the aid of several seminars, training sessions, and continuous support systems. By using a hands-on approach, the participating farmers were guaranteed to be able to successfully adapt the information and skills they had learned to their regular agricultural activities. A strategy for monitoring and evaluating these treatments was probably devised to determine their efficacy. This structure made it possible for academics and other interested parties to gauge the treatments' effects over time. Any required modifications might be made to better improve the results by measuring progress consistently. In a nutshell, this technique exemplifies a comprehensive and integrated strategy that combines thorough research, data-driven analysis, and precisely targeted interventions to improve smallholder farmers' quality of living. Its primary goal is to improve farming methods while also promoting sustainability and ensuring food safety in the bitter gourd industry. Furthermore, this technique seeks to empower farmers by addressing inclusion concerns within the farming community, enabling them to flourish in an environment that promotes both their well-being and the more general objectives of safe and sustainable agricultural production.

3 Results and Discussion

3.1 Study site

The study's focal point was the Philippine province of Laguna's Rizal town (Figure 1). This town, which is about 80 kilometers southeast of Metro Manila, is located on the northern slope of Mount Banahaw. San Pablo City, Nagcarlan, and Dolores are a few of the nearby cities that border Rizal. A total of 2,327.9 hectares of land makes up the municipality of Rizal, which has different altitudes from 230 and 1,450 meters above sea level. Perennial agricultural activities occupy at least 55% of the total land area of Rizal, where they represent the primary land use. This covers regions of open woodlands and scrub lands as well as the cultivation of perennial crops. The terrain is mostly covered by closed woods at higher elevations. The investigation carried out in the area is set against this geographic and biological setting.

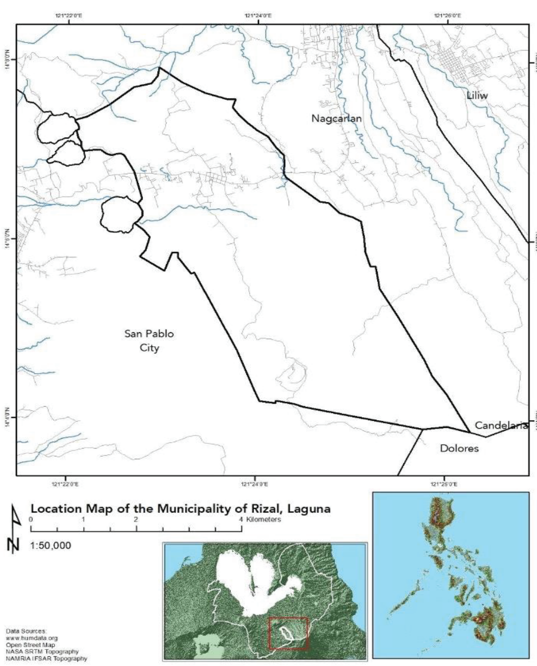

Fig. 1. Location Map of the Municipality of Rizal, Laguna

3.2 Socio-demographic profile of bitter gourd farmers

An incisive look at the sociodemographic traits of the study's participants, who are actively involved in bitter gourd cultivation, can be seen in Table 1. Notably, the bulk of these participants are millennials, with a sizable subset consisting of those in their mid- to late-forties. The dynamic and changing nature of agricultural operations, with millennials having a significant part in the industry, is reflected in this generational portrayal.

The study shows a significant presence of male participants, who make up around 67% of the sample, in terms of gender distribution. This finding is consistent with more general patterns in agriculture, where males have historically held significant responsibilities. With almost 73% of participants reporting being married, marital status among them primarily represents a married demographic. Regarding farming and agricultural management, this marital status frequently has ramifications for family dynamics and decision-making processes. The socio-demographic composition of the participants is significantly influenced by education levels. The results show that the majority of participants—roughly 57% of the sample—completed eighth grade in their educational endeavors. Understanding the knowledge and skill basis that these farmers bring to their agricultural methods is made easier thanks to their educational backgrounds.

Another notable feature of the sociodemographic profile is the size of homes, with almost 60% of participants living in relatively tiny households. About 57% of the participants said that these homes normally had 2 to 4 children. In the context of bitter gourd farming, the size of the family can have a substantial impact on resource allocation, labor availability, and decision-making dynamics.

