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# Food safety traceability readiness of cabbage and eggplant farmers

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## ABSTRACT

A growing global concern on food safety has much more been emphasized at the time of the pandemic. This includes the internal control system (ICS) for conventional safe farming, which has proven its ability to control pesticide residue within the safe and sustainable maximum limits for cabbage and eggplant compliant with the most stringent regulations implemented globally. Cabbage and eggplant farmers have realized the benefits of safe and sustainable production of cabbage and eggplants. To maintain safe quality food throughout the chain, a system of tracing is of utmost importance. This study proposes a traceability system to ensure that food safety is sustained throughout the value chain in the case of cabbage and eggplant and evaluates farmer readiness in food safety and traceability. In this study, farmer readiness is further described in terms of preparedness, willingness and potential to adopt. Results show that the cabbage and eggplant farmer clusters in Benguet and Quezon were not yet fully prepared in terms of actual practice but have acknowledged the importance of implementing necessary Good Agricultural Practices measures. This exhibits a positive response towards potential adoption of a food safety traceability system. Thus, to further enhance farmers' readiness, farming consolidation in order to develop a sense of accountability and responsibility to other farmers would

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serve as “each other's push” to ensure successful delivery of farmer clusters' food safety standards.

**Keywords**: food safety, traceability, internal control system, farmer readiness

## INTRODUCTION

At the time of pandemic concerns for food safety was heightened. Globally, the Codex Alimentarius Commission together with the Food and Agriculture Organization and World Health Organization lead in setting food safe standards. The European Union food safety standards (EPSA 2020) are regarded among the most stringent regulatory body which serves as benchmark for most economies initiating their own. Food safety in the Philippines is governed and monitored through the Republic Act No. 10611 or the Food Safety Act of 2013 as framework to ensure consumer protection, fair trade practices and global competitiveness (Rustia et al 2021). The Philippines, spearheaded by selected government agencies, creates initiatives to adhere with the internationally agreed standards to food safety. The internal control system (ICS) is one innovative farming system proposed to ensure safety and compliance of farm production with international standards.

The internal control system (ICS) program funded by the Department of Science and Technology – Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (DOST PCAARRD) consisted of two tightly coordinated projects to pilot-test conventionally safe cabbage and eggplant value chains. Project 1 initiated the development of an ICS for conventionally-grown cabbage and eggplant. Project 2 piloted the viability of the value chain in terms of its profitability and market potential through which these vegetables were produced and marketed. Project 2 also covered the development of a proposed traceability system for these conventionally-grown cabbage and eggplant. The ICS program aimed at ensuring sustainable pesticide management practices of cabbage and eggplant within the maximum residue limits prescribed by food safety standards. However, despite the success of maintaining safety at the farm level, more opportunities for food safety hazards may be encountered through several nodes in the value chain. Hence, the ICS must be supported by a reliable traceability system in order to sustain food safe quality from farm to table.

In order to sustain food safety throughout the value chains, a traceability system network was proposed. Both internal and external traceability are essential for a sustainable value chain. For this study, analysis focused on the farm production level anchored on the principles of Good Agricultural Practices (GAP).

The changing food production patterns, expectations of the public and international trade policies are among the various factors that influence food safety as a fundamental public health concern in the Philippines (Rustia et al 2021).

Food safety in the Philippines is governed and monitored through the Republic Act No. 10611 or the Food Safety Act of 2013 as framework to ensure consumer protection, fair trade practices and global competitiveness (Rustia et al 2021). However, being implemented by several government agencies and bureaus, the national food safety strategy is described as highly fragmented with plenty of overlap and gaps that resulted to reactive rather than pre-emptive government response to food borne illness outbreaks and recalls of substandard quality products in the market (Collado et al 2015).

In relation to food safety hazard from pesticide exposure, the Codex Alimentarius Commission, Food and Agriculture Organization and World Health Organization jointly approve the maximum residue limits considered safe on humans (Zikankuba, Mwanyika, Ntwenya, James 2019). Aside from being a member of the Codex Alimentarius Commission, Philippines also abides by the Uruguay Round Trade Organization and takes legitimate measures to uphold life and ensure health of consumers as stipulated in the Sanitary and Phytosanitary Agreement and Technical Barriers to Tradec (Rustia et al 2021).

Good Agricultural Practices provide rules and recommendations on reasonable pesticide use to ensuring safe farming practices (Cuggino et al 2018 as cited by Zikankuba et al 2019). Furthermore, non-hazardous safe produce below Maximum Residue Limits (MRL) may still accumulate in body tissue through time being fat soluble (Zikankuba et al 2019).

Adherence to food safety is associated with several factors. Awareness should be of primary importance towards compliance to food safety. Past studies reveal that geographical location, gender, age and education, in particular, were some factors identified to affect farmer's awareness. Lack of farmer's awareness lead to unscientific pesticides application increasing risks posed by pesticide residues in China (Hou & Wu 2010). Empirical evidence of unsuccessful traceability system initiative in Taiwan identified program awareness and pesticide residue testing as significant determinants of farmer participation (Liao et al 2011).

In Northern Greece however, a number tobacco farmers, despite awareness of potential risks, still chose not to wear special protective equipment when spraying pesticides due to discomfort, expensiveness, time-consuming, unavailability, and unnecessary (Damalas et al 2006). Aside from health hazards inducing health conditions as neurotoxicity and other chronic-poisoning related illnesses, pesticide residues also cause environmental run off affecting non-targeted organisms (Zikankuba et al 2019).

In the Philippines, a rapid test kit on pesticide residue detection developed by UPLB National Crop Protection Center as applied to string beans, green beans, tomato, eggplant, bitter gourd, pechay and okra proved detectability of Maximum Residue Limits covering FPA-registered Organophosphate (OP) and carbamate (CBM) pesticides (Manuben et al 2022).

Ringsberg (2014) through a systematic literature review summarized supply chain risk management (SCRM) approaches namely, logistics management for food supply chain complexity and unique identification of goods, information management for transparency and interoperability, production management for in-house production and outsourcing, and quality management for food quality and safety requirements and food characteristics monitoring. Empirical evidence of unsuccessful traceability system initiative in Taiwan identified program awareness and pesticide residue testing as significant determinants of farmer participation (Liao et al 2011).

Traceability allows the ability of tracing of product flow along the value chain from downstream to upstream or vice versa. Specifically, different bodies provided almost similar definitions of traceability system (Banerjee & Menon 2015) such as the "ability to follow the movement of a feed or food through specified stage(s) of production, processing and distribution" (ISO) or "the ability to follow the movement of a food through specified stage(s) of production, processing and distribution" (CAC). In addition, the Codex Alimentarius Commission (CAC) has also set out principles for traceability as a tool within a food inspection and certification system (Banerjee & Menon 2015).

With traceability, prevention of hazard is emphasized instead of simply reacting or responding to food safety breaches in relation to good agricultural practices (GAP), good manufacturing practices (GMT) and hazard analysis and critical control point (HACCP). If applied correctly in conjunction with information and communication technologies (ICTs), business may monitor and control risk. (Banerjee and Menon 2015).

Traceability has proven its role in connecting producers and consumers through assurance of safe food supplies. Issues such as bovine spongiform diseases and genetically modified organisms have made the need of linking the food chain even more sought for. With the use of alphanumerical codes, barcodes and radio frequency identification (RFID) technology, the system has proved to work well for cheese producers and consumers (Regattieri et al 2006).

