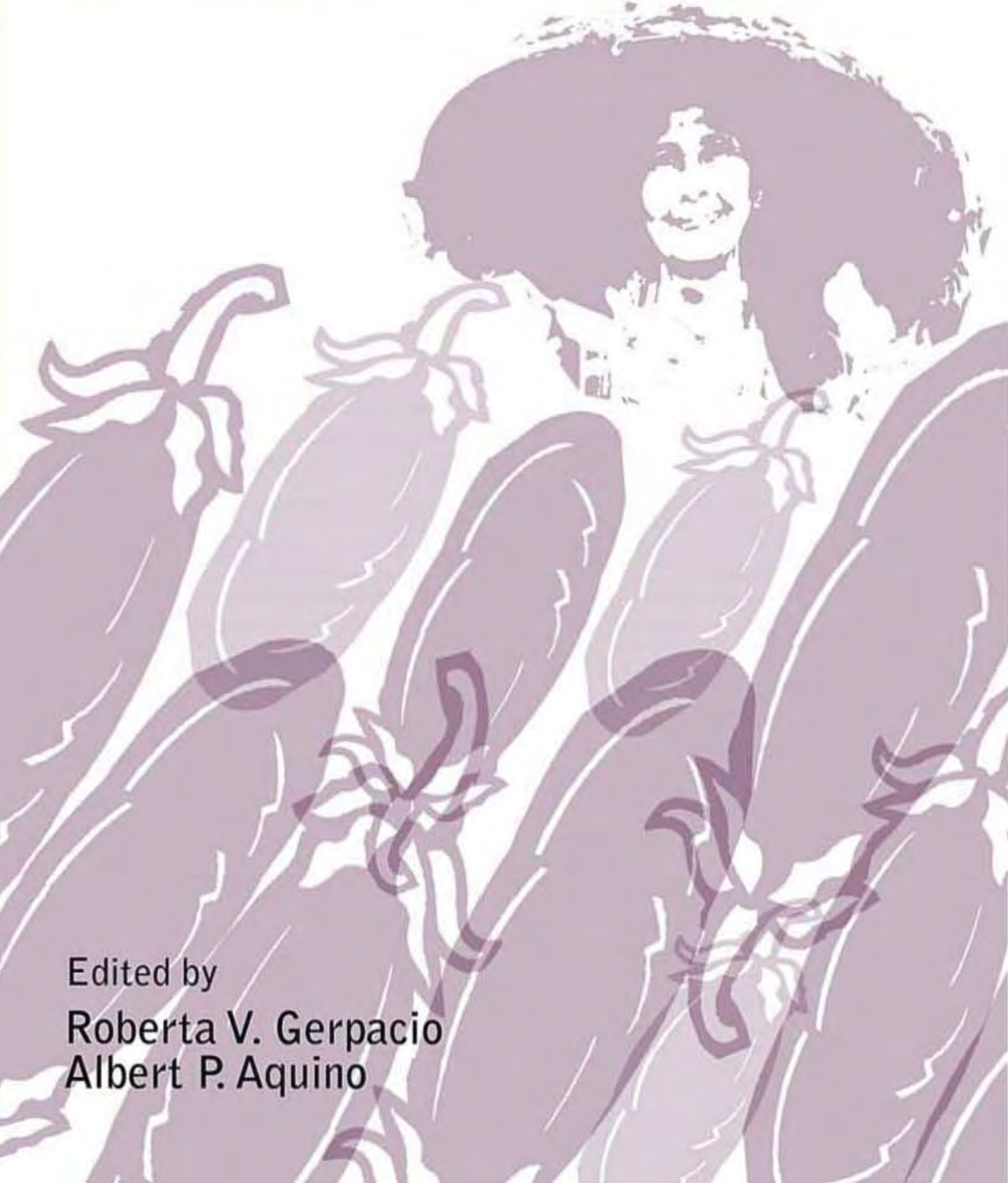
SOCIOECONOMIC IMPACTS OF *Bt* EGGPLANT

Ex-ante Case Studies in the Philippines



Edited by
Roberta V. Gerpacio
Albert P. Aquino

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This publication was compiled with support provided by the Agricultural Biotechnology Support Project II (ABSPII), a consortium of public and private sector institutions led by Cornell University and supported by the United States Agency for International Development (USAID)

Citation: Gerpacio, Roberta V. and Albert P. Aquino (eds). 2014. Socioeconomic Impacts of *Bt* Eggplant: *Ex-ante* Case Studies in the Philippines. International Service for the Acquisition of Agri-biotech Applications (ISAAA), Ithaca, New York, USA and SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), Los Baños, Laguna, Philippines.

First published in the Philippines by the International Service for the Acquisition of Agri-biotech Applications and the SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture with ISBN 978-971-93983-3-2.

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Roberta V. Gerpacio has been a freelance consultant in the last 5 years. She has a MSc in Agricultural Economics (Resource Economics and Environmental Sciences) from the University of the Philippines Los Baños (UPLB) and post-graduate trainings from Wageningen University, Netherlands; University of California-Davis, USA; and University of Cape Town, South Africa. She spent about 20 years conducting agricultural research with five international organizations under the CGIAR system (IRRI, IFPRI, CIMMYT, ICRAF, and WorldFish Center) before pursuing full time consulting work with international, regional, and national development agencies.

Albert Perez Aquino is the Director of the Socioeconomics Research Division, Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (PCAARRD) of the Department of Science and Technology (DOST), Philippines. He has a PhD in Agricultural Economics from Chiba University (Japan), and a MSc in Agricultural Economics and BSc in Agricultural Business from the University of the Philippines Los Baños (UPLB). He was the former president of the Philippine Agricultural Economics and Development Association (PAEDA), 2011-2013. He has (co-)authored/edited journal articles, books, reports, and conference papers related to socioeconomics of agriculture and rural development, science and development, monitoring and evaluation, and impact assessment.

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Foreword

This book marks another important milestone in the research and development of *Bt* eggplant in the Philippines. It is a significant addition to several empirical studies on the potential impact of the products of modern biotechnology. The studies on the potential benefits of *Bt* eggplant presented in the book are valuable information to support our advocacy for technologies that provide opportunities to improve customary agriculture, and farmers' practices and technologies.

The quantified market prospects, and the potential economic, health and environmental impacts of *Bt* eggplant mirror what we also hope to realize with this technology. We would like to spare our eggplant farmers of significant marketable yield loss due to fruit and shoot borer, of pesticide use that accounts for almost one-third of total production costs, and of pesticide-related health problems. We capitalize on the worthwhile technology that will potentially help farmers grow the vegetable with higher net farm income and not having to resort to frequent and heavy spraying of insecticides.

The book is a good information resource for policy-makers and technology adopters to guide investments in the technology, and other stakeholders to know more about *Bt* eggplant in order to help them make informed decisions.

Bt eggplant promises to be one of the better options for farmers. The Department of Agriculture has always been consistent with the goal of modernizing agriculture to improve food self-sufficiency as well as product competitiveness. This provides us with impetus to work on a variety of options.

Segfredo R. Serrano
Undersecretary, Policy, Planning, Program Development,
R&D and Regulations
Chair, Biotech Program Steering Committee
Department of Agriculture

January 2014

Preface

Eggplant is an economically important vegetable in Philippines. It is vital to the domestic vegetable industry making the country the 7th top eggplant producer in the world. It provides many small-scale farmers their major source of employment and livelihood. It also has significant health and nutritional value, being a good source of vitamins, fiber, and minerals.

However, eggplant production in the country suffers from significant yield losses due to pests and diseases, mainly the fruit and shoot borer (FSB). To address this production constraint, the Institute of Plant Breeding at the University of the Philippines Los Baños (IPB-UPLB) developed FSB-resistant eggplant (also called *Bt* eggplant) for the Philippines, in partnership with the Indian Maharasthra Hybrid Seeds Company Ltd. (Mahyco) and Cornell University, and with support from the United States Agency for International Development (USAID) through the Agricultural Biotechnology Support Project II (ABSPII), the International Service for the Acquisition of Agri-Biotech Applications (ISAAA), and the Philippine Department of Agriculture (DA). Promising varieties of this *Bt* eggplant are currently under advanced stage of evaluation for horticultural performance and biosafety.

Between 2006 and 2013, ISAAA commissioned renowned researchers to conduct baseline studies on conventional eggplant production system and *ex-ante* impact assessment studies of *Bt* eggplant in the Philippines. More specifically, these studies assessed the Philippine eggplant industry at the national level and in selected major production areas, including in-depth analysis of the environmental impacts of current pesticide use in eggplant production, and *ex-ante* assessment of the potential economic, environmental, and health impacts of the *Bt* eggplant technology. Results of some of these studies have been presented in local seminars and published in both local and international refereed journals.

This book provides a systematized compilation of all these results and other major empirical findings for wider dissemination to key stakeholders (e.g., policy makers, farmer groups, government institutions, private sector, and academic and research community) and the general public. It is hoped that valuable information contained in this book will generate greater support from and appreciation of stakeholders on the potential benefits of *Bt* eggplant.

We would like to thank the principal researchers and their respective research teams who conducted the individual studies, particularly for their patience and cooperation in finalizing the chapters of this book. We especially would like to express sincere appreciation for the trust and support of Dr. Randy A. Hautea and Panfilo G. de Guzman at ISAAA *SEAsia*Center, and for the administrative and logistical assistance provided by the rest of the ISAAA staff, in this undertaking.

Roberta V. Gerpacio
Los Baños, Laguna, Philippines

Albert P. Aquino
Los Baños, Laguna, Philippines

January 2014

Message from ABSPII

ABSPII is a consortium of public and private sector institutions that helps countries and Asia and Africa gain access to the benefits of agricultural biotechnology. Because we are a not-for-profit organization led by Cornell University and funded by the United States Agency for International Development (USAID) our consortium is able to focus on crops that are important to resource-poor farmers and consumers. We partner with national research organizations, agricultural universities and private biotechnology companies to implement projects that complement national and regional efforts to develop and commercialize locally relevant bioengineered crops.

ABSPII has been working since 2003 to coordinate efforts by agricultural universities in the Philippines, India and Bangladesh to develop fruit and shoot borer resistant (*Bt*) eggplant. As you will see in this book, eggplant is an important market crop for small-scale farmers in the Philippines but yield is significantly smaller than what it should be because of the destructive fruit and shoot borer. This insect causes plants to wither and die and prompts farmers to apply costly and dangerous pesticides. However, ABSPII facilitated access to *Bt* technology that has allowed researchers at the University of the Philippines Los Baños, to develop locally important eggplant varieties with resistance to the fruit and shoot borer.

Vegetable farming households remain in general poverty in the Philippines, including those in the eggplant subsector. Results of impact studies presented in this book highlight the potential economic benefits that can be derived from *Bt* eggplant through higher net farm income and reduction in poverty incidence among farming households adopting the technology.

I thank ISAAA and SEAMEO SEARCA for collecting the important studies contained within this book. Readers will be rewarded with a deeper understanding of the potential benefits to farmers and consumers of fruit and shoot borer resistant eggplant in the Philippines. It is my hope that this will help inform the debate over the cultivation of genetically modified eggplant by demonstrating the potential impacts in terms of improved yield, reduced pesticide use, increased farmer income and improved environmental quality.

Frank A. Shotkoski, PhD
Director, Agricultural Biotechnology Support Project II (ABSPII)
Cornell University
Ithaca, New York, USA

January 2014

Chapter 1

Overview and Synthesis

Asia produces 87% of the world's eggplant production and accounts for 90% of the world's production area (Chen and Li, 2008). The Philippines ranked 7th among the world's top eggplant producers (PCARRD, undated) although eggplant is grown primarily for domestic markets. Eggplant (*Solanum melongena* L.), is one of the economically important vegetable crops in the Philippines, leading in terms of area planted, and volume and value of production (Hautea and Narciso, 2007). It is claimed to have significant health and nutritional value, being a good source of vitamins, fiber, and minerals; and believed to be a cure for various ailments including toothache, asthma, bronchitis, diabetes, dull vision, high cholesterol, inflammation and swellings, and liver complaints (Maghirang, 2001; Paredes, 2005; Tan, 2007; Chen and Li, 2008).

This book presents the findings of completed studies on the market prospects and potential economic, health, and environmental impacts of a biotech eggplant, *Bt* eggplant, in the Philippines. These analyses are complemented by studies on pesticide use, and costs and returns of conventional eggplant production, and on supply chains in eggplant marketing. All the studies were conducted in major eggplant-producing provinces in the country, and used both primary and secondary data and information for scientifically-sound methods of analysis. Focus group discussions; key informant interviews; farmer, trader, and/or household surveys; and detailed reviews of literature were employed in these studies. This chapter presents the key findings and implications from these studies, and readers are strongly encouraged to refer to the specific chapter(s) for further details.

Current Status of Conventional Eggplants in the Philippines

- *Total eggplant production in the Philippines has been increasing since 2000, despite relatively slight increases in area planted and crop yield. While annual net income fluctuates from one year to the next, eggplant production remains a profitable venture for farmers.*

Total eggplant production in the Philippines increased by 2.1% per annum during 2000-2009 despite a lower growth rate in area planted. In the same period, the national eggplant yield levels showed a generally increasing trend, albeit only slightly, and appeared to be stable at around 9 m tons/ha (Chapter 2). More recently in 2006-2011, production increased by 8.4%, area planted by 2.3%, and yield by almost 6%, to 9.7 m tons/ha. Eggplants are available year round in the markets, with supply highest between January to August. In 2000-2007, farmers' annual net income from eggplant production averaged at almost PhP20,000 per hectare (ha).

Eggplant fruits are graded or classified mainly by length and color prior to marketing. The national average farmgate, wholesale, and retail prices of eggplant from 2000 to 2009 shows that the retailers' margin over the wholesalers' price is larger than the wholesalers' margin over the farmgate price (Chapter 2). As such, an eggplant farmer could enjoy additional income if produce is directly sold to consumers.

Poor water supply and pests and diseases (including fruit and shoot borer [FSB], fruit fly, and bacterial wilt) were cited as important production problems. FSB in particular can cause a 80% yield loss if left unmanaged or uncontrolled, and pesticides account for 30% of total production costs, the highest among all inputs. Both farmers and traders reported low market price of eggplants during peak production period as their only marketing problem.

- *The eggplant seed system in the Philippines is generally formal and organized, where both public and private sectors are involved in production, quality control, and marketing, mostly of seeds of hybrid eggplants.*

The eggplant seed production and marketing system in the Philippines is generally formal and organized, where both public and private sectors have well established quality control strategies (Chapter 2). Commercial eggplant farmers generally adopt hybrid seeds produced by private seed companies, while small-scale producers (those growing eggplant in backyard gardens or for home consumption) mainly use open-pollinated varieties from public or private sectors.

In the national seed system, government agencies play an active role from research and development (R&D), importation/production and quality control, distribution and marketing, information dissemination, and policy and regulation. The private sector also plays an active role in these areas, except in policy and regulation (Chapter 2). A number of eggplant varieties are in the Philippine seed market but only a few are registered with the National Seed Industry Council (NSIC) or has plant variety protection. Discouraged by the rigorous process involved, seed companies instead strengthen their marketing and promotional activities to improve seed sales.

- *Eggplant fruit and shoot borer (FSB) is the most commonly reported insect pest, against which farmers resort to frequent and heavy spraying of insecticides. Such practice can lead to insecticide residues contaminating agricultural soils and water, as well as cause occupational health concerns to farming households.*

Across the soil and water and eggplant fruit studies conducted in Sta. Maria, Pangasinan, eggplant farmers were found applying a broad spectrum of insecticides. These consisted of 25 commercial brands, with two being category I (highly toxic) pesticides; nine category II (moderately toxic) pesticides; and seven each of categories III and IV (respectively slightly toxic and practically non-toxic) pesticides (Chapter 3). Soil samples from 11 (about 42%) out of the 26 farms tested positive for insecticide residues, some of which exceeded the acceptable maximum residue limit. The insecticide residues detected were chlorpyrifos, cypermethrin, malathion, profenofos, and triazophos. No insecticide residues were detected from water samples.

Meanwhile, wet season sample eggplants in two farms (of 10 sample farms) tested positive to having chlorpyrifos and cypermethrin, with the former at a level higher than the prescribed maximum residue level. From the dry season analysis, cypermethrin was detected in samples from three farms, at levels equal to the prescribed limit. All market samples from both wet and dry season tested negative for insecticide residues.

The most common pesticide-related health problems that farmers and farm workers reported were itchiness or burning sensation of the skin, redness of the eyes, headaches, and muscle pain.

- *Eggplant farmers are very much aware of the eggplant fruit and shoot borer, estimating that, on average, infestation begins a few weeks after transplanting and can cause significant crop damage. Most of the farmers interviewed was not aware of biotechnology nor of genetically modified crops planted in the Philippines.*

A baseline study conducted in four provinces showed that most eggplant farmers had farming as primary occupation and were landowners with 0.76 hectares (ha) of land, of which about 41% (0.31 ha) was planted to eggplant (Chapter 4). Hybrid varieties were most commonly grown, with native variety grown by only 9% of the respondents. Apart from eggplants, farmers also grew rice, other vegetables, and corn.

Majority of the farmers were aware of eggplant fruit and shoot borer (FSB), which on average was estimated to begin at 43 days after transplanting and can cause 84% damage. Across the survey sites, most (82%) farmers applied insecticides to control FSB while about 13% manually removed and buried the infested shoots.

Most farmer-respondents were not aware of biotechnology (72%) nor of genetically modified crops planted in the country (84%) (Chapter 4). Among those aware of biotechnology, majority perceived it as beneficial to the development of Philippine agriculture and are interested in learning more particularly about the technology's potentials for increasing farm productivity and income.

- *The eggplant supply chain in the Philippines is well developed (and can be complicated) with key roles actively played by the farmers, traders, and end-users or consumers, in important domestic markets. Quality of the produce and fluctuation in prices are the main problems that players meet in eggplant marketing.*

Chapter 5 presents a study that employed a supply chain management framework to analyze eggplant marketing in two important production provinces in the Philippines. The study examined the eggplant supply chain's key players and their roles; key customers and product requirements; activities and processes; product, information and payment flow; supply chain performance (costs and returns, marketing margins); and logistic issues, concerns and external influences.

Similar to any other agricultural crop, eggplant farmers and traders consider product price fluctuations as a major marketing problem. They are also concerned with market/consumer quality preferences, eggplant shelf life, and transportability (firmness). Quality of produce will depend not only on farmers' choice of inputs such as seeds and adoption of proper management practices but also on proper handling, post-harvest facilities, and marketing system. Among the players in the eggplant supply chain, farmers receive the highest net incomes.

Bt Eggplant Impact Assessment Studies

Chapter 6 to Chapter 9 of the book showcase empirical works that studied in-depth the potential costs and benefits from *Bt* eggplant adoption and commercialization in the Philippines.

- *A Bt farm stands to gain a net benefit (net farm income) higher than what can be obtained from the current or conventional variety. The higher benefit can be attributed to increased marketable yield and savings from reduced expenses on insecticides and hired labor.*

The present study quantifies the benefits from *Bt* eggplant technology based on results obtained from multi-location field trials, and analyzes its performance relative to non-*Bt* eggplant in terms of yield, cost efficiency, net profitability, and other economic parameters. It provides information to support the commercialization of *Bt* eggplant, and also details the knowledge, awareness, and perception (KAP) of farmers in Pangasinan and Camarines Sur where the field trials were conducted.

A spin-off of Francisco (2006), the study presented in Chapter 6 fine-tuned the assumptions used in the benefit-cost analysis by relying on results of multi-location trials conducted in two eggplant-producing provinces. It echoed earlier results in terms of the technology's influence in increasing marketable yield, reducing production costs, and thereby, increasing net farm income. It relied on the two-season data of the multi-location trials to construct partial budgets. Its results showed that, on average, Pangasinan farmer-respondents' potential net benefit if they used *Bt* eggplant seeds rather than conventional varieties should be higher by about PhP272,000/

ha; Camarines Sur farmer-respondents stand to gain PhP120,000/ha more, also on average. The study also pointed out that if the parameters of the economic surplus estimation in the Francisco (2006) were recalibrated using the results of Chapter 6, the estimates of societal welfare improvement could be higher.

- *In addition to increased marketable yield and profit, the adoption of Bt eggplant could provide significant health and environmental benefits mainly through significant reduction in the environmental impacts of pesticides used in eggplant production.*

The health and environmental impacts of reduced pesticide application as a result of *Bt* eggplant adoption are documented in Chapter 7 to highlight the other benefits attributable to the technology aside from farm yield and income improvements. Using the risk avoidance principle, the study found that the benefits to human health due to *Bt* technology is valued at PhP2.5 million while the aggregate benefits to farm animals, beneficial insects and avian species could amount to PhP6.8 million. These values represent the health costs that would be saved and estimated value for improvement in environmental quality due to adoption of *Bt* eggplant technology by the farmers. The aggregate savings on human health costs could amount to PhP2.1 million assuming a 50% adoption rate. A 48% reduction in pesticide application per hectare can be translated to a field environmental impact quotient (EIQ) among adopters of about 198 per hectare or a 19.5% lower environmental footprint relative to non-adopters. Farmers were willing to pay a higher per unit price for a pesticide formulation that is safer to humans as well as to the environment.

- *Poverty analysis of Bt eggplant adoption implies the technology's significant potential in reducing poverty incidence among adopters. The net impact of Bt eggplant to improving the nutritional status of consumers, in terms of change per capita calorie intake per day, though positive, could be negligible.*

Bt eggplant adoption can lower per unit cost of production, increase the supply of eggplants, and raise the incomes of farmer-adopters who are mostly poor. With higher eggplant production due to better *Bt* eggplant yields, consumers may gain because more eggplants will be available at lower prices. Chapter 8 explores the poverty and nutritional dimensions of technological change that may occur with *Bt* eggplant commercialization and adoption. Analysis pointed to significant reduction in poverty incidence among adopters, as well as welfare gains to consumers with cheaper eggplants available in the market.

The nutritional impact of *Bt* eggplant was estimated to be small because of the eggplant's very small share in the household's total food expenditure. The study highlighted that a decrease in eggplant prices as a result of *Bt* eggplant adoption is not expected to have a significant effect in terms of added consumption. Overall, the net impact of *Bt* eggplant to improving the nutritional status of consumers, in terms of change in per capita calorie intake per day, though positive, could be negligible.

- *Majority of seed companies/distributors/dealers were found willing to sell Bt eggplant seeds; the farmers, to adopt the technology; traders, to market Bt eggplant; consumers, to buy Bt eggplants; and concerned local government units to promote the Bt eggplant technology.*

A research study assessed the market prospects of *Bt* eggplant at the seed market and food market levels using survey data collected from industry players in four major eggplant-producing provinces (Chapter 9). While majority of the respondents were not aware about the *Bt* eggplant technology, the seed companies/distributors/dealers would be willing to sell the seeds; the farmers to adopt them; the traders to market the products; the consumers to buy them; and the concerned local government units to promote the technology. The major reasons cited for the positive support were: marketability (for the seed suppliers); worsening fruit and shoot borer infestation (for the farmers); anticipated profit (for traders); curiosity and perceived safety with products having less or no chemical pesticides (for consumers); and higher yield, expected increased returns, and reduced cost of eggplant production for the farmers (for the local government units).

Majority of the farmers would be willing to pay for *Bt* eggplant seeds at a price higher than those of eggplant seeds currently available in the market, mainly because of the foreseen large savings from less use of chemical pesticides. Although seed suppliers wanted a lower price for *Bt* eggplant seeds, the price would still depend on the mark-up or pricing system of the seed companies. Traders and consumers in general suggested a lower price for *Bt* eggplant to make it more affordable to consumers.

References

Chen, N.C. and H.M. Li. 2008. Cultivation and Seed Production of Eggplant. Asian Vegetable Research and Development Center. www.scribd.com/doc/2297037/Eggplant-Seed. Accessed August 5, 2010.

Francisco, S.R. 2006.Economic impact of *Bt* eggplant adoption in the Philippines. Final Report submitted to ABSPII and International Service for the Acquisition of Agri-biotech Applications (ISAAA).September. Los Baños, Laguna, Philippines.

Hautea, D.M. and J.O. Narciso. 2007. *Questions and Answers on the Development of Fruit and Shoot Borer Resistant Eggplant in the Philippines*. IPB-UPLB-ABSPII.

Maghirang, R.G. 2001. *Organikong Gulayan: Pagtatanim ng Organikong Talong*. www.bar.gov.ph/veggies today.vol 2-3.htm. Accessed August 5, 2010.

Paredes, J. 2005. *Eggplant Getting More Value*. Biotechnology Information Center, SEARCA. College, Laguna. www.bic.searca.org/. Accessed on August 15, 2010.

Tan, T.J.O. 2007. Analysis of the marketing system of eggplants produced in selected towns of Batangas. Undergraduate thesis. University of the Philippine Los Baños (UPLB).

Chapter 2

The Eggplant Industry in the Philippines: Seed System, Production, and Marketing[1]

Agnes R. Chupungco, Dulce D. Elazegui, and Miriam R. Nguyen

Introduction

Asia produces 87% of the world's eggplant production and accounts for 90% of the world's production area (Chen and Li, 2008). The Philippines ranked 7th among the world's top eggplant producers (PCARRD, undated) although eggplant is grown primarily for domestic market. Eggplant (*Solanum melongena* L.), is one of the economically important vegetable crops in the Philippines, leading in terms of area planted, and volume and value of production (Hautea and Narciso, 2007). It is claimed to have significant health and nutritional value, being a good source of vitamins, fiber, and minerals; and believed to be a cure for various ailments including toothache, asthma, bronchitis, diabetes, dull vision, high cholesterol, inflammation and swellings, and liver complaints (Maghirang, 2001; Paredes, 2005; Tan, 2007; Chen and Li, 2008).

Given the significance of the eggplant industry in the Philippine agricultural economy, this chapter provides a comprehensive profile of the crop's seed, production, and marketing systems, including production trends, technologies, and cultural practices; output prices at the farm, wholesale,

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[1] An earlier version of this chapter was published in *Philippine Journal of Crop Science* 2011 36(2): 37-47.

and retail levels; production costs and returns analyses; marketing activities; key industry players and current policies; and important issues and challenges confronting the industry. These information could guide industry stakeholders in responding to the demands of consumers and end-users, as well as crucial inputs in policy design and formulation to promote sustainable industry development.

Methodology

Conceptual Framework

This industry analysis examines the interaction of three components—seed system, production system, and market (Figure 1). Seed system refers to the flows of seed or other planting materials through the production system, and the roles of both formal and informal sector, institutions, and farmers in these flows (Almekinders et al., 1994, as cited in Jarvis et al., 2004). Agricultural production system is the totality of productive activities at the farm level using resources available on the farm or supplied by the environment. The management of a production system includes a range of decisions regarding the selection of crops that will structure farm activities, and the allocation of farm resources to individual operations over time and space, based on the farmer's objectives (P.Y. Le Gal et al., 2010).

Marketing and consumption involves creating opportunities for adding value to the crops; improving postharvest handling and storage; developing market enterprises; and promoting food consumption and nutrition (Campilan, undated). Demand for the commodity would determine to a large extent what kind of seeds to plant and the quantity of the commodity that has to be produced. Overall, the benefits derived by the industry's stakeholders are subject to the enabling environment and market and community values. Technical, financial, and policy support from both public and private sectors are likewise essential in achieving the objectives of all key players in the system.

Data Collection and Analysis

Based on area planted to eggplant and volume of production as of 2011, three municipalities and provinces were selected for this study, namely Sta. Maria, Pangasinan; Tanauan, Batangas; and Tiaong, Quezon. Pangasinan and Quezon belong to the top 10 eggplant-producing provinces at that time.

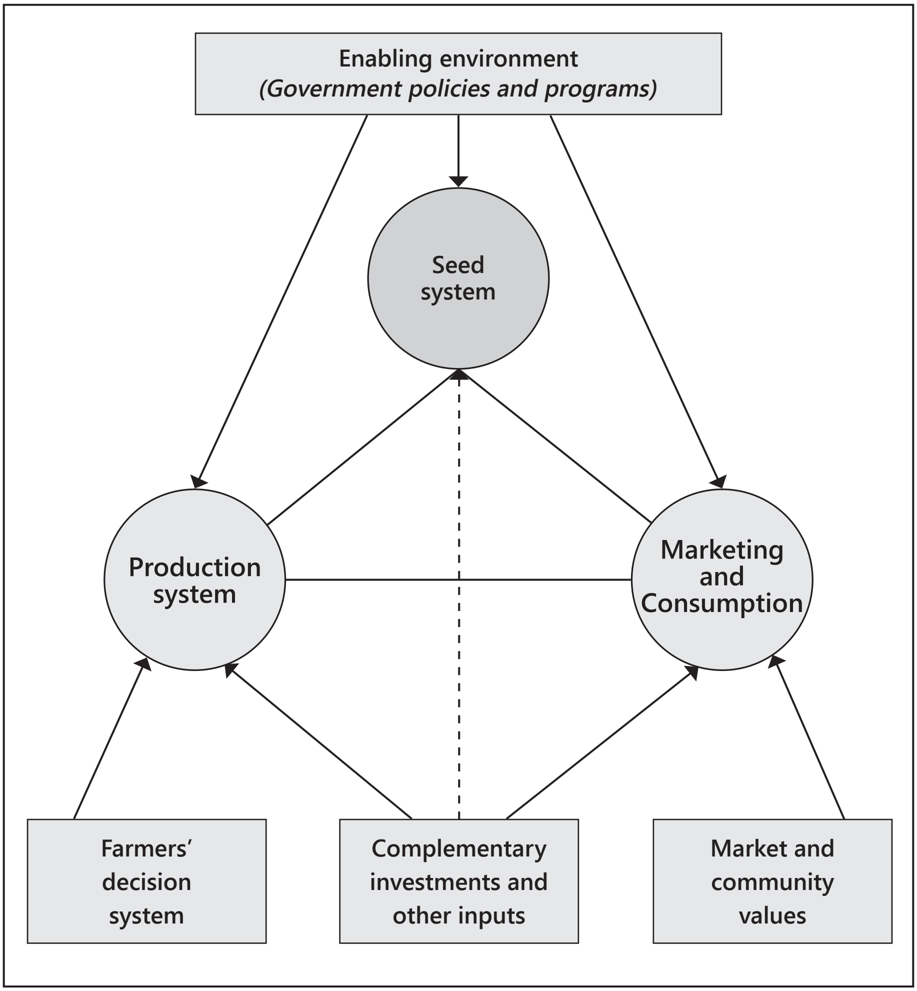

Figure 1. Conceptual framework

The study collected primary data on the eggplant seed system, including varieties available in the market; processes and actors involved in the range of activities from development to marketing of eggplant seeds; farmers' current production and marketing practices; and problems encountered in both seed and fruit production and marketing. The primary data were obtained from four respondent groups, using techniques deemed most practical yet appropriate: (i) focus group discussions (FGDs) with eggplant farmers; (ii) key informant interviews (KIIs) of representatives of selected seed companies (Allied Botanical Corporation, Pilipinas Kaneko Seeds Corporation, and Ramgo Seeds International Corporation) producing and marketing eggplant seeds based in Metro Manila, and East-West Seed Company Inc. based in Bulacan; (iii) KIIs of seed distributors/dealers, and eggplant traders in the study sites; and (iv) KIIs of scientists and researchers from the Institute of Plant Breeding (IPB), Department of Agronomy, and National Seed Foundation (NSF) at the University of the Philippines Los Baños (UPLB); Philippine Seed Industry Association (PSIA) president at UPLB; and Bureau of Plant Industry (BPI) in Manila.

The study also conducted an exhaustive review of literature on eggplant production; available production technologies; cultural practices; and postharvest, marketing, and distribution systems. This was supplemented with secondary data on eggplant production, area, yield, and prices at the farm, wholesale, and retail levels, collected from the Philippine Bureau of Agricultural Statistics (BAS) and related published and unpublished documents. Reports and publications of local government units (e.g., Office of the Provincial Agriculturist, and Municipal or City Agriculturist Office) and research and development (R&D) institutions, as mentioned above, likewise provided some relevant secondary data.

The study involved a review and synthesis of past and ongoing studies on eggplant and analysis of the seed system for eggplant. A trend analysis in production, area planted, yield, and prices by region was done. For the study areas, production and marketing activities of eggplant growers were examined to some extent and a cost and returns analysis of eggplant production was done.

The Eggplant Seed System

In general, a seed system is comprised of the materials, processes, and actors involved (Hodgkin and Jarvis, 2004, as cited in Rola et al., 2009). The materials refer to the germplasm base, varieties, and their characteristics. The processes refer to the flows of seed and other planting materials through the production system, seed production and quality management, seed distribution and marketing, and provision of knowledge and information. Actors refer to the individuals (e.g., farmers), institutions, and other sectors involved in these processes (Almekinders et al., 1994, as cited in Jarvis et al., 2004; Hodgkin and Jarvis, 2004).

There are two fundamental seed systems: the informal seed system, and the formal seed system. The informal seed system[2] is identified as the farmers' or the local seed system since it operates at farmer and community levels in terms of production and exchange mechanisms, local seed selection, and diffusion (Louwaars and van Marrewijk, 1996). Under this system, farmers follow their own operational procedures (Jarvis et al., 2004).

Meanwhile, the formal seed system corresponds to the 'organized seed sector' (Reusché and Chopra, 1993). Seed production and supply mechanisms are operated by public or private sector specialists with well-defined methodologies, and regulated by national and even international policies (Louwaars, 2007). Seed production techniques and quality control system are well established and controlled by proper authorities (Jarvis et al., 2004).

In the Philippines, the eggplant seed system is dominantly formal with private seed companies and government institutions playing major roles in R&D, seed production and quality control, marketing, and distribution (Figure 2). The informal seed system (bottom left portion of Figure 2) is limited as saving seeds from harvested eggplant fruits is rarely practiced. Saved seeds are based on farmers' selection and may also be sourced from cultivars coming from the formal system.

Mostly hybrid seeds[3] circulate in the system, particularly for commercial production, while traditional or open pollinated varieties (OPVs)[4] are usually adopted for backyard production. Experts have varying views on the performance of hybrids and OPVs in eggplants. Some claim that with the same inputs, hybrid seeds have 10%-15% higher yield than OPVs (farmers FGD; Espino, personal communication, 2010), while others say that OPVs can match the performance of hybrids (Maghirang, personal communication, 2010). A seed company representative (personal communication, 2010) opined that OPVs have shorter storability (2 days) (compared to a hybrid's

[2] Also referred to as the 'traditional' seed system (Cromwell, 1996) or 'conventional' seed sector (Camargo et al., 1993)

[3] F1 hybrid seeds are produced by crossing two varieties to mix their characteristics. However, in the next generation (F2 seeds), the characteristics of F1 seeds segregate and the purity of F1 seed is lost. As a result, F2 seeds may express different characteristics—e.g., some tolerant, some susceptible, some very susceptible to certain pests and diseases (Rola et al., 2009). Thus, growers who use hybrid seed must buy new seed every planting.

[4] An open-pollinated plant means that it is capable of being pollinated by other plants of the same or closely related species (CAST, 2001).

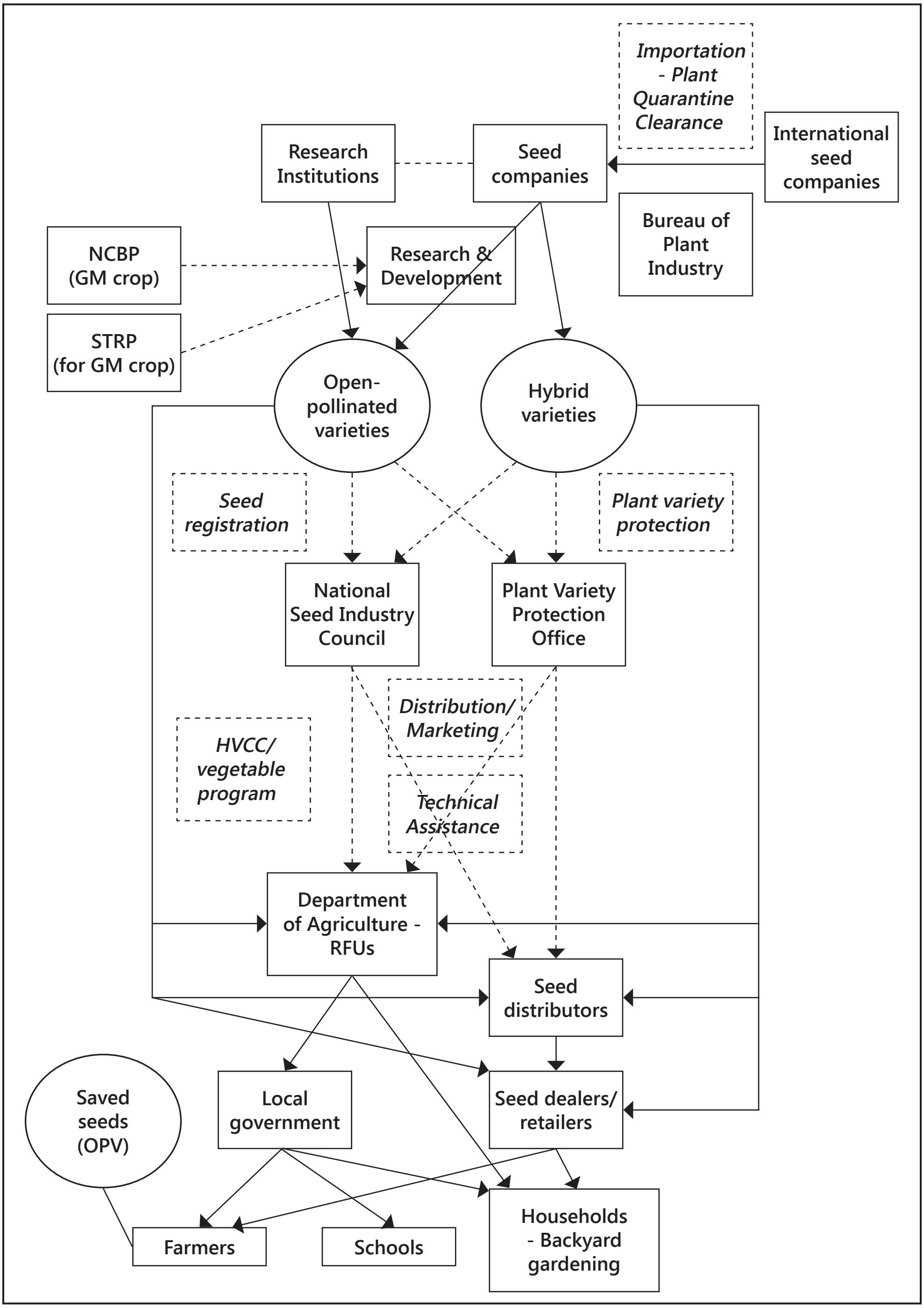

Figure 2. Current eggplant seed system in the Philippines.

2-year shelf life), delayed maturity, and class B, medium-sized, uniformity standard. OPVs are sustainable because seeds are saved from farmers' harvests and a particular variety could be multiplied, thus ensuring its supply. OPVs are hence important to maintain for gene reserves, genetic biodiversity, and germplasm conservation (Maghirang, personal communication, 2010).

Processes and Actors

The processes and actors in the eggplant seed system range from those in the research and development (R&D) of seed varieties to those in distribution and marketing, and regulatory activities. Table 1 summarizes the role(s) of each actor in each of these processes in the system.

Research and Development (R&D). The public and private sectors are both actively involved in eggplant R&D. The public sector, particularly the state universities and colleges (SUCs), are engaged in the R&D of OPVs. The Institute of Plant Breeding at the University of the Philippines Los Baños (IPB-UPLB) spearheads this for eggplant. OPV varieties developed by IPB-UPLB include Mestisa, Mora and Mamburao (Masongsong, personal communication, 2010). It is currently developing a *Bacillus thuriengensis* (*Bt*) eggplant resistant to fruit and shoot borer (FSB), a major pest of eggplant which can result to 20%-90% yield loss (Francisco, undated). However, lack of funding constrains further improvement of OPVs. IPB receives only PhP50,000[5] (about US$1,100) total annual R&D budget for various crops (Maghirang, personal communication, 2010). Funding is usually only a one-shot deal—i.e., on a per project basis with a specific time duration—making it difficult to sustain R&D (Salazar, personal interview, 2010). Plant breeding in eggplants takes 5 years.[6]

Meanwhile, private seed companies are developing mainly hybrid varieties for commercial eggplant production but also have OPVs for household or backyard gardening. Three private seed companies (East-West Seed Co. Inc., Kaneko, and Allied Botanical Corporation [ABC]) have strong R&D programs not only on eggplant but also on other vegetables and fruits. East-West and

[5] US$1.00 = PhP45.00.

[6] Life span of a variety is 10 years if received well in the market. Considerations in varietal improvement include: shelf life of fruits (e.g., 3-4 days); tolerance/resistance to pests (e.g., shoot borer) and diseases (e.g., bacterial wilt); and yield increase of 10-15%; prolificacy and earliness in fruit setting; plant stand; adaptability; and consumer acceptability.

Table 1. Processes, actors, and respective roles in the Philippine eggplant seed system

Processes	Actors: Respective Roles		
	Public Sector		Private Sector
	National Government	Local Government	
Research and development (R&D)	SUCs: R&D on OPVs		Seed companies: OPV and hybrid seed R&D
	DA (BPI, RFUs, RIARCs): R&D on OPVs		
	NCBP and STRP: R&D of genetically modified (GM) crops		Seed companies: R&D on GM crops
Seed importation	BPI: Processing of importation permits and quarantine clearances		Seed companies: Sourcing from international markets; seed importation
Seed production and quality control	SUCs: OPV seed production and quality control		Seed companies: OPV and hybrid seed production and quality control Contract seed growers: OPV and hybrid seed production
Seed distribution and marketing	DA High Value Crop Component (HVCC) Program	Office of the Provincial/Municipal Agriculturist: HVCC Program	Seed companies; distributors; dealers
	BPI: Retail seed marketing		
	STRP: Biosafety assessment for commercial propagation of GM crops		GM crop proponent
Provision of technical assistance, knowledge, and information	DA High Value Crop Component (HVCC) Program	Office of the Provincial/Municipal Agriculturist (DA HVCC Program)	Philippine Seed Industry Association (PSIA) Seed companies

Table 1. Processes, actors, and respective roles in the Philippine eggplant seed system

Processes	Actors: Respective Roles		
	Public Sector		Private Sector
	National Government	Local Government	
Policy and regulation	BPI: Implement and monitor regulatory policies on plants; distribution, regulation of breeder, foundation, and registered seeds of all varieties developed by the public sector		PSIA (lobbying, advocacy)
	NSIC: Seed registration; promote systems and practices for improving seed quality		
	PVPO: Issues certificate of plant variety protection to breeders		
	NSQCS: Control and supervision over field inspection, certification and seed control services, and seed testing laboratories		

BPI=Bureau of Plant Industry, DA=Department of Agriculture, NCBP=National Committee on Biosafety in the Philippines, NSIC=National Seed Industry Council, NSQCS=National Seed Quality Control Services, OPV=open pollinated variety, PVPO=Plant Variety Protection Office, RFU=Regional Field Units, RIARCs=Regional Integrated Agricultural Research Councils, STRP=Scientific and Technical Review Panel, SUC=state universities and colleges

Kaneko have R&D facilities in Batangas and ABC in Pangasinan. Ramgo has a research farm and trial station in South Cotabato. ABC does continuous breeding for varietal improvement such as higher yield, longer shelf life, improved tolerance to pests and diseases; it takes 5-7 years to develop a variety with a total cost of PhP100,000.

The Department of Agriculture Bureau of Plant Industry (DA-BPI) used to conduct eggplant R&D when priorities shifted to other crops like legumes (Mamaril, personal communication, 2010). Meanwhile, the Vegetable Crops Technical Working Group under DA's National Seed Industry Council (NSIC) is not very active and eggplant is not their priority. Aside from budget constraint, this is because the government cannot compete with the private sector in eggplant R&D. There is a need to strengthen this Technical Working Group (Mabesa, personal communication, 2010).

Seed Production and/or Importation and Quality Control. The public sector (SUCs) produce mainly OPV seeds, while the private seed companies multiply their own hybrid and OPV seeds, for commercialization. The National Seed Foundation (NSF) at IPB-UPLB produces OPV seeds once a year both in-house and through contract seed growing in selected areas in Laguna province. It has 25 in-house farmers for 3 hectares (ha), which can produce 100-160 kilograms (kg) of seeds per year. To help in production, IPB-UPLB also has accredited OPV eggplant seed growers in SUCs in Nueva Vizcaya and Cotabato provinces to expand seed production and improve farmers' access to seeds.

NSF buys the OPV raw seed at PhP170/kg from the contract growers and does the final seed processing and packaging. To ensure good quality, seed production observes proper isolation distance, cultural management, and harvesting practices. It also requires proper seed processing and handling in drying and seed extraction, storage (15°C-18°C), and packaging (0.003 mm plastic) (Masongsong, personal communication, 2010).

For hybrid seeds, NSF observes the following quality management practices (Espino, 2010, personal interview): (i) genetic analysis (using markers) to test if seed is hybrid; (ii) physical check of seed purity (not mixed with other seeds, or stones); (iii) checking seed germination rate (85%); (iv) testing for quality control such as amount of good seed in a particular lot; (v) storage at an optimal low temperature (10°C-12°C) for longer shelf life of seeds (about 4-6 months); and (vi) packaging in aluminum foil to reduce respiration and protect the seeds against humidity, insect and mechanical damage. Plastic pack is recommended only for short-term storage.

Private seed companies generally produce their seeds via contract growers. For example, Kaneko produces OPV seeds through contract growers following dealership requirements of 550 kg/year. (One hectare can produce 150 kg of seeds.) For a contract grower with at least 0.5 ha, the company provides foundation seeds and inputs and buys the raw seeds (not yet cleaned and processed) produced at PhP650-700/kg. Seed production is in September to March, to target the planting season between March and May (depending on the locality). For seed quality control, the company conducts hybridity test (through DNA testing done in Japan) and seed treatment (done by BPI) before commercialization.

Meanwhile, some private companies develop their varieties in the Philippines but seed production is done abroad then imported and repacked in the Philippines. Some companies, aside from producing seeds locally, also import hybrid and OPV seeds from their branch companies abroad. For these cases, import permit and renamed plant quarantine clearance (as per BPI AO No. 01 of 2005) must be obtained from BPI prior to market release. These strategies must be cost effective to the companies although the importation process involves additional regulatory costs.

Seed Distribution and Marketing. Through DA's Regional Field Units (DA-RFUs) and the local government units, the national government's High-Value Crop Component (HVCC) Program, *GMA Programang Gulayan para sa Masa* (GMA Vegetable Program for the People), provides either hybrid or OPV seeds to farmers with at least 1,000 square meters (sq. m.) of land for commercial eggplant production. The DA-RFUs acquire the seeds from private seed companies through the government's standard bidding process. Seeds are provided to farmers on a 50-50 sharing scheme (subsidized), i.e., the cost of the seed is equally shared by the farmer and the government (e.g., DA). Through the LGUs, seeds are provided depending on 'farmers' choice'. For commercial eggplant production, a seed distribution program is undertaken usually when farmers are affected by a climate-related event, such as a typhoon.

In partnership with the Department of Education, the HVCC Program also provides OPV seeds to households to promote backyard gardening and help improve nutrition. The program is targeting to reach 800,000 households nationwide in priority areas with high hunger incidence. The program distributes for free assorted vegetable seeds packed in one pouch (worth PhP16.00/pouch) for planting in 10 sq. m. per household.

The major markets of OPV eggplant seeds from IPB-UPLB are the local government units, DA-RFUs, and the UPLB La Granja Experiment Station in La Carlota, Negros (beginning in 2010) for their seed distribution program. Often IPB-UPLB cannot meet the annual seed demand. DA BPI is a retailer of seeds including eggplant, for example, in Metro Manila for backyard gardening of urban households. It remains, however, that the public sector cannot compete with private seed companies as the latter have better marketing and promotion campaign.

Seed companies also join the Philippine Seed Industry Association (PSIA), a non-stock, non-profit organization established in 1976. With mainly private company-members, PSIA's objective is to make readily available to farmers high-quality seeds of superior varieties of all economically important crops. The privileges of being a member of PSIA include: guarantee of being a good supplier of high-quality seed, joining government bidding in seed procurement and subsidy by PSIA in technology demonstration activities. PSIA continues to provide the Seedsmen Update Courses for seed companies and the Vegetable Variety Awareness for farmers.

Similar to those of other agricultural crops (e.g., corn), the private sector dominates the eggplant seed market in the Philippines. They supply seeds to the market through their network of sales representatives, seed distributors and dealers, and sub-dealers. As some seed companies are reluctant to show data on sales, it is difficult to compute their respective market share. Seed companies have their respective turfs. Key informants estimated that East-West reportedly has a bigger share of hybrid seeds in the market, while Kaneko has more product lines for OPV. For instance, in Region IVA, East-West gets 80% of the market while other companies (Kaneko, Ramgo, and Allied) share the remaining 20%. Sales also depend on the number of field workers that a seed company has. East-West has one regional sales manager for Luzon and one for Visayas and Mindanao. Kaneko has 300 dealers, 50% of whom are assigned in Luzon; 20% in Visayas; and 30% in Mindanao. ABC has 500 dealers and 50 technicians. Ramgo has 30 sales representatives/field personnel and 200-300 dealers.

Seed companies also have their own marketing strategies. East-West, for instance, chooses clients from its Marketing and Information Base (MIB). Incentives to dealers include term discounts: (i) within 1-15 days payment, good as cash; (ii) beyond 16 days (50% higher); (iii) cash-on-delivery gets 5% discount; 16-30 days, 2.5% discount; and beyond 30 days, no discount. Another scheme is volume discount based on Business Pact Agreement

(BPA) or based on historical value of sales (e.g., over 3 years). Depending on semestral target, with 100% sales, there is a corresponding incentive for year-ender cumulative sales.

Provision of Technical Assistance, Knowledge and Information. Two major policies relevant to the vegetable industry, including eggplant, are Republic Act 7900 of 1995, also referred to as the High Value Commercial Crops (HVCC) Law; and Republic Act 8435 of 1997, also known as the Agriculture and Fisheries Modernization Act (AFMA) Law. The HVCC Law promotes the production and marketing of high value crops by providing P1 billion fund allocation for credit. AFMA Law enhances government support for modernizing agriculture and fishery sectors and empowering people to attain food security and poverty alleviation.

In line with the government programs, seed companies provide technical assistance to both seed dealers and farmers as part of their distribution and marketing strategies, as well as product marketing assistance to farmers, e.g., market matching. For example, East-West Co. conducts training of seed dealers such as basic characteristics of the product; and company-related policies. For eggplant farmers, there are trainings on cultural management; and identification and control of pests and diseases.

Kaneko promotes its hybrid seeds through annual technology demonstration ('techno-demo') activities, and periodical farmers' meetings. ABC participates in DA's *Aral Saka*, providing six-week trainings on eggplant production; conducts orientation seminars for seed dealers and farmers; and conducts techno-demo activities with LGUs and/or with farmers. ABC also serves as facilitator in trading, and does market matching by linking vegetable growers with the wholesalers.

The national government's HVCC Program can provide commercial farmers and backyard producers with trainings on eggplant production, saving seeds for sustainability, organic fertilizer production, and other related agricultural technology.

Regulation and Government Programs. National government agencies play a regulatory role in the seed system. These agencies include BPI and its National Crop Research and Development Centers (NCRDCs) in the regions, National Seed Quality Control Services (NSQCS), and NSIC. BPI is mandated to implement and monitor regulatory policies on plants, and has direct responsibility for the regulation and distribution of breeder, foundation, and registered seeds of all varieties developed by both government and private sectors.

There are two major policies governing the seed industry in the Philippines: Republic Act (RA) No. 7308, the Seed Industry Development Act of 1992; and RA No. 9168, the Philippine Plant Variety Protection (PVP) Act of 2002 (Table 2). However, compliance with the provisions of these Acts concerning registration and plant variety protection is voluntary.

Based on RA No. 7308, NSIC has the responsibility to 'encourage persons, associations, cooperatives and corporations engaged in genetic resources conservation and preservation, varietal development, production and processing, quality control, and storage, marketing and distribution of seeds to adopt systems and practices, which will improve the quality of seeds for distribution to farmers/growers. NSIC approves on the basis of superior yield, better agronomic and grain characteristics, or higher levels of resistance to pests and diseases over the check, or reigning, variety. (In variety accreditation, seed varieties should be as good as or better than a check variety (reigning) in terms of agronomic or horticultural characteristics.) Permit to propagate means the material is safe, and there will be no problem in its progeny when it is crossed with other lines. BPI and NSQCS, and research institutions such as UPLB, PhilRice and Philippine Council for Agriculture, Aquaculture, Forestry and Natural Resources Research and Development (PCAARRD) have significant roles under this Act.

The Philippines is a member of the International Seed Testing Association (ISTA) and adheres to standard seed testing procedures (FAO, undated). A national cooperative testing (NCT) is necessary for varieties to be approved for registration. This is conducted jointly by IPB-UPLB, DA-RFUs, BPI, and PCAARRD.

The accreditation of an eggplant variety requires that it should be as good as or better than a check variety in terms of agronomic or horticultural characteristics, e.g., 10% higher yield. For national recommendation, field trials of two wet and two dry seasons should be conducted in a minimum of six locations (two locations each in Luzon, Visayas, and Mindanao) to compare yields with a check variety. For regional recommendation, the field trials can be conducted in at least two locations for at least two growing seasons. However, the seed companies do not usually register their seeds because of this lengthy process, and opt for strengthening their promotional activities instead.

Table 2. Provisions of the Seed Industry Development Act of 1992 and the Philippine Plant Variety Protection (PVP) Act of 2002

R.A. No. 7308: Seed Industry Development Act of 1992	R.A. No. 9168: Philippine Plant Variety Protection (PVP) Act of 2002
NSIC shall provide assistance in registering and documenting patents of discoveries of new seed varieties developed by local seed producers; in protecting the intellectual property rights of seed producers	An Act to provide protection to new plant varieties, establishing a National Plant Variety Protection Board (NPVPB), which shall promulgate policy guidelines for the effective implementation of the provisions of this Act
BPI shall have direct responsibility for the distribution, regulation of breeder, foundation and registered seeds of all varieties developed by the government sector	Any breeder, with respect to the variety developed, may apply for a plant variety protection and obtain a Certificate of Plant Variety Protection.
National Seed Quality Control Services (NSQCS) shall have control and supervision over field inspection, certification and seed control services, and seed testing laboratories.	'Plant variety protection' means the rights of breeders over their new plant variety. The Certificate of Plant Variety Protection shall be granted for varieties that are: a) new; b) distinct; c) uniform; and d) stable.
Regional and provincial seed coordinators shall establish linkages and working mechanisms with other government agencies, local government units, NGOs, and other agricultural institutions.	Composition of NPVPB: a) Chairman: Secretary, Department of Agriculture; b) Co-Chairman: Secretary, Department of Science and Technology; c) Vice Chairman: Director-General, Intellectual Property Office (IPO); d) Director, Bureau of Plant Industry (BPI); e) Director, Institute of Plant Breeding of the University of the Philippines Los Baños (IPB-UPLB); f) President, Philippine Seed Industry Association (PSIA); g) A representative from a federation of small farmers' organizations to be nominated by the Secretary of Agriculture; h) A representative from the scientific community to be nominated by the National Academy of Science and Technology (NAST); and i) the National Plant Variety Protection Registrar.(ex officio)
'Seed certification' shall mean a system of seed production geared towards maintaining the genetic identity, varietal purity, and standards of quality seeds of superior crop varieties.	
Composition of NSIC: a) Chairman: Secretary, Department of Agriculture b) Vice Chairman and Executive Director: Director, Bureau of Plant Industry (BPI) c) Dean, College of Agriculture, University of the Philippines at Los Baños, Laguna (UPLB) d) Director, Institute of Plant Breeding (IPB-UPLB) e) Director, Crops Research Division, Philippine Council for Agriculture, Aquaculture, Forestry and Natural Resources Research and Development (PCAARRD) f) Director, Philippine Rice Research Institute (PhilRice) g) Two (2) representatives from accredited farmer's organizations h) One (1) representative from the Philippine seed industry	

Sources: R.A. No. 7308 and R.A. No. 9168 documents

Public sector organizations (SUCs, DA-RFUs and RIARCs) usually have their seeds registered with NSIC at no cost. With registered seeds, these organizations can join government bidding in seed procurement, which is a manner of promoting the seed/variety. For farmers, using registered seeds include coverage by crop insurance and access to agricultural loans from government institutions such as the Land Bank of the Philippines (LBP) or Quedan and Rural Credit Guarantee Corp (Quedancor). Quedancor, a partner financial institution of government agricultural programs, provides credit to farmers with LGUs as conduit or directly to farmer cooperatives, people's organizations for crop production, marketing, acquisition of machinery and equipment. IPB-UPLB also has an in-house seed registration office, the Germplasm and Technology Registration and Release Office (GTTRO) and breeders may opt to have their eggplant varieties registered here (Salazar, personal communication, 2010). According to the Seed Act, the Dean of the UPLB College of Agriculture and the IPB Director are members of NSIC.

Under the PVP Act, a breeder has the option to apply for plant variety protection to acquire exclusive rights over the propagating material so that it cannot be sold without the owner's permission; or to acquire defensive protection, being the first-to-file or the one-and-only developer, to exclude others from producing or using the product without the breeder's permission. Application for PVP requires only planting twice in one location but more detailed data, such as the description of the variety and particulars of the variety bred, including particulars of its characteristics, e.g., new, distinct, uniform and stable. For eggplant, a breeder's right is valid for 20 years.

Meanwhile, based on DA Administrative Order No. 8 of 2002, regulations concerning the R&D and propagation of genetically modified eggplant involve more stringent procedures. For example, approval of multi-locational field trials of the *Bt* eggplant developed by IPB-UPLB has gone through the required application procedures (e.g., risk assessment) and approval involving the Institutional Biosafety Committee (IBC), BPI, the National Committee on Biosafety of the Philippines (NCBP), and the Scientific and Technical Review Panel (STRP). The STRP was created by BPI as an advisory body, composed of at least three (3) reputable and independent scientists to evaluate the potential risks of the proposed activity to human health and the environment based on available scientific and technical information (DA AO8 of 2002). Approval for commercial propagation of *Bt* eggplant would require further evaluation and risk assessment, such as food safety assessment by the Bureau of Agriculture and Fisheries Product Standards (BAFPS), and several rounds of public consultation.

The Materials: Eggplant Varieties in the Philippines

Characteristics. In general, farmers select the varieties to plant based on both fruit characteristics and seed qualities. For eggplants, farmers consider fruit characteristics (color, shape, size) preferred by consumers, shelf life, and transportability (firmness). In terms of seed quality, farmers prefer those that are uniform, viable, undamaged, ripened, cleaned; with high germination rate and better pest and disease resistance; are adapted to local conditions; and are new or improved, ideally with new characteristics to meet old problems.

There are around 30 varieties noted in the Philippine eggplant seed system (Table 3), with hybrids mainly from private seed companies and OPVs from both private companies and government seed agencies (e.g., DA, BPI, and IPB-UPLB). The country has no native eggplant variety, as eggplant originated from other countries such as India (Maghirang, personal communication, 2010).

In terms of marketability, the general preference of consumers is the hybrid, purple and elongated eggplant. But preferences vary by region (Table 4). For example, northern Philippines (CAR, Regions I, II) prefer the green and oval eggplant, mainly for local dishes. There are also special (but small) markets such as for green, elongated eggplant in San Juan and Lemery, Batangas; and for Japanese variety in Nueva Ecija. Tagaytay City and Baguio City also grow greenhouse eggplant for 10 months with one plant producing 10 kg.

Retail Prices of Eggplant Seeds. Hybrid seeds are sold retail in 50-gram cans from about PhP632/can to PhP1,149/can, while those of OPVs sell from PhP165/can to PhP388/can (Table 5). Seeds are also sold in pouches; for example, a 7-gram pouch of Early Bird hybrid seed from Japan costs PhP300.00, higher than other varieties. In contrast, the actual cost of OPV seeds from Kaneko is PhP31.00 per 3-gram pack.

For comparison purposes, per-gram seed prices of the eggplant varieties were estimated based on the selling price of their available seed packages. As such, prices vary widely from PhP10.33 (for Black Ninja) to PhP43.75 (Sikat F1) for hybrids, and from PhP3.30 (Long Purple) to PhP49.75 (Dumaguete Long Purple) for OPVs.

Seed companies give suggested retail price but the dealers can adjust it. There is a price war among dealers, thus prices vary. The incentives, e.g., discount, dealers get from seed companies influence how dealers adjust

Table 3. Eggplant varieties and characteristics in the Philippines, 2010

Variety/ Source	Maturity (days after transplanting, DAT)/Yield	Resistance to pests/ disease	Fruit Characteristics				Other Varietal Features
			Length (cm)[a]	Shape	Color	Weight (grams)[a]	
HYBRIDS							
East-West Seed Co.							
Morena (F1, with PVP)	55-60 DAT 28-30 tons/ha	Tolerant to bacterial wilt Highly tolerant to phomopsis (fungal) wilting			Deep purple		Attractive glossy fruits; have excellent eating and keeping qualities; endure 5 days shipping
Domino (F1, with PVP)		Good tolerance to pests (e.g., mites) and diseases	9	Oblong	Green, striped with creamy white color at the blossom end		
Casino (F1)	55-60 DAT 25 tons/ha	Less tolerant to wilting			Dark purple		Long shelf life (more than 5 days); suitable for planting for all seasons
Jackpot (F1)		High yielding for year round cropping		Long	Purple		
Banate King (F1, with PVP)	55 DAT yield? No data	Tolerant to bacterial wilt		Long	Purple		Popular in Mindanao
Gwapito F1, with PVP)	45-50 DAT Every other day harvest 50% higher than OPV	Tolerant to fruit and shoot borer (FSB)		Round	Purple green; uniform glossy fruits		Firm fruits, long shelf life, good transportability; early maturing; highly adaptable, can be planted in lowland area; 5-7 days storability

Table 3. Eggplant varieties and characteristics in the Philippines, 2010

Variety/ Source	Maturity (days after transplanting, DAT)/Yield	Resistance to pests/ disease	Fruit Characteristics				Other Varietal Features
			Length (cm)[a]	Shape	Color	Weight (grams)[a]	
HYBRIDS							
Kaneko Seed Co.							
Purple Heart (F1)	60 DAT 28-40 fruits/ plant		21	Cylindrical	Purplish pink	95	Long shelf life
Purple Star (F1)	78 DAT 37-44 fruits/ plant		21	Cylindrical	Purple	78	Long harvest period
Black Ninja (F1)	65 DAT 30-44 fruits/ plant	Rated resistant to bacterial wilt in Laguna but moderately resistant in Quezon (Lit, undated)	26	Cylindrical	Purple	86	High fruit setting even during rainy season; longer harvesting period
Checkmate (F1)	65-68 DAT 33-42 fruits/ plant		24	Cylindrical	Purple	79	Very prolific, long shelf life
Ramgo Seed Co.							
Sikat Hybrid	60 DAT		20-25		Shiny deep purple	90-120	
Allied Botanical Corp. (ABC)							
Spitfire (Condor)	65-70 DAT 4 kg/plant	Strong resistance to bacterial wilt	25	Long, cylindrical	Glossy deep purple	150-200	Firm, long shelf life, few seeds
Early Bird	60 DAT 25-30 pcs per plant	Not resistant to bacterial wilt		Plump, very small fruit, bulb type	Glossy purple black	100	Firm, ideal for for specialty market (e.g., Japanese restaurants)

Table 3. Eggplant varieties and characteristics in the Philippines, 2010

Variety/ Source	Maturity (days after transplanting, DAT)/Yield	Resistance to pests/ disease	Fruit Characteristics				Other Varietal Features
			Length (cm)[a]	Shape	Color	Weight (grams)[a]	
Allied Botanical Corp. (ABC)							
Mustang (with PVP)	60-65 DAT	Resistant to bacterial wilt		Long	Deep purple	150-200	
OPEN-POLLINATED VARIETIES (OPVs)							
East-West Seed Co.							
Batangas Long Purple							
Bulakena LP	65-70 DAT 10-15 tons/ha	Tolerant to bacterial wilt, blight, wilting	25-28	Elongated	Purple		
Kaneko Seed Co.							
Sarangani Long Purple	67 DAT		23	Cylindrical	Glossy purple	125	Firm, shiny, long, good shipping quality
Dumaguete Long Purple	70-72 DAT	High tolerance to bacterial wilt	22	Cylindrical	Purple	80	
Claveria Long Purple	70 DAT		18	Cylindrical	Glossy purple	120	Glossy fruits, well-branched plants
Batangas Long Green	76-78 DAT		27	Cylindrical	Green	115	Long
Ilocos Round Green	68-68 DAT		6.5	Round	Green	122	Smooth, round
Aurora Round Green	76-78 DAT		7	Oval	Green	64	Firm, oval, good shipping quality

Table 3. Eggplant varieties and characteristics in the Philippines, 2010

Variety/ Source	Maturity (days after transplanting, DAT)/Yield	Resistance to pests/ disease	Fruit Characteristics				Other Varietal Features
			Length (cm)[a]	Shape	Color	Weight (grams)[a]	
Ramgo Seed Co.							
Claveria							
Dumaguete							
Allied Botanical Corp. (ABC)							
Long Purple	60-75 2 kg/plant	Resistant to bacterial wilt and nematodes		Long	Purple	120	
UPLB-Institute of Plant Breeding (IPB)							
Mara (NSIC Registration number: NSIC 2007 Eg 01; Line: Acc 95-56)	Dry season: 65 DAT; Wet season: 62-68 DAT	(Lit, undated) Resistant to green leafhopper; Moderately resistant to bacterial wilt; Resistant to Phomopsis; Resistant to bacterial wilt Laguna strains; Moderately resistant to Batangas and Pangasinan strains; Moderately susceptible susceptible to Nueva Ecija strains		Cylindrical	Purple	Dry season: 58.68 Wet season: 59.63	With good storage life
Mamburao (NSIC 2007 Eg 02)	Dry season: 67 DAT; Wet season: 74 DAT	Resistant to bacterial wilt and leafhopper		Long	Dark purple, and glossy	Dry season: 69.42 Wet season: 74.00	

Table 3. Eggplant varieties and characteristics in the Philippines, 2010

Variety/ Source	Maturity (days after transplanting, DAT)/Yield	Resistance to pests/ disease	Fruit Characteristics				Other Varietal Features
			Length (cm)[a]	Shape	Color	Weight (grams)[a]	
UPLB-Institute of Plant Breeding (IPB)							
Mistisa	55 DAT	Resistant to bacterial wilt; Moderately resistant to fruit borer, leafhopper, and phomopsis		Medium long	Striped light violet		With 1 week storage life Very good for "pinakbet" Ideal for organic production
Batangas long purple							

[a] Retailers classification: Length: large (primera)=11-12 inches (28-30 cm) long; medium (segunda or semi)=8-10 inches (20-25cm); and small (tercera)=below 8 inches (below 20 cm.). Weight is based on number of fruits per kilo: large=6 pieces; medium=8 pieces; and small=12 pieces.

Sources:
- Lit, M.C. undated. Identification of Eggplant Varieties Resistant to Leafhopper, Shoot/Fruit Borer and Phomopsis Blight. IPB-UPLB. http://www.bar.gov.ph/vegrde/VeggiesTodayVol2-3.htm
- Mamaril, 2010, personal interview.
- National Seed Industry Council (NSIC), Bureau of Plant Industry, Manila
- Plant Variety Gazette, Volume 1 Issue 1, December 28, 2005, Bureau of Plant Industry - Plant Variety Protection Office
- Philippines Seed Industry Association (PSIA) Seed Catalogue
- www.agribusinessweek.com/26-years-of-pioneering-in-hybrid-seed-production
- http://58.69.172.67/Bid/shopping/rfq09b/RFQ_09-191-223B/RFQ_09-209B.pdf
- www.mixph.com/2010/02/growing-talong-or-eggplant-with-cost-analysis.html
- http://blog.agriculture.ph/eggplant-industry-situationer-in-the-philippines.html

Table 4. Regional preferences for eggplant varieties in the Philippines

Region	Province	Variety
CAR	Abra	Batangas Long Purple and Native
	Apayao, Benguet, Ifugao, Kalinga, Mountain Province	Batangas Long Purple
I	Ilocos Norte	Morena, Casino, and Banate King
	Ilocos Sur	Spitfire, Casino, Morena, Banate King, Checkmate, and Cluster King
	La Union	Dumaguete Long Purple, Mustang F1 Hybrid, Casino, Pepito OPV, Mayumi OPV, Aurora Round Green, and Spitfire
	Pangasinan	Morena, Spitfire, Casino, and Checkmate
II	Cagayan	Casino 901, Morena, Batangas Long Purple, Dumaguete Long Purple, and Long Violet
	Isabela	Casino, Domino, Aurora Green, and Liwit
	Quirino	Casino 9
	Nueva Vizcaya	Morena, Casino 901, Batangas Long Purple, and Dumaguete Long Purple
III	Aurora, Pampanga, and Zambales	Casino and Morena
	Bataan, Bulacan, and Tarlac	Morena
	Nueva Ecija	Morena and Gwapito
IVA	Cavite	Casino
	Laguna	Morena
	Batangas	Casino and Morena
	Rizal	Long Purple and Casino
	Quezon	Morena and Casino
IVB	Occidental Mindoro, Oriental Mindoro, and Marinduque	Casino and Morena
	Romblon	Batangas Long Purple, Casino 901, Morena, and Dumaguete Long Purple
	Palawan	Batangas Long Purple, Dumaguete Long Purple, and Casino
V	Albay	Morena
	Camarines Norte	Casino
	Camarines Sur, Masbate, and Sorsogon	Casino and Morena
	Catanduanes	Casino Long Purple
VI	Aklan, Antique, Capiz, Guimaras, Iloilo, Negros Occidental	Batangas Long Purple and Casino 901

Table 4. Regional preferences for eggplant varieties in the Philippines

Region	Province	Variety
VII	Cebu	Batangas Long Purple, Casino, and Morena
	Bohol	Batangas Long Purple, Casino, Morena, Spitfire, and Jackpot
	Negros Oriental	Batangas Long Purple, Casino, Morena, and Jackpot
	Siquijor	Fond May
VIII	Leyte: Biliran, Southern Leyte, Northern Samar	Long Purple
	Eastern Samar	Long Purple and Batangas Long Purple
IX	Zamboanga del Sur	F1 Sikat and Banate King
	Zamboanga del Norte and Zamboanga Sibugay	Casino and Banate King
	Zamboanga City	F1 Sikat Maharlika
	Isabela City	Casino and Banate King
X	Misamis Oriental	Casino, Batangas Long Purple, and Morena
	Misamis Occidental	Señorita and Casino
	Bukidnon	Casino
XI	Davao Oriental	Fond May and Morena
	Davao del Norte	Casino and Banate King
	Compostela Valley	Banate King
	Davao del Sur	Banate King and Sarangani Long Purple
	Davao City	Banate King, Morena, Bulakena, and Batangas Long Purple
XII	North Cotabato, Sarangani, South Cotabato, Sultan Kudarat, and General Santos	Banate King
XII	Agusan del Norte, Agusan del Sur, Surigao del Norte, and Surigao del Sur	Banate King and Casino
ARMM	Basilan	Banate King, Morena, and Batangas Long Purple
	Lanao del Sur	Casino, Batangas Long Purple, and Claveria Long Purple
	Maguindanao	Banate King, F1 Sikat, Claveria Long Purple, and Morena
	Marawi City	Morena, Batangas Long Purple, American Beauty, and Casino
	Tawi-tawi	Claveria Long Purple, American Beauty, and Dumaguete Long Purple

Source: DA High Value Commercial Crop Regional Coordinators, personal communication, Quezon City, 2010.