Table 1. Smallholder farmers' socio-demographic profile (n=30)

Socio-demographic variables		Frequency	Percentage	Central Tendency
Age	27-42 (Millennials)	15	50	45 years (mean)
	42-58 (Generation X)	8	27	
	57-75 (Baby Boomers)	7	23	
Gender	Male	20	67	
	Female	10	33	
Civil Status	Single	6	20	
	Married	22	73	
	Widow/widower	2	7	
Highest Educational Attainment	Primary	17	57	
	Secondary	12	40	
	Vocational	1	3	
	Tertiary	0	0	
Household Size	2-4	18	60	4 (mode)
	6-7	12	40	

More than half of the participants (57%) were only able to finish primary education, a few (40%) reached secondary level, only 1 farmer (3%) attended vocational school, and none reached tertiary level. This lack of education is a presumed deterrent according to past studies where educational attainment influences rates and willingness to adopt new technologies and improved farming practices [19] and vital at promoting sustainable and safe practices.

Table 2 summarizes the farming profiles of farmer participants showing 17 years mean average of farming experience. Almost all (90%) heavily relied on farming as their primary source of income. With more than 10 years of farming experience, they have been exposed to farming activities even at very young ages. This long experience in farming may be instrumental in order to empower farmers towards adopting new farming practices such as the use of newly developed fertilizers and pesticides [20].

All farmers do not own the land that they till. Location, size, and proximity to the farmers' homes may influence farmer welfare and decisions under different tenancy agreements. Being a 5th class municipality, it is still undergoing developments with vast agricultural lands providing enough room for bitter gourd farmers to thrive except at extreme altitudes where bitter gourd crops do not flourish.

Table 2. Smallholder farmers' farming profile (n=30)

Farming profile variables		Frequency	Percentage	Central Tendency
Years of Farming Experience	Less than a year	1	3	17.10 years (mean)
	1 to 5	5	17	
	6 to 10	9	30	
	11 to 15	0	0	
	16 to 20	5	17	
	20 and above	10	33	
Farm ownership	Owned	0	0	
	Tenant/Rented	30	100	
Farming as the main source of income	Yes	27	90	
	No	3	10	

3.3 Current sustainable and safe practices

Table 3 presents the common practices of farmers on pesticide use and management. All (100%) bitter gourd farmer participants do not mix different pesticides in one application. They also signified that they read the pesticide label before they apply and perform routine monitoring. Most of the participants confirmed wearing protective gear during pesticide applications (77%) and responded positively about record keeping (72%). They also elaborated on the need to practice daily monitoring in order to immediately address possible occurrence of pests and diseases. However, even though the majority complained about trying to practice a system of record keeping, some (22%) admitted not doing it all. This presents a gap for improvement among farmers to properly monitor inventory of inputs and produce.

Table 3. Farmer practices on pesticide use and management (n=30)

Practices		Frequency	Percentage
Cocktailing (mixing) of different pesticides	unsafe	0	0
Reading of pesticide label before application	safe	30	100
Wearing of protective gear when applying pesticides	safe	23	77
Routine monitoring	safe	30	100
Record keeping	safe	22	72

Despite the limited formal education, most smallholder bitter gourd farmers were fully aware of the importance of using protective gears when applying pesticides. Results show that most farmers are aware of the detrimental effects of pesticides on human health. This somehow deviates from the result of a past study where formal educational attainment played an important role at determining the rates, and willingness to adopt new technologies, and improved farming practices [21] significant at achieving a more sustainable and empowered farming system.

On the other hand, Table 4 shows the practices of farmers in the implementation of GAP-related food safety practices. A substantial percentage (70%) practiced the removal of crop residues and plant materials that can be infected by diseases "*sometimes*", 13% do this "*always*" and 17% do not adopt it at all. Sixty percent of the farmers used chemical fertilizers based on nutrient requirement while 40% applied processed organic fertilizers in their fertilizer system application. Twenty percent of farmers practiced intercropping "*always*" and eighty percent applied intercropping intermittently at varied cropping seasons. All farmers (100%) have access to a clean water source. The same water is being used for irrigation and other farm use. However, there are few instances when irrigation water sources are located near residential areas since most farmlands are only a few meters away from the residences of farmers.