Through the years, more technological developments emerge to improve traceability systems for quality monitoring of supply chains including Internet of Things (IoT) and blockchain technology. These have improved network transparency but require an architecture design framework for the improvement of food sustainability (Feng et al 2020).

Given the importance of establishing a food safe traceability system throughout the value chain, the study aimed to: (1) propose a traceability flowchart for cabbage and eggplants, (2) identify the critical control points in cabbage and eggplant production, and (3) evaluate the traceability readiness of cabbage and eggplant farmers.

This paper is an offshoot research from the DOST-PCAARRD Funded Program on Conventionally Safe Cabbage and Eggplant Value Chain conducted from July 1, 2017 to September 30, 2019.

## METHODOLOGY

### *Data Collection*

Following a descriptive research design, inferences on farmer readiness were derived from the responses generated from supervised surveys of participants during the baseline data gathering conducted in October 2017 prior to introducing ICS interventions as well as focus group discussions after the interventions had been completed during an assessment of feedback in early 2019.

### *Interventions*

The program was comprised of two parts. Project 1 covered the development of an internal control system for conventionally-grown cabbage and eggplant whereas Project 2 piloted the viability of the value chain in terms of its profitability and market potential through which these vegetables were produced and marketed. Project 2 also covered the development of a proposed traceability system for these conventionally-grown cabbage and eggplant. The proposed traceability system intended to weave the two projects in order to recommend a viable sustainable geographical value chains for cabbage and eggplant in Benguet and Quezon, respectively.

Farmer Cluster 1 in Buguias, Benguet was composed of a total of 40 cabbage growers. Seventy five percent were female, with an average age of 40 years (30–76 years), average years of schooling of 10 years (4–14 years), and average farming experience of 25 years (1–50 years). The majority (85%) were married with average household size of four.

Farmer Cluster 2 in Dolores, Quezon had thirty-nine eggplant farmers included in the program, among which 64% are female, with an average age of 42 years (23– 60 years), average years of schooling of 10 years (4–14 years), and average farming experience of 14 years (1–32 years). The majority (97%) was married with average household size of five.

One limitation of the study encountered was extreme weather conditions with four typhoon incidences that affected the study site at the time of study. This resulted in a failure to accurately estimate income from the ICS application on cabbage. The threat of extreme weather, due to Typhoon Ompong (International Name: Mangkhut) that badly hit the Cordillera region, led to the premature harvest of the cabbages causing a drop in the selling price.

### *Program Framework*

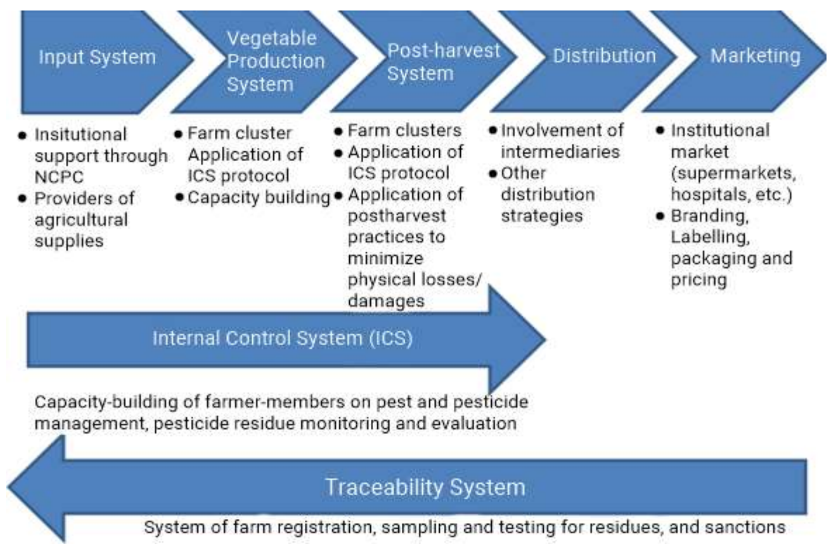


Figure 3. Value Chain Piloting of Food Safe Cabbage and Eggplant in Buguias Benguet and Dolores, Quezon, respectively.

### *Findings of the Study*

Pilot testing of farmer participants subjected to ICS training conducted in project 1 was successful at ensuring sustainable pesticide usage as confirmed by chemical analyses as presented in Table 1. Future duplication with subsystems appears promising.

Following the proposed traceability network system and identified critical control points, processes involved in the success of its implementation lies in the readiness of farmers in adopting and participating in farm consolidation for enhanced competitiveness and food safe quality compliance.

Table 1. Pesticide residue analysis of ICS produced eggplant and cabbage (Project 1)

| Crop | Residue Analysis | Remarks |
|---|---|---|
| Eggplant | <0.01mg $kg^{-1}$ (20 samples) | All samples below PNS MRL |
| Cabbage | <0.01mg $kg^{-1}$ (16 samples)<br>0.08mg $kg^{-1}$ profenos (1 sample)<br>0.06mg $kg^{-1}$ chlorpyrifos (1 sample)<br>0.01mg $kg^{-1}$ cypermethrin (2 samples) | All samples below PNS MRL |

NB. Philippine National Standards (PNS), Maximum Residue Limit (MRL)

Following the proposed traceability network system and identified critical control points, processes involved in the success of its implementation lies in the readiness of farmers in adopting and participating in farm consolidation for enhanced competitiveness and food safe quality compliance.

### *Proposed Traceability System*

To ensure food safety in the agricultural value chain, an organized system of tracing from the upstream to the downstream chain involves all participants in the industry subsystem.

### *Internal Traceability*

Though internal traceability usually applies within a unit enterprise, through farm clustering and consolidation, standards and monitoring may be shared among smallholder farming communities that adopt the same ICS strategy for ensuring food safety (Figure 4.1 Steps 1 to 7).

In spite of the efforts in the coordinated farming clusters, efforts will be futile without the consistent assurance all throughout the value chain until reaching the final consumer. Thus, strict record keeping, information sharing must be ensured across all channels of distribution (Figure 4.1 Steps 7 to 14).

For this study, analysis of readiness only focuses on the farm production side (internal traceability) which was within the scope of the project.