Table 5. Retail prices of selected eggplant seeds in the Philippines, 2010

Variety/Source	1,000 g	50 g	100 g	7 g	5 g	3 g	2 g	1 g*
HYBRIDS								
East-West Seed Co.								
Morena F1		1,149.47						22.98
Domino F1		632.52						12.65
Casino F1		1,021.22						20.42
Jackpot F1								
Banate King F1		1,074.34						21.48
Gwapito		826.87						16.53
Kaneko Seed Co.								
Purple Heart F1								
Purple Star F1								
Black Ninja F1		975.00						10.33
Check Mate F1		1,013.00						20.26
Allied Botanical Corp.								
Spitfire		825.00		35.00				16.50
Early Bird				300.00				42.85
Ramgo Seed Co.								
Sikat F1		987.00						43.75*
OPEN-POLLINATED VARIETIES (OPVs)								
East-West Seed Co.								
Batangas Long Purple		363.25			60.54			7.27

Table 5. Retail prices of selected eggplant seeds in the Philippines, 2010

Variety/Source	1,000 g	50 g	100 g	7 g	5 g	3 g	2 g	1 g*
Kaneko Seed Co.								
Sarangani Long Purple						31.00		10.33
Dumaguete Long Purple						31.00		10.33
Sarangani LP						31.00		10.33
Claveria Long Purple		388.00				31.00		7.76
Batangas Long Green						31.00		10.33
Ilocos Round Green						31.00		10.33
Aurora Round Green						31.00		10.33
Allied Botanical Corp.								
Long Purple		165.00	300.00					3.30
Ramgo Seed Co.								
Dumaguete Long Purple								49.75*
National Seed Foundation (IPB-UPLB)								
Mistisa	5,625.00						30.00	15.00
Dumaguete Long Purple	5,625.00						30.00	15.00

Note: East-West prices effective January 15, 2010; Kaneko prices effective July 15, 2010.
* Price per gram is actual only for Sikat F1 and Dumaguete Long Purple. The price per gram for other varieties was estimated based on weight of package actually available.
Source: Unit price list of East-West and Kaneko; key informant interview of ABC and Kaneko executives; NSF-IPB-UPLB.

prices. Discounts could be term or volume discount. For term discount, dealers are given a higher discount the sooner the seeds are sold and the dealers pay the seed companies. For example, dealers paying within 15 days after delivery get a 5% discount, while payment within 16-30 days have 2.5% discount. For volume discount, historical value of sales has a corresponding discount. The higher the sale, the higher is the discount. Dealers also avoid having leftover seeds. They can return unsold seeds within the quarter but there is a 20% deduction in the amount refunded by seed companies.

Government Programs Related to the Eggplant Industry

One of the DA's flagship programs is the High Value Crops Program, which includes vegetables. Although eggplant is not considered as a high-value crop, eggplant is part of the general program on 20 species of vegetables, operating at the household and national levels. At the household level, the program aims to improve nutrition by promoting backyard gardening. The program provides participating households free OPV seeds (Dumaguete long purple), organic fertilizers, and trainings on production practices including on how to save seeds. The national level program is for commercial production (with at least 1,000 sq.m. of farm land). This component includes training people in producing on commercial scale; provision of hybrid seeds on a 50-50 sharing scheme (subsidized); and work on 'farmers' choice' system, i.e., seeds distributed depend on farmers' choice.

The *GMA Programang Gulayan para sa Masa* (GMA Vegetable Program for the People) is a national vegetable backyard raising program (through the HVCC Program) that aims to address hunger and malnutrition in selected areas of the country. This program, along with other livestock, poultry and fishery programs, are anchored on promoting integrated food production through backyard gardening in the country's most vulnerable rural communities and provision of training with starter seeds, planting materials, chicken, swine, small livestock, and fish. Implementing this program is BPI, together with other DA agencies such as the Bureau of Animal Industry (BAI), Agricultural Training Institute (ATI), Bureau of Fisheries and Aquatic Resources (BFAR) and DA-RFUs, in coordination with the local government units (LGUs) and the Department of Social Welfare and Development (DSWD). Technical assistance is given by the DA agencies co-implementing the program.

The Eggplant Seed Market in the Study Areas

This study conducted key informant interviews of two eggplant seed distributors and three seed dealers in Quezon; one seed distributor and two dealers in Batangas; and one dealer in Quezon, who were identified by the LGU staff and farmers in the study areas. Seed distributors are those who procure the seed directly from the seed company and supply the seeds to various dealers who sell retail to farmers. An authorized seed distributorship requires at least some collateral, net worth, and vehicle. There are exclusive seed distributors that sell only the products of one seed company; others also sell in retail. Meanwhile, there are dealers who can also get seeds directly from the seed company. Dealers are required to have a business permit.

In Quezon, the three distributors supply eggplant seeds to dealers both within and outside the province. Together, they sell to about 15 vegetable seed dealers in four municipalities within Quezon (Candelaria, Catanauan, San Antonio, Sariaya), and to four dealers across three municipalities and one city in Batangas (Lipa City, Padre Garcia, Sto. Tomas, Tanauan). Peak sales are during the eggplant planting season in March to May. One dealer in Quezon, for example, has to maintain five boxes (each with 24 50-gram cans) of seeds every day. During ordinary days, the dealer keeps one box in stock. Morena is the highest selling variety in the area with price ranging from PhP840 to PhP1,200 per 50-gram can.

Seed company sales representatives deliver bulk orders to the dealers, but send smaller orders through local commercial couriers. While the companies provide suggested retail prices for their seeds, the dealers can adjust the prices depending on their targeted sales and/or company discounts. For example, under a seed company's volume discount scheme for dealers, every 100 boxes of seeds sold get a price discount whose rate increases with (higher) volume of sales.

Tanauan City, Batangas has only one seed distributor, who sells to six dealers across three municipalities and two cities within the province (Bauan, Lipa City, Lemery, Nasugbu, Tanauan City) and to one dealer in Cavite province. These six dealers include two farmers' cooperatives. Twenty-five percent of the distributor's seeds are sold over the counter while 75% are sold to dealers. Lemery and Tanauan appear to be significant eggplant seed markets since they respectively acquire about 50% and 25% of the seeds supplied. In Batangas, seed sales peak during the months of April through December. In one year, the distributor sells more Casino hybrid than other varieties, at about 50 boxes of 24 50-gram cans and 50 boxes of 100 pouches (each with 100 seeds). One can costs PhP1,200 and one pouch costs PhP38 at retail price. Two other dealer-respondents reported having higher sales from Morena.

In Sta. Maria, Pangasinan, eggplant growers buy their seeds from a dealer in the municipality of Rosales. Overall, despite the different varieties reported earlier, only a few varieties were found in the market in the study areas; and these are mostly hybrid from two to three seed companies (Table 6). Farmers also mentioned that Morena seedlings could be ordered from East-West at PhP140/seedling.

Eggplant Production, Area, and Yield at the National Level[7]

Production

Total eggplant production in the Philippines generally increased from 176,991 metric tons (m tons) in 2003 to 211,854 m tons in 2012, posting a growth rate of 19.7% and average production of 197,822 m tons (Appendix Table 1). In the same period, the regions of Caraga, SOCCSKSARGEN, and Northern Mindanao exhibited the highest production growth rates of about 80.3%, 49.5%, and 44.3%, respectively. The top eggplant-producing provinces in these regions were Agusan del Sur (Caraga), North Cotabato (SOCCSKSARGEN), and Lanao del Norte (Northern Mindanao).

The top five regions in terms of average production in 2003-2012 were Ilocos Region, CALABARZON, Central Luzon, Cagayan Valley, and Western Visayas (in this order). In 2012, these same regions were also the top eggplant producers, with Pangasinan, Quezon, Iloilo, and Isabela as the leading eggplant-producing provinces.

Area Planted

The area devoted to eggplant in the Philippines similarly showed a generally increasing trend from 20,984 hectares (ha) in 2003 to 21,481 ha in 2012 (Appendix Table 1). It averaged at 21,255 ha during the period, with small farms ranging from 0.22 ha to 0.50 ha. The top five largest areas planted to eggplant were in Ilocos Region, Central Luzon, Cagayan Valley, CALABARZON, and Central Visayas. Among these five, Cagayan Valley and Ilocos Region expanded their eggplant areas between 2003 and 2012, while Central Luzon, CALABARZON, and Central Visayas reduced their areas planted to eggplant.

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[7] The secondary data used in this section came from the Philippine Bureau of Agricultural Statistics (BAS) online databases, accessed in 2013.

Table 6. Market price of eggplant seeds, by dealer in selected locations, Philippines, 2010

	Morena (East-West)			Casino 901 (East-West)			Maharlika Sikat F1 (Ramgo)		Checkmate (Kaneko)	Spitfire (ABC)
	Can (50g)	Can (875 seeds)	Pouch (275 seeds)	Can (50g)	Can (900 seeds)	Pouch (300 seeds)	Can (50g)	Pouch (300 seeds)	Can (50g)	Can (50g)
Tiaong, Quezon										
Suggested retail price	1,200	-	-	-	-	-	-	-	-	
Dealer 1	900	110	50	800	110	50	840	50	820	
Dealer 2	840	110	50	820	110	na	na	na	na	
Dealer 3	900	110	na	820	110	50	830	na	na	
Dealer 4	900	na	na	800	Na	50	na	na	na	
Average	*885*	*110*	*50*	*810*	*110*	*50*	*835*	*50*	*820*	
Tanauan City, Batangas										
Dealer 1	890	-	50			50				
Dealer 2	920	-	50	850		50	650		600	850
Dealer 3	900		45	850	120	50				
Average	*903*		*48*	*850*	*120*	*50*	*650*		*600*	*850*
Seed distributor 1										
Dealer's price	920	816								
Over-the-counter price	965	-	45	860		45				

Table 6. Market price of eggplant seeds, by dealer in selected locations, Philippines, 2010

	Morena (East-West)			Casino 901 (East-West)			Maharlika Sikat F1 (Ramgo)		Checkmate (Kaneko)	Spitfire (ABC)
	Can (50g)	Can (875 seeds)	Pouch (275 seeds)	Can (50g)	Can (900 seeds)	Pouch (300 seeds)	Can (50g)	Pouch (300 seeds)	Can (50g)	Can (50g)
Rosales, Pangasinan										
Dealer 1	1,000	110	50	888	110	50	-	45		45

Notes:
n.a.=not available during the interview. Seeds in 50-gram cans are reported to sell more than other pouches.
Farmers in Rosales, Pangasinan reported that Morena seedlings could be ordered from East-West at PhP140/seedling.
US$1.00 = PhP45.00

Noticeably, some regions in Mindanao significantly expanded their areas planted to eggplant during 2003-2012. SOCCSKSARGEN posted the highest increase at 28.3%, followed by Davao Region (22.2%), and Northern Mindanao at 19.2%. In Luzon, the Bicol Region posted the highest area expansion at almost 13%.

At the provincial level in 2012, Pangasinan posted the highest area planted to eggplant with 3,781 ha, followed by Nueva Ecija (1,547 ha), Isabela (988 ha), and Cebu (894 ha).

Yield

During 2003-2012, the national eggplant yield levels showed a generally increasing trend with an average of 9.3 m tons/ha (Appendix Table 1). At the regional level, it ranged from almost 3 m tons/ha (in MIMAROPA, ARMM, and Zamboanga Peninsula) to about 18 m tons/ha in CALABARZON. The latter is followed by Ilocos Region and SOCCSKSARGEN with 15 m tons/ha and 11 m tons/ha, respectively.

Looking more closely, the country posted a 17% improvement in eggplant yield between 2003 and 2012. At the regional level, Caraga posted the highest percentage change of 86%, followed by Central Visayas (52%) and Western Visayas (25%). Data also shows, however, that eggplant yield levels posted some declines in Davao Region (22%) and Zamboanga Peninsula (9%).

Production Cost and Return Analysis

Based on BAS data, per-hectare yields of eggplant in the Philippines generally increased during 2003-2012, and averaged at about 9.30 m tons/ha. In contrast, farm prices fluctuated with the lowest of PhP10.84 in 2003 and the highest of PhP20.44 in 2011. Average farm price was PhP14.39/kg. With total production costs generally increasing through the period, both gross revenue (yield multiplied by farm price) and net income (gross revenue less total costs) varied with farm price levels, and hence also fluctuated (Table 7). Gross revenue ranged from PhP91,435 in 2003 to a peak of PhP198,881 in 2011. Net income was lowest in 2010 at PhP10,245 and highest in 2012 at almost PhP53,000. Gross revenue averaged at about PhP134,714/ha, and net income at almost PhP35,000/ha, during the said period.

Meanwhile, Maghirang et al. (2007) estimated the net income from eggplant production at almost PhP161,000/ha, based on total costs of

Table 7. Market price of eggplant seeds, by dealer in selected locations, Philippines, 2010

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*	Average
Costs (PhP)	1,000	110	50	888	110	50	-	45		45	
Seeds	1,344	1,567	1,432	1,771	1,483	2,043	1,974	1,510	2,532	2,174	1,783
Fertilizer	11,692	15,828	19,678	19,554	17,897	32,066	22,674	22,444	23,606	25,011	21,045
Pesticides	12,257	12,301	12,273	11,705	11,136	11,549	10,928	12,043	10,886	10,932	11,601
Labor	31,272	326,712	34,595	36,099	37,497	41,068	41,940	44,501	46,719	48,863	39,522
Other costs**	19,172	21,920	22,835	25,380	24,103	29,829	29,138	27,744	34,077	33,209	26,741
Total (PhP)	75,737	84,287	90,813	94,509	92,116	116,555	106,654	108,242	117,820	120,189	99,692
Yield (kgs)	8,435	8,674	8,844	9,182	9,724	9,370	9,492	9,720	9,730	9,865	9,304
Farm price (PhP/kg)	10.84	12.64	11.55	14.29	11.97	16.49	15.94	12.19	20.44	17.55	14.39
Gross revenue (PhP)	91,435	109,639	102,148	131,211	116,396	154,511	151,302	118,487	198,881	173,131	134,714
Net income	**15,698**	**25,352**	**11,336**	**36,702**	**24,280**	**37,957**	**44,648**	**10,245**	**81,061**	**52,941**	**35,022**

*Preliminary
**Other costs include rents, fuel and oil, irrigation fees, interest on capital, and landlord shares.
Source of data: Bureau of Agricultural Statistics, October 24, 2013

PhP121,260/ha, yield of 15 m tons/ha, and farm price of PhP20/kg (Table 8). For crop year 2009-2010, focus group discussions (FGDs) conducted in this study gathered costs and returns information for eggplant production in Tanauan, Batangas; Sta. Maria, Pangasinan; and Tiaong, Quezon. Eggplant seed use ranged from 2 50-gram cans (total of 100 grams) per hectare in Sta. Maria, Pangasinan to 4 cans (200 grams) per hectare in Tanauan, Batangas. Fertilizer and fertilizer application costs ranged from PhP22,070 in Sta. Maria, Pangasinan to PhP39,750 in Tiaong, Quezon. Farmers commonly sprayed their eggplant crops, though in differing frequencies. Among the three sites, pesticide and pesticide application costs were highest in Sta. Maria, Pangasinan at PhP113,160/ha.

Based on above, total eggplant production cost ranged from PhP167,470/ha in Tanauan, Batangas to PhP237,920/ha in Tiaong, Quezon. On average across the three sites, 40% of farmers' production costs went to pesticides and application costs, 17% to fertilizers and application costs, and only 1% to seeds. Because of the high frequency of pesticide application in Sta. Maria, Pangasinan, a high 57% of farmers' production costs was accounted for by pesticides and its application costs (Figure 3). The lowest share of 26% was noted in Tanauan, Batangas.

Although per-hectare yield in Sta. Maria, Pangasinan was highest at 27.5 m tons/ha, eggplant farm price was lowest at only PhP10/kg. As such, among the three sites, it posted the lowest net income of almost PhP76,500/ha. Had the output price been higher, eggplant farmers in Sta. Maria, Pangasinan could have enjoyed the highest net incomes across the three sites—almost PhP214,000/ha at a farm price of PhP15/kg or PhP351,500/ha at PhP20/kg.

In Tanauan, Batangas, average yield was 21.6 m tons/ha and farm price was PhP20/kg, giving farmers a net income of PhP264,530/ha. If price declined to PhP15/kg, net income would decline by 69% but would still be high at PhP156,530/ha. Meanwhile, in Tiaong, Quezon, yield was higher than in Tanauan by 11% but total production costs was also higher by 42%. Average farm price in Tiaong was PhP15/kg, giving farmers a net income of PhP122,080/ha. At a farm price of PhP20/kg, a farmer's net income would rise by 98% to PhP242,080/ha (Table 8).

Eggplant Marketing

In the Philippines, eggplant is generally available in the market throughout the year, with supply highest between January to August. In general,

Table 8. Per-hectare costs and returns (PhP) of eggplant production by study site, Philippines, crop year 2009-2010

	This Study			Philippines 2007[a]
	Tiaong, Quezon	Tanauan, Batangas	Sta. Maria, Pangasinan	
Inputs (average)				
Seeds (grams)	150	200	100	
Frequency of pesticide application	Every 4 days immediately after harvesting	Weekly	1-2 times daily	
Production Costs (PhP/ha)				
Seeds	2,700	3,600	1,740	2,550
Fertilizer and application labor	39,750	36,430	22,070	33,050
Pesticides and application labor	89,870	43,200	113,160	10,000
Other costs	105,600	84,240	61,548	75,660[b]
Total Production Costs	*237,920*	*167,470*	*198,518*	*121,260*
Yield (kg/ha)	24,000	21,600	27,500	15,000
Output Price (PhP/kg)	15-20	15-20	10	20
Gross Revenue (PhP/ha)				
At price of PhP10/kg	–	–	275,000	–
At price of PhP15/kg	360,000	324,000	–	–
At price of PhP20/kg	480,000	432,000	–	300,000
Net Income (PhP/ha)				
At price of PhP10/kg	–	–	76,482	–
At price of PhP15/kg	122,080	156,530	–	–
At price of PhP20/kg	242,080	264,530	–	160,551

[a] Source: Maghirang et al. (2007)
[b] Includes all labor and other costs

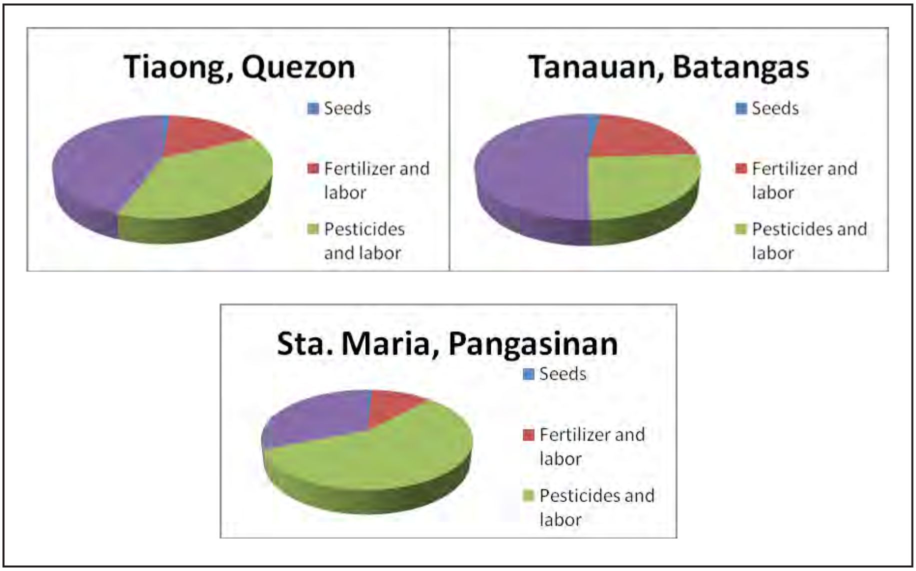


Figure 3. Average share (%) of input costs in total production costs, all study sites, 2009-2010

wholesale or bulk trading is by the hundreds of pieces (or 'ginatos'), with minimum sale volume of 100 pieces. These are bundled in sacks, wooden baskets ('kaings'), or 'bulto'. The 'bulto' has three types: small, which contains 1,000 pieces of eggplant; medium, with 1,800 pieces; and large, with 3,000 pieces of eggplant (http://blog.agriculture.ph/eggplant-industry-situationer-in-the-philippines.html).

Eggplants sold in the market are also graded by fruit length: 'primera' or first class, 11-12 inches; 'segunda' or second class, 8-10 inches; and 'tercera' or third class, 5-7 inches. These are equivalent to having around 6 pieces/kg, 8 pieces/kg, and 12 pieces/kg, respectively. The prices of medium and large eggplants differed by PhP0.30-0.50 per piece, while those of small and medium fruits differed by PhP0.35-PhP0.55 per piece (http://blog.agriculture.ph/eggplant-industry-situationer-in-the-philippines.html). Selected towns of Batangas, however, used a slightly different grading practice for eggplants: 'primera' was 8-10 inches long, and 'segunda' was 6-7 inches long (Tan, 2007).

Farm, Wholesale, and Retail Prices of Eggplant[8]

Farmgate Prices. During the 2003-2012 period, the farmgate price of Long Purple eggplant was lowest in 2003 at PhP10.84/kg and highest in 2011 at PhP20.44/kg (Appendix Table 2). In 2012, the average farmgate price across the country was PhP17.54/kg, and was highest in MIMAROPA, followed by Eastern Visayas and Central Luzon (Figure 4). Five regions, all in Mindanao, posted average farmgate prices lower than the national average in 2012.

Wholesale Prices. The wholesale price of Long Purple eggplant was lowest in 2003 at PhP14.79/kg, and highest in 2011 at PhP29.15/kg (Appendix Table 3). In 2012, the average wholesale price across the country was PhP23.75/kg, and was highest in Central Luzon at PhP29.41/kg. Metro Manila, Ilocos Region, Central Luzon, CALABARZON, and Western Visayas posted average wholesale prices higher than the national average.

Retail Prices. Similar to the trend in farmgate and wholesale prices of Long Purple eggplant, the national average retail price was highest in 2011 at PhP42.05/kg, while the lowest was in 2003 at PhP22.84/kg. In 2012, the

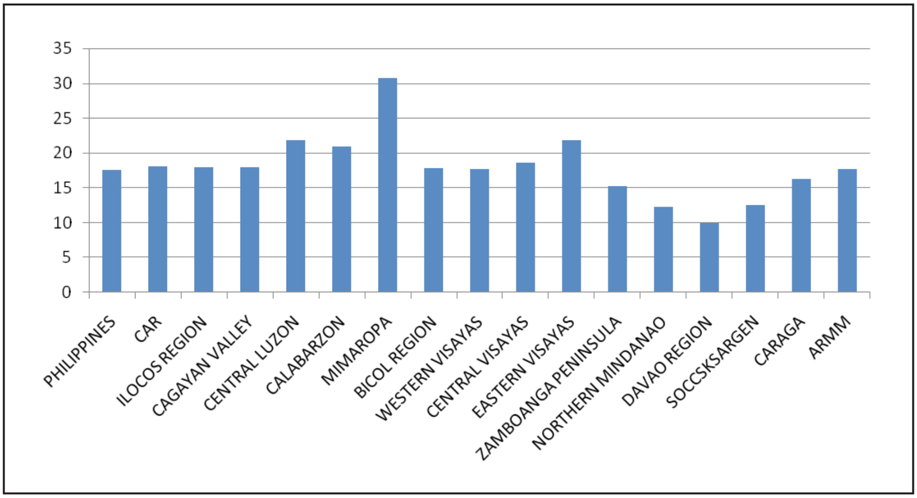


Figure 4. Farmgate prices (PhP/kg) of eggplant by region, Philippines, 2012

8 Eggplant price data for this section were acquired from the Philippine Bureau of Agricultural Statistics (BAS) online services, but were limited only to the Long Purple variety.

average retail price in the Philippines was PhP38.05/kg, with the highest level being in MIMAROPA at PhP46.01/kg, and the lowest in SOCCSKSARGEN at PhP25.19/kg. Most of the regions across the country posted average retail price of Long Purple eggplant much higher than the national average (Figure 5 and Appendix Table 4).

Figure 6 summarizes the national average farmgate, wholesale, and retail prices of eggplant from 2000 to 2009, indicating similar trends. As the distance between the lines indicates the price difference, it can be observed that the retailers' margin over the wholesalers' price is larger than the wholesalers' margin over the farmgate price. Based on 2003-2012 data, price margins between national average farmgate and wholesale prices ranged from PhP3.72/kg to PhP8.71/kg across the regions, and those between farmgate and retail prices ranged from PhP8.05/kg to PhP14.30/kg. For some regions, the retailers' margin is greater than the per-kilogram price that the farmer received. Thus, if the eggplant farmer sells his/her produce directly to consumers, he/she could earn an additional PhP1.00/kg of eggplants sold.

Marketing Practices in the Study Areas

This section focuses on farmers' and traders' marketing practices in the study areas, as well as of traders in the major trading centers or public markets where the eggplants harvested in the study sites are marketed. The other major players in the eggplant market are assembler-wholesaler-retailers, wholesaler-retailers, and retailers.

The assembler-wholesaler-retailers procure eggplants from several farmers and sell them regularly in large volumes both within and outside the province; they also do retail activities. Some assembler-wholesaler-retailers are also farmers who buy the products of other farmers and transport them to major markets using either own or hired vehicle. These traders have retail stalls in public markets, which are also used as temporary storage and as working areas for classifying the eggplants.

Wholesaler-retailers usually have permanent stalls in public markets or major trading centers, and sell either in bulk or small quantities to both retailers and household consumers. Retailers sell only small quantities to consumers, often from the roadside or in public market stalls. The general product flow can be depicted as follows:

Retailers
Farmers → Assembler-wholesaler-retailers → Wholesaler-retailers ↗ ↘ ↓
Consumers

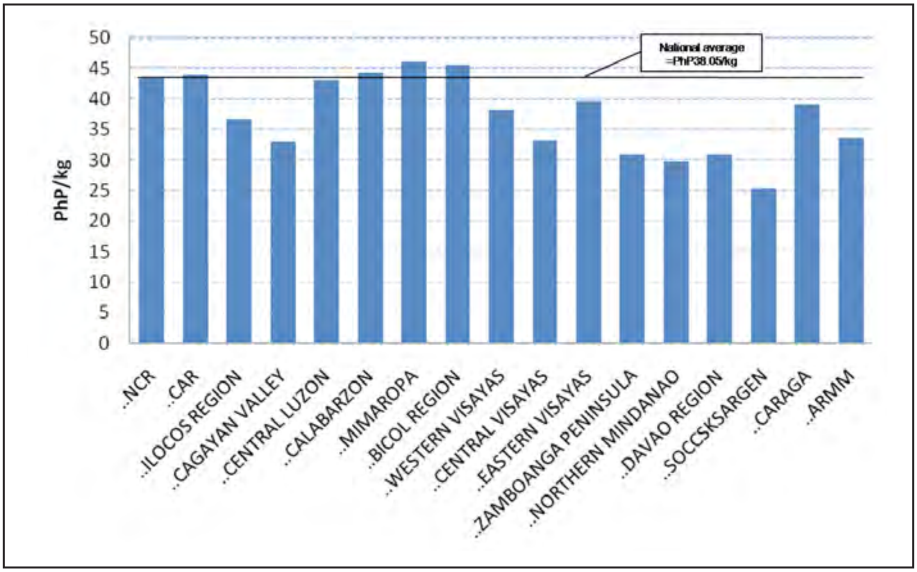


Figure 5. Retail price (PhP/kg) of eggplant by region, Philippines, 2012.

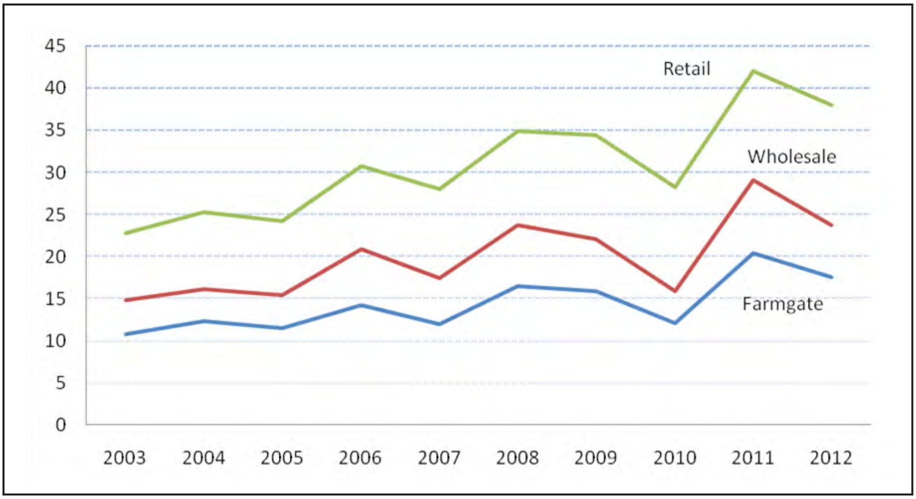


Figure 6. Average farmgate, wholesale, and retail prices (PhP/kg) of eggplant, Philippines, 2003-2012.

Tanauan City, Batangas. Among the vegetables grown in Batangas, eggplant ranks third after tomato and bittergourd in terms of area planted and production. As of December 2009, the province had 562 ha planted to eggplant by 947 farmers in its 24 towns and cities (Office of the Provincial Agriculturist, 2009). Six percent of these farmers and 10% of the total eggplant area are in Tanauan City. Of the total eggplant produced in Batangas, 60% goes to Metro Manila markets (Divisoria, Alabang, and Marikina); 10% to Binan, Laguna, and 30% is sold in the local markets.

The Tanauan City public market is one of the major trading centers for eggplants in Batangas and for the adjacent provinces of Laguna, Quezon, and Oriental Mindoro. The eggplants traded in this market come from Quezon (42%), mostly from Candelaria, Sariaya, and Tiaong; Oriental Mindoro (21%); and Laguna (7%) (Figure 7). Locally produced eggplants provide the remaining 30% (according to the City Agriculturist, 30% goes to assembler-wholesaler-retailers or to wholesaler-retailers, and 70%, to retailers). From Tanauan public market, 85% of the eggplants goes to Metro Manila, and the remaining 15% is traded locally or in adjacent provinces.

The Tanauan farmer-respondents reported that they usually do not incur any marketing cost as traders provide the plastic bags and pick up the eggplants from their farms. Farm price received ranged from PhP2.00/kg to PhP35.00/kg, depending on season and size.

There are about 20 eggplant assembler-wholesaler-retailers/wholesaler-retailers and 60 retailers in the Tanauan public market. Retailers get their supply from assembler-wholesaler-retailers or wholesaler-retailers trading

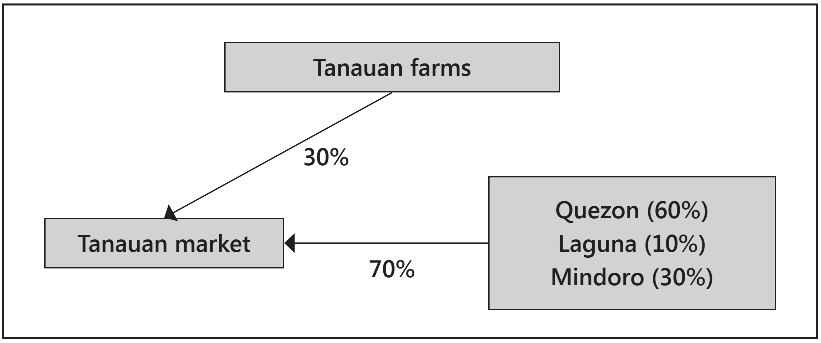


Figure 7. Sources of eggplant in Tanauan City public market, Batangas, Philippines, 2009-2010.

in the Tanauan trading post (‘bagsakan’), who handle about 0.5 ton to 2.5 tons daily. The assembler-wholesaler-retailers/wholesaler-retailers come from Tiaong, Quezon; San Pablo, Laguna; Cavite, Pasig, Pampanga, and Bulacan.

Some retailers can sell 70 kgs of eggplants daily (50% are “good” and 50% are “semi”), without any wastage or losses. Other retailers handle only 10 kgs of “good” quality eggplants 2-3 times per week, and can sell only “second class” eggplants (also called “semi” or ‘segunda’) when supply is short. As with any other agricultural product, eggplants are sold at a lower retail price if it does not look good anymore. Up to 10% of the total volume handled by retailers was reportedly wasted.

Retailers can dictate the price to consumers while wholesaler-retailers dictate the price to retailers. Prices are based on the prevailing market price. In a year, wholesaler-retailer price can range at PhP10.00/kg-PhP50.00/kg, and at PhP15.00-PhP20.00/kg to PhP70.00-PhP80.00/kg at the retail level. There often is a PhP10.00/kg price difference between “good” and “semi” eggplants.

One assembler-wholesaler-retailer procures 5 tons of eggplants from about 30 farmers in Tiaong, Quezon daily. To ensure her daily supply of eggplants, this trader provides PhP20,000-PhP40,000 financial assistance to each of 15 farmers, in addition to the seeds and fertilizer which are given in-kind per cropping season.

Of the 5 tons procured daily, 1,000-1,500 kg/day (about 25%) are sold in Sariaya, Quezon; about 7% sold twice a week in Divisoria, and the rest sold in the Tanauan trading post. Of the total volume handled, 80%-90% are “good” and the rest are “semi” or ‘segunda’. When eggplant supply is short, even poor quality ones (“rejects”, those with holes) can be sold.

The assembler-wholesaler-retailer sets the farmgate price and retail price, depending on the prevailing market price, allowing for some margin. No price discount is given even for large volumes traded. Farmers are often paid in cash for their produce. High supply and low eggplant prices are often observed from June to December/January; eggplant price is usually high in October (especially after a typhoon).

Traders also commonly pay market fees. This assembler-wholesaler-retailer pays PhP350 per jeepney full of products, or PhP2.00 for every 10 kgs of eggplant. Market stalls are also rented at PhP1,500 per month. In addition, eggplant traders also sell other vegetables such as string beans, chili pepper, and lady fingers (‘okra’).

San Pablo City, Laguna. Eggplants in this market come mostly from Tiaong and other municipalities of Quezon. Eggplants are packed as 10-kg or 20-kg plastic bundles. They are classified as "good" if of good quality, 6-7 inches long, dark purple, more or less straight, and have no holes; "semi" if shorter and not so straight; and "rejects" if with a lot of holes.

There are about 25 eggplant assembler-wholesaler-retailers/wholesaler-retailers and 50 retailers in the San Pablo City public market, some of whom have been in business for 7-20 years. During peak harvest, some retailers become assembler-wholesaler-retailers or wholesaler-retailers procuring 0.5 m ton to 1 m ton of eggplant (which can be 50% good, 50% "semi") daily from Tiaong, Quezon, for sale in the Tanauan trading post.

Retailers in San Pablo City public market regularly buy 40 kgs of good and 10 kgs of "semi" quality eggplants from wholesalers-retailers in the same market. Prices and volume traded depend on the interaction of supply and demand during the day, and prices could change within the same day. If there is low supply, retailers can procure only 20 kgs "good" and no "semi"; if there is high supply, they procure only 10 kgs "good" and no "semi." When there is high supply, the market is flooded with eggplants and eggplant retailers will most likely increase in number. Hence, retailers would procure a lower volume of eggplant so as to be able to sell all their eggplants during the day.

Some other retailers procure 20 kgs daily, composed of 75% "semi" and 25% rejects (which are sliced and mixed with other sliced vegetables, e.g., squash, stringbeans, bittergourd, in a plastic bag for consumers who will cook "pinakbet"). Some buy eggplants 2-3 times per week from farmers and 4-5 times per week from wholesaler-retailers in San Pablo trading post. A farmer could bring 500 kgs to 1.5 m tons of eggplants everyday to this trading post, for sale to traders. The farmers are usually paid in the afternoon when the eggplants have been sold.

During regular days, farm price is PhP20.00/kg for good quality eggplants, and PhP10.00/kg for "semi", and PhP5.00/kg for rejects. A PhP5.00 difference per kilogram can be observed between farmgate price and wholesale price, and between wholesale price and retail price.

During low supply periods, the farm price of good quality eggplants is PhP60.00/kg, wholesale price is PhP70.00/kg, and retail price is PhP80.00/kg. When supply is high, prices are much lower and a "good" eggplant sells at PhP5.00/kg at the farm level, PhP7.50/kg on wholesale, and PhP10.00 at the retail level. Eggplant wastage or spoilage is zero during low supply, but can be 5% during regular days and even up to 20% during high supply. To avoid wastage, if the eggplants cannot be completely sold in two days, traders would sell the remaining eggplants at a lower price (even to a breakeven price) so as to recover his/her capital.

Retailers are charged PhP10.00/ticket/day as market fee for 1 cart of vegetables being sold. Since half of a retailer's cart can be occupied by eggplants, it is estimated that PhP5.00 is the market fee for selling eggplants.

Overall, trader-respondents in San Pablo City opined that eggplant marketing gives good income. If a trader loses a few times during the year, the loss could easily be recovered.

Tiaong, Quezon. Across the province, eggplant ranks third in terms of area planted, and first in total production. In 2009, the province had 389 ha planted to eggplant by 626 farmers (Office of the Provincial Agriculturist, 2009). The municipality of Tiaong contributed 3% of the total eggplant area in the province, and 0.4% of the total eggplant production.

Almost all eggplant traders in Tiaong were assembler-wholesaler-retailers, who pick up the products from local farmers, and deliver them to public markets in Divisoria, Metro Manila (50%), Tanauan, Batangas (25%), and San Pablo, Laguna (25%). The local market gets less than 1% of the marketed produce. For trucking or jeepney rental per trip with a 3,000-kg load, the traders spend about PhP3,500 going to Divisoria, PhP1,500 going to Tanauan, and PhP1,000 going to San Pablo City. Transport losses when delivering to Divisoria come to about 20 kgs per trip. The barangay in Tiaong collects a fee of PhP10.00 per jeepney load of eggplants (reportedly for the barangay's cleanliness drive and/or environmental protection activities).

At the farm level, eggplants in Tiaong can be classified (and priced) into three categories, based on length and overall quality: first class, which usually costs PhP25.00-PhP30.00/kg; second class, PhP10.00/kg; and third class (rejects), which are normally for home consumption or given away. It was estimated that 50 kg/year goes to home consumption, and 150 kgs/ha/year are given away.

Farm prices normally range at PhP2.00-PhP30.00/kg during the year, again based on the market supply and demand situation. Farmers can quote the price but traders can negotiate. Market deals between farmers and traders can be made using cellular (mobile) phones. No discounts are given even with large volumes bought. Farmers are paid in cash, but can take credit if the buyer picks up the produce, for which the buyer has to pay in cash at least 25% of the total value. The balance should be paid by the next harvest time, which is 3-4 days after.

Of the total eggplant produced in Quezon, about 50% goes to Metro Manila (Divisoria, Nepa Q-Mart); 10% to Tanauan, Batangas; and 5% each to Bicol region and Laguna province (Sta. Cruz and San Pablo City). About 20% is traded locally and 10% is consumed at home (Office of the Provincial Agriculturist, 2009). Eggplant buyers are usually wholesalers-retailers from adjacent provinces.

Pangasinan. In crop year 2009, Pangasinan produced 31,655 m tons of eggplants from 1,320 ha, or almost 24 m tons/ha (Office of the Provincial Agriculturist, 2010). Its total production constituted 86% of that of Ilocos Region (BAS, 2010). Within the province, 34% and 23% of the eggplant area, and 45% and 33% of the total production, were in the municipalities of Villasis and Asingan, respectively. The share of Sta. Maria was 3% in both area planted and production.

Of the total eggplant produced in Pangasinan, majority (75%) is brought to Metro Manila (mostly to Divisoria, some to Balintawak), and 5% each are traded in Ilocos Region and Baguio City. Only 15% of the produce goes to the local market (Figure 8). Overall, 70% of the produce is handled by assembler-wholesaler-retailers and 30% by retailers. The cost of transporting eggplants from Pangasinan to Divisoria is PhP0.20 per kilogram.

In the Villasis public market, there are about 10 eggplant wholesaler-retailers and 40 retailers, some of whom have been in the business for 14-20 years. Wholesaler-retailers handle 100 kgs or more while retailers handle about 10 kgs to 40 kgs daily. About 60% of traded eggplants were of the Morena variety, and 40% were native varieties (e.g., ‘palupalo’, ‘baginay’). The farmers deliver the eggplants already packed in plastic bags, and are paid in cash by the traders. The farmers can dictate eggplant prices but the traders can negotiate. Prices however are based on prevailing market prices and can change within the day depending on the interaction of supply and demand forces in the market.

Retail price per kilogram ranges from PhP10.00 to PhP40.00 for the Morena variety and from PhP20.00 to PhP60.00 for the native varieties. There is

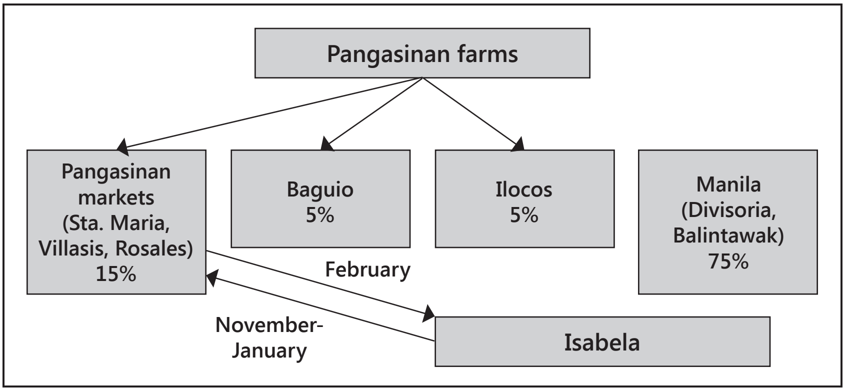


Figure 8. Geographical distribution of eggplants produced and traded in Pangasinan, 2009-2010.

about a PhP3.00 to PhP5.00 per kg price difference between farm price and wholesale price, and about PhP5.00/kg between wholesale and retail price. If the retail price is high, e.g. at PhP40.00-PhP60.00/kg, the price difference between levels could range at PhP5.00-PhP10.00/kg.

There is low demand for eggplants during August and September, when people seem to have less money. High demand is observed during November and December, the rice harvest months, as people have relatively more money.

Traders are required to pay a market fee of PhP20.00/day for all the commodities handled. Since eggplant is only about one-tenth of all commodities handled, retailers pay a market fee of only PhP2.00/day for handling eggplants. Traders also pay PhP2,500 a year for a municipal (mayor's) permit to conduct business. The trader-respondents reported that about 5% of the eggplants handled are spoiled/wasted when the demand is low.

At the time of this study, one big supermarket in Pangasinan sells about 50 kgs of the Morena variety daily, 5 kgs of Miracle (a native variety), and 5 kgs of a round eggplant (variety unspecified). Another huge commercial buyer is Dizon Farms (based in Taguig City, Metro Manila) which is reported to regularly buy Pangasinan eggplants through a consolidator. After classification and repacking, the eggplants are delivered to supermarket chains for retail sale to consumers.

Divisoria, City of Manila. There are more than 300 wholesaler-retailers and retailers selling eggplants in Divisoria.The three retailer-respondents in this study were not aware of the variety of eggplant they were selling. Each buys 10 kgs of unclassified eggplants daily, which are delivered by wholesaler-retailers often coming from Bulacan, Nueva Ecija, Pangasinan, Batangas (Tanauan), and Quezon.

Almost everyday, the retailers can sell all their eggplants with no spoilage as the volume handled is small. The retail price of eggplant in crop year 2009-2010 ranged from PhP20.00/kg to PhP80.00/kg. Retailers usually add a PhP5.00/kg mark-up if the wholesaler's price is low, and about PhP10.00/kg if the buying price is high (especially when supply is short). Retailers pay the wholesaler-retailers in cash. Eggplant prices are usually high during January to March.

Retailers also pay a market fee of PhP20.00 per day for the stall. Since eggplant is only about one-tenth of all the vegetables a retailer is selling, the daily market fee for eggplants is estimated at only PhP2.00.

Production and Marketing Concerns

This study's farmer-respondents cited poor water supply and pests and diseases (including fruit and shoot borer, fruit fly, and bacterial wilt) as important production problems. Both farmers and traders reported low market price of eggplants during peak production period as their only marketing problem.

One alarming finding of this study is the excessive pesticide application in the study areas. Eggplants are sprayed with pesticides weekly in Tanauan, Batangas; every four days in Tiaong, Quezon; and once or twice daily in Pangasinan. There were also reports of harvested eggplants being dipped in pesticide solution. These practices lead to an important area of concern: impacts on the environment, and on human health. As such, it will be important for the local government units to conduct pesticide safety awareness programs/campaigns. Eggplant farmers can also be trained to practice integrated pest management (IPM) or in judicious pesticide use in their farms. The introduction and commercialization of *Bt* eggplant could significantly reduce farmers' high dependence on pesticides, and promote environmental health and production sustainability in the long term.

References

Agricultural Biotechnology Support Project (ABSPII). 2010. *Fruit and Shoot Borer Resistant (FSBR) Eggplant*. Project Profile. www.absp2.cornell.edu/projects/project.cfm?productid=2. July 27.

Camargo, C.P., C. Bragantini, and A. Monares. 1989. *Seed Production Systems for Small Farmers: A Non-conventional Perspective*. International Centre for Tropical Agriculture (CIAT), Cali, Colombia.

Campilan, D. undated. *A Livelihood Systems Framework for Participatory Agricultural Research: The Case of UPWARD*. http://www.idrc.ca/en/ev-85070-201-1-DO_TOPIC.html

Chen, N.C. and H.M. Li. 2008. Cultivation and Seed Production of Eggplant. Asian Vegetable Research and Development Center. www.scribd.com/doc/2297037/Eggplant-Seed. Accessed August 5, 2010.

Francisco, S.R., J. Maupin, and G.W. Norton. 2009. Value of Environmental Impacts of *Bt* Eggplant in the Philippines. In Norton, G.W. Hautea, D.M. (eds). Projected Impacts of Agricultural Biotechnologies for Fruit and Vegetables in the Philippines and Indonesia. ISAAA and SEAMEO SEARCA, Los Baños, Laguna.

Guanzon, Y.B. and R.J. Holmer. 2003. *Basic Cultural Management Practices for Vegetable Production*. Xavier University College of Agriculture. www.puvep.com/rjhpublications.htm

Hautea, D.M. and J.O. Narciso. 2007. *Questions and Answers on the Development of Fruit and Shoot Borer Resistant Eggplant in the Philippines*. IPB-UPLB-ABSPII.

Hodgkin, T. and D. Jarvis. 2004. Seed systems and the maintenance of diversity on-farm: Introductory remarks. In Jarvis, D.I., R. Sevilla-Panizo, J.L. Chavez-Servia and T. Hodgkin (eds.) *Seed Systems and Crop Genetic Diversity On-Farm*. Proceedings of a Workshop, 16–20 September 2003, Pucallpa, Peru. International Plant Genetic Resources Institute, Rome, Italy.

Integrated Pest Management-Collaborative Research Support Program (IPM CRSP). 2007. *Bacterial Wilt of Eggplant*. Open Academy for Philippine Agriculture. Accessed August 5, 2010.

Jarvis, D.I., R. Sevilla-Panizo, J.L. Chavez-Servia and T. Hodgkin (eds.). 2004. *Seed Systems and Crop Genetic Diversity On-Farm*. Proceedings of a Workshop, 16–20 September 2003, Pucallpa, Peru. International Plant Genetic Resources Institute, Rome, Italy.

Johnson, G.I., K. Weinberger, and M. Wu. 2008. The Vegetable Industry in Tropical Asia: The Philippines. An overview of Production and Trade. *Explorations Series #1*. AVRDC: The World Vegetable Center.

Kolady, D.E. and W. Lesser. 2006. Who Adopts What Kind of Technologies? The Case of *Bt* Eggplant in India. AgBioForum 9(2):94-103.

Krishma, V.V. and M. Qaim. 2007. *Potential Impacts of Bt Eggplant on Economic Surplus and Farmers' Health in India*. University of Hohenheim.

Lit, M.C. undated. *Identification of Eggplant Varieties Resistant to Leafhopper, Shoot/Fruit Borer and Phomopsis Blight*. IPB-UPLB. http://www.bar.gov.ph/vegrde/VeggiesTodayVol2-3.htm

Louwaars, N.P. and G.A.M. van Marrewijk. 1996. *Seed Supply Systems in Developing Countries*. Wageningen, CTA, 135 p.

Louwaars, N.P. 2007. Seeds of Confusion: The Impact of Policies on Seed Systems. PhD dissertation, Wageningen, The Netherlands.

Maghirang, R.G. 2001. *Organikong Gulayan: Pagtatanim ng Organikong Talong*. www.bar.gov.ph/veggies today.vol 2-3.htm. Accessed August 5, 2010.
Maghirang, R.G. undated. *On-Farm Trials of Eggplant*. www.bar.gov.ph/vegrde/VeggiesTodayVol2-3.htm
Maghirang, R., M.L. Guevarra, and G. Rodulfo. 2007. Eggplant Production Guide. *Information Bulletin No.147-A/2007*. Philippine Council for Agriculture, Forestry and Natural Resources Research and Development, Los Baños, Laguna.
National Seed Industry Council (NSIC). www.nseedcouncil.bpinsicpvpo.com.ph/
Paredes, J. 2005. *Eggplant Getting More Value*. Biotechnology Information Center, SEARCA. College, Laguna. www.bic.searca.org/. Accessed on August 15, 2010.
Plant Variety Protection Office (PVPO). 2005. *Plant Variety Gazette,* Volume 1, Issue 1, December 28. Bureau of Plant Industry.
P.Y. Le Gal, A. Merot, C.H. Moulin, M. Navarrete, and J. Wery. 2010. A Modelling Framework to Support Farmers in Designing Agricultural Production Systems, *Environmental Modelling & Software* 25:258–268.
Quicoy, C.B. 2010. Productivity and Technical Efficiency of Eggplant Production in Selected Provinces in the Philippines: Stochastic Production Function Approach. SEARCA Professorial Chair Lecture. SEARCA, College, Laguna.
Rola, A., R. Abgona, A. Alfonso, A. Chupungco, D. Depositario, E. Dumayas, D. Elazegui, L. Mojica, J. Narciso, M. Palacpac, M. Paunlagui, R. Rogel, A. Solsoloy, Z. Sumalde, and R. Tagarino. 2008. *Methodologies for Ex-Ante Assessment of Crop Biotechnologies*. ISPPS-CPAf-UPLB, UPLB-FI, College, Laguna; DA Biotechnology Program, Quezon City; and PhilRice, Muñoz, Nueva Ecija, Philippines.
Srinivasan, R. 2008. Integrated Pest Management for Eggplant Fruit and Shoot Borer (*Leucinodes orbonalis*) in South and Southeast Asia: Past, Present and Future. *Journal of Biopesticides* 1(2):105-112.
Tan, T.J.O. 2007. Analysis of the marketing system of eggplants produced in selected towns of Batangas. Undergraduate thesis. University of the Philippine Los Baños (UPLB).
Tripp, R. 2003. How to Cultivate a Commercial Seed Sector, Paper prepared for the symposium “Sustainable Agriculture in the Sahel”, Bamako, Mali, 1-5 December 2003.
Villancio, G., P. Manalo, V. Arellano, R. Cahiles, and A. Saez. 2002. *Socio-Economic Assessment of Eggplant Production and Marketing Systems in the Philippines*. FSSRI-DA-BAR.
http://blog.agriculture.ph/eggplant-industry-situationer-in-the-philippines.html. Eggplant Industry Situation in the Philippines. 2008. Agri-Center.

Appendix Table 1. Eggplant production, area planted, and yield, by region, Philippines, 2003-2012.

Region	Production (metric tons)					Area Planted (hectares)					Yield (metric tons/hectare)				
	2003	2008	2012	2003-2012 Average	2003-2012 % Change	2003	2008	2012	2003-2012 Average	2003-2012 % Change	2003	2008	2012	2003-2012 Average	2003-2012 % Change
Philippines	176991	199579	211854	197822	19.70	20984	21299	21481	21,255	2.37	8.4	9.4	9.9	9.3	16.93
CAR	744	789	823	776	10.64	139	135	137	136	-1.65	5.3	5.8	6.0	5.7	12.50
Ilocos Region	64630	73100	76193	73628	17.89	4855	4908	4905	4,960	1.02	13.3	14.9	15.5	14.8	16.70
Cagayan Valley	14941	19335	19841	17915	32.79	1774	1960	1889	1,879	6.48	8.4	9.9	10.5	9.5	24.71
Central Luzon	18505	19107	19019	18827	2.77	3094	2894	2938	2,928	-5.04	6.0	6.6	6.5	6.4	8.23
CALABARZON	32074	32213	36150	33039	12.71	1972	1762	1803	1,817	-8.57	16.3	18.3	20.0	18.2	23.27
MIMAROPA	2440	2354	2768	2424	13.44	944	919	988	941	4.64	2.6	2.6	2.8	2.6	8.41
Bicol Region	5475	7102	7306	6457	33.43	1206	1362	1363	1,286	12.99	4.5	5.2	5.4	5.0	18.10
Western Visayas	11141	13486	15660	13587	40.57	1360	1384	1527	1,434	12.32	8.2	9.7	10.3	9.5	25.14
Central Visayas	5949	6842	7562	6730	27.12	1953	1750	1632	1,806	-16.46	3.0	3.9	4.6	3.7	52.2
Eastern Visayas	2034	2219	2315	2194	13.81	320	339	355	337	10.83	6.4	6.5	6.5	6.5	2.7
Zamboanga Peninsula	1738	1752	1848	1767	6.36	514	532	602	539	17.09	3.4	3.3	3.1	3.3	-9.2
Northern Mindanao	2996	3608	4323	3480	44.33	683	755	814	742	19.22	4.4	4.8	5.3	4.7	21.1
Davao Region	6926	6425	6632	6643	-4.25	951	1193	1162	1,114	22.19	7.3	5.4	5.7	6.0	-21.6
SOCCSKSARGEN	4951	6624	7400	6445	49.48	497	613	638	583	28.34	10.0	10.8	11.6	11.0	16.5
Caraga	1865	4006	3363	3302	80.29	516	579	499	536	-3.16	3.6	6.9	6.7	6.1	86.2
ARMM	582	616	652	607	11.86	206	215	230	216	11.58	2.8	2.9	2.8	2.8	0.3

Source of basic data: www.bas.gov.ph (accessed on October 24, 2013)

Appendix Table 2. Farmgate prices (PhP/kg) of eggplant by region, Philippines, 2003-2012.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average
Philippines	**10.84**	**12.37**	**11.55**	**14.29**	**11.97**	**16.50**	**15.94**	**12.19**	**20.44**	**17.54**	**14.36**
NCR	-	-	-	-	-	-	-	-	-	-	-
CAR	12.29	16.93	16.98	17.09	16.69	19.51	18.64	18.11	18.83	18.08	17.32
Ilocos Region	11.57	15.01	12.88	16.07	13.53	17.86	20.21	12.87	23.62	17.98	16.16
Cagayan Valley	10.46	14.09	13.67	17.02	14.20	17.00	16.09	11.40	19.93	18.00	15.19
Central Luzon	11.53	14.70	13.47	17.64	13.38	14.87	17.97	11.48	24.64	21.84	16.15
CALABARZON	10.16	12.48	12.93	14.94	10.71	15.75	15.34	12.58	22.07	20.89	14.79
MIMAROPA	16.54	18.05	18.36	23.40	20.06	26.27	31.99	24.01	31.64	30.72	24.10
Bicol Region	8.83	11.18	11.25	15.27	13.73	19.10	18.27	12.91	20.90	17.81	14.93
Western Visayas	12.25	14.04	11.70	16.29	13.35	23.65	16.45	13.14	21.09	17.73	15.97
Central Visayas	11.54	14.35	13.77	15.44	16.24	21.43	18.59	17.10	20.70	18.64	16.78
Eastern Visayas	13.97	17.85	14.46	18.46	14.27	23.71	21.89	18.51	24.98	21.84	18.99
Zamboanga Peninsula	7.40	8.58	8.67	9.42	10.06	12.64	11.97	11.43	16.99	15.21	11.24
Northern Mindanao	6.86	8.46	9.01	8.65	8.91	11.60	12.70	12.53	16.09	12.26	10.71
Davao Region	6.66	8.24	7.29	9.15	8.77	9.59	9.20	8.82	13.05	9.98	9.08
SOCCSKSAR-GEN	7.54	10.10	7.97	9.43	11.39	13.01	12.24	11.50	13.62	12.58	10.94
CARAGA	8.29	8.16	6.53	13.13	9.92	13.51	15.17	11.14	20.49	16.26	12.26
ARMM	12.94	10.71	9.67	11.37	11.94	14.64	17.33	17.25	18.66	17.64	14.22

Source of basic data: www.bas.gov.ph (accessed on November 22, 2013)

Appendix Table 3. Wholesale prices (PhP/kg) of eggplant by region, Philippines, 2003-2012.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average
Philippines	14.79	16.09	15.33	20.91	17.38	23.81	22.14	15.88	29.15	23.75	19.92
NCR	15.87	16.65	15.77	23.35	18.02	21.72	23.50	15.18	32.57	28.21	21.08
CAR	-	-	-	-	-	-	-	-	-	-	-
Ilocos Region	16.24	16.67	16.63	21.76	15.02	21.20	22.32	13.09	30.49	28.21	20.16
Cagayan Valley	15.04	15.42	15.93	20.39	16.13	21.84	21.20	14.65	28.67	21.61	19.09
Central Luzon	-	-	-	-	-	-	-	-	36.11	29.41	32.76
CALABARZON	14.72	13.48	14.74	22.69	16.16	21.57	21.58	14.59	29.09	26.40	19.50
MIMAROPA	-	-	-	-	-	-	-	-	-	-	-
Bicol Region	13.17	14.53	15.30	25.77	24.05	25.77	22.72	13.89	27.13	20.52	20.29
Western Visayas	17.06	18.88	18.24	26.12	20.73	35.23	28.41	19.95	32.26	25.32	24.22
Central Visayas	17.12	18.25	17.02	19.68	21.40	25.71	21.14	19.40	23.71	19.80	20.32
Eastern Visayas	-	-	-	-	-	-	-	-	-	-	-
Zamboanga Peninsula	-	-	-	-	-	-	-	-	-	-	-
Northern Mindanao	13.18	16.59	13.09	17.49	17.40	26.11	21.93	17.21	26.85	20.16	19.00
Davao Region	8.94	11.82	11.22	15.06	13.61	18.06	16.50	16.04	24.38	19.42	15.51
SOCCSKSAR-GEN	-	-	-	-	-	-	-	-	-	-	-
CARAGA	-	-	-	-	-	-	-	-	-	-	-
ARMM	-	-	-	-	-	-	-	-	-	-	-

Source of basic data: www.bas.gov.ph (accessed on November 22, 2013)

Appendix Table 4. Retail prices (PhP/kg) of eggplant by region, Philippines, 2003-2012.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average
Philippines	22.84	25.35	24.24	30.75	28.03	34.99	34.42	28.25	42.05	38.05	30.90
NCR	28.64	30.69	30.22	39.20	31.97	35.72	37.76	26.97	45.77	43.36	35.03
CAR	25.74	31.60	29.07	35.21	30.25	35.65	37.56	31.72	47.90	43.88	34.86
Ilocos Region	22.11	24.86	23.32	29.96	27.35	33.79	37.35	26.65	42.86	36.60	30.49
Cagayan Valley	21.72	23.17	21.50	27.70	23.25	31.31	29.89	20.84	41.39	33.03	27.38
Central Luzon	26.37	28.07	26.53	36.37	28.71	34.27	36.44	27.22	48.03	43.10	33.51
CALABARZON	26.26	28.98	28.12	35.97	29.26	35.00	37.22	28.69	45.84	44.23	33.96
MIMAROPA	25.61	27.09	27.80	35.09	31.52	41.20	42.77	33.78	45.32	46.01	35.62
Bicol Region	23.22	26.00	25.95	34.95	28.61	38.48	39.29	28.11	49.63	45.57	33.98
Western Visayas	27.16	29.79	26.81	34.96	31.89	51.45	37.35	30.22	46.62	38.11	35.44
Central Visayas	21.69	24.82	23.90	29.15	30.65	38.15	34.67	32.24	37.99	33.25	30.65
Eastern Visayas	22.68	25.12	20.87	29.26	26.00	40.53	35.18	30.66	44.54	39.54	31.44
Zamboanga Peninsula	18.86	20.47	19.05	21.70	23.53	29.04	25.77	25.05	32.30	30.78	24.66
Northern Mindanao	18.00	19.43	19.08	22.57	24.06	28.94	28.18	26.41	32.09	29.70	24.85
Davao Region	17.69	22.73	20.69	25.39	25.93	28.71	28.69	27.08	36.25	30.91	26.41
SOCCSKSAR-GEN	13.97	16.01	15.54	17.29	18.76	22.67	21.50	21.16	25.31	25.19	19.74
CARAGA	19.35	23.22	21.91	28.83	28.21	34.17	35.55	33.19	45.52	39.07	30.90
ARMM	20.05	20.43	22.98	24.87	30.53	30.53	31.21	30.43	36.27	33.57	28.09

Source of basic data: www.bas.gov.ph (accessed on November 22, 2013)

Chapter 3

Insecticide Residues in Soil, Water, and Eggplant Fruits: The Case of Sta. Maria, Pangasinan[1]

Jinky Leilanie Lu

Introduction

Eggplant (*Solanum melongena* L.) is an important vegetable crop that is widely cultivated in the tropical and subtropical areas in Asia. Globally, as of 2007, the top three eggplant producers are China with 18 million tons (t), India with 8.5 million t, and Egypt with 1 million t. In the same year, the Philippines was one of the top 10 eggplant-producing countries based on area planted and crop productivity (yield) (although it shared less than 1% of global production) (Table 1).

During 2006-2011 in the Philippines, eggplant was consistently the leading vegetable crop in terms of production, which increased by 8.4% from about 192,000 t in 2006 to nearly 208,000 t in 2011. In the same period, area planted increased by 2.3% from about 20,900 hectares (ha) in 2006 to almost 21,400 ha in 2011, while its yield increased by almost 6% from 9.2 tons per hectare (t/ha) to 9.7 t/ha (BAS, 2013). In 2011, the top five eggplant producing provinces in the Philippines are Pangasinan, Quezon, Iloilo, Isabela, and Cagayan (in this order). Pangasinan provided almost 31% of the country's total eggplant production and accounted for about 18% of the total area

[1] An earlier version of this chapter was published in *Water, Air, & Soil Pollution* 220(1-4): 413-422 (September 2011).

Table 1. Top 10 eggplant producers in the world, 2007

Country	Area (ha)	Production (tons)	Yield (tons/ha)	% of World Production
China	1,200,000	18,000,000	15.00	56.2
India	512,800	8,450,200	16.47	26.4
Bangladesh	57,747	339,795	5.80	1.1
Indonesia	53,000	390,000	7.35	1.2
Egypt	43,000	1,000,000	23.25	3.1
Turkey	30,000	791,190	26.37	2.5
Iraq	22,000	380,000	17.27	1.2
Philippines	21,000	198,000	9.42	0.6
Italy	12,059	271,358	22.50	0.8
Japan	12,000	375,000	31.25	1.2

Source of data: Choudhary, B. and K. Gaur. 2009. The Development and Regulation of *Bt* Brinjal in India (*Eggplant/Aubergine*). ISAAA Brief No. 38. ISAAA: Ithaca, NY.

planted. However, at 17.0 t/ha, eggplant yield in Pangasinan was only half of the yield level in Quezon province in 2011 (Table 2).

Like many other crops, eggplant – from seedling to fruiting stage - is susceptible to damage by various insects and diseases, among which the fruit and shoot borer (FSB) (*Leucinodes orbonalis* Guenee) has caused yield losses of 20-92% in the Philippines (Francisco, 2009). FSB is a pink, sesame seed-sized moth larva that feeds on eggplant stems and fruits from the inside out (Bleicher, 2009). This insect also bores into the terminal shoots, causing the shoots to wither thus delaying the crop's vegetative development (AgriBusiness Week, 2010).

To control FSB, farmers resort to frequent and heavy spraying of insecticides. Informal interviews with eggplant farmers in the Philippines found cases of spraying at 60-80 times during a normal fruiting duration of at least 4 months (Francisco, 2009). Similarly in India, farmers sprayed an average of 20-30 times per crop season at about 26.7 liters (li)/ha of "cocktail" pesticides, such as chlorpyrifos, cypermethrin, monocrotophos, and dimethoate (Baral et al., 2006; Choudhary and Gaur, 2009). Manual removal of damaged fruits and shoots has proven to be effective, yet it is rarely adopted because it is labor intensive.

Table 2. Top 10 eggplant producing provinces in the Philippines, 2011

Country	Area (ha)	Production (tons)	Yield (tons/ha)	% of Total Production
Philippines	**21,377.2**	**207,994.0**	**9.7**	**100.0**
Pangasinan	3,780.0	64,122.7	17.0	30.8
Quezon	800.0	27,467.9	34.3	13.2
Iloilo	835.0	10,368.0	12.4	5.0
Isabela	991.0	9,702.2	9.8	4.7
Cagayan	726.0	7,009.2	9.7	3.4
Nueva Ecija	1,547.0	6,922.5	4.5	3.3
Batangas	750.0	6,290.0	8.4	3.0
Ilocos Norte	610.6	5,641.5	9.2	2.7
Tarlac	785.0	5,576.3	7.1	2.7
North Cotabato	440.0	5,443.3	12.4	2.6

Source: BAS (Bureau of Agricultural Statistics). CountryStat Philippines. www.countrystat.bas.gov.ph. Accessed on 3 May 2013.

However, since FSB larvae are internal feeders, control through chemical pesticide application is often futile and even presents high risks of environmental degradation and contamination. The literature is rich with reports and studies confirming that injudicious pesticide use in agricultural crop production can pose environmental problems such as soil and water contamination; pest tolerance or resistance; damage to nontarget organisms and biodiversity loss; excessive chemical exposure for applicators; and health risks for consumers.

On May 2010 to January 2011, two studies were conducted to determine insecticide residues first in the soil and water, and second in eggplant fruits in Sta. Maria, Pangasinan, the top eggplant producing province in the Philippines. More specifically, the studies aimed to:

(i) determine the nature of insecticide residues that can be found in the soil and water in eggplant farms, and detect and quantify residues in eggplant fruits;
(ii) determine through a literature review the soil properties that best influence the persistence and mobility of insecticides in the soil and water;
(iii) differentiate insecticide residues in eggplant fruits in three stages: farm (for immature fruit prior to harvesting), post-harvest, and

market, and between two cropping seasons[2];
(iv) evaluate the level of insecticide residues detected in the soil, water, and eggplant fruits against maximum residue limits (MRLs) set by local and international authorities (e.g., Codex Alimentarius, Environmental Protection Agency [EPA], European Union Commission [EC]);
(v) identify farm practices that may be associated with farmers' increased insecticide exposure;
(vi) with an intensive literature review, evaluate the occupational and environmental health impact of pesticide exposure; and
(vii) determine implications of insecticide exposure to health of farmers/ applicators and insecticide residue in eggplants on health of consumers.

Although the two studies were conducted separately, their findings and results will be reported together in this chapter.

Methodology

Study Area and Sampling

The two studies were cross sectional designs of randomly selected eggplant farms in Sta. Maria, Pangasinan, established based on the sample size estimation equation below:

$$n = \frac{NZ^2 \text{ x } p\,(1\text{-}p)}{Nd^2 + Z^2\,[\,p\,(1\text{-}p)]}$$

where:

Z is the value of the normal variable for a reliability level, set at 90% reliability in this study, considering budget and feasibility;
p is the proportion of getting a positive sample based on previous studies, set at 0.20;
(1-p) is the proportion of getting a negative sample based on previous studies, set at 0.80;
d is the sampling error, set at 0.10;

[2] July to August for wet season, and September to June for dry season, following the Philippine Department of Agriculture standard.

N is the population size (128 eggplant farms, as of 2010 [Municipal Agricultural Office of Sta. Maria, Pangasinan]); and
n is sample size.

Based on the above estimation equation, 26 farms were selected from five villages (barangays) for the soil and water study, with a total of 58 farmers and farm workers who participated in the health assessment aspect. The eggplant fruit study was conducted in four of the said villages with another group of 10 farms, whose farmer-owners were interviewed about production practices and insecticide exposure factors. Medical doctors conducted health profiling and assessment of the 68 farmer-respondents.

Sample Collection

Soil and water. Two 1-kilogram (kg) soil samples were taken from various plottings within each of the 26 sample farms. For each farm, the 1-kg soil samples were mixed well together and a final 1-kg soil sample was drawn, placed in an opaque plastic bag, and taken for laboratory analysis. A soil auger was used to get the soil samples from a depth of 1 meter.

Similarly, two 2-liter water samples were taken from various sources such as river, irrigation canal, and drinking water system located within the 26 sample farms. Two samples/replicates of the soil and water samples and one field blank were collected from each farm. All soil and water samples were placed in an icebox, and delivered to the laboratory within 24 hours. The samples were stored in a laboratory refrigerator at a temperature of 5^{o}C, and analyzed using gas chromatography.

Eggplant fruits. A total of 12 1-kg eggplant samples (six 1-kg samples per farm, two replicates) were taken from various plottings within each of the 10 sample farms. For each farm, each replicate group of six 1-kg eggplant samples were mixed well together, and a final 1-kg eggplant sample was drawn, placed in an icebox, and delivered within 24 hours for laboratory analysis. In the laboratory, the samples were stored in a freezer at a temperature of less than 20^{o}C.

Sample Analysis and Quality Control

A standard laboratory procedure was used to analyze the material samples (BPI, 2008). Briefly, the insecticide residues were desorbed from the samples and analyzed using gas chromatography operated in a split mode. Major chromatogram peaks were identified in the samples by comparing retention times and mass spectra to peaks from a calibration method.

In the gas chromatography analysis for multi-pesticide residues in the soil and eggplant samples, two detectors—nitrogen phosphorous and electron capsule detectors—were used. Solid phase extraction was done using acetonitril. The vegetable samples underwent a three-stage clean up to remove particulates and impurities. The first clean up stage used C18; the second, carbon graphite; and the third and final stage used flourisil. The water samples underwent both liquid-liquid extraction, and one phase solid phase extraction using C18, as the water samples were cleaner than the soil samples.

The elements in the oven program such as the temperature programming, retention time of various pesticides, and temperature of the detector were previously determined and depended on each type of pesticide. The recovery method was 70%-100%. The coefficient of variation was less than 10%. Two trials were done for each sample. The limit of determination (LOD) for organophosphates was 0.02 mg/kg, and 0.005 mg/kg for organochlorines and pyrethroids.

Results and Discussion

Farmers' Socio-demographic Profile

A combined total of 36 eggplant farmers were interviewed in the two studies: 26 farmers from barangays Samon, Cabagbagan, Nauplasan, Cal-litang, and Pilar for the soil and water study, and 10 farmers from the same barangays, except Cal-litang, for the eggplant fruit study. All farms in the eggplant fruit study were included in the soil and water study. Table 3 presents the summary sociodemographic characteristics of the farmer-respondents.

Farmers' Insecticide Use in Eggplant Production

The farmer-respondents in the studies reported that fruit and shoot borer is the most common pest of eggplants in their communities. Other pests that have been encountered were aphids, bacterial wilt, blight, and thrips. To control the various pests in eggplant production, farmers used different pesticides, each of which targets a range of pests (Table 4). Conversely, the farmers also used different insecticides (e.g., Brodan®, Lannate®, Malathion®,

Table 3. Summary socio-demographic characteristics of eggplant farmer-respondents, Sta. Maria, Pangasinan

Characteristics of Respondents	Soil and Water Study	Eggplant Fruit Study
Number of farmer-respondents	26	10
Number of male (female) respondents	25 (1)	9 (1)
Average age (years)	45	47
Educational attainment (no. of respondents)	26	10
Grade school	3	1
Secondary school	15	4
Vocational education	6	1
College education	2	4
Majority civil status	Married	Married
Average household size	5	5
Average residency in the village (years)	35	40
Average farming experience (years)	—	11.6
Average no. of years growing eggplant	—	11.6
Mean distance of farmer's house to his farm (meters)	515	315

Table 4. Selected pesticides used and their target pests, Sta. Maria, Pangasinan

Registered Brand Name	Target Pests
Malathion	Sucking and chewing insects on fruits and vegetables, mosquitoes, flies, household insects, animal parasites (ectoparasites), and head and body lice
Prevathon	Stem borers, leaf folders, fruit and shoot borer
Tamaron	Borers, rice fly louses, rice leafhoppers, rice leaf rollers, rice plant skippers, armyworms, cotton red spiders, aphids, mole crickets, mites
Brodan	Ants, ticks, cutworms, chinch bugs, earwigs, grubs, cockroaches, silverfish, spiders, fleas, dog ticks, mosquitoes, termites, fruit borers, diamond black moth, shoot borer, shoot fly, jassids, hairy caterpillar epilachna grub
Lannate	Borers, leaf miners, caterpillar, looper, weevil, aphid, armyworm, beetle, leafhopper, and thrips

Prevathon®, and Tamaron®) to control fruit and shoot borer. Appendix Table 1 shows the basic description of these pesticides used by the farmer-respondents, as summarized by the Philippine Fertilizer and Pesticide Authority (FPA).

Average amount applied. Most, if not all, farmer-respondents in the soil and water study used Prevathon® (active ingredient chlorantraniliprole; toxicity category I), Malathion® (malathion; IV), and Lannate® (methomyl, II). In terms of amount used per application, Brodan® (chlorpyrifos, II) came on top at 264 milliliters (ml), followed by Siga® (chlorpyrifos, II) at 183 ml, and Malathion® at 173 ml. On average, the farmers used 77 ml of insecticides per application (Table 5).