Table 4. Farmer implementation of GAP-related safety practices (n=30)

	GAP-related safety practices	Frequency of Implementation (Percentage)		
		Never	Sometimes	Always
Land preparation	Removal of crop residues and other plant materials that may be sources of diseases	17	**70**	13
Nutrient management	Use of processed organic fertilizers and dried manures to prevent microbial contamination.	**60**	17	23
	Usage of commercial fertilizer depends on the needs of the plant and nutrient deficiency of the soil.	0	23	**77**
Pest management	Apply intercropping for segregation of pests and diseases.	0	**80**	20
	Regulated standard amounts of pesticides should be used and properly recorded.	0	**80**	20
Irrigation	Use of a clean water source	0	0	**100**
	Irrigation systems must be far from residential areas to avoid contamination.	3	**70**	27
Harvest and post-harvest	Quality control and segregation during harvest.	0	**73**	27
	The sewage and toilet systems in the area are functioning properly.	27	**63**	10

In terms of quality control upon harvesting, most farmers have a system of segregating good quality produce from rejects. The current grading system being used by farmers to assess the quality of their bitter gourd harvests includes grade A- best produce, grade B - good quality of fruits with minimal damages, and grade C - for rejects or those with physical damages in the bitter gourds. The survey results showed that 27% of respondents indicated that they lack access to adequate sewage and toilet facilities, while the remaining respondents said they had such accessibility. This information relates to the supply of suitable sewage and toilet infrastructure inside the agricultural premises. The majority of those with access—63%—said they used these amenities only sometimes, while a smaller portion—10%—said they used them often, demonstrating a discrepancy in how often people used these services. Inadequate toilet and sewage facilities may present challenges that could permit hazard resulting from indirect biological contamination of produce by coliform bacteria. Proper and clean facilities play a vital role in producing good quality foods, safe graded harvests and produce.

3.4 Sustainability gaps

In order to achieve safe and sustainable farming of bitter gourd, the following sustainability gaps that may hinder success of interventions have been pre-identified.

High occurrence of pests and diseases. One primary gap that hampers successful production of bitter gourd in the area is the high occurrence and prevalence of pests and diseases in the field which prevalence considered the greatest challenge in bitter gourd farming. This gap also implies the highest costs in terms of input expenses as farmers are then required to constantly tend to the pesticide requirements of striving against pest infestation.

Dependence on chemical methods in managing pests and diseases. As farmers struggle in addressing pests and diseases, they tend to develop high dependence on chemical controls perceived as the most effective and direct technique of disease control.

Lack of access to knowledge and new technologies. Most of the farmers involved in bitter gourd production are used to traditional and conventional ways of farming. This can imply that farmers tend to shy away from newer technologies, such as mechanizations, newer methods of production, along with others. But this happens not because farmers are totally unwilling to cater to new technologies. This can be brought upon by the lack of access to knowledge through seminars and lectures. The data conveys that almost all farmers were unable to attend as well as enroll to events that cater new knowledge on farming technologies.

No organized system of proper record keeping. Record keeping, despite being an essential part of business, tends to be very difficult to be achieved and used by smallholder farmers. As farmers were followed up on how they were able to keep records of farm and production data, they tend to only record information that they think is important, leaving other details which leads to an unsystematic documentation of farm records. Even though a significant number of the farmers who responded to the survey said they keep track of their expenses and inputs, a careful review of the data indicates that there is immense room for improvement in their existing record-keeping procedures.

Prevalence of pest damage during harvesting leads to a high volume of rejects. The occurrence of pests and diseases do not only happen during the production season of crops but continues to occur even during and after harvesting seasons. Even though crops and produce have already reached the stage where they are already physiologically matured and seem to be of good quality, the occurrence of pests can produce detrimental effects on the harvests. These factors play a central role in the financial challenges faced by farmers, as they result in substantial profit reductions. Specifically, these challenges manifest through the considerable quantity of produce that is rejected or deemed of inferior quality, ultimately commanding lower, if any, market value.

Susceptibility to natural calamities. The project area's propensity to experience risky situations such as floods, torrential rain, and storms tends to hinder the effective production of high-quality bitter gourds. The country in general is susceptible to a significant number of heavy rains and typhoons. Farmers often complain about the unprecedented effects and occurrence of typhoons. Such an example is that there are incidents where crops are already nearing their maturity and harvesting seasons but are then obstructed by typhoons and flooding. These incidents always result in high profit loss. But as natural calamities cannot be prevented, farmers often just face the consequences of these events.