**Food safety traceability readiness of cabbage**

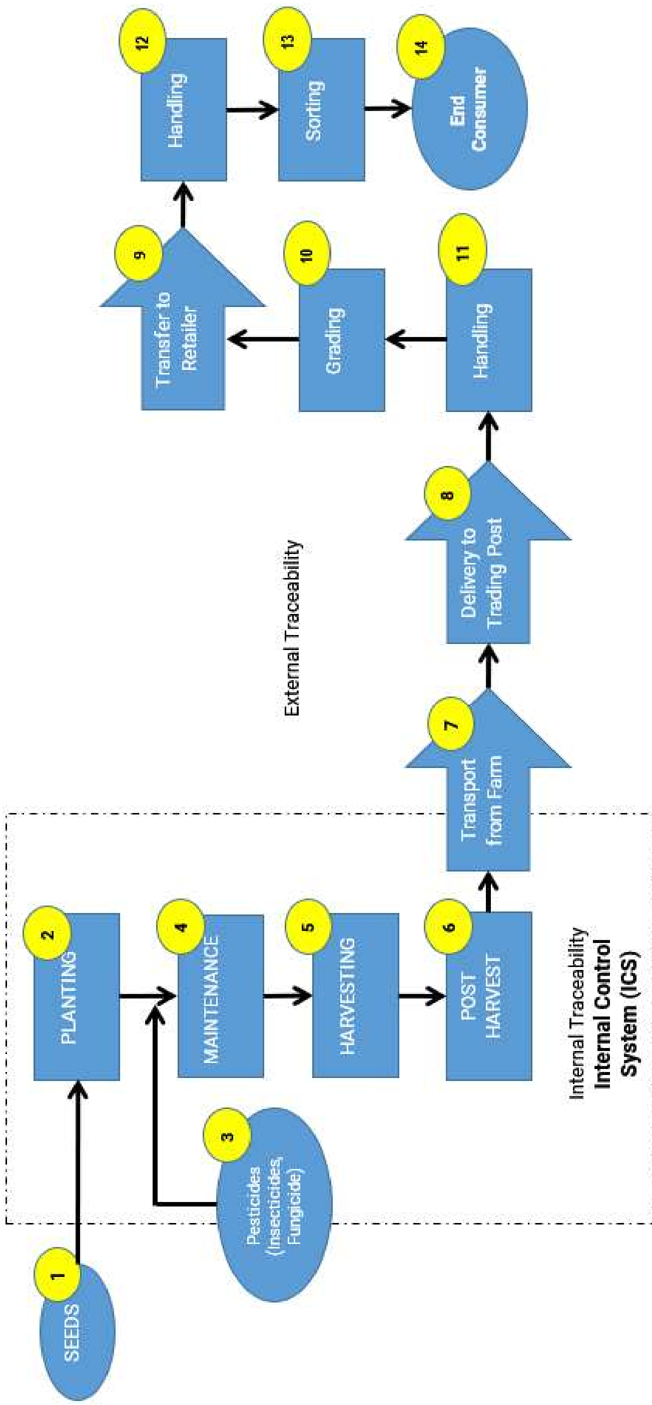


Figure 4.1 Proposed Food Safety Traceability Flow Chart

Table 4.1 Farm level traceability system nodes

| Node | Internal/ External | Information Needed | Testing Need | Additional tasks | Monitoring |
|---|---|---|---|---|---|
| | External | • Authenticity of seeds<br>• Duly registered chemicals<br>• Processed/ treated organic fertilizers | • Verification of authenticity<br>• Testing of pathogens in organic fertilizer | • Coordinated/ consolidated purchase | • Accredited suppliers<br>• With assigned QR codes<br>• Encoding |
| | Internal | • Soil properties<br>• Absence of residues<br>• Absence of pathogens<br>• Clean water source/irrigation system | • Soil testing<br>• Soil residue testing<br>• Test of coliforms | • Organized association of farmers<br>• Assignment of QR codes | • Inspection<br>• Record-keeping<br>• Monitoring<br>• Encoding |
| | Internal | • Appropriate fertilizer application<br>• Judicious pest control | • Testing of pathogens in organic fertilizer | • Organized association of farmers with assigned QR codes | • Inspection<br>• Record-keeping<br>• Monitoring<br>• Encoding |
| | Internal | • Appropriate fertilizer application<br>• Judicious pest control<br>• Clean water source/irrigation system | | • Organized association of farmers with assigned QR codes | • Inspection<br>• Record-keeping<br>• Monitoring<br>• Encoding |
| | Internal | • GAP compliant<br>• Proper handling, hygiene and sanitation | • MRL testing<br>• Sorting | • Organized association of farmers with assigned QR codes | • Inspection<br>• Record-keeping<br>• Monitoring<br>• Encoding |
| | Internal | • GAP compliant (Proper handling, hygiene and sanitation, storage, packing) | | • Organized association of farmers with assigned QR codes | • Inspection<br>• Record-keeping<br>• Monitoring<br>• Encoding |
| | External | • Proper handling, hygiene and sanitation, safe and clean container<br>• Destination<br>• Storage Temperature<br>• Protected from physical, chemical, biological contaminants | • Occasional swabbing of containers or storage area | • Logistics Details<br>• Assignment of QR codes of trucks<br>• Regular schedule of cleaning and sanitizing<br>• Proper training of handlers | • Registered / Accredited vehicles<br>• Inspection<br>• Record-keeping<br>• Monitoring<br>• Encoding |

Table 4.2 Assessment of critical control points in cabbage production

| Reactors of the Chain | GAP Standards | Common Practices | Remarks |
|---|---|---|---|
| I. Producers: | | | |
| A. Land Preparation | • Soil testing and recording of residues which may affect food quality should be done thoroughly. | • No soil testing prior to land preparation was done by farmers.<br>• There were some left overs of previously planted crops in the furrows. | • Excessive application of synthetic fertilizers without prior soil testing led to the decline in soil fertility which in turn would need more fertilizers. |
| B. Fertilizer Application | • Testing for pathogens on organic fertilizers.<br>• Usage of commercial fertilizer depends on the needs of the plant and nutrient deficiency of the soil. | • Absence of pre-testing for pathogens (and sterilization) of organic fertilizer used.<br>• Inadequate treatment of organic fertilizer (chicken manure) promotes the propagation of coliforms and pathogens.<br>• There was excessive use of commercial fertilizers before the ICS Program. | • Microbial contamination pose hazards in terms of food safety as well as productivity.<br>• Chemical residues from excessive use of commercial fertilizers pose hazards to food safety and environment preservation. |
| C. Pesticide Use | • Lessen dependency on pesticide.<br>• Apply intercropping for segregation of pest and diseases.<br>• Regulated standard amount should be used and properly recorded. | • There was no proper record keeping and monitoring of pesticide usage prior to ICS training.<br>• Some pesticides used were non-duly registered for eggplant.<br>• Though difficulty acknowledged, farmers always applied intercropping. | • Lack of monitoring and record keeping are detrimental to both environmental, health (of farmers) and food safety (of consumer).<br>• Chemical residues on produce pose hazard to human health. |

Table 4.2 continued

| Reactors of the Chain | GAP Standards | Common Practices | Remarks |
| --- | --- | --- | --- |
| A. Irrigation System | • Confirmed clean water source.<br>• Irrigation system must be far from residential areas to avoid contamination. | • Farmers claimed that water is clean with irrigation system far from contamination. | • Inadequate watering will not wash pesticide residues which cause chemical contamination detrimental to food safety. |
| B. Harvest and Post-Harvest | • Quality control and segregation during harvest. | • There was quality control but only occasional segregation practices during harvest. | • Quality control systems are essential to ensure non-contamination. |
| II. Distributors | • Quality check and proper handling and transportation. Packaging must contain basic information and label. | • No quality check due to items already packed. No recording and labels indicated. | • Lack of labeling or coding prevents segregation of "safe" produce from possible "unsafe" produce. |
| III. Retailers | • Can be traced. Proper disposal and quality check are practiced. | • There was no means of traceability as there is no labeling and coding practices employed. Mixing of produce is common. | • Lacks knowledge on food safety practices, quality control, and cross contamination. |