Similar to the above findings, most farmer-respondents in the eggplant fruit study used Prevathon® and Malathion®, but Magnum® had the highest application rate at 2 liters/application, with Brodan®, a distant second highest at 473 ml/application. (These application rates appear to be outliers, as the other insecticides were used at a range of 2.5-20.0 ml/application.) If Magnum® and Brodan® are included, the mean amount used per application is 235 ml; if excluded, the mean amount used is about 12.8 ml/application.

Average spraying time. Table 6 details the average spraying time of the farmers in the two studies covered in this report. Farmer-respondents in the soil and water study sprayed pesticides at an average of 2 hours/day, 3 days/week, 1 week/month, and 7 months/year, or 42 hours/year, equivalent to 5.25 person-days/year. Meanwhile, farmer-respondents in the eggplant fruit study sprayed pesticides at an average of about 1 hour/day, 4 days/week, almost 4 weeks/month, and 4 months/year, or 64 hours/year, equivalent to 8 person-days/year.

Farmers' pesticide exposure. The 26 farmer-respondents in the soil and water study have been using pesticides for almost 9 years, on average, while the 10 farmer-respondents in the eggplant fruit study have been using them for nearly 23 years (Table 5). Looking more closely, all farmer-respondents in the soil and water study have been using Prevathon® for about 3 years at a rate of 68 ml/application, equivalent to 0.212 liter-years of exposure. Although Brodan® and Siga® were not prevalently applied, the farmers' liter-years of exposure to the active ingredients of these insecticides were highest at about 3.036 and 2.948, respectively.

Table 5. Pesticide use (ml) and exposure (liter-years) of eggplant farmers by pesticide type and toxicity category, Sta. Maria, Pangasinan

Pesticide Type (Family)	Toxicity Category	Registered Brand Name	Active Ingredient	Soil and Water Study (n=26 farmers)						Eggplant Fruit Study (n=10 farmers)					
				% Farmers Who Used the Pesticide	No. of Farmers Who Used the Pesticide	Amount Used/ Application (ml)	Mean No. of Years Used	Farmers' Liter-Years of Exposure	Liter-Years of Exposure per % Farmers Used	% Farmers Who Used the Pesticide	No. of Farmers Who Used the Pesticide	Amount Used/ Application (ml)	Mean No. of Years Used	Farmers' Liter-Years of Exposure	Liter-Years of Exposure per % Farmers Used
Anthranilic diamide	I	Prevathon	Chlorantraniliprole	100	26	68	3.12	0.212	0.212	100	10	10	24	0.240	0.240
Organophosphate	I	Tamaron	Methamidophos	65	17	105	14.94	1.569	1.020	10	1	30	20	0.600	0.060
Carbamate	II	Lannate	Methomyl	88	23	129	15.83	2.042	1.797	40	4	8.75	15	0.131	0.053
Neonicotinoid + Pyrethroid + Petroleum derivative	II	Solomon	Imidacloprid + betacyfluthrin + cyclohexane	62	16	117	2.13	0.249	0.155						
Organophosphate	II	Brodan	Chlorpyrifos	38	10	264	11.50	3.036	1.154	10	1	473	40	18.920	1.892
Organophosphate	II	Hostathion	Triazophos	65	17	115	13.47	1.549	1.007						
Organophosphate	II	Selecron	Profenofos	50	13	33	3.54	0.117	0.058						
Organophosphate	II	Siga	Chlorpyrifos	35	9	183	16.11	2.948	1.032						
Organophosphate	II	Super insecticide	Profenofos	8	2	23	3.00	0.069	0.006						

Table 5. Pesticide use (ml) and exposure (liter-years) of eggplant farmers by pesticide type and toxicity category, Sta. Maria, Pangasinan

Pesticide Type (Family)	Toxicity Category	Registered Brand Name	Active Ingredient	Soil and Water Study (n=26 farmers)						Eggplant Fruit Study (n=10 farmers)					
				% Farmers Who Used the Pesticide	No. of Farmers Who Used the Pesticide	Amount Used/ Application (ml)	Mean No. of Years Used	Farmers' Liter-Years of Exposure	Liter-Years of Exposure per % Farmers Used	% Farmers Who Used the Pesticide	No. of Farmers Who Used the Pesticide	Amount Used/ Application (ml)	Mean No. of Years Used	Farmers' Liter-Years of Exposure	Liter-Years of Exposure per % Farmers Used
Organophosphate	II	Ultimate	Profenofos	31	8	19	3.38	0.064	0.020						
Thiourea	II	Pegasus	Diafenthiuron	31	8	20	5.25	0.105	0.033	10	1	2.5	40	0.100	0.010
Carbamate	III	Extreme	Cartap hydrochloride	4	1	30	20.00	0.600	0.024						
Carbamate	III	Padan	Cartap hydrochloride	42	11	156	13.36	2.084	0.875	10	1	2.5	40	0.100	0.010
Carbamate	III	Super cartap	Cartap hydrochloride	8	2	63	20.50	1.292	0.103						
Carbamate	III	Triband	Cartap hydrochloride	23	6	25	3.83	0.096	0.022	10	1	20	10	0.200	0.020
Neonicotinoid	III	Mospilan	Acetamiprid	58	15	118	4.60	0.543	0.315						
Organonitrogen	III	Ascend	Fipronil	4	1	10	10.00	0.100	0.004						
Organophosphate	III	Kotetsu	Chlorphenaphyr	15	4	13	2.25	0.029	0.004	10	1	20	10	0.200	0.020
Anthranilic diamide	IV	Fenos	Flubendiamide	8	2	2	4.00	0.008	0.001						

Table 5. Pesticide use (ml) and exposure (liter-years) of eggplant farmers by pesticide type and toxicity category, Sta. Maria, Pangasinan

Pesticide Type (Family)	Toxicity Category	Registered Brand Name	Active Ingredient	Soil and Water Study (n=26 farmers)						Eggplant Fruit Study (n=10 farmers)					
				% Farmers Who Used the Pesticide	No. of Farmers Who Used the Pesticide	Amount Used/ Application (ml)	Mean No. of Years Used	Farmers' Liter-Years of Exposure	Liter-Years of Exposure per % Farmers Used	% Farmers Who Used the Pesticide	No. of Farmers Who Used the Pesticide	Amount Used/ Application (ml)	Mean No. of Years Used	Farmers' Liter-Years of Exposure	Liter-Years of Exposure per % Farmers Used
Anthranilic diamide + Neonicotinoid	IV	Voliam flexi	Chlorantraniliprole + Thiamethoxam	12	3	9	2.00	0.018	0.002						
Inorganic fungicide	IV	Vitigran Blue	Copper oxychloride							10	1	5	20	0.100	0.010
Neonicotinoid	IV	Starkle	Dinotefuran	8	2	15	3.50	0.053	0.004						
Organophosphate	IV	Malathion	Malathion	92	4	173	11.13	1.925	1.771	100	10	16.5	25	0.413	0.413
Pyrethroid	IV	Decis	Deltamethrin	62	16	23	16.38	0.377	0.234						
Pyrethroid	IV	Magnum	Cypermethrin	46	12	136	4.67	0.635	0.292	10	1	2000	5	10.000	1.000
Mean						*77*	*8.69*	*0.820*	*0.480*			*235*	*22.6*	*2.819*	*0.339*
Standard deviation						*71*	*6.24*	*0.970*	*0.640*			*146*	*11.9*	*5.912*	*0.584*

Toxicity category: I=Highly toxic and severely irritating; II=Moderately toxic and moderately irritating; III=Slightly toxic and slightly irritating; and IV=Practically non-toxic and not an irritant.

Table 6. Pesticide spraying time of eggplant farmers, Sta. Maria, Pangasinan

Registered Brand Name	Active Ingredient	Soil and Water Study (n=26 farms)				Eggplant Fruit Study (n=10 farms)			
		Hours/ Day	Days/ Week	Weeks/ Month	Months/ Year	Hours/ Day	Days/ Week	Weeks/ Month	Months/ Year
Prevathon	Chlorantraniliprole	2.23	2.65	1.35	7.35	2.00	3.40	4.00	3.80
Fenos	Flubendiamide	3.00	4.00	2.00	6.50				
Voliam flexi	Chlorantraniliprole + Thiametoxam	2.33	2.67	1.33	6.50				
Lannate	Methomyl	2.28	2.61	1.30	7.28	1.00	4.25	3.88	3.88
Extreme	Cartap hydrochloride	2.00	4.00	2.00	3.00				
Padan	Cartap hydrochloride	2.00	3.09	1.55	6.32	1.00	7.00	3.50	3.50
Super cartap	Cartap hydrochloride	1.50	3.50	1.50	5.75				
Triband	Cartap hydrochloride	1.92	3.67	1.83	4.17	1.00	3.50	4.00	3.50
Vitigran Blue	Copper oxychloride					2.00	1.00	4.00	3.50
Mospilan	Acetamiprid	2.20	2.40	1.20	8.80				
Starkle	Dinotefuran	2.00	1.50	1.00	6.25				
Solomon	Imidacloprid + betacyfluthrin + cyclohexane	2.31	2.5	1.25	7.53				
Ascend	Fipronil	1.50	4.00	2.00	6.00				
Tamaron	Methamidophos	2.03	2.83	1.41	7.53	2.00	5.00	3.00	3.00
Brodan	Chlorpyrifos	2.10	2.20	1.20	7.55	2.00	3.30	4.00	3.50
Hostathion	Triazophos	2.24	2.59	1.29	7.03				
Selecron	Profenofos	2.46	2.23	1.15	7.38				
Siga	Chlorpyrifos	1.78	3.33	1.56	5.56				

Table 6. Pesticide spraying time of eggplant farmers, Sta. Maria, Pangasinan

Registered Brand Name	Active Ingredient	Soil and Water Study (n=26 farms)				Eggplant Fruit Study (n=10 farms)			
		Hours/ Day	**Days/ Week**	**Weeks/ Month**	**Months/ Year**	**Hours/ Day**	**Days/ Week**	**Weeks/ Month**	**Months/ Year**
Super insecticide	Profenofos	3.00	2.00	1.00	9.75				
Ultimate	Profenofos	2.19	2.63	1.25	8.25				
Kotetsu	Chlorphenaphyr	2.38	2.50	1.25	8.13	1.50	3.50	4.00	3.50
Malathion	Malathion	2.27	2.67	1.33	7.48	1.00	3.35	4.00	3.80
Decis	Deltamethrin	2.22	2.75	1.38	7.22				
Magnum	Cypermethrin	2.33	3.00	1.58	5.92				
Pegasus	Diafenthiuron	2.00	3.25	1.63	5.19	1.00	7.00	3.50	3.50
	Mean	*2.18*	*2.86*	*1.43*	*6.77*	*1.40*	*4.13*	*3.79*	*3.55*
	Standard deviation	*0.35*	*0.65*	*0.29*	*1.45*	*0.53*	*1.90*	*0.22*	*0.16*

In the eggplant fruit study, all farmers have been using Prevathon® for 24 years at a rate of 10 ml/application, and Malathion® for 25 years at about 16.5 ml/application, respectively equivalent to 0.24 liter-years and 0.413 liter-years of exposure. Similar to the findings in the soil and water study, although Brodan® and Magnum® were not prevalently applied, the farmers' liter-years of exposure to these insecticides, and their active ingredients, were highest at about 18.92 and 10.0, respectively.

Risk factors in farmers' pesticide application. The 26 farmer-respondents in the soil and water study reported not being able to use the complete and standard personal protective equipment (PPE) in applying pesticides.[3] Instead, they used improvised PPE such as long sleeved shirts or polo shirts to cover their arms, t-shirts to cover their face, and a wide-brimmed hat. Twenty-four farmer-respondents (92%) had experienced pesticide spills on their body during application, most commonly in the back, legs, arms, shoulders, hands, and face. Sixty-five percent had experienced insecticide spill while spraying and 62% while mixing. Fourteen farmers (54%) reported having experienced chemical spill due to leaking backpack sprayer. Some farmers also reported having inadvertently used insecticide-contaminated cloth in wiping their sweat, not bathing immediately after experiencing chemical spillage, re-entering the previously sprayed area, and having sprayed against the wind (Table 7).[4]

Insecticide Residue Analysis of Soil and Water

Pesticides can infiltrate air, oceans, rivers, groundwater, and soil (Cooper, 2010). They can also move into other areas away from sites of application, such as to water bodies through runoff, soil through adsorption and leaching, and air through spray/vapor drift (British Columbia, 2010). Varca (2002) found that, during application, only around 15% of the pesticides applied on crops hit the target organism; a larger proportion is distributed in the soil and air. (This may also explain why some of the eggplant samples were not positive for insecticide residue [see next section]).

In general, the soil serves as a "purifying filter" that influences pesticide contamination of groundwater. The soil profile plays a significant role in

[3] Standard personal protective equipment (PPE) for pesticide applicators and other handlers include long sleeved shirt and long pants, shoes, and socks. These clothing should also be kept and washed separately from other household laundry.
[4] While no such information was gathered in the eggplant fruit study, it can be safely assumed that such risk factors were also experienced by the farmer-respondents in the said study.

Table 7. Risk factors associated with pesticide exposure of eggplant farmers, Sta. Maria, Pangasinan

Pesticide Exposure Risk Factors	No. of Farmers	% of Total
Lack of, or inappropriate use of, personal protective equipment	26	100
Spillage of pesticide while spraying	17	65
Spillage of pesticide while mixing	16	62
Use of pesticide-contaminated cloth	11	44
Did not bathe after spraying pesticide	10	40
Re-entered previously sprayed area	6	23
Sprayed against the wind	4	15

determining the chemical's leachability to the groundwater, and soil organic content on pesticide persistence. (Pesticides are more persistent in soils with high organic content.) However, modern technology has developed pesticides that are more water-soluble, thermolabile, polar, and persistent, to better enable effective pest control. These may explain why pesticide compounds, specifically herbicides, have been detected in surface and ground waters (Aharonson et. al., 1987; Barnard et. al., 1997; Hamilton et. al., 2003; Andreu and Pico, 2004).

The fate of insecticides and their transformation products (TPs) in the soil depend on the properties of their active ingredients and degree of interaction with the soil particles (or adsorption). Parameters such as water solubility, soil-sorption constant (Koc), octanol/water partition coefficient (Kow), and half-life of insecticides in the soil (DT50), as well as properties such as chemical functions, polarity, polarizability, and charge distribution of both soil and insecticide molecules measure the persistence and movement of insecticides and their TPs in the soil (Bailey and White, 1970; Senesi, 1992; Pignatello and Xing, 1996; Andreu and Pico, 2004). In this study, insecticide residues with low polar characteristics and detected in the soil samples were chlorpyrifos, cypermethrin, malathion, profenofos, and triazophos (Table 8).

The persistence and mobility of insecticides in the soil are also influenced by chemical degradation (e.g., photolysis, hydrolysis, oxidation and reduction) and microbial degradation with the aid of soil microorganisms. The degradation process ranges from the formation of TPs to the decomposition of inorganic products. Meanwhile, mobility of insecticides in the soil includes sorption, plant uptake, volatilization, wind erosion, runoff, and leaching.

Table 8. Characterization of pesticide residues found in the soil in this study

Pesticide Class[a]	Description[a]	Results of Pesticide Residue Analysis in this Study
Hydrophobic, persistent, and bioaccumulable pesticides	These insecticides strongly bound to the soil. Examples are organochlorine DDT, endosulfan, heptachlor, endrin, lindane and their transformation products. Majority of the pesticides included in this group were already banned but their residues still exist in the environment.	None found in the soil samples in this study.
Polar pesticides	These insecticides move from the soil through runoff and leaching, thus may possibly contaminate groundwater. Insecticides that belong to this group are the carbamates, fungicides, some organophosphates, and their transformation products.	This study found residues of these insecticides in some soil samples: chlorpyrifos, cypermethrin, malathion, profenofos, and triazophos.

[a] Source: Andreu, V. and Y. Pico. 2004. Determination of pesticides and their degradation products in soil: critical review and comparison of methods. *Trends in Analytical Chemistry* 23 (10–11):772-789.

Furthermore, the fate of insecticides in the soil depends on soil type, agricultural practices, and climate (Andreu and Pico, 2004).

Insecticides vary in toxicity, persistence (of active ingredients) and mobility, and thus also pose differing degrees of environmental risks (Barnard et. al., 1997). An insecticide with low sorption coefficient, long half-life, and high water solubility has the potential to contaminate groundwater through leaching (Andreu and Pico, 2004). Half-life, the typical measure for persistence, ranges at 10-100 days for modern pesticides. Insecticides with longer half-lives have active ingredients or residues that stay longer in the environment, posing more danger to other non-target organisms (Wolfe et. al., 1973; Davidson et. al., 1980; Schoen and Winterlin, 1987; Winterlin et. al., 1989; Gan et. al., 1995; Barnard et. al., 1997) (Appendix Table 2).

Sediments can serve as a sink of pesticide residues, increasing the risks of bioavailability and accumulation in the food chain through resuspension. The soil, as the main reservoir of pesticide residues, poses toxicity to terrestrial and benthic organisms (FAO, 2000). In California, residues of permethrin, fenvalerate, bifenthrin, lamba-cyhalothrin were detected in sediment samples (Weston et. al., 2004). In the Philippines, chlorpyrifos residues were found in soil samples in Benguet and were associated with muscle fasciculations among the local farmers (Lu, 2010).

Residues of five insecticides were detected in the soil of 11 farms (42%) among the 26 sample farms. Profenofos and triazophos were found in three and six eggplant farms, respectively, some at levels exceeding the acceptable maximum residue level (MRL) set by the European Commission (EC) and/or the US Environmental Protection Agency (EPA). (One farm had 0.10 ppm of profenofos in the soil, which is twice the acceptable MRL. Four farms had 0.02-0.05 ppm of triazophos, which is higher than the 0.01 ppm MRL.) Chlorpyrifos, cypermethrin, and malathion were each found in two farms, although none of them exceeded the MRL. These results have been influenced by the insecticides' behavior in the soil, as indicated by their mobility, leachability, persistence, and volatility (Table 9).

None of the water samples was found positive with insecticide residues (Table 10). Almost all of the insecticide residues detected in the soil have high Koc and hence low leaching potential (Appendix Table 2). The compound's movement is therefore limited throughout and over the soil profile, such that there is less potential for groundwater contamination.

In Southwestern, Nigeria, the sources of drinking water of farmers had been found contaminated with diazinon and propouxr at concentrations exceeding the acceptable daily intake (ADI) (Sosan et. al., 2008). In Laguna and Nueva Ecija provinces, both in the Philippines, residues of pesticides including chlorpyrifos, butachlor, endosulfan, carbofuran, methyl parathion, and monocrotrophos were detected in groundwater samples taken from tube wells adjacent to rice fields (Castaneda and Bhuiyan, 1996). In this study, the deep wells where farmers get their drinking water are possibly contaminated with pesticide residues, because they are located near the farms.

Appendix Table 3 shows the inherent characteristics of selected insecticides and their environmental fate in soil, water, air, and plants.

Insecticide Residue Analysis of Eggplant Fruits

All of the farmers in the eggplant fruit study reported applying Prevathon® (active ingredient chlorantraniliprole, pesticide type anthranilic diamide, toxicity class I) and Malathion (malathion®, organophosphate, class IV) to control pests in their eggplant crops. However, farmers used Brodan® (chlorpyrifos, organophosphate, toxicity class II) at the highest average rate

Table 9. Insecticide residues found in the soil of 26 eggplant farms, Sta. Maria, Pangasinan

Types of Insecticide Residue Detected	No. of Farms where Insecticide Residue was Detected	Amount of Insecticide Residue Detected (range, in ppm)	Maximum Residue Level (ppm)	Evaluation of Detected Residue Level	Reference for Maximum Residue Level
Chlorpyrifos	2	0.01 – 0.03	0.03	Within MRL	EPA
Cypermethrin	2	0.02 – 0.03	0.05	Within MRL	EPA
Malathion	2	0.01 – 0.04	0.05	Within MRL	EPA
Profenofos	3	0.01 – 0.10	0.05	One farm exceeded MRL	EPA
Triazophos	6	0.01 – 0.05	0.01	Four farms exceeded MRL	EC
Insecticide Residue Behavior in the Soil					
	Mobility	**Leachability**	**Persistence**	**Volatility**	**Bioaccumulation Potential**
Chlorpyrifos	Non-mobile	Low	Moderate	Volatile	High
Cypermethrin	Non-mobile	Low	Moderate	Moderate	High
Malathion	Moderate	Low	Non-persistent	Volatile	Low
Profenofos	Slightly mobile	Low	Non-persistent	Moderate	Low
Triazophos	Moderate	In transition	Moderate	Moderate	Moderate

EC=European Commission, EPA=US Environmental Protection Agency, ppm=parts per million
The soil and water study adopted the EPA Method 8141A limit of analytical determination (LOD) for analyzing soil and water, and EC's default LOD maximum residue level (MRL). [Based on EC MRL setting procedures under Regulation 396/2005, the LOD can be set as MRL when no alternative safe level is proposed (HSE, 2009).]

Table 10. Summary results of insecticide residue analysis in the soil and water of 26 eggplant farms, Sta. Maria, Pangasinan

Sample	No. of Samples (With Replicates)	Positive for Insecticide Residues		Insecticide Residues Exceeding MRL	
		No. of Farms	No. of insecticides found	No. of Farms	No. of insecticides found
Soil	26	11 (42.3%)	19 (73.1%)[a]	4 (15.4%)	6 (23.1%)[a]
Water	26	0	0	0	0

[a] There were more than one insecticide found in one farm.

of 473 ml/application, followed by Magnum® (cypermethrin, pyrethroid, class IV) at an average of 30 ml/application. Tamaron® (methamidophos, organophosphate, class I) was also reported as used at an average of 30 ml/application (Table 5).

Of the 10 sample farms, wet season sample eggplants in 2 farms were detected as having chlorpyrifos and cypermethrin, with the former at a level higher than the prescribed maximum residue level (Table 11). Similarly, cypermethrin was detected in harvested eggplants from 2 farms, with levels within the prescribed limit. From the dry season analysis, cypermethrin was detected from samples in 2 farms, and also from harvested eggplants in 1 farm, at levels equal to the prescribed limit. All market samples from both wet and dry seasons tested negative for insecticide residues. In summary, a maximum of 20% of the eggplant samples, and sample farms, tested positive for insecticide residues at any one stage of sampling done (Table 12).

Pesticide residues in plants may reach the consumers through ingestion of raw foods (Lukassowitz, 2007). Karanth (2002) cited that various surveys around the world found that 50%-70% of vegetables are contaminated

Table 11. Insecticide residues found in eggplant fruits, by season, Sta. Maria, Pangasinan

Types of Insecticide Residue Detected	**No. of Farms where Insecticide Residue was Detected**	**Amount of Insecticide Residue Detected** (in ppm)	**Maximum Residue Limit[a]** (ppm)	**Evaluation of Detected Residue Level**
Wet Season				
Farm samples (pre-mature fruits):				
Chlorpyrifos	1	0.03	0.01	Exceeded MRL
Cypermethrin	2	0.01	0.03	Within MRL
Harvest samples:				
Cypermethrin	2	0.01	0.03	Within MRL
Dry Season				
Farm samples (pre-mature fruits):				
Cypermethrin	2	0.03	0.03	Within MRL
Harvest samples:				
Cypermethrin	1	0.03	0.03	Within MRL

[a] Reference: Codex Alimentarius

Table 12. Percentage distribution of positive residues in eggplants in various stages, Sta. Maria, Pangasinan

Stages of Sampling	Crop Seasons	
	Wet Season	Dry Season
Farm samples (pre-mature fruits)	20%	20%
Harvest samples	20%	10%
Market samples	—	—

with insecticide residues, which plant roots absorbed from contaminated soils and migrated to edible parts. In Tanzania, for example, Mwevura et. al. (2002) found high levels of organochlorine pesticide residues in edible biota in coastal areas. In India, Mukherjee and Gopal (1992) detected residues of fenvalerate, tau-fluvalinate, lamba-cyhalothrin, and monocrotophos in eggplant fruits. In the United States, endosulfan sulfate was the most prevalent (16.76%) pesticide residue found in eggplants, followed by endosulfan II (12.8%) and metamidophos (4.5%) (USDA Pesticide Program, 2008).

Health Profile of Eggplant Farmers

Detectable concentrations of insecticide residues in soil, water (both groundwater and surface water), air, and even commodities pose risks to human health and the environment (Fawcett et. al., 1994; Kookana et. al., 1998). A study of farming families with houses within 200 feet from their farms detected higher concentrations of organophosphorous pesticides (including chlorpyrifos, parathion, phosmet, and azinphosmethyl) in the household dust than those found in the farm soils (Simcox et. al., 1995). In this study, the residents are potentially exposed to insecticide-contaminated house dusts and soil since houses are very close to the farms.

The 58 farmers and farm workers in the soil and water study and 10 farmer-respondents in the eggplant fruit study were interviewed on their medical history and health profile, and a medical doctor conducted their physical health assessment. Table 13 shows the health concerns (complaints) that the respondents reported as related to their application of agricultural pesticides.

The farmers and farm workers in the soil and water study reported experiencing itchiness of the skin (63.8%), redness of the eyes (29.3%), muscle pains (27.6%), and headaches (27.6%), as being related to their

Table 13. Distribution of eggplant farmers by health concerns related to pesticide exposure, Sta. Maria, Pangasinan

Health Concerns (Complaints) Reported	Soil and Water Study (n=58 farmers and farm workers)		Eggplant Fruit Study (n=10 farmers)	
	No.[a]	**% Total**	**No.[a]**	**% Total**
Itchiness of the skin	37	63.8	3	30.0
Redness of the eyes	17	29.3		
Muscle pains	16	27.6	1	10.0
Headache	16	27.6	4	40.0
General weakness	10	17.2		
Burning sensation on the skin	8	13.8	3	30.0
Dizziness	8	13.8		
Blurred vision	7	12.1	1	10.0
Fever	7	12.1	2	20.0
Nausea	6	10.3	1	10.0
Coughing	5	8.6	2	20.0
Vomiting	5	8.6		
Feeling easily fatigued	3	0.1		

[a] Multiple responses

pesticide exposure. Meanwhile, the farmer-respondents in the eggplant fruit study reported experiencing headaches (40%), itchiness of the skin (30%), and burning sensation of the skin (30%). While all the respondents reported getting (or feeling) sick immediately after applying pesticides to their eggplant crops, none of them sought any medical attention. The clinical manifestations of the farmer-respondents indicate that, with complaints of mild symptoms without obvious cholinesterase depression (based on blood chemistry), only mild pesticide poisoning has occurred. In more severe instances, tremors, abdominal cramps, excessive urination, bradycardia, staggering gait, pinpoint pupils, and hypotension may be oberved (Boiko et al., 2005). Significant effects of pesticide exposure have also been reported on motor or neuromuscular involvement, with symptoms that may include paresthesia, convulsions, tremors, ataxia, local or general fasciculation, and tremors (Boiko et al., 2005). Intervention to reduce the farmers' pesticide exposure can focus on the risk factors identified earlier, primarily the toxicity of pesticides used, and their (unsafe) application practices.

Skin is the most exposed organ of the body. Farmers are exposed to pesticides during mixing and loading the pesticides, spraying them in the fields, as well as when disposing empty pesticide containers and cleaning the spray equipment. In the eggplant fruit study, the farmer-respondents reported possibly having had dermal contact (100%), respiratory exposure (90%), and ocular contact (50%) with the pesticides during preparation and/or field application.[5]

Related to exposure through skin contact, reports of pesticide-related dermatoses are recently increasing. These include allergic or irritant contact dermatitis, and rare clinical forms such as urticaria, erythema multiforme, ashy dermatoses, parakeratosis variegata, and porphyria cutanea tarda, chloracne, nail and hair disorder (Boiko et al., 2005).

Table 14 presents a summary of the effects on human health of exposure to various pesticides as have been reported in the literature.

Summary and Conclusions

Across the soil and water and eggplant fruit studies covered in this chapter, farmers from Sta. Maria, Pangasinan were found to be applying a broad spectrum of insecticides on their eggplant crop. These consisted of 25 commercial brands, with two being category I (highly toxic) pesticides; nine category II (moderately toxic) pesticides; and seven each of categories III and IV (respectively slightly toxic and practically non-toxic) pesticides. Soil samples from 11 (about 42%) out of the 26 farms tested positive for insecticide residues, six of which from four farms exceeded the acceptable maximum residue limit. No insecticide residues were detected from water samples taken from the 26 farms. From the eggplant fruit study, residues of two commercial insecticides were detected in the samples.

Pesticide residues can remain as environmental pollutants in the soil, water, and even air, and impact flora and fauna, including humans and human health. The studies' findings suggest that environmental monitoring (including in water, groundwater, soil, air, and plants) for pesticide residues ought to be promoted and institutionalized, especially in key agricultural

[5] This information was not collected from the interviewed farmers and farm workers in the soil and water study.

Table 14. Reported effects of pesticide exposure on human health

Pesticide / Chemical	Reported Effects on Human Health	Reference
Pesticides in general	Dermal irritation considered as a potential acute pesticide exposure hazard, with pesticide-related dermal symptoms such as dermal rashes, damaged fingernails, contact dermatitis, urticaria, skin hypopigmentation and hair disorders; also integumentary abnormalities	Spiewak (2001); Cantor and Young-Holt (2002)
	Respiratory problems wheezing and breathlessness, chronic bronchitis and asthma, may be due to increased airway hyperactivity induced by certain pesticides	Yalemtsehay et. al. (2002) Hoppin et. al. (2007)
	92% of the farmers complained of health-related problems right after applying pesticides, including tiredness, weakness, dizziness, nausea, vomiting, blurred vision, rashes, itchy skin, burning sensations in the throat, chest pain, and difficulty of breathing.	Iishii-Eitemann and Ardhianie (2002)
	Autonomic distress may result from acute exposure that includes excessive salivation, lacrimation, urinary frequency, diarrhea, decreased neuromuscular and motor activity, hypothermia and altered cardiovascular function.	Gianato (1997); Vermiere et. al. (2003)
	Pesticide applicators were two times more likely to develop reduced muscular strength as compared to control group.	Cole et. al. (1998)
	Dizziness, headache, skin irritation, and burning sensation on the face were reported by farmers in Malaysia, Ghana, Gaza strip, and Tanzania. Eye tearing or eye redness is also common, as well as nausea and salivation for gastrointestinal symptoms.	Clarke et. al. (1997); Nordin et. al. (2002); Yassin (2002); Lekei and Ngowi (2006)
Anthranilic diamide	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	EPA (2010)
Arsenic pesticides	With exposure route through the skin, present risks of occupational skin cancer, mostly morbus Bowen (carcinoma in situ), multiple basal cell carcinomas, and squamous cell carcinomas	Spiewak (2001)
Carbamates	Caused an 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	Tongzhang et. al. (2001)

Table 14. Reported effects of pesticide exposure on human health

Pesticide / Chemical	Reported Effects on Human Health	Reference
Organophos-phates	Top cause of clinical cases in pesticide poisoning among Japanese	Nagami et. al. (2005)
	Can inhibit the paraoxonase (PON1) enzyme	Sozmen et. al. (2007)
	Can significantly inhibit cholinesterase, specifically erythrocyte acetylcholinesterase (AChE) and butyrylcholinesterase (BuChE)	Jintana et. al. (2009)
	Correlated with skin itchiness and skin rashes	Lu (2010)
	Acute effects of organophosphate exposure include delayed neuromuscular function particularly in the extremities that may lead to irreversible paralysis, a condition often referred to as organophosphate- induced delayed neuropathy (OPIDN)	Boiko (2005)
	Dermal exposure to chlorpyrifos to hands and feet was associated with atrophy and paralysis of the exposed body parts. Paralysis is one of the most serious effects of pesticide exposure.	Meggs (2004)
Pyrethroid	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.	Chen et. al. (2001)

production areas and communities. Insecticide monitoring in eggplants can be done simultaneously with soil and water monitoring since some insecticides (such as those found to be used by Pangasinan farmers in this study) can leach into the soil and even groundwater.

Farmers also ought to be made better aware of the environmental and human health impacts of pesticide use and exposure, and encouraged to practice more judicious pesticide application, and to observe proper and safer application practices. These farmer education/awareness campaigns could be led by the municipal agriculture office, with support from and coordination with other concerned stakeholders, both from the public sector and the private sector (e.g., agricultural chemical companies). Environmental management programs can be developed and incorporated in these campaigns to minimize, if not neutralize, the potential adverse effects of contaminated soil, water, and groundwater, and promote remediation practices for contaminated such elements (if any).

In the future, these studies could be replicated and/or scaled up to include more farmer-respondents and/or eggplant-producing communities/ towns/provinces in the Philippines. Such will provide a more robust set of observations as to the variety of eggplant production practices, extent of pesticide contamination in eggplant production areas/environments, as well as of farmer exposure to pesticides applied to eggplant crops. For example, variants of these future investigations could analyze the level of insecticide residues in eggplant fruits according to farmer cultural (pesticide application) practices, or examine the level of pesticide residues in eggplant fruits in various stages of development up to when they are sold retail to consumers.

Lastly, more extensive research could be conducted on the transformation products of insecticides applied in eggplant production in the Philippines, looking at their fate in the soil, and the bonding forces between the soil and the pesticide active ingredient.

References

Afful, S., A.K. Anim, and Y. Serfor-Armah. 2010. Spectrum of Organochlorine Pesticide Residues in Fish Samples from the Densu Basin. *Research Journal of Environmental and Earth Sciences* 2(3): 133–139.

AgriBusiness Week. 2010. Scientists Develop Eggplant Varieties Resistant to Fruit and Shoot Borer. www.agribusinessweek.com/?s=Scientists+Develop+Eggplant+Varieties+ Resist ant+to+Fruit+and+Shoot+Borer.

Aharonson, N., S.Z. Cohen, N. Drescher, T.J. Gish, S. Gorbach, P.C. Kearney, S. Otto, T.R. Roberts, and J.W. Vonk. 1987. Potential Contamination of Ground Water by Pesticides. *Pure Appl. Chem.* 59: 1419–1446.

Andreu, V. and Y. Pico. 2004. Determination of Pesticides and their Degradation Products in Soil: Critical Review and Comparison of Methods. *Trends in Analytical Chemistry* 23(10–11): 772–789.

Bailey, G.W. and J.L. White. 1970. Factors Infuencing the Adsorption, Desorption, and Movement of Pesticides in Soils. *Residue Reviews* 32: 29–92.

Baral, K., B.C. Roy, K.M.B Rahim, H. Chatterjee, P. Mondal, D. Mondal, D. Ghosh, and N.S. Talekar. 2006. *Socioeconomic Parameters of Pesticide Use and Assessment of Impact of an IPM Strategy for the Control of Eggplant Fruit and Shoot Borer in West Bengal, India.* Technical Bulletin No. 37. AVRDC publication number 06-673. AVRDC–The World Vegetable Center, Shanhua, Taiwan, p. 36.

Barnard, C., S. Daberkow, M. Padgitt, M.E. Smith, and N.D. Uri. 1997. Alternative Measures of Pesticide Use. *The Science of the Total Environment* 203: 229-244.

BAS (Bureau of Agricultural Statistics). 2008. *CountryStat Philippines.* http://countrystat.bas.gov.ph/.

BAS. 2013. *CountryStat Philippines.* http://www.countrystat.bas.gov.ph. Accessed on 3 May 2013.

Bleicher, A. 2009. Will Eggplant be the World's Next GM Crop. *Life Science.* www.scienceline. org/2009/11/will-eggplant-be-the-world%E2%80%99s-next-gm-crop/.

British Columbia. 2010. *Pesticide Names*. www.agf.gov.bc.ca/pesticides/a_1.htm. Accessed on July 10, 2010.

Boiko, P., M. Keifer, J. Furman, K. Weyrauch, and C. Hanks. 2005. *Cholinesterase Monitoring for Agricultural Pesticide Handlers: Guidelines for Health Care Providers in Washington State*.

Cantor, A. and B. Young-Holt. 2002. Pregnancy Related Symptoms Among Farm Workers in Rural Honduras. *International Journal of Occupational and Environment Health* 1: 41-46.

Castaneda, A.R. and S.I. Bhuiyan. 1996. Groundwater Contamination by Ricefield Pesticides and Some Influencing Factors. *Jour. Environ. Sci. Health* 31(1): 83-99.

Chen, N., H. Li, and T. Kalb. 2001. *Suggested Cultural Practices for Eggplant. AVRDC Training Guide*. Asian Vegetable and Research Development Center. Shanhua, Taiwan.

Choudhary, B. and K. Gaur. 2009. *The Development and Regulation of Bt Brinjal in India (Eggplant/Aubergine)*. ISAAA Brief No. 38. ISAAA: Ithaca, NY.

Clarke, E.E.K., L.S. Levy, A. Spurgeon, and I.A. Calvert. 1997. The problems Associated with Pesticide Use by Irrigation Workers in Ghana. *Occupational Medicine* 47: 301-308.

Cole, D.C., F. Carpio, J. Julian, and N. Leon. 1998. Assessment of Peripheral Nerve Function in an Ecuadorian Rural Population Exposed to Pesticides. *J Toxicol Environ Health A* 55(2): 77-91.

Cooper, S. 2010. Toxic Effects of Pesticide Residue on Fruits and Veggies. http://blog.friendseat.com/danger-of-pesticides-in-fruits-and-vegetables/.

Davidson, J.M., P.S.C. Rao, L.T. Ou, W.B. Wheeler, and D.F. Rothwell. 1980. *Adsorption, Movement, and Biodegradation of Large Concentrations of Selected Pesticides in Soils*. USEPA, CI, 600/2-80-124.

EC (European Commission). Regulation (EC) No 396/2005. http://ec.europa.eu/food/plant/protection/pesticides/regulation_ec_396_2005_en.htm.

EPA (Environment Protection Agency). 2010. Chlorantraniliprole Chemical documents. www.epa.gov/opprd001/factsheets/chloran.html.

EPA (Environment Protection Agency). Typical Method Detection Limits Using EPA Method 8141A for Soils and Waters. www.emalab.com/epa_OPs.htm. Accessed 9 March 2011.

FAO (Food and Agriculture Organization of the United Nations). 2000. *Assessing Soil Contamination: A Reference Manual*. FAO Pesticide Disposal Series. Rome.

Fawcett, R., B. Christensen, and D. Tierney. 1994. The Impact of Conservation Tillage on Pesticide Runoff into Surface Water: A Review and Analysis. *Journal of Soil and Water Conservation* 49(2): 126-135.

Francisco, S.R. 2009. Costs and benefits of *Bt* eggplant with resistance to fruit and shoot borer in the Philippines. In G.W. Norton and D.M. Hautea (eds.). *Projected Impacts of Agricultural Biotechnologies for Fruits and Vegetables in the Philippines and Indonesia*. International Services for the Acquisition of Agri-biotech Applications (ISAAA) and Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA): Los Baños, Laguna, Philippines.

Fuhremann, T.W. and E.P. Lichtenstein. 1978. Release of Soil-bound Methyl[14C]parathion Residues and their Uptake by Earthworms and Oat Plants. *Journal of Agriculture and Food Chemistry* 26: 605-610.

Gan, J., W.C. Koskinen, R.L. Becker, and D.D. Buhler. 1995. Effect of Concentration on Persistence of Alochlor in Soil. *Journal of Environmental Quality* 24: 1162-1169.

Gevao, B., K.T. Semple, and K.C. Jones. 2000. Bound Pesticide Residues in Soils: A Review. *Environmental Pollution* 108: 3-14.

Gianato S. 1997. Use and Care of Protective Clothing by Certified Private Pesticide Applicators. *Journal of Family and Consumer Sciences* 89: 6-11.

Hague, A., I. Schuphan, and W. Ebing. 1982. Bioavailability of Conjugated and Soil-bound [14C]hydroxymonolinuron-b-d-glucoside Residues to Earthworms and Ryegrass.

Pesticide Science 13: 219-228.
Hamilton, D.J., A. Ambrus, R.M. Dieterle, A.S. Felsot, C.A. Harriss, P.T. Holland, A. Katayama, N. Kurihara, J. Linder, J. Unsworth, and S.S. Wong. 2003. Regulatory Limits for Pesticide Residues in Water (IUPAC Technical Report). *Pure Appl. Chem.* 75(8): 1123–1155.
Harper, S. 1994. Sorption-desorption and Herbicide Behavior in Soil. *Rev. Weed Sci* 6: 207-255.
Helle, E., M. Olsson, and S. Jensen. 1976. DDT and PCB Levels and Reproduction in Ringed Seal from the Bothnian Bay. *Ambio* 5: 188–189.
Helling, C.S. and A.E. Krivonak. 1978. Biological Characteristics of Bound Dinitroaniline Herbicides in Soils. *Journal of Agricultural and Food Chemistry* 26: 1164.
Hoppin J.A., M. Valcin, P.K. Henneberger, G.J. Kullman, D.M. Umbach, S.J. London, M.C. Alavanja, and D.P. Sandler. 2007. Pesticide use and chronic bronchitis among farmers in the Agricultural Health Study. *American Journal of Industrial Medicine* 50:969-979.
Hoppin, J.A., D.M. Umbach, G.J. Kullman, P.K. Henneberger, S.J. London, M.C. Alavanja, and S.P. Sandler. 2007. Pesticides and other agricultural factors associated with self-reported farmer's lung among farm residents in the Agricultural Health Study. Occupational and Environmental Medicine 64:334-341.
HSE (Health and Safety Executive). 2009. General Guidance Concerning Maximum Residue Levels. www.pesticides.gov.uk/food_safety.asp?id=2624. Accessed 10 January 2011.
Ibitayo, O. 2007. Agricultural pesticide contamination. In: *Encyclopedia of Earth*. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment). www.eoearth.org/article/Agricultural_pesticide_contamination.
Iishii-Eitemann, M.J. and N. Ardhianie. 2002. Community monitoring of integrated pest management versus conventional pesticide use in a World Bank project in Indonesia. *International Journal of Occupational and Environmental Health* 8(3): 220-232.
Ize-Iyamu, O.K., I.O. Asia, and P.A. Egwakhide. 2007. Concentrations of Residues from Organochlorine Pesticide in Water and Fish from Some Rivers in Edo State, Nigeria. *International Journal of Physical Sciences* 2(9): 237-241.
Jintana, S., K., Sming, Y. Krongtong, and S. Thanyachai. 2009. Cholinesterase activity, pesticide exposure and health impact in a population exposed to organophosphates. *International Archives of Occupational and Environmental Health* 82(7): 833-842, DOI: 10.1007/s00420-009-0422-9.
Kamel, F. and Hoppin, J.A. 2004. Association of pesticide exposure with neurologic dysfunction and disease. *Environmental Health Perspective* 112(9).
Karanth, N.G.K. 2002. Challenges of Limiting Pesticide Residues in Fresh Vegetables: The Indian Experience. Food Safety Management in Developing Countries. Proceedings of the International Workshop. December 2000: Montpellier, France.
Kookana, R.S., S. Baskaran, and R. Naidu. 1998. Pesticide fate and behaviour in Australian soils in relation to contamination and management of soil and water: a review. *Australian Journal of Soil Research* 36(5): 715-764.
Lars, H. 2000. Environmental Exposure to Persistent Organohalogen and Health Risks. In: Lennart, M. (ed.), *Environmental Medicine* 2000. Ch: 12, Available from: www.envimed.com.
Lekei, E.E. and A.V.F. Ngowi. 2006. Self-reporting of pesticide exposure and health effects among workers at a coffee estate. *African Newsletter on Occupational Health and Safety* 16:56-58.
Lu, J.L. 2010. Multipesticide residue assessment of agricultural soil and water in major farming areas in Benguet, Philippines. Archives of *Environmental Contamination and Toxicology* DOI 10.100/s00244-90-9748-5. Published online Feb 17, 2010.
Lukassowitz, I. 2007. Analysis and assessment of pesticide residues. Federal Institute of Risk Assessment 2007. www.jstor.org/pss/1295710.

Machiwa, J.F. 2000. Heavy metals and organic pollutants in sediments of Dar es Salaam harbour prior dredging in 1999. *Tanz. J. Sci* 26: 29–45.

Maghirang, R., M.L. Guevarra, and G. Rodulfo. 2009. *Eggplant Production Guide.* Department of Trade and Industry (DTI) and Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD). Los Baños, Laguna, Philippines.

Meggs, W.J. 2004. Permanent paralysis at sites of dermal exposure to chlorpyrifos. *J Toxicol Clin Toxicol* 42 (7): 991-992.

Mukherjee I. and M. Gopal. 1992. Residue Behaviour of Fenvalerate, tau-Fluvalinate, lambda-Cyhalothrin and Monocrotophos in Eggplant (*Solanum melongena* L.) Fruits. *Pesticide Science* 36(3):175-179.

Mwevura, H., C.O. Othman, and G.L. Mhehe. 2002. Organochlorine Pesticide Residues in Edible Biota from the Coastal Area of Dar es Salaam City, Western Indian Ocean. *J. Mar. Sci* 1(1): 91–96.

Nagami, H., Y. Nishigaki, S. Matsushima, and T. Matsushita. 2005. Hospital-Based Survey of Pesticide Poisoning in Japan. *International Journal of Occupational and Environmental Health* 11(2): 2-7.

Nordin, R.B., S. Araki, H. Sato, K. Yokohama, W.A.M.B. Wan Muda, and D. Win Kyi. 2002. Effects of Safety Behaviors with Pesticide Use on Occurrence of Acute Symptoms in Male and Female Tobacco-Growing Malaysian Farmers. *Industrial Health* 40: 182-190.

Pignatello, J.J. and B. Xing. 1996. Mechanisms of Slow Sorption of Organic Chemicals to Natural Particles. *Environmental Science and Technology* 30: 1-11.

Roberts, T.R. 1984. Non-Extractable Pesticide Residues in Soils and Plants. *Pure and Applied Chemistry* 56: 945-956.

Roberts, T.R. and M.E. Standen. 1981. Further Studies of the Degradation of the Pyrethroid Insecticide Cypermethrin in Soils. *Pesticide Science* 12: 285-296.

Schoen, S.R. and W.L. Winterlin. 1987. The Effects of Various Soil Factors and Amendments on the Degradation of Pesticide Mixtures. *Journal of Environmental Science Health* 22: 347-377.

Senesi, N. 1992. Binding Mechanisms of Pesticides to Soil Humic Substances. *Science of the Total Environment* 123/124: 63-76.

Simcox, N., R. Fenske, S. Wole, I. Lee, and D. Kalman. 1995. Pesticides in Household Dust and Soil: Exposure Pathways for Children of Agricultural Families. *Environ Health Perspect* 103: 1126-1134.

Spiewak, R. 2001. Pesticides as a Cause of Occupational Skin Diseases in Farmers. *Ann Agric Environ Med* 8(1): 1-5.

Sosan, M.B., A.E. Akingbohungbe, I.A.O. Ojo, and M.A. Durosinmi. 2008. Insecticide Residues in the Blood Serum and Domestic Water Source of Cacao Farmers in Southwestern Nigeria. *Chemosphere* 72: 781–784.

Sozmen, B., S. Peker, and U. Kaya. 2007. Markers of long-term exposure to organophosphorus pesticides in farmers who work in viniculture and tobacco production in Turkey. *Toxicology Mechanisms and Methods* 17(7).

Suss, A. and B. Grampp. 1973. The Uptake of Absorbed Monolinuron in the Soil by Mustard Plants. *Weed Research* 13: 254.

Swackhamer, D. and R.A. Hites. 1988. Occurrence and Bioaccumulation of Organochlorine Compounds in Fish from Siskiwit Lake, Isle Royale, Lake Superior. *Environ. Sci. Technol* 22: 543–548.

Tongzhang, Z., H.Z. Shelia, P.C. Kenneth, D.W. Dennis, Z. Yawei, and B. Aaron. 2001. Agricultural Exposure to Carbamate Pesticides and Risk of Non-Hodgkin Lymphoma. *Journal of Occupational & Environmental Medicine* 43(7): 641-649.

USA Gardener. 2010. *How to Grow Eggplant.* http://usagardener.com/how_to_grow_vegetables/how_to_grow_eggplant.php.

US Department of Agriculture Pesticide Program. 2008. Pesticides Data Program. http://www.ams.usda.gov. Accessed on July 10, 2010.
Varca, L.M. 2002. Pesticide Toxicology and Chemistry Laboratory. .National Crop Protection Center, University of the Philippines at Los Baños (NCPC-UPLB). www.agnet.org/library/eb/520/.
Vassilopoulou, V. and E. Georgakopoulous-Gregoriades. 1993. Factors Influencing the Uptake of Organochlorines in Red Mullet (*Mullus barbatus*) from a Gulf of Central Greece. *Mar. Poll. Bull.* 26: 285–287.
Vermeire, T., R. McPhail, and M. Waters. 2003. Integrated Human and Ecological Risk Assessment: A Case Study of Organophosphorous Pesticides in the Environment. *Human and Ecological Risk Assessment* 9(1): 343-358.
Weston, D.P., J. You, and M.J. Lydy. 2004. Distribution and Toxicity of Sediment-Associated Pesticides in Agriculture-Dominated Water Bodies of California's Central Valley. *Environ Sci Technol.* 38(10): 2752-2759.
Winterlin, W.L., J.N. Seiber, A. Craigmail, T. Baier, J. Woodrow, and G. Walker. 1989. Degradation of Pesticide Waste Taken from a Highly Contaminated Evaporation Pit in California. Archives of Environmental Contamination and Toxicology 18: 734-747.
Wolfe, H.R., D.C. Staiff, J.F. Armstrong, and S.W. Comer. 1973. Persistence of Parathion in Soil. *Bulletin of Environmental Contamination and Toxicology* 10: 1-9.
Yalemtsehay, M. and A. Tadesse. 2002. Effects of Pesticide Applications on Respiratory Health of Ethiopian Farm Workers. *International Journal of Occupational and Environmental Health* 8: 35-41.
Yassin, M.M., T.A. Abu Mourad, and J.M. Safi JM. 2002. Knowledge, Attitude, Practice, and Toxicity Symptoms Associated with Pesticide Use Among Farm Workers in the Gaza Strip. *Occupational and Environmental Medicine* 59: 387-93.

Appendix Table 1. Selected pesticides used by eggplant farmer-respondents, Sta. Maria, Pangasinan

Pesticide Use and Toxicity Category	Pesticide Type (Family)	Brand Name[a]	Active Ingredient	Concentration	Formulation Type
Fungicide					
IV	Inorganic fungicide	Vitigran Blue 58WP	Copper oxychloride	580 g/kg	WP
Insecticide					
I	Organophosphate	Tamaron 600SL	Methamidophos	600 g/L	SL
II	Carbamate	Lannate 40SP	Methomyl	400 g/kg	SP
II	Neonicotinoid + Pyrethroid + Petroleum derivative	Solomon 300 OD	Imidacloprid + betacyfluthrin + cyclohexane	210+90 g/L	OD
II	Organophosphate	Brodan 31.5EC	Chlorpyrifos+BPMC	210+105 g/L	EC
II	Organophosphate	Selecron 500EC	Profenofos	500 g/L	EC
II	Organophosphate	Siga 300EC	Chlorpyrifos	300 g/L	EC
II	Organophosphate	Superinsecticide 50EC	Profenofos	500 g/L	EC
II	Organophosphate	Ultimate 50EC	Profenofos	500 g/L	EC
II	Thiourea	Pegasus 250 SC	Diafenthiuron	250 g/L	SC
III	Carbamate	Extreme 50SP	Cartap hydrochloride	500 g/kg	SP
III	Carbamate	Super Cartap 50SP	Cartap hydrochloride	500 g/kg	SP
III	Carbamate	Triband	Cartap hydrochloride	500 g/kg	SP
III	Neonicotinoid	Mospilan 3EC	Acetamiprid	30 g/L	EC
III	Organonitrogen	Ascend 50SC	Fipronil	50 g/L	SC
III	Organophosphate	Kotetsu 10EC	Chlorphenaphyr	100 g/L	SC
IV	Anthranilic diamide	Fenos SC480	Flubendiamide	480 g/L	SC
IV	Anthranilic diamide	Prevathon SC	Chlorantraniliprole	50 g/L	SC

Appendix Table 1. Selected pesticides used by eggplant farmer-respondents, Sta. Maria, Pangasinan

Pesticide Use and Toxicity Category	Pesticide Type (Family)	Brand Name[a]	Active Ingredient	Concentration	Formulation Type
IV	Anthranilic diamide + Neonicotinoid	Voliam Flexi 300SC	Chlorantraniliprole + Thiametoxam	100+200 g/L	SC
IV	Carbamate	Padan 4G	Cartap hydrochloride	40 g/kg	G
IV	Neonicotinoid	Starkle 20SG	Dinotefuran	200 g/kg	SG
IV	Organophosphate	Malathion 57EC	Malathion	570 g/L	EC
IV	Pyrethroid	Decis R	Deltamethrin	10 g/L	EC
IV	Pyrethroid	Magnum 5EC	Cypermethrin	50 g/L	EC

[a] All the brand names are trademarked.
Toxicity category: I = Highly toxic and severely irritating; II = Moderately toxic and moderately irritating; III = Slightly toxic and slightly irritating; and IV = Practically non-toxic and not an irritant.
Formulation type: EC = Emulsifiable concentrate; G = Granules; SC = Suspension concentrate; SG = Soluble granules; SL = Soluble (liquid) concentrate; SP = Soluble powder; WP = Wettable powder
g/Kg = grams per kilogram; g/L = grams per liter
Source: Philippine Fertilizer and Pesticide Authority (FPA). 2010. List of Registered Agricultural Pesticides as of 01 January 2010. Department of Agriculture, Quezon City. (accessed on 12 June 2013)

Appendix Table 1a. Pesticide toxicity categories for acute hazards of pesticide products

	I – Highly Toxic and Severely Irritating	II – Moderately Toxic and Moderately Irritating	III – Slightly Toxic and Slightly Irritating	IV – Practically Non-toxic and Not An Irritant
Oral LD_{50}	Up to and including 50 mg/kg	From 50 to 500 mg/kg	From 500 to 5000 mg/kg	Greater than 5000 mg/kg
Inhalation LC50	Up to and including 0.2 mg/L	From 0.2 to 2 mg/L	From 2. to 20 mg/L	Greater than 20 mg/L
Dermal LD50	Up to and including 200 mg/kg	From 200 to 2000 mg/kg	From 2000 to 20,000 mg/L	Greater than 20,000 mg/kg
Eye Effects	Corrosive; corneal opacity not reversible within 7 days	Corneal opacity reversible within 7 days; irritation persisting for 7 days	No corneal opacity; irritation reversible within 7 days	No irritation.
Skin Effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation at 72 hours

Note: Most human hazard, precautionary statements, and human personal protective equipment statements are based upon the toxicity category of the pesticide product as sold or distributed. In addition, toxicity categories may be used for regulatory purposes other than labeling, such as classification for restricted use and requirements for child-resistant packaging. In certain cases, statements upon the toxicity category of the product as diluted for use are also permitted.
Source: http://en.wikipedia.org/wiki/Toxicity_category_rating (accessed 12 June 2013)

Appendix Table 2. Physico-chemical properties of the active ingredients of insecticides

Active Ingredient	**Water Solubility (mg/li at 20°C)**	**Vapor Pressure (mPa at 25°C)**	**Henry's Law of Constant at 20°C (dimension-less)**	**Koc - Organic-Carbon Sorption Constant (ml/g)**	**GUS Leaching Potential Index***	**Soil (typical aerobic) Half–Life (days)**	**Bio-accumu-lation Potential**	**Characteristics**
Chlorpy-rifos	1.05	1.43	2.80 X 10-04	8,151	0.15	50	High	Low water solubility Volatile(based on Henry's Law of Constant) Moderately persistent in soil Low leachability Non-mobile
Profenofos	28.0	2.53	1.39 X 10-05	2,016	0.59	7	Low	Low water solubility Moderately volatile(based on Henry's Law of Constant) Non-persistent in soil Low leachability Slightly mobile
Triazophos	35.0	1.33	1.30 X 10-06	358	2.38	44	Moderate	Low water solubility Moderately volatile(based on Henry's Law of Constant) Moderately persistent in soil Transition state Moderately mobile
Cyperme-thrin	0.004	0.00034	1.75 X 10-05	57,889	-1.18	35	High	Low water solubility Moderately volatile(based on Henry's Law of Constant) Moderately persistent in soil Low leachability Non-mobile

Appendix Table 2. Physico-chemical properties of the active ingredients of insecticides

Active Ingredient	**Water Solubility (mg/li at 20°C)**	**Vapor Pressure (mPa at 25°C)**	**Henry's Law of Constant at 20°C (dimension-less)**	**Koc - Organic-Carbon Sorption Constant (ml/g)**	**GUS Leaching Potential Index***	**Soil (typical aerobic) Half–Life (days)**	**Bio-accumu-lation Potential**	**Characteristics**
Malathion	148.0	3.1	4.80 X 10-05	217	-1.28	0.17	Low	Moderate water solubility Volatile(based on Henry's Law of Constant) Non-persistent in soil Low leach ability Moderately mobile

Source of data: International Union of Pure and Applied Chemistry (IUPAC). 2011. Global Availability of Information on Agrochemicals. http://sitem.herts.ac.uk/aeru/iupac/index.htm. Accessed on March 22, 2011.

Appendix Table 3. Environmental fate of insecticides in soil, water, air and plants and inherent characteristics of these insecticides

Insecticide Used by Farmers for Eggplants	Pesticide Type (Family)	Brand Name[a]	Active Ingredient
Prevathon	Chlorantranilip-role	Soil: Persistent and mobile in terrestrial environments. It leaches through the soil profile beyond 60 cm and may therefore enter groundwater. *Sorption:* The sorption in soil can be classified as medium high but correlated with the percent clay and clay type for the soils tests. Water: Has low solubility in water. It is considered to be moderately persistent in aerobic water-sediment systems, and slightly persistent in anaerobic water-sediment systems. Degradation in water system is classified as moderate fast. Air: It has low vapour pressure and Henry's law constant indicating that it is non-volatile in the environment. Therefore, chlorantraniliprole residues in the atmosphere and long-range transport are not persistent.	Chlorantraniliprole should be measured in soil and water because it is highly mobile. Groundwater should be tested for this type of pesticides. The sorption in soil is medium high, although the study area has more sandy soil than clay type. Because of persistence in this substrate, water sediment sampling should be done.
Malathion	Malathion	Air: Volatile residue. Small droplet residues produced by aerial applications have been shown to drift for long distances, causing adverse effects in surrounding waterways (Lenoir, 1999). Water: Degrades quickly in water. Does not accumulate in sediment. Soil: Moderately to highly mobile in soil so there is potential for movement to groundwater especially in soils with low organic matter and high sand content. Since malathion is normally applied to foliage, potentially a factor that mitigates movement to ground water. Plants: Malathion studies support that malathion is taken up and stored in plant tissues (EPA 2000).	Malathion should be monitored in the air. Malathion should be monitored in groundwater. Although malathion is taken up and stored in plant tissues, it was not found in the eggplant fruits.
Tamaron	Metamidophos	Plants: Can be rapidly translocated into the leaves with the transpiration flow but uptake via the roots cannot be expected because of rapid degradation in the soil. Soil: Rapidly degraded in soil. Water: The chemical will break down in the presence of sunlight.	Metamidophos was not found in the eggplant fruit samples; more likely to remain in leaves. Metamidophosshould be monitored in soil samples. Metamidophos is not likely to be found in water samples because it degrades rapidly.

Appendix Table 3. Environmental fate of insecticides in soil, water, air and plants and inherent characteristics of these insecticides

Insecticide Used by Farmers for Eggplants	Pesticide Type (Family)	Brand Name[a]	Active Ingredient
Lannate	Methiocarb	Soil: Rapid degradation, and slightly mobile. Air: Methiocarb is volatile.	Since methiocarb degrades rapidly in soil, it will most likely not to be found. It should be monitored in soil. Methiocarb should be monitored in air samples as it is volatile.
Hostathion	Triazophos	Water: Has low solubility in water. It is rapidly degraded in aquatic systems. Soil: Triazophos is imoderately mobile in soil. Air: Triazophos is volatile.	Triazophos should be monitored in soil. Due to its high volatility, triazophos should be measured in air.
Brodan	Chlorpyrifos	Soil: Less soluble and is not very mobile. Moderately persistent. The half-life of chlorpyrifos in soil is usually between 60 and 120 days, but can range from 2 weeks to over 1 year, depending on the soil type, climate, and other conditions. Adsorbs strongly to soil particles and not readily soluble in water. It is therefore immobile in soils and unlikely to leach or to contaminate groundwater. Water: Has a low water solubility. Unstable in water, and the rate at which it is hydrolyzed increases with temperature, decreasing by 2.5- to 3-fold with each 10 C drop in temperature. Air: Has an intermediate vapor. Its volatility is a significant mechanism of dissipation. Plants: May be toxic to some plants, such as lettuce. Residues remain on plant surfaces for approximately 10-14 days. Data indicate that this insecticide and its soil metabolites can accumulate in certain crops.	Due to its strong adsorption in soil and being non mobile in soil, chlorpyrifos should be monitored in the soil sample. Chlorpyrifos is less likely to be found in water samples due its low water solubility. Chlorpyrifos should be monitored in air because of its volatility. Chlorpyrifos was found in eggplants due to its adsorption to plants.
Magnum	Cypermethrin	Soil: Strong tendency to adsorb to soil particles. Photodegrades rapidly in soil with a half-life of 8-16 days. Undergoes microbial degradation under aerobic conditions. Degrades more rapidly on sandy clay and sandy loam soils than on clay soils and more rapidly in soils low in organic materials. Water: Has low water solubility. Plants: Remains in plants such as strawberry, wheat, celery, and others.	Monitoring should be done for soil contamination. Cypermethrin was found in the eggplant samples because of its absorption in eggplants.

Chapter 4

The Eggplant Subsector in Davao Region, North Cotabato, Iloilo, and Southern Leyte

Cesar B. Quicoy

Introduction

The Philippine vegetable industry is generally characterized by smallhold subsistence farming that often provides farmers minimal marketable surplus and low income. Despite the industry's important role in the Philippine economy, vegetable-growing communities remain in general poverty, in need of better attention and stronger support from the government. A number of research and development (R&D) programs had introduced production-enhancing technologies yet so far failed to have significant impact on farmers' harvests and income. In areas where the intended benefits were observed, no baseline information and feedback mechanism were in place to allow results-based monitoring and evaluation.

The same can be said of the Philippine eggplant industry. The existing conditions of area-specific eggplant industry need to be established in order to design and provide appropriate localized R&D and information dissemination programs. The impending commercialization of *Bt* eggplant highlights the need for key baseline information for use in evaluating the technology's impacts on farmers' livelihoods and on the vegetable industry as a whole.

This baseline and benchmark study characterized the eggplant subsector in selected production provinces of the country. More specifically, in Davao, Iloilo, and Southern Leyte where the conduct of *Bt* eggplant field trials is approved by the Bureau of Plant Industry (BPI) and North Cotabato, where *Bt* eggplant field trials had been conducted, the study (i) collected information on eggplant farmers' socio-demographic characteristics, and available eggplant production technologies and farmers' existing production and marketing practices; (ii) determined the factors of, and assessed, the local industry's productivity, efficiency, and profitability; (iii) estimated the potential financial and economic impact of *Bt* eggplant; and (iv) identified problems and constraints confronting the local eggplant subsector. As *Bt* eggplant is in its final stage of commercialization, the information generated will be useful for assessing the technology's potential impact on the environment, health, and farmers' socioeconomic conditions.

In addition, the new information will be key inputs to current and planned national and/or regional R&D programs on eggplant production and marketing, and may help government planners and policy makers prepare appropriate policies (or policy reforms) for the industry's further development.

Methodology

Study Area

The study was conducted in Davao City; and in the municipalities of Leon, Pavia, and Almodian in Iloilo; Baybay and Ormoc in Southern Leyte; and Kabacan, Kidapawan, Makilala, and Magpet in North Cotabato. These sites were selected based on the hectarage planted to eggplant.

Sampling Design and Data Collection

The study used a simple random sampling technique with replacement in selecting the eggplant farmer-respondents. Proportionate sampling was used in determining the number of municipalities from each study area and the sample respondents from each municipality. A total of 469 eggplant farmers were interviewed: 125 each from Iloilo, North Cotabato, and Southern Leyte, and 94 from Davao City.

Primary data were generated through farm surveys conducted during August to December 2011. Primary data collected included farmers' socioeco-demographic characteristics; area planted and production; type and quantity of production inputs used; and production and marketing practices, including problems and constraints. The study also collected information on the farmers' knowledge, attitude and perception (KAP) regarding biotechnology, eggplant fruit and shoot borer, and genetically modified commodities.

In each province, five farmer-cooperators were asked to maintain a daily record of all their respective eggplant production-related activities. The study provided the farmer-cooperators a template for their farm record keeping.

In addition, time series data on domestic production, area planted, yield, and prices of eggplant were gathered from secondary sources.

Analytical Tools Used

Descriptive Analysis. Simple descriptive statistics such as mean, frequencies, and percentages were computed to describe the (i) socioeco-demographic characteristics (e.g., age, educational attainment, and income) of the sample eggplant farmers and their household members; (ii) farmers' current production and marketing practices (e.g., pesticides applied, spraying frequency, timing of application, use of protective gear in spraying, credit availment, and market outlet); and (iii) farmer perception of genetically modified crops, and awareness of *Bt* eggplant field trials in the study areas.

Production Function Analysis. Stochastic frontier production functions were estimated to determine the factors affecting the, and sources of, inefficiency of eggplant production in the selected study areas. Mathematically, these stochastic functional forms are expressed as:

$$Y = f(X_1, X_2, X_3, X_4)\exp(V_i - U_i)$$

where

Y = yield of eggplant (kilograms per hectare; kg/ha)
X_1 = quantity of seeds used (grams per hectare; gms/ha)
X_2 = labor (person-days per hectare; p-day/ha)
X_3 = cost of pesticides applied (Philippine pesos per hectare; PhP/ha)
X_4 = quantity of fertilizers applied (kg/ha)
U_i = technical efficiency variable
V_i = random errors of the output

The technical inefficiency effect U_i is defined by:

$$U_i = Z_1 + Z_2 + Z_3 + Z_4 + Z_5 + Z_6 + Z_7 + Z_8 + Z_9 + Z_{10} + Z_{11} + Z_{12} + Z_{13}$$

where
Z_1 = eggplant production area (ha)
Z_2 = farmer's age (years)
Z_3 = farmer's educational attainment (years)
Z_4 = farmer's gender (1 = male; 0 = female)
Z_5 = farm experience (years)
Z_6 = farmer's tenure status (1 = landowners; 0 = otherwise)
Z_7 = distance of farm from input supplier (kilometers)
Z_8 = farmer's awareness of eggplant fruit and shoot borer (EFSB)
Z_9 = method used to control pest and diseases (1 = chemical; 0 = otherwise)
Z_{10} = percentage damage due to EFSB
Z_{11} = province dummy 1 (1 = Southern Leyte; 0 = other provinces)
Z_{12} = province dummy 2 (1 = Northern Cotabato; 0 = other provinces)
Z_{13} = province dummy 3 (1 = Davao City; 0 = other provinces)

The proposed stochastic frontier production function was assumed to be truncated normal random variable, in which the inefficiency effects are directly influenced by a number of variables (Misuya, Hisano and Nariu, 2008).

The t-test was used to determine which explanatory variable had a significant effect on the dependent variable (yield). The F-value was used to determine the overall significance of the estimated regression model while the coefficient of determination (R^2) was used to examine the goodness of fit of the data.

Cost and Returns Analysis. Cost and returns analysis on a per farm and per hectare basis was conducted to estimate and compare the mean costs, gross income, net cash income and net farm income among eggplant farmers in the four study areas. The study also used the partial budget technique to determine the potential impact of *Bt* eggplant on farmers' income.

Farmers' Demographic Profile and Socioeconomic Conditions

Most of the farmer-respondents were males (76%), middle-aged at 46 years, and married (86%). About 22% of all respondents finished elementary education, while only 5% were college graduates; two respondents were not able to go to school. The farmer-respondents had, on average, five members in the household (Table 1).

Table 1. Demographic profile of eggplant farmers and households in selected provinces, Philippines, 2011

Characteristic	Davao City	Iloilo	Southern Leyte	North Cotabato	All Areas
No. of respondents	94	125	125	125	469
Demographic Profile					
Farmers' mean age (years)	42.6	42.9	48.4	49.2	46.0
No. of male respondents	54	119	78	105	356
Civil status (no.)					
Single	9	26	9	4	48
Married	79	96	111	116	402
Living-in	2	2	2	2	7
Widow(er)	4	1	3	5	13
Farmers' educational attainment (no.)					
None	0	1	0	1	2
Pre-elementary	5	–	–	–	5
Elementary undergraduate	9	13	20	23	65
Elementary graduate	5	19	31	39	94
High school undergraduate	20	17	25	29	91
High school graduate	2	32	27	21	82
Vocational undergraduate	1	2	0	0	3
Vocational graduate	20	8	2	3	33
College undergraduate	9	12	4	6	31
College graduate	3	11	6	2	22
Average household size (no.)	5.4	5.1	4.6	5.3	5.1
Family Living Conditions					
Home lot ownership (no.)					
Owned	46	79	101	48	274
Rented	33	5	15	41	94
Rent free	12	33	8	34	87
Type of house construction (no.)					
Permanent	46	84	101	48	279
Semi-permanent	33	23	15	41	112
Temporary	12	17	8	34	71
Shanty	3	1	1	2	7
House roofing material (no.)					
Tiles	7	5	3	4	19
Galvanized iron (GI) sheet	79	120	103	90	392

Table 1. Demographic profile of eggplant farmers and households in selected provinces, Philippines, 2011

Characteristic	Davao City	Iloilo	Southern Leyte	North Cotabato	All Areas
Nipa	7	0	18	23	48
Cogon/grass	1	0	0	4	5
House wall material (no.)					
Concrete	16	59	66	22	163
Wood	62	21	23	64	170
Bamboo	14	41	24	31	110
Combination	2	4	12	8	26
Source of home lighting (no.)					
Electricity	43	115	119	97	374
Kerosene	39	9	4	12	64
Coleman	3	0	0	0	3
Oil	0	0	0	12	12
Others	9	1	2	4	10
Water system (no.)					
Rain water	2	6	0	3	11
Spring/river	67	64	15	15	161
Open well	4	7	27	13	51
Artesian well	1	8	0	6	15
Pump well	0	27	12	30	69
Piped water	20	7	69	54	150
Type of cooking fuel (no.)					
Wood	87	98	110	109	404
Charcoal	6	14	2	5	27
Liquefied petroleum gas (LPG)	0	7	10	7	24
Kerosene	0	0	2	0	2
Electricity	0	1	0	0	1
Type of toilet facility (no.)					
Open pit	23	10	0	34	67
Antipolo	18	3	4	50	75
Water sealed	29	75	93	36	233
Flush	22	33	21	3	79
None	2	4	7	2	15

Across all study areas, 98% of the respondents had farming as primary occupation, 43% were landowners, and about 24% were share tenants. Most farmer-respondents from Davao City were owner-operators (66%) while those from Iloilo were share-tenants (51%). Similarly, majority (58.4 %) of the respondents owned their home lots, while 20% are renting. About 18% lived on home lots for which the landowners granted permission, and for free (no land rent is paid).

Majority of the respondents live in permanent houses (almost 60%) with roofing made of galvanized iron (GI) sheets (about 84%), electricity (nearly 80%) as source of lighting, and spring/river (34%) and piped water (32%) as main sources of water. Almost half (49.7%) of all respondents had water-sealed toilet facilities, while a few (3.2%) did not have any. Fuelwood was the most common (86%) type of cooking fuel used by the respondents.

On average, the farmer-respondents worked on 0.76 hectare (ha) of land, of which about 41% (0.31 ha) was planted to eggplant. The mean farm size ranged from 0.32 ha in Southern Leyte to 1.01 ha in Davao City. Those in North Cotabato and Iloilo was 0.82 ha and 0.95 ha, respectively. In 2011, total eggplant production per farm ranged from 2.4 tons in Davao City to 11.9 tons in Iloilo, with an overall average of 7.3 tons per year. Meanwhile, average eggplant yield ranged from 11.4 tons/ha in Davao City to 39.4 tons/ha in Southern Leyte (Table 2).

The most common eggplant varieties planted were Banate King, Casino, and Domino Bilog (in this order). About 9% of all respondents still plant the native variety. Apart from eggplant, the farmer-respondents also commonly grew rice, other vegetables, and corn. Majority (92%) of the Iloilo respondents considered eggplant as a crop secondary to rice, and grow eggplant in the dry season after the wet-season rice crop.

On average across the study areas, farms were relatively near (less than 7 kilometers (kms) away) the barangay road, farm-to-market road, and primary and secondary schools. They were however quite far—at least 12 kms on average—from other public facilities such as the agricultural extension office, public market, bank, hospital, and tertiary school.