3.5 Association between farmer profile and safe agricultural practices

Some GAP-related safety practices at specific stages of production were found associated with farmer socio-demographic profile. Table 5 presents the safety practices with significant associations.

Age. Proper use of pesticides within regulated standards, recordkeeping and clean water sources were found to be inversely associated with age. This implies that younger farmers are more open to practice regulated pesticide management and ensure cleanliness of water source. As the farmer ages, the less important they find the safety practices. Safety practices

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on pesticide use within strict regulated limits and clean water sources may be more convenient for younger than older farmers.

Table 5. Safety practices associated with socio-demographic variables at 5% significance (n=30)

Associated GAP-related safety practices	Socio-economic variables	Correlation coefficient	P-value
Usage of commercial fertilizer depends on the needs of the plant and nutrient deficiency of the soil.	income	0.5430	0.0019
Apply intercropping for segregation of pests and diseases.	income	0.3826	0.0369
Regulated standard amounts of pesticides should be used and properly recorded.	age poverty	-0.4238 0.3877	0.0196 0.0343
Use of a clean water source	age poverty	-0.4238 0.3877	0.0196 0.0343
The sewage and toilet systems in the area are functioning properly.	income years of farming tenancy arrangement	-0.6459 0.3829 0.3907	0.0001 0.0367 0.0328

Income. Income has been found to be positively correlated with 3 safety practices: a) use of commercial fertilizer in relation to nutrient deficiency, b) application of intercropping, and c) maintaining proper sewage and toilet systems. Income may serve as an effective motivator for these safety practices or safety practices could translate to better income.

Poverty. Farmers whose monthly incomes are above the poverty line have better tendency of following safety guidelines in terms of proper pesticide usage (within regulated limit) as well as ensuring clean water source for irrigation.

Years of farming. More years of farming experience is significantly associated with properly functioning sewage and toilet systems in the area.

Tenancy arrangement. All farmer participants do not own the land that they till but tenancy arrangements vary: a) those who were allowed to use the land without paying anything (free), b) those who share their income with land owners (profit-sharing), and c) those who solely rely independently in terms of costs to invest on the land they till but pay a specific amount equivalent to the area (rent). Those who have higher accountability to pay for lease adhere to proper sewage and toilet systems.

3.6 Interventions

The topics on the training intervention provided were determined from the identified knowledge gaps from the baseline survey. The training tried to address any technical gaps found based on the main constraints and opportunities suggested by several preliminary exchanges through baseline interviews with farmers and meeting with the different stakeholders. The training further equipped farmers of the advantages of inclusive family farming, including the empowerment of farmers—particularly women and young people—to make wise purchasing decisions and acquire sound agricultural techniques alongside their relatives who also work the land. Farms may be able to run more profitably, productively, and most importantly, inclusively, when women and youth are also involved. Only a small number of people have had the opportunity to receive formal education or technical training in agricultural practices in rural agricultural communities, similar to Rizal, Laguna. The training interventions made it easier to plan and provide farmers with the right agricultural extension services.

To better follow the correct pesticide management and avoid pesticide misuse, the topic on internal control system (ICS) was introduced to the farmer participants. ICS is a process designed to ensure that operations are implemented according to the regulations and applicable laws and in a simple, efficient, and effective approach to assure that the objectives of the group are achieved. ICS applied in conventional production is envisioned to promote correct pesticide management and food safety. An ICS is applicable in an organization or a group with an organizational structure since the system requires complete cooperation within the farmer members. The system requires an internal group who will be responsible for monitoring the farmer's practices through actual field monitoring and through the record system.

According to a study by Sam et. al. [22], since farmers in underdeveloped nations are sometimes uneducated, illiterate, and believed it is impracticable and expensive to utilize safety equipment, especially in tropical settings, occupational poisoning with pesticides was a widespread occurrence. If preventative education campaigns are started in places where poisoning is more common, the benefits will be greater. It was concluded that the score for safe pesticide handling was enhanced by an educational intervention among pesticide handlers.