Table 4.3 Assessment of critical control points in eggplant production

| Reactors of the Chain | GAP Standards | Common Practices | Remarks |
|---|---|---|---|
| I. Producers: | | | |
| A. Land Preparation | • Soil testing and recording of residues which may affect food quality should be done thoroughly. | • No soil testing prior to land preparation was done by farmers.<br>• Continuous used of land for eggplant farming repetitively after harvest using the same type of nutrients from the soil in the absence of intercropping. | • Untested chemical residues may pose possible hazards to food safety. |
| B. Fertilizer Application | • Testing for pathogens on organic fertilizers.<br>• Usage of commercial fertilizer depends on the needs of the plant and nutrient deficiency of the soil. | • Absence of pre-testing for pathogens (and sterilization) of organic fertilizer used.<br>• There was excessive use of commercial fertilizers before the ICS Program.<br>• There was no accurate recording of amount and type 33applied. | • Microbial contamination pose hazards in terms of food safety as well as productivity.<br>• Chemical residues from excessive use of commercial fertilizers pose hazards to food safety. |
| C. Pesticide Use | • Lessen dependency on pesticide.<br>• Apply intercropping for segregation of pest and diseases.<br>• Regulated standard amount should be used and properly recorded. | • There was no proper record keeping and monitoring of pesticide usage prior to ICS training.<br>• Some pesticides used were non-duly registered for eggplant.<br>• Minimal to non-application of intercropping. | • Lack of monitoring and record keeping are detrimental to both environmental, health (of farmers) and food safety (of consumer).<br>• Chemical residues on produce pose hazard to human health. |

Table 4.3 continued

| Reactors of the Chain | GAP Standards | Common Practices | Remarks |
|---|---|---|---|
| D. Irrigation System | • Confirmed clean water source.<br>• Irrigation system must be far from residential areas to avoid contamination. | • Farmers claim water is clean but there is no Irrigation system.<br>• Dependent on rain water alone.<br>• Collection basins do not guarantee safety. | • Microbiological and chemical contaminant from unconfirmed water source may pose food safety hazard.<br>• Inadequate watering will not wash pesticide residues which cause chemical contamination detrimental to food safety. |
| E. Harvest and Post-Harvest | • Quality control and segregation during harvest. | • There were no quality control practices during harvest and post-harvest stages.<br>• After harvesting, the next stage is already packing and shipping were from farmers' end. | • Quality control systems are essential to ensure non-contamination.<br>. |
| I. Distributors | • Quality check and proper handling and transportation. Packaging must contain basic information and label. | • No quality check due to items already packed. No recording and labels indicated. | • Lack of labeling or coding prevents segregation of "safe" produce from possible "unsafe" produce. |
| II. Retailers | • Can be traced. Proper disposal and quality check are practiced. | • There was no means of traceability as there is no labeling and coding practices employed. Mixing of produce is common. | • Lacks knowledge on food safety practices, quality control, and cross contamination. |

The seven steps identified as points for control and monitoring in the internal traceability include a. farm inputs (ex. seeds), b. planting, c. pest and weed management, d. maintenance, e. harvesting, f. post-harvest (prior to transporting). The table below presents the specifications in terms of information and testing needed, additional tasks and monitoring associated with each node in the flowchart comprising the traceability system in the farm level.

### *Critical Control Points*

The food safety critical control points refer to opportunities for safety hazards to enter the food system. At the farm level, the principles of GAP serve as the basis for standard practices. Comparing the GAP practices with actual farming practices, the following inferences were noted to form observed deviations.

**Land Preparation.** The absence of soil testing may lead to excessive use of synthetic fertilizers causing further decline in soil fertility instead of simply proper balancing of nutrients available in the soil. The same way, undetected chemical residues pose a hazard to food safety.

**Fertilizer Application.** Although the use of organic fertilizers can prevent chemical residues to be left in the soil and produce, microbiological pathogens may emerge due to improper treatment prior to its use as well as absence of testing for pathogens. Microbiological contamination may pose a threat to both food safety and productivity.

**Pesticide Use.** Lack of monitoring and record keeping are detrimental to both the environment, health (of farmers) and food safety (of consumers). Chemical residues on produce pose a hazard to human health.

**Irrigation System.** Inadequate watering will not wash off pesticide residues which cause chemical contamination detrimental to food safety. Microbiological and chemical contaminants from unconfirmed water source may pose a food safety hazard (eggplant).

**Harvest and Post-harvest.** Quality control systems are essential to ensure non-contamination. Lack of segregation of produce prior to packing can cause cross-contamination.

### *Farmer Readiness*

Farmer Readiness may be measured in terms of Farmer Preparedness, Farmer Willingness and Farmer Potential (Shaukat 2014). In this study, survey responses were used to describe farmer preparedness in relation to the principles of Good Agricultural Practices (GAP). Farmer willingness was obtained from the Focus Group Discussions (FGDs) conducted with the farmer project beneficiaries toward the completion of the project. Farmer Potential was deduced from the farmer profiles in comparison with secondary literature cited.

At the farm level, food safety is assured by following the principles of Good Agricultural Practices or GAP. Farmers were asked about their usual practices and how they perceive adherence to food safety standards in terms of importance and ease of implementation.

For both cabbage and eggplant, value chains start with the input system, followed by production system and marketing leading to consumption.

### *Seed Quality and Procurement Practices*

There was no organized cabbage seeds system in Buguias, Benguet. Almost all farmers except for one purchased their seeds from the agri-supply shops in La Trinidad, Benguet which were paid for by cash. They had a number of shops to choose from: Sunrise, Bright Crop, Total Care, Super Farmer, among others. Although most seeds grown were F1 hybrids from well-known stores, tracing was not assured. The majority of the respondents used the Wonderball variety, with only one indicating their reason for this variety choice was "resistance to club root".

Authenticity of the seeds could not be verified by farmers who simply purchased seeds and other farm inputs from available farm supply merchandisers in La Trinidad. There was no assurance that the seeds and chemicals used came from accredited sources. In addition, as the farmers bought their inputs from diverse sources, the quality and safety of farm inputs could not be easily traced.

According to GAP, seeds and planting materials require verification when procured from non-accredited farm sources. In case of procurement from accredited nurseries or seed producers, specific details (eg, cultivar, supplier, date of procurement) should be recorded. To ensure high quality seeds and planting materials, accredited seed growers or plant nursery operators should be verified.

On the other hand, most eggplant farmers (72.5%) in Dolores, Quezon have been using Morena F1 seeds. All seeds being used were hybrid seeds with almost all (97.5%) using cash payment. Geographical source of seeds were identified to come from Dolores/Munisipyo/Edsel. Seventeen out of 40 (42.5%) claimed that the seeds covered <25 of total input cost, 10 (25%) stated that seeds covered 25-40% of total input cost.

In addition, the highest frequency of eggplant farmers considered good quality (27.5%) as the basis for choosing the seed variety, followed by reliability or well-tested (22.5%), accessibility (12.5%) and soil compatibility (2.5%).

### *Fertilizer Application*

In terms of fertilizers usage, most of the cabbage farmers (84.4%) used a combination of inorganic and organic fertilizers with a few using only organic (6.3%) or inorganic (6.3%). One specific nutrient required for growing cabbage is Boron which is supplied by the inorganic fertilizers that the farmers used. As with the seeds, they purchased their inorganic fertilizers from La Trinidad mostly on a cash basis (93.8%).