Most farmer-respondents used traders (often to wholesaler-retailers) to market their eggplant produce, while about 16% sold their produce directly to (walk-in) consumers. Most respondents from Southern Leyte sold their products directly to consumers. Similar to other crops, the eggplants were

Table 2. Socioeconomic characteristics, agricultural profile and marketing practices of eggplant farmers in selected provinces, Philippines, 2011

Characteristic	Davao City	Iloilo	Southern Leyte	North Cotabato	All Areas
No. of respondents	94	125	125	125	469
Socioeconomic characteristics					
Primary occupation (no.)					
Farmer	92	121	123	117	455
Hired farm worker	–	3	–	–	3
Non-farm worker	2	-	1	5	6
Practice of profession	0	1	1	1	3
Business operator	–	–	–	3	3
Farm tenure status (no.)					
Landowner	62	18	57	65	202
Amortizing	–	2	7	–	9
Claimant	–	1	1	7	9
Leaseholder	4	14	2	1	21
Share tenant	12	64	26	12	114
Renting free	10	2	24	39	75
Others	6	24	8	1	39
Agricultural production profile					
Number of parcels					
One	93	116	83	96	388
Two	1	7	30	19	57
Three	0	2	7	8	17
More than three	0	0	4	2	6
Average farm size (ha)	1.0	1.0	0.3	0.8	0.8
Average area planted to egg-plant (ha)	0.5	0.5	0.2	0.2	0.3
% Area planted to eggplant	50.5	54.7	50.0	23.2	40.8
Average eggplant production					
In tons per farm	2.44	11.92	4.10	9.55	7.33
In tons per hectare	11.38	24.12	39.40	31.10	27.48
Other crops planted (no. of respondents)					
Other vegetables	4	8	22	12	46
Rice	6	115	15	16	152
Coconut	0	0	26	0	26
Corn	0	0	2	0	2

Table 2. Socioeconomic characteristics, agricultural profile and marketing practices of eggplant farmers in selected provinces, Philippines, 2011

Characteristic	Davao City	Iloilo	Southern Leyte	North Cotabato	All Areas
Other crops	4	0	2	7	13
Mean distance of farm from public facilities (kilometers)					
Barangay road	7.1	2.9	0.3	0.9	2.5
Farm-to-market road	11.3	4.3	2.5	2.4	4.7
Agricultural extension office	17.3	11.7	13.3	6.7	11.9
Public market	17.9	10.8	11.7	7.6	11.6
Nearest bank	18.3	10.7	13.5	10.0	12.8
Nearest hospital	17.5	16.9	13.2	10.6	14.4
Nearest elementary school	5.8	8.1	3.6	3.3	5.2
Nearest secondary school	6.3	9.3	4.2	5.8	6.4
Nearest tertiary school	14.8	13.2	13.2	14.5	13.9
Marketing profile					
Market outlets used (no. of respondents)					
Commission agents		6		2	8
Viajero	17	2	2	13	31
Wholesaler	9	48	18	29	104
Wholesaler-retailer	23	37	30	37	127
Retailer	2	5	4	18	29
Consumers	15	6	34	22	77
Combination	25	10	33	1	69
Mode of sale (no. of respondents)					
Buyers pick up	33	47	23	34	137
Farmer-sellers deliver	57	43	100	73	273
Both	1	33	–	–	34
Mode of transport used (no. of respondents)					
Man power	12	20	25	12	69
Animal power	4	6	2	2	14
Motorcycle	2	2	36	40	80
Jeep	5	33	24	13	75
Bus	0	10	3		13
Truck	27	0	2		29
Combination	11	6	5	0	22
Not applicable	33	47	24	34	138

Table 2. Socioeconomic characteristics, agricultural profile and marketing practices of eggplant farmers in selected provinces, Philippines, 2011

Characteristic	Davao City	Iloilo	Southern Leyte	North Cotabato	All Areas
Reason for choice of market outlet (no. of respondents)					
Regular buyer ('suki')	49	49	96	87	281
Credit tie up	1	15	4	–	20
Accessibility	26	28	14	2	70
Higher price	12	20	4	24	60
Obliged by landowner	–	4	–	2	6
Combination	1	7	5	8	21

either brought to the buyers (delivered) or picked up from the farms, using various modes of hauling transportation (e.g., truck, jeepney, tricycle, motorcycle, animal power, human labor). In general, the choice of market outlet was determined by a regular trading ('suki') relationship, better accessibility/convenience, and higher product price received by farmers. Unlike for other crops, however, credit marketing tie-up is not a predominant practice among eggplant farmers. This implies that eggplant traders/buyers are not credit lenders (be it in cash or in kind).

Farmer Awareness of Production Factors and Technology

Credit. Across the four provinces, majority (72%) of the farmer-respondents was aware of credit sources but only few (20%) availed. Of those who are aware of credit sources, North Cotabato and Iloilo respectively had the lowest and highest proportion of farmers who actually availed. Of those who availed credit, many took from cooperatives, private lenders, and/or friends, mainly for buying inputs for eggplant production, investment in other businesses, or farm improvement. Of those who did not avail of credit, the main reason cited was the high interest rate (almost 51% per year) being charged by creditors. It is surprising that about 40% of Iloilo eggplant farmers claimed as not being aware of any credit sources in their locality (Table 3).

Eggplant Fruit and Shoot Borer. As expected, majority (about 74%) of the farmers were aware of eggplant fruit and shoot borer (EFSB) (Table 4). They estimated that EFSB infestation can begin anytime from 30 days to 50 days after transplanting, resulting in at least 63% damage. On average, infestation

Table 3. Eggplant farmers' credit awareness and availment in selected provinces, Philippines, 2011

Item	Davao City	Iloilo	Leyte	North Cotabato	All
	n=94	n=125	n=125	n=125	n=469
Credit awareness					
Yes	58	62	110	107	337
No	26	49	13	16	104
No response	10	14	1	1	26
Credit availment					
Yes	13	28	30	21	92
No	69	74	92	102	337
No response	12	23	3	2	40
Sources of credit					
Banks	0	2	2	7	11
Coops	2	11	11	12	36
Private lenders	4	9	12	1	26
Friends	2	13	1	1	17
Traders	1	0	0	0	1
NGO	0	0	4	0	4
Others	2	2	3	0	7
Credit purpose					
Inputs	10	28	14	6	58
Farm improvement	1	1	5	4	11
Household consumption	0	1	2	1	4
Education	0	1	3	1	5
Other business	0	1	9	7	17
House repair	0	0	1	1	2
Reasons for non-availment of credit					
Not needed	0	4	11	11	26
High interest rate	6	14	48	48	116
Not willing	1	5	15	9	30
Can cause problem	14	2	6	10	0

Table 4. Eggplant farmers' awareness of eggplant fruit and shoot borer (EFSB) in selected provinces, Philippines, 2011

Item	Davao City		Iloilo		Southern Leyte		North Cotabato		All	
	No.	%	No.	%	No.	%	No.	%	No.	%
Awareness of EFSB										
Aware	53	56	100	80	75	60	117	94	345	74
Not aware	21	22	18	14	46	37	8	6	93	20
EFSB control method										
Chemical	69	92	98	88	88	86	81	66	336	82
Removal and burying of infested shoots	4	5	14	13	12	12	21	17	51	12
Both	0	0	0	0	1	1	7	6	8	2
Source of information										
Government	35	48	22	21	53	67	50	43	160	43
Private chemical companies	7	10	58	54	18	23	53	45	136	36
Other farmers, friends, mass media	31	43	27	25	8	10	12	10	78	21

begins at about 43 days after transplanting and can cause 84% damage. Across sites, most (82%) farmers applied insecticides to control EFSB while about 13% manually removed and buried the infested shoots. Very few farmers used both methods to control EFSB.

Government and private chemical companies were the most common sources of agricultural information, including those on EFSB and EFSB control. Other farmers and friends were also a popular source of information, implying that "word-of-mouth" is a good vehicle for information dissemination in rural areas.

Pesticide Safety Practices. Majority (83%) of the eggplant farmers interviewed read pesticide labels, paying particular attention on recommended dosage and manner of application, type of chemical, and expiry date (Table 5). Aware of the chemicals' risks to health and environment, majority also employed precautionary measures in transporting pesticides (84%) and stored them outside their respective houses (88%). In transporting pesticides, farmers sealed them in a box and plastic, and carried them separate from other items, especially food. Meanwhile, some farmers who stored the pesticides inside the house did so inside a locked cabinet.

Biotechnology and Genetically Modified Organisms (GMOs). Across the four study sites, most of the farmers interviewed was not aware of biotechnology (72%) nor of genetically modified crops planted in the country (84%) (Table 6). With the second highest proportion of eggplant farmers who are aware of GMOs grown in the Philippines, North Cotabato appears to be more aware of the development of genetically modified commodities in the country than their counterparts in the other study areas.

Among eggplant farmers aware of biotechnology, majority perceived it as beneficial to the development of Philippine agriculture and are interested in learning more about it, particularly with respect to potentials for increasing their farm productivity and income. Meanwhile, hybrid rice, *Bt* corn, *Bt* eggplant, and golden rice were commonly perceived as all being genetically modified crops. Across the provinces, most respondents expressed willingness to plant genetically modified crops, with those from Davao City and North Cotabato also indicating willingness to consume them.

Bt Eggplant Development. Majority (84%) of the interviewed farmers was not aware of the development of *Bt* eggplant, nor of the current and/or planned multi-location trials in their respective provinces (Table 7). Most of

Table 5. Eggplant farmers' pesticide safety practices in selected provinces, Philippines, 2011

Item	Davao City		Iloilo		Southern Leyte		North Cotabato		All	
	No.	%	No.	%	No.	%	No.	%	No.	%
No. of respondents	94		125		125		125		469	
Reads labels of chemicals used										
Yes	82	87	117	94	98	78	94	75	391	83
No	4	4	5	4	0	0	12	10	21	4
Not applicable (Did not apply pesticides)	8	9	3	2	27	22	19	15	57	12
Information looked for in the label										
Dosage	51	17	106	36	71	24	65	22	293	71
Instruction	37	16	90	38	62	26	47	20	236	57
Category	4	4	67	67	4	4	25	25	100	24
Ingredient	3	3	69	67	4	4	27	26	103	25
Expiry date	5	4	73	53	12	9	47	34	137	33
Exercised caution in transporting chemicals										
Yes	78	91	116	95	71	72	81	76	346	84
No	5	6	4	3	24	24	24	23	57	14
Location of pesticide storage										
Outside the house	64	75	111	93	91	93	91	86	357	88
Inside the house	21	25	7	6	7	7	15	14	50	12
Storing pesticides inside the cabinet (inside the house)										
Yes	19	90	7	100	4	57	10	67	40	80
No	2	10	0	0	3	43	5	33	10	20
Placing pesticide containers with other items										
Yes	6	7	42	36	8	9	7	7	63	16
No	78	93	74	63	84	91	99	93	335	84

Table 6. Eggplant farmers' awareness of biotechnology and GMOs in selected provinces, Philippines, 2011

Item	Davao City		Iloilo		Southern Leyte		North Cotabato		All	
	No.	%	No.	%	No.	%	No.	%	No.	%
No. of respondents	94		125		125		125		469	
Awareness of biotechnology										
Yes	26	28	30	24	42	34	26	21	124	26
No	65	69	95	76	83	66	97	78	340	72
Awareness of genetically modified crops planted in the country										
Aware	11	12	12	10	25	20	22	18	70	15
Not aware	83	88	113	90	100	80	99	79	395	84
Perception on the positive effects of biotechnology on Philippine agriculture										
Yes	20	77	22	73	40	95	23	89	105	85
No	3	12	5	17	1	2	2	8	11	9
Willingness to know about biotechnology										
Willing	19	73	26	87	39	93	24	92	108	87
Not willing	7	27	4	13	3	7	2	8	16	13
Perceived genetically modified products										
Hybrid rice	13	50	20	69	41	98	6	22	80	65
Golden rice	0	0	10	34	20	48	3	11	33	27
Bio-N	1	4	12	41	8	19	2	7	23	19
IR-8 (Rice)	1	4	4	14	14	33	3	11	22	18
Bt eggplant	15	58	9	31	7	17	2	7	33	27
IV-R sweet potato	1	4	0	0	20	48	1	4	22	18
Bt corn	14	54	8	28	11	26	9	33	42	34
Willingness to plant GMO products										
Willing	23	89	19	66	41	98	23	85	106	86
Not willing	3	12	9	31	1	2	1	4	14	11

Table 7. Eggplant farmers' awareness of *Bt* eggplant development in selected provinces, Philippines, 2011

Item	Davao City		Iloilo		Southern Leyte		North Cotabato		All	
	No.	%	No.	%	No.	%	No.	%	No.	%
No. of respondents	94		125		125		125		469	
Awareness of *Bt* eggplant development										
Aware	17	18	10	8	10	8	12	10	49	10
Not aware	76	81	113	90	113	90	90	72	392	84
Awareness of ongoing *Bt* eggplant research in their locality										
Aware	4	23	2	20	2	20	6	50	14	29
Not aware	13	77	4	40	8	80	6	50	31	63
Plans re farm area planted to eggplant										
Expanding area	72	77	90	72	63	50	80	64	305	65
Reducing area	2	2	2	2	7	6	5	4	16	3
Maintaining current area	18	19	28	22	48	38	36	29	130	28

these respondents were from Iloilo and Southern Leyte. While Davao City posted the highest proportion of farmers aware of *Bt* eggplant development, most North Cotabato farmers were aware that *Bt* eggplant field trials are being conducted in their locality, with the provincial government's official permission.

With their awareness of current research and development on *Bt* eggplants, albeit minimal, most (65%) of the farmer-respondents across the four provinces had a positive outlook of the general eggplant industry, and expressed plans to expand their farm areas and put available idle lands into eggplant production. Other eggplant farmers are planning to reduce, or at most just maintain, their current farm sizes, citing extent of EFSB infestation and unstable product prices as the main deterring factors. The highest proportion of farmers who plan to expand the production areas are in Davao City, while the lowest are in Southern Leyte.

Technical Efficiency of Eggplant Production

This aspect of the study examined the factors affecting the productivity of the sample eggplant farms, namely, seeds, fertilizers, pesticides, farm labor; and those influencing their technical efficiency, such as farm area, availability of credit, distance from nearest input supplier, pest control method applied, proportion of pest damage, location, and farmer's characteristics (age, education, gender, farming experience, tenure status, and knowledge of EFSB). Appendix Table 1 summarizes the results of these analyses.

In econometric terms, the farm labor, pesticides, and amount of seeds used are, in this order, the most important factors of productivity of eggplant farms in the four study areas. A 1% increase in labor use, cost of pesticides, and amount of seeds used would respectively lead to a 0.24%, 0.15%, and 0.09% increase in eggplant production (all other factors held constant). This indicates that eggplant production is labor-intensive (confirming findings of other studies), and that pests and diseases are important constraints in eggplant production. The amount of fertilizer used did not appear as a statistically significant factor because the farmer-respondents applied relatively the same amount per unit area (i.e., the amount of fertilizer used was less variable across the sample farms).

The analysis also suggest that farm area; farmer's age, educational attainment, gender, experience in eggplant production, and knowledge of eggplant fruit and shoot borer (EFSB); availability of credit; distance of the farm from the nearest input supplier; pest control method applied; proportion of pest damage; and dummy for provinces are critical determinants of technical inefficiency in eggplant production. The coefficients of these factors indicate the magnitude and direction of their influence on the latter variable.

Results suggest that farmers who are male, older, have lower educational attainment, less farming experience, less aware of EFSB, used manual pest control method, and/or have availed of credit, were less technically efficient than farmers who are or did otherwise. In addition, larger farms and those farther from input sources or suppliers were less technically efficient. Larger farms are more difficult to manage, while those far from input sources are more likely to apply less inputs resulting in less production.

The analysis indicates further that eggplant farms in the study areas were operating at decreasing return to scale. That is, increasing the application of all inputs will not increase the productivity of eggplant production because of major constraints posed by pests and diseases.

In terms of individual farm efficiency, the study found that 50% of the farms operate at less than 40% efficiency while about 83% are at most 60% efficient. The predicted farm-specific technical efficiencies of eggplant farmers averaged at a low 39%, ranging from 0.004% for the “least efficient” farmers to 82% for the “best practice” or the “most efficient” farmers. Nevertheless, the wide technical efficiency differentials among the farmers indicate that there is substantial potential for efficiency improvement if eggplant farmers will improve their current practices and/or by adopting new technology in eggplant production.

Profitability of Eggplant Production

This study conducted a simple cost and return analysis of eggplant production in the four selected provinces. Total production cost comprised of both cash and non-cash costs, while revenue generated (returns) comprised of the value of product sold, consumed at home, given away, and/or paid to landowners. The analysis was done on a per-farm and a per-hectare basis (Table 8).

Table 8. Average by-farm and by-hectare costs and returns of eggplant production in selected provinces, per season, Philippines, 2011

Item	Per Farm Analysis					Per Hectare Analysis				
	Davao City	Iloilo	Southern Leyte	North Cotabato	All Areas	Davao City	Iloilo	Southern Leyte	North Cotabato	All Areas
No. of respondents	94	125	125	125	469	94	125	125	125	469
Returns										
Total cash	59,760	94,771	64,008	124,117	87,597	338,243	363,758	813,270	682,973	561,691
Total non-cash	1,375	2,762	1,930	2,141	2,096	13,119	17,361	17,319	12,294	12,273
Household consumption	546	498	659	1,193	737	546	498	659	1,193	737
Given away	162	819	544	735	591	8,714	8,714	8,714	8,714	5,871
Landowner's share	668	1,383	722	90	716	3,858	7,799	7,908	1,050	5,199
Others	0	62	5	123	51	0	350	38	1,337	465
Total Returns	61,136	97,532	65,938	126,258	89,693	351,361	381,119	830,589	695,267	573,963
Costs										
Total cash	15,553	32,514	15,407	9,929	18,509	66,824	142,796	169,147	121,405	141,209
Hired labor	523	2,731	2,940	901	1,841	5,233	17,249	19,599	9,845	23,837
Seeds	175	1,089	253	63	408	735	4,835	3484	406	2,452
Fertilizer	1,877	10,215	7,471	1,673	5,495	6,417	41,226	69,849	17,857	35,255
Pesticides	12,067	14,209	682	1,792	6,900	30,974	56,011	14,205	16,896	29,475
Transport	911	4,270	4,061	5,500	3,865	23,464	23,474	62,011	76,401	50,190
Total non-cash	2,621	13,639	7,282	5,203	7,464	14,297	60,626	73,357	57,676	53,708
Depreciation	371	1,323	773	454	751	2,069	5,839	11,036	6,392	6,571
Unpaid family labor	51	202	415	1,752	646	730	1,448	8,058	16,606	7,120
Landowner's share	668	1,383	722	90	716	3,858	7,799	7,908	1,050	5,199

Table 8. Average by-farm and by-hectare costs and returns of eggplant production in selected provinces, per season, Philippines, 2011

Item	Per Farm Analysis					Per Hectare Analysis				
	Davao City	Iloilo	Southern Leyte	North Cotabato	All Areas	Davao City	Iloilo	Southern Leyte	North Cotabato	All Areas
Harvest lost	1,531	10,732	5,372	2,907	5,350	7,639	45,540	46,356	33,628	34,818
Total Costs	18,174	46,153	22,689	15,132	25,973	81,121	203,423	242,504	179,081	194,917
Gross Margin	43,384	52,904	44,437	113,332	65,118	273,040	184,983	607,178	539,184	392,737
Net Cash Income	44,207	62,257	48,601	114,188	69,088	271,419	220,962	644,122	561,568	420,482
Net Farm Income	42,962	51,379	43,248	111,126	63,720	270,241	177,696	588,085	516,186	379,046

Average exchange rate in 2011: US$1.00=PhP43.31.
Gross margin = Total returns less total variable costs; Net cash income = Total cash returns less total cash costs; Net farm income = Total returns less total costs

Per-Farm Analysis

Costs. Across the four study areas, the top three components of cash cost were pesticides (37%), fertilizers (30%), and transport (21%), at respective average amounts of PhP6,900, PhP5,495, and PhP3,865. (At 2011 average foreign exchange rate, these are equivalent to US$159.32, US$126.88, and US$89.24, respectively.) Eggplant farmers from Davao City and Iloilo cited the occurrence of diseases, like the fruit and shoot borer, as the main reason for applying pesticides. Other farmers applied pesticides as a preventive measure and to ensure having some harvest from their farms. Iloilo farmers spent the most on pesticides at about PhP14,209, which was relatively high considering that they grew eggplant for only 6 months a year; the other study areas grew eggplant for about 8-10 months.

Average expenditure on fertilizers ranged from PhP1,673 in North Cotabato to PhP10,215 in Iloilo. The most common types of fertilizer applied were urea (16-0-0) and complete fertilizers (14-14-14 and 12-12-12). Meanwhile, transport cost ranged from PhP911 in Davao City to PhP5,500 in North Cotabato. This included the costs of transporting the product from the farm to the market and labor for loading and unloading the products, and was mainly determined by the volume of harvest. In Calinan, Davao City, where only few vehicles were available, eggplant farmers had to first walk a few kilometers before they are able to take public transport to bring their products to the market.

On average, hired labor cost was only about 10% (PhP1,841 per farm per season) of all cash costs in eggplant production. It ranged from PhP901 in North Cotabato to PhP2,940 in Southern Leyte, and included the cost of hired labor for land preparation, transplanting, and fertilizer and pesticide application. Low hired labor costs were due to more use of family labor in eggplant production. Seed expense was the lowest cash cost incurred by eggplant farmers at an average of PhP408 per farm, and contributed only about 2% of total cash cost. The low seed expense was due to farmers' use of seeds saved from the previous production season.

Among non-cash costs in eggplant production, harvest losses—due to pests and diseases, and shrinkage and damage during transport to the market—was the major item (almost 72%), at an average of PhP5,350 per farm. Iloilo farmers reported the highest harvest losses, claimed as due to heavy infestation of eggplant fruit and shoot borer (EFSB), despite high application of pesticides and employing other pest control measures. Other non-cash cost items in eggplant production were depreciation of farm tools and equipment; unpaid family labor used in land preparation, fertilizer and pesticide application, and harvesting; and landowner's share in the harvest, which averaged at PhP751, PhP646, and PhP646, respectively.

Returns. Returns in eggplant production can also be classified into cash and non-cash returns. Earnings from products sold are the cash returns, while the value of products consumed, given away, and/or paid to landowners are the non-cash returns. On average, returns consisted about 98% cash and 2% non-cash, at PhP87,597 and PhP2,096 per farm per season, respectively.

From the above cost and return figures, eggplant farmers realized an average net cash income of PhP69,088, gross margin of PhP65,118, and net farm income of PhP63,720. Across sites, farmers from North Cotabato reported the highest figures of these parameters; those from Davao City reported the lowest. The area's level of productivity, the main factor in these trends, was influenced by (the absence or presence of) EFSB infestation during the production period. On average, North Cotabato yielded almost 9.6 tons/farm while Davao City yielded only 2.4 tons/farm in 2011.

Per-Hectare Analysis

The top three components of cash cost on a per-hectare basis were transport (36%), fertilizers (25%), and pesticides (21%), at respective average amounts of PhP50,190, PhP25,255, and PhP29,475. Non-cash costs due to harvest losses was significant at almost 65%, equivalent to an average of PhP34,818 per hectare. Across the four provinces, per-hectare production cost averaged at PhP194,917, and returns at almost PhP574,000, with Davao City reporting the lowest, and Southern Leyte the highest, for both parameters (Table 8).

The average net cash income realized by the farmer-respondents ranged from PhP220,962 in Iloilo to PhP644,122 in Southern Leyte, and averaged at PhP420,482 per hectare. Although eggplant growers from Southern Leyte incurred the highest per-hectare production cost, they also enjoyed high productivity, hence the highest returns, which significantly offset the total cost. The high productivity (39.4 t/ha) realized by eggplant farmers from Southern Leyte was due to high fertilizer application and low disease infestation.

Potential Impact of *Bt* Eggplant on Farmers' Income

The use of *Bt* eggplant can be expected to increase seed expense, decrease expense on pesticides and labor for pesticide application, and increase farm yields by about 30% due to less EFSB damage. However, the expected increase in eggplant production will also increase product transport cost and landlord's share. Overall, *Bt* eggplant farms are expected to incur lower production costs than non-*Bt* eggplant farms (Table 9).

Enterprise budget analysis showed that, on average, the adoption of *Bt* eggplant can increase per-hectare cash returns by almost PhP117,000 (or by about 21%), and per-hectare net farm income and net cash income by PhP130,225 and PhP124,060, respectively (Table 9). These increases in profitability will be due to increase in marketable surplus resulting from minimal or zero EFSB damage and overall lower cost of production. The biggest cash cost saving is expected to come from savings in pesticide expense. Non-cash cost in the form of harvesting losses is also expected to decrease due to minimal EFSB damage.

Sensitivity analysis estimated that if 15% of the total eggplant area (21,377 ha as of 2011 [BAS, 2012]) will be planted to the *Bt* variety, the eggplant sub-sector can realize an increase in net farm income of about PhP3 million, while about PhP7 million will be realized if 30% of the total eggplant area will be planted with *Bt* eggplant. For a 10-year period, the analysis showed that the net present value of the increase in net farm income in adopting *Bt* eggplant ranges from PhP25 million to PhP49 million. The estimated potential benefits do not include the consumers' surplus due to lower prices of eggplant, and health and environmental benefits of lesser pesticide use in eggplant production.

Problems Encountered in Eggplant Production

Across the four study areas, majority (87%) of the respondents identified pests and diseases as the major problem in eggplant production. Other production-related problems encountered were lack of capital, occurrence of calamities, high input costs, lack of technology, and poor soil condition (Table 10). Meanwhile, marketing-related problems identified were low and unstable eggplant prices, high transportation costs, poor farm-to-market roads, exploitative buyers, and lack of transportation facilities.

Table 9. Estimated per-season per-hectare costs and returns of eggplant production in selected provinces, Philippines, 2011

	Non-*Bt* Eggplant	*Bt* Eggplant	Difference
Returns			
Total cash	561,691	678,579	116,888
Total non-cash	12,274	12,274	–
Household consumption	737	737	–
Given away	5,871	5,871	–
Landowner's share	5,199	5,199	–
Others	465	465	–
Total Returns	*573,964*	*690,852*	*116,888*
Costs			
Total cash	141,209	134,037	(7,172)
Hired labor	23,837	21,453	(2,384)
Seeds	2,452	4,904	2,452
Fertilizer	35,255	35,255	–
Pesticides	29,475	11,790	(17,685)
Transport	50,190	60,635	10,445
Total non-cash	53,708	47,544	(6,164)
Depreciation	6,571	6,571	–
Unpaid family labor	7,120	7,120	–
Landowner's share	5,199	6,281	1,082
Harvest lost	34,818	27,572	(7,246)
Total Cost	*194,917*	*181,581*	*(13,336)*
Net Cash Income	**420,482**	**544,542**	**124,060**
Net Farm Income	**379,046**	**509,271**	**130,225**

Assumptions used in the partial budget analysis: (i) 20.81% EFSB damage; (ii) Labor used in spraying insecticide to control EFSB is 10% of the total labor cost spent in eggplant production; (iii) *Bt* eggplant seeds twice as expensive as those of non-*Bt* eggplant; (iv) Pesticide used to control ESFB is 60% of the total pesticide cost; (v) Base yield is 27.48 t/ha (average yield of the farmer-respondents); and (vi) Price of eggplant will be the same at PhP15.71 per kilogram.

Table 10. Production- and marketing-related problems encountered in eggplant production in selected provinces, Philippines, 2011

	Davao City		Iloilo		Southern Leyte		North Cotabato		All	
	No.	%	No.	%	No.	%	No.	%	No.	%
No. of respondents	94		125		125		125		469	
Production Problems										
Pest and diseases	85	90	97	78	117	94	110	88	409	87
Lack of capital	58	62	80	64	42	34	68	54	248	53
High cost of inputs	18	19	25	20	6	5	36	29	85	18
Poor soil condition	12	13	20	16	5	4	10	8	47	10
Natural calamities	17	18	58	46	60	48	12	10	147	31
Other problems	15	16	23	18	5	4	16	13	59	13
None	0	0	0	0	0	0	5	4	5	1
Marketing Problems										
Poor farm-to-market road	28	30	20	16	16	13	20	16	84	18
High transport cost	20	21	22	18	14	11	43	34	99	21
Low/unstable prices of output	66	70	86	69	101	81	101	81	354	75
Exploitative traders	20	21	34	27	18	14	4	3	76	16
Lack of transportation facilities	6	6	8	6				0	14	3
None					2	2	3	2	4	1

Summary and Recommendations

The cost and return analysis in this study showed that eggplant production is a highly profitable enterprise in the Philippines, with farmers' net farm income and cash income both relatively high. The study also presented evidence of improved farm productivity and profitability with *Bt* eggplant. Improved farm productivity (higher yield and marketable surplus) is mainly due to lesser damage from EFSB infestation, hence reduced harvesting losses, while improved farm profitability can be attributed mainly to savings in pesticide and pesticide application costs.

The commercialization of *Bt* eggplant should be facilitated for farmers to have an additional option as to what variety to grow, and to enjoy significant increase in farm income. Based on this study's findings, farmer adoption of *Bt* eggplant should be encouraged (once it becomes commercially available), especially if improved profitability is the main goal of an individual farmer or of a government production program. *Bt* eggplant thus offers the national government an opportunity to help reduce poverty incidence in the vegetable industry.

Considering the main thrust of the Philippine Department of Agriculture "to go organic all the way", and the pending case in the Supreme Court against conducting *Bt* eggplant multi-location field trials in the country, the possibility of this product not becoming commercially available is not remote nor surprising. As such, some strategic education campaigns, initial information dissemination activities, and awareness-raising programs, targeting various stakeholders (e.g., farmers, policy makers, concerned government agencies, NGOs, etc.) would be useful in paving the path for public acceptance of *Bt* eggplant toward commercialization.

References

Ahearn, M.J. Yee, E. Ball, and R. Nehring. 1998. *Agricultural Productivity in the United States*. Economic Research Services. USDA.

Aigner, D.J., C.A.K. Lovell, and P. Schmidt. 1977. Formulation and Estimation of Stochastic Frontier Production Model. *Journal of Econometrics* 6(1):21-37.

Baral, K., B.C. Roy, K.M.B. Rahim, H. Chatterice, P. Mondal, D. Mondal, D. Ghosh, and N.S. Talekar. 2006. Socio-economic Parameters of Pesticide Use and Assessment of Impact of an IPM Strategy for the Control of Eggplant Fruit and Shoot Borer in West Bengal, India. AVRDC – The World Vegetable Center, Taiwan. Technical Bulletin No. 37.

Bureau of Agricultural Statistics. Database of the Bureau of Agricultural Statistics. COUNTRY Stat. http://www.fao.org/economic/ess/ess-capacity/countrystathome/country-statistics/en/. (accessed January 2012).

Battese, G.E. and D.S.P. Rao. 2002. Technology Gap, Efficiency, and a Stochastic Metafrontier Function. *International Journal of Business and Economics* 1(2):87-93.

Battese, G.E. and T.J. Coelli. 1985. Prediction of Firm-Level Technical Efficiency with a Generalized Frontier Production Function and Panel Data. *Journal of Econometrics* 38, 387-399.

Battese, G.E. and T.J. Coelli. 1995. A Model for Technical Inefficiency in a Stochastic Frontier Production Function for Panel Data. *Empirical Economics* 20: 325-332.

Bhagvath, V. (undated) Technical Efficiency Measurement by Data Envelopment Analysis: An Application in Transportation. *Alliance Journal of Business Research*. pp. 60-68. http://ajbr.org/archeive.htm (accessed January 2012).

Baten, MD. Azizul, A.A. Kamil and K. Fatama. 2009. Technical Efficiency in Stochastic Frontier Production Model: An Application to the Manufacturing Industry in Bangladesh. *Australian Journal of Basic and Applied Science* 3(3): 1160-1169.

Coelli, T. 1996. *A Guide to Frontier Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation.* CEPA Working Paper 96/07, Center for Efficiency and Productivity Analysis, University of New England, Armidale.

Coelli, T. and D.S.P. Rao. 2003. Total Factor Productivity Growth in Agriculture: A Malmquist Index Analysis of 93 Countries, 1980-2000. Paper presented during the 2003 International Association of Agricultural Economics Conference, Durban, South Africa on16-22 August 2003.

Coelli, T., P.D.S. Rao, C.J. O'Donnell, and G.E. Battese. 2005. *An Introduction to Efficiency and Productivity Analysis*, 2nd Ed. Springer, New York.

Drew, E.A., V.V.S.R. Cupta, and D.K. Roget. 2007. Herbicide Use, Productivity and Nitrogen Fixation in Field Pea (*Pisum sativum*). *Australian Journal of Agricultural Research* (58): 1204-1214.

Farrel, M.J. 1957. The Measurement of Productive Efficiency. *Journal of Royal Statistical Society* Series A, 120, 253-281.

Fraser, I.M. and W.C. Horrace. 2003. Technical Efficiency of Australian Wool Production: Point and Confidence Interval Estimates. *Journal of Productivity Analysis* 20(2): 169-190. September.

Hassan, S. and B. Ahmad. 2005. Stochastic Frontier Production Function, Application and Hypothesis Testing. *Industrial Journal of Agriculture and Biology* 1560-8530: 427-430.

Idiong, I.C. 2007. Estimation of Farm Level Technical Efficiency in Small-scale Swamp Rice Production in Cross River State of Nigeria: A Stochastic Frontier Approach. *World Journal of Agricultural Sciences* 3(5): 653-658.

Javed, M.I., S.A. Adil, A. Ali, and M. Arif Raza. 2010. Measurement of Technical Efficiency of Rice-Wheat System in Punjab, Pakistan Using DEA Technique. *Journal of Agricultural Research* 48(2): 226-237.

Ketin, S. 2009. *Economic Assessment of Mangosteen Farmers' Adopting Good Agricultural Practices (GAP) in Rayong Province, Thailand.* Unpublished MS Thesis. University of the Philippines Los Baños (UPLB), Philippines.

Masterson, T. 2007. *Productivity, Technical Efficiency, and Farm Size in Paraguayan Agriculture*. Working Paper No. 490. The Levy Economic Institute of Bard College, February.

Misuya, E., S. Hisano, and T. Nariu. 2008. *Explaining Productivity Variation among Smallholder Maize Farmers in Tanzania.* Paper presented in the XII World Congress of Rural Sociology of the International Rural Sociology Association, Goyang, Korea.

Swastika, D.K.S. 1995. *The Decomposition of Total Factor Productivity Growth: The Case of Irrigated Rice Farming in West Java, Indonesia.* Unpublished Ph.D. Dissertation. University of the Philippines Los Baños (UPLB), Philippines.

Teruel, R.G. and Y. Kuroda. 2004. An Empirical Analysis of Productivity in Philippine Agriculture, 1974-2000. *Asian Economic Journal* 18(3): 319-351.

Appendix Table 1. Maximum likelihood estimates of the Cobb-Douglas stochastic production function analysis in selected provinces, Philippines, 2011

Parameter	Unit	*OLS*	Model2
Dependent Variable			
Yield	kilograms per hectare		
Independent Variables			
Constant		6.2310***	9.9345***
Seeds	grams	0.0923*	0.0655***
Labor	person-days	0.2430***	0.0843***
Pesticide cost	pesos	0.1506***	0.0584***
Fertilizer	50-kilogram sacks	-0.0166	-0.0117
Costs			
Constant			8.3876***
Farm size	hectare		-2.8371***
Age	years		-0.3581***
Educational attainment	years		2.4746***
Gender			-1.8611*
Farm experience	years		0.8266***
Tenure			0.8684
Availability of credit			-9.2091***
Distance from nearest	7,120	7,120	–
input supplier	kilometers		1.6535***
Knowledge of EFSB			3.9135***
Pest control method			7.9976***
% Damage			-0.4097***
Prov 1			10.7469***
Prov 2			7.0234***
Prov 3			30.1201***
Sigma			60.3380
Gamma			0.9876
Return to scale			0.4693

*** Significant at 1% level, * Significant at 10% level.

Chapter 5

Supply Chain of the Eggplant Industry in Selected Areas in the Philippines

Agnes R. Chupungco, Dulce D. Elazegui, Miriam R. Nguyen, and Samantha Geraldine G. de los Santos

Background

In 2011, the Philippines ranked 10th among the world's top eggplant producers (FAOSTAT, 2013), although eggplant is primarily for the domestic market. It is considered to be one of the most economically important vegetable crops in the country, leading in terms of area planted, volume, and value of production (Hautea and Narciso, 2007). Given the significance of the eggplant industry in the Philippine agricultural economy, this book's Chapter 2 provides a comprehensive profile of the crop's seed, production, and marketing systems, including production trends, output prices, marketing activities, key industry players, and current policies. It provides useful information for industry stakeholders to better respond to end-users' demands, as well as be crucial inputs in policy design to promote sustainable industry development.

Similar to any other agricultural crop, eggplant farmers and traders consider product price fluctuations as a major marketing problem. They are also concerned with market/consumer quality preferences, eggplant shelf life, and transportability (firmness). Quality of produce will depend not only on farmers' choice of inputs such as seeds and adoption of proper management practices but also on proper handling, post-harvest facilities, and marketing system. Market matching, tie-ups between traders and growers, and other market assistance are some of the activities in the industry.

Related to Chapter 2, this chapter examines the entire spectrum of the eggplant supply chain, i.e., all the interrelated activities in production and distribution until the product reached the final processors and/or consumers (Porter, 1985, as cited in Oracion, 2008).[1] It identifies key areas along the chain needing improvement, and suggests potential interventions to address the concerns. More specifically, this chapter:

i. presents the eggplant supply chain maps, showing the production activities and services; key players involved; logistics issues and external influences; and flow of product, information and payments;
ii. analyzes the performance of the eggplant supply chain in terms of efficiency, flexibility, and overall responsiveness;
iii. identifies areas for improvement in the supply chain, e.g., behavioral, institutional, and process; and
iv. recommends specific projects/programs and policies to improve the eggplant supply chain and the industry in general.

Conceptual Framework

This study adapted and employed the supply chain management framework used by earlier supply chain studies funded by the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) (e.g., Brown and Esguerra, 2007; Guiamal, 2008; Soliven et al., 2008). The analysis focuses on: key players and their roles; key customers and product requirements; activities and processes along the supply chain; product, information and payment flow; supply chain performance (costs and returns, marketing margins); and logistic issues, concerns and external influences.

Supply chain management (SCM) is a systems approach, which draws contributions from various disciplines. It represents the management of the entire set of production, processing/transformation, distribution, and marketing activities by which a consumer is supplied with the desired product. SCM is a strategic management tool used to enhance overall consumer satisfaction that is intended to maximize the firm's competitiveness and profitability as well as the whole supply chain network including the end-customers. Its major objective is to enhance working relationships among the

[1] At each stage of the supply chain, the products' value can also be improved with added inputs in moving or transforming the products. Oracion (2008) and Guiamal (2008) discuss this process of value addition through several primary and support activities.

various stakeholders to ensure better performance of the entire supply chain. The coordination of all the activities among the supply chain members hopes to achieve the best mix of responsiveness and efficiency for the markets being served.

Figure 1 shows the supply chain management framework for the eggplant industry, showing the main actors/players. For the chain to be efficient and responsive to end-users' product requirements (in terms of quality and quantity), activities within should be synchronized and well coordinated, also for the benefit of the players. It will also be easier and more effective for the public and private sectors to channel support services for the overall improvement and smooth operation of the eggplant supply chain. Optimizing the entire chain also requires correct information flows that will guide every member in decision-making. Information sharing, teamwork, cooperation, and collaboration are hence the major driving forces for the optimal delivery of products desired by the market (Brown and Esguerra, 2007; Guiamal, 2008; Soliven et al., 2008).

In a product supply chain, the primary activities include those that are directly related to the movement of goods and services among the producers and users. These primary activities and their components are as follows:

1. Inbound logistics, which revolve around the required elements in eggplant production from selection of planting materials, crop care and maintenance, until harvesting;
2. Outbound logistics, which include all activities (e.g., packaging, transportation, storage) and players in moving the product to the end-users or consumers;
3. Marketing and sales, which refer to the selling and delivery of the products, identifying the needs or preferences of consumers with attention to pricing; and
4. Customer service, which means assuring buyers' satisfaction of the products and attending to their complaints.

Related support activities in the eggplant industry are the following:

1. Infrastructure, including highly developed and cost-effective information system to capture buyers' preference, with focus on producing high quality products;
2. Human resources development programs and trainings to enhance the skill and efficiency of the industry's key players or stakeholders

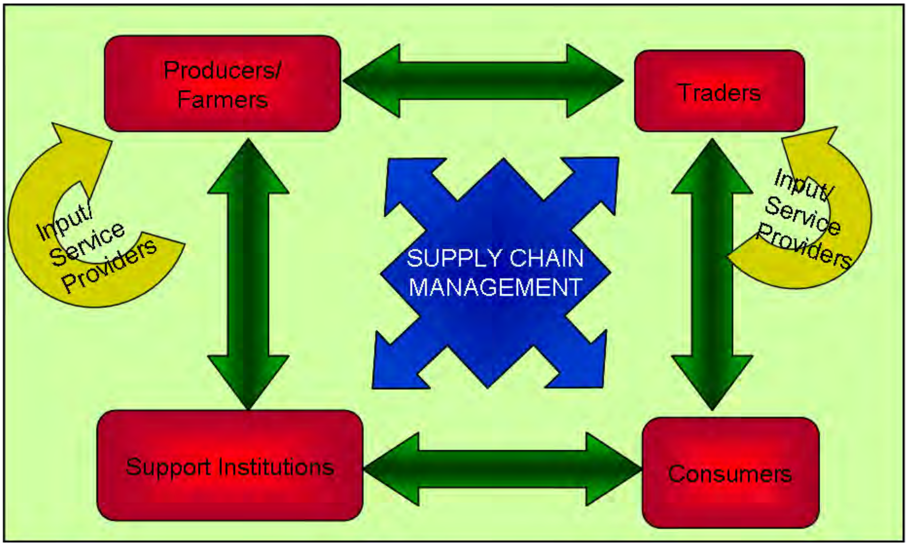


Figure 1. The Supply Chain Management (SCM) conceptual framework

(e.g., farmers and traders) while encouraging productivity, innovation and resourcefulness, among others;

3. Technologies that are easy to use and investment in technologies that increase the quantity, or improve the quality, of products and by-products; and
4. Procurement procedures to find the highest quality inputs to maximize productivity and minimize waste.

Methodology

Study Sites

This study was conducted in the top two eggplant-producing provinces of Pangasinan (Region I, Ilocos Region) and Quezon (Region IVA, CALABARZON). More specifically, it was conducted in the top eggplant-producing municipalities of Villasis, Asingan, and Sta. Maria in Pangasinan, with 25 growers and 28 traders as respondents, and 13 supply chains analyzed (Table 1). In Quezon, the study was conducted in Tiaong, Dolores, and Sariaya, with 23 growers and 31 traders as respondents, and 15 supply chains analyzed. Manila and other key demand centers for eggplant were likewise studied for the product flows.

Table 1. Number of respondents by type and study area, January-April, 2011

Type of Respondent	Number of Respondents	
	Quezon	Pangasinan
Farmer/Grower	23	25
Grower-Assembler-Wholesaler	3	1
Grower-Assembler-Wholesaler-Retailer	2	
Broker	1	
Assembler-Wholesaler	3	8
Wholesaler	7	6
Wholesaler-Retailer	7	5
Retailer	8	8
Total	**54**	**53**

Data Collection

The latest secondary data and related information on eggplant production, area, yield, and prices (farm, wholesale, and retail) at the provincial level and municipal level were gathered from the Bureau of Agricultural Statistics (BAS), the Office of the Provincial Agriculturist (OPAg) and the Municipal/City Agriculturist Office in the study sites, and from related published and unpublished documents.

Primary data were gathered through consultations, key informant interviews (KIIs) of the industry's stakeholders (e.g., farmers, traders, Provincial Agriculturists, Municipal/City Agriculturists, and other local government officials). Purposive sampling or snowball sampling was used as the supply chain was traced from the production sites to the final market.

KIIs generated data on key customers and product requirements; product, information and money flow; activities and services rendered and key players and respective roles at each stage in the supply chain; critical logistic issues; and external influences. For each stage of the supply chain from every province, at least one shipment from the product source to the ultimate destination in the Philippines was traced to (i) validate all information in the supply chain map initially drawn based on the interviews; (ii) monitor and document all practices; (iii) determine and quantify all costs and margins associated with such practices; and (iv) track changes in product volume and quality along the chain.

Data Analysis

The efficiency of the eggplant supply chain was evaluated based on performance indicators, namely, profit and return on investment; its flexibility, by the interaction among volume, quality, and delivery of products; and its responsiveness, by customer satisfaction regarding price, product quality, volume delivered, and other social concerns (environment, equity, fairness).

The areas for improvement of the supply chain were identified based on the data gathered, the current state of the industry, supply chain maps, and performance. Improvement measures were guided by the following principles of successful value chains: (i) satisfaction and need of customers and consumers; (ii) creating and sharing value with all members in the chain; (iii) having effective logistics and distribution; (v) ensuring information and communication strategies; and (vi) developing relationships that gives leverage and shared ownership (Soliven et al., 2008).

The next section presents and discusses the responses to the following questions:

a) Who are the key customers and what are their product requirements (especially quality standards)?
b) How do the product, information, and money flow through the supply chain?
c) What are the activities and services provided at each step in the supply chain?
d) Who are the key players and what are their respective roles?
e) What are the critical logistical issues?
f) What are the external influences?

Results and Discussion

Key Players and Roles in the Supply Chain

The major players in the eggplant supply chain were almost the same for both Pangasinan and Quezon except that a dicer was also part of the supply chain in the latter.

Eggplant Farmer. On average, eggplant farmer-respondents from Quezon were 47 years old, and had 1.44 hectares (ha) of farm land. Thirty-six percent of these respondents finished primary (elementary) school and 50% graduated from secondary school. Meanwhile, those from Pangasinan were 46 years old, and had 0.87 ha of farm land, on average. Fifty-six percent finished elementary and 19% have graduated from high school.

Dicer. There is one trader in Dolores, Quezon who procures eggplants on behalf of the assembler-wholesaler and assembler-wholesaler-retailer. He moves around the major eggplant-producing villages ('barangays') to look for regular suppliers of eggplant. He normally pays the farmers 50% of the agreed amount, upon delivery of the commodity at the barangay pickup point. The other 50% is paid a day after his contact trader has given him full payment.

Assembler-Wholesaler. Locally known as 'viajeros', these middlemen have the financial and logistical capacity to procure eggplants either directly from farmers and/or other traders, or through the assistance of dicers, and transport the commodity to major demand centers within and outside the province. In Quezon, the assembler-wholesaler's presence in 13 of the 15 eggplant supply chains analyzed indicates its very crucial role.

Assembler-Wholesaler-Retailer. These traders play multiple roles: procure eggplants from several farmers; sell the products in large volume outside the province; and/or sell them in retail within and outside the province. Some of these traders are farmers with own transport, or who can hire one, to deliver the eggplants to major markets. They also usually own retail stalls in public markets, which likewise serve as temporary storage for, and work areas for sorting, the eggplants.

Wholesaler-Retailer. Largely concentrated in public markets in major trading areas, wholesaler-retailers procure eggplants mainly from regular deliveries of farmers and other trader/wholesaler-suppliers. Most of them have permanent stalls, and sell either in bulk or small quantities to retailers.

Retailer. This type of trader sells small quantities of eggplants and operates either as roadside retailers or occupies stalls in public markets.

Quezon trader-respondents were 27-66 years old with 2-25 years experience in eggplant trading, while those from Pangasinan were 31-66 years old with 5-30 years experience. Twenty percent of the eggplant traders in Quezon completed elementary schooling and 52%, secondary education. In Pangasinan, 39% of the eggplant traders finished elementary education, and 43% graduated from high school.

Key Markets, Customers, and Product Requirements

In Pangasinan, only 15% of the marketable surplus is sold locally as 75% goes to Metro Manila (e.g., Divisoria, Balintawak), and the rest to Ilocos and Baguio City. During the months of November to January, Pangasinan supplies eggplants to the province of Isabela; in February, the former procures eggplants from the latter.

In Pangasinan, eggplants are generally sold at the farm to traders. But there are redundant or overlapping channels in the marketing chain. Buyers (assembler-wholesalers) at the farm bring the commodity to the trading post ('bagsakan') in Villasis or Urdaneta City, where they are picked up by the next chain of buyers (wholesalers, wholesaler-retailers) for distribution in Metro Manila markets such as Divisoria (City of Manila) and Balintawak (Quezon City). Buyers in these markets are again another layer of wholesalers and retailers. Some wholesalers-retailers from Baguio City also buy from the Villasis and Urdaneta City trading posts for distribution in the former's market.

There are also institutional buyers sourcing eggplants from assembler-wholesalers who are in direct contact with certain farmer-suppliers. Some repacks and distributes the produce to supermarket chains. These institutional buyers impose stricter quality requirements, and will not pay for eggplants that do not pass their quality standards, making farmers hesitant to sell to them. Supermarket chains impose daily volume and on-time delivery requirements, and payment takes relatively longer than with other traditional buyers (e.g., wet market).

In Quezon, the local market gets 20% of the marketable surplus. From discussions with OPAg and data gathered from growers and traders, it was estimated that Metro Manila wet markets obtain 50%; Tanauan, 10%; Laguna and Cavite, 5% each; Bicol and Samar, 5%; and other provinces such as Nueva Ecija and Pampanga, 5%. Eggplants harvested are usually brought to three major markets, namely, '*Sentrong Pamilihan ng Produktong Agrikultura ng Quezon*' (SPPAQ) (Quezon Central Market for Agricultural Products), popularly known to vegetable growers and traders as "Procy"; Tanauan City Public Market, Batangas; and Metro Manila wet markets (e.g., Divisoria, Balintawak). An assembler-wholesaler-retailer who is a resident of Dolores, Quezon also sells eggplants on retail at the Kadiwa Public Market in Dasmariñas, Cavite.

Eggplant buyers at the SPPAQ come from provinces mostly within the region (Cavite, Laguna, Batangas, Rizal, Quezon), as well as from those in Bicol Region (e.g., Daet, Camarines Norte; Naga City, Camarines Sur) and Rawis, Samar. From the Tanauan City wet market, the eggplants are brought to various markets such as the Mahogany Public Market in Tagaytay; Metro Manila; Laguna; Pampanga; and Nueva Ecija.

Some assembler-wholesalers prefer to bring eggplants to Tanauan City than to Divisoria or Balintawak in Metro Manila, since it is nearer to Quezon, eggplant buying price is higher, and buyers are easier to deal with.

During July to November when volume of eggplant harvest is large, traders deliver to Divisoria, Balintawak, or Pasig as the Tanauan and Sariaya markets cannot fully absorb the supply. Other assembler-wholesalers already have their 'suki' (regular buyers) in Metro Manila. However, wholesalers in Divisoria sometimes pay the Quezon assembler-wholesalers a price lower than the agreed price, especially when large volumes of eggplants were delivered during the day. This leads to Quezon assembler-wholesalers getting a negative profit (loss) due to the high cost of transport to Divisoria.

The market players require varying volumes of the product, with the assembler-wholesalers requiring the most at 12 tons per day of good eggplants in Quezon, and 8 tons per day in Pangasinan. As expected, the retailers require the smallest volume of good eggplants at 3-250 kgs per day. The assembler-wholesalers, wholesalers, and retailers also require eggplants of "semi" quality when eggplant supply in the market is low.

Eggplants are graded based on customer or buyer preference, in turn based on the fruit's color, firmness, length, and shape: good or 'primera'; semi or 'segunda'; and reject or 'butas' (Table 2). Semi grade eggplants include those oversized or bent, while the rejects are those with holes due to some insect pests (e.g., fruit and shoot borer, and other kinds of worms).

Activities and Processes along the Supply Chain

Activities and processes along the eggplant supply chain range from those in farm production to those in selling to final consumers (Figure 2).

Pangasinan

Production. Eggplant is a warm-weather crop with a relatively long growing season of about 120-150 days. In Pangasinan, farmers generally prefer long

Table 2. Eggplant buyers/customers and product requirements in Quezon and Pangasinan, 2011

Key Players	Buyers/ Customers	Estimated Volume Required (kg per day)		Grade Specifica-tions[a]
		Quezon	Pangasinan	
Dicer	Assembler-wholesaler; Wholesalers	300 - 500	-	Good
Assembler-wholesaler	Wholesalers; Wholesaler-retailers; Retailers	300 - 12,000	150 – 8,000	Good
		500 – 6,000	80 – 600	Semi
Assembler-wholesal-er-retailer	Retailers; Consumers	1,000 - 1,500		Good
Wholesaler	Retailers	50 – 5,000	700 – 5,000	Good
		50 – 1,500	500	Semi
Wholesaler-retailer	Retailers, Con-sumers	80 – 1,000	80 – 3,000	Good
			200 – 800	Semi
Retailer	Consumers	3 - 200	20 – 250	Good
		15 - 25		Semi

[a] Grade specification and quality requirements:
Good = Purple, firm, elongated (10-12 inches), average in size and straight.
Semi = Paler than the 'good', firm, <10 inches long, or oversized, bent.

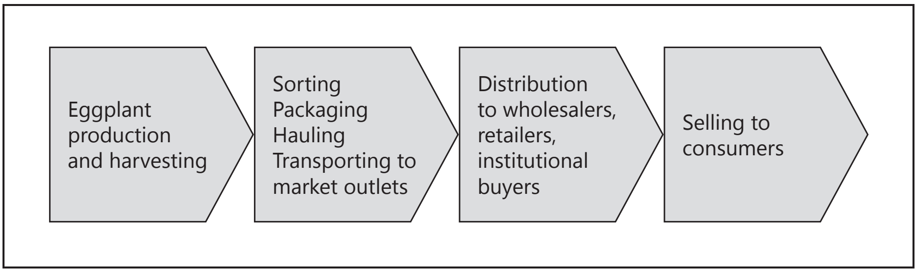


Figure 2. Activities and processes in the supply chain, Pangasinan and Quezon, 2010-2011

and purple hybrid varieties (such as Morena and Casino), start seedbed preparation in August/September, and transplant after 1 month. Farmers buy their material inputs from dealers and/or output traders, pay either in cash or through a credit arrangement, or borrow initial operating capital.

Land preparation involves plowing, harrowing, and digging holes for transplanting seedlings. Crop maintenance includes irrigation, fertilizer application, and pest and disease management. Farmers in Pangasinan generally have irrigation pump facilities. Fertilizers are applied thrice, for example, 2 weeks after transplanting (ammonium phosphate 16-20-0; Crop Giant®); and 1 month and 2 months after with complete fertilizer, ammonium sulfate, and Crop Giant®. Pesticide application is intensive, done every 4-5 days during fruiting stage (3-4 weeks from flowering to market-fruit size). This activity accounts for almost 21% of total labor, and 15% of total labor cost, in eggplant production. Farmers use more family labor for seedbed preparation and care, plowing, and furrowing. More hired labor is used in weeding and harvesting. Exchange labor ('bayanihan') is used during transplanting wherein farmers help each other at no cost, but with meals provided.

First eggplant harvest is at 55-60 days after transplanting, and consequent harvests, done every 4-5 days, could last for 3-6 months, involving a total of 250 person-days. Harvesting cost accounts for 23% of total labor cost, while postharvest activities (e.g., bagging and hauling) account for 28% of total person-days and labor costs (Table 3).

Marketing. In general, traders, including wholesalers and assembler-wholesalers pick up the eggplants at the farm, thus sparing farmers the cost of transport. Farmers indebted to buyers/traders are also spared with the cost and time of looking for markets. However, their bargaining power is weakened as they can no longer negotiate the price.

The buyers or their representatives classify the eggplants into 'primera' (good), 'segunda' (semi-good), 'kulatong' (rejects), and price them accordingly. When eggplant prices are high, even the rejects are sold; when the prices are low, the rejects are just given away or disposed.

Quezon

Production. As a first step, eggplant growers look for a suitable farm lot for planting eggplant, since they normally do not plant on the same farm lot in successive seasons to avoid declining yields. Apart from that, eggplant farmers in Quezon perform production activities similar to those

Table 3. Labor inputs (person-days) per hectare in eggplant production and post-harvest activities, Quezon and Pangasinan, 2010-2011

Variety/Source	QUEZON				PANGASINAN			
	Family Labor (person-days)	Hired Labor		Total Labor (person-days)	Family Labor (person-days)	Hired Labor		Total Labor (person-days)
		Person-days	Cost (PhP)			Person-days	Cost (PhP)	
Seedbed preparation	2.5	4.0	866.00	6.9	3.0	1.5	380.00	4.5
Seedbed care	10.1	6.8	2,019.28	16.9	13.7	3.5	450.00	17.2
Land clearing	8.8	8.8	7,861.46	17.5	0.	2.1	2,493.85	2.9
Plowing		4.4	2,918.75	4.4	8.2	1.9	1,645.11	10.1
Harrowing	14.0	10.0	2,300.00	24.0	2.7	3.2	1,015.11	5.8
Furrowing	4.7	7.6	2,060.00	12.3	6.9	2.	550.00	9.4
Digging holes	2.5	5.2	1,498.33	7.7	7.9	9.5	1,985.71	17.4
Transplanting	6.1	6.9	1,877.86	13.0	9.0	11.6	1,552.38	20.6
Weeding	50.4	86.8	23,132.13	137.2	5.6	58.2	9,035.41	63.9
Hilling up	6.8	20.4	5,266.67	27.2	5.0	6.0	1,475.00	11.0
Fertilizer application	16.5	21.6	5,787.00	38.1	15.9	27.3	6,855.27	43.2
Pesticide application	66.5	42.8	14,230.00	109.3	136.4	109.3	16,283.28	245.6
Watering		21.0	48,150.00	21.0	67.3	67.1	16,765.37	134.4
Harvesting	53.9	155.2	40,685.98	209.1	62.6	190.4	26,189.34	253.0
Sorting	67.5	150.6	25,588.23	218.1	65.1	64.5	7,232.79	129.6
Bundling	53.9	98.1	15,719.22	152.0	35.0	55.4	7,469.66	90.3
Hauling	66.0	80.9	14,382.14	147.0	61.3	56.0	10,550.94	117.3
Total	430.1	731.4	214,343.05	1,161.5	506.3	669.8	111,929.21	1,176.1
% of total person-days	*37.0*	*63.0*		*100.0*	*43.05*	*57.0*		*100.0*

of Pangasinan farmers. However, Quezon farmers employ less number of person-days for irrigation and fertilizer and pesticide application (Table 3).

Overall, hired labor constitutes almost 63% of all production labor; the rest are family labor. Transporting is usually the responsibility of the buyer or assembler-wholesaler, while price is negotiated between the buyer and the farmer. In Tiaong and Dolores, eggplant season is 6 months, beginning in June/July and ending in January-March. In Sariaya, eggplant season is from February to July.

Marketing. Similar to the case of Pangasinan, traders' activities in Quezon begin even before harvest, when traders lend production capital or inputs to farmers to assure themselves of a regular supply of eggplant. In addition, the regular activities of traders consist of assembling the harvested eggplants, sorting or grading, packing, hauling, transporting to the market, pricing, and selling.

Product, Information, and Payment Flows

Supply Chain Maps

Pangasinan. There are 13 supply chains identified in Pangasinan. Five chains end in retail markets in Divisoria; 2 in Balintawak, Quezon City; 2 in Batangas/Cavite; 1 in Baguio City; 2 within Pangasinan markets such as Villasis and Pangasinan; and 1 to institutional buyers like SM and Robinson's (see Appendix Figures 1 to 13).[2] Transport of eggplants from farm to final market takes one day for local markets in Pangasinan and two days for other market destinations. All the supply chains start from the farm to assembler-wholesaler from Villasis, Urdaneta City and Asingan, Pangasinan. All these assembler-wholesalers supply to wholesalers, retailers, and wholesaler-retailers. There is one chain where an assembler-wholesaler in Urdaneta City supplies another assembler-wholesaler from Tanauan City, Batangas when supply of eggplant from Quezon is low. Tables 4 and 5 summarize the data collected on these supply chains.

Since eggplant production period varies widely across Pangasinan (e.g., June/July to April, June to September, or October/November/December to March/

[2] Supply chain maps provide information such as the route of a particular commodity from the producer to the consumer, volume requirements, buying and selling prices as well as price margins of each player involved.

Table 4. Volume handled by traders and prices of eggplant in the supply chains from Pangasinan to areas outside of Metro Manila, 2010-2011

Item / Eggplant Quality	Grower	Assembler-Wholesaler	Wholesaler	Wholesaler-Retailer	Retailer
Volume handled (kg)					
Good	80-600/month	800-8,000/day	150-1,000/day	20-2,250/day	20-100/day
Reject	750-1,500/ month	40-130/day	No data collected	No data collected	No data collected
Buying price (PhP/kg)					
Good		3.00-40.00	14.00-45.00	4.00-50.50	9.00-55.50
Reject		1.33-6.00	n.a.	n.a.	n.a.
Selling price (PhP/kg)					
Good	3.00-38.00	4.00-45.00	17.00-55.50	9.00-65.50 (wholesale); 11.00-75.50 (retail)	14.00-55.00
Reject	1.33-6.00	2.83-8.50	n.a.	n.a.	n.a.
Spoilage (%)	0.96-10.0 (of harvest)	0.12-20.0	0.18	1.0-1.3	1.8-10.0

Note: Production period was July 2010-April 2011 for good eggplant and November 2010-February 2011 for rejects.
n.a.=not applicable.

April/May), the supply of eggplants is spread over the year. On average, the daily volume requirement of assembler-wholesalers supplying Divisoria is about 350 kgs-8,000 kgs; Balintawak, 150 kgs-500 kgs; and Batangas and Cavite, 800 kgs-8,000 kgs. Farm-level spoilage was reported as from about 1% to almost 22.7% of the harvest, while assembler-wholesalers reported a spoilage rate of 3%-20% of volume traded during transit from Pangasinan to Divisoria.

Eggplant price fluctuates widely within a year, with the highest observed during December to January. The lowest farm selling price for good quality eggplant is PhP3 per kg and the highest at PhP40 per kg. In the retail market, eggplants are no longer classified and assigned a single price. In Divisoria, retail (selling) price ranges at PhP10.50-PhP62.00 per kg. In Balintawak market, the lowest retail price is PhP23 per kg and the highest is PhP48 per kg. In Pangasinan and Baguio retail markets, retail price ranges at PhP25-PhP55 per kg, and at PhP24.50-PhP65.50 per kg in Tanauan City, Batangas. In Mendez, Cavite, price in the retail market ranges from PhP14 per kg to PhP52

Table 5. Volume handled by traders and prices of eggplant in the supply chains from Pangasinan to Metro Manila, 2010-2011

Item	Grower	Assembler-Wholesaler	Wholesaler	Wholesaler-Retailer	Retailer
Volume handled (kg)					
Good	60-10,800/ month	150-8,000/day	3,000-5,000/ day	200-750/day (wholesale); 2,250/day (retail)	100-250/ day
Semi	40-2,400/ month	80-812.50/ day	500/day	500/day	0
Reject	20 - 1,500/ month	40-500/day	500/day	500/day	0
Buying price (PhP/kg)					
Good		2.00-48.50	15.00-50.00	4.00-52.50	5.00-55.00
Semi		2.50-7.50	4.50-8.50	4.50-8.50	n.a.
Reject		1.33-7.50	4.50	2.50-7.50	n.a.
Selling price (PhP/kg)					
Good	2.00-40.00	4.00-52.50	20.0-55.00	9.00-50.0 (wholesale); 11.00-52.00 (retail)	10.50-62.00
Semi	2.00-7.50	4.50-8.50	7.0-11.00	6.50-10.50	n.a.
Reject	1.33-7.50	2.83-8.50	7.50	5.50-10.50	n.a.
Spoilage (%)	0.48-22.68	0.16-20	0.09	0.09	0 or nil

Note: Production period was June 2010-May 2011 for good eggplant, June 2010-February 2011 for semi, and August 2010-March 2011 for rejects.
n.a.=not applicable.

per kg; for institutional buyers such as restaurants, retail price ranges from PhP47 per kg to PhP75 per kg.

Quezon. Fifteen supply chains were identified in Quezon province. Three supply chains end in retail markets in Balintawak, Quezon City; 1 in Divisoria; 1 in Biñan, Laguna; 4 in Tanauan City; 4 in Cavite; and 2 in Naga, Camarines Sur (see Appendix Figures 14 to 28). The popular cropping period for eggplant is June/July to March for the municipalities of Tiaong and Dolores, and February to July for Sariaya. The number of middlemen ranged from two to four, and the shortest chains were those for Dolores, Quezon to Tanauan City, Batangas, and Dolores, Quezon to Balintawak, Quezon City. The two supply chains starting from Sariaya both have three middlemen. Tables 6 and 7 summarize the data from the Quezon eggplant supply chains.

Table 6. Volume handled by traders and prices of eggplant in the supply chains from Quezon to areas outside of Metro Manila, 2010-2011

Item	Growers	Assembler-Wholesaler	Wholesaler 1	Wholesaler 2	Wholesaler-retailer	Retailer
Volume handled (kg)						
Good	210-14,000/ month	300-6,000/ day	50-4,000/ day	300 every other day	80-1,000/ day	10-200/day
Semi	28-630/ month	292/month - 1,000/day	50-300/day	50 every other day	-	25 every other day
Reject	18 - 1,750 / month	146/mo.-29/ day	-	-	-	-
Buying price (PhP/kg)						
Good	-	1.50-40.00	3.00-45.00	4.00-46.00	2.50-50.00	4.00-62.50
Semi	-	2.00-44.00	3.00-23.20	3.75-23.95	-	8.00-28.95
Reject	-	0.93-30.00	-	-	-	-
Selling price (PhP/kg)						
Good	1.50-40.00	3.00-45.00	4.00-50.00	9.00-51.00	12.50-62.50	7.50-67.50
Semi	2.00-18.20	2.00-30.75	3.75-23.95		17.50-67.50	14.00-56.00
Reject	6.40-18.20	2.00-30.75	-	-	-	-
Spoil-age (%)	0.36-1.83	0.13-6.00	0.10-30.00	-	0.20-30.00	0.02-10.00

Note: Production season was from June to March and from February to July for some areas.

Across the Quezon supply chains, the farm price of eggplant averaged at PhP16.91 per kg while the average retail market price is PhP31.21 per kg. The lowest farm price per kg was PhP5.25 while the highest market price was PhP43.32. Price margin ranged from PhP6.00 to PhP32.50 per kg.

With regard to daily volume requirements of the different players in the eggplant supply chain, the assembler-wholesaler registered the highest at 12 m tons, the wholesaler at 5 m tons, wholesaler-retailer at 1 m tons, and retailer at 300 kgs.

Notably from Tables 4 to 7, retailers in Metro Manila handle bigger volumes of eggplants than retailers outside of Metro Manila. The trading centers of Balintawak and Divisoria in Metro Manila cater to a large number of people compared to public markets or trading centers outside of Metro Manila. Buying prices and selling prices were likewise higher for eggplants traded in Metro Manila. It is interesting to note that, at the retail level, rejects were

Table 7. Volume handled by traders and prices of eggplant in the supply chains from Quezon to Metro Manila, 2010-2011

Item	Growers	Assembler-Wholesaler	Commission Agent	Assembler-wholesaler-retailer	Wholesaler	Wholesaler-retailer	Retailer
Volume handled (kg)							
Mixed	-	-	-	-	-	-	50-100/day
Good	35-17,500/ month	300/month - 12,000/day	300-500/day	1,000-4,000/ month	500/day	200-300/ day	50-200 /day
Semi	10-1,575/ month	500-1,500/day	140-400/day	250-1,000/day	500-1,500/day	-	
Reject	315-2,625/ month	315-2,625/ month	-	-	500-1,500/day	-	
Buying price (PhP/kg)							
Mixed	-	-	-	-	-	-	2.00 - 39.40
Good	-	1.00-35.00	3.00-35.00	3.50-37.50	3.40-37.40	8.50-42.50	5.00-47.50
Semi	-	2.67-4.00	1.50-4.67	1.75-4.92	4.00	-	-
Reject	-	1.33-2.00	-	-	2.00	-	-
Selling price (PhP/kg)							
Mixed	-	-	-	-	-	-	7.00-44.40
Good	1.00-35.00	3.40-37.40	3.50-37.50	8.50-42.50 wholesale; 13.50-47.50 retail	5.40-39.40	13.50-47.50 wholesale; 18.50-52.50 retail	10.00-52.50
Semi	1.50-4.67	4.00	1.75-4.62	3.75-6.92 wholesale only	5.00	-	-
Reject	1.33-2.00	2.00		-	2.00-3.00	-	-
Spoilage (%)	0.9-18	0.1-1.0	0.01	-	-	-	2

Note: Production season was from June to March and from February to July for some areas.

usually sliced and combined with other sliced vegetables (e.g., 'okra', squash, and bittergourd), for sale as 'pinakbet' mix to consumers.

Information Flow

Output Supply. Traders, such as assembler-wholesalers and wholesaler-retailers, get their supply of eggplants from farmers or other traders. Buyers can easily identify eggplant farmers in the villages by just looking around, or by asking for references. Social capital between farmers and buyers, and among buyers, tends to be strong as tie-ups are built on personal relationships and high level of trust. Trade negotiations are very casual, informal, and could be made through text messaging or phone calls. Operations can be effectively located and coordinated at local (inter-barangay and inter-town) and regional level (e.g., between Metro Manila and Pangasinan).

The decision as to where to sell or deliver the eggplants would be logically based on the volume of supply in the destination market. Such information can be obtained from traders, and/or regular buyers ('suki') in the said market.

Price. In Pangasinan, the buying and selling prices of eggplants are based on the prevailing prices in major markets or trading posts. The local government units (LGUs) of Villasis and Urdaneta City monitor daily and record wholesale and retail prices of commodities (including eggplants) in the trading posts. In Villasis, the LGU also put up a billboard in the trading post to announce prevailing prices.

In Quezon, eggplant traders set the farm price often based on the price in the trading post the previous day. Farmers get their price information from other farmers and traders in their area. Traders and farmers negotiate to agree on a final buying price. Some trader-respondents opined that mobile phones have diminished their ability to buy eggplants from farmers at lower prices, since farmers are often updated of price levels in the trading posts.

In general, price information moves backwards from the last segment of the supply chain to the eggplant farmers. Through mobile phones and personal communication, both farmers and buyers could quickly monitor eggplant prices, guiding them during negotiations. While buyers usually dictate the price to farmers, the latter's knowledge of the prevailing price gives them a better negotiation position. However, farmers with credit tie-up (e.g., through input loans) with the traders have weak bargaining power.

Technical Information. Farmers' knowledge about eggplant production and marketing (trading) is oftentimes handed down from parents and relatives, gained through experience over time, or learned from other farmers or traders. Seed and chemical companies through their sales representatives, and LGUs through the High Value Crop Commercialization Program, also provide technical assistance to farmers, such as seminars on cultural management; and pests and diseases and control. During periods of calamities due to extreme weather events (e.g., typhoons, droughts, El Niño/ La Niña), the LGUs distribute free seeds to farmers for rehabilitation.

This study validated the information on prices, demand, supply, and other market information through the traders especially the wholesaler-retailers and retailers who are often located in wet markets and in direct interaction with final buyers of eggplant. Table 8 summarizes the kind of information along the chain, source of that information, and basis for validation.

Payment Flow

Pangasinan. Eggplant farmers need a starting operating capital of about PhP25,000 (or around US$579) per hectare for material farm inputs such as seeds, fertilizers, and pesticides. Some farmers use their savings to acquire the inputs, while others borrow cash or inputs from eggplant traders or input dealers. Repayment starts when the farmers have begun harvesting and selling eggplants.

Traders generally have their own operating capital for their selling and buying operations. Farmers are often paid in cash right after the buyers pick up the eggplants at the farm. In some cases, they are paid the day after the traders sell the eggplants to the next buyers. Buyers are given discounts in the next delivery when rejects have inadvertently been included in the packs.

Quezon. Both farmers and traders reported either using their savings or taking a loan from banks, private money lenders, or traders for their operating capital. The average initial production capital per hectare of eggplant is PhP60,000 (about US$1,390), utilized for land preparation, seeds, initial fertilizer application, pesticides, and labor. For loans taken by farmers, payment is deducted from the sale of produce after harvest. Farmers are paid in cash either within the day or on the following day by traders. Traders from Quezon who deliver to Divisoria sellers are paid only when the eggplants are sold the next day. Similar to Pangasinan, wholesalers in Quezon are paid in cash by wholesaler-retailers or after the eggplants have been sold. Retailers sell on cash basis to final consumers.