It was inferred that training and workshops were the cheapest and most reliable method to encourage proficiency in areas farmers were lacking [23]. Even though these activities were short, the subjects or topics were chosen and may measure the degree of comprehension of the crowd on specific points so calibrating should be possible later. In some studies, conducted, training was found to have a positive effect on yield and income when compared to untrained farmers [24]. Moreover, the training proved to be an effective extension tool for farmers to learn the proper pesticide handling and disposal. Training also increased farmers' knowledge of the differences between various pesticides, which improved their ability to select pesticides [25].

In a study by Wesseling et. al. [26], it was concluded that only a few studies have assessed cutaneous and respiratory exposure, and exposure evaluation mostly relies on cholinesterase testing. The few intervention studies show the necessity to assess the effectiveness of policies and procedures for prevention. There is little proof that widely implemented "safe use" initiatives have significantly changed exposure and morbidity. It was determined that research should concentrate on straightforward techniques for monitoring exposure and monitoring acute sickness and its causes in order to create and assess quick local therapies. Studies on chronic impacts should be conducted in a few chosen nations with an eye toward extensive, long-term interventions. The result of this study shows the importance of furtherly equipping farmers in the importance of safety in pesticide use and management.

In light of the study's findings, it becomes evident that the adoption and implementation of sustainable farming practices and Good Agricultural Practices (GAPs) present notable challenges for smallholder farmers. These challenges are compounded by the evolving complexities within the agricultural sector, which have, regrettably, led to income losses among farmers. While it is understandable that smallholder farmers prioritize rapid revenue production in order to maintain their general livelihoods, this propensity can actually work in their favor. Smallholders may not only ensure their daily income by proactively addressing these issues and shifting their attention to sustainable practices, but they can also create a more resilient and prosperous future for themselves and their community.

The findings of the research essentially emphasize the significance of specialized interventions and support initiatives that enable smallholder farmers to adopt sustainable and innovative farming practices. In addition to enhanced financial stability, this empowerment improves environmental sustainability, guarantees food security, and increases the adaptability of agricultural systems to new challenges. As a result, it is the responsibility of stakeholders to see the potential for good change within the smallholder farming sector and to actively support the shift towards more profitable and sustainable agricultural methods.

4 Conclusion and Recommendations

The fundamental goal of the interventions was to improve farmers' understanding of a bitter gourd farming system that is more suitable, sustainable, and ecologically sound. This was accomplished through raising farmers' awareness of and knowledge of more effective and sustainable practices. Farmers were encouraged to make the most of the new information and ideas in order to improve the efficiency, output, and sustainability of their current farming practices. By following the recommendations, farmers will be better equipped to compete in the existing and ever-increasing competition in the bitter gourd, and the vegetable industry in general. Additionally, the interventions aimed to increase farmers' comprehension of how each player and actor in the competitive landscape influences the overall production in their industry.

The prevalence of both pests and diseases in crops, especially the bitter gourd, was one of the top challenges that are being faced by the partner smallholder farmers. In the promotion of both farmer empowerment and sustainability, a better understanding of the importance of proper and sustainable pest management was included in the interventions for the study. With this, farmers were provided with a training course on the lectures of proper pest management as well as pesticide management. Another course during the training was the introduction to GAP.

In conclusion, empowering smallholder farmers is a complex issue that needs coordinated action from several stakeholders. No individual or a single body could ever completely understand the complexities of addressing farmers' evolving needs, which are inextricably linked to maintaining food production for a larger population. The urgent necessity for financial help emerges as one of the pressing requirements. In order to pay for input expenses and maintain a steady level of agricultural production, farmers need access to money. The creation of fair remuneration arrangements for their labor is equally important. A further requirement for reducing the major risks associated with agriculture is the accessibility and affordability of insurance products.

Most importantly, it is critical that smallholder farmers prosper financially from their participation in the food supply chain. While farmers have a wealth of practical experience, ongoing research reveals new ways to improve output, quality, yield optimization, resource conservation, and pest control, among other aspects of farming. It is critical to offer farmers continual training, assistance, and access to relevant technology. Frontline agricultural stakeholders must promote these concepts and offer the required tools through extension services and specialized channels in order to close the knowledge gap between theoretical understanding and practical application. A variety of channels, including associations, cooperatives, networks, extension agents, and community groups, must be used to engage with farmers. The key to successful agricultural transformation is inclusivity, which ensures that farmers are engaged participants on the path to transformation.

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