According to GAP, fertilizers must be applied according to soil nutrient quantitative information. However, in actual practice, no prior testing was done before fertilizer application. Fertilizers and soil additives should be judiciously checked especially for heavy metals and only duly registered fertilizers (inorganic and bio/organic) should be used. However, there was no assurance that the existing farm supply stores were accredited. There should be proper treatment of organic fertilizer materials prior to application. Chicken manure should be thoroughly dried to kill pathogens and coliforms which, in this study, was not the case. Drying was not faithfully applied. One indication was the prevalence of colonies of flies surrounding the area and there was no designated area for drying chicken manure.

Most eggplant farmers (82.5%) in the study have been using synthetic fertilizers (21-0-0, 14-14, 16-16-16, 24-0-0, 46-0-0, complete, Maria Bulaklak). A smaller percentage (15%) used both organic and inorganic (chicken manure). Almost all (80.0%) used cash payment when purchasing fertilizes. Geographical sources of fertilizers were identified (San Mateo/Dolores/Barangay). The topmost reason for choosing which fertilizers to buy was accessibility (17.5%), followed by loyalty (10%) and reliability or already well-tested (10%).

Likewise, the eggplant farmers did not have prior quantitative information regarding soil nutrients before fertilizer application. There was no judicious selection of fertilizers and soil additives according to the presence of heavy metals and suitable registration. Untreated (undecomposed) organic materials must not be applied due to the presence of potential contaminants. Composting, solarization, heat drying etc. should be designed to reduce or eliminate pathogens in manure, biosolids and other natural fertilizers.

### *Pest Control*

Though a number of duly registered insecticides and fungicides had been used by the cabbage farmers in Buguias, Benguet before the ICS project, still the majority were using unregistered pesticides.

Even with regulated pesticides, lack of judicious measurements still pose a significant health risk. The absence of record-keeping and non-compliance to safe application procedures allow exposure to both health and environmental hazards not only for consumers of the produce but also for the farmers, families and farming communities.

On the other hand, only 8 out of 12 pesticides identified by eggplant farmers belonged to the list of duly registered active ingredients (based on Project 1) which means some farmers had been using four other non-duly registered pesticides which could pose hazard to safety.

Organophosphates are the top cause of clinical cases in pesticide poisoning among Japanese. Carbamates cause increased risk of non-Hodgkin lymphoma to the farmers who personally handled the product, and those who used the product for about 20 years or more.

Observed prevalence of pyrethroid poisoning among the cotton farm workers, with symptoms such as abnormal facial sensations, dizziness, headache, fatigue, nausea, loss of appetite and signs of listlessness or muscular fasciculation. Dermal exposure to chlorpyrifos to hands and feet were associated with atrophy and paralysis of the exposed body parts. Paralysis is one of the most serious effects of pesticide exposure. Anthranilic diamide was found to have low acute toxicity by the oral, dermal, and inhalation routes of exposure and has little to no irritation effect on the eyes or skin.

Table 4.4 List of registered insecticides, fungicides and unregistered pesticides used by farmers in Lengaoan, Buguias, Benguet for cabbage production

| Brand Name | Active Ingredient | n | Percent | Brand Name | Active Ingredient | n | Percent |
|---|---|---|---|---|---|---|---|
| Registered Insecticides | | | | | | | |
| Success naturalyte | spinosad | 23 | 54.8 | Atmos | abamectin | 1 | 2.4 |
| Selecron | profenofos | 9 | 21.4 | Flipper | fipronil | 1 | 2.4 |
| Fenos | flubendiamide | 7 | 16.7 | Vasthrin | cypermethrin | 1 | 2.4 |
| Exalt | spinetoram | 6 | 14.3 | Destroy | cypermethrin | 1 | 2.4 |
| Ammate | indoxacarb | 5 | 11.9 | Actara | thiamethoxam | 1 | 2.4 |
| Pennant | phentoate | 5 | 11.9 | Cartap | cartap HCl | 1 | 2.4 |
| Magnum | cypermethrin | 5 | 11.9 | Venus | abamectin | 1 | 2.4 |
| DuPont Steward | indoxacarb | 4 | 9.5 | Voltz | cartap HCl | 1 | 2.4 |
| Padan | cartap HCl | 3 | 7.1 | Atabron | chlorfluazuron | 1 | 2.4 |
| Prevathon | chloranthraniliprole | 2 | 4.8 | Paspas | cartap HCl | 1 | 2.4 |
| Ventures | profenofos | 2 | 4.8 | | | | |
| Registered Fungicides | | | | | | | |
| Rainfast | mancozeb | 15 | 35.7 | Ranman | cyazofamid | 3 | 7.1 |
| Dithane | mancozeb | 14 | 33.3 | Fungitox | thiophanate methyl | 2 | 4.8 |
| Score | difenoconazole | 9 | 21.4 | Vondozeb | mancozeb | 1 | 2.4 |
| Trunil | chlorothalonil | 9 | 21.4 | Armor | thiophanate methyl | 1 | 2.4 |
| Previcur-N | propamocarb HCl | 4 | 9.5 | Fungufree | benomyl | 1 | 2.4 |
| Folicur | tebuconazole | 4 | 9.5 | Saprol | triforine | 1 | 2.4 |
| Daconil | chlorothalonil | 3 | 7.1 | Thio-met | thiophanate methyl | 1 | 2.4 |
| Rover | chlorothalonil | 3 | 7.1 | | | | |
| Unregistered Pesticides | | | | | | | |
| Bida | lambda cyhalothrin | 26 | 61.9 | Kriss | lambda cyhalothrin | 2 | 4.8 |
| Antracol | Propineb | 13 | 31.0 | Actara | thiamethoxam | 2 | 4.8 |
| Siga | Chlorpyrifos | 5 | 11.9 | Resbak | carbaryl | 1 | 2.4 |
| Furadan | Carbofuran | 5 | 11.9 | Wild Kid | methomyl | 1 | 2.4 |
| Slam | lambda cyhalothrin | 4 | 9.5 | Aria | flonicamid | 1 | 2.4 |
| Lorsban | Chlorpyrifos | 3 | 7.1 | Solomon | imidacloprid + betacyfluthrin | 1 | 2.4 |
| Sevin | Carbaryl | 2 | 4.8 | | | | |

Source: Data Collected by Project 1 (2018)

Table 4.5. List Pesticides used by ICS Farmer Participants in Dolores, Quezon

| Pesticide | Active Ingredient | n | Percent | Duly Registered |
|---|---|---|---|---|
| Megatonic | methomyl | 7 | 17.5 | Yes |
| Prevathon | chlorantraniliprole | 6 | 15.0 | Yes |
| Malathion | malathion | 6 | 15.0 | Yes |
| Selecron | profenofos | 5 | 12.5 | Yes |
| Actara | thiamethoxam | 4 | 10.0 | Yes |
| Solomon & Starkle | imidacloprid/ beta-cyflaton | 4 | 10.0 | Yes |
| Dithane | mancozeb | 2 | 5.0 | Yes |
| Romectin | abamectin | 1 | 2.5 | Yes |
| Brodan | organophosphate/carbonate | 7 | 17.5 | No |
| Magnum | s-metolachlor | 3 | 7.5 | No |
| Sevin | carbonyl | 1 | 2.5 | No |
| Lorsban | chlorpyrifos | 1 | 2.5 | No |

### *Farmers Preparedness*

The first ingredient for readiness for food safety traceability is that farmers should subscribe to food safety principles, guidelines and procedures.