Table 8. Information needs along the major eggplant supply chains in Pangasinan and Quezon, 2010-2011

Information Needs	Supply Chain Player		
	Farmer	Assembler-Wholesaler/ Assembler-Wholesaler-Retailer	Retailer
Kind of Information			
Product information	Eggplant farming	Eggplant quality	Eggplant quality
Market/marketing information	Pricing, supply and demand situation, selling prices	Trading arrangements, pricing, supply and demand situation, and other selling practices	Trading arrangements, pricing, supply and demand situation, and other selling practices
Sources of Information			
Product information	Own experience, other farmers, seminars, government agencies, seed and chemical companies	Own experience, relatives, other traders	Own experience, relatives, other retailers
Market/marketing information	Own experience, other farmers, government agencies	Other traders, family business (acquired from parents)	Other traders
Basis for Validation			
Product information	Through other farmers	Through other traders	Through other traders
Market/marketing information	Through other farmers	Through other traders	Through other traders

Supply Chain Performance Analysis

Production Cost and Return Analysis

Eggplant farmers in Pangasinan reported an average production of about 31.4 m tons/ha, 89% of which were of good quality, commanding a price of PhP19.45/kg (Table 9). Total cost of production per hectare was about PhP453,080, of which expenses on pesticides and hired labor accounted for 51% and 27% respectively. Spoiled and 'reject' eggplants thrown away and fed to animals constituted 48% of non-cash costs. Excluding those for home consumption and given away, farmers earned, on average, a net cash income of PhP160,285/ha, and a net farm income of PhP120,089/ha (or PhP3.83/kg). Every peso invested in eggplant production generated a return of PhP0.27.

Table 9. Per-hectare cost and returns for eggplant production in Pangasinan and Quezon, 2010-2011

Items	**Pangasinan**		**Quezon**	
	PhP/ha	**%**	**PhP/ha**	**%**
Quantity harvested (kg)	31,380		33,770	
Quantity sold by quality (kg)				
Good	26,135	89	28,659	85
Semi	1,995	7	2,572	8
Reject	1,127	4	2,364	7
Output price (PhP/kg)				
Good	19.45		16.05	
Semi	6.90		4.27	
Reject	6.05		3.07	
Cash Returns				
Eggplant sales				
Good	508,454	96	460,034	96
Semi	13,776	3	10,975	2
Reject	6,817	1	7,256	2
Total Cash Returns	*529,047*	*100*	*478,265*	*100*
Non-Cash Returns				
Home consumption	453	1	631	5
Given away	3,067	7	4,033	29
Losses/spoilage	40,601	92	9,322	67
Total Non-Cash Returns	*44,122*	*100*	*13,986*	*100*
TOTAL RETURNS	**573,169**		**492,251**	
Cash Costs				
Land rent	0	0	5,500	3
Seeds	3,881	1	1,650	1
Tools and equipment	2,179	1	910	0
Fertilizer	36,126	10	40,145	22
Pesticides	187,236	51	30,632	16
Hired labor	101,172	27	70,095	38
Marketing costs (transport, hauling, sorting, bundling, etc.)	17,393	5	21,590	12
Other Production Costs (irrigation, fuel, etc.)	20,774	6	15,288	8
Total Cash Cost	*368,762*	*100*	*185,808*	*100*

Table 9. Per-hectare cost and returns for eggplant production in Pangasinan and Quezon, 2010-2011

Items	Pangasinan		Quezon	
	PhP/ha	%	PhP/ha	%
Non-cash Costs				
Losses/spoilage	40,601	48	9,322	18
Depreciation	1,682	2	5,498	10
Unpaid family labor	42,035	50	38,229	72
Total Non-cash Cost	84,318	100	53,049	100
TOTAL COSTS	**453,080**		**238,858**	
TOTAL COST/kg output	**14.44**		**7.07**	
Net Farm Income	120,089		253,393	
Net Farm Income/kg output	3.83		7.50	
Net Cash Income	160,285		292,457	
Return on Expenses	0.27		1.06	

In Quezon, total quantity harvested was about 33.8 m tons/ha (8% higher than that in Pangasinan), with 95% of good quality. Total cash returns amounted to PhP478,265/ha while non-cash returns was PhP13,986/ha, of which a high 29% was given away. Most eggplant farmer-respondents reported that hired harvesters usually ask for some eggplants for home consumption every time they harvest. Total returns amounted to PhP492,251/ha, and total costs to PhP238,858/ha per season. Spoilage and 'rejects' thrown away or fed to animals constitute 18% of non-cash costs. Net cash income of Quezon eggplant farmers was about PhP292,457/ha per season, about 82% higher than that in Pangasinan. Eggplant production in Quezon proved profitable with a return on expenses of 1.06.

Components of Price Margins

Price margin is the difference between the buying price and selling price of a commodity for each marketing intermediary, or the difference between the selling prices of two marketing participants. Components of price margin include profit, labor cost, transport cost, market fees and other marketing costs.

Pangasinan. Price margins ranged at PhP1.50/kg-PhP6.72/kg between farmers and assembler-wholesalers, and PhP2.00/kg-PhP15.00/kg between other traders. The highest price margin of PhP25.00/kg was estimated to be between wholesalers and wholesaler-retailers selling to restaurants.

Tables 10 and 11 present the average price margins and percent share of its components in supply chains leading to areas outside of Metro Manila, and to Metro Manila respectively. These tables indicate that the profit component accounts for the bulk of the price margin. Among the traders, the wholesaler-retailers selling to restaurants and at the retail level in supply chains leading to areas outside of Metro Manila got the most profit per kilogram at PhP23.68 and PhP9.61, respectively, equivalent to 95% and 83% of the corresponding price margins.

The wholesalers obtained the least profit per kilogram (PhP1.80-PhP2.20, or 36%-44% share of the price margin), followed by the assembler-wholesalers (PhP2.73-PhP4.42, or 58%-85% share of the price margin). Notably, among the traders, the assembler-wholesalers enjoy the highest overall profits as they handle large volumes of eggplants compared to wholesaler-retailers and retailers who handle smaller volumes.

The second largest component of the price margin is transport cost, which gets as high as PhP2.00/kg and PhP3.00/kg for wholesalers bringing eggplants to Divisoria and to the wet market in Tanauan, respectively. Except in Batangas and Cavite, retailers do not incur transport costs as traders deliver the eggplants to them at the marketplace.

In terms of cost shares among the marketing intermediaries, the wholesaler-retailer incurred the largest cost of PhP1.32-PhP2.34/kg, or 4%-13% of the total costs of the key players (Table 12). The marketing cost of assembler-wholesalers ranged at PhP0.72-PhP2.75/kg (or 3%-11%). The retailers incurred the least cost at PhP0.41-PhP2.26/kg, or 1%-11% of the total cost.

Among the supply chains, the difference between farm price and retail price is lowest at PhP11.50/kg for supply chains from Villasis to Divisoria and highest at PhP41.38 for supply chains from Villasis to Tagaytay City (Table 13). In Tagaytay City, the end-users are restaurants and traders were lucky to have negotiated a high price for their good quality eggplant.

Quezon. The per-kilogram price margins ranged at PhP2.00-PhP8.82 between farmers and assembler-wholesalers; PhP1.00-PhP5.00 between assembler-wholesalers and wholesalers; PhP2.00-PhP5.00 between wholesalers and retailers, and between wholesaler-retailers and retailers; and at PhP2.00-

Table 10. Components of the price margin of traders in the eggplant supply chains from Pangasinan to areas outside of Metro Manila, 2010-2011

Supply Chain Participant	Average Selling Price (PhP/kg)	Components of Price Margin		% Share to Total Price Margin
		Component	Average Cost (PhP/kg)	
Assembler-Wholesaler	26.73	Transport cost	0.50	10
		Materials	0.19	4
		Labor	0.06	1
		Market fees	0.05	1
		Net Income	4.42	85
		Margin	*5.22*	*100*
Wholesaler	36.43	Transport cost	2.50	50
		Materials	0.10	2
		Labor	0.56	11
		Market fees	0.02	0.4
		Communication	0.06	1
		Net Income	1.80	36
		Margin	*5.04*	*100*
Wholesaler-Retailer Wholesale	37.95	Transport cost	0.94	20
		Market fees	0.20	4
		Labor	0.39	8
		Communication	0.07	2
		Net Income	3.02	65
		Margin	*4.62*	*100*
Retail	43.40	Transport cost	1.02	9
		Materials	0.22	2
		Labor	0.49	4
		Market fees	0.16	1
		Communication	0.07	1
		Net Income	9.61	83
		Margin	*11.57*	*100*
Restaurant	62.18	Transport cost	0.37	1
		Labor	0.47	2
		Market fees	0.28	1
		Labor	0.20	1
		Net Income	23.68	95
		Margin	*25.00*	*100*

Table 10. Components of the price margin of traders in the eggplant supply chains from Pangasinan to areas outside of Metro Manila, 2010-2011

Supply Chain Participant	Average Selling Price (PhP/kg)	Components of Price Margin		% Share to Total Price Margin
		Component	Average Cost (PhP/kg)	
Retailer	43.61	Materials	0.31	5
		Labor	0.26	4
		Market fees	0.24	4
		Net Income	5.08	86
		Margin	*5.89*	*100*

Table 11. Components of the price margin of traders in the eggplant supply chains from Pangasinan to Metro Manila, 2010-2011

Supply Chain Participant	Average Selling Price (PhP/kg)	Components of Price Margin		% Share to Total Price Margin
		Component	Average Cost (PhP/kg)	
Assembler-Wholesaler	27.73	Transport cost	1.35	29
		Materials	0.21	4
		Labor	0.30	6
		Market fees	0.07	2
		Communication	0.01	0.2
		Net Income	2.73	58
		Margin	*4.67*	*100*
Wholesaler	29.13	Transport cost	2.00	40
		Materials	0.20	4
		Labor	0.49	10
		Market fees	0.09	2
		Communication	0.03	1
		Net Income	2.20	44
		Margin	*5.01*	*100*
Wholesaler-Retailer		Transport cost	0.71	15
Wholesale	29.96	Market fees	0.71	15
		Labor	0.50	10
		Communication	0.06	1
		Net Income	2.84	59
		Margin	*4.82*	*100*

Table 11. Components of the price margin of traders in the eggplant supply chains from Pangasinan to Metro Manila, 2010-2011

Supply Chain Participant	Average Selling Price (PhP/kg)	Components of Price Margin		% Share to Total Price Margin
		Component	Average Cost (PhP/kg)	
Retail	33.46	Transport cost	0.71	9
		Labor	0.50	6
		Market fees	0.71	9
		Communication	0.06	0.7
		Net Income	6.34	76
		Margin	*10.00*	*100*
Retailer	35.04	Materials	0.28	5
		Labor	0.50	9
		Market fees	0.38	7
		Net Income	4.34	79
		Margin	*5.50*	*100*

Table 12. Percent shares of key players in the per-kilogram price, total cost, and total net income of eggplant by supply chain, Pangasinan, 2011

Supply Chain and Key Player	Price Margin (PhP/kg)	% Share	Cost (PhP/kg)	% Share	Net Income (PhP/kg)	% Share
Supply Chains 1&2: From Villasis, Pangasinan to Divisoria						
Farmer	19.41	63	12.31	75	7.10	49
Assembler-Wholesaler	1.50	5	1.32	8	0.18	1
Wholesaler/ Wholesaler-Retailer	5.00	16	1.99	12	3.01	21
Retailer	5.00	16	0.80	5	4.20	29
Total	30.91	100	16.42	100	14.49	100
Supply Chain 3: From Villasis, Pangasinan to Balintawak, Quezon City						
Farmer	24.00	62	13.94	70	10.06	53
Assembler-Wholesaler	5.00	13	1.50	7	3.50	18
Wholesaler-Retailer	5.00	13	2.34	12	2.66	14
Retailer	5.00	13	2.26	11	2.74	14
Total	39.00	100	20.04	100	18.96	100

Table 12. Percent shares of key players in the per-kilogram price, total cost, and total net income of eggplant by supply chain, Pangasinan, 2011

Supply Chain and Key Player	Price Margin (PhP/kg)	% Share	Cost (PhP/kg)	% Share	Net Income (PhP/kg)	% Share
Supply Chain 4a: From Villasis, Pangasinan to Urdaneta City Retail Markets						
Farmer	22.80	59	20.81	94	1.99	12
Assembler-Wholesaler	5.84	15	0.72	3	5.12	31
Retailer-Urdaneta City	10.00	26	0.59	3	9.41	57
Total	38.64	100	22.12	100	16.52	100
Supply Chain 4b: From Villasis, Pangasinan to Pangasinan Retail Markets (including Lingayen, Dagupan City, and San Carlos City)						
Farmer	22.80	55	20.81	82	1.99	12
Assembler-Wholesaler	5.84	14	0.72	3	5.12	32
Wholesaler-Urdaneta	3.00	7	1.42	6	1.58	10
Wholesaler-Retailer (Pangasinan Retail Markets)	5.00	12	1.43	6	3.57	22
Retailer	5.00	12	1.07	4	3.93	24
Total	41.64	100	25.45	100	16.19	100
Supply Chain 5a: From Villasis, Pangasinan to Batangas and Cavite						
Farmer	22.80	43	20.81	76	1.99	8
Assembler-Wholesaler	6.28	12	1.09	4	5.19	21
Wholesaler	5.05	10	3.25	12	1.80	7
Wholesaler-retailer	15.00	29	1.32	5	13.68	54
Retailer-	3.50	7	0.85	3	2.65	10
Total	52.63	100	27.32	100	25.31	100
Supply Chain 5b: From Villasis, Pangasinan to Institutional Buyers in Tagaytay City						
Farmer	22.80	36	20.81	79	1.99	6
Assembler-Wholesaler	6.28	11	1.09	4	5.19	16
Wholesaler-Tanauan City	5.05	9	3.25	12	1.80	6

Table 12. Percent shares of key players in the per-kilogram price, total cost, and total net income of eggplant by supply chain, Pangasinan, 2011

Supply Chain and Key Player	Price Margin (PhP/kg)	% Share	Cost (PhP/kg)	% Share	Net Income (PhP/kg)	% Share
Wholesaler-Retailer selling to Institutional Buyers (Restaurants)	25.00	42	1.32	5	23.68	73
Total	59.13	100	26.47	100	34.46	100
Supply Chain 6: From Sta. Maria, Pangasinan to Divisoria						
Farmer	20.63	52	16.07	77	4.56	25
Assembler-Wholesaler	6.72	17	1.17	6	5.55	30
Wholesaler	5.00	13	2.80	13	2.2	12
Retailer	7.00	18	0.8	4	6.2	33
Total	39.35	100	20.84	100	18.51	100
Supply Chain 7: From Sta. Maria, Pangasinan to Balintawak						
Farmer	20.35	58	18.98	76	4.56	34
Assembler-Wholesaler	4.86	14	1.51	6	3.35	25
Wholesaler	5.00	14	2.34	9	2.66	20
Retailer	5.00	14	2.26	9	2.74	21
Total	35.21	100	25.09	100	13.31	100
Supply Chain 8: From Asingan, Pangasinan to Divisoria						
Farmer	26.96	64	18.98	77	7.98	46
Assembler-Wholesaler	5.00	12	2.75	11	2.25	13
Wholesaler-Retailer	5.00	12	1.99	8	3.01	17
Retailer	5.00	12	0.80	3	4.20	24
Total	41.96	100	24.52	100	17.44	100
Supply Chain 9: From Asingan, Pangasinan to Divisoria						
Farmer	26.96	61	18.98	75	7.98	43
Assembler-Wholesaler	5.00	11	2.75	11	2.25	12
Wholesaler	5.00	11	2.80	11	2.20	12
Retailer	7.00	16	0.80	3	6.20	33
Total	43.96	100	25.33	100	18.63	100

Table 12. Percent shares of key players in the per-kilogram price, total cost, and total net income of eggplant by supply chain, Pangasinan, 2011

Supply Chain and Key Player	Price Margin (PhP/kg)	% Share	Cost (PhP/kg)	% Share	Net Income (PhP/kg)	% Share
Supply Chain 10: From Asingan, Pangasinan to Urdaneta City						
Farmer	22.42	60	11.25	90	11.17	45
Assembler-Wholesaler	5.00	13	0.72	6	4.28	17
Retailer-Urdaneta City	10.00	27	0.59	5	9.41	38
Total	37.42	100	12.56	100	24.86	100
Supply Chain 11: From Asingan, Pangasinan to Baguio City						
Farmer	22.42	60	11.25	74	11.17	50
Assembler-Wholesaler	5.00	13	0.72	5	4.28	19
Wholesaler-Retailer-Baguio	5.00	13	2.03	13	2.97	13
Retailer-Baguio	5.00	13	1.28	8	3.72	17
Total	37.42	100	15.28	100	22.14	100
Supply Chain 12: From Pangasinan to Mendez, Cavite						
Farmer	19.41	57	12.31	76	7.10	39
Assembler-Wholesaler	4.82	14	0.72	4	4.10	23
Wholesaler-Retailer-Divisoria	5.00	15	1.99	12	3.01	17
Retailer-Mendez	5.00	15	1.19	7	3.81	21
Total	34.23	100	16.21	100	18.02	100
Supply Chain 13: From Villasis, Pangasinan to Dizon Farms						
Farmer	19.96	82	15.93	95	4.03	54
Assembler-Wholesaler	4.30	18	0.91	5	3.39	46
Total	24.26	100	16.84	100	7.42	100

Table 13. Average of farm prices, retail prices, and price margins in Pangasinan, 2010-2011

Supply Chain	No of Middle-men	Farm Price (PhP/kg)		Retail Market Price (PhP/kg)		Price Margin (PhP/kg)
		Range	Average	Range	Average	
1 & 2. Villasis, Pangasinan to Divisoria (chain 1 involved a wholesaler; chain 2 a wholesaler-retailer)	3	3.00-32.00	19.41	11.00-9.00	30.91	11.50
3. Villasis, Pangasinan to Balintawak, Quezon City	3	10.00-8.00	24.00	23.00-48.00	39.00	15.00
4a. Villasis, Pangasinan to Urdaneta City Retail Markets	2	10.00-8.00	22.80	24.00-49.00	38.64	15.84
4b. Villasis, Pangasinan to Pangasinan Retail Markets	3	10.00-38.00	22.80	27.00-52.00	41.64	18.84
5a. Villasis, Pangasinan to Batangas	4	10.00-38.00	22.80	24.50-65.50	41.18	18.38
5b. Villasis, Pangasinan to Tagaytay City and Mendez, Cavite	5	10.00-38.00	22.80	42.50-75.50	59.18	36.38
5c. Villasis, Pangasinan to Institutional Buyers in Tagaytay City	4	10.00-38.00	22.80	47.50-80.50	64.18	41.38
6. Sta. Maria, Pangasinan to Divisoria	4	7.50-25.00	20.63	34.00-52.00	39.35	18.72
7. Sta. Maria, Pangasinan to Balintawak	3	7.50-35.00	20.35	23.00-48.00	35.21	14.86
8. Asingan, Pangasinan to Divisoria	3	10.00-40.00	26.96	22.00-52.00	41.96	15.00
9. Asingan, Pangasinan to Divisoria	3	10.00-40.00	26.96	27.00-62.00	43.96	17.00
10. Asingan, Pangasinan to Urdaneta City	2	10.00-35.00	22.42	25.00-55.00	37.42	15.00
11. Asingan, Pangasinan to Baguio City	3	10.00-35.00	22.42	25.00-55.00	37.42	15.00
12. Pangasinan to Mendez, Cavite	3	3.00-32.00	19.41	14.00-52.00	34.23	14.82
13. Villasis, Pangasinan to Dizon Farms	1	2.00-30.00	19.96	5.00-52.50	24.26	4.30
Average			**22.25**		**39.97**	**17.72**

PhP25.00 between wholesalers and wholesaler-retailers. Similar to Pangasinan, net income is the largest component of price margin in Quezon, followed by transport cost. The per-kilogram net incomes ranged at PhP0.88-PhP6.14 (37%-73% of price margin) for the assembler-wholesalers, Php0.40-PhP4.31 (32%-90%) for the wholesalers, PhP0.84-PhP20.66 (42%-83%) for the wholesaler-retailers, and at PhP0.59-PhP13.64 (26%-89%) for the retailers.

Meanwhile, per-kilogram transport cost ranged from PhP0.02 for the dicer to PhP2.00 for the wholesaler-retailer who brings and sells eggplants at the Kadiwa Public Market in Dasmarinas, Cavite. Spoilage was worth zero to PhP2.50/kg.

Tables 14 and 15 present the average price margins and percent share of its components in Quezon supply chains leading to areas outside of Metro Manila and to Metro Manila, respectively. It can be observed that average selling prices, average price margins, and average net income of assembler-wholesalers and wholesalers in supply chains leading to areas outside of Metro Manila were higher than those in supply chains leading to Metro Manila. Average selling prices, average price margins, and average net income of retailers and wholesaler-retailers selling at retail, however, were higher in the latter supply chains. Prices in Metro Manila markets are generally higher than prices in other trading centers.

In Pangasinan, there were no distinct differences between supply chains leading to Metro Manila and those leading to areas outside Metro Manila. All selling prices of traders in supply chains originating from Pangasinan were notably higher than those originating from Quezon; this must have been due to lower eggplant supply in the former market. Wholesaler-retailers selling to restaurants in areas outside Metro Manila, whether coming from Pangasinan or from Quezon, had the highest price margin and highest net income across all the supply chains.

In terms of cost shares, the farmers have the largest share of up to PhP4.75-PhP20.18/kg (or 38%-92%) (Table 16). The assembler-wholesaler incurred PhP0.57-PhP2.68 (4%-31%); dicer, PhP0.41; wholesaler, PhP0.24-PhP1.02 (1%-11%); wholesaler-retailer, PhP0.08-PhP4.34 (less than 1%-22%); and retailer PhP0.56-PhP2.23/kg (6%-17%).

Among the supply chains, price margins are lowest (PhP24) for Naga, Camarines Sur if eggplants were harvested in Sariaya and highest (PhP48) for wholesaler-retailers selling to institutional buyers (e.g., restaurants) in

Table 14. Components of price margin of traders in the eggplant chains from Quezon to areas other than Metro Manila, 2010-2011

Supply Chain Participant	Average Selling Price (PhP/kg)	Components of Price Margin		% Share to Total Price Margin
		Component	Average Cost (PhP/kg)	
Assembler-Wholesaler	27.06	Transport cost	0.77	16
		Materials	0.06	1
		Labor	0.11	2
		Market fees	0.15	3
		Spoilage	0.26	6
		Net Income	3.32	71
		Margin	*4.67*	*100*
Wholesaler 1	24.06	Materials	0.04	2
		Labor	0.14	6
		Market fees	0.11	5
		Communication	0.07	2
		Spoilage	0.05	6
		Net Income	1.84	82
		Margin	*2.25*	*100*
Wholesaler 1	32.23	Transport cost	0.43	9
		Labor	0.20	4
		Market fees	0.05	1
		Communication	0.01	0.2
		Net Income	4.31	86
		Margin	*5.00*	*100*
Wholesaler-Retailer		Transport cost	0.86	13
Wholesale	27.29	Market fees	0.24	4
		Spoilage	0.93	14
		Labor	0.17	3
		Net Income	4.25	66
		Margin	*6.45*	*100*
Retail	30.79	Transport cost	0.83	8
		Materials	0.63	6
		Labor	0.08	1
		Market Fees	0.24	2
		Spoilage	*0.93*	*9*
		Communication	*0.01*	0.1
		Net Income	*7.27*	73
		Margin	*9.99*	100

Table 14. Components of price margin of traders in the eggplant chains from Quezon to areas other than Metro Manila, 2010-2011

Supply Chain Participant	Average Selling Price (PhP/kg)	Components of Price Margin		% Share to Total Price Margin
		Component	Average Cost (PhP/kg)	
Restaurant	48.32	Transport cost	0.16	1
		Labor	0.54	2
		Market fees	0.94	4
		Communication	0.20	1
		Spoilage	2.50	10
		Net Income	20.66	83
		Margin	*25.00*	*100*
Retailer	31.78	Materials	0.51	16
		Labor	0.08	3
		Market fees	0.04	1
		Spoilage	0.35	11
		Communication	0.002	0.06
		Net Income	2.18	69
		Margin	*3.16*	*100*
Assembler-Wholesaler	19.60	Transport cost	1.22	33
		Materials	0.12	3
		Labor	0.22	6
		Market fees	0.16	4
		"Tong"	0.005	0.1
		Spoilage	0.04	1
		Net Income	1.94	52
		Margin	*4.67*	*100*
Assembler-Wholesaler-Retailer Wholesale	23.94	Transport cost	1.57	31
		Materials	0.25	5
		Labor	0.13	3
		Market fees	0.02	0
		Net Income	3.03	61
		Margin	*5.00*	*100*
Retail	28.94	Transport cost	1.57	16
		Materials	0.25	3
		Labor	0.13	1
		Market fees	0.02	0.2
		Net Income	8.03	80
		Margin	*10.00*	*100*

Table 14. Components of price margin of traders in the eggplant chains from Quezon to areas other than Metro Manila, 2010-2011

Supply Chain Participant	Average Selling Price (PhP/kg)	Components of Price Margin		% Share to Total Price Margin
		Component	Average Cost (PhP/kg)	
Wholesaler	20.06	Materials	0.20	10
		Labor	0.49	25
		Market fees	0.09	4
		Communication	0.03	1
		Net Income	1.20	60
		Margin	*2.00*	*100*
Wholesaler-Retailer Wholesale	28.22	Labor	0.50	10
		Communication	0.08	2
		Market fees	1.37	27
		Net Income	3.05	61
		Margin	*5.00*	*100*
Retail	33.22	Materials	0.39	4
		Labor	0.50	5
		Market fees	1.37	14
		Communication	0.08	1
		Net Income	7.66	77
		Margin	*10.00*	*100*
Retailer	30.17	Materials	0.34	7
		Labor	0.50	11
		Market fees	0.93	20
		Net Income	2.89	62
		Margin	*4.66*	*100*

Table 15. Components of price margin of traders in the eggplant chains from Quezon to Metro Manila, 2010-2011

Supply Chain Participant	Average Selling Price (PhP/kg)	Components of Price Margin		% Share to Total Price Margin
		Component	Average Cost (PhP/kg)	
Assembler-Wholesaler	19.60	Transport cost	1.22	33
		Materials	0.12	3
		Labor	0.22	6
		Market fees	0.16	4
		"Tong"	0.005	0.1
		Spoilage	0.04	1
		Net Income	1.94	52
		Margin	*4.67*	*100*
Assembler-Wholesaler-Retailer Wholesale	23.94	Transport cost	1.57	31
		Materials	0.25	5
		Labor	0.13	3
		Market fees	0.02	0
		Net Income	3.03	61
		Margin	*5.00*	*100*
Retail	28.94	Transport cost	1.57	16
		Materials	0.25	3
		Labor	0.13	1
		Market fees	0.02	0.2
		Net Income	8.03	80
		Margin	*10.00*	*100*
Wholesaler	20.06	Materials	0.20	10
		Labor	0.49	25
		Market fees	0.09	4
		Communication	0.03	1
		Net Income	1.20	60
		Margin	*2.00*	*100*
Wholesaler-Retailer Wholesale	28.22	Labor	0.50	10
		Communication	0.08	2
		Market fees	1.37	27
		Net Income	3.05	61
		Margin	*5.00*	*100*

Table 15. Components of price margin of traders in the eggplant chains from Quezon to Metro Manila, 2010-2011

Supply Chain Participant	Average Selling Price (PhP/kg)	Components of Price Margin		% Share to Total Price Margin
		Component	Average Cost (PhP/kg)	
Retail	33.22	Materials	0.39	4
		Labor	0.50	5
		Market fees	1.37	14
		Communication	0.08	1
		Net Income	7.66	77
		Margin	*10.00*	*100*
Retailer	30.17	Materials	0.34	7
		Labor	0.50	11
		Market fees	0.93	20
		Net Income	2.89	62
		Margin	4.66	100

Table 16. Percent shares of key players in the per-kilogram price, total cost incurred, and total net income by eggplant supply chain, Quezon, 2010-2011

Key Player	Price Margin	%Share	Cost (PhP/kg)	% Share	Net Income (PhP/kg)	% Share
Supply Chain 1: From Tiaong, Quezon to Binan, Laguna through the Sentrong Pamilihan ng Produktong Agrikultura ng Quezon sa Sariaya						
Farmer	16.91	45	4.75	49	12.16	44
Grower-Assembler-Wholesaler	8.82	24	2.68	28	6.14	22
Wholesaler	1.50	4	1.02	11	0.48	2
Wholesaler	5.00	13	0.69	7	4.31	16
Retailer	5.00	13	0.56	6	4.44	16
Total	*37.23*	*100*	*9.70*	*100*	*27.53*	*100*
Supply Chain 2: From Tiaong, Quezon to Divisoria						
Farmer	14.29	60	5.87	65	8.42	57
Grower-Assembler-Wholesaler	2.40	10	1.52	17	0.88	6
Wholesaler	2.00	8	0.80	9	1.20	8
Retailer	5.00	21	0.8	9	4.20	29
Total	*23.69*	*100*	*8.99*	*100*	*14.70*	*100*

Table 16. Percent shares of key players in the per-kilogram price, total cost incurred, and total net income by eggplant supply chain, Quezon, 2010-2011

Key Player	Price Margin	%Share	Cost (PhP/kg)	% Share	Net Income (PhP/kg)	% Share
Supply Chain 3: From Tiaong, Quezon to Tanauan City, Batangas						
Farmer	16.91	56	4.75	55	12.16	56
Grower-Assembler-Wholesaler	8.82	29	2.68	31	6.14	28
Wholesaler	2.50	8	0.24	3	2.26	10
Retailer	2.00	7	1.01	12	0.99	5
Total	*30.23*	*100*	*8.68*	*100*	*21.55*	*100*
Supply Chain 4: From Tiaong, Quezon to Tanauan City, Batangas						
Farmer	15.82	62	14.17	84	1.65	19
Assembler-Wholesaler	5.00	20	1.42	8	3.58	42
Wholesaler	2.50	10	0.24	1	2.26	27
Retailer	2.00	8	1.01	6	0.99	12
Total	*25.32*	*100*	*16.84*	*100*	*8.48*	*100*
Supply Chain 5: From Tiaong, Quezon to Tanza, Cavite through Tanauan City, Batangas						
Farmer	15.82	51	14.17	81	1.65	12
Assembler-Wholesaler	5.00	16	1.42	8	3.58	27
Wholesaler	5.00	16	0.89	5	4.11	31
Wholesaler-Retailer	2.00	6	0.08	0	1.92	14
Retailer	3.00	10	0.99	6	2.01	15
Total	*30.82*	*100*	*17.55*	*100*	*13.27*	*100*
Supply Chain 6: From Tiaong, Quezon to Tanza, Cavite through Tanauan City, Batangas						
Farmer	15.82	64	14.17	78	1.65	25
Assembler-Wholesaler	5.00	20	1.42	8	3.58	54
Wholesaler-Retailer	2.00	8	1.16	6	0.84	13
Retailer	2.00	8	1.48	8	0.59	9
Total	*24.82*	*100*	*18.23*	*100*	*6.66*	*100*
Supply Chain 7a: From Tiaong, Quezon to Tagaytay City and Mendez, Cavite						
Farmer	15.82	37	14.17	68	1.65	7
Assembler-Wholesaler	5.00	12	1.42	7	3.58	16
Wholesaler	2.50	6	0.24	1	2.26	10

Table 16. Percent shares of key players in the per-kilogram price, total cost incurred, and total net income by eggplant supply chain, Quezon, 2010-2011

Key Player	Price Margin	%Share	Cost (PhP/kg)	% Share	Net Income (PhP/kg)	% Share
Wholesaler-Retailer	15.00	35	4.34	21	10.66	47
Retailer	5.00	12	0.70	3	4.3	19
Total	*43.32*	*100*	*20.88*	*100*	*22.45*	*100*
Supply Chain 7b: From Tiaong, Quezon sold to Institutional Buyers in Tagaytay City						
Farmer	15.82	33	14.17	70	1.65	6
Assembler-Wholesaler	5.00	10	1.42	7	3.58	13
Wholesaler	2.50	5	0.24	1	2.26	8
Wholesaler-Retailer	25.00	52	4.34	22	20.66	73
Total	*48.32*	*100*	*20.17*	*100*	*28.15*	*100*
Supply Chain 8: From Tiaong, Quezon to Kadiwa Public Market, Cavite through Sentrong Pamilihan in Sariaya						
Farmer	16.91	41	4.75	38	12.16	42
Grower-Assembler-Wholesaler	8.82	21	2.68	21	6.14	21
Wholesaler	1.00	2	0.31	2	0.69	2
Wholesaler-Retailer	10.00	24	2.67	21	7.33	25
Retailer	5.00	12	2.18	17	2.82	10
Total	*41.73*	*100*	*12.59*	*100*	*29.14*	*100*
Supply Chain 9: From Tiaong, Quezon to Naga City, Camarines Sur through the Sentrong Pamilihan ng Produktong Agrikultura ng Quezon sa Sariaya						
Farmer	15.82	53	14.17	67	1.65	19
Assembler-Wholesaler	5.00	17	1.42	7	3.58	41
Wholesaler	1.00	3	0.58	3	0.42	5
Wholesaler-Retailer	5.00	17	2.62	12	2.38	27
Retailer	3.00	10	2.23	11	0.77	9
Total	*29.82*	*100*	*21.03*	*100*	*8.79*	*100*
Supply Chain 10: From Sariaya, Quezon to Naga City, Camarines Sur through the Sentrong Pamilihan ng Produktong Agrikultura ng Quezon sa Sariaya						
Farmer	5.25	37	13.15	71	-7.9	182
Wholesaler	1.00	7	0.58	3	0.42	-10
Wholesaler-Retailer	5.00	35	2.62	14	2.38	-55

Table 16. Percent shares of key players in the per-kilogram price, total cost incurred, and total net income by eggplant supply chain, Quezon, 2010-2011

Key Player	Price Margin	%Share	Cost (PhP/kg)	% Share	Net Income (PhP/kg)	% Share
Retailer	3.00	21	2.23	12	0.77	-18
Total	*14.25*	*100*	*18.59*	*100*	*-4.34*	*100*
Supply Chain 11: From Sariaya, Quezon to Tanauan City, Batangas						
Farmer	32.50	84	6.33	78	26.17	86
Grower-Assembler-Wholesaler	2.00	5	0.57	7	1.43	5
Wholesaler	2.00	5	0.24	3	1.76	6
Retailer	2.00	5	1.01	12	0.99	3
Total	*38.50*	*100*	*8.15*	*100*	*30.35*	*100*
Supply Chain 12: From Dolores, Quezon to Tanauan City, Batangas						
Farmer	21.00	75	20.18	92	0.82	13
Grower-Assembler-Wholesaler	3.10	11	0.84	4	2.26	37
Retailer	4.00	14	0.95	4	3.05	50
Total	*28.10*	*100*	*21.97*	*100*	*6.13*	*100*
Supply Chain 13: From Dolores, Quezon to Balintawak, Quezon City						
Farmer	17.50	56	11.53	65	5.97	30
Grower-Assembler-Wholesaler	5.00	16	1.97	11	2.99	15
Wholesaler-Retailer	5.00	16	1.95	11	3.05	16
Retailer	4.00	13	2.26	13	7.66	39
Total	*31.50*	*100*	*17.71*	*100*	*19.67*	*100*
Supply Chain 14: From Dolores, Quezon to Balintawak, Quezon City						
Farmer	16.90	50	9.31	59	7.59	42
Commission Agent	2.04	6	0.41	3	1.63	9
Grower-Assembler-Wholesaler-Retailer	5.00	15	1.97	12	3.03	17
Wholesaler-Retailer	5.00	15	1.95	12	3.05	17
Retailer	5.00	15	2.26	14	2.74	15
Total	*33.94*	*100*	*15.90*	*100*	*18.04*	*100*

Table 16. Percent shares of key players in the per-kilogram price, total cost incurred, and total net income by eggplant supply chain, Quezon, 2010-2011

Key Player	Price Margin	%Share	Cost (PhP/kg)	% Share	Net Income (PhP/kg)	% Share
Supply Chain 15: From Dolores, Quezon to Kadiwa Public Market						
Farmer	17.50	64	11.53	82	5.97	44
Grower-Assembler-Wholesaler-Retailer	5.00	18	1.76	13	3.24	24
Retailer	5.00	18	0.78	6	4.22	31
Total	*27.50*	*100*	*14.07*	*100*	*13.43*	*100*

Tagaytay City (Table 17). The low price in Naga could be attributed to back loading of eggplants after transporting coconut and other products from Camarines Sur to Sariaya. In Tagaytay City, demand for high quality eggplant by institutional buyers commands higher prices. For Manila markets, price margins range at PhP24-PhP34 while they range at PhP25-PhP39 in Tanauan City. The chain from Quezon to Cavite (including Tagaytay, Mendez, and Tanza) has a wider price range at PhP25-PhP43. The chain leading to Biñan, Laguna had an average price margin of PhP37.

Efficiency Analysis

The efficiency of the supply chains were analyzed based on the less number of key players involved, low volume of spoilage/wastage, shorter travel time from farm to end-market, and low marketing costs. The greater the number of middlemen or marketing intermediaries would mean higher eggplant prices for consumers; the higher the spoilage/wastage would lower the supply of eggplant in the market and could result in higher eggplant prices also. Longer travel time would increase spoilage of the commodity. Anything that increases marketing costs—unless it is due to a necessary added marketing service—is inefficient.

Pangasinan. Inefficiencies in the supply chains were characterized by high production input costs and spoilage due to pests and diseases. As they buy only first class or good eggplants, traders implement stricter grading and sorting, resulting in farmers receiving a high volume of rejects. (Segunda and rejects were marketable only if supply is relatively low.) The supply chains leading to Urdaneta City retail markets were the most efficient as these involved growers, assembler-wholesalers, and retailers only. Consumers can

Table 17. Average of farm prices, retail prices, and price margins in Quezon, 2010-2011

Supply Chain	No of Middle-men	Farm Price (PhP/kg)		Retail Market Price (PhP/kg)		Price Margin (PhP/kg)
		Range	Average	Range	Average	
1. Tiaong, Quezon to Biñan, Laguna through SPPAQ	4	1.50-35.00	16.91	13.75-56.00	27.53	10.62
2. Tiaong , Quezon to Divisoria	3	1.00-35.00	14.29	7.00-44.00	23.69	9.40
3. Tiaong, Quezon to Tanauan City, Batangas	3	1.50-35.00	16.91	7.50-48.50	30.23	13.32
4. Tiaong, Quezon to Tanauan City, Batangas	3	1.50-40.00	15.82	7.50-50.00	25.32	9.50
5. Tiaong, Quezon to Tanza, Cavite through Tanauan City, Batangas	4	1.50-40.00	15.82	16.50-55.00	30.82	15.00
6. Tiaong, Quezon to Tanza, Cavite through Tanauan City, Batangas	3	1.50-40.00	15.82	10.50-49.00	24.82	9.00
7a. Tiaong, Quezon to Tagaytay City and Mendez, Cavite	4	1.50-40.00	15.82	29.00-67.50	43.32	27.50
7b. Tiaong, Quezon to institutional buy-ers (restaurants) in Tagaytay City	3	1.50-40.00	15.82	34.00-72.50	48.32	32.50
8. Tiaong, Quezon to Kadiwa Public Market, Cavite through SPPAQ	4	1.50-35.00	16.91	17.50-60.00	41.73	24.82
9. Tiaong, Quezon to Naga City, Cama-rines Sur through SPPAQ	4	1.50-40.00	15.82	15.50-54.00	29.82	14.00
10. Sariaya, Quezon to Naga City, Cama-rines Sur through SPPAQ	3	4.50-6.00	5.25	13.50-15.00	14.25	9.00
11. Sariaya, Quezon to Tanauan City, Batangas	3	25.00-40.00	32.50	31.00-46.00	38.50	6.00
12. Dolores, Quezon to Tanauan City, Batangas	2	3.00-35.00	21.00	5.00-43.00	28.10	7.10

Table 17. Average of farm prices, retail prices, and price margins in Quezon, 2010-2011

Supply Chain	No of Middle-men	Farm Price (PhP/kg)		Retail Market Price (PhP/kg)		Price Margin (PhP/kg)
		Range	Average	Range	Average	
13. Dolores, Quezon to Balintawak, Quezon City	3	1.50-20.00	17.50	22.00-47.00	31.50	14.00
14. Dolores, Quezon to Balintawak, Quezon City	5	3.00-35.00	16.90	18.50-52.50	33.94	17.04
15. Dolores, Quezon to Kadiwa Public Market	2	1.50-20.00	17.50	10.00-30.00	27.50	10.00
Average			**16.91**		**31.21**	**14.30**

readily avail of farm-fresh eggplant within the day. The least efficient chain was the chain leading to Batangas and Cavite public markets because of many layers of intermediaries. For example, an assembler-wholesaler gets the eggplants in Villasis and brings them to a wholesaler in Urdaneta City who in turn transports them to Tanauan City, Batangas. Another wholesaler in Tanauan City buys the eggplants and sells them to a wholesaler-retailer from Cavite. This long chain increases transport cost and results in 10% spoilage at the retailer level. There was no report of illegal fee payments (kotong) during delivery of eggplant to markets, somehow adding no cost, hence improving efficiency.

Quezon. Inefficiency within the eggplant supply chains is very minimal. The common causes of chain inefficiencies for eggplant are spoilage due to fruit and shoot borer (FSB) and foliar fertilizers and pesticide residues. Farmers experience spoilage due to fruit and shoot borer while traders experience spoilage due to blotches and early rotting of eggplants when fertilizers were applied a day before harvest. Unless supply is low, semi and rejects were thrown or given as feeds to farm work animals. Another cause of spoilage would be the improper sorting, grading or handling. Sellers either provide replacement for spoiled eggplants to their buyers or provide discounts. On the other hand, farmers were paid a lower price by traders for them to recover for the cost of spoiled eggplants.

The most efficient chain in Quezon was the one leading to Kadiwa Public Market in Cavite which consisted of farmers and a farmer-assembler-wholesaler-retailer from Dolores, Quezon. There was also no reported spoilage along the chain. The least efficient chain was the one leading to

Naga City participated by farmers, an assembler-wholesaler, wholesaler, wholesaler-retailer and retailers. The length of travel time and improper handling from the farm to the Naga City Public Market led to 30% spoilage of volume procured. Illegal fees were occasionally reported by traders going to Divisoria and Balintawak due to overloading or alleged violations of the Number Coding Scheme in Metro Manila.

Logistics Issues and Concerns

Inbound Logistics. Major concerns in the eggplant supply chain include the quality of the produce and consequent effect in its marketability. The occurrence of pests and diseases has continually constrained production of quality eggplant which in turn has also affected the marketability of the commodity.

1. Infestation of pests and diseases and farmers' inadequate knowledge of appropriate practices

Eggplant growing in Pangasinan entails intensive application of pesticides due to infestation of pests and diseases in order to maintain good quality (in terms of physical appearance) of the fruit. The most common pest is the fruit and shoot borer, and other pests include other types of worms, white flies, aphids, and ants. However, spraying close to harvest time to avoid pest damage threatens food safety of the crop. Other farmers even increase the dosage of pesticides when they observed that the recommended dosage is not effective anymore. In some cases, farmers have inadequate knowledge in identifying pests and diseases, thus do not know what to do about it. Some farmers make their own formulation or combination of different pesticides.

Respondents say that based on their experience, if they would not apply chemicals, they would not harvest the fruits. Pest and diseases affect the quality and quantity of produce.

2. Poor quality of inputs and other farm resources

There were some instances when farmers reported a low germination of eggplant seeds, thus the need for some measure to assure farmers of quality planting materials. Moreover, deteriorating quality of land as a result of continuous cultivation and fertilizer application has consequently affected land productivity.

3. Rising cost of inputs

Farmers lament the rising price of inputs such as chemicals, fertilizer and fuel, thus increasing their expenses for production, including irrigation pump and tractor. They would need financial sustainability to cope with rising costs of production and marketing.

Outbound Logistics

1. Variability of market prices

The seasonal nature of eggplant production results to supply fluctuations and variations in the market price. During the middle of the production season, when supply is at its peak, farm prices could get as low as PhP2/kg (in Quezon) causing farmers to stop taking care of their plants by no longer applying fertilizer and pesticides until the plants die, as buying more agricultural inputs would simply add costs and to their negative profits. However, farmers and traders can get high profits when market prices are high.

2. Food safety concerns

Even with increasing awareness on the extent of pesticide usage in eggplant, there is no mechanism in place to monitor this in the market. Nor is there a 'track-and-trace' system to identify sources of the commodity once the packages are all dumped in the market. Most farmers and traders are just interested in the profits that they can get, notwithstanding the health and environmental hazards of pesticide use.

3. High perishability of eggplant

Eggplant has a short shelf life (2-3 days), and thus poses a high potential for wastage cost. When eggplant does not look good anymore, retailers are compelled to sell it at its buying price or at even a lower price.

4. Redundant players within the chain

Redundancy of players in any marketing chain or channel (e.g., a wholesaler sells the eggplant to another wholesaler) would increase the market price of the commodity. The shorter the channel, the lower would be the market price.

5. Problems on payment

Delayed payments or non-payment of debts were usual problems shared by some assemblers. Retailers sell in cash, thus they did not experience this problem. None of the growers interviewed mentioned this problem.

6. Poor product handling

Product handling starts from harvesting, packing, hauling, loading, transporting and unloading. Improper handling during any of these activities may have untoward effects on the quality of eggplant and therefore the value and the price of the commodity.

7. Spoilage

Since eggplant is highly perishable, packing and transporting should be taken into consideration. Packaging is usually in plastic bags which are stacked with 10-20 kgs of eggplant. Moisture inside the packed eggplants results to spoilage.

According to some traders, another cause of spoilage is when the eggplants are fertilized prior to harvesting. Fruits tend to have soft blotches after harvest. There is also wilting during transport due to the moistening of plastic bags aggravated by the presence of fertilizer residues.

8. Costs on illegal fees

Some trader-respondents mentioned as additional marketing costs illegal fees (*"tong"* or *"kotong"*) imposed by some policemen in delivering eggplants to Metro Manila.

External Influences

1. Extreme weather events

Typhoon was one of the causes of eggplant farm damage in Pangasinan. There were instances when the farmers have already invested a lot of inputs but the typhoon damaged the standing crop and they were not able to recover the costs. Adaptation strategies must be identified to help farmers reduce risks and cope with climate change impacts. Some farmers feel though that if one season's crop fails, they should not lose hope as losses can be recovered in the next season(s) since planting eggplant is indeed a profitable endeavor.

2. Lack of regulatory mechanism on eggplant price

Like palay, farmers would like some regulatory measures to protect them from very low price of eggplant to help them recover their production cost. Moreover, there is no formal mechanism (government or private) that governs the supply chain as the players are apparently operating on their own. The overlapping or redundant layers of actors in the supply chain increase the retail price to consumers.

Appropriate strategies for pricing, e.g., cost-based pricing, should be considered to assure players of adequate net income margins above production costs, and adequate returns on investment.

3. Use of more environment-friendly packaging

With rising consciousness for the environment, there must be a policy promoting the use of biodegradable package, instead of plastic bags, in transporting eggplants.

4. Lack of knowledge/skills for alternative cropping

Eggplant growers generally practice monocropping, thus are very vulnerable if eggplant farming fails. Farmers should diversify crops planted.

Summary, Conclusions, and Recommendations

This study analyzed the existing supply chains of eggplant in Pangasinan (in Region 1) and Quezon (in Region 4A) to help identify areas for improvement. To achieve this, trend, costs and returns, efficiency, and descriptive analyses were done. A total of 25 farmers and 28 traders in Pangasinan, and 23 farmers and 31 traders in Quezon were surveyed in addition to interviews of key informants in some areas.

Product Flow and Key Players

Majority of the marketable surplus of the two study sites went to Metro Manila. In general, Metro Manila gets its supply of eggplant from Pangasinan during December to March; from Nueva Ecija in March to June; and from Quezon during July to November when the supply of eggplant is high and prices are low.

The general flow of eggplant was from farmers to assembler-wholesaler to wholesaler-retailers and consumers. From wholesaler-retailers, the eggplant goes to retailers and consumers. In Dolores, Quezon, there is a dicer who helps the assembler-wholesalers find sources of eggplant in the area.

Activities and processes along the eggplant supply chain span from farm production and harvesting; post-harvest practices such as sorting, packaging, hauling, transporting to trading posts; distributing to wholesalers, retailers, institutional buyers; and selling to final consumers.

Product Requirements

In the two study provinces, customers (traders and consumers) select eggplants based on fruit qualities. Consumers' criteria include: fruit color (purple or green); shape (cylindrical, oblong, or round); and size (long and heavy). Based on retailers' classification, large (*primera*) eggplant is 11-12 inches (28-30 cm) long; medium (*segunda* or semi) is 8-10 inches (20-25 cm); and small (*tercera*) is below 8 inches (below 20 cm). Weight is based on the number of fruits per kilogram, e.g., a kilogram of large eggplants may have 6 pieces (pcs); medium (8 pcs); and small (12 pcs). The market in general prefers the hybrid, purple, and elongated eggplant.

Eggplant Supply Chains

In Pangasinan, 13 supply chains were identified. All these supply chains passed through the assembler-wholesalers in Villasis or Urdaneta City who distributed the product to wholesalers and/or retailers in Metro Manila major markets such as Divisoria and Balintawak, and other markets such as Baguio, Tanauan City and Tagaytay City. Of the key players in the supply chains identified, the assembler-wholesaler in Villasis had the highest volume of eggplants procured with around 8 m tons per day.

On the other hand, 15 supply chains were identified in Quezon. The number of marketing intermediaries ranged from two to four, with the shortest chains in the Dolores, Quezon to Tanauan City supply chain and in the Dolores, Quezon to Balintawak, Quezon City chain. The two supply chains starting from Sariaya both have three middlemen. The highest volume procured was about 12 m tons per day by assembler-wholesalers.

Information Flow

Information on supply. Traders such as the assembler-wholesalers and wholesaler-retailers get information on supply of eggplant from growers or co-traders. Social capital is strong as tie up between farmers and buyers and among traders is built on personal relationships (e.g., godparents, relatives, or friends) and trust. Negotiations are very casual or informal and could be made through text messaging or phone calls.

The decision as to where to sell the eggplant would be logically based on the volume of supply as well as prevailing price in the market. Assemblers and wholesalers have to decide as to whether to bring the eggplants procured from the growers to Tanauan City, Sariaya, Divisoria, or Balintawak.

Price information. Market prices normally depend on the intervention of supply and demand forces. Buying and selling prices of eggplant are based on the prevailing prices in major markets or trading posts. In Villasis, the LGU also put up a billboard in the trading post to announce prevailing prices.

The flow of price information moves backwards from the last segment of the supply chain to eggplant producers. The buyers usually set the price of eggplant. Growers validate their price information from co-farmers and other traders in the area. Some trader-respondents commented that cell phones have somehow adversely influenced strategizing on price since speculation is diminished.

Technical information. Information about cultural practices in eggplant farming and knowledge in buying and selling practices of traders are sourced from parents and relatives, gained experience over time, co-growers and co-traders and seed and chemical companies. Technical assistance to eggplant growers are likewise extended by some local government units.

Payment Flow

Eggplant growers in Pangasinan need a starting operating capital of about PhP25,000 per ha for farm inputs such as seeds, fertilizers and chemicals. Quezon growers require a higher starting capital of PhP60,000 as they also have to pay for the use of the land. Growers are usually paid in cash right after the buyers pick up of the eggplants at the farm. Complaints about rejects included in the packs are settled by giving discounts to buyers or replacing the quantity of rejects with good ones the next time around.

Wholesalers are paid in cash by wholesaler- retailer or after the eggplants have been sold. Retailers sell on cash basis to final consumers.

Cost and Return Analysis

Cost and return analysis for eggplant farmers revealed that growers in Pangasinan realized a net farm income of PhP120,089 per ha per year or PhP3.83/kg as compared to PhP253,393 or PhP7.50/kg for growers in Quezon. This could be attributed to the high production costs particularly pesticide inputs. Transport cost in procuring and selling eggplant constituted 1%-55% for Pangasinan traders and 1%-50% for Quezon traders. It was estimated that for every peso spent on production and marketing of eggplant, growers earned PhP1.06 in Quezon and PhP0.27 in Pangasinan. Average per-kilogram farm price was PhP18.08 in Pangasinan and PhP14.23 in Quezon.

Generally, the farmers in Pangasinan got the highest net income (as high as PhP11.17/kg accounting for 50% of the price margin) among the market players. Similarly, farmers in Quezon received the highest net income among the players (as high as PhP26.17/kg accounting for 81% of the price margin). For the Pangasinan supply chains, the wholesaler-retailer in Cavite had the higher average net income of PhP23.68/kg if eggplant is sold to restaurants than selling to wholesaler-retailer where average net income ranged from PhP13.00 to PhP18.00/kg. In Quezon, assembler-wholesalers get profits ranging from PhP0.88 to PhP6.14/kg; wholesalers, PhP0.40-4.31/kg; wholesaler-retailer, PhP0.84-10.66/kg; and retailer, PhP0.59-13.64/kg.

Efficiency Analysis

Inefficiency within the eggplant supply chains in Quezon is very minimal. Growers experience spoilage due to fruit and shoot borer while traders experience spoilage/rejects due to blotches and early rotting of eggplants when fertilizers were applied a day before harvest. Another cause of spoilage would be the improper sorting, grading or handling.

In Pangasinan, inefficiencies in the supply chains were characterized by high production input costs and spoilage due to pests and diseases. Traders implement stricter grading and sorting of eggplants, resulting in high volume of rejects to farmers. Second class and third class eggplant were marketable only if supply is relatively low.

Logistics Issues/Concerns and External Influences

Inbound logistics were found to be infestation of pests and diseases and farmers' inadequate knowledge of appropriate practices, poor quality of inputs and other farm resources, and rising cost of inputs. On the other hand, outbound logistics and marketing concerns consist of variability of market prices, problems on payment, poor product handling, food safety concerns, high perishability of eggplant, redundant players within the chain, and costs on illegal fees.

External influences affecting production and marketing of eggplant were extreme weather events, lack of regulatory mechanism on eggplant price, appropriate strategies for pricing, use of more environment-friendly packaging, and lack of knowledge/skills for alternative cropping.

One emerging concern is the heavy application of pesticides in the study areas. This should call the attention of local government units which are in the forefront of providing extension services. There should be farmer training on integrated pest management, and use of alternative pest control strategies, e.g., intercropping with other crops. A mechanism to monitor pesticide usage should also be established. The BPI in coordination with the LGUs through their agricultural technicians can play an important role in this.

Research and development (R&D) should continuously receive adequate support to address these concerns. R&D thrusts could include varietal improvement of eggplant and safer pest control technologies. If *Bt* eggplant seeds would be commercialized, dependence of farmers on pesticides and hazards to public health and the environment would be greatly reduced. Although its release would require rigid tests and procedures, monitoring the socioeconomic and environment impacts of its use should be sustained over the years. Also, development of drought-tolerant varieties should be pursued to address water supply problem particularly in rainfed areas.

The main marketing problem reported was the low market price of eggplant during times of oversupply. Thus, the need to put up a processing center for eggplant in the area was raised.

Adaptation strategies must be identified to help farmers reduce risks and cope with climate change impacts. For instance, crop insurance scheme for eggplant growers should be explored.

Lastly, the establishment of traders' associations can help reduce layers in marketing channels and costs, and regulate prices. Similarly, a study on the establishment of eggplant growers' cooperative or association would aid in improving access on production inputs, production practices, and marketing.

References

Agricultural Biotechnology Support Project (ABSP) II. *Fruit and Shoot Borer Resistant (FSBR) Eggplant. Project Profile.* http://www.absp2.cornell.edu/projects/ project.cfm?productid=2. July 27, 2010.

Brown, E. and E. Esguerra. 2007. *Supply Chain Improvement for Mangoes in the Philippines.* Annual Report.

Food and Agriculture Organization of the United Nations FAOSTAT 2013. http://faostat3.fao.org/faostat-gateway/go/to/download/Q/QC/E. Accessed January 1, 2014.

Guiamal, M. 2008. *Supply Chain Improvement for Goat in Selected Areas in the Philippines (Phase I): An Evaluation (Region 12).* Terminal Report. Submitted to PCARRD.

Hautea, D.M. and J.O. Narciso. 2007. *Questions and Answers on the Development of Fruit and Shoot Borer Resistant Eggplant in the Philippines.* IPB-UPLB-ABSPII.

Oracion, E. 2008. Supply Chain Analysis for Coconut Oil and By-Products in Central Visayas, Philippines. A Project Proposal submitted to PCARRD.

Porter, M.E. 1985. *Competitive Advantage, Creating and Sustaining Superior Performance.* New York: The True Press.

Soliven, M.L.R., A.L. Deriada, and T.A.S. Rivera. 2009. Supply Chain Improvement for Fresh Vegetables in Region X. Paper presented at the PAEDA Convention held at the Bureau of Soils and Water Management, October 22.

Appendix Figure 1. Supply Chain 1: Product flow, volume handled, and price/monetary flow of eggplant from Villasis, Pangasinan to Divisoria

Day 1

Growers, Villasis, Pangasinan
Vol. (Good): 80 kg-6,000 kg/month; Ave.: 3,788.40 kg/month
Production Months: July 2010-April 2011
Selling Price: Php 3.00 – Php 32.00; Ave.: Php 19.41/kg

Vol. (Semi): 240 kg-2,400 kg/month; Ave.: 855 kg/month
Production Months: August 2010-February 2011
Selling Price: Php 2.50 - Php 3.38/kg

Vol. (Reject):60-1365.00 kg/month, Ave.: 375.12 kg/month
Production Months: August 2010-February 2011
Selling Price: Php 2.50 – 7.50/kg

Spoilage: 0.96% - 10% of harvest

↓

Day 1

Assembler-Wholesaler
(Ms. Fabro, Mrs. Mira, Mrs. Sarmiento, Mr. Meniano, Mrs. Andaya, Mrs. Almiron), Villasis Bagsakan

Vol. (Good): 150 kg-8000 kg/day/AW; Ave.: 2,321 kg/day/AW
Buying Price: Php 3.00 – Php 40.00/kg
Selling Price: Php 4.00 – Php 42.00/kg

Vol. (Semi): 80 kg-600 kg/day; Ave.: 289.29 kg/day;
Production Months: August 2010-February 2011
Buying Price: Php 2.50 - Php 5.00/kg
Selling Price: Php 4.50 – Php 7.00/kg

Vol. (Reject):40-100 kg/day, ave.
Production Months: August 2010-February 2011
Buying Price: Php 2.50 – Php 4.50/kg
Selling Price: Php 4.50 – Php 6.50/kg

Spoilage: 3-20% of volume, most were cut into "pinakbet" and sold at buying price

↓

Day 1

Wholesaler-Retailer, Divisoria
Vol. (Good): 750 kg for wholesale, 2250 kg for retail daily
Buying Price: Php 4.00 – Php 42.00/kg
Selling Price: Php 9.00 – Php 47.00/kg, wholesale
Php 11.00 – Php 49.00/kg, retail

Vol. (Semi): 500 kg daily, wholesale only
Buying Price: Php 4.50 – Php 7.00/kg
Selling Price: Php 7.00 – Php 9.50/kg, wholesale

Vol. (Reject): 500 kg daily, wholesale only
Buying Price: Php 2.50 – Php 4.50/kg
Selling Price: Php 5.50 – Php 7.50/kg, wholesale

Spoilage: 0.09% per day

↓

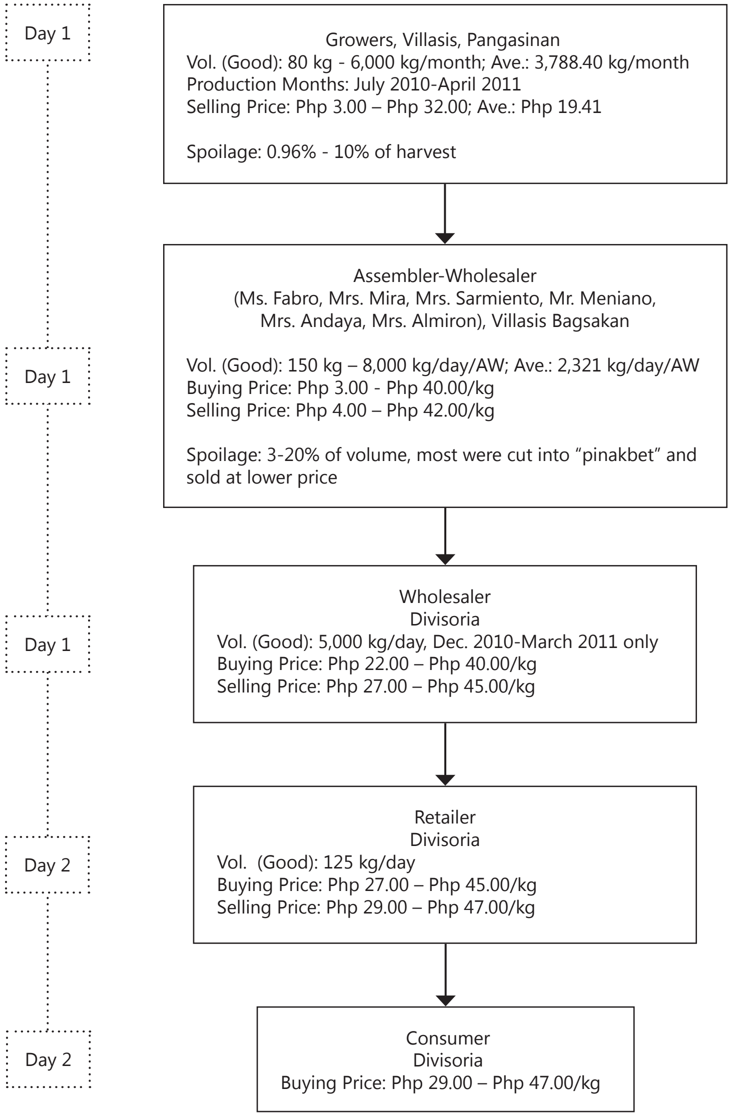
Day 1 – Day 2

Retailer
Divisoria
Vol. (mixed): 125 kg/day
Buying Price: Php 5.50 – 47.00/kg
Selling Price: Php 10.50-52.00/kg

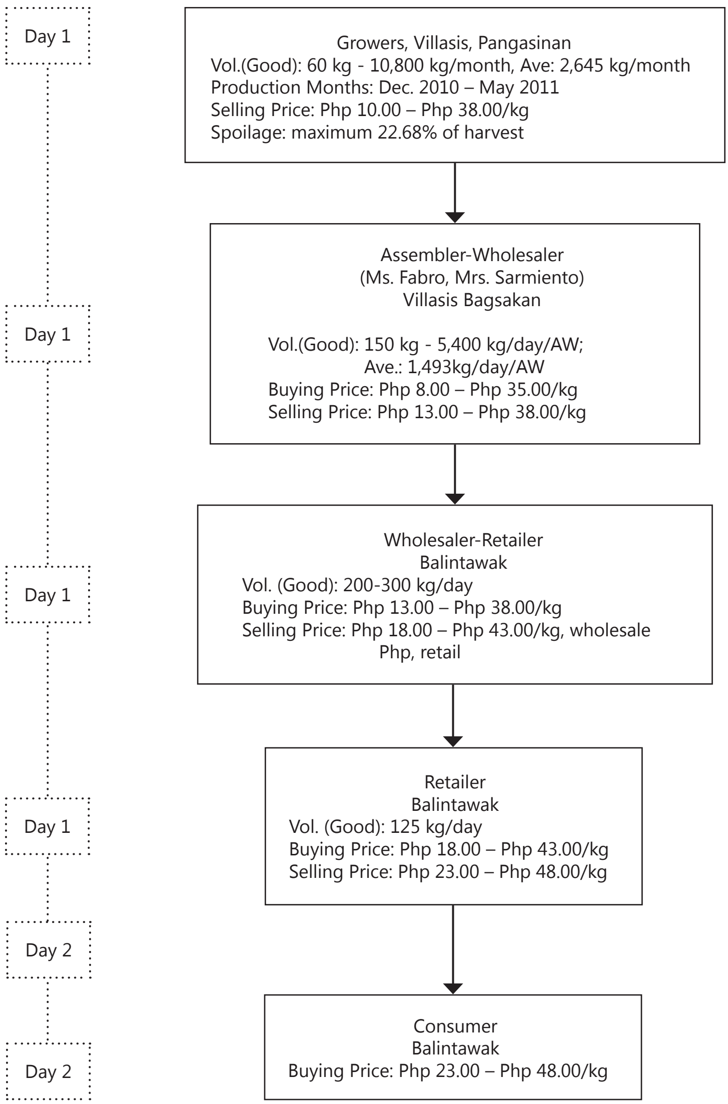
→

Consumer
Divisoria
Buying Price: Php 5.50 – 52.00/kg

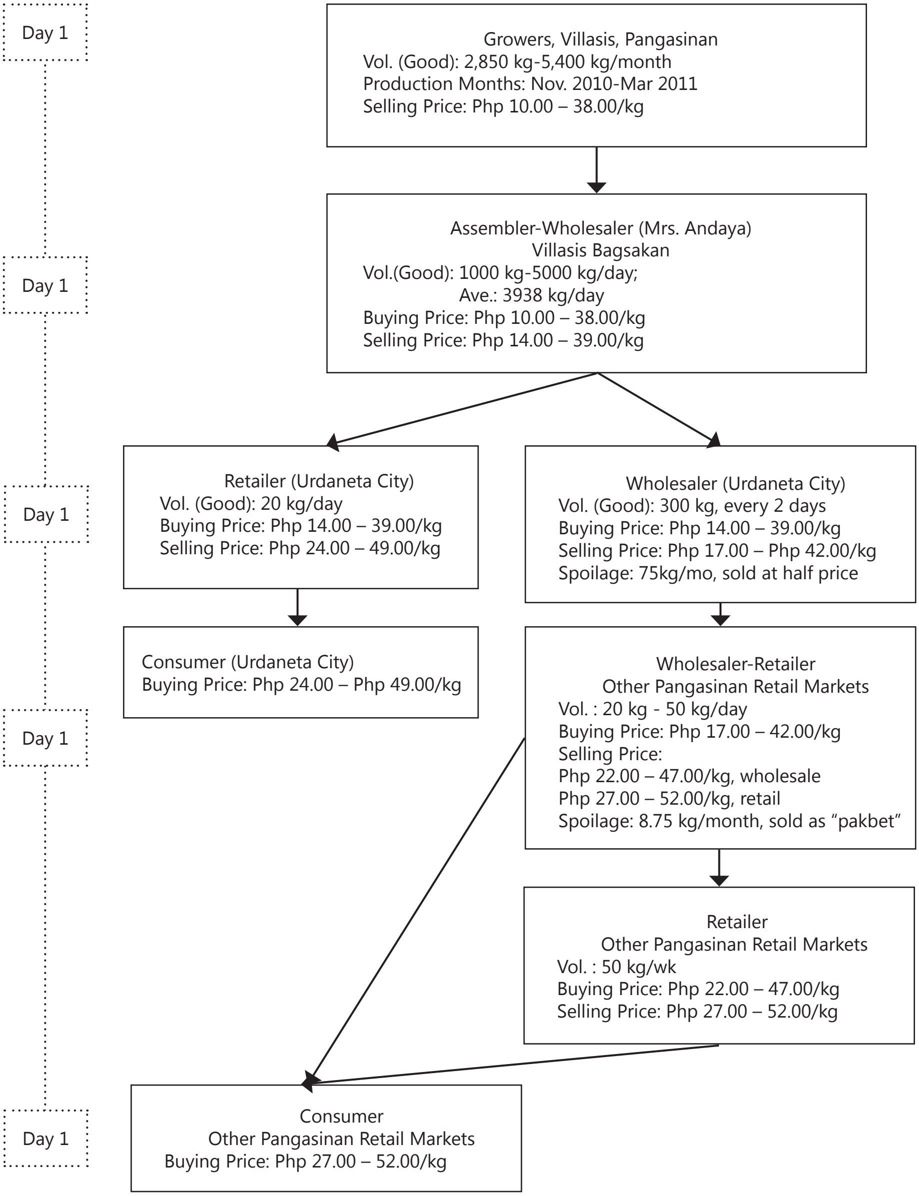
Appendix Figure 2. Supply Chain 2: Product flow, volume handled, and price/monetary flow of eggplant from Villasis, Pangasinan to Divisoria



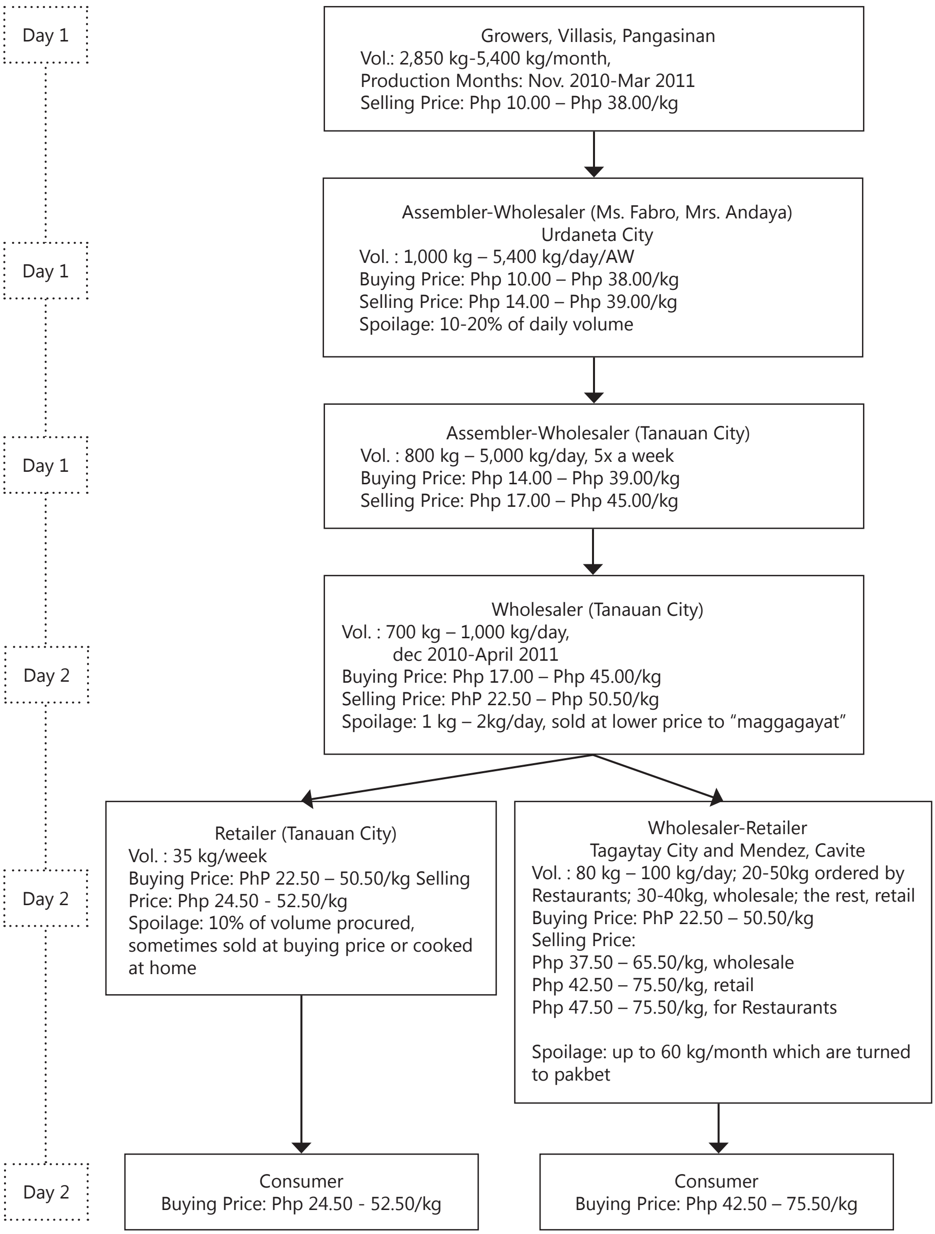
Appendix Figure 3. Supply Chain 3: Product flow, volume handled, and price/monetary flow of eggplant from Villasis, Pangasinan to Balintawak, Quezon City



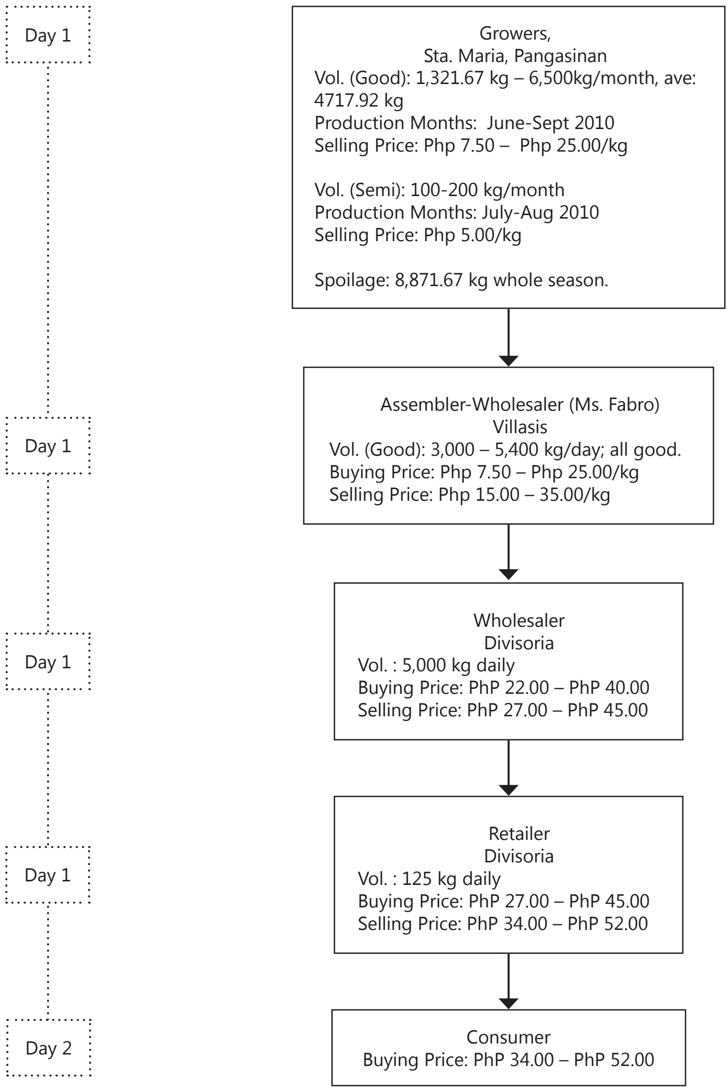
Appendix Figure 4. Supply Chain 4: Product flow, volume handled, and price/monetary flow of eggplant from Villasis, Pangasinan to Pangasinan retail markets (includes Urdaneta City, Lingayen, Dagupan City, and San Carlos City)



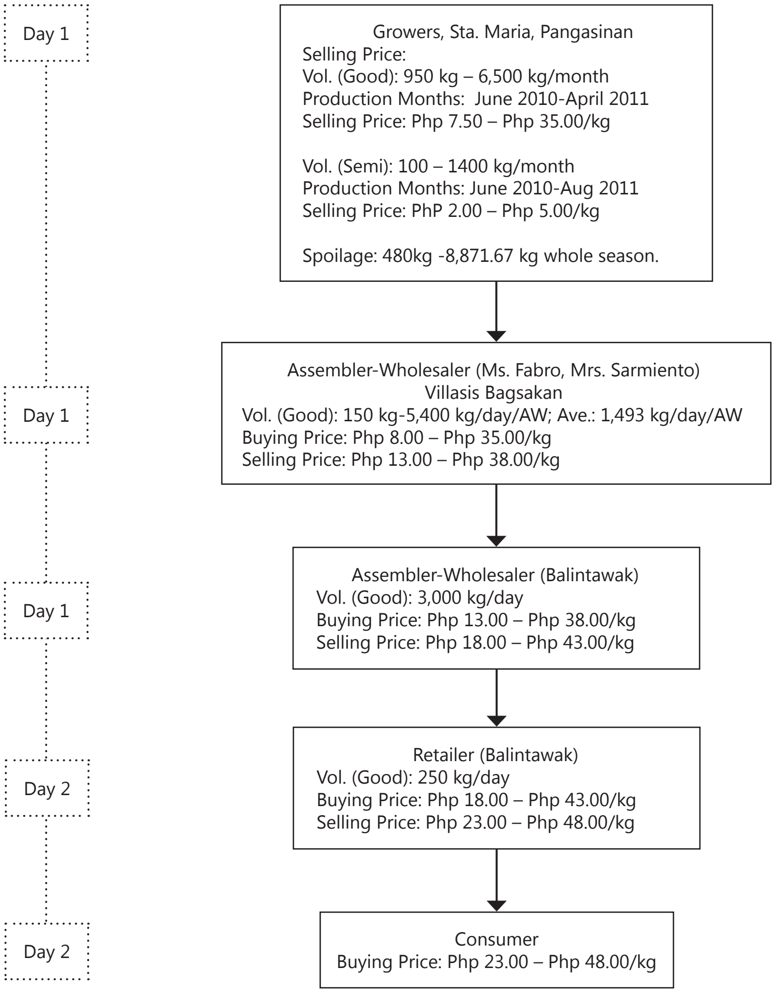
Appendix Figure 5. Supply Chain 5: Product flow, volume handled, and price/monetary flow of eggplant from Villasis, Pangasinan to Batangas and Cavite



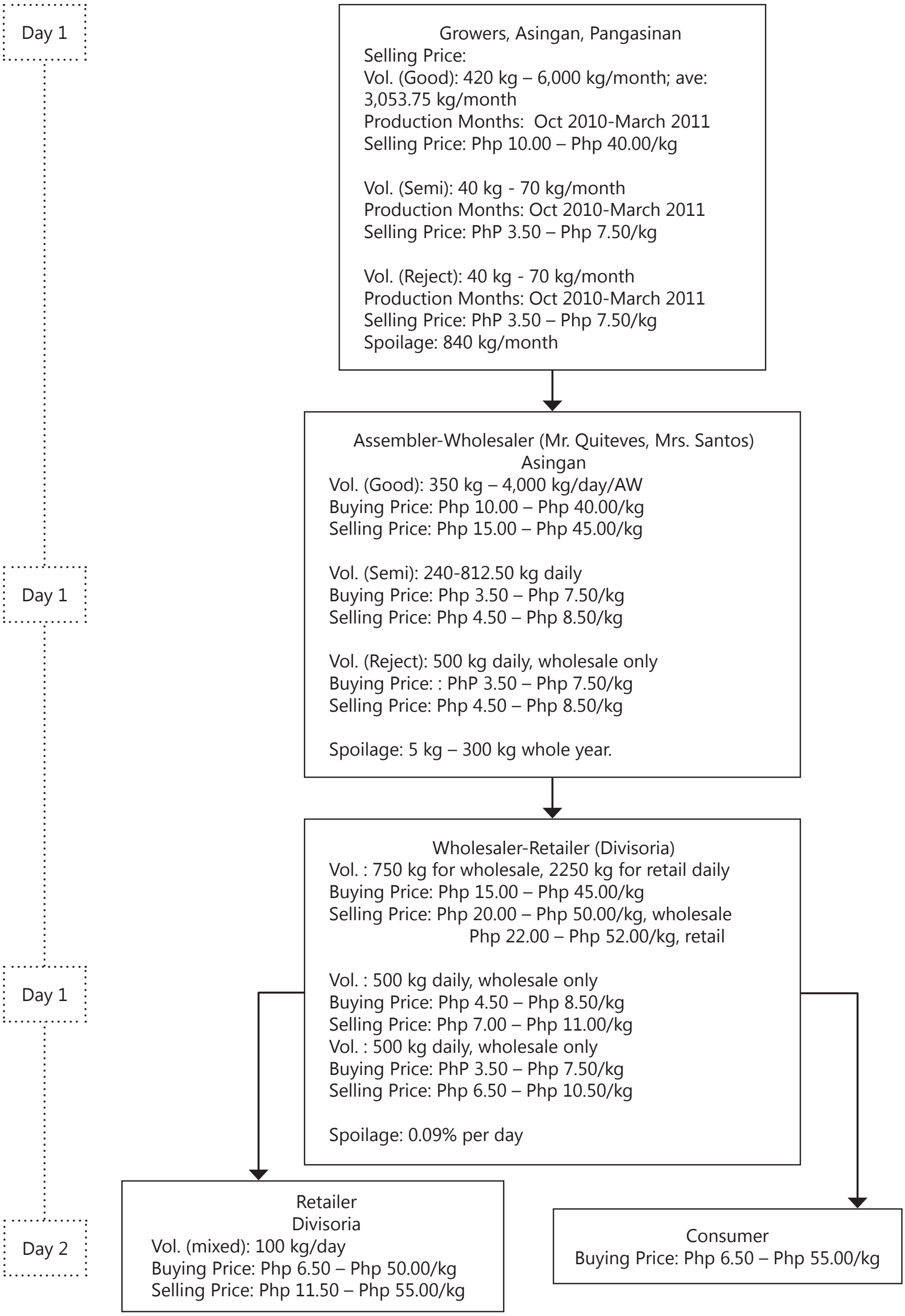
Appendix Figure 6. Supply Chain 6: Product flow, volume handled, and price/monetary flow of eggplant from Sta. Maria, Pangasinan to Divisoria



Appendix Figure 7. Supply Chain 7: Product flow, volume handled, and price/monetary flow of eggplant from Sta. Maria, Pangasinan to Balintawak



Appendix Figure 8. Supply Chain 8: Product flow, volume handled, and price/monetary flow of eggplant from Asingan, Pangasinan to Divisoria



Appendix Figure 9. Supply Chain 9: Product flow, volume handled, and price/monetary flow of eggplant from Asingan, Pangasinan to Divisoria

Day 1

Growers, Asingan, Pangasinan
Vol. (Good): 420 kg – 6,000 kg/month; Ave.: 3,142.50 kg/month
Production Months: Oct 2010 - March 2011
Selling Price: Php 10.00/kg – Php 40.00/kg;

Vol. (Semi): 40 kg - 70 kg/month; Ave.: 55 kg/month;
Production Months: Oct 2010 - March 2011
Selling Price: Php 3.50 – Php 7.50 /kg;

Vol. (Reject): 20 kg – 1,500 kg
Production Months: Oct 2010 - March 2011
Selling Price: Php 1.33 – Php 6.00/kg

Spoilage: 840 kg/month

↓

Day 1

Assembler-Wholesaler (Mr. Quiteves, Mrs. Santos)
Asingan
Vol. (Good): 350 kg – 4,000 kg/day/AW
Buying Price: Php 10.00 – Php 45.00/kg
Selling Price: Php 15.00 – Php 50.00/kg

Vol. (Semi): 240 kg - 750 kg/day
Buying Price: Php 3.50 – Php 7.50 /kg
Selling Price: Php 4.50 – Php 8.50/kg

Vol. (Reject):40-130 kg/day
Buying Price Php 1.33 – Php 6.00/kg
Selling Price: Php 2.83 – Php 8.50/kg

Spoilage: 5 kg – 300 kg whole season

↓

Day 1

Wholesaler (Divisoria)
Vol. (Good): 3000 kg for wholesale
Buying Price: Php 15.00 – Php 50.00/kg
Selling Price: Php 20.00 – Php 55.00/kg

Vol. (Semi): 500 kg daily, wholesale only
Buying Price: Php 4.50 – Php 8.50/kg
Selling Price: Php 7.00 – Php 11.00/kg

Vol. (Reject): 500 kg daily, wholesale only
Buying Price: Php 4.50/kg
Selling Price: Php 7.50/kg

Spoilage: 0.09% per day

↓

Day 2

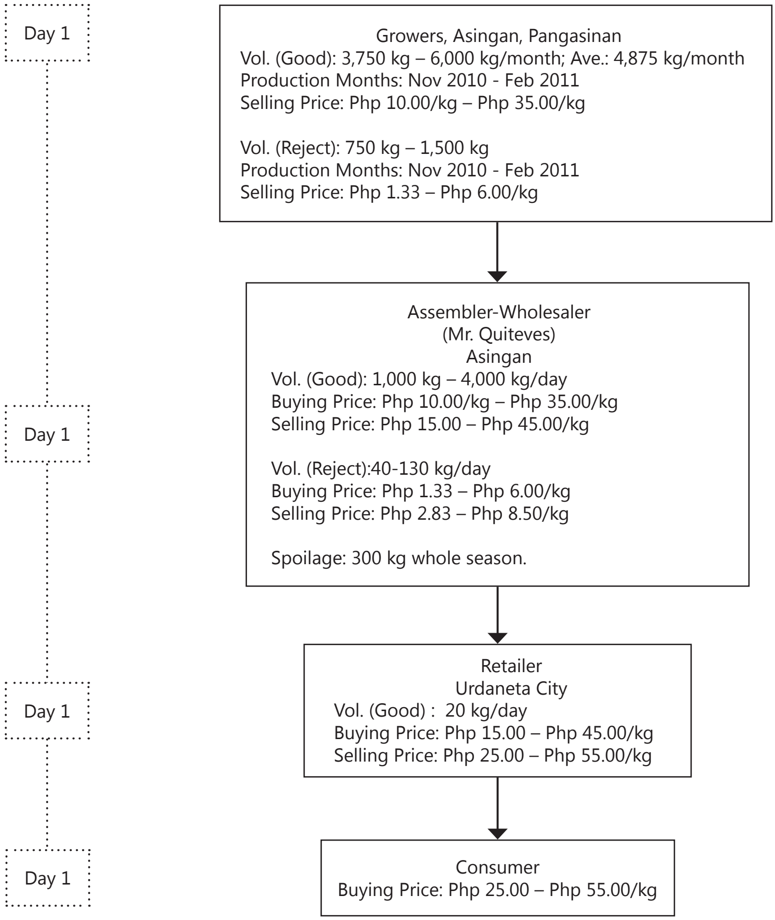
Retailer (Divisoria)
Vol. : 125 kg daily
Buying Price: Php 20.00 – Php 55.00/kg
Selling Price: PhP 27.00 – Php 62.00/kg

↓

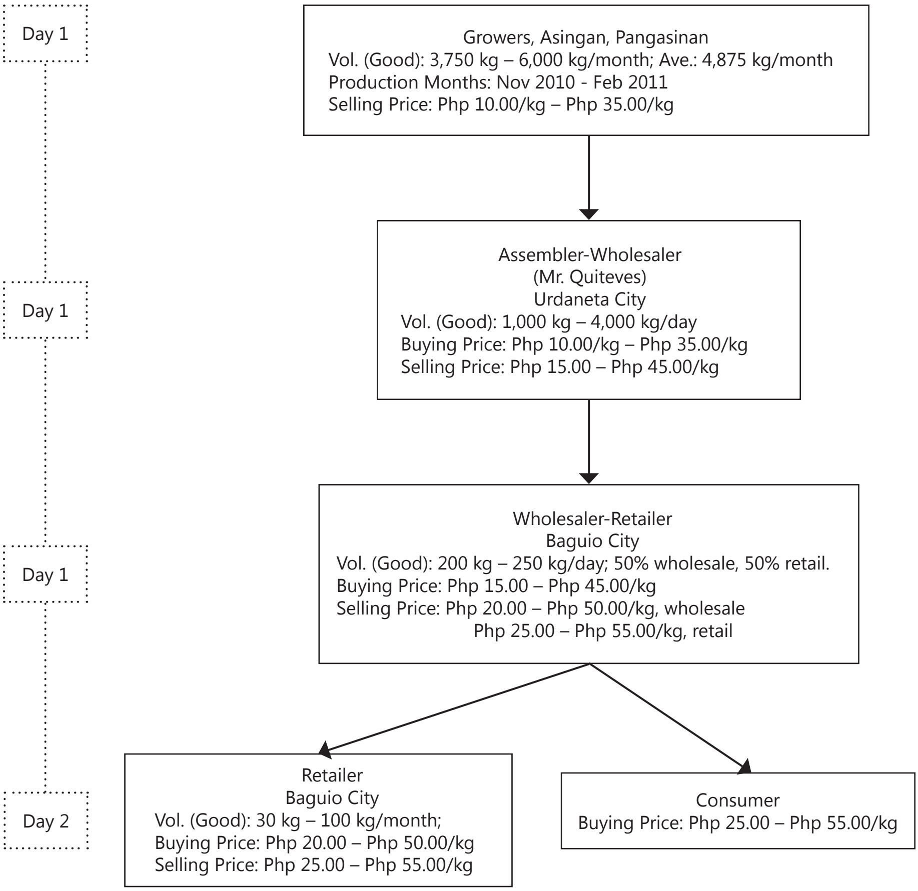
Day 2

Consumer
Buying Price: PhP 27.00 – Php 62.00/kg

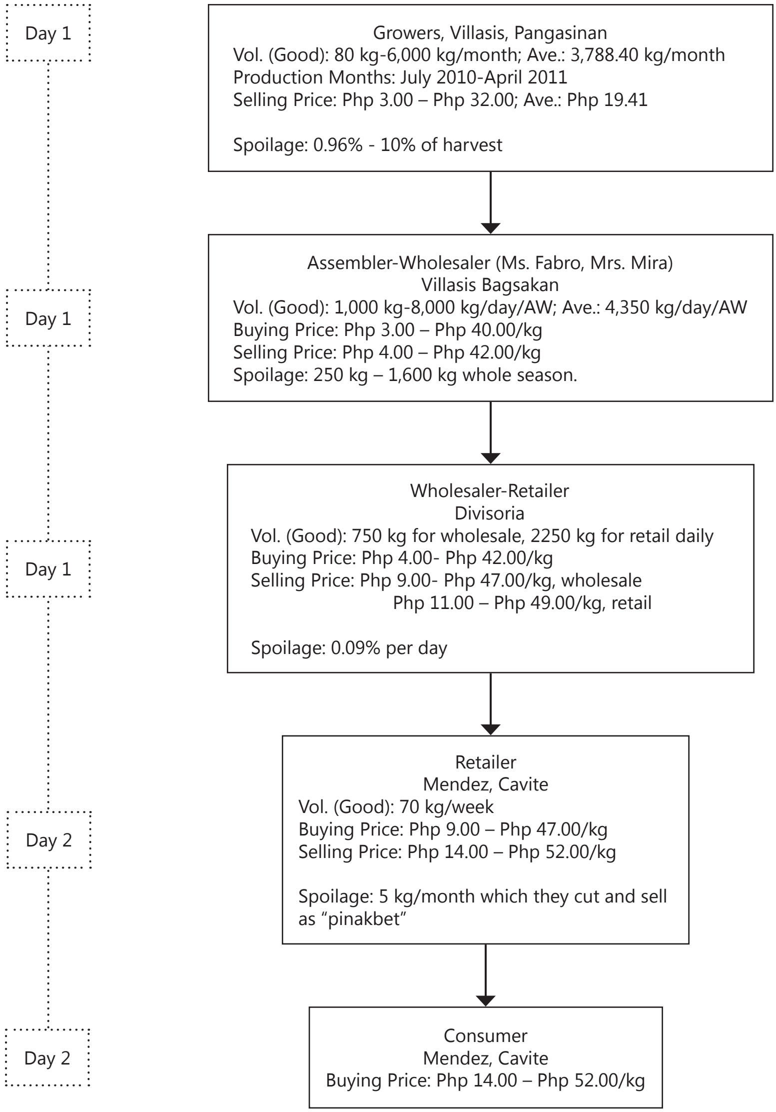
Appendix Figure 10. Supply Chain 10: Product flow, volume handled, and price/monetary flow of eggplant from Asingan, Pangasinan to Urdaneta City



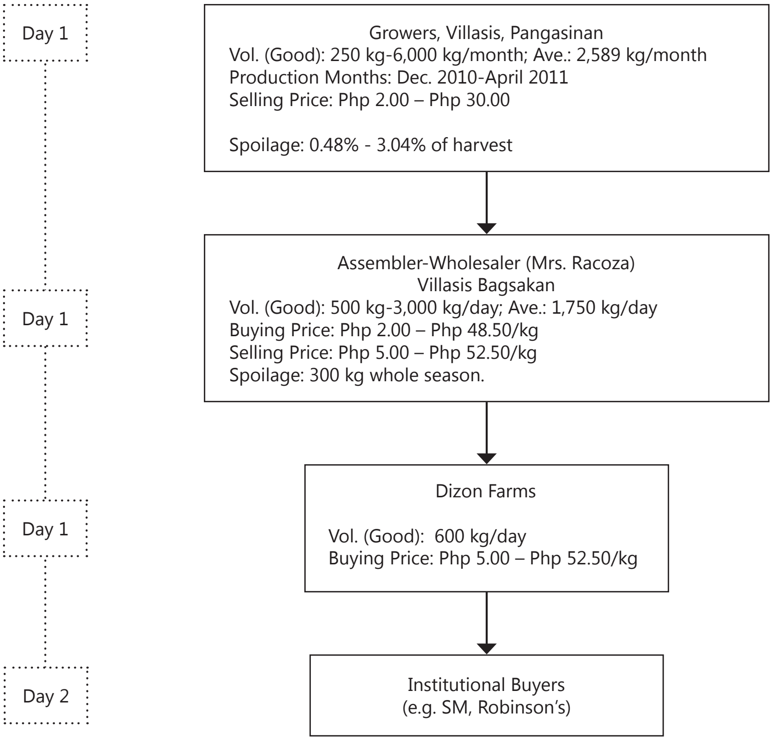
Appendix Figure 11. Supply Chain 11. Product flow, volume handled, and price/monetary flow of eggplant from Asingan, Pangasinan to Baguio City



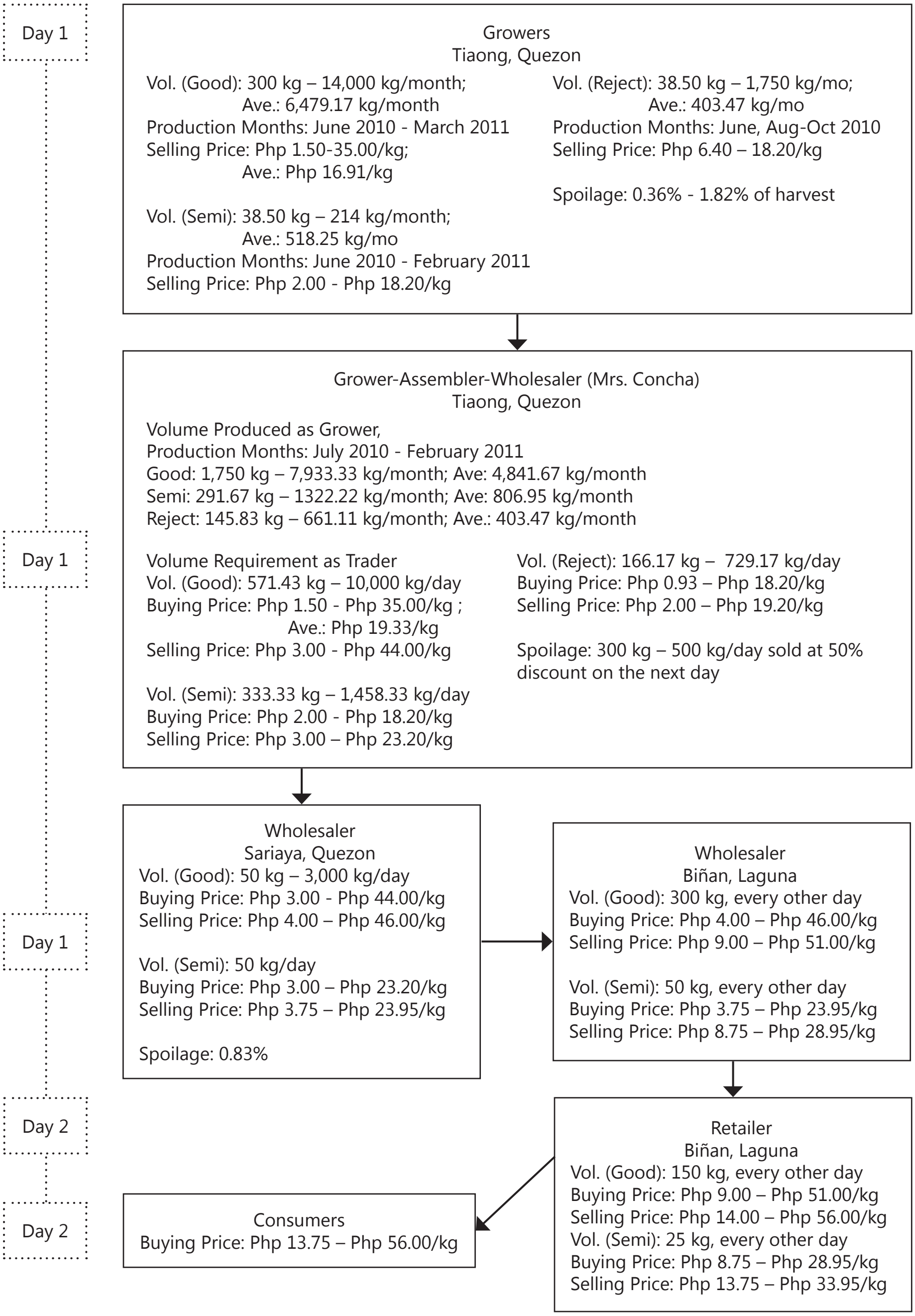
Appendix Figure 12. Supply Chain 12: Product flow, volume handled, and price/monetary flow of eggplant from Pangasinan to Mendez, Cavite



Appendix Figure 13. Supply Chain 13: Product flow, volume handled, and price/monetary flow of eggplant from Villasis, Pangasinan to an institutional buyer



Appendix Figure 14. Supply Chain 1: Product flow, volume handled, and price/monetary flow of eggplant from Tiaong, Quezon to Binan, Laguna through the Sentrong Pamilihan ng Produktong Agrikultura ng Quezon (SPPAQ) in Sariaya, Quezon



Appendix Figure 15. Supply Chain 2: Product flow, volume handled, and price/monetary flow of eggplant from Tiaong, Quezon to Divisoria

Day 1

Growers, Tiaong, Quezon

Vol. (Good): 392 kg – 17,500 kg/month; Ave.: 7,007 kg/month
Production Months: July 2010 - February 2011
Selling Price: Php 1.00- Php 35.00/kg

Vol. (Semi): 175 kg – 1,575 kg/month; Ave.: 704.67 kg/month
Production Months: September 2010 - February 2011
Selling Price: Php 2.67 – Php 4.00/kg

Vol. (Reject): 315 kg – 2625 kg/month; Ave.: 992.83 kg/month
Production Months: September 2010 - February 2011
Selling Price: Php 1.33 – Php 2.00/kg

Spoilage: 1.83% – 17.5%

↓

Day 1

Grower-Assembler-Wholesaler (Mrs. Garcia)
Tiaong, Quezon

Volume Produced as Grower,
Production Months: July - September 2010
Good: 5,250 kg – 14,000 kg/month; Ave: 9,625 kg/month

Volume Requirement as Trader
Vol. (Good): 3,000 kg– 12,000 kg/day,
Jul–Dec 2010; 3,000 kg, 14 times in January 2011
Buying Price: Php 1.00 - Php 35.00/kg
Selling Price: Php 3.40 – Php 37.40/kg

Vol. (Semi): 500 – 1,500 kg/day
Buying Price: Php 2.67 – Php 4.00/kg
Selling Price: Php 4.00/kg

Vol. (Reject): 315 kg – 2625 kg/month
Buying Price: Php 1.33 – Php 2.00/kg
Selling Price: Php 2.00/kg
Spoilage: 1,765 kg whole season.

↓

Day 1

Wholesaler (Divisoria)

Vol. (Good): 5,000, July – Nov 2010
Buying Price: Php 3.40 – Php 37.40/kg
Selling Price: Php 5.40 – Php 39.40/kg

Vol. (Semi): 500 – 1,500 kg/day, jul-aug 2010
Buying Price: Php 4.00/kg
Selling Price: Php 5.00/kg

Vol. (Reject): 500kg –1500 kg/day
jul-aug 2010
Buying Price: Php 2.00/kg
Selling Price: Php 2.00 – 3.00/kg

↓

Day 1

Retailer (Divisoria)
Vol. : 50 – 100 kg/day, mixed
Buying Price: Php 2.00 – Php 39.40/kg
Selling Price: Php 7.00 – Php 44.40/kg
Spoilage: 1-2 kg/week.

↓

Day 2

Consumer
Buying Price: Php 7.00 – Php 44.40/kg

Appendix Figure 16. Supply Chain 3: Product flow, volume handled, and price/monetary flow of eggplant from Tiaong, Quezon to Tanauan City, Batangas

Day 1

Growers (Tiaong, Quezon)

Vol. (Good): 300 kg – 14,000 kg/month;
Ave.: 4,468.75 kg/month
Production Months: June 2010 - March 2011
Selling Price: Php 1.50 – Php 35.00/kg;
Ave.: Php 16.91/kg

Vol. (Semi): 38.50 kg – 214 kg/month;
Ave.: 121.13 kg/mo
Production Months: June 2010 - February 2011
Selling Price: Php 2.00 - Php 18.20/kg

Vol. (Reject): 38.50 kg –125 kg/month
Production Months: June, Aug-Oct 2010
Selling Price: Php 6.40 – Php 18.20/kg

Spoilage: 0.36% - 1.82% of harvest

Day 1

Grower-Assembler-Wholesaler (Mrs. Concha)
Tiaong, Quezon

Volume Produced as Grower,
Production Months: July 2010 - February 2011
Good: 1,750 kg – 7,933.33 kg/month; Ave: 4841.67 kg/month
Semi: 291.67 kg – 1322.22 kg/month; Ave: 806.95 kg/month
Reject: 145.83 kg – 661.11 kg/month; Ave.: 403.47 kg/month

Volume Requirement as Trader
Vol. (Good): 571.43 kg – 10,000 kg/day
Buying Price: Php 1.50 - Php 35.00/kg ;
Ave.: Php 19.33/kg
Selling Price: Php 3.00 - Php 44.00/kg

Vol. (Semi): 333.33 kg – 1,458.33 kg/day
Buying Price: Php 2.00 - Php 18.20/kg
Selling Price: Php 3.00 – Php 23.20/kg

Vol. (Reject): 166.17 kg – 729.17 kg/day
Buying Price: Php 0.93 – Php 18.20/kg
Selling Price: Php 2.00 – Php 19.20/kg

Spoilage: 300 kg – 500 kg/day sold at 50% discount on the next day

Day 1

Wholesaler (Tanauan City)
Vol. (Good): 1,000 kg/day
Buying Price: Php 3.00 - Php 44.00/kg
Selling Price: Php 5.50 – Php 46.50/kg

Vol. (Semi): 300 kg/day
Buying Price: Php 3.00 – Php 23.20/kg
Selling Price: Php 3.75 – Php 23.95/kg

Spoilage: 1 kg – 2kg/day

Day 1

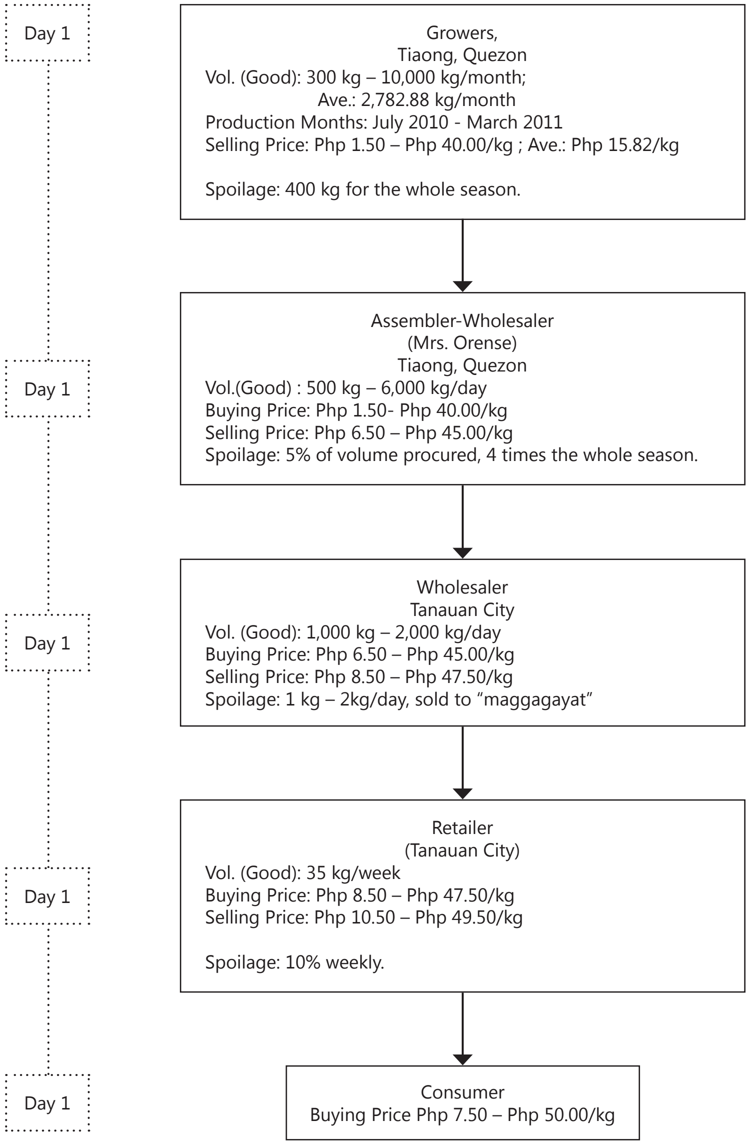
Retailer (Tanauan City)
Vol. (Good): 35 kg/week
Buying Price: Php 5.50 – Php 46.50/kg
Selling Price: Php 7.50 – Php 48.50/kg

Spoilage: 10%

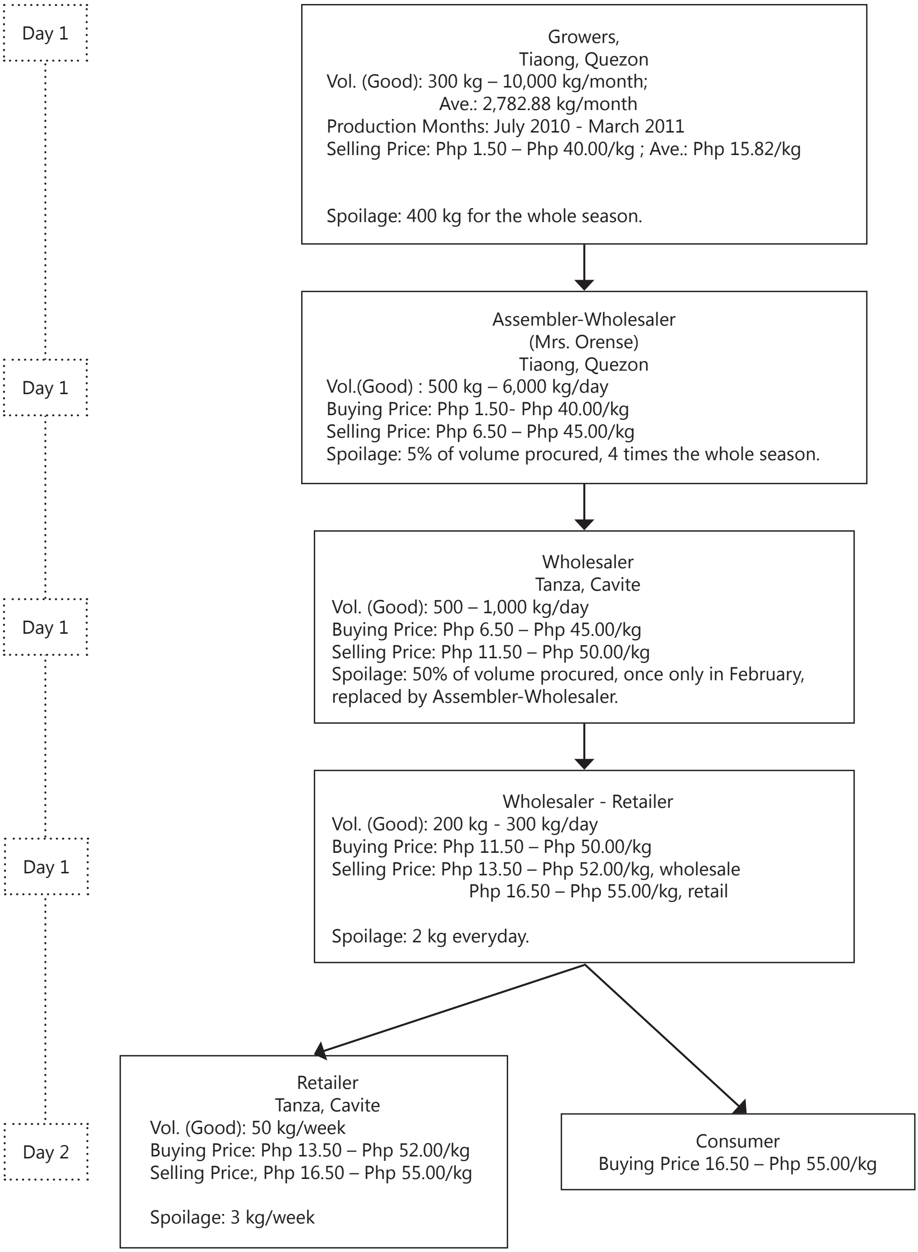
Day 1

Consumer
Buying Price: Php 7.50 – Php 48.50/kg

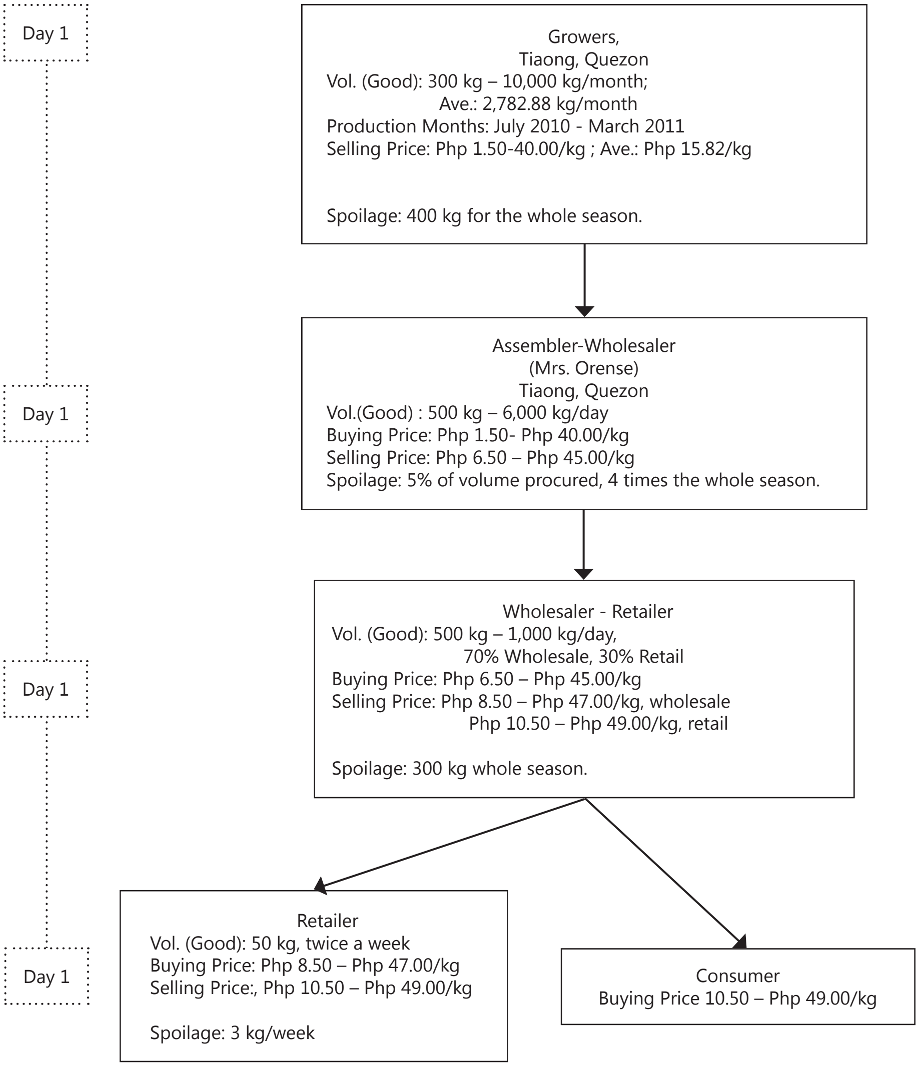
Appendix Figure 17. Supply Chain 4: Product flow, volume handled, and price/monetary flow of eggplant from Tiaong, Quezon to Tanauan City, Batangas



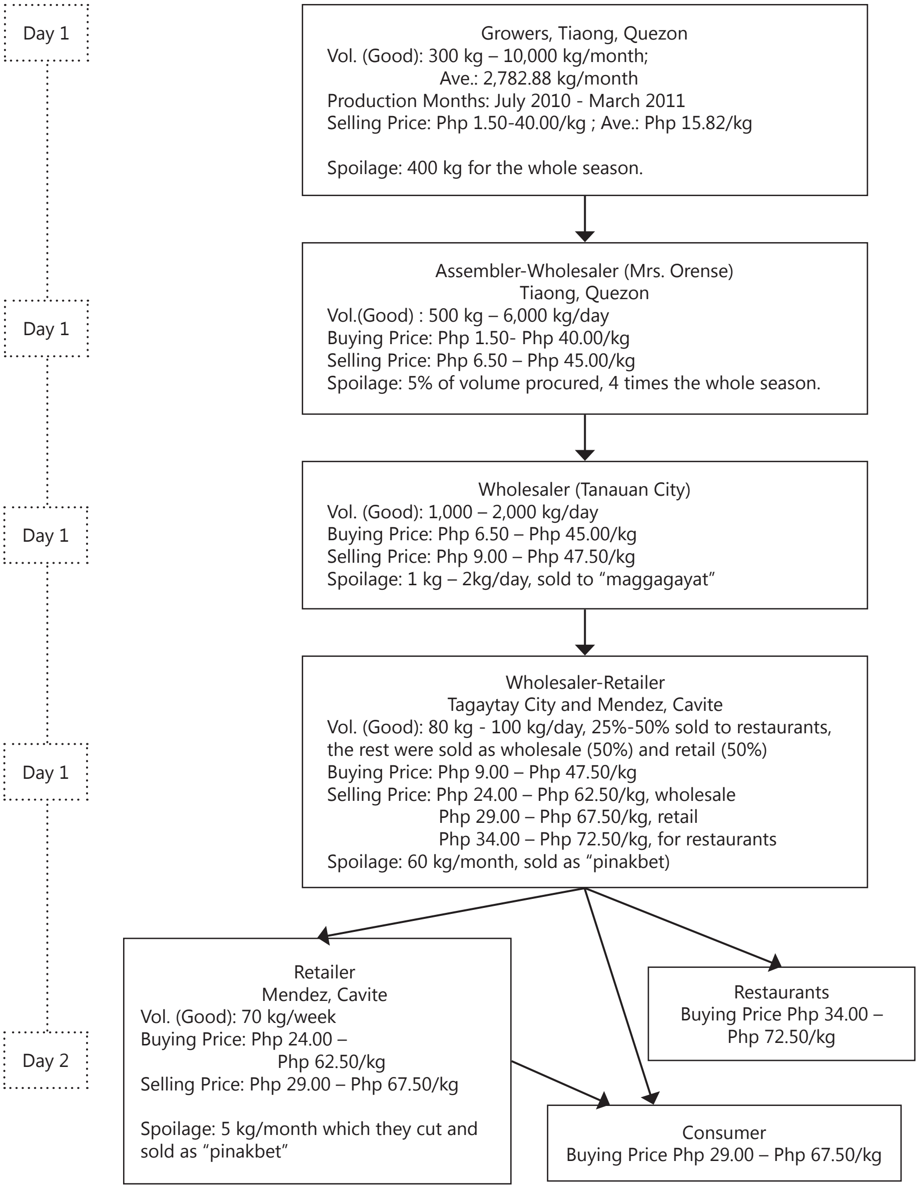
Appendix Figure 18. Supply Chain 5: Product flow, volume handled, and price/monetary flow of eggplant from Tiaong, Quezon to Tanza, Cavite through Tanauan City, Batangas



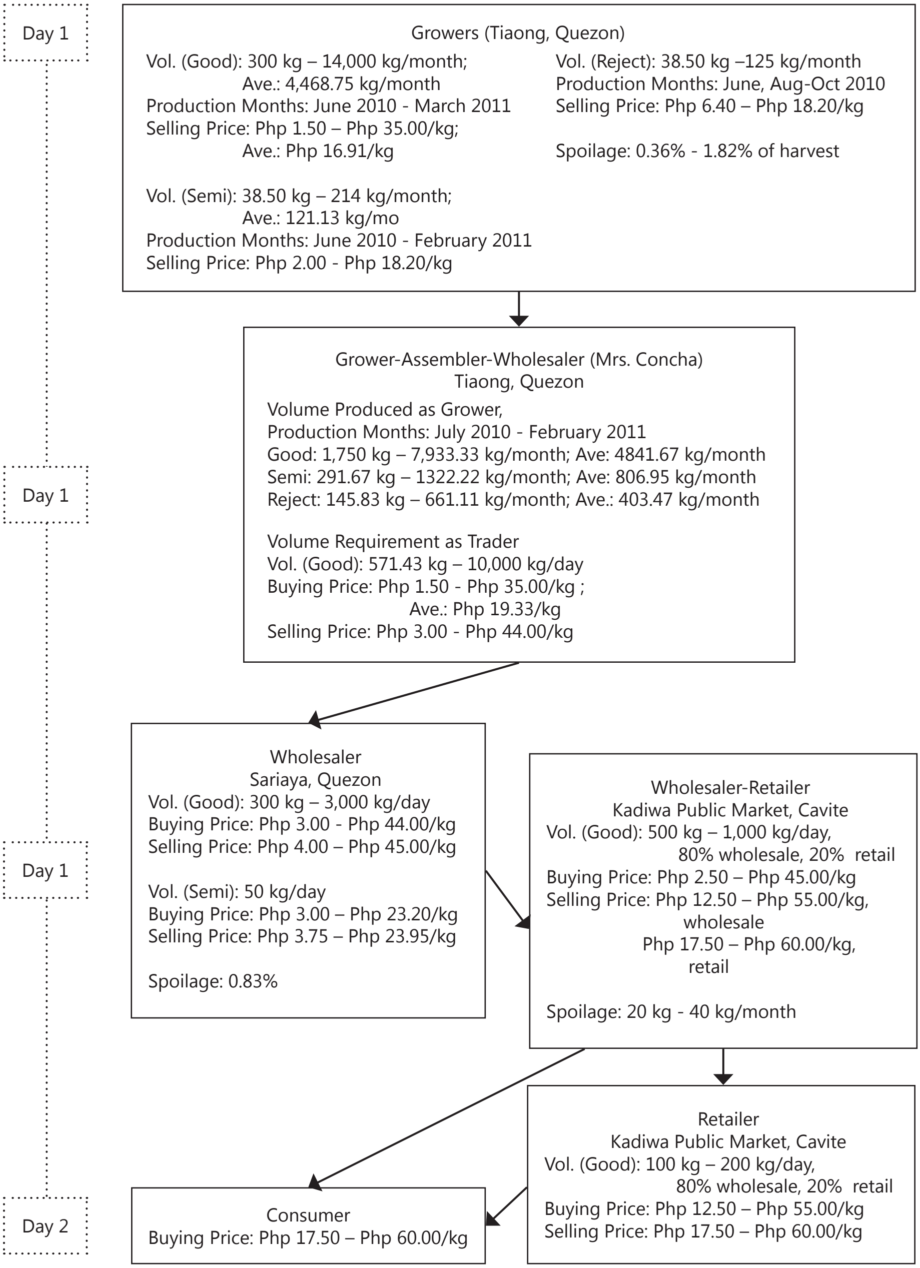
Appendix Figure 19. Supply Chain 6: Product flow, volume handled, and price/monetary flow of eggplant from Tiaong, Quezon to Tanza, Cavite through Tanauan City, Batangas



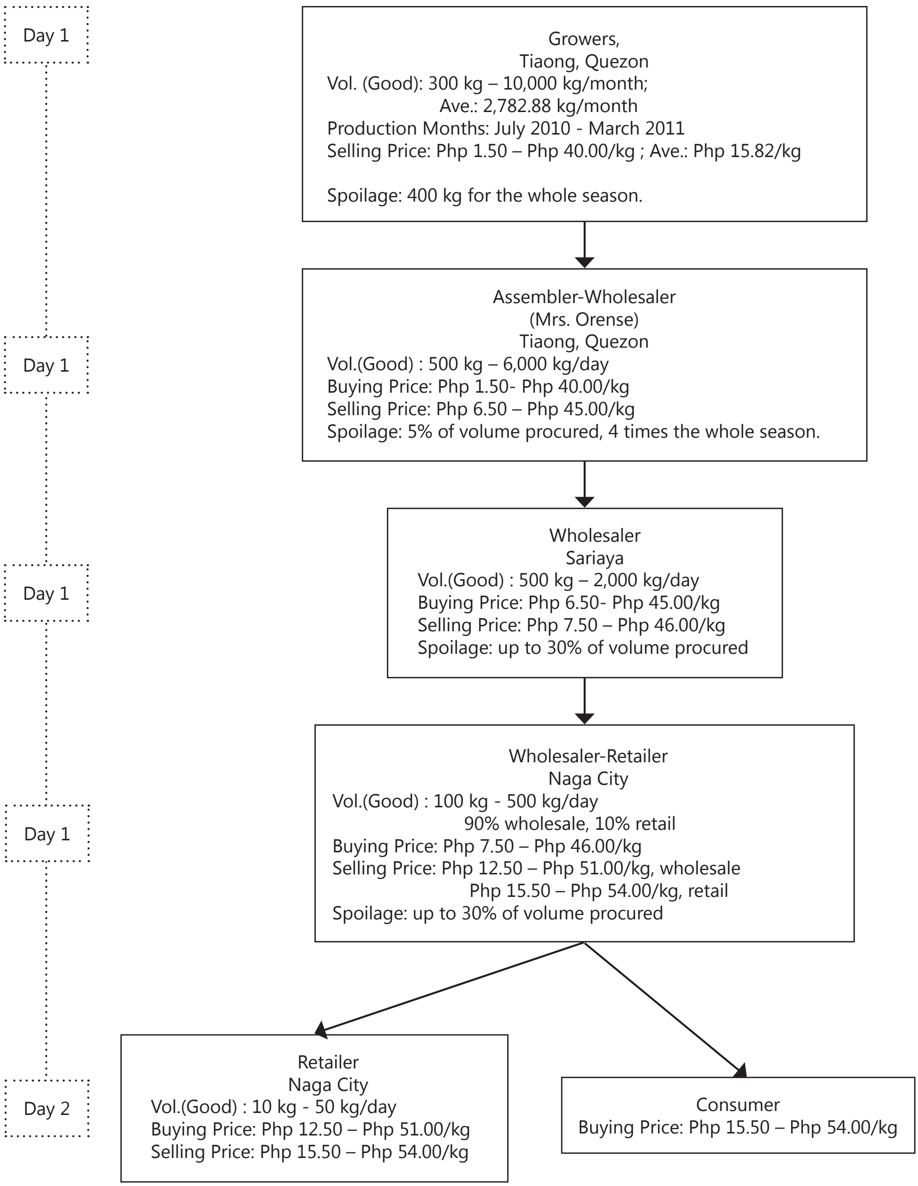
Appendix Figure 20. Supply Chain 7: Product flow, volume handled, and price/monetary flow of eggplant from Tiaong, Quezon to Tagaytay City and Mendez, Cavite



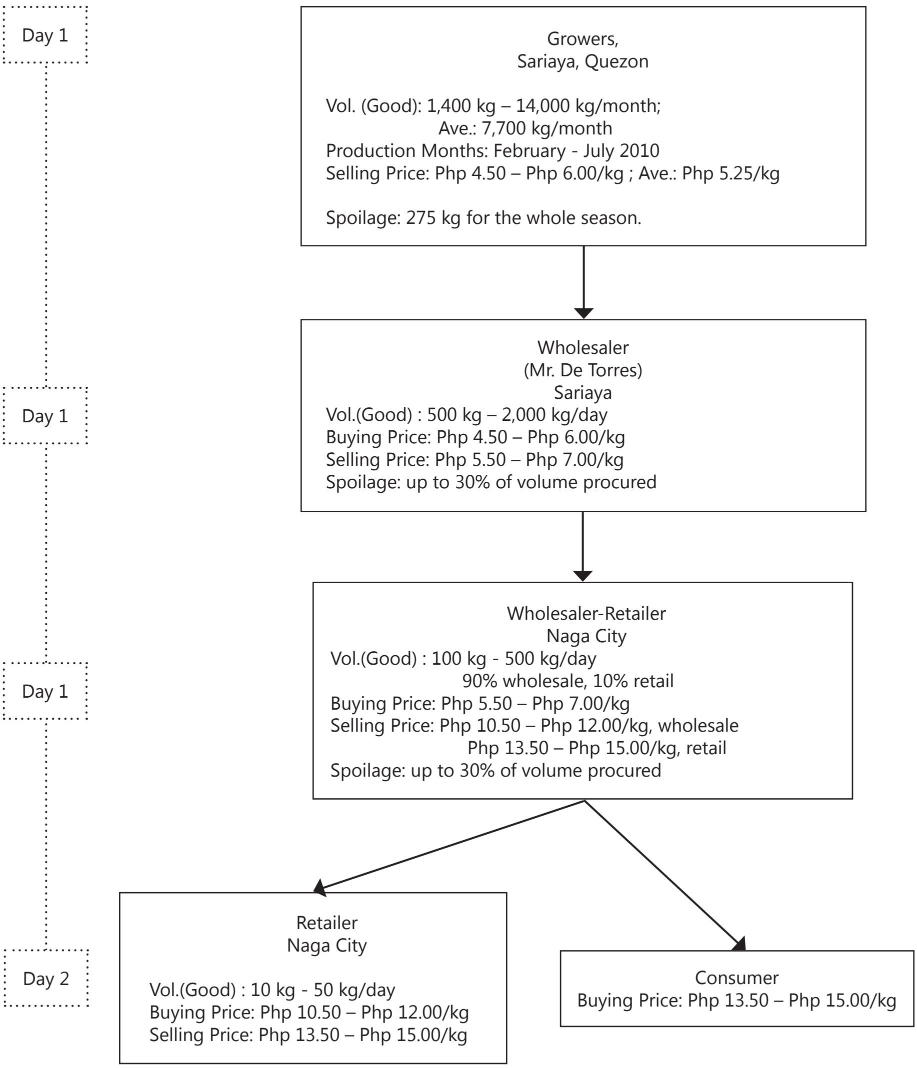
Appendix Figure 21. Supply Chain 8: Product flow, volume handled, and price/monetary flow of eggplant from Tiaong, Quezon to Kadiwa Public Market, Cavite through Sentrong Pamilihan ng Produktong Agrikultura ng Quezon (SPPAQ) in Sariaya, Quezon



Appendix Figure 22. Supply Chain 9: Product flow, volume handled, and price/monetary flow of eggplant from Tiaong, Quezon to Naga City, Camarines Sur through the Sentrong Pamilihan ng Produktong Agrikultura ng Quezon (SPPAQ) in Sariaya, Quezon



Appendix Figure 23. Supply Chain 10: Product flow, volume handled, and price/monetary flow of eggplant from Sariaya, Quezon to Naga City, Camarines Sur through the Sentrong Pamilihan ng Produktong Agrikultura ng Quezon (SPPAQ) in Sariaya, Quezon



Appendix Figure 24. Supply Chain 11: Product flow, volume handled, and price/monetary flow of eggplant from Sariaya, Quezon to Tanauan City, Batangas

Day 1

Growers (Sariaya, Quezon)

Vol. (Good): 210 kg – 12,000 kg/month;
Ave.: 5,227.5 kg/month
Production Months: December 2010 - March 2011
Selling Price: Php 25.00 – Php 40.00/kg ;
Ave.: Php 32.50/kg

Vol. (Semi): 52.50 kg – 75 kg/month;
Ave.: 63.75 kg/mo
Production Months: December 2010 - March 2011
Selling Price: Php 17.50/kg

Vol. (Reject): 17.50 kg - 25kg/month
Production Months: December 2010 – March 2011
Selling Price: Php 17.50/kg

Spoilage: 0.36% - 1.82% of harvest

Day 1

Grower-Assembler-Wholesaler (Mrs. Villamin)
Sariaya, Quezon

Volume Produced as Grower,
Production Months: July 2010-January 2011
Good: 2,500 kg – 6,000 kg/month; Ave: 4,250 kg/month

Volume Requirement as Trader
Vol. (Good): 1,000 kg – 4,000 kg/day
Buying Price: Php 25.00- Php 40.00/kg
Selling Price: Php 27.00 – Php 42.00/kg

Vol. (Semi): 52.50 kg – 75 kg/day
Buying Price: Php 17.50/kg
Selling Price: Php 19.50/kg

Vol. (Reject): 17.5 kg – 25 kg/day
Buying Price: Php 17.50/kg
Selling Price: Php 19.50/kg

Day 1

Wholesaler (Tanauan City)
Vol. (Good): 1,000 kg/day
Buying Price: Php 27.00 – Php 42.00/kg
Selling Price: Php 29.00 – Php 44.00/kg

Spoilage: 1 kg – 2kg/day

Day 1

Retailer (Tanauan City)
Vol. (Good): 35 kg/week
Buying Price: Php 29.00 – Php 44.00/kg
Selling Price: Php 31.00 – Php 46.00/kg

Spoilage: 10%

Day 1

Appendix Figure 25. Supply Chain 12: Product flow, volume handled, and price/monetary flow of eggplant from Dolores, Quezon to Tanauan City, Batangas

Day 1

Growers (Dolores, Quezon)

Vol. (Good): 280 kg – 6,300 kg/month;
Ave.: 2,355.5 kg/month
Production Months: July 2010 - March 2011
Selling Price: Php 3.00 – Php 35.00/kg;
Ave.: Php 21.00/kg

Vol. (Semi): 28 kg – 630 kg/month;
Ave.: 339.50 kg/mo
Production Months: September 2010 - February 2011
Selling Price: Php 4.67 – Php 30.00/kg;
Ave.: Php 17.33/kg

Vol. (Reject): 19.25 kg – 57.75 kg/mo
Production Months: September 2010 – February 2011
Selling Price: Php 2.00/kg

Spoilage: 1.83% of harvest

↓

Day 1

Grower-Assembler-Wholesaler (Mrs. Marasigan)
Dolores, Quezon

Volume Produced as Grower:
Production Months: July 2010-January 2011
Good: 300 kg – 3,500 kg/month
Semi: 75 kg – 525 kg/month
Reject: 8.25 kg – 57.75 kg/month

Volume Requirement as Trader
Vol. (Good): 1,000 – 4,000 kg/day
Buying Price: Php 3.00 – Php 35.00/kg
Selling Price: Php 4.00 – Php 39.00/kg

Vol. (Semi): 250 – 1,000 kg/day
Buying Price: Php 4.67 – Php 30.00/kg
Selling Price: Php 5.22 – Php 30.75/kg

Vol. (Reject): 17.5 kg – 25 kg/day
Buying Price: Php 2.00/kg
Selling Price: Php 2.75/kg

↓

Day 1

Retailer (Tanauan City)
Vol. (Good): 30 kg/day
Buying Price: Php 4.00 – Php 39.00/kg
Selling Price: Php 8.00 – Php 43.00/kg

Vol. (Semi): 15 kg/day
Buying Price: Php 5.22 – Php 30.75/kg
Selling Price: Php 7.00 – Php 33.25/kg

Vol. (Reject): 15 kg/day
Buying Price: Php 2.75/kg
Selling Price: Php 5.00/kg

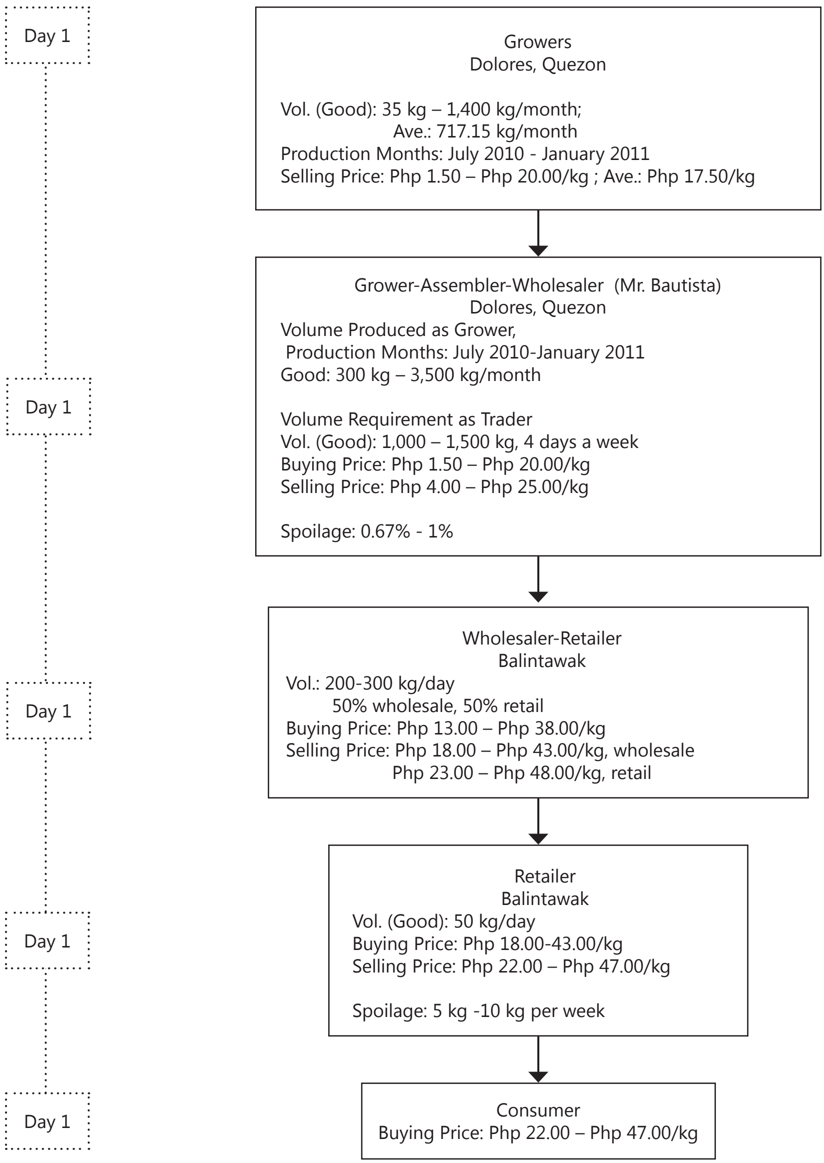
Spoilage: 5 kg -10 kg per week

↓

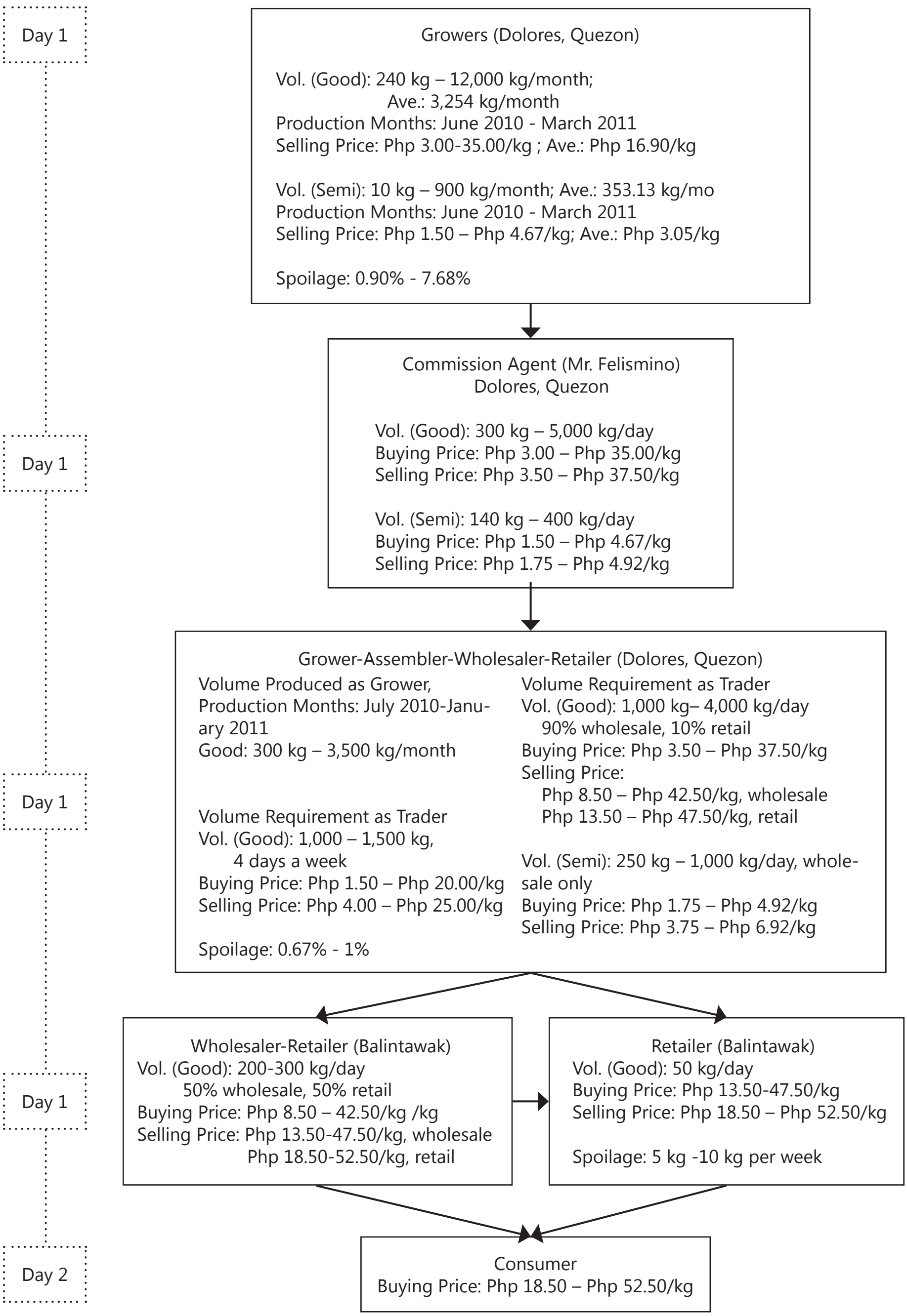
Day 1

Consumer
Buying Price: Php 5.00 – Php 43.00/kg

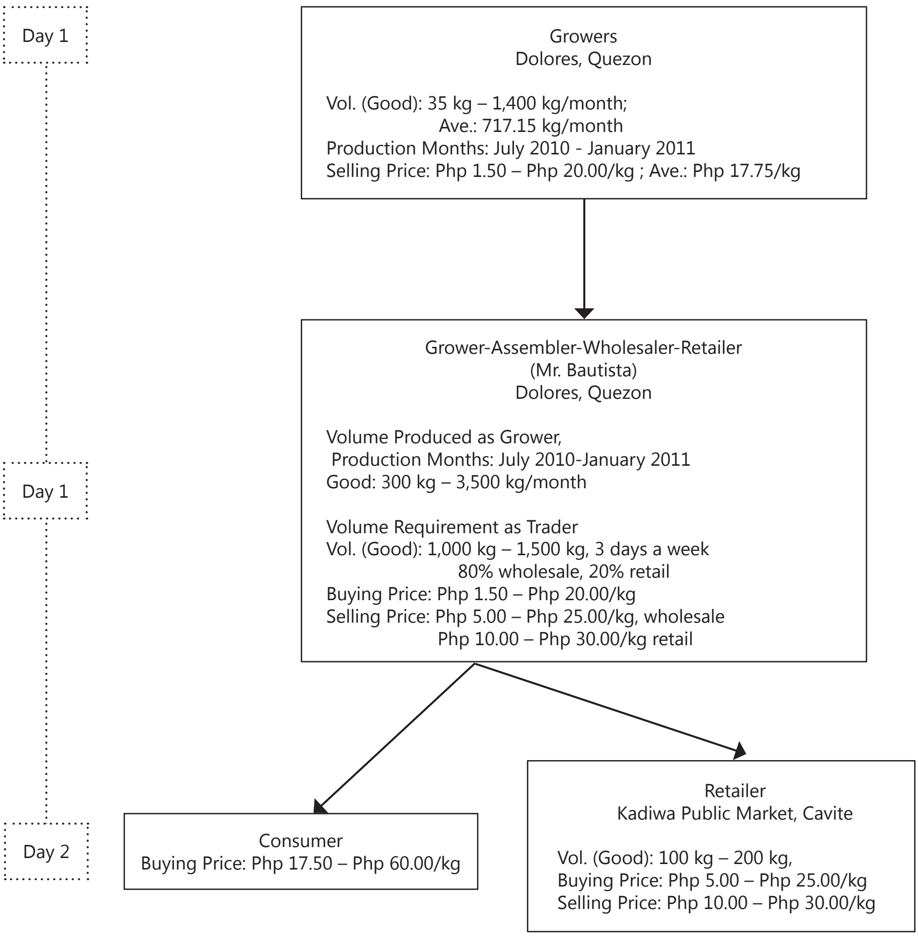
Appendix Figure 26. Supply Chain 13: Product flow, volume handled, and price/monetary flow of eggplant from Dolores, Quezon to Balintawak, Quezon City



Appendix Figure 27. Supply Chain 14: Product flow, volume handled, and price/monetary flow of eggplant from Dolores, Quezon to Balintawak, Quezon City



Appendix Figure 28. Supply Chain 15: Product flow, volume handled, and price/monetary flow of eggplant from Dolores, Quezon to Balintawak, Quezon City



Chapter 6

Socioeconomic Impacts of *Bt* Eggplant: Evidence from Multi-location Field Trials

Sergio R. Francisco

Introduction

In 2006-2009, the author conducted a series of *ex-ante* impact assessments of *Bt* eggplant adoption to evaluate potential benefits in terms of improving farmers' and consumers' welfare, improving the environment, alleviating poverty of eggplant farmers, and improving nutritional status of consumers. Results of these studies showed big potential of the technology once released and adopted by farmers. In the absence of information on actual field plantings of *Bt* eggplant, these studies used information on the potential yield levels, benefits, and costs elicited from farmers, scientists and industry experts.

This present study provides a thorough socioeconomic analysis of the eggplant production environment where multi-location field trials of *Bt* eggplant technology were conducted, including the socioeconomic profile of eggplant farmers and farms within the field trial sites. It quantifies the benefits from *Bt* eggplant technology based on results obtained from multi-location field trials, and analyzes its performance relative to non-*Bt* eggplant in terms of yields, cost efficiency, net profitability, and other economic parameters. It provides information to support the commercialization of *Bt* eggplant. It also details the knowledge, awareness, and perception (KAP) of farmers in Pangasinan and Camarines Sur where the field trials were conducted.

The conduct of field trials of the eggplant fruit and shoot borer (EFSB)-resistant (*Bt*) eggplant in Luzon was approved by the Bureau of Plant Industry through biosafety permits issued on 15 March 2010. The field trials aimed to generate information on the efficacy, yield, and horticultural performance of promising EFSB-resistant transgenic eggplant lines (*Bt* eggplant) containing MAHYCO event EE-1 into an open-pollinated variety (OPV). It also aimed to generate local data on non-target arthropods in support of biosafety regulatory approval for propagation and Fertilizer and Pesticide Authority (FPA) registration. Two of the approved trial sites in Luzon include Sta. Maria, Pangasinan and Central Bicol State University for Agriculture (CBSUA) in Pili, Camarines Sur.

Data Collection and Analysis

Unlike the author's similar studies in 2006-2009, this *ex-ante* economic impact assessment of *Bt* eggplant was carried out using data collected from the multi-location field trials. The first season field trials started simultaneously in the approved sites in April 2010 and were completed in July 2010. The second season field trials started in November 2010 and were completed in March 2011. Throughout the trials, all data to the *ex-ante* assessment were collected and recorded.

Farm-level technology effects on the cost and income of eggplant production were analyzed using the *with* and *without* framework, i.e., by comparing currently observed farmer's practice with *Bt* eggplant field trial results. The experimental field trials of *Bt* eggplant were laid out in randomized complete block with two treatments, *Bt* plots and non-*Bt* plots. The varieties planted were all open-pollinated and the production period was only 4-5 months, 2-3 months shorter than the usual production period of 7 months. Hence, yields obtained where lower than hybrids, the common variety planted in the areas. The trials were carried out for two seasons.

A knowledge, awareness and perception (KAP) survey was carried out in Pangasinan and Camarines Sur to determine how farmers in the trial sites view *Bt* eggplant technology. Using a structured questionnaire, the KAP survey was conducted in 2011, with 54 and 30 farmer-respondents in Pangasinan and Camarines Sur, respectively.

Descriptive statistics were used to summarize data from the survey. Data generated from the experimental field trials were used to analyze economic performance of *Bt* eggplant relative to its non-*Bt* counterpart. The parameters that were analyzed are yield levels, cost efficiency, and profitability. For yield performance analysis, marketable yields, i.e., harvested undamaged fruits, of multi-location trials were compared with data collected from the surveyed farmers' yields. For net profitability comparisons, the on-farm net revenues and costs of actual eggplant production in farmers' fields was integrated in the analysis using prevailing prices of eggplant and production inputs in the sites.

Results and Discussion

Respondents' Socio-demographic and Farm Profiles

Majority of eggplant farmers surveyed in Pangasinan and Camarines Sur were male, married and middle aged (Table 1). On average, Pangasinan farmers had 10 years of formal schooling compared to only 6 years for Camarines Sur farmers. Most have been farming for almost 2 decades, of which more than 10 years were devoted to eggplant; they considered farming as their primary occupation that provided them the bulk of their annual income. Pangasinan farmers were mostly landowners while about 50% of Camarines Sur farmers were share-tenants.