### *Soil Testing and Recording Residues*

In the case of cabbage farmers, standard GAP practices relevant to land preparation particularly soil testing and recording residues were used only "sometimes" (67.7%) and "never" (48.4%) by the majority of farmers. However,the majority felt that the steps they missed were still important" (51.6%) and "very important" (48.4%). They noted that both steps, though difficult, were not impossible to implement.

Lack of compliance in soil testing and non-recording of residues indicate partial preparedness and non-preparedness among cabbage farmers, respectively. However, noting that most farmers perceived the steps to be important suggests potential in terms of attitude and interests. The communicated difficulty but not impossible response can be resolved through further capacity building in terms of trainings and provision of resources. During project 1, the farmers were taught how to test for soil nutrients and residues. A rapid test kit was provided by ICS Project 1 implementers for use by the farmer cluster. More of this kind of assistance would better prepare the cabbage farmers in this aspect.

For eggplant farmers, soil testing and recording residues were not complied with by greater percentages responding they "never" applied soil testing (35.0%) and recording of residues (25.0%). However, they felt that the steps they missed are "very important" (65.0%) and "important" (50.0%). They also noted that these steps though difficult were not impossible.

Similarly to the cabbage farmers, the eggplant farmer are not prepared but the potential exists and more capacity-building could prepare them better.

### *Testing of Pathogens in Organic Fertilizer and Use of Synthetic Fertilizer Based on Nutrient Needs*

Even though the majority of the cabbage farmers considered testing of pathogens in organic fertilizer as "important" (58.1%), still most of them (71.0%) never did. The majority (74.2%) thought the step was "possible but difficult" to implement. With respect to the use of specific commercial fertilizer based on nutrient needs, the majority of the farmers perceived it to be "important" (77.4%), "sometimes" compliant (51.6%) and found implementation "possible but difficult" (48.4%).

These responses suggest unpreparedness of cabbage farmers in this aspect but with observed potential.

Although an equal number of eggplant farmers (comprising the majority) considered testing of pathogens in organic fertilizer "important" and "very important", many (37.5%) of them never did. Most (37.5%) thought this is possible but difficult to implement. This depicts unpreparedness but with great potential. There may be a need to resolve the difficulty by equipping these farmers with necessary training and technological assistance.

The use of specific commercial fertilizer according to nutrient needs was perceived by the majority of the eggplant farmers to be "very important" (62.5%). In fact the majority (52.5%) were compliant and found implementation "easy" (45.0%). This indicates that most eggplant farmers were actually fully equipped and prepared in this aspect.

### *Use of Controlled Prescribed Amount for Pest Control and Application of Intercropping as Means of Segregating Pests and Diseases*

Most cabbage farmers perceived the practice of regulating spraying as "important" (61.3%) but "sometimes" followed (51.6%). They found it "possible but difficult" to implement (61.3%). More incentives in this aspect may help alleviate the difficulty encountered by cabbage farmers. There is a need for them to get used to stringent measuring of pesticides for spraying.

The application of intercropping as a means of segregating pests and diseases appeared "important" (54.8%) among the cabbage farmer participants which they signified that they "always" (51.6%) comply with. However, still many (38.7%) found this activity "possible but difficult" to implement. Despite the perceived difficulty by the farmers, intercropping has always been practiced.

For eggplant farmers, with respect to the use of controlled prescribed amount for pest control, most farmers perceived the practice of regulating spraying as "very important" (45.0%), "always" followed (37.5%) and "easy" to implement (45.0%). This confirms that eggplant farmers are fully prepared in this aspect.

Table 4.6 Farmer preparedness in land preparation

| GAP Standards | Parameter | Description | Cabbage Farmers | | Eggplant Farmers | |
|---|---|---|---|---|---|---|
| | | | Freq | Percent | Freq | Percent |
| Soil Testing | Perceived Importance | Not Important | 0 | 0.0 | 1 | 2.5 |
| | | Important | 16 | 51.6 | 13 | 32.5 |
| | | Very Important | 15 | 48.4 | 26 | 65.0 |
| | Frequency of Use | Never | 7 | 22.6 | 14 | 35.0 |
| | | Sometimes | 21 | 67.7 | 13 | 32.5 |
| | | Always | 3 | 9.7 | 6 | 15.0 |
| | Ease of Implementation | Not possible | 1 | 3.2 | 5 | 12.5 |
| | | Possible but difficult | 25 | 80.6 | 21 | 52.5 |
| | | Easy | 5 | 16.1 | 8 | 20.0 |
| Recording of Residues | Perceived Importance | Not Important | 0 | 0.0 | 1 | 2.5 |
| | | Important | 16 | 51.6 | 20 | 50.0 |
| | | Very Important | 15 | 48.4 | 19 | 47.5 |
| | Frequency of Use | Never | 15 | 48.4 | 10 | 25.0 |
| | | Sometimes | 10 | 32.3 | 10 | 25.0 |
| | | Always | 6 | 19.4 | 4 | 10.0 |
| | Ease of Implementation | Not possible | 2 | 6.5 | 5 | 12.5 |
| | | Possible but difficult | 27 | 87.1 | 21 | 52.5 |
| | | Easy | 2 | 6.5 | 3 | 7.5 |

Table 4.6 continued

| GAP Standards | Parameter | Description | Cabbage Farmers | | Eggplant Farmers | |
|---|---|---|---|---|---|---|
| | | | Freq | Percent | Freq | Percent |
| Testing of pathogens in organic fertilizer | Perceived Importance | Not Important | 0 | 0.0 | 0 | 0.0 |
| | | Important | 18 | 58.1 | 16 | 40.0 |
| | | Very Important | 13 | 49.9 | 16 | 40.0 |
| | Frequency of Use | Never | 22 | 71.0 | 15 | 37.5 |
| | | Sometimes | 4 | 12.9 | 5 | 12.5 |
| | | Always | 5 | 16.1 | 3 | 7.5 |
| | Ease of Implementation | Not possible | 3 | 9.7 | 3 | 7.5 |
| | | Possible but difficult | 23 | 74.2 | 15 | 37.5 |
| | | Easy | 5 | 16.1 | 5 | 12.5 |
| Use of specific commercial fertilizer based on nutrient needs | Perceived Importance | Not Important | 0 | 0.0 | 0 | 0.0 |
| | | Important | 24 | 77.4 | 10 | 25.0 |
| | | Very Important | 7 | 22.6 | 25 | 62.5 |
| | Frequency of Use | Never | 6 | 19.4 | 4 | 10.0 |
| | | Sometimes | 16 | 51.6 | 7 | 17.5 |
| | | Always | 9 | 29.0 | 21 | 52.5 |
| | Ease of Implementation | Not possible | 4 | 12.9 | 0 | 0.0 |
| | | Possible but difficult | 15 | 48.4 | 14 | 35.0 |
| | | Easy | 11 | 35.5 | 18 | 45.0 |
| Minimize use of sprays based on recommended amount | Perceived Importance | Not Important | 0 | 0.0 | 1 | 2.5 |
| | | Important | 19 | 61.3 | 12 | 30.0 |
| | | Very Important | 12 | 38.7 | 18 | 45.0 |
| | Frequency of Use | Never | 1 | 3.2 | 0 | 0.0 |
| | | Sometimes | 16 | 51.6 | 14 | 35.0 |
| | | Always | 14 | 45.2 | 15 | 37.5 |
| | Ease of Implementation | Not possible | 0 | 0.0 | 3 | 7.5 |
| | | Possible but difficult | 11 | 61.3 | 3 | 7.5 |
| | | Easy | 20 | 38.7 | 18 | 45.0 |
| Application of intercropping for segregation of pests and diseases | Perceived Importance | Not Important | 2 | 6.5 | 9 | 22.5 |
| | | Important | 17 | 54.8 | 4 | 10.0 |
| | | Very Important | 12 | 38.7 | 8 | 20.0 |
| | Frequency of Use | Never | 9 | 29.0 | 6 | 15.0 |
| | | Sometimes | 6 | 19.4 | 10 | 25.0 |
| | | Always | 16 | 51.6 | 4 | 10.0 |
| | Ease of Implementation | Not possible | 3 | 9.7 | 4 | 10.0 |
| | | Possible but difficult | 12 | 38.7 | 4 | 10.0 |
| | | Easy | 16 | 21.6 | 11 | 27.5 |