Both sites have access to information (market, technology, and inputs) with Camarines Sur respondents having to travel shorter distance to reach the information source. Although respondents' average farm size in Pangasinan was smaller than Camarines Sur's, the former devoted 70% of the entire farm to eggplant compared to the latter's 43% (Table 1). Pangasinan farm depended mainly on pump irrigation while those in Camarines Sur mostly relied on rainfall for water. However, Camarines Sur farms were more diversified than those in Pangasinan since the former planted other crops aside from eggplant and raised livestock.

Pangasinan farmer-respondents were somehow economically better-off than Camarines Sur farmers as indicated by the make of their houses and ownership of appliances (Table 2). Most Pangasinan farmers lived in permanent houses with galvanized iron (GI)-sheet roofing and concrete walls, have electricity and semi-flush toilets.

Table 1. Socio-demographic and farm profiles of eggplant farmer-respondents, Camarines Sur and Pangasinan, 2010/2011

Demographic Characteristics	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Gender (% of farmers)		
Male	80	52
Female	20	48
Civil status (% of farmers)		
Single	2	3
Married	96	90
Widowed	2	7
Age (years)	42	45
Average number of years in schooling	10	6
Secondary occupation (% of farmers)		
Farming		3
Carpentry		10
Buy and sell	4	3
Barangay official	7	3
Average annual income (PhP)		
Primary occupation	64,351	41,129
Secondary occupation	7,109	1,822
Total farming experience (years)	18	20
Eggplant farming experience (years)	14	12
Tenure (% of farmers)		
Landowner	61	33
Part-owner	2	3
Share-tenant	28	50
Leaseholder	4	10
Mortgage owner	2	
Owner/share-tenant	2	
Accessibility to information		
Distance of farm to market (km)	6	5
Distance of farm to technology/ information source (km)	6	4
Distance of farm to input dealers (km)	6	5
Total area of the farm (ha)	0.81	2.43
Total eggplant area (ha)	0.57	1.07
Type of irrigation (% of farmers)		
Rainfed	2	80

Table 1. Socio-demographic and farm profiles of eggplant farmer-respondents, Camarines Sur and Pangasinan, 2010/2011

Demographic Characteristics	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Gravity irrigation	11	7
Pump (sprinkler)	85	13
Farmers planting crops aside from eggplant (%)	70	90
Farmers who raise livestock (%)	24	73

Poverty threshold (2010): Pangasinan – PhP15,186; Camarines Sur – PhP13,365 (NSCB, 2012)
Household size (2006-2007): Pangasinan – 4.5; Camarines Sur – 5.0 (NSO, 2010)
US$1.00 = PhP45.00 (as of 2010, NSCB 2012)

Table 2. Distribution of housing components of farmer-respondents (%), Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Type of house		
Permanent	74	52
Semi-permanent	19	24
Temporary	4	24
Shanty	4	
Type of roof		
Tiles	2	10
GI sheets	91	76
Nipa	6	10
Cogon/grass	2	3
Source of lighting		
Electric	93	76
Kerosene	7	24
Toilet facilities		
Semi-flush	89	48
Flush	6	21
Open pit		24
Antipolo		3
None	6	3
Cooking fuel*		
Wood	72	59
Charcoal	2	34

Table 2. Distribution of housing components of farmer-respondents (%), Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
LPG	26	24
Availability of electrical services		
Yes	91	83
No	9	17

* Multiple responses

Production Options and Practices

Varieties Planted. Results show that hybrid eggplant varieties are most commonly grown in the two study areas, with *Morena* as the most popular, having an average replacement period of one year (Table 3).The most common sources of information on varieties were seed companies, other farmers, and government agricultural technicians. Farmers normally buy their seeds from input dealers/agricultural suppliers and seed companies. High yield had always been the primary reason for choosing which eggplant variety to plant. Other reasons were larger fruit, longer productive life span, and consumer preference.

Other Crops Planted. Table 4 shows the distribution of farmers according to crops grown aside from eggplant. The most popular crops planted are corn and rice in Pangasinan, and corn and string beans in Camarines Sur. Other crops planted include pepper, tobacco, bitter gourd and pechay. Ratooning[1] of eggplant was not practiced in both survey areas because farmers completely replace their variety for the next cropping season. Some farmers reported that they also planted other crops after eggplant is harvested.

Planting Intentions and Sources of Farm Capital. Most farmer-respondents planned to continue growing eggplant in the next season, maintaining the same area. Less than 50% were planning to expand their eggplant area to increase income while others thought of decreasing the area due to capital and labor constraints. The average area intended for expansion is 0.98 ha in Pangasinan and 1.29 ha in Camarines Sur (Table 5).

[1] Ratooning in eggplant is done by cutting the old branches and allowing new branches to regenerate. This is usually done by backyard eggplant farmers.

Table 3. Eggplant varieties grown, seed sources, and reasons for choice of variety by respondents, Camarines Sur and Pangasinan, 2010/2011

	Pangasinan (n=54)			**Camarines Sur** (n=30)		
	No. of Farmers Planting	**Freq of Seed Procure-ment**	**% Seedling Mortality**	**No. of Farmers Planting**	**Freq of Seed Procure-ment**	**% Seedling Mortality**
Eggplant variety grown						
Native (OP)	7	2	22			
Morena (H)	63	1	12	47	1	17
Casino (H)	17	2	6	53	1	12
Sikat (H)	7	1	12			
Checkmate (H)	6	2	8			
Checkout (H)		1				

	Pangasinan (n=54)	**Camarines Sur** (n=30)
Source of eggplant seeds	(% of respondents)	(% of respondents)
Seed companies	39	40
Input dealers/ agricultural suppliers	74	17
Other farmers	6	
Own harvest	6	
Dept of Agriculture		33
Others	20	10
Reason for choice of variety		
High yielding	48	43
Bigger fruits	2	7
Common in the area	4	
Readily available	2	
Good market price	2	3
No choice	2	
Pest and disease resistant	2	
Seeds are cheaper		3
Longer productive life span		13
Preferred variety by consumers		13

Multiple responses possible.
H=hybrid variety, OP=open-pollinated variety.

Table 4. Crops planted by farmer-respondents (%), Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Crops planted*		
Eggplant	93	67
Corn	80	17
Rice	19	
Hot pepper	7	3
Okra	4	
String beans	4	17
Pepper	4	
Tobacco	4	13
Bitter gourd		13
Tomato		3
Peanut		3
Pechay		10
Reasons for not practicing eggplant ratooning		
Complete replacement of variety	63	60
Field planted with other crops after harvest	30	30

*Multiple responses

Table 5. Farming plans and sources of farm capital of eggplant farmers (%), Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Farming plans		
Will plant eggplant next season		
Yes	98	85
No	2	15
Has plans of expanding eggplant farm		
Yes	44	27
No	54	73
If yes, mean area of expansion (ha)	0.98	1.29
Has plans to decrease eggplant farm		
Yes	4	23
No	48	50
No answer	48	27

Table 5. Farming plans and sources of farm capital of eggplant farmers (%), Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Sources of farm capital		
Borrowed capital		
Yes	80	57
No	19	43
Amount borrowed (mean, PhP)	9,082	7,441
Interest rate per year (%)	13	25
Source of capital*		
Trader	69	3
Friend	2	
Lending institution	4	27
Neighbor	2	
Relative	6	20
Require collateral?		
Yes	80	3
No	11	97

*Multiple responses

Majority of the farmers borrowed capital for eggplant production, which averaged at less than PhP10,000 (Table 5). The annual interest rate charged stood at 13% and 25% in Pangasinan and Camarines Sur, respectively. The major sources of borrowed capital were traders, money lenders and relatives. Pangasinan farmers were required to provide collateral by lenders (80%) while the Camarines Sur farmers were seldom required collaterals.

Eggplant Marketing and Prices

Table 6 summarizes the farmers' mode of disposal, and point of sale of eggplants. Farmers in Pangasinan and Camarines Sur sell their produce on-farm mainly to viajeros, wholesaler-retailers, and assemblers. On the other hand, Camarines Sur eggplant farmers had their produce picked up or delivered to the traders' collection point.

When asked whether the price of hybrids and open-pollinated eggplant differ, majority of Pangasinan farmers responded that there was no price

Table 6. Eggplant varieties grown, seed sources, and reasons for choice of variety by respondents, Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)		**Camarines Sur** (n=30)	
	No.	**% Total**	**No.**	**% Total**
Market agent*				
Assemblers	15	28	4	13
Viajeros	20	37	17	57
Wholesalers	17	31	1	3
Wholesaler-retailers	7	13	10	33
Retailers	1	2	3	10
Mode of disposal*				
Picked up	44	81	20	67
Delivered	10	19	16	53
Place where product is sold*				
Farm	44	81	12	40
Market	7	13	17	57
Others	1	2	4	13

*Multiple responses

difference between varieties; Camarines Sur eggplant farmers believed otherwise (Table 7). Traders and farmers considered volume and prevailing market price in setting output price. Both groups had many sources of price information mainly buyers, followed by co-traders whom farmers ask about prices, and other farmers.

Production and Marketing Problems

Farmers cited pests and diseases, particularly EFSB, as the major problem in producing eggplants. Other production problems include lack of capital, weather/calamities, and soil problems. The major eggplant marketing problems cited were low market price and price instability (Table 8).

Farmers' Knowledge and Awareness of Production Technologies

Knowledge and Awareness of EFSB and Control Methods. Farmers' awareness of eggplant fruit and shoot borer (EFSB) was high — 89% of the Pangasinan respondents and 90% in Camarines Sur were familiar to this pest (Table 9). Chemical spray was used to control EFSB infestation as reported by 89% of

Table 7. Eggplant pricing information and source of price information (% of respondents), Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Similarity in prices of hybrid and open-pollinated variety		
Yes	26	69
No	61	27
No response	13	4
Factors considered in pricing*		
Volume	15	77
Prevailing market price	94	69
Dryness	2	4
Size		4
Color		4
Sources of price information*		
Buyer	61	88
Radio/newspaper	4	4
Co-traders	24	35
Other farmers	11	38
Other sources:		
AT	2	
Divisoria	2	

*Multiple responses

Table 8. Eggplant farmers' production and marketing problems (% of respondents), Camarines Sur and Pangasinan, 2010/2011

Problems Encountered*	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Production Problems		
Pests and diseases (EFSB, hoppers, whiteflies)	95	73
Lack of capital	20	13
Low yield	4	
Weather/calamities	9	17
Soil-borne diseases (bacterial/Fusarium wilt**)	6	7
Variety's susceptibility to pest and diseases	2	
Fruit easily gets rotten	2	
High cost of production	2	23
No irrigation	2	7
High seedling mortality	4	7

Table 8. Eggplant farmers' production and marketing problems (% of respondents), Camarines Sur and Pangasinan, 2010/2011

Problems Encountered*	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Marketing Problems		
Low market price	57	80
Buyers control prices	2	3
No buyer		13
Fluctuating price	6	3

* Multiple responses
** Farmers in Pangasinan called this disease "high blood".

Table 9. Awareness and knowledge about EFSB (% of respondents), Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Familiarity with EFSB		
Yes	89	90
No	7	7
Not sure	2	3
Methods for controlling EFSB*		
Chemical control	89	80
Removal and burying of infested shoots	30	10
Pheromone traps	4	0
Burning		3
Source of information against EFSB control*		
Government extension workers	6	23
Company technicians	67	23
Other farmers	6	10
Input dealers	13	7
Land owner	4	3
Own knowledge		3

* Multiple responses

the eggplant farmers in Pangasinan and 80% in Camarines Sur. Some farmers reportedly removed and buried infested shoots; a few in Pangasinan used sex pheromone traps, and some burned infested fruits in Camarines Sur. The major sources of information on EFSB control were the pesticide company technicians, government extension workers, other farmers, and input dealers.

The two chemical classes most commonly used by Pangasinan farmers to control EFSB were chlorantraniliprole (59%) and malathion (35%). In Camarines Sur, farmers used chlorantraniliprole, cypermethrin and lambdacyhalothrin (Table 10). Although majority of the farmers are using category 4 insecticides, some were still using the more hazardous category 2. The latter has some implications to applicators since they are in contact with the insecticides during spraying, to pickers considering that insecticides were applied a day before harvest, to consumers, and ultimately, the environment.

Attitude Towards Technology Change. The survey of farmers' attitudes showed that, in both study areas, only 37% would try a new technology immediately; more farmers would rather first wait-and-see then follow other farmers if they see that the technology really works (Table 11). The farmers' main reason for trying a new technology was to test its overall advantage.

Farmers' Knowledge, Attitude, and Perceptions of Agricultural Biotechnology

Knowledge. Majority of the eggplant farmer-respondents were not aware of biotech crops and agricultural biotechnology products in the country (Table 12). For those who were aware, the most known agricultural biotechnology product was *Bt* corn, followed by golden rice and Bio-N.

Among farmer-respondents who know about agricultural biotechnology, around 96% and 20% in Pangasinan and Camarines Sur, respectively, were interested in using its products. Farmers learned about biotechnology products primarily from extension workers, mass media, farmer colleagues, scientists, religious organizations, and non-government organizations (NGOs). However, only less than 10% of the respondents believed they have enough information on biotech products; many opined that information was not enough or totally lacking. Among Pangasinan farmers, 72% believed that agricultural biotechnology products can improve agricultural productivity. In Camarines Sur, only 17% of the farmer-respondents believed that agriculture biotechnology has the potential to improve Philippine agriculture.

Table 10. Insecticides used by eggplant farmers for pest management (% of respondents), Camarines Sur and Pangasinan, 2010/2011

Insecticide Class	Category	Pangasinan (n=54)	Camarines Sur (n=30)
First cropping season			
Chlorantraniliprole	4	59	33
Malathion	4	35	3
Deltamethrin	4	9	
Triazophos	2	7	
Methomyl	2	7	
Chlorpyrifos + BPMC	2	6	3
Imidacloprid+Beta-Cyfluthrin	2	6	
Profenofos	2	6	
Flubendiamide	4	4	
Indoxacarb	3	4	
Diafenthiuron	2	4	
Cypermethrin	4	4	30
Imidacloprid	4	2	
Cartap Hydrochloride	3	2	3
Betactfluthrin	3	2	
Lambdacyhalothrin	2	2	23
Fipronil	4	2	
Acetamiprid	3	2	
Chlorantraniliprole+Thiamethoxam	4	2	
Lambdacyhalothrin + Thiametoxam	2	2	13
Granazole			3
Second cropping season			
Malathion	4	6	
Chlorantraniliprole	4	6	
Cypermethrin	4		7
Lambdacyhalothrin	2		3
Profenofos	2		3

* Multiple responses

Table 11. Farmers' attitude and reasons for change (% of respondents), Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Attitude of farmers towards change		
Change immediately	37	37
Wait for a while, then follow	48	57
Change when everyone has done so	7	3
Stick to old proven/tested practices	7	
Main reason for trying out something new		
Test overall advantage of new idea, practice, or technology	78	87
Approval of others for being the first to try	9	3
Commercial economic orientation	6	10
Try if effective	2	
Self-fulfillment	2	

Table 12. Farmer's awareness and knowledge about agricultural biotechnology (% of respondents), Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Awareness on existence of biotech crops in the country		
Yes	35	10
No	65	90
Awareness on agricultural biotechnology products		
Bt corn	26	20
Golden rice	7	3
Bio-N	2	3
Not aware	65	74
Interested in uses of biotech in agriculture		
Yes	96	20
No	4	80
Sources of biotechnology information		
Mass media (TV, radio, newspaper)	7	13
Interpersonal (family, friends, and colleagues)	20	13
Scientists	13	7
Agriculture extension workers	52	10
Religious groups		7
Print publications (books, pamphlets, magazines)	2	7

Table 12. Farmer's awareness and knowledge about agricultural biotechnology (% of respondents), Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Electronic (websites, emails, etc.)	4	7
Agricultural suppliers/dealers	8	10
Non-government organizations (NGOs)		10
Extent of information/knowledge on biotechnology		
Not enough	81	7
Enough	7	7
No knowledge on biotechnology	2	3
No answer	10	83
Usefulness of information as basis for knowledge on biotech		
Not useful	39	7
Moderately useful	28	10
Very useful	20	
No knowledge on biotechnology	2	
No answer	11	83
Opinion if biotech will improve Philippine agriculture		
Yes	72	17
No	9	
Do not know	11	
No answer		83

Attitude. Whether or not they were aware of biotechnology, Pangasinan farmers were very much interested in using agriculture biotechnology products (Table 13). This may be because they have experienced, or are at least aware of, *Bt* corn performance in the province. On the other hand, only 19% of the unaware respondents in Camarines Sur were interested in using biotech products. Pangasinan farmers also opined that agriculture biotechnology can benefit small-scale farmers as well as consumers.

Among farmers who are aware of agricultural biotechnology, 78% in Pangasinan and 27% in Camarines Sur expressed their willingness to plant and consume biotech crops (Table 14). Similarly, more Pangasinan farmers were in favor of agricultural biotechnology food products compared to Camarines Sur. Again, this may be because some (24%) of the farmer-respondents in Pangasinan have experienced planting *Bt* corn.

Table 13. Farmer's perception about agricultural biotechnology (% of respondents), Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)		**Camarines Sur** (n=30)	
	Aware	**Unaware**	**Aware**	**Unaware**
	%	%	**%**	%
Interest in using biotechnology products				
Not interested	0	7	25	0
Interested	83	81	75	19
Very interested	17	12	0	0
No answer				81
Opinion if small-scale farmers benefit from biotechnology				
Yes	92	93	75	12
No	0	5	0	0
Do not know	8	2	0	0
No answer			25	88
Opinion if consumers benefit from biotechnology				
Yes	58	86	25	88
No	25	10	0	0
Do not know	17	5	0	0
No answer			75	12

Table 14. Farmers' willingness to plant and consume agricultural biotechnology products (% of respondents), Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Willingness to plant/consume agri-biotech product		
Yes	78	27
No	20	0
No answer		73
In favor of agri-biotech as food		
Yes	83	27
No	13	0
Do not know	4	0
No answer		73
Experience in planting *Bt* corn		
No	74	20
Yes	24	3
No answer		77

Farmers' Knowledge, Attitude, and Perceptions of *Bt* Eggplant

Awareness. Only 22% of the Pangasinan farmer-respondents, and 13% of those from Camarines Sur, were aware of the existence of *Bt* eggplant (Table 15). More farmers in Pangasinan, however, were aware of the *Bt* eggplant research and development of UP Los Baños (UPLB) compared to those from Camarines Sur.

There was a mix of information heard and shared by those farmers who know or are aware of *Bt* eggplant (Table 16). This pertains to its existence in India, potential benefits such as high yield and better quality fruits, characteristics as a new eggplant variety resistant to pests and diseases, and potential health risks. The farmers learned of these from agricultural extension workers, other farmers, friends, pamphlets, UPLB researchers, and the internet.

Majority of those aware of *Bt* eggplant were also interested in acquiring more information about the technology. Information desired are on its effectiveness against EFSB, human health effects, fruit-bearing ability and quality of fruits, environmental implications, production technology, yield potentials, food safety, and pesticide savings (Table 16).

Table 15. Farmers' awareness of *Bt* eggplant, Camarines Sur and Pangasinan, 2010/2011

Particulars	Distribution	
	Frequency	**%**
Pangasinan		
Aware of *Bt* eggplant	12	22
Unaware of *Bt* eggplant	42	78
Camarines Sur		
Aware of *Bt* eggplant	4	13
Unaware of *Bt* eggplant	26	87
Both sites		
Aware of *Bt* eggplant	16	19
Unaware of *Bt* eggplant	68	81
Awareness on a research being conducted in UPLB		
Yes	42	25
No	58	75

Table 16. Farmers' responses regarding information about *Bt* eggplant, Camarines Sur and Pangasinan, 2010/2011

*Sources of information on Bt eggplant**	*Information needed on Bt eggplant**	*Information needed to plant Bt eggplant**
Extension worker	Effectiveness against EFSB and health effects	Fruit quality (bigger in size, good and heavier in weight)
Other farmers/friends	Fruit bearing ability and quality of fruits	Effectiveness against EFSB
Family/relatives	If it is environment friendly	High yielding
Pamphlets/brochures	How to plant	Preferred by buyers
UPLB researchers	If high yielding	Resistant to bacterial wilt
Internet	If it has no side effects/safe for food	If feasible to plant in our area
	If it really does not need pesticides	If it has no side effects to human
		Confirmation that it does not need pesticide
		If there is seed subsidy
*Information heard about Bt eggplant**	*Considerations to try or not to try planting Bt eggplant*	*Motivations to plant Bt eggplant**
Bt eggplant in India	Would need actual proofs to make an assessment	Higher yield
Good to plant	Cannot believe that they would not be attacked by EFSB	Reduced pesticide usage
High yielding		Low cost of production
Produces heavier fruits		Safe to eat
New variety of eggplant		Environment friendly
No need to spray pesticides		
Pests and diseases resistant		
May have side effects		

Nevertheless, at least 75% of the aware farmers indicated that they would need proof before deciding to plant (or not plant) *Bt* eggplant. To help them decide, they need information about fruit quality (size and weight), effectiveness to control EFSB, yielding ability, buyer preference, resistance to other pests, and production cost (Table 16).

When asked about their willingness to try *Bt* eggplant, majority of respondents in both survey areas responded positively — about 70% in Pangasinan and 60% in Camarines Sur (Table 17). On the other hand, 30%

Table 17. Farmer's willingness to plant and opinion regarding *Bt* eggplant, Camarines Sur and Pangasinan, 2010/2011

Particulars	**Pangasinan** (n=54)	**Camarines Sur** (n=30)
Willingness to plant *Bt* eggplant		
Yes	69	60
Only after I know about its performance	30	27
No	2	
No answer		13
Opinion if *Bt* eggplant will benefit small scale farmers:		
Yes	81	80
No	11	3
No answer		17

of Pangasinan farmers and 27% of Camarines Sur farmers will only try *Bt* eggplant after they see its performance.[2]

When asked about whether they think *Bt* eggplant will benefit small-scale farmers, at least 80% of the respondents in both survey areas responded positively.

Cost and Return Analysis

Table 18 presents the crop budgets generated from the survey of eggplant farmers in Pangasinan and Camarines Sur. On average, the yields of Pangasinan eggplant farmers were slightly higher than Camarines Sur farmers'. Since Pangasinan farmers obtained about 31 metric tons per hectare (m tons/ha) of marketable yield compared to Camarines Sur farmers' 26 m tons/ha, Pangasinan farmers' gross revenue was expectedly higher, at the same product prices. However, in the same production season, Pangasinan farmers reported receiving an average price of PhP22.37/kg while those in Camarines Sur received only PhP7.38/kg. As such, even if the total production cost of Pangasinan farmers (PhP184,783/ha) was far higher than that of Camarines Sur (PhP103,247/ha), the net income difference between these two groups was significant at about PhP420,000/ha.

[2] During the course of the interview, farmers were given some information on the potential benefits of *Bt* eggplants.

Table 18. Cost and return analysis of eggplant production, Pangasinan and Camarines Sur, 2010

Item	Survey Site	
	Pangasinan	Camarines Sur
Production		
Yield (m tons/ha)	3.363	2.770
Total harvest sold (m tons)	3.099	2.601
Average price per metric ton (PhP)	2,237	738
Gross sales (PhP)	693,279.04	191,868.95
Production Costs (PhP)		
Seeds	2,570.91	1,421.00
Fertilizers		
Organic	4,195.63	1,115.71
Inorganic	33,931.90	19,427.00
Pesticides		
Liquid	34,172.15	28,265.00
Solid	8,190.80	3,650.14
Labor		
Hired	45,819.66	12,438.90
Imputed	34,489.70	14,123.02
Other input costs		
Fuel	19,071.26	2,126.18
Transportation	861.40	12,294.12
Food	1,479.95	8,386.11
Total Production Cost	*184,783.35*	*103,247.18*
Net Income (PhP)	**508,495.69**	**88,621.77**

In order to make a better comparison and eliminate price effect, a common price of PhP10/kg was assumed for both sites. Table 19 shows the comparative cost and return analysis under this assumption. As can be seen, the cost of production in Pangasinan was higher in many cost items compared to Camarines Sur's. For example, seeds, fertilizer, pesticides and labor costs for Pangasinan eggplant production were higher than those of Camarines Sur. Hence, even if the average yield in Pangasinan was higher than in Camarines Sur, the net income difference was not as large as in the previous cost and return table because the high production costs negated the yield advantage of Pangasinan over Camarines Sur.

Table 19. Comparative cost and return analysis of eggplant production among surveyed farmers in Pangasinan and Camarines Sur, 2010

Item	Survey Site		Pooled
	Pangasinan	Camarines Sur	
Production			
Yield (m tons/ha)	3.368	2.770	3.066
Marketable yield (m tons/ha)	3.099	2.601	2.850
Price per metric ton (PhP)	10,000.00	10,000.00	10,000.00
Gross sales (PhP)	**309,895.00**	**260,085.00**	**284,990.00**
Production Costs (PhP)			
Seeds	2,570.91	1,421.00	1,995.96
Fertilizers			
Organic	4,195.63	1,115.71	2,655.67
Inorganic	33,931.90	19,427.00	26,679.45
Pesticides			
Liquid	34,172.15	28,265.00	31,218.58
Solid	8,190.80	3,650.14	5,920.47
Labor			
Hired	45,819.66	12,438.90	29,129.28
Imputed family	34,489.70	14,123.02	24,306.36
Other input costs			
Fuel	19,071.26	2,126.18	10,598.72
Transportation	861.40	12,294.12	6,577.76
Food	1,479.95	8,386.11	4,933.03
Total Production Cost	*184,783.35*	*103,247.18*	*144,015.27*
Net Income (PhP)	**125,111.65**	**156,838.32**	**140,974.99**

Comparative Production and Profitability Performance of *Bt* and Non-*Bt* Eggplant Using Field Trial Results

Data generated from the field trials in Camarines Sur and Pangasinan were used to compare the production and profitability performance of *Bt* eggplant relative to its non-*Bt* counterpart.

Yield Effects. In Pangasinan, *Bt* eggplant's gross yield was higher than that of non-*Bt* eggplant by more than 12 m tons/ha and 25 m tons/ha in the first and second season, respectively. *Bt* eggplant also had marketable yield advantage of 4.9 m tons/ha and 20.7 m tons/ha also for first and second seasons, respectively. The overall marketable yield advantage of *Bt* eggplant over non-*Bt* eggplant was 14 m tons/ha (1,156%) (Table 20).

In Camarines Sur, the yields of non-*Bt* eggplant were slightly higher than those of *Bt* eggplant in the first season, but the relationship was reversed in the second season (Table 20). Noticeably however, the marketable yields of *Bt* eggplant in both seasons were higher than those of the non-*Bt* variety. Hence even if *Bt* eggplant had lower yields during the first season, income was expected to be higher than that of non-*Bt* eggplant. The marketable yield advantage is more pronounced during the second season.

Comparing the yield performance of the *Bt* eggplant relative to what the farmers were getting in the area and considering that the yield data from the sites were only 65% of the potential yield, the *Bt* eggplant's yield performance was generally lower. It was because the varieties used by farmers in the survey areas were almost all hybrids, while the *Bt* eggplant used in the experimental field trials were inbred or open-pollinated varieties[3], which have lower yield potentials.

If *Bt* is introgressed into hybrids, the yield advantage in terms of marketable yield of *Bt* eggplant could be replicated. *Bt* eggplant is a cost-reducing technology that prevents EFSB damage, hence increasing marketable yields. Across all trial sites, the marketable yield advantage of *Bt* eggplant was 8.2 m tons/ha (or about 192% of non-*Bt*'s). This result was very much higher than the 40% reported during an FGD in Francisco (2006).

Cost Effects. In Pangasinan, the cost savings due to *Bt* eggplant was about PhP49,722/ha in the first season and PhP261,944/ha in the second season. Similarly in Camarines Sur, PhP80,000/ha was saved from insecticide use during the first season and PhP105,694/ha was saved during the second season. The savings come from reduction in insecticide use to control EFSB during the production season (Table 21).

Across trial sites, the cost advantage of *Bt* eggplant was about 15%, slightly lower than the 16% cost savings obtained during an FGD in Francisco (2006).

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[3] The *Bt* was introgressed into inbreds (OPV) so that farmers would be able to plant the variety continuously and allay the fear of having hybrid seed companies benefiting more out of the technology.

Table 20. Comparative yield performance of *Bt* and non-*Bt* eggplant, Pangasinan and Camarines Sur trial sites, 2010

Crop Season	Particulars	*Bt* Egg-plant	Non-*Bt* Eggplant	Difference	% Difference
Pangasinan					
Season 1	Yield (m tons/ha)	16.72	4.44	12.28	276.58
	Marketable (m tons/ha)	9.08	1.68	7.40	440.48
	Non-marketable (m tons/ha)	7.64	2.76	4.88	176.81
	% Marketable	54.31	37.84		
Season 2	Yield (m tons/ha)	29.49	3.61	25.88	716.90
	Marketable (m tons/ha)	21.46	0.75	20.71	2,761.33
	Non-marketable (m tons/ha)	8.03	2.86	5.17	180.77
	% marketable	72.77	20.78		
Both seasons	Marketable yields (t/ha)	15.27	1.22	14.05	1,151.64
Camarines Sur					
Season 1	Yield (m tons/ha)	14.68	16.31	(1.63)	(9.99)
	Marketable (m tons/ha)	7.62	7.38	0.24	3.15
	Non-marketable (m tons/ha)	7.06	8.93	(1.87)	(20.94)
	% Marketable	51.91	45.25		
Season 2	Yield (m tons/ha)	17.26	16.09	1.17	7.27
	Marketable (m tons/ha)	12.41	7.50	4.91	65.47
	Non-marketable (m tons/ha)	4.85	8.59	(3.74)	(43.54)
	% marketable	71.90	46.61		
Both seasons	Marketable yields (t/ha)	10.02	7.44		34.61

Average yield of farmer-respondents in Pangasinan and Camarines Sur is 33.6 m tons/ha (21.9 m tons/ha at 65%) and 27.7 m tons/ha (18.0 m tons/ha at 65%), respectively.
Figures in parentheses are negative.

If the new parameters — marketable yield advantage of 192% and cost advantage of 15% — will be incorporated into the economic surplus model used in Francisco (2006), the benefits would be much higher than projected therein.

Table 21. Comparative production cost structures (PhP) of *Bt* eggplant and non-*Bt* eggplant in Pangasinan and Camarines Sur, 2010

Particulars	Season 1	Season 2
Pangasinan		
Site development and land preparation	69,444	22,222
Crop care and maintenance, labor and irrigation	54,861	201,389
Material inputs		
Fertilizer	87,188	86,979
Insecticides for EFSB control	47,222	97,222
Fungicides	5,104	22,969
Other insecticides	938	61,771
Total production costs of non-*Bt* eggplant	264,757	395,330
Share of insecticides in total cost	18%	20%
Total production costs of *Bt* eggplant	217,535	379,780
Camarines Sur		
Site development and land preparation	52,083	41,667
Crop care and maintenance, labor and irrigation	72,917	114,583
Material inputs		
Fertilizer	54,427	55,521
Insecticides for EFSB control	32,778	105,694
Fungicides	5,104	
Other insecticides	17,708	
Total production costs of non-*Bt* eggplant	235,017	317,465
Share of insecticides in total cost	14%	33%
Total production cost of *Bt* eggplant	217,309	211,771

Partial Budget Analysis. On average in Pangasinan, the added returns due to increased marketable yield was PhP140,550/ha while the reduction in cost (added benefits) was about PhP133,000/ha. The total incremental net benefit that accrued to the *Bt* eggplant farmers was about PhP272,000/ha. In Camarines Sur, where the average yield advantage was relatively low, the net incremental benefit that accrued to *Bt* eggplant farmers was about PhP120,000/ha (Table 22). Again, this increment came from the increased marketable yields and cost savings due to reduced insecticide use in controlling EFSB in eggplant production.

Table 22. Partial budget analysis (PhP) of *Bt* eggplant vis-a-vis non-*Bt* eggplant in Pangasinan and Camarines Sur trial sites, 2010

Particulars	Season 1	Season 2	Average
Pangasinan			
Added benefits			
Added returns	74,000	207,100	140,550
Reduced costs	47,222	97,222	133,333
Total added benefits	121,222	304,322	273,883
Added cost			
Reduced returns	—	—	—
Added costs	2,000	2,000	2,000
Total added costs	*2,000*	*2,000*	*2,000*
Net incremental benefits	**119,222**	**302,322**	**271,883**
Camarines Sur			
Added benefits			
Added returns	2,400	49,100	29,250
Reduced costs	32,778	105,694	92,847
Total added benefits	*35,178*	*154,794*	*122,097*
Added cost			
Reduced returns	—	—	—
Added costs	2,000	2,000	2,000
Total added costs	*2,000*	*2,000*	*2,000*
Net incremental benefits	**33,178**	**152,794**	**120,097**

Assumed price of eggplant: PhP10/kg

Conclusions

Results of the knowledge, attitude and perception (KAP) survey showed that majority of the eggplant farmer-respondents were not aware of biotech crops and agricultural biotechnology products in the country. However, among farmer-respondents who knew about agricultural biotechnology, around 96% in Pangasinan and 20% in Camarines Sur were interested in using its products and believed that it has the potential to improve Philippine agriculture. They also expressed their willingness to plant and consume biotech crops. Majority of those aware of *Bt* eggplant were also interested in acquiring more information about the technology. Information desired are on the technology's effectiveness against EFSB, pesticide savings, and yield potentials; effects on the crop's fruit-bearing ability and fruit quality; and environmental and food safety implications. A strong information dissemination campaign through advocacies and technology demonstrations needs to be vigorously implemented to make farmers aware of the economic potential of *Bt* eggplant technology.

This multi-location study also confirmed the results of Francisco (2006), which showed that the *Bt* eggplant technology can increase farmers' marketable yields and reduce production costs due to savings in insecticides against EFSB. Moreover, if the marketable yield and cost-saving advantage found in this study (marketable yield advantage of 192% and cost advantage of 15%) will be incorporated into the economic surplus model used in Francisco (2006), the benefits would be much higher than the latter's projection.

Although *Bt* eggplant yield was lower than that planted by the farmers in the survey area (mostly hybrids), the difference was due to the yield potentials of the varieties. The *Bt* eggplant, being an open-pollinated variety, has lower potential yields than the hybrid varieties planted by the farmers. However, if *Bt* would be introgressed into hybrid eggplants, the increase in marketable yields and reduction in costs of *Bt* eggplant would be replicated.

The decision of incorporating the *Bt* into an OPV eggplant favors resource-constrained eggplant farmers because the *Bt* variety can be planted for the succeeding season(s) without buying new seeds like when using hybrids. However, incorporating it into hybrids will benefit both the producers and consumers. The adopting producers will have more income due to increased marketable yields and reduced cost of insecticides for the control of EFSB. The consumers benefit in terms of more eggplant supply in the market and may even end up paying lower price due to increased volume of eggplants in the market.

References

Francisco, S.R. 2006.Economic impact of *Bt* eggplant adoption in the Philippines. Final Report submitted to ABSPII and International Service for the Acquisition of Agri-biotech Applications (ISAAA). September. Los Baños, Laguna, Philippines.

Francisco, S.R. 2007. Environmental impacts of *Bt* eggplant in the Philippines. Final Report submitted to ABSPII and International Service for the Acquisition of Agri-biotech Applications (ISAAA). October. Los Baños, Laguna, Philippines.

Francisco, S.R., C.T. Aragon and G.W. Norton. 2009. Poverty and nutrition impact of *Bt* eggplant adoption in the Philippines. Final Report submitted to ABSPII and International Service for the Acquisition of Agri-biotech Applications (ISAAA). December. Los Baños, Laguna, Philippines.

Francisco, S.R. Cost and benefits of *Bt* eggplant with resistance to fruit and shoot bore in the Philippines. *In* Norton, G.W. and D.M. Hautea. 2009. *Projected Impacts of Agricultural Biotechnologies for Fruits and Vegetables in the Philippines and Indonesia*. International Service for the Acquisition of Agri-biotech Applications (ISAAA) and SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA). September. Los Baños, Laguna, Philippines.

NSCB (National Statistical Development Board). 2012. Philippine Statistical Yearbook. Makati, Philippines.

NSO (National Statistics Office). 2010. Available at: www.census.gov.ph/census/population-and-housing.

Chapter 7

Health and Environmental Impacts of *Bt* Eggplant

Sergio R. Francisco

Introduction

Eggplant (*Solanum melongena* L.) is one of the most economically important vegetable crops in the Philippines, accounting for nearly a third of the total volume of the top vegetables grown, with value of production estimated to be the highest among the leading vegetables. It is a vegetable available almost all year round.

Eggplant production is now seriously affected by fruit and shoot borer (FSB) (*L. orbonalis* Guenee), one of its major pests. FSB damages eggplants during the early vegetative and whole fruiting stages. In the early vegetative stage, FSB larvae feed within the pedicles and midribs of the leaves causing shoots to droop and wither. At fruiting stage, larvae bore into the flowers preventing fruit formation and into the fruits rendering them unmarketable and unfit for human consumption. To control the pest, farmers resort to frequent and heavy spraying. However, since the larvae are internal feeders, FSB control is difficult since the larvae are only vulnerable for few hours after hatching. Farmers therefore resort to multiple sprays to control the pest.

Estimates of yield losses due to FSB damage in the Philippines vary widely depending on the level of infestation. Saavedra (1987) reported 51%-73%

yield loss while Esguerra and Barroga (1982) and Navasero (1983) estimated 42%-92% and about 20%, respectively.

A socioeconomic study of eggplant pest control in Bangladesh found that 60% of the surveyed farmers sprayed their eggplant crop 140 times or more for a period of 6-7 months (Rashid, 2003). Farmers often opt to use insecticides to control FSB since information dissemination on other means to control FSB is limited. The severity of FSB infestation forces farmers to use these pesticides indiscriminately, and also often apply the wrong chemicals and dosages. In the Philippines, many farmers spray their eggplant crop at least twice a week, with some spraying as often as every other day, or 60-80 times during a normal fruiting duration of at least 4 months. The baseline surveys of the Integrated Pest Management-Collaborative Research Support Program (IPM-CRSP) in 1994 and 1999 in Nueva Ecija found eggplant farmers spraying twice a week, on average. Pesticide, however, is not only expensive but also presents problems related to environmental pollution (particularly of ground water and food sources), development of resistance in pest populations, detrimental effects on non-target organisms, secondary pest outbreaks, resurgence of target pests, and dangers to human health.

A pesticide is any substance or mixture which is formulated to inhibit the growth of or eliminate organisms regarded as pest in order to minimize its negative impacts on crop production. It is deliberately designed to be toxic or poisonous to pests it intends to control. Ideally, it should be selective such that when applied, it should only affect target organisms, and afterwards, should breakdown into components that are not harmful to the environment (Conway and Pretty, 1991). In reality, however, pesticides are rarely selective. Most pesticides are broad spectrum, and act and interfere with the fundamental biochemical and physiological processes that are common to a wide range of organisms, including humans. Many studies have shown that the use and misuse of pesticides have negative externalities to humans and the environment.

Farmers, especially in developing countries, frequently use excessive pesticides. Such excessive pesticide use can negatively affect the environment, human health, and even farm economics (Huang et al, 2002; Rashid, 2003). Use of toxic chemicals can kill beneficial insects, cause environmental pollution, lead to pest resistance and resurgence, and create hazards to humans, animals, fish, and wildlife. As objections to pesticide use in food and fiber production have grown over the years, researches were done on different non-chemical approaches such as cultural, mechanical and biological strategies, and host plant resistance. Results from these researches however are fragmented and hence, the use of chemical insecticides remains to be the primary method of pest control.

The low marketable yields and heavy application of pesticides associated with FSB motivated the Agricultural Biotechnology Support Project II (ABSPII) to develop and commercialize *Bt* eggplant—more specifically, a transgenic open-pollinated (OP) FSB-resistant eggplant—for resource-limited farmers in the Philippines, India and Bangladesh through public-private sector partnerships. To fast track the process, ABSPII is collaborating with India-based Maharasthra Hybrid Seeds Company (Mahyco), which has developed a transgenic eggplant variety highly resistant to FSB. The eggplant has been genetically engineered to contain *Bacillus thuringiensis* (*Bt*), a species of soil-borne bacteria, to confer resistance towards the targeted insect. When an insect ingests the *Bt* spores, the protein crystal gets dissolved, releasing protoxins which are then activated by specific enzymes. When the target insect, the FSB larvae, tries to feed on a transgenic eggplant crop expressing the *Bt* protein, it stops feeding and dies as a result of the binding of the *Bt* toxin to its gut wall (Gianessi and Carpenter, 1999).

Scope and Objectives

This chapter assesses the potential environmental impacts of *Bt* eggplant, and investigates whether they may indeed be realized when *Bt* eggplant is introduced in the Philippines. Due to lack of information and scientific evidence even in other countries, the analysis will mainly focus on insecticides. Insecticide use, albeit treated as a proxy for environmental damage, is a major concern from an environmental, human health, and even economic perspective. Hence, environmental impact of *Bt* eggplant in the context of insecticide use is the main scope of this research.

In general, the study aims to quantify the health and environmental impacts of *Bt* eggplant adoption in the Philippines. More specifically, it was conducted to:

- identify appropriate methods to measure health cost savings and improvement of the environment as a result of reduced pesticide use;
- estimate the health and environmental benefits associated with *Bt* eggplant technology adoption; and
- assess the policy implications of the health and environmental impacts of *Bt* eggplant adoption.

Methodology

This section discusses the theoretical framework and the component methodologies employed to estimate the health and environmental impacts of adopting *Bt* eggplant.

Environmental Impact Framework

The estimation of benefits to society from *Bt* eggplant adoption, in terms of its ability to improve the quality of the environment and human health, relies on deriving the impacts of adoption on the risks caused by pesticides to various non-target species, and society's willingness to pay to reduce these risks. These two estimates provide the bases for the economic assessment of the environmental and health impacts of *Bt* eggplant adoption in the Philippines. Figure 1 illustrates the process of assessing environmental impacts and its corresponding valuation.

The analysis begins with the identification and classification of relevant environmental categories that are affected by pesticide use (Cuyno, 1999). These categories are classified according to the type of non-target organisms affected such as humans, birds, beneficial insects, and farm animals. The next step is an environmental impact assessment of the consequences of pesticide use on the identified impact categories to determine the degree or severity of the impacts of pesticide use. This involves estimating the risks posed by individual pesticide's active ingredients to the impact categories by approximating toxicity levels and exposure levels of the organisms to the toxic substance. The impact of the active ingredient is then determined by combining risk estimates with actual field use (dosage and concentration of active ingredient in the formulation). To be able to measure the benefits of *Bt* eggplant adoption, the level of adoption of the technology should be determined. The degree and level of adoption of *Bt* eggplant can be predicted using an econometric model or can be sourced from previous studies. The last step establishes the impacts of *Bt* eggplant on pesticide risk reduction. The change in the degree of pesticide impacts brought about by changes in pest management activities due to *Bt* eggplant adoption is calculated and combined with the estimate of society's willingness to pay for the reduction in pesticide impacts.

Component Methodologies

Risk Avoidance Principle. This study applied the methodology of Cuyno,

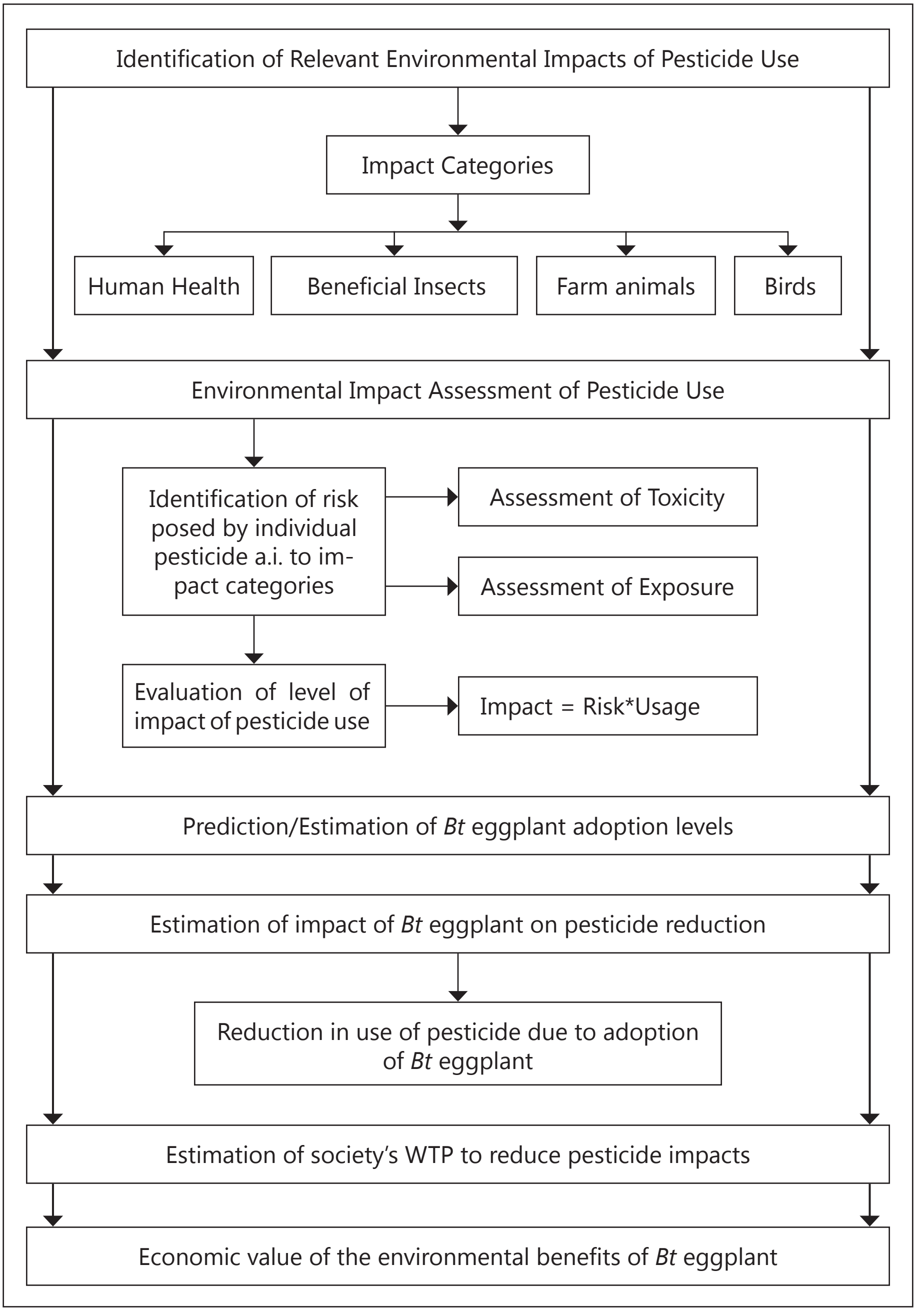

Figure 1. Framework of analysis of environmental impact of *Bt* eggplant adoption (Adapted from Cuyno, 1999)

Norton and Rola (2001) in incorporating the level of toxicity and probability of exposure in the analysis of environmental impact of pesticides. The ecological rating (risk) scores of pesticides are computed as follows:

$$ES_{ij} = IS_j * (\% \text{ a.i.}) * Rate_i$$

where: ES_{ij} = eco-rating score for active ingredient i and environmental category j;
IS_j = risk score for environmental category j;
% a.i. = percent active ingredient in the pesticide formulation; and
$Rate_i$ = pesticide application rate per hectare.

The ecological rating or risk impact score is computed for the *with* and *without Bt* eggplant technology. The difference in the risk impact scores represents the amount of risks avoided if the *Bt* eggplant technology is adopted.

Willingness to Pay (WTP). Estimating the savings in social cost due to *Bt* eggplant adoption necessitates estimating society's willingness to pay (WTP) to avoid risks associated with pesticide use. There is no market for this WTP, but a hypothetical market can be established using the concept of contingent valuation (CV). Among the procedures used in contingent valuation, WTP is used to elicit values or bids from the respondents. Specifically, a close-ended, iterative bidding method is used to elicit eggplant farmers' WTP. The procedure entails asking the farmers whether they will be willing to pay a specified amount for the insecticide that has been described. If the respondent answers affirmatively, the amount is increased until such time the respondent is unwilling to pay the amount specified. The last value where the respondent positively answered represents his/her willingness to pay for the product described. This WTP estimate refers directly to the value that eggplant farmers place on the improvement of environmental quality or conversely, the risks avoided due to lessened harm with improvement in pesticide formulation. This study determined farmers' WTP for reduction in risks associated with the different impact categories considered.

Estimating the Environmental Benefits of Bt Eggplant. The environmental benefits of adopting *Bt* eggplant technology is quantified by combining the estimated risks avoidance value and the elicited WTP for the improvement of the environment by reducing risks of pesticide externalities. The estimate represents the monetary savings due to *Bt* eggplant adoption and its impact on reducing the risks to the four environmental impact categories, i.e., human health, avian species, farm animals, and beneficial insects.

Health Cost Model. The health cost model estimated by Dung and Dung (1999)[1] is used to determine *ex-ante* the savings that farmers and pesticide users could save with *Bt* eggplant adoption. The model is as follows:

$$\text{Ln HC} = 2.7 + 1.24 \ln\text{Age} - 0.02\ \text{Health} + 0.12\ \text{Smoke} + 0.62\ \text{Drink} + 0.075 \ln\text{Ins} + 0.144 \ln\text{Herb}$$

where: HC = health cost;
Age = age of farmer-respondent;
Health = weight over height ratio;
Smoke = (0 for non-smoker, 1 for smoker);
Drink = (0 for non-drinker, 1 for drinker);
Ins = insecticide active ingredient rate of application; and
Herb = herbicide active ingredient rate of application.

Environmental Impact Quotient (EIQ). The most common way to present changes in pesticide use with genetically modified (GM) crops is in terms of the volume of pesticide applied under the *with* GM and *without* GM scenarios. While this method of analysis is a useful indicator of environmental impact, it can be categorized as an imperfect measure because it does not account for differences in (i) specific products used in GM versus conventional crop systems, (ii) rates of pesticides used for efficacy, and (iii) environmental characteristics. These are usually masked in general comparisons of total pesticide volumes used.

To provide a more robust measurement of the environmental impacts of *Bt* eggplant, an analysis known as environmental impact quotient (EIQ) is used. This analysis includes both an assessment of pesticide active ingredient used as well as an assessment of the specific pesticide used. This universal indicator, developed by Kovach et al. (1992), effectively integrates the various environmental impacts of individual pesticides into a single field value per hectare. This provides a more balanced assessment of the impacts of *Bt* eggplant on the environment by drawing on all key toxicity and environmental exposure data related to individual products and relating impacts on farm workers, consumers and ecology. EIQ, therefore, provides a

[1] A similar model was used by Huang et al (2000), Pingali et al (1994; 1995), and Rola and Pingali (1993).

consistent and comprehensive measure of impacts given the environmental components mentioned.

Following the work of Kovach et al. (1992), the EIQ consists of three components (each given equal weight), namely: effect on farm worker, consumer, and ecology. The farm worker component, defined as the effect on the applicator and pickers due to exposure to pesticides, is formulated as:

$$C * [(DT * 5) + (DT * P)] \quad (1)$$

Consumer component, the sum of consumer exposure potential and potential ground water effects, is formulated as:

$$C * [((S + P)/2) * SY + L] \quad (2)$$

The ecology component, which considers pesticide effects on fish, birds, bees, and beneficial arthropods, is modeled as:

$$(F * R) + (D * ((S + P)/2) * 3) + (Z * P * 3) + (B * P * 5) \quad (3)$$

EIQ is the average of the farm worker component, consumer component and ecology component, and is calculated as follows:

$$\begin{aligned} EIQ = \; & \{(C*[(DT*5) + (DT*P)) + [C*((S+P)/2)*SY+L] + \\ & [(F*R) + D*((S+P)/2)*3) + (Z*P*3) + (B*P*5)]\}/3 \end{aligned} \quad (4)$$

where:
- DT = dermal toxicity;
- C = chronic toxicity;
- SY = systemicity;
- F = fish toxicity;
- L = leaching potential;
- R = surface loss potential;
- D = bird toxicity;
- S = soil half-life;
- Z = bee toxicity;
- B = beneficial arthropod toxicity; and
- P = plant surface half-life.

The field rate EIQ is calculated as:

Field rate EIQ = EIQ*(% active ingredient)* Rate used

The field rate EIQ can be used to compare the total environmental footprint or load of the conventional and *Bt* eggplant crop production systems. The difference between the environmental footprints or loads of the two systems represents the impact of *Bt* eggplant on the eggplant production system.

The EIQ has been criticized because it includes many arbitrary weights in its formulas, especially across environmental categories. However, it has been widely applied as an environmental indicator of pesticide risks to health and the environment.

Data Sources

The data used in the analysis were gathered through farmer interviews in four eggplant producing provinces, namely: Pangasinan, Nueva Ecija, Batangas, and Quezon. Twenty five randomly selected farmers from each site were interviewed using a pre-tested structured questionnaire. Information asked from respondents pertains to crop losses due to FSB, pest management practices for FSB, pesticide use and cost, perceived effects of pesticides on the environment, and willingness to pay to avoid perceived risks of pesticides.

Secondary data were also used in the analysis. For example, information regarding adoption rate and reduction in pesticide use were sourced from Francisco (2009); data on risk scores of different pesticides for the different environmental impact categories being addressed in the study was sourced from the listing provided in Cuyno (1999) and data on EIQ were sourced from the New York State Integrated Pest Management Program (NYSIPM) website (www.nysipm.cornell.edu) (Appendix Table 1).

Results and Discussion

Farmer Profile, Pest Control Practices, and Perceptions on Pesticides

Table 1 presents the summary of findings from the farmer interviews conducted in four provinces. On average, farmer-respondents were middle aged, barely reached second year high school and have been farming less than a hectare for less than 15 years. Batangas farmers were the oldest, with least number of schooling years, and had the most experience in planting eggplant in less than 0.5 ha. Quezon farmers, on the other hand, were the youngest and had the largest farm areas devoted to eggplant.

Table 1. Summary findings from interviews of eggplant farmers, by location, Philippines, 2007

	Batangas	Pangas-inan	Quezon	Nueva Ecija	All Sites
Farmers' demographic profile					
Age (years)	43.20	41.08	36.24	41.12	40.41
No. of schooling years	7.16	9.96	8.28	8.48	8.47
Farming experience (years)	18.04	13.12	9.96	14.64	13.94
Farm area (ha)	0.39	0.61	1.26	0.53	0.70
Yield and yield loss in eggplant production					
Yield last year (tons/ha)	18.04	25.05	21.86	22.30	21.56
Yield last 5 years (tons/ha)	25.78	29.70	21.86	24.04	25.35
% Crop loss	41.56	37.88	37.48	28.96	36.47
% Crop loss last 5 years	38.40	37.40	37.48	25.96	34.81
Pesticide use and expenditures					
Frequency of spraying	27.92	31.08	55.01	52.28	41.56
Total volume applied (liters)	74.24	42.13	79.05	62.96	65.63
Total active ingredient applied (kg)	6.24	10.14	16.93	14.47	11.94
Pesticide expenditure (PhP)	31,463	17,383	29,592	33,099	27,884
Share to total cost (%)	19.97	25.66	36.48	34.21	29.27

Across all survey sites, the average reported eggplant yield of 21.56 tons per ha (t/ha) was lower than the average yield of 25.35 t/ha reported by farmers in the last 5 years. On the other hand, the reported mean yield loss of 36.47% was higher than the reported yield loss of 34.81% in the last 5 years (Table 1). This result implies that FSB has become more severe over time, making the marketable yield smaller. Among the survey areas, Pangasinan reported the highest average yield of 25.05 t/ha, while Batangas had the highest average yield loss of 41.56%.

While farmers across all sites applied pesticides 42 times, on average, to manage FSB during the production period, Quezon farmers sprayed 13 times more than the average (Table 1). The average volume of pesticides applied was more than 65 liters per hectare, with total active ingredients of around 12 kg. Still, Quezon farmers applied more compared to others. Cross-referencing the farmers' pesticide use with yield loss, the average yield of Quezon was not substantially higher than those in other areas. In fact, except for Batangas, Quezon farmers' average yield was lower than Pangasinan's and Nueva Ecija's. This indicates that the pesticides applied by Quezon farmers were not effective in controlling FSB since yield loss was still high.

In terms of pesticide effectiveness against FSB, Table 2 summarizes the perceptions of farmers. The top five insecticides that farmers see as most effective are Cartap HCL-based insecticides (18%), Cypermethrin-based insecticides (12%), Methiocarb and Imidacloprid (10%), and Carbofuran (8%) (in this order).

Across all sites, farmers spent an average of about PhP28,000 (about US$560) per ha on pesticides to control FSB, equivalent to 29% of total production costs (Table 1). Nueva Ecija farmers spent more on insecticides than Quezon farmers but the latter had lower production costs and higher pesticide expenses as a proportion of total cost. If pesticide expenses can be reduced by adopting *Bt* eggplant, farmers can realize substantial savings and greater net income. Further, less environmental damage and health impairment would occur.

Farmers were aware of the effects of pesticides on human health and the environment (Table 3). Overall, most farmers believed that pesticides have a negative effect on human health, beneficial insects, and farm animals. Nearly half (46%) of all farmer-respondents reported to have experienced sickness after pesticide application, including dizziness, nausea, shortness of breath,

Table 2. Farmers' reported most effective insecticide for FSB control

Effective Insecticide	% Farmers Reporting	Effective Insecticide	% Farmers Reporting
CartapHCl	18	Prochlorazmin	2
Cypermethrin	12	Lambdacyhalothrin	2
Methiocarb	10	Dimethoate	2
Imidacloprid	10	Carbaryl	2
Carbofuran	8	Chlorpyfiros	2
Imidacloprid + Cyfluthrin	7	Methamidophos	1
Deltamethrin	6	Imazaquin	1
Profenofos	4	Fipronil	1
Brodan	3	Esfenvalerate	1
Chlorpyfiros + BPMC	2	Dimethoate	1
Carbaryl	2	Malathion	1

Table 3. Farmer perception regarding effects of pesticide

Location	Response	Human Health	Beneficial Insects	Birds	Farm Animals	Sickness* from Pesticide
Batangas	No	3 (*12*)	9 (*36*)	12 (*48*)	7 (*28*)	6 (*24*)
	Do not know		2 (*8*)	2 (*8*)		4 (*16*)
	Yes	22 (*88*)	14 (*56*)	11 (*44*)	18 (*72*)	15 (*60*)
Pangasinan	No	1 (*4*)	5 (*20*)	17 (*68*)	9 (*36*)	11 (*44*)
	Do not know	2 (*8*)	1 (*4*)	3 (*12*)		4 (*16*)
	Yes	22 (*88*)	19 (*76*)	5 (*20*)	16 (*64*)	10 (*40*)
Quezon	No	1 (*4*)	4 (*16*)	18 (*72*)	14 (*46*)	16 (*64*)
	Do not know				1 (*4*)	
	Yes	24 (*96*)	21 (*84*)	7 (*28*)	10 (*40*)	9 (*36*)
Nueva Ecija	No	3 (*12*)	2 (*8*)	18 (*72*)	6 (*24*)	11 (*44*)
	Do not know	1 (*4*)	1 (*4*)		1 (*4*)	2 (*8*)
	Yes	21 (*84*)	22 (*88*)	7 (*28*)	18 (*72*)	12 (*48*)
All sites	No	8	20	65	36	44
	Do not know	3	4	5	2	10
	Yes	89	76	30	62	46

* Sickness experienced included drowsiness, nausea, shortness of breath, loose bowel movement, and itchiness.
Italicized figures enclosed in parentheses are % response based on location total.

loose bowel movement, and itchiness. As such, when asked to rank the importance of the different impact categories presented, the farmers ranked human health as the most important, followed by farm animals, beneficial insects, and birds.

Assessing Health and Environmental Impacts

This section discusses in three parts, the health and environmental impacts and projects the effects of reduced pesticide use as a result of *Bt* eggplant adoption. The first part quantifies the value to the environment in terms of risks avoided with reduced pesticide use. The second and third part, respectively deal with the savings in health costs (to treat acute and chronic ailment) and quantifying the environmental effects as a consequence of reduced pesticide use in eggplant production.

In addition to the direct environmental benefits, a positive effect expected from *Bt* eggplant adoption, with indirect environmental benefits, is the change in farmers' agronomic practices (modifying or displacing conventional or "traditional" activities) such as the use of pesticides. For instance, studies in other countries have projected that *Bt* eggplant adoption will yield significant reduction in insecticide applications as the technology replaces broad spectrum chemicals (Kolady and Lesser, 2005; 2006).

Risk Avoidance. The following section summarizes and discusses the step-by-step procedure used in valuing the health and environmental impacts of *Bt* eggplant adoption.

Pesticide impact scores. The different pesticides used in eggplant production (as gathered from the farmer interviews) were each assigned impact (risk) scores by environmental category, ISj (Table 4). These were used to compute for their ecological rating (risk) scores ESij, for scenarios *with* and *without Bt* eggplant technology (Table 5). Analysis shows that the estimated change in ecological rating (which represent improvement in environment) due to the adoption of *Bt* eggplant are as follows: 19.02% for human health and farm animals, 21.37% for bird species, and 18.67% for beneficial insects. These values represent the *would be* reduction in the risks associated with reduced pesticide use due to *Bt* eggplant adoption, and potential improvement in environmental integrity.

Farmers' willingness to pay. Farmers' willingness to pay (WTP) to avoid risks provides a means to estimate the monetary values of the health and

Table 4. Risk scores (IS_j) of pesticides used in eggplant production

Active Ingredient	Brand Name	Risk Scores by Impact Category			
		Human	Animals	Birds	Beneficial Insects
Insecticides					
Betacypermethrin	Chix 2.5 EC	4	4	1	5
Carbaryl	Sevin WP 85	2	2	3	5
Carbofuran	Furadan	3	3	5	5
Cartap HCL	Super Cartap 50 SP	3	3	3	5
Cartap HCL	Padan 50 SP	3	3	3	5
Cartap HCL	Dimo 50 SP	3	3	3	5
Cartap HCL	Buenas 50 SP	3	3	3	5
Cartap HCL	Dimotrin	3	3	3	5
Cartap HCL	Ingam 50 SP	3	3	3	5
Chlorpyfiros + BPMC	Brodan 31.5 EC	3	3	5	5
Chlorpyrifos	Siga 300 EC	3	3	5	5
Chlorpyrifos	Lorsban 40 EC	3	3	5	5
Chlorpyrifos + Cyper	Nurelle D	3	3	5	5
Cypermethrin	Magnum 5 EC	4	4	1	5
Cypermethrin	Poker 5 EC	4	4	1	5
Cypermethrin	Hukom 5 EC	4	4	1	5
Cypermethrin	Cypex 50 EC	4	4	1	5
Cypermethrin	Lakas 5 EC	4	4	1	5
Cypermethrin	Magik 5% EC	4	4	1	5
Cypermethrin	Servwell TKO 50 SC	4	4	1	5
Cypermethrin	Cypermethrin 5 EC	4	4	1	5
Cypermethrin	Cymbush 5 EC	4	4	1	5
Deltamethrin	Decis 2.5 EC	4	4	3	5
Deltamethrin	Superquick 2.5 EC	4	4	3	5
Dimethoate	Perfekthion 40 EC	4	4	3	3
Fenvalerate	Legend 2.5 EC	3	3	1	5
Fipronil	Ascend 50 SC	3	3	3	1
Imidacloprid	Admire 5 WP	3	3	5	3
Imidacloprid	Confidor SL 100	3	3	5	3
Imidacloprid + Cy-fluthrin	Provado Supra 050 EC	3	3	5	3
Lambdacyhalothrin	Bida 2.5 EC	3	3	3	5
Lambdacyhalothrin	Karate 2.5 EC	3	3	3	5
Malathion	Malathion	4	4	3	5

Table 4. Risk scores (IS_j) of pesticides used in eggplant production

Active Ingredient	Brand Name	Risk Scores by Impact Category			
		Human	Animals	Birds	Beneficial Insects
Malathion	Malathion 57 EC	4	4	3	5
Malathion	Planters Malathion 57 EC	4	4	3	5
Methamidophos	Tamaron 600 SL	4	4	3	5
Methomyl	Lannate 40 SP	4	4	3	5
Profenofos	Selecron 500 EC	4	4	5	5
Profenofos	Kilabot 500 EC	4	4	5	5
Triazophos	Hercules 20 EC	3	3	3	3
Triazophos	Hostathion	3	3	3	3
Fungicide					
Copper Hydroxide	Funguran-Oh	3	3	3	3
Copper Oxychloride	Vitigran Blue 58 WP	3	3	3	3
Mancozeb	Dithane M-45 WP	3	3	3	5

Source of data for risk score: The EXtension TOXicology NETwork (EXTOXNET) database (extoxnet.orst.edu/ghindex.html). The rating represents the degree of hazard of pesticides to the environmental categories.

Table 5. Value and percentage changes in ecological rating (ES_{ij})[a] due to *Bt* eggplant technology adoption

Impact Category	Type of use	Ecological Rating without *Bt* Eggplant	Ecological Rating with *Bt* Eggplant	% Risks Avoided
Human health	Insecticides	1,013.66	456.15	19.02
	Fungicide	1,917.56	1,917.56	
Total		*2,931.22*	*2,373.71*	
Farm animals	Insecticides	1,013.66	456.15	19.02
	Fungicide	1,917.56	1,917.56	
Total		*2,931.22*	*2,373.71*	
Avian species	Insecticides	1,222.51	550.13	21.37
	Fungicide	1,924.56	1,924.56	
Total		*3,147.07*	*2,474.69*	
Beneficial insects	Insecticides	1,493.14	671.91	18.67
	Fungicide	2,904.74	2,904.74	
Total		4,397.74	3,576.65	

[a] $ES_{ij} = IS_j * (\%a.i.) * Rate_i$

where: ES_{ij} = eco-rating score for active ingredient i and environmental category j;
IS_j = risk score for environmental category j;
% a.i. = percent active ingredient in the pesticide formulation; and
$Rate_i$ = pesticide application rate per hectare.

environmental benefits of *Bt* eggplant. WTP values were obtained during the farmer interviews using the contingent valuation method, which simulates a buy and sell exercise. Farmer respondents were asked about their WTP for a safer formulation of pesticide, which they perceive as effective for controlling FSB. Four different formulations were offered for specific risk avoidance, i.e., those that prevent risks to: 1) human health; 2) farm animals; 3) birds; and 4) beneficial insects. The farmers were told of the actual price of the pesticide they are presently using. The price was raised by PhP50.00 and asked if they are willing to pay for it. If they answered 'Yes', the price was further raised by PhP50.00; the last price before saying 'No' represents the farmer's WTP for the safer product.

On average, farmers are willing to pay a higher price up to PhP1,019/liter for a pesticide formulation safer for humans; up to PhP945/liter for those safe for farm animals; up to PhP894/liter for those safe for beneficial insects; and up to PhP867/liter for those safe for bird species (Table 6).These results support the importance ranking farmers placed on the different impact categories.

Value of Health and Environmental Benefits of Bt Eggplant. To estimate the value of the potential health and environmental benefits from *Bt* eggplant, the percentage change in risks avoided is converted to a monetary value, by combining it with the farmers' WTP for risk avoidance in the different impact categories (Table 7). The estimated values of benefits are multiplied by the assumed farmers' *Bt* eggplant adoption rate to come up with the projected benefits derived from risks avoided for the different impact categories. For example, the savings from human health costs would be about PhP2.5 million while the aggregate projected benefits to farm animals, beneficial insects, and avian species would amount to about PhP6.8 million. These values represent the health costs that would be saved and the value of environmental improvement with farmers' adoption of *Bt* eggplant technology.

Table 6. Farmers' willingness to pay to avoid risk of the different impact categories

Impact Category	Average Insecticide Price (PhP)	Std Dev	Farmer's WTP (PhP)	Std Dev	Difference (PhP)
Human health	724.00	416	1,019.00	572	295.00
Farm animals	724.00	416	945.00	531	222.00
Beneficial insects	724.00	416	894.00	508	170.00
Avian Species	724.00	416	867.00	493	144.00

Std Dev=standard deviation, WTP=willingness to pay.

Health Cost. Following the health cost function in Dung and Dung (1999), the farmers' health costs for the *with Bt* eggplant and *without Bt* eggplant were estimated individually using the coefficients of the health cost function. The incremental health benefit is determined as the difference between the *with* and *without Bt* eggplant farmers' health cost estimates (Table 8). The estimated health costs for *Bt* eggplant adopters is PhP2,570 compared to PhP2,733 for the conventional eggplant farmers. This translates to a savings in health cost of PhP163.00 per farmer. Assuming a 50% adoption rate of *Bt* eggplant technology, the aggregate estimated savings on health costs amounted to about PhP2.1 million. This value represents the savings in health costs of the projected adopters of the technology. If adoption rate would be higher, the projected savings would also increase.

The Environmental Impact Quotient (EIQ). Applying the procedure outlined in the methodology section and using the EXtension TOXicology NETwork (EXTOXNET) database (extoxnet.orst.edu/ghindex.html), the EIQ and field rate EIQ of the different insecticides and fungicides were estimated (Table 9). The average pesticide use by non-*Bt* eggplant farmers was 11.98 liters/ha

Table 7. Projected yearly health and environmental benefits of *Bt* eggplant

Impact Category	% Risk Avoided	Farmers' WTP (PhP)	Benefits (PhP per farmer)	Projected Benefits* (PhP)
Human health	19.02	1,019.15	193.84	2,492,229
Farm animals	19.02	945.25	164.95	2,120,786
Beneficial insects	21.37	893.69	190.94	2,454,943
Avian species	18.67	867.25	176.51	2,269,414

* Assumed adoption rate of 50% of total eggplant area (or 9,000 ha) across the Philippines and farm area = 0.7 ha
1USD = PhP50.00 (2007)

Table 8. Incremental health benefits of adopting *Bt* eggplant using health cost model

Particular	Health Cost (PhP)
Without *Bt* eggplant per farmer	2,733
With *Bt* eggplant per farmer	2,570
Savings in health cost per farmer	163
Projected total health benefits*	2,095,714

* Assumed adoption rate is 50% of total eggplant area (or 9,000 ha) in the Philippines and farm size=0.7 ha.

Table 9. Reduction in environmental footprint from changes in pesticide use associated with *Bt* eggplant adoption

	Without *Bt* Eggplant	With *Bt* Eggplant	Difference
Pesticide use (li/ha)	11.98	6.22	5.76
Field EIQ	245.59	197.75	47.84
% Change in pesticide use			48.08
% Change in EIQ footprint			19.48

EIQ = (Farm worker component + Consumer component + Ecology component)/3
Field rate EIQ = EIQ* % active ingredient* Rate used
Change in EIQ footprint represents improvement in the environment

while that of would-be *Bt* eggplant adopters was 6.22 liters/ha, a reduction of around 48%. The field EIQ for the non-*Bt* eggplant was 245 per ha while that of *Bt* eggplant was around 198, equivalent to a 19.5% reduction in environmental footprint.

Summary and Conclusion

The study estimated *ex-ante* the value of health and environmental benefits of adopting *Bt* eggplant using the methods of risk avoidance, health cost function, and environmental impact quotient. Its data came primarily from a survey of 100 eggplant farmers in four provinces. Secondary data were also used.

The farmer-respondents' average yield was lower than that for the last 5 years (based on official statistics) and the reported mean yield loss was higher compared with the reported yield loss in the last 5 years, implying that FSB may have become more severe over time. Farmers applied pesticides 42 times during the production period at a mean rate of more than 65 liters/ha and around 12 kg a.i./ha. Farmers spent about PhP28,000/ha on pesticides to control FSB, representing 29% of total production costs. Majority of the farmers believed that pesticides have negative effects on human health, beneficial insects, and farm animals but not likely on birds. Human health was ranked as the most important among the impact categories considered, followed by farm animals, beneficial insects, and birds.

Combining the farmers' willingness to pay and percentage reduction in risks for the different impact categories showed that the adoption of *Bt* eggplant technology could save about PhP2.5 million in health costs and improve the overall environment (farm animals, beneficial insects, and avian species) at a value of about PhP6.8 million using the risk avoidance principle. Similarly, using the health cost model, the projected savings from human health costs amounted to about PhP2.1 million, a similar magnitude to that obtained from the risk avoidance model.

With the adoption of *Bt* eggplant technology, farmers' pesticide usage would decline by 48%, contributing to a significant reduction in the health and environmental impacts of pesticide use. Results of this study, together with the agronomic and direct economic benefits, reinforce the need for continued support for the development, commercialization, and promotion of *Bt* eggplant. These may be used to convince consumers and other interest groups of the benefits of allowing the commercialization and use of *Bt* eggplant.