For the eggplant farmer participants, the application of intercropping as a means of segregating pests and diseases did not appear "important" (22.5%), which they had used occasionally or "sometimes" (25.0%) but which many (27.5%) found "easy" to implement. This aspect of good practice was not welcomed by the eggplant farmers who found convenience with the traditional mono-cropping practices. There may be a need to exert more efforts to initiate shift in mindset toward intercropping. Future extension trainings and researches can focus on this.

### *Irrigation and Clean Water System*

The practice of assuring a clean water system/source among cabbage farmer participants appeared “important” (54.8%) by the majority. They “sometimes” followed this (45.0%), with most (48.4.5%) finding it “possible but difficult” to implement. In addition, having an irrigation system far from residential areas was perceived “important” (54.8%), “always” practiced by the majority (41.9%) and perceived “possible but difficult” to implement (54.8%). The need for assistance with infrastructure assistance was identified for this purpose.

For the eggplant farmers, the practice of assuring a clean water system/source was “very important” (35.0%), which they “sometimes” (20.0%) or “always” (20.0%) followed while many (25.5%) found it “possible but difficult” to implement. The same as the cabbage farmers, a clean water source is deemed to be a priority for most eggplant farmers. This difficulty when resolved through infrastructural projects or innovation would substantially help farmers comply with this step. Government initiatives prioritizing this aspect would support the proposed food safe traceability network to proceed.

### *Quality Control and Segregation*

According to GAP, harvesting and post-harvest handling practices, specific to the crop grown, prove essential in assuring safety and quality during production.

GAP practices associated with harvesting received positive compliance among cabbage participants with expressed “difficulty”. Majority (51.6%) found quality control “very important” which they “always” practiced (45.2%) but found “possible but difficult” to implement (65.0%). In addition, segregation of produce after harvest likewise was perceived by the majority as “important” (54.8.0%), “sometimes” practiced (41.9%) and “possible but difficult” to implement (54.6%).

In terms of quality control, no matter how difficult the process is, cabbage farmers made sure that they don't skip the step as quality would largely affect the market price of the produce. For this to be sustained, technology that would lessen the difficulty would be of utmost help especially upon subscribing to a traceability network. This makes them well prepared in this aspect.

Segregation however was less frequently practiced and given just “moderate” importance as no further testing was performed during post-harvest as basis for segregation aside from the physical appearance addressed during quality control. Thus, to ensure that residues beyond the maximum limit are prevented, an additional step such as residue testing may be instrumental prior to segregation. However, as this may only be randomly applied, due to high cost, proper record keeping from land preparation and through-out the vegetative stage until harvest would be a more reliable intervention.

Among the eggplant farmer participants on the other hand, GAP practices associated with harvesting displayed positive compliance. The majority (65.5%) found quality control “very important” which they “always” practiced (72.5%) and found “easy” to implement (65.0%). In addition, segregation of produce after harvest likewise was perceived “very important” (55.0%), “always” practiced (82.5%) and “easy” to implement (72.5%).

Table 4.7 Farmer preparedness on irrigation, clean water system, quality control and segregation during harvest

| GAP Standards | Parameter | Description | Cabbage Farmers | | Eggplant Farmers | |
|---|---|---|---|---|---|---|
| | | | Freq | Percent | Freq | Percent |
| Clean water system/source | Perceived Importance | Not Important | 0 | 0.0 | 1 | 2.5 |
| | | Important | 17 | 54.8 | 12 | 30.0 |
| | | Very Important | 14 | 45.2 | 18 | 45.0 |
| | Frequency of Use | Never | 3 | 9.7 | 0 | 0.0 |
| | | Sometimes | 14 | 45.2 | 14 | 35.0 |
| | | Always | 14 | 45.2 | 15 | 37.5 |
| | Ease of Implementation | Not possible | 2 | 6.5 | 3 | 7.5 |
| | | Possible but difficult | 15 | 48.4 | 3 | 7.5 |
| | | Easy | 14 | 45.2 | 18 | 45.0 |
| Quality control system during harvest | Perceived Importance | Not Important | 0 | 0.0 | 0 | 0.0 |
| | | Important | 15 | 48.4 | 9 | 22.5 |
| | | Very Important | 16 | 51.6 | 26 | 65.5 |
| | Frequency of Use | Never | 5 | 16.1 | 0 | 0.0 |
| | | Sometimes | 12 | 38.7 | 2 | 5.0 |
| | | Always | 14 | 45.2 | 29 | 72.5 |
| | Ease of Implementation | Not possible | 1 | 3.2 | 2 | 5.0 |
| | | Possible but difficult | 19 | 61.3 | 0 | 0.0 |
| | | Easy | 11 | 35.5 | 26 | 65.0 |
| Segregation during harvest | Perceived Importance | Not Important | 0 | 0.0 | 1 | 2.5 |
| | | Important | 17 | 54.8 | 13 | 32.5 |
| | | Very Important | 14 | 45.2 | 22 | 55.0 |
| | Frequency of Use | Never | 8 | 25.8 | 0 | 0.0 |
| | | Sometimes | 13 | 41.9 | 1 | 2.5 |
| | | Always | 10 | 32.3 | 33 | 82.5 |
| | Ease of Implementation | Not possible | 1 | 3.2 | 0 | 0.0 |
| | | Possible but difficult | 17 | 54.8 | 2 | 5.0 |
| | | Easy | 13 | 41.9 | 29 | 72.5 |

For the eggplant farmers, both quality control and segregation were religiously implemented and very easy for them to practice. There was no difficulty encountered which indicates their full preparedness in this aspect.

### *Farmer Readiness and Willingness*

Based on the FGDs with cabbage and eggplant farmers toward the completion of the ICS project, the farmer participants expressed the benefits of adhering to food safety practices both for consumers and the producers themselves that signify their readiness and willingness to adopt the traceability system as part of the ICS protocol.

### *Understanding Pesticide Labeling and Information*

With the capacity-building activities given to both farmer groups, the farmer-participants have become knowledgeable and equipped on pests and pesticide management particularly in the gaining of an understanding of the pesticide labels and the appropriateness of the various pesticides for a particular pest or disease. The farmers have become more keen in choosing the right pesticide(s) to be used, together with the proper application parameters such as dosage, frequency, etc. By equipping them with this knowledge, the farmers feel empowered in making the right decisions in choosing the appropriate pesticides for their crop's needs and problems. The farmers said they were glad they had got rid of their old habit of doubling the dosage of pesticides on certain pests because previously they thought that this fixed the problem without knowing that the practice only caused more harm than good.