This type of analysis is usually missing in the valuation of total economic benefits and costs of biotechnology products, such as *Bt* eggplant. When combined with private benefit-cost analysis, it can however provide a more complete picture of the valuation of social costs and benefits associated with the adoption of the technology, which can accrue to farmers, consumers, as well as the environment.

References

ABSPII (Agricultural Biotechnology Support Project II) (Southeast Asia). undated. Development and Commercialization of Fruit and Shoot Borer-Resistant Eggplant for India, Bangladesh, and the Philippines. Document accessed June 2005 from http://www.isaaa.org/Regional_centers/SEAsiacenter/ABSPII.htm

Brookes, G. and P. Barfoot. 2006. GM crops: The global economic and environmental impact-the first nine years. *AgBio Forum* 8(2&3).

Conway, G. and J. Pretty. 1991. *Unwelcome Harvest: Agriculture and Pollution*. London: Earthscan Publications Ltd.

Cuyno, L. 1999. An economic evaluation of health and environmental benefits of IPM Program (IPM CRSP) in the Philippines. PhD dissertation. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. USA.

Cuyno, L., G.W. Norton, and A.C. Rola. 2001. Economic analysis of environmental benefits of integrated pest management: A Philippine case study. *Agricultural Economics* 25:227-233.

Dung, N.H. and T.T. Dung. 1999. Economic and Health Consequences of Pesticide Use in Paddy Production in the Mekong Delta, Vietnam. Economy and Environment Program for Southeast Asia (EEPSEA), Singapore. 39 p.

Esguerra, N.M. and S.F. Barroga. 1982. Status of pest control in solanaceous crops. Paper presented in the workshop "The State of the Art of Growing Vegetables". PCARRD Research Report.

EXTOXNET. The EXtensionTOXicologyNETwork pmep.cce.cornell.edu/profiles/extoxnet/: A Pesticide Information Project of Cooperative Extension Offices of Cornell University, Michigan State University, Oregon State University, and University of California at Davis.

Francisco, S. 2009. Costs and Benefits of *Bt* Eggplant with Resistance to Fruit and Shoot Borer in the Philippines. In Norton, G.W. and D.M. Hautea (eds.). 2009. *Projected Impacts of Agricultural Biotechnologies for Fruits and Vegetables in the Philippines and Indonesia*. International Service for the Acquisition of Agri-biotech Applications (ISAAA) and SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA). College, Laguna, Philippines.

Gianessi, L., and J. Carpenter. 1999. Agricultural biotechnology: Insect control benefits. www.ncfap.org/reports/biptech/insectcontrolbenefits.pdf

Huang, J., R. Hu, S. Rozelle, F. Qiao, and C.E. Pray. 2002. Transgenic varieties and productivity of smallholder cotton farmers in China. *The Australian Journal of Agricultural and Resource Economics* 46(3):367-387.

Kolady, D. and W. Lesser. 2005. Adoption of genetically modified eggplant in India: An *ex-ante* analysis. Paper presented at the American Agricultural Economic Association Annual Meeting, Providence, Rhode Island, July 24-27. ageconsearch.umn.edu/handle/19262

Kolady, D. and W. Lesser. 2006. Is it feasible to provide genetically modified crops to small farmers on preferential terms?: An *ex ante* analysis of *Bt* eggplant in India. Paper presented at the American Agricultural Economic Association Annual Meeting, Long Beach, California, July 23-26.

Kovach, J., C. Petzoldt, J. Degni, and J. Tette. 1992. A method to measure the environmental impacts of pesticides. *New York's Food and Life Science Bul.* Geneva, NY: NYS Agric Experiment Station, Cornell Univ. www.nysipm.cornell.edu/publications/EIQ.html.

Navasero, M.V. 1983. Biology and control of eggplant fruit and shoot borer, *Leucinodes orbonalis* Guenee. Unpublished B.S. thesis. Department of Entomology. University of the Philippines Los Baños, College, Laguna.

New York State Integrated Pest Management Program (NYSIPM) www.nysipm.cornell.edu/publications/eiq/files/EIQ_values_2012entire.pdf

Pingali, P.L., C.B. Marquez, and F.G. Palis. 1994. Pesticides and Philippine rice farmers: a medical and economic analysis. *American Journal of Agricultural Economics* 76:587-592.

Pingali, P.L., C.B. Marquez, F.G. Palis, and A.C. Rola. 1995. The effect of long-term pesticide exposure on farmer health: A medical and economic analysis in Philippines. In P. Pingali and P. Rogers (eds). *Impact of Pesticides on Farmer Health and the Rice Environment.* Kluwer Academic Publishers. Boston.

Rashid, M.A. 2003. Socio-economic parameters of eggplant pest control in Jessore district of Bangladesh. Asian Vegetable Research and Development Center.

Rola, A.C. and P.L. Pingali. 1993. *Pesticides, Rice Productivity, and Farmers' Health: An Economic Assessment.* International Rice Research Institute and World Resources Institute.

Saavedra, N.T. 1987. Eggplant fruit and shoot borer. *NCPC Newsletter* 2(1): 3-4.

Appendix Table 1. Environment impact quotient (EIQ) and field rate EIQ of different pesticides used in eggplant production, Philippines

Pesticide	Brand Name	EIQ	Rate (per ha)	Active Ingredient (ai)	Field EIQ (per ha)
Insecticides					
Carbofuran	Furadan	50.67	96.00	0.05	126.16
Chlorpyrifos	Siga 300 EC	43.52	13.05	0.30	313.25
Chlorpyrifos	Lorsban 40 EC	43.52	25.00	0.40	435.17
Cypermethrin	Magnum 5 EC	30.67	18.00	0.05	18.94
Cypermethrin	Poker 5 EC	30.67	43.20	0.05	60.28
Cypermethrin	Hukom 5 EC	30.67	13.05	0.05	20.01
Cypermethrin	Cypex 50 EC	30.67	6.25	0.05	9.58
Cypermethrin	Lakas 5 EC	30.67	5.54	0.05	28.35
Cypermethrin	Magik 5% EC	30.67	4.00	0.05	7.41
Cypermethrin	Servwell TKO 50 SC	30.67	5.60	0.05	8.59
Cypermethrin	Cypermethrin 5 EC	30.67	36.00	0.05	55.20
Cypermethrin	Cymbush 5 EC	30.67	2.64	0.50	40.48
Dimethoate	Perfekthion 40 EC	73.97	4.00	0.40	118.35
Fenvalerate	Legend 2.5 EC	49.58	4.00	0.03	4.96
Fipronil	Ascend 50 SC	90.92	9.60	0.05	93.33
Imidacloprid	Admire 5 WP	34.91	5.40	0.05	7.75
Imidacloprid	Confidor SL 100	34.91	0.40	0.10	4.91
Lambdacyhalothrin	Karate 2.5 EC	43.53	145.00	0.03	40.69
Lambdacyhalothrin	Bida 2.5 EC	43.53	8.40	0.03	9.14
Malathion	Malathion	23.83	25.20	0.57	94.69
Malathion	Malathion 57 EC	23.83	10.00	0.57	199.48
Malathion	Planters Malathion 57 EC	23.83	12.00	0.57	257.93
Methamidophos	Tamaron 600 SL	36.83	1.92	0.60	195.11
Methomyl	Lannate 40 SP	30.67	14.77	0.40	125.42
Fungicide					
Copper Hydroxide	Funguran-Oh	40.08	6.00	0.77	231.48
Mancozeb	Dithane M-45 Neotec WP	15.77	0.60	0.80	47.09

Chapter 8

Poverty and Nutrition Impacts of *Bt* Eggplant Adoption

Sergio R. Francisco, Catherine Aragon-Chiang, and George W. Norton

Background and Objectives

Research and development (R&D) in agriculture can significantly influence the level and the distribution of income among farmers. Moreover, R&D in agriculture can also have implications in terms of reducing poverty among farmers and improving the nutritional status of consumers. For example, the adoption of either a yield-increasing or cost-reducing technology can lower per unit cost of production, increase the supply of food, and raise incomes of adopting producers. The corresponding outward supply shifts, in turn, can lower food prices to the benefit of the consumers. However, producers may also lose, particularly, those who are late-adopters. The higher productivity could create significant multiplier effects in the rural community, inducing rural employment and other services related to agricultural production. These distributional effects, however, are theoretical, and the net impacts of technological innovation on the poor, in terms of poverty alleviation and nutrition, require empirical quantification.

Poverty and malnutrition remain a serious problem particularly in the developing countries in Asia and Africa. Thus, R&D institutions were always asked to provide concrete evidence that their research outputs reach the targeted beneficiaries. Because of this, there has been refocusing and shifting in the paradigm in R&D by incorporating poverty and nutrition dimension in impact evaluation. However, despite increased interest in understanding poverty and nutrition impacts of agricultural research, few *ex-ante* studies on impacts of R&D on aggregate poverty and nutrition have been conducted. *Ex-ante* assessment tools, such as economic surplus analysis, can be used in this type of analysis by disaggregating the population into subgroups and then examining the distribution of research impacts on groups such as households in poorer income strata.

Aside from economic impacts, *Bt* eggplant adoption has potential impacts on poverty reduction as eggplant is often grown on small farms. Since it has positive effects on profits, it can significantly influence the level and distribution of income of eggplant producers and thereby, may reduce poverty. Once commercialized, *Bt* eggplant adoption can lower per-unit cost of production, increase supply of eggplant, and raise income of adopting farmers who are mostly poor. Moreover, with the expected increase in eggplant production due to increase in yield, consumers may gain because they can buy more eggplant at a lower price.

This research sought to determine the poverty and nutrition impact of *Bt* eggplant technology adoption in the Philippines. It also aimed to complement the works done on economic and environmental impacts of *Bt* eggplant adoption in order to completely enumerate and project quantitatively the overall impact of *Bt* eggplant adoption.

Methodological Framework

This study combined the economic surplus analysis with household-level data analysis to construct *ex-ante* estimates of changes in poverty and nutrition status resulting from adopting *Bt* eggplant. Economic surplus analysis provides estimates of changes in prices and economic surplus under various assumptions about technology adoption. The household-level analysis uses consistent information about changes in production costs associated with adoption and consumption patterns to infer household-specific changes in income and allocates the change in economic surplus to individual producers and consumers. With appropriate accounting and survey weights, household income changes can be used to estimate changes in aggregate poverty and aggregate income as well as nutrition status, which in the context of the model should be consistent with findings from the market-based surplus analysis.

Economic Surplus Analysis

Standard approaches to *ex-ante* estimation of impacts of technological innovation involve several steps: first is the calculation of a k-shift, which represents the unit-cost reduction associated with use of a new technology; second is gathering of information on expected adoption rates and their evolution over time; and the third step involves combining the first two steps with market-related information on supply and demand elasticities and equilibrium prices and quantities (Alston et al., 1995). These steps allow estimation of price, quantity and corresponding economic surplus changes associated with technology adoption. Some modifications that need to be done to fit the techniques to the desired analysis include efforts to distinguish among producer groups who may vary in propensity to adopt different technologies (Mutangadura and Norton, 1999), regional variation to reflect spatial differences in cost, shipping, prices and markets (Mills, 1997), and regional differences in productivity (Karanja et al., 2003). The challenge then is to allocate the economic surplus to specific households.

The changes in economic surplus can be calculated under various market situations. For example, in a closed economy, the primary beneficiaries from adopting a cost-reducing technology are the eggplant farmers, either through sales or home consumption (Figure 1) and consumers. The initial

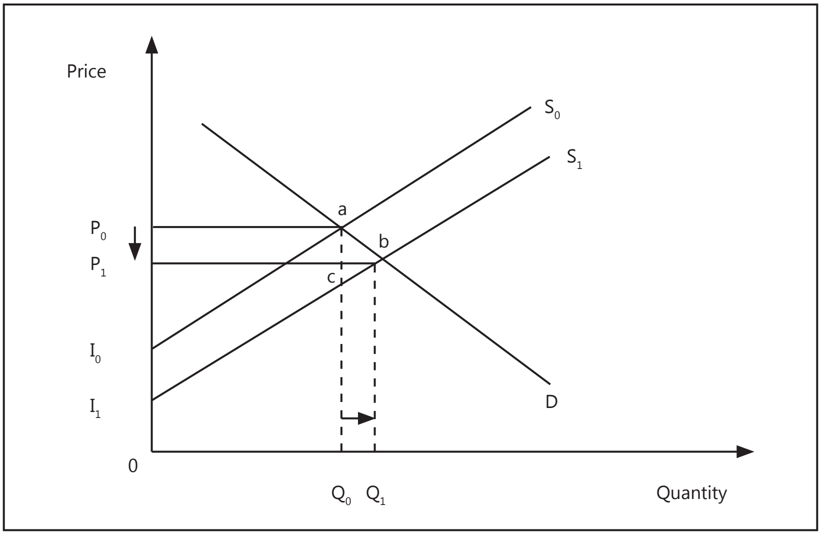

Figure 1. Research benefits in a small closed economy

equilibrium is defined by consumption C_0, and production Q_0, at the price P_0. Research increases yield or lowers the unit cost of production, causing supply to shift from S_0 to S_1 and production to increase to Q_1. Economic surplus change is equivalent to producer surplus change and is equal to area I_0abI_1. This surplus is the one we seek to allocate to the stakeholders in eggplant production.

Algebraically, the formulas for the consumer surplus, producer surplus, and total surplus are expressed as (Alston et al., 1995):

Producer Surplus: $\Delta PS_t = (K_t - Z_t)P_0Q_0(1 + 0.5Z_t\, ŋ)$;
Consumer Surplus: $\Delta CS_t = P_0Q_0\, Z_t\, (1 + 0.5Z_t\, ŋ)$; and
Total Surplus: $\Delta TS_t = \Delta PS_t + \Delta CS_t = P_0Q_0K_t\, (1 + 0.5\, Z_t\, ŋ)$,

where

$$Kt = \frac{E(Y)}{\varepsilon} - \frac{E(C)}{(1 + E(Y))} * p\, At\, (1\text{-}dt)$$

K = technical change; vertical shift of the supply function expressed as a proportion of the initial price;
E(Y) = expected proportionate yield change per hectare;
ε = price elasticity of supply;
E(C) = expected proportionate change in variable input costs per hectare;
p = probability of success of achieving the expected yield change from adoption;
At = adoption rate of technology in time t;
dt = depreciation rate of the new technology;
P_0 = farm-level price of the commodity;
Q_0 = total domestic production of the commodity (metric tons);
Z_t = $K_t\, \varepsilon/(\varepsilon+ŋ)$ proportionate decrease in price (in year t) due to supply shift; and
ŋ = absolute value of the price elasticity of demand.

The net welfare effect on producers may generally be positive or negative, depending on supply and demand elasticities. The change in total surplus measures the net welfare change in the sense that the gainers from the technical change could, in principle, compensate the losers and still be better off by the amount I_0abI_1.

Poverty and Nutritional Status Changes: Allocating Surplus to Households

The most common measure of poverty is the number of households whose per capita income is below the poverty threshold. Nutritional indicators that stem from changes in food consumption due to changes in supply or changes in technology include changes in per capita calorie consumption. The amount of calorie intake in return, has a bearing on the percentage of malnourished population.

Bt Eggplant Economic Surplus Assumptions

Table 1 summarizes the parameters of the base economic surplus model used by Francisco (2006). Orogo (1976) estimated that the general demand elasticity for fruit bearing vegetables in the Philippines was -0.85 while that for vegetables in general was -0.75. Francisco (2006) assumed a -0.8 demand elasticity and 0.5 supply elasticity of eggplant based on the high level of seasonality in the growth of this crop as well as its production limitations. Farmers cannot simply increase eggplant production during the wet season even if price is high due to the inability of eggplant to grow in overly wet areas. Francisco (2006) obtained the other necessary information for the base parameters of the model from the Bureau of Agricultural Statistics (BAS) and by conducting focus group discussions with eggplant farmers, scientists, and industry experts. From these data sources, Francisco (2006) projected a 40% yield increase, a 16% decrease in input costs, a price of PhP10,000 per metric ton, and a production of 182,750 metric tons.

Poverty Impact

Linking Economic Surplus Analysis to Poverty Analysis. Under the closed economy assumption, prices are expected to decline in response to a

Table 1. Model parameters for *Bt* economic surplus analysis

Item	Values
Elasticity of supply	0.5
Elasticity of demand	0.8
Expected yield change	40%
Change in input costs per ha	-16%
Price (PhP/mt)	PhP10,000.00
Base quantity (mt)	182,750

Source: Francisco (2006)

research-induced outward shift in supply in Figure 1. There are three distinct components of surplus, first is a loss in producer surplus for all producers (i.e., adopters and non-adopters) owing to the price decline, which is represented by the area P_0aeP_1 in Figure 1; second is an increase in producer surplus among adopting farmers due to the lower cost of production represented by area P_1bI_1 less P_0aI_0; and the third is the gain to consumers owing to price decrease (P_0abP_1) (Moyo et al., 2007). These three components of surplus must be allocated to specific households according to whether they produce eggplant, whether they are likely to adopt the new technology, and whether they consume eggplant. Similar to Moyo et al. (2007), producer surplus change is assigned to each of the eggplant households by first computing total production and then producer surplus change was assigned according to a household's production share and its probability of technology adoption. This report focuses only on allocating the change in producer surplus to each of the adopting and non-adopting households. The consumer surplus allocation to the consuming household was not computed. Although *Bt* eggplant technology has a large potential impact on consumers in the aggregate as shown by Francisco (2006), the change in consumer surplus is not large enough to affect income of individual consumers. Based on the computation of Mutuc (2003), the share of eggplant expenditures in the total household budget is barely 1%. Thus, reductions in the price of eggplant owing to the *Bt* eggplant technology will have a minimal effect on an individual consumer's income and is most likely not sufficient to remove them from poverty.

The change in eggplant production and household income as a result of *Bt* eggplant adoption is related to the value of eggplant production before the adoption of the technology, and the per unit cost reduction as a result of adoption. The same K-shift as used in the surplus analysis can also be used at the household level to approximate $d\pi_i(\tau)$. For example, the i^{th} household, the change in surplus (income) is

$$d\pi_i(\tau) \approx K_i P_i Q_i \left(1 + 0.5 K_i \varepsilon\right) = I_0 ab I_1 \tag{1}$$

where

P_i is the pre-research price;
Q_i is the pre-research quantity;
ε is the elasticity of supply; and
K_i is the proportionate shift downward in the marginal cost curve due to research.

Adopters of the technology receive this income benefit. The market K-shift shown in Figure 1 incorporates assumptions about rates of technology adoption.

Household-level Adoption. In projecting the *ex-ante* poverty change, it is necessary to identify farmers who are likely to adopt *Bt* eggplant technology. A model of adoption probabilities was estimated to identify households most likely to adopt the new technology. In the modeling process, it is assumed that farm decision makers face two alternatives—to adopt or not, with the decision based on expected profits associated with each alternative, perceptions about risks, availability of information, and household-specific constraints. The adoption probability for each household can be predicted given observations on the adoption of similar technologies and variables affecting the probability of adoption. Households can then be ranked in order of decreasing probability of adoption and "adopting households" can be identified as those whose predicted probability of adoption exceeds a threshold prediction probability. If it is assumed, for example, that 25% of households adopt, those households are selected whose predicted probability of adoption exceeds that of the household at the 75th percentile of the ranking.

Poverty Measurement. The analysis of projected changes in poverty status resulting from the adoption of a technological innovation like *Bt* eggplant involves three steps: (1) computing the household-level value of the welfare measure and comparing it to the poverty line; (2) determining which households are most likely to adopt the technology and estimating how household welfare will change following adoption; and (3) adding up the change in the number of poor people or households resulting from adoption. The resulting household analysis of *ex-ante* income changes among adopting farming households can be used to create an estimate of market-level surplus changes which correspond to the total change in income for all participants in the market, and of changes in poverty in the population.

The FGT indices (Foster et al., 1984) are commonly used indicators of poverty in a given population. These indices are useful because they are additively decomposable with population share weights (Ravallion, 1992). Its additive decomposability allows evaluation of impacts of agricultural and other policies on sub-groups. The FGT class of poverty measures is defined as

$$P_\alpha = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{z - y_i}{z}\right]^\alpha \qquad (2)$$

where

- n is the total number of people;
- q is the number of poor people;
- y_i is income or expenditure of the ith poor household;
- z is the poverty line, measured in the same units as y; and
- α is a parameter of inequality aversion.

When α = 0, Pα is the headcount index, which is a measure of the prevalence of poverty or the proportion of the population that is poor. When α = 1, Pα is the poverty gap index, a measure of depth of poverty. It is based on the aggregate poverty deficit of the poor relative to the poverty line. When α = 2, Pα is a measure of severity of poverty. Each α tells the analyst different things about the patterns of poverty in a population. The head count index (P_0) (for α = 0) is the simplest which indicates the proportion of the population for whom consumption *y* is less that the poverty line *z*. The poverty gap index (P_1) (for α = 1) is a measure of depth of poverty. It is based on the aggregate poverty deficit of the poor relative to the poverty line. A value of $P_1 = 0.1$ means that the aggregate deficit of the poor relative to the poverty line, when averaged over all households, represents 10% of the poverty line. A severity of poverty measure (P_2) (for α = 2), unlike the other two, is sensitive to the distribution of income among the poor. It satisfies the "transfer axiom," which requires that when a transfer is made from a poor person to someone who is poorer, the measure indicates a decrease in aggregate poverty. For both P_1 and P_2 the individual poverty measure is strictly decreasing in the living standard of the poor, i.e., the lower the standard of living, the poorer you are deemed to be.

Survey data on household production and income allow estimation of poverty rates, and our study examined how adoption of *Bt* eggplant technology changes those rates. The correspondence between the economic surplus approach and the household approach comes from the change in marginal cost of production caused by adoption of the technology.

Nutritional Impact

Nutritional impacts of *Bt* eggplant technology were examined by disaggregating the market demand curve into demand curves by income groups using their separate price elasticities of demand. Considering only the effect of prices, the increase in yields following a per unit cost reduction due to *Bt* eggplant technology is expected to have a positive effect on the daily calorie intake per capita in the different income classes.

In this study, only the impact of *Bt* eggplant technology to nutrition owing to changes in calorie intake was considered and the impact due to changes in other nutrients was not considered in the quantification. The model used heavily draws from the model of Pinstrup-Andersen et al. (1976) and Mutuc (2003). The model reflects a situation for a hypothetical supply increase of any good available to a population and addresses the question of how this supply increase is distributed among different income classes after allowing adjustments in consumption of all other goods through price changes and the ultimate impact on nutrition in terms of changes in calorie intake.

The methodology has two stages. In the first stage, a price elasticity of demand matrix is estimated for each of the income strata using the methodology developed by Frisch (1959). The second stage quantifies the change in calorie intake by income strata caused by a shift in the supply curve of a commodity.

Price Elasticity of Demand. The Frisch (1959) methodology is used in estimating a complete set of direct and cross price elasticities of demand. According to Frisch (1959), price elasticities can be obtained by using money flexibility, income elasticities, and budget proportions. If one has the money flexibility, use of unit values or observation of prices is not needed, which is required by other conventional means. With money flexibility, the price elasticities can be derived from cross-sectional household survey data which allows for estimation of income elasticities and provides data on budget shares.

Direct and cross-price elasticities of demand for income stratum are estimated as:

$$e_{ii(m)} = -E_{i(m)} \left[A_{(m)} - \frac{1 - A_{i(m)} E_{i(m)}}{\phi_{(m)}} \right] \tag{3}$$

and

$$e_{ij(m)} = -E_{i(m)} A_{j(m)} \left[1 + \frac{E_{j(m)}}{\phi_{(m)}} \right] \quad i \neq j \tag{4}$$

where

$\phi_{(m)}$ = money flexibility;
e_{ii} = direct price elasticity of demand for good *i*;
e_{ij} = cross price elasticity of good i with respect to good *j*;
E_i, E_j = income elasticities for goods i and j; and
A_i, A_j = budget proportions spent on goods i and j.

It is assumed that consumers face the same market for any one commodity. Therefore, the average per capita direct and cross-price elasticities of demand for good *i* would be the weighted average of the income strata elasticities using quantity of good *i* consumed by stratum *m* using the relative proportion of total population found in stratum *m* as weights:

$$e_{ij} = \frac{\sum_{m=1}^{n} e_{ij(m)} Q_{i(m)} N_{(m)}}{\sum_{m=1}^{n} Q_{i(m)} N_{(m)}} \quad (5)$$

where

$e_{ij(m)}$ = direct or cross-price elasticity of demand for stratum *m*;
$Q_{i(m)}$ = quantity consumed per capita of commodity *i* in stratum *m*; and
$N_{(m)}$ = population in stratum *m*.

Income Elasticities. For each of the income strata, the income elasticity for each food was estimated. It is assumed that consumers generally face the same price for any given food commodity and that their tastes and preferences have little or no variation within a particular stratum. Initially, only the method used by Mutuc (2003) was utilized wherein the per capita real income was regressed on per capita quantity consumed within each income stratum with the coefficient as the income elasticity:

$$\ln\left[\frac{Q_{i,h(m)}}{N_{h(m)}}\right] = \alpha + \beta \ln\left[\frac{Y_{h(m)}}{N_{h(m)}}\right] \quad (6)$$

where

$Q_{i,\,h(m)}$ = total quantity consumed of good *i* by household *h* in stratum *m*;
$N_{h(m)}$ = total family size of household *h* in stratum *m*; and
$Y_{h(m)}$ = total family income of household *h* in stratum *m* adjusted for inflation.

However, using the above equation yielded insignificant coefficients for some commodities. Thus, the model was modified as follows:

$$\ln\left[\frac{Q_{i,h(m)}}{N_{h(m)}}\right] = \alpha + \beta \ln\left[\frac{Y_{h(m)}}{N_{h(m)}}\right] + \Sigma\alpha_i \text{ Island} \qquad (7)$$

Major island dummy variables were added to these models since island differences can account for changes in tastes and preferences. The island of Luzon was set as the reference dummy.

Budget Proportions. The budget proportion spent on each commodity is estimated as the ratio between total expenditure on a particular commodity and total food expenditure for each stratum *m*:

$$A_{i(m)} = \frac{C_{i(m)}}{F_{(m)}} \qquad (8)$$

where

$A_{(m)}$ = budget proportion spent on commodity *i*;
$C_{i\,(m)}$ = total expenditure on good *i* for stratum *m*; and
$F_{(m)}$ = total food expenditure of stratum *m*.

Money flexibility. Money flexibility ϕ is the elasticity of the marginal utility of income with respect to changes in income. It is estimated on the basis of the income elasticity and the direct price elasticity of one good and the budget proportion spent on that good. Solving (3) for ϕ, it is necessary to estimate e_{ii} for at least one good for each income strata using an alternative method:

$$\phi_{(m)} = \frac{E_{i(m)}\left[1 - A_{i(m)}E_{i(m)}\right]}{e_{ii(m)} + A_{i(m)}E_{i(m)}} \qquad (9)$$

Changes in calorie intake. To estimate the distribution of additional supply of the eggplant among income strata for which the supply curve is shifted and to calculate the resulting adjustments in the consumption of all other foods, a set of recursive equations that incorporate the price and income elasticities computed for each stratum was used. The model estimates the new equilibrium for prices and quantities for all commodities using an iterative procedure. For this model, the following were assumed: (1) all consumers face the same market that operates under perfect competition; and (2) prices and quantities for all commodities are in equilibrium before the shift in the supply curve.

Only shifts in the demand curves due to changes in prices of other goods brought about by the initial shift in the supply curve and subsequent adjustments were considered. Hence, consumer incomes, tastes, preferences and other possible demand shifters are held constant. The framework used by Pinstrup-Andersen and Tweeten (1970) in computing the impact of decreased food aid on the world market is the one patterned in estimating the new equilibrium price after shifts in the supply and/or demand curves. The new equilibrium price is estimated as:

$$P_i^1 = P_i^o \left[1 - \frac{\Delta S_i - \Delta D_i}{(e_{si} - e_{ii}) Q_i^o} \right] \qquad (10)$$

where

ΔS_i	=	horizontal shift in supply curve of commodity *i*;
ΔD_i	=	horizontal shift in the demand curve of commodity *i*;
e_{si}	=	price elasticity of supply for commodity *i*; and
e_{ii}	=	market price elasticity of demand for commodity *i*.

Meanwhile, the new equilibrium quantity of commodity *i*, Q_i^1, is estimated as:

$$Q_i^1 = Q_i^o + \Delta D_i + \frac{\Delta S_i - \Delta D_i}{1 - (e_{si} / e_{ii})} \qquad (11)$$

Using these two equations, the change in the price and quantity of the commodity *i* whose supply increased is estimated as:

$$P_i^k = P_i^{k-1} \left[1 - \frac{B}{(e_{si} - e_{ii})} \right] \qquad (12)$$

where

k = 1; and

$B = \frac{\Delta S_i}{Q_i^{k-1}}$ = the horizontal shift in the supply curve of commodity *i* as a proportion of initial quantity, *k* represents the number of rounds the impact of a supply shift had in terms of price and quantity changes.

The final equilibrium price and quantity of the commodity whose supply shifted is traced through a series of price and quantity changes working their way through cross-price elasticities of demand. This happens recursively. If e_{ji} = 0 or e_{ij} = 0 for all $j \neq i$ then the final equilibrium price and quantity for commodity i would be P_i^1, Q_i^1 respectively. It should be noted that e_{ji} is the cross-price elasticity of demand for *j* given the change in the price of *i*. If, on the other hand, e_{ji} = 0 for all $j \neq i$ then the equilibrium quantities and prices for all other commodities remain unchanged. However, neither e_{ji} or e_{ij} is expected to be 0. Hence, the initial change in P_i will cause a shift in the demand curve for other commodities j. The new equilibrium prices, P_j^1 and quantities, Q_j^1 are:

$$Q_j^k = Q_j^{k-1}\left\{1 + p_i e_{ji}\left[1 - \frac{1}{1 - \frac{e_{sj}}{e_{jj}}}\right]\right\} \tag{14}$$

and

$$P_j^k = P_j^{k-1}\left(1 + \frac{p_i e_{ji}}{(e_{sj} - e_{jj})}\right) \tag{15}$$

where

$k = 1$ and $p_i = \dfrac{(P_i^k - P_i^{k-1})}{P_i^{k-1}}$, $j = 1, 2, \ldots n$ excluding i and $j \neq i$.

These changes in prices and quantities of the affected commodities *j* affect several rounds of shifts in the demand for commodity *i* unless e_{ji} = 0 for all *j*. For subsequent rounds, the new equilibrium price and quantity for *i* is given by:

$$Q_i^k = Q_i^{k-1}\left\{1 + \sum_{j=1}^{n} p_j e_{ij}\left[1 - \frac{1}{1 - \frac{e_{si}}{e_{ii}}}\right]\right\} \tag{16}$$

and

$$P_i^k = P_i^{k-1}\left[1+\sum p_j e_{ij}\left(\frac{1}{e_{si}-e_{ii}}\right)\right] \qquad (17)$$

where

k = 2 and $p_j = \dfrac{(P_j^1 - P_j^0)}{P_j^0}$, $j \neq i$, j=1,... n excluding i.

This iterative process continues with k moving onto $k+1$ until a steady state is reached, ($k=F$). That is, when the equilibrium price and quantity for all commodities is reached or simply the case when quantities and prices no longer change.

After the new market equilibrium was estimated, the distribution among income strata of the quantity changes for each commodity was determined. The final quantity of commodity j obtained by stratum m,

$$Q_{j(m)}^F = \frac{N_{(m)}}{N} Q_j^0\left[1 + p_i^{'} e_{ji(m)} + p_j^{'} e_{jj(m)}\right] \qquad (18)$$

where

j = 1,... n excluding i; m is equal to the number of strata;
$N_{(m)}$ = number of consumers in stratum m;
N = total number of consumers; and

$$p_i^{'} = \frac{(P_i^F - P_i^o)}{P_i^o}$$

The final quantity of commodity i obtained in stratum m denoted by $Q_{i(m)}^F$ is given by:

$$Q_{i(m)}^F = Q_{i(m)}^o\left[1+\sum_{j=1}^{n} p_j^{'} e_{ij(m)} + p_i^{'} e_{ii(m)}\right], j \neq i \qquad (19)$$

The direct impact on calorie intake in stratum *m*, $C_{i(m)}$, is estimated as

$$C_{i(m)} = \left[Q_{i(m)}^{F} - Q_{i(m)}^{o} \right] c_i \qquad (20)$$

where c_i is the calorie content per unit of commodity *i*.

Likewise, the indirect impact is

$$C_{j(m)} = \sum_{j=1}^{n} \left[Q_{j(m)}^{F} - Q_{j(m)}^{o} \right] c_j \qquad (21)$$

Combining the direct and indirect impact gives the net impact

$$C_m = C_{i(m)} + C_{j(m)} \qquad (22)$$

Data Sources

Primary and secondary sources provided the information required in analyzing the poverty and nutrition impact of technology. Parameters of the economic surplus models came from the studies of Francisco in 2006 and 2007.

Poverty Analysis. Unlike in Francisco (2006 and 2007), the adoption rate was not assumed but was quantitatively determined by using the adoption model. The data used in the adoption analysis came from survey of three eggplant producing provinces in Luzon, namely Batangas, Pangasinan, and Nueva Ecija.

Nutrition Analysis. The data used in the nutrition analysis came from secondary sources. Data on eggplant production, per capita consumption and retail prices were obtained from the Department of Agriculture-Bureau of Agricultural Statistics (BAS). The supply elasticity of eggplant, expected yield changes from *Bt* eggplant adoption, and *Bt* eggplant adoption rates were obtained from Francisco (2006). For the model used in the study particularly on estimating the distribution among income strata of quantity changes due to a supply shift in eggplant production, the data were sourced from the Family Income and Expenditure Survey (FIES) of 2003 from the

National Statistics Office (NSO). To compute for real per capita income of the households, consumer price index was also obtained from NSO. The calorie content (kilocalories per 100 grams) of commodities was obtained from the Agriculture Research Service of the United States Department of Agriculture (USDA).

Commodities considered. Similar to that of Mutuc (2003), 11 commodities, in addition to eggplant, were considered in this study for which reliable initial price data were available. The commodities include: rice, onion, 'ampalaya' (bitter gourd), carrots, tomato, cabbage, 'mongo' (mungbean), 'camote' (sweet potato), cassava, 'gabi' (taro), and potato.

Income elasticities and budget proportion. In this study, the households were stratified into income quintiles. Thus, the household survey data from the FIES 2003 were categorized into five income strata. The income elasticity for each abovementioned food was then estimated using equations (6) and (7) for each of the income strata using data within each stratum. Budget proportions were computed for each stratum using equation (8).

Money flexibility. To estimate ϕ by income quintile, it was necessary to estimate e_{ii} (direct price elasticity) for at least one good or a composite of goods. The direct price elasticity was computed by simply regressing the price of a commodity as well as the price of other commodities on the per capita quantity consumed with the β_i coefficient as the direct price elasticity:

$$\ln [Q_i] = \alpha + \beta_i \ln [P_i] + \Sigma \beta_j \ln [P_j] \quad (23)$$

where

$Q_{i,h(m)}$ = per capita quantity consumed of good *i*;
P_i = price of commodity *i* being considered for direct price elasticity; and
P_j = price of commodity *j*, as *j*=1…11.

Similar to that of Mutuc (2003), direct price elasticities were computed for eggplant and rice. It should be noted that there were no other available data that will yield per capita consumption values for 2003. Therefore, weekly per capita consumption data from the *Consumption of Selected Food Commodities in the Philippines Survey* conducted by the BAS during May, August, and November 1999 and February 2000 were used. Correspondingly, the two estimated direct price elasticities were used to compute for different estimates for money flexibility using equation (9). The simple average of the two was then obtained to get an overall measure of money flexibility for each income strata.

Results and Discussions

Impact on Poverty

Determinants of Adoption of New Technologies. An adoption model was formulated and the probability of adoption was predicted to allocate change in producer surplus to household eggplant farmers. Since *Bt* eggplant is not yet commercialized, the adoption of hybrid eggplant was used as proxy to *Bt* eggplant adoption. All of the 171 eggplant-producing households in the ABSPII survey were asked to identify the eggplant variety they planted (e.g., Casino, Tagalog, etc.). Their responses were converted to a binary number, 1 if the respondents mentioned a hybrid variety and 0 otherwise. Table 2 summarizes the characteristics of those households that fall into these two categories.

A total of 122 eggplant farmers reported planting hybrid eggplant while 49 farmers planted non-hybrid variety of eggplant. Adopting households were headed by slightly younger people, had slightly less members, and earned higher income than non-adopting households. Moreover, adopting households had slightly larger farm size, slightly bigger farm area devoted to eggplant production, and had less experience in eggplant farming compared with non-adopting households. Non-adopters were farther from possible sources of technology information and from market roads. Both non-adopters and adopters were mainly male (85% and 71%, respectively). The majority of the adopters were from Nueva Ecija (38%), while non-adopters were mainly from Batangas (59%). A greater percentage of the adopters (23%) reached college/post-secondary education than non-adopting households (16%). More non-adopters (37%) owned their farm land than adopters (31%) and more adopters (95%) reported more severe fruit and shoot borer (FSB) problem than non-adopters (82%).

A logistic model was used to estimate the probability of adopting hybrid eggplant. Results of the adoption model are summarized in Table 3. Results showed that of the 17 factors analyzed, the probability of adoption was significantly associated with 4 of these factors: (1) Batangas location; (2) Nueva Ecija location; (3) years of experience in eggplant farming; and (4) distance to nearest agricultural technician.

Table 2. Characteristics of adopting and non-adopting households

Variable description	Adopters (n=122)		Non-adopters (n=49)	
	Mean	SD	Mean	SD
Age of household head (years)	49.48	11.30	52.20	12.36
Household size	5.13	2.27	5.33	2.32
Income per capita (PhP)	29,335	35,375	21,627	42,944
Total farm area (ha)	1.49	1.15	1.28	1.06
Area allotted to eggplant (ha)	0.51	0.46	0.42	0.33
Experience in eggplant production (yrs)	12.51	11.39	18.57	12.70
Average distance (km)				
From village to nearest AT	4.96	3.37	7.61	4.72
From village to nearest major road	1.63	2.07	1.97	1.69
	N	%	N	%
Male	104	85.25	35	71.43
Province				
Batangas	31	25.41	29	59.18
Nueva Ecija	46	37.7	12	24.49
Pangasinan	45	36.89	8	16.33
Education				
Reached elementary level	14	11.48	5	10.20
Elementary graduate	21	17.21	12	24.49
Reached high school	11	9.02	6	12.24
High school graduate	48	39.34	18	36.73
Reached college level	28	22.95	8	16.33
Land Tenure				
Owned	38	31.15	18	36.73
Share cropping	37	30.33	6	12.24
FSB severity				
High	116	95.08	40	81.63

Based on the results, the Batangas site dummy has a significant impact on probability of adoption at 5% significance level while Nueva Ecija site dummy has a significant impact at 10% significance level. The negative coefficients mean that farmers in Batangas and Nueva Ecija are less likely to adopt hybrid eggplant than those in our base group, which is the Pangasinan site. Years of farming experience is negatively associated with adoption at 1%

significance level. Hence, probability of adoption decreases as a farmer has more farming experience. This finding is similar with Kebede et al. (1990) which found that farm experience is negatively related to likelihood of new technology adoption. Hybrid eggplant requires certain management and resource requirements in order to successfully obtain the desired yield. For farmers who have many years of farming experience, adopting hybrid eggplant might require more change in their cultivation practices. Distance to nearest agricultural technician variable is found to have a significant negative relationship with adoption at 1% probability level indicating that the farther farmers are to sources of technology information, the less inclined to adopt hybrid eggplant.

Estimated logistic regression coefficients did not indicate the amount of change in the probability that a farmer will adopt hybrid eggplant given a unit change in each independent variable, and therefore the marginal effects were calculated (Table 3). Eggplant farmers in Batangas are 30% less likely to adopt hybrid eggplant than farmers in Pangasinan while farmers in Nueva Ecija are 23% less likely to adopt. A one year increase in eggplant farming experience results in the probability of adoption decreasing by 17% [(0.0116)*(14.31)*100]. A kilometer increase in the distance of the eggplant producer's farm from the agricultural technician decreases the probability of adoption by 12% [(.0223)*(5.58)*100].

The predicted probability of adoption based on the model was used to determine who are the likely adopters of the *Bt* eggplant technology. This was done by ranking the predicted probabilities of adoption in descending order. The income changes from the *Bt* eggplant technology were then applied to the first 12%, 25%, 50%, and 100% according to adoption probability. After the resulting income changes were computed for each producer-household of adopters and non-adopters, the income per capita for each household resulting from technology adoption was compared to the poverty line. The FGT poverty measures were then computed.

Changes in Producers' Surplus. In a closed economy, prices are expected to decline in response to a downward supply shift, and thus producers and consumers will both be affected. As mentioned earlier, only the impact on the producers through the changes in producer surplus as a result of new technology was considered in the study. All producers (i.e., non-adopters and adopters) experience a loss in producer surplus owing to the price decline while only adopters experience an off-setting increase in producer surplus owing to the lower cost of production as a result of the technology.

Table 3. Summary of the logistic regression

Parameter	Probit estimates			Parameter estimates for marginal effects		
	Estimate	Standard error	P-value	Marginal effect	Standard error	P-value
Intercept	1.4771	0.8524	0.0830			
Gender	0.4434	0.3136	0.1570	0.1481	0.1120	0.1860
Batangas Province	-0.9081	0.4236	0.0320	-0.3004	0.1456	0.0390
Nueva Ecija Province	-0.6936	0.3664	0.0580	-0.2270	0.1243	0.0680
Age	0.0071	0.0127	0.5750	0.0022	0.0039	0.5760
Household size	-0.0438	0.0536	0.4130	-0.0135	0.0164	0.4120
Experience in eggplant farming	-0.0377	0.0114	0.0010	-0.0116	0.0035	0.0010
Total farm area	-0.0173	0.1277	0.8920	-0.0053	0.0392	0.8920
Area devoted to eggplant	0.4325	0.3719	0.2450	0.1327	0.1131	0.2410
Leased tenure status	-0.0505	0.3474	0.8840	-0.0157	0.1092	0.8860
Sharecropping tenure status	0.5213	0.3479	0.1340	0.1452	0.0863	0.0920
Other tenure type	-0.0381	0.3170	0.9040	-0.0118	0.0986	0.9050
Distance to major road	0.0500	0.0697	0.4740	0.0153	0.0215	0.4760
Distance to near-est AT	-0.0726	0.0375	0.0530	-0.0223	0.0116	0.0550
Reached elementary level	0.2865	0.4881	0.5570	-0.1286	0.1594	0.4200
Completed elementary level	-0.1027	0.3887	0.7920	0.0843	0.1371	0.5390
Reached high school	-0.4897	0.4643	0.2920	-0.1687	0.1737	0.3320
Completed high school	-0.3209	0.3278	0.3280	-0.1011	0.1054	0.3370

N= 180; Log-likelihood = -82.0591; Chi-squared= 46.65; Chi-square probability=.0001

The income gain to adopting households ranged from 172% to 299% relative to pre-adoption income, depending on the assumed rate of adoption (Table 4). However, the price decline resulted in a large reduction in total income for non-adopters (i.e., 83%-88%). Similarly, there was a loss in the per capita producers' surplus ranging from 85% to 90%. It should be noted

Table 4. Changes in producers' surplus, annual and per capita household income at different levels of adoption of *Bt* eggplant

Item	Percent of Households Assumed to be Adopting			
	12%	**25%**	**50%**	**100%**
	(n=21)	(n=43)	(n=86)	(n=171)
% Change in producer surplus				
Adopters	299.06	287.62	269.39	172.03
Non-adopters	-83.42	-83.36	-88.31	NA
Mean household income per capita before adoption (PhP)				
Adopters	46,022	33,606	31,441	27,127
Non-adopters	24,481	24,950	22,761	
% Change in producer surplus per capita				
Adopters	302.79	290.25	275.97	176.85
Non-adopters	-85.33	-85.79	-89.67	NA

that the average per capita income of non-adopters is close to the poverty line of PhP15,075 per household member. In fact, even prior to *Bt* eggplant adoption, the majority of non-adopters were poor.

Based on the headcount index, about 60%, 58%, and 64% of the non-adopters were deemed poor prior to *Bt* eggplant introduction for the 12%, 25%, and 50% adoption scenarios, respectively. For example, of the 96 poor producers prior to adoption, 90 of them were ranked as non-adopters (Table 5).

The poverty-reducing impact of *Bt* eggplant technology is quite substantial for those who will adopt the technology. However, the impact was negative for the non-adopting eggplant farmers. The following section discusses these impacts.

12% Adoption Rate. Before the adoption of the 12% of the eggplant farmers in the survey sites, six farmers were poor and the average household income was PhP103,300 (or about US$3,000[1]). The number of poor eggplant farmers was reduced to only one after the adoption and the household income increased to PhP310,410. On the contrary, the number of poor eggplant

[1] 1 USD = PhP45.00 (NSCB, 2011).

Table 5. **Number of poor lifted out of poverty/becoming poor and average income before and after adoption at various levels of adoption rate**

Particular	**Proportion of Eggplant Farming Households Assumed to be Adopting**							
	12%		**25%**		**50%**		**100%**	
	Before	***After***	***Before***	***After***	***Before***	***After***	***Before***	***After***
Adopter								
No of poor	6	1	23	7	42	15	96	45
No of non-poor	15	20	20	36	44	71	75	126
No of poor lifted out of poverty	5		16		27		51	
% of poor lifted out of poverty	83		70		64		53	
Ave income (PhP'000)	104.30	310.41	80.94	231.84	82.33	221.22	73.12	198.92
Non-adopter								
No of poor	90	126	74	109	54	78		
No of non-poor	60	24	54	19	31	3		
Increase in number of poor	36		35		24			
Ave income (PhP'000)	68.76	11.40	70.50	11.73	63.81	7.46		
Net increase (de-crease) in number of poor after adoption		31		19		(3)		(51)

farmers increased among the non-adopters, from 90 to 126 farmers. Similarly, the income of non-adopters decreased from PhP68,760 to PhP11,400. The net impact on poverty was an increase by 31 in the number of poor farmers.

25% Adoption Rate. Before the adoption of *Bt* eggplant technology among 25% of the farmers in the survey sites, 23 farmers were deemed poor and 20 were non-poor. The average household income was PhP80,940. After the adoption, the number of poor eggplant farmers was reduced to seven and the household income increased to PhP231,840. On the other hand, the number of non-adopting poor farmers increased from 74 to 109. Similarly, the income of non-adopters decreased from PhP70,500 to PhP11,730. The net impact on poverty was an increase in the number of poor farmers by 19.

50% Adoption Rate. Before the adoption of *Bt* eggplant technology among 50% of the eggplant farmers in the survey sites, 42 farmers were deemed poor and 44 were not. The average household income was PhP82,330. After the adoption, the number of poor eggplant farmers was reduced to 15 and the household income increased to PhP221,220. Among the non-adopting farmers, the number of poor eggplant farmers increased from 54 to 78. Similarly, the income of non-adopters decreased from PhP63,810 to PhP7,460. At this point, however, the net impact on poverty was decrease in the number of poor farmers by 3 eggplant farming households.

100% Adoption Rate. Before the adoption of *Bt* eggplant technology among 100% of the eggplant farmers in the survey sites, 96 farmers were poor. The average household income was PhP73,120. After the adoption, the number of poor eggplant farmers was reduced to 45 and the household income increased to PhP198,120. The net impact on poverty was a decrease in the number of poor farmers by 51 eggplant farming households.

Poverty Incidence. The incidence of poverty in the surveyed provinces was high. Of the total 171 respondents, 96 were below the poverty line of PhP15,059 per person (Table 6). This represents about 56% of the sample respondents. The poverty gap was around 36% and a severity index of 29%.

At 12% adoption, the headcount index increased by about 19% (from 0.5614 to 0.7427). The headcount index was also higher than the pre-adoption value for a 25% adoption (from 0.5614 to 0.6784). The same is true for the other two FGT indices. With the 50% adoption however, the headcount index (0.5322) was now slightly lower than the pre-adoption headcount index. Though this was the case, it is noteworthy that the poverty gap and severity

Table 6. Poverty indices for eggplant-producing households at various adoption rates

Item	Adoption Rate									
	0% (before adoption)		12%		25%		50%		100%	
	no. of poor	*Index*	*no. of poor*	*Index*	*no. of poor*	*Index*	*no. of poor*	*Index*	*no. of poor*	*Index*
Headcount	96	0.5614	127	0.7427	116	0.6784	93	0.5338	45	0.2632
Depth		0.3592		0.9135		0.8064		0.5612		0.1357
Severity		0.2780		1.4178		1.2494		0.7718		0.0864

indices at 50% adoption (0.5612 and 0.7718, respectively) were still higher compared to their pre-adoption values (0.3592 and 0.2780). This result indicates that a number of the poor households moved farther below the poverty line and there is greater inequality in the income distribution among the farmers as a result of limited adoption. At a low rate of adoption, only very few farmers benefited from the *Bt* eggplant technology. This could be attributed to the fact that those non-adopters who were slightly above the poverty line prior to *Bt* eggplant introduction have now become poor due to their loss in income. For instance, with 12% adoption, 90 out of the 150 non-adopting households were considered poor. After adoption, about 127 of the 150 non-adopters became poor (Table 7). Another possible reason for the increase in poverty is that a number of the non-adopters are already considered poor prior to *Bt* technology introduction. Then, given their loss in producer surplus, they have become poorer.

At 100% adoption, the headcount index falls by 30% (from 0.5614 to 0.2632). Moreover, the degree of poverty is also reduced since the depth and severity of poverty indices (0.1357 and 0.0864) are lower than their pre-adoption values. The poverty gap index falls by 22% while severity of poverty falls by 19%.

In summary, the adoption of *Bt* eggplant has a big potential to reduce the poverty incidence among adopting eggplant farmers. Results indicated that the poverty prevalence is reduced significantly when farmers adopt *Bt* eggplant. However, the non-adopting farmers were penalized owing to the decline in prices. As a result, the overall impact on poverty was negative when adoption rate does not reach 50%. Similar trend was observed for poverty gap and severity of poverty. At 100% adoption, 53% of the poor were lifted out of poverty.

Table 7. Poverty indices among non-adopters

Indicator	Adoption Rate					
	12% (Non-adopters=150)		25% (Non-adopters=128)		50% (Non-adopters=85)	
	n	Index	n	Index	n	Index
Headcount index before adoption	90	0.600	74	0.578	54	0.635
Headcount index after adoption	126	0.847	109	0.852	78	0.894
Depth before adoption		0.391		0.391		0.454
Depth after adoption		1.039		1.057		1.042
Severity before adoption		0.306		0.314		0.379
Severity after adoption		1.615		1.657		1.497

Impact on Nutritional Status

Income Elasticities and Budget Proportions. Majority of the commodities showed a declining trend of income elasticity for increasing income levels (Table 8). Though some spikes were observed, the trend was downward. As expected, the lowest income group had the highest income elasticity across most of the commodities.

The largest single food expenditure among the commodities for all quintiles is rice, which accounts for 12-28% of the total food budget (Table 9). The remaining food items considered had an average proportion of less than 1%. For example, eggplant consumes only about 0.8% of the total food expenditures. In general, the budget proportion spent on the food items decreases with increasing income levels.

Table 10 presents the estimated cross-price elasticities of eggplant with rice and other vegetables. Results show that the cross-price elasticities are all low and negative. This means that they are all considered substitute for eggplant, i.e., a rise in price of eggplant would reduce their consumption of these goods and vice versa. The largest cross-price elasticity among the goods considered is rice. The low cross-price elasticities also indicate that even if

Table 8. Income elasticities of selected commodities by income strata

Commodity	Income Quintile				
	I	II	III	IV	V
Rice	0.490	0.158	0.094	0.028	0.044
Potato	0.428	0.665	0.599	0.478	0.399
Cassava	-0.748	-0.886	-1.123	-1.018	-0.588
Camote	-0.241	-0.290	-0.507	-0.684	-0.333
Gabi	0.512	0.383	0.471	0.510	0.613
Cabbage	0.404	0.515	0.283	0.245	0.242
Ampalaya	0.513	0.215	0.095	0.141	0.377
Eggplant	0.187	0.132	0.099	0.082	0.176
Tomato	0.409	0.265	0.220	0.195	0.230
Mongo	1.023	0.770	0.666	0.553	0.410
Carrot	0.165	0.396	0.423	0.449	0.555
Onion	0.294	0.109	0.159	0.205	0.238

Table 9. Average budget proportions of selected food commodities

Commodity	Income Quintile				
	I	II	III	IV	V
Rice	0.2752	0.2817	0.2366	0.1817	0.1242
Potato	0.0010	0.0017	0.0030	0.0041	0.0049
Cassava	0.0090	0.0061	0.0034	0.0015	0.0005
Camote	0.0086	0.0058	0.0040	0.0026	0.0016
Gabi	0.0038	0.0026	0.0022	0.0017	0.0014
Cabbage	0.0012	0.0023	0.0033	0.0042	0.0046
Ampalaya	0.0040	0.0046	0.0048	0.0045	0.0040
Eggplant	0.0077	0.0073	0.0067	0.0058	0.0045
Tomato	0.0057	0.0060	0.0060	0.0057	0.0050
Mongo	0.0044	0.0046	0.0042	0.0033	0.0022
Carrot	0.0004	0.0007	0.0012	0.0018	0.0028
Onion	0.0077	0.0075	0.0071	0.0064	0.0054

changes in prices of eggplant would occur, these changes is of very little bearing on the quantity of other goods being considered.

Money flexibility. To estimate money flexibility (ϕ) by income quintile, it was necessary to estimate direct price elasticity (e_{ii}) for at least one good or

Table 10. Cross price elasticities of eggplant with rice and selected vegetables

Eggplant *with:*	Income Quintile					Weighted Cross Price
	I	II	III	IV	V	
Rice	-0.21224	-0.16345	-0.07577	-0.10418	-0.03011	-0.10716
Potato	-0.00227	-0.00112	-0.00001	-0.00002	-0.00034	-0.00064
Cassava	-0.00110	-0.00026	-0.00009	0.00007	-0.00006	-0.00023
Camote	-0.00141	-0.00092	-0.00026	-0.00034	-0.00020	-0.00056
Gabi	-0.00275	-0.00130	0.00014	0.00071	-0.00024	-0.00053
Cabbage	-0.00068	-0.00117	-0.00007	0.00052	-0.00027	-0.00029
Ampalaya	-0.00241	-0.00256	-0.00050	-0.00065	-0.00037	-0.00117
Tomato	-0.00368	-0.00236	-0.00025	0.00072	-0.00070	-0.00106
Mongo	-0.00275	-0.00062	0.00035	0.00012	-0.00031	-0.00050
Carrot	-0.00073	-0.00046	0.00070	-0.00010	-0.00019	-0.00011
Onion	-0.00290	-0.00178	0.00038	0.00072	-0.00057	-0.00067

a composite of goods. The direct price elasticity was computed by simply regressing the price of a commodity as well as the price of other commodities on the per capita quantity consumed. Direct price elasticities were computed for eggplant, ampalaya and rice using equation (10). Correspondingly, estimates for money flexibility were computed (Table 11). In general, there is no way to verify whether the above money flexibility coefficients are appropriate in the absence of studies done for the Philippines. However, the estimates are consistent, to an extent, with Frisch's (1959) conjecture that the absolute value of ϕ decreases as the level of income increases if we note the disparity between the lowest and the highest income levels, hence a downward trend can be observed.

Price elasticities. In general, the trend in direct price elasticities increases as income level increases (Table 12). That is, as income increases, the propensity to consume more of this product increases as their price decline and vice versa. The computed values, however, are larger compared to other studies whose values generally range from -0.6 to -1.0.

Changes in calorie intake. The changes in calorie intake that may result owing to increase/decrease in consumption of goods like eggplant can be quantified by converting the change in the amount consumed multiplied by the calorie content of eggplant. Table 13 summarizes the calorie content and 2007 average daily per capita consumption of the different goods considered in this study. For example, the average daily per capita consumption of

Table 11. Estimated money flexibility coefficients by income quintile

Income Quintile	Value
I	-0.225
II	-0.097
III	-0.064
IV	-0.036
V	-0.071

Table 12. Estimates of direct price elasticities by income strata

Crop	Income Quintile					Average
	I	II	III	IV	V	
Rice	-0.4576	-0.4175	-0.4268	-0.1794	-0.1246	-0.3212
Potato	-0.3263	-1.6379	-2.6371	-2.9646	-1.0814	-1.7295
Cassava	0.5802	2.2013	4.9709	6.3343	1.5973	3.1368
Camote	0.1861	0.7186	2.2415	4.2621	0.9054	1.6627
Gabi	-0.3910	-0.9451	-2.0752	-3.1645	-1.6617	-1.6475
Cabbage	-0.3083	-1.2683	-1.2454	-1.5244	-0.6568	-1.0006
Ampalaya	-0.3919	-0.5300	-0.4178	-0.8787	-1.0243	-0.6486
Eggplant	-0.1433	-0.3272	-0.4368	-0.5072	-0.4784	-0.3786
Tomato	-0.3132	-0.6526	-0.9708	-1.2094	-0.6252	-0.7543
Mongo	-0.7795	-1.8938	-2.9323	-3.4304	-1.1112	-2.0294
Carrot	-0.1257	-0.9748	-1.8635	-2.7875	-1.5056	-1.4514
Onion	-0.2254	-0.2697	-0.7026	-1.2755	-0.6461	-0.6238

eggplant in 2007 is only 5.97 grams per day. This is equivalent to 1.97 kcal per capita per day. Rice, on the other hand, has an equivalent of 451 kcal per capita per day.

Equilibrium Price and Quantity. The cumulative change in calorie intake was evaluated over a 12-year period, 2007-2018. In each year, the supply of *Bt* eggplant is shifted out by the increase in the yield per hectare over the total area planted to eggplant. This is adjusted for the rate of adoption each year. Subsequent demand and price changes by the end of the year, conveyed through cross price elasticities, generate new equilibrium values that are then used as initial values the following year and so on and so forth as presented in Table 14. It is assumed that in each of the next 12 years, farmers will

Table 13. Calorie content and per capita consumption of selected commodities

Commodity	Calorie content (kcal per 100g)	2007 ave. per capita consumption (grams/day)	Equivalent per capita consumption (kcal/day)
Rice	130	347.51	451.76
Potato	86	2.71	2.33
Cassava	116	5.78	6.70
Camote	76	16.79	12.76
Gabi	142	3.34	4.74
Cabbage	23	3.51	0.81
Ampalaya	19	2.36	0.45
Eggplant	33	5.97	1.97
Tomato	16	4.19	0.67
Mongo	341	1.92	6.55
Carrot	41	1.86	0.76
Onion	40	3.84	1.54

Table 14. Price and quantity schedule for *Bt* eggplant

Year	Price (PhP/kg)	Quantity (mt)
2007	28.03	210,155.69
2008	27.92	210,603.29
2009	27.48	212,436.50
2010	26.70	215,734.36
2011	25.28	221,999.84
2012	23.73	229,468.83
2013	22.73	234,760.01
2014	22.64	235,231.73
2015	22.56	235,712.49
2016	22.47	236,202.47
2017	22.38	236,701.85
2018	22.30	237,210.79

continue to use *Bt* eggplant every planting season, thus the shock occurs every year. The adoption of *Bt* eggplant technology increases supply which in turn depresses prices (Table 14). The price effect is more pronounced up to 2013 and then almost has negligible price change in the years that follow. This is because of the assumed adoption profile.

Direct impact on calorie intake. Using the information on price and quantity schedules at an assumed adoption profile and computing the projected per capita consumption due to the changes in prices and quantity by the different income strata, it can be observed that lower eggplant prices lead to relatively more eggplant consumption, which is reflected in the direct effect and is increasing with higher income (Table 15). The trend, however, is not smooth as the observed increases are until the fourth quintile only and dipped at the highest income quintile.

The direct impact is small because the share of eggplant to total food expenditure (i.e., budget proportion) is very minimal and since it is price inelastic, a decrease in the price of eggplant (due to *Bt* eggplant technology) is expected not to have a very significant effect on consumption. It cannot be expected that the direct impact (in terms of kcal) would be significant. Eggplant, however, although low in calories, is very low in saturated fat and cholesterol. It is also a good source of Vitamin K, thiamin, Vitamin B6, folate, potassium and manganese, and a very good source of dietary fiber. The nutritional value and health benefits of eggplant make it ideal for optimum health. The impact of these minerals and vitamins is not within the scope of this work.

Indirect impact on calorie intake. In terms of indirect impact on calorie intake due to change in consumption pattern of other goods in consideration, the opposite trend was observed in terms of increase in consumption of other goods being considered in the study such as rice, vegetables and root crops. As shown in Table 16, the general trend is decreasing, indicating that the 'extra' savings derived from lower prices is spent by the poor to buy more rice and a little bit more of both eggplant and other vegetables. Hence, the poor is likely to spend 'extra' savings from low eggplant price on augmenting rice intake that could go well with small increases in vegetable intake, both eggplant and other vegetables. In terms of magnitude, the impacts are small. This could again be expected considering that the cross-price elasticities of eggplant with the other selected commodities are very low. Thus, a decrease in price of eggplant (due to *Bt* eggplant adoption) does not change/increase much the consumption of these other commodities.

Net impact on calorie intake. Results show that the per capita calorie intake per day is generally positive but is negligible (Table 17). This is due in part to the fact that price effects were the only factor that was considered and allowed to work their way through cross-price elasticities, ignoring income effects in the process. Further, the low own-price elasticities of

Table 15. Direct impact by income strata, change/increase by year (kcal/capita/day)

Year	Income Quintile					Average
	I	II	III	IV	V	
2008	0.0022	0.0022	0.0048	0.0064	0.0028	0.0038
2009	0.0091	0.0091	0.0197	0.0263	0.0113	0.0154
2010	0.0164	0.0163	0.0356	0.0476	0.0202	0.0278
2011	0.0311	0.0308	0.0680	0.0915	0.0380	0.0530
2012	0.0369	0.0363	0.0818	0.1112	0.0447	0.0635
2013	0.0260	0.0254	0.0586	0.0806	0.0311	0.0453
2014	0.0023	0.0023	0.0053	0.0073	0.0027	0.0041
2015	0.0024	0.0023	0.0054	0.0074	0.0028	0.0041
2016	0.0024	0.0023	0.0055	0.0076	0.0028	0.0042
2017	0.0024	0.0024	0.0056	0.0078	0.0029	0.0043
2018	0.0025	0.0024	0.0057	0.0079	0.0029	0.0044

Table 16. Indirect impact by income strata (kcal/capita/day)

Year	Income Quintile					Average
	I	II	III	IV	V	
2008	-3.5620	-1.8493	1.5647	1.8330	1.5998	0.116
2009	0.8983	0.6991	0.3273	0.4334	0.1423	0.476
2010	1.2894	1.0821	0.6954	0.8057	0.5029	0.850
2011	2.4677	2.0555	1.2863	1.5057	0.9035	1.594
2012	2.1615	2.0169	1.7471	1.8240	1.6128	1.855
2013	0.6009	0.9205	1.5169	1.3468	1.8137	1.278
2014	-1.2578	-0.6115	0.5943	0.2504	1.1945	0.112
2015	0.1161	0.1150	0.1130	0.1135	0.1120	0.114
2016	0.1181	0.1170	0.1149	0.1155	0.1139	0.116
2017	0.1201	0.1190	0.1169	0.1175	0.1159	0.118
2018	0.1222	0.1211	0.1190	0.1196	0.1179	0.120

eggplant and also the very low cross price elasticities of eggplant with other goods considered all contributed to low net impact on increased calorie intakes of the consumers as a result of increased output and decreased price due to *Bt* eggplant technology.

Using the information on price and quantity schedules at an assumed adoption profile, estimated own- and cross-price elasticities of eggplant

Table 17. Net impact by income strata, change/increase by year (kcal/capita/day)

Year	Income Quintile					Average
	I	II	III	IV	V	
2008	-3.5597	-1.8471	1.5695	1.8394	1.6025	0.1202
2009	0.9075	0.7082	0.3471	0.4597	0.1535	0.4915
2010	1.3058	1.0984	0.7310	0.8534	0.5231	0.8779
2011	2.4988	2.0863	1.3544	1.5972	0.9415	1.6471
2012	2.1983	2.0532	1.8289	1.9352	1.6574	1.9185
2013	0.6269	0.9460	1.5755	1.4274	1.8448	1.3236
2014	-1.2555	-0.6093	0.5996	0.2577	1.1973	0.1159
2015	0.1184	0.1173	0.1183	0.1210	0.1148	0.1179
2016	0.1205	0.1193	0.1204	0.1231	0.1168	0.1200
2017	0.1226	0.1214	0.1225	0.1253	0.1188	0.1221
2018	0.1247	0.1235	0.1247	0.1275	0.1209	0.1242

and different goods considered in this study, the direct, indirect and the net impact on nutrition of *Bt* eggplant adoption was estimated. The results showed that the direct impact is small since the share of eggplant to total food expenditure (i.e., budget proportion) is very small and it is price inelastic, hence a decrease in the price of eggplant due to *Bt* eggplant technology is not expected to have a very significant effect on its added consumption. Similarly, the indirect impacts on calorie intake due to change in consumption pattern of other goods are small. This could again be expected considering that the cross-price elasticities of eggplant to the other goods are very low indicating that a change on the price of eggplant would not cause a significant change in the consumption of the goods. The net impact of *Bt* eggplant adoption in terms of change in per capita calorie intake per day is generally positive but negligible. This is because only price effect was considered in the analysis via own- and cross-price elasticities. Moreover, the low own-price elasticities of eggplant and the very low cross-price elasticities of eggplant with other goods considered all contributed to low net impact on increased calorie intakes of the consumers as a result of increased output and decreased price due to *Bt* eggplant technology.

Summary and Conclusion

Poverty and malnutrition remain a serious problem particularly in the developing countries and this had added new dimension in impact evaluation. However, despite increased interest in understanding poverty and nutrition impacts of agricultural research, few *ex-ante* studies of impacts of R&D on aggregate poverty and nutrition have been conducted. This research undertaking sought to determine the poverty and nutrition impact of the *Bt* eggplant technology adoption in the Philippines.

The estimation of projected changes in poverty status resulting from the adoption of a technological innovation like *Bt* eggplant was carried out by computing the household-level value of the welfare measure and comparing it to the poverty line; determining which households are most likely to adopt the technology and estimating how household welfare will change following adoption; and adding up the change in the number of poor people or households resulting from adoption. The FGT indices were used to analyze the prevalence of poverty in a given population. Nutritional impacts of the technology were examined by disaggregating the market demand curve into demand curves by income groups using their separate price elasticities of demand. The methodology has two stages: estimation of price elasticity of demand matrix for each of the income strata using the methodology developed by Frisch (1959); and quantifying the change in calorie intake by income strata caused by a shift in the supply curve of a commodity. Using data from both primary and secondary sources, the poverty and nutrition impacts were quantified. The data used in the poverty impact analysis came from a survey conducted in three eggplant producing provinces, namely, Batangas, Nueva Ecija, and Pangasinan. The nutrition analysis utilized secondary data from the Bureau of Agricultural Statistics (BAS), the Family Income and Expenditure Survey (FIES) of 2003 from the National Statistics Office (NSO) and the Agriculture Research Service of the United States Department of Agriculture (USDA).

Results of the poverty analysis showed that the adoption of *Bt* eggplant has a big potential to reduce the poverty incidence among adopting eggplant farmers. However, the non-adopting farmers got penalized by the price reduction due to *Bt* eggplant technology. As a result, poverty became more prevalent and income inequality became worse at low adoption rate. However, there was a large reduction in the number of poor farmers and more equitable distribution of income when the adoption rate is 100%.

The results of nutritional impact analysis showed that the direct impact is small since the share of eggplant to total food expenditure (i.e., budget proportion) is very small and it is price inelastic. Hence, a decrease in the price of eggplant due to *Bt* eggplant technology is not expected to have a very significant effect on its added consumption. Similarly, the indirect impacts on calorie intake due to change in consumption pattern of other goods are small. This could again be expected considering that the cross-price elasticities of eggplant to the other goods are very low indicating that a change on the price of eggplant would not cause a significant change in the consumption of the goods. The net impact of *Bt* eggplant adoption in terms of change in per capita calorie intake per day is generally positive but negligible. This is because only price effect was considered in the analysis using own- and cross-price elasticities. Moreover, the low own-price elasticities of eggplant and the very low cross-price elasticities of eggplant with other goods considered all contributed to low net impact on increased calorie intakes of the consumers as a result of increased output and decreased price due to *Bt* eggplant technology.

Based on the results obtained from the analyses, it can be concluded that if *Bt* eggplant would be adopted by many farmers, it can have a significant impact on reducing poverty of the eggplant producers and improving the nutritional status of the eggplant consumers. At lower rate of adoption, however, the overall impact on poverty reduction is negative. These results can therefore complement the past studies that were conducted to project the economic and environmental impacts of *Bt* eggplant adoption in the Philippines. The positive impacts of the technology can be used to strongly advocate for the commercialization and wide spread adoption of *Bt* eggplant technology.

References

Alston, J.M., G.W. Norton, and P.G. Pardey. 1995. *Science Under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting.* Ithaca, NY: Cornell University Press.

Foster, J., J. Greer, and E. Thorbecke. 1984. A class of decomposable poverty measures. *Econometrica* 52:761-766.

Francisco, S.R. 2006. Economic impact of *Bt* eggplant adoption in the Philippines: Report submitted to ABSPII and ISAAA, Los Baños, Laguna.

Francisco, S.R. 2007. Environmental impact of *Bt* eggplant adoption in the Philippines. Report submitted to ABSPII and ISAAA, Los Baños, Laguna.

Frisch, R. 1959. A complete scheme for computing all direct and cross price elasticities in a model with many sectors. *Econometrica* 27: 177-196.

Karanja, D.D., M. Renkow, and E. Crawford. 2003. Welfare effects of maize technologies in marginal and high potential regions of Kenya. *Agricultural Economics* 29:331-41.

Mills, B.F. 1997. Ex-ante agricultural research evaluation with site specific technology generation: The case of sorghum in Kenya. *Agricultural Economics* 16:125-138.

Mutangadura, G. and G.W. Norton. 1999. Agricultural research priority setting under multiple objectives: An example from Zimbabwe. *Agricultural Economics* 20:277-286.

Mutuc, E.M. 2003. Increase in Calorie Intake due to Eggplant Grafting: Proof of Concept with the Use of Minimum Datasets. M.S. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA.

NSCB (National Statistical Development Board). 2012. Philippine Statistical Yearbook. Makati, Philippines.

Pinstrup-Andersen, P., N. Ruiz de Londono, and E. Hoover. 1976. The impact of increasing food supply on human nutrition: Implications for commodity priorities in agricultural research and policy. *American Journal of Agricultural Economics* pp. 131-142.

Pinstrup-Andersen, P. and L. Tweeten. 1970. The impact of food aid on commercial food export. *In* Policies, Planning and Management for Agricultural Development. International Conference of Agricultural Economists.

Ravallion, M. 1992. *Poverty Comparisons: A Guide to Concepts and Methods*. LSMS Working Paper No. 88. The World Bank: Washington, DC.

Chapter 9

Market Prospects of *Bt* Eggplant

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Background

Eggplant production is a generally profitable farm enterprise, despite seasonal price variations typically experienced by agricultural products. However, productivity challenges posed by fruit and shoot borer (FSB) infestation and bacterial wilt disease make farmers resort to intensive pesticide use, posing risks to human health and the environment (Chupungco et al., 2011). The current research and development (R&D) efforts on *Bt* eggplant mainly aim to simultaneously address these production concerns.

An *ex-ante* assessment of *Bt* eggplant in the Philippines indicated that farmers would gain more profit even without raising the output price because the technology would increase the marketable yield and lower production costs. Consumers, on the other hand, would have adequate supply of zero to low-insecticide residue eggplant at lower price. With its high internal rate of return, *Bt* eggplant would be economically superior to current technology from a consumer and producer standpoint as well as for society as a whole. Even if the baseline yield gain and cost reduction were only half of baseline assumptions, and the adoption rate was only half of the assumed rate, investment in the development of *Bt* eggplant technology would still be highly viable (Francisco, 2009).

In India, Kumar et al. (2011) showed that adoption of *Bt* brinjal hybrids would provide a yield gain of 37% and reduction in total insecticide use of about 42% over non-*Bt* hybrids. The major gains would go to consumers (66% of total) and the rest would go to farmers. In brief, *Bt* brinjal offers a large scope to increase income of farmers, reduce its cost to consumers, improve food safety, and reduce health hazards and environmental pollution.

As the first biotech crop being developed for human consumption in the Philippines, *Bt* eggplant instantly became a subject of public scrutiny (Panopio and Mercado, 2013). Many civil society organizations, particularly groups against genetically modified organisms (