### *Understanding the ICS Protocol*

The ICS protocol was not just a mere listing of activities that farmers should follow to improve their vegetable production. The ICS protocol also provided the scientific foundational concepts which is the rationale behind why these activities must be accomplished in a certain way. The farmers are not merely following orders blindly because the funding agency or the sponsoring organization says so but because the farmers were properly informed of the consequences for not doing so. Moreover, their awareness of the benefits of the ICS protocol serves as motivation for the farmers to comply.

The farmers also reiterated that they have saved more time with the new farming practices resulting from compliance to the ICS protocol. This paved the way for farmers to pursue other productive activities such as engaging in other lucrative activities and personal affairs. This helped them get in touch with their loved ones and in establishing new connections and networks from the ICS program.

### *Farm Recordkeeping Remains a Challenge*

Although the farmers have come to understand and appreciate the ICS protocol, farm recordkeeping is one of the tasks or activities that farmers have a hard time doing. They admit that during their whole farming experience, they have not included recordkeeping as part of their farming tasks. So until now, keeping farm records remains to be a concept that is yet to be introduced to them. On the other hand, a few farmers have recognized the benefits of farm record keeping throughout the project implementation such as getting a real picture of their farm expenses rather than just computing things in their head.

### *Understanding Traceability as a Continuum Process*

Traceability as a process may initially seem complicated with the sequence of steps, information details and rationale behind each step. On the other hand, an end-to-end approach to the “ends justifies the means” of the traceability system made the farmers become goal oriented in following the ICS protocol. One of the goals of the traceability system is ensuring food safety, thereby making the farmers more confident in eating their own produce and in ensuring that their buyers will also eat safe produce.

## *Being ICS Ambassadors in their Community*

Each of the farmer clusters, for both cabbage and eggplant, have been limited to 40 farmer-participants. During the project implementation, there were other farmers who were interested in joining the ICS program but could not be part of the program because of the limited number of participants allotted per cluster. All throughout the ICS program, the farmer-participants were able to understand and appreciate their learnings while also seeing the benefits of following the ICS protocol in their vegetable production. The success in the farmers' vegetable production made the farmers empowered in sharing what they have learned with their fellow farmers in the community. their initiative to become ICS ambassadors themselves translate to the farmers' willingness to adopt the ICS program after the project completion.

Based on the FGDs with cabbage and eggplant farmers toward the completion of the ICS project, the farmer participants expressed the benefits of adhering to food safety practices both for consumer and the producers themselves. In addition, net economic benefits from controlling use of pesticides while adding more steps in the process invoked interests among farmer beneficiaries in terms of sustaining the practices learned from the trainings.

For eggplant farmers, adhering to food safety protocols not only ensures environmental and health sustainability but also creates economically efficient farming practices through reinforcement of stringent record-keeping, monitoring and safeguarding accurate use of chemicals for pest control.

Table 4.8 presents the critical control points in the food safety traceability system for both cabbage and eggplant that exhibit the farmers' preparedness and potential as indicators of farmer readiness for the food safety traceability system.

Table 4.8 Summary table on farmer preparedness and farmer potential

| Critical Control Points | Farmer Preparedness | | Farmer Potential | |
|---|---|---|---|---|
| | Cabbage | Eggplant | Cabbage | Eggplant |
| Soil testing | partially prepared | Unprepared | with potential | great potential |
| Recording of residues | unprepared | Unprepared | with great potential | potential |
| Testing of pathogens in organic fertilizer | unprepared | Unprepared | with potential | great potential |
| Use of specific commercial fertilizer based on nutrient needs | partially prepared | Prepared | with potential | great potential |
| Minimize use of sprays based on recommended amount | partially prepared | Prepared | with potential | great potential |
| Application of intercropping for segregation of pests and diseases | prepared | partially prepared | with potential | no potential |

Table 4.8 continued

| Critical Control Points | Farmer Preparedness | | Farmer Potential | |
|---|---|---|---|---|
| | Cabbage | Eggplant | Cabbage | Eggplant |
| Clean water system/source | partially prepared | Partially prepared | with potential | with great potential |
| Quality control system during harvest | prepared | prepared | with potential | Great potential |
| Segregation during harvest | partially prepared | prepared | with potential | Great potential |

### *Challenges*

Although farmer readiness in the two farmer clusters for the food safety traceability system have indicated overall positive result in terms of preparedness and potential, there are still critical control points that both cabbage and eggplant farmers have difficulty in dealing with. They are still considered unprepared when it comes to the following critical points:

### *Recording of Residues*

Previously, it has been discussed how farmers were not used to including record keeping as part of their farm routine. In fact, record keeping has been typically confined to the recording of cost items and expenses incurred for a given period which farmers often fail to accomplish. In this case, recording of residues is levelingup the farmers standard of their perspective and value on food safety. Since the goal is for farmers to eventually become GAP-ready through compliance with the ICS protocol, farmers should be keen in recording the residue values of their produce. In the long run, residue values of their produce should serve as the basis for purchases by their clients and markets in general.

### *Testing of Pathogens in Organic Fertilizer*

Farmers were still found to have been unprepared in testing of pathogens in organic fertilizer. With organic farming gaining popularity nowadays, usage of organic fertilizer has also been considered a better alternative in improving vegetable production. On the other hand, what remains unknown by most farmers is that organic fertilizers may have the possibility of containing pathogens that would eventually be detrimental in vegetable production. Learning about pathogens in organic fertilizers would make the farmers aware that they should not immediately apply and use this on their farms. Having this in mind farmers would consider having these pathogen tests as a lot could be at stake if these tests are overlooked or skipped.

## CONCLUSION

Both cabbage and eggplant farmers were not fully prepared in terms of actual practice but the perceived importance of adopting the necessary GAP steps to safeguard the critical control points suggest farmer potential at adhering to food safety standards. The matrix on farmer preparedness and potential based on identified critical control points has exhibited a high chance of farmers' readiness for the food safety traceability system.

Despite some factors that could deter the farmers' readiness for the food safety traceability system, the two farmer clusters in Buguias, Benguet and Dolores, Quezon have exhibited an overall positive response for them to adopt the food safety traceability system.

To further enhance the farmers' readiness, farming consolidation could be pursued in order to achieve both quality and competitiveness. The sense of accountability and responsibility for each of the farmer members would serve as “each other's push” to ensure that each member delivers according to their cluster's standards. If each famer would be in compliance with the food safety traceability system that the farmer cluster adopts, they would have the same standard measures that would serve as the basis for quality and competitiveness. Individual farmers would find it hard to following the system by themselves so by doing it with the cluster team would somehow make it easier for them to accomplish.

Moreover, by focusing on their long-term goals for their vegetable production, farmers realized that the goal of being GAP- ready through the traceability system could help them to be diligent followers of the system.

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### AUTHOR CONTRIBUTIONS

MMEDC and JJSC made significant contributions as part of Project 2.

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### AVAILABILITY OF DATA AND MATERIALS

All data used in this research were obtained from the project database.

## ETHICAL CONSIDERATIONS

At the time of submission, there was no ethics committee in place; however, data privacy was upheld throughout all aspects of the research.

## COMPETING INTEREST

The authors declare no conflicting interests.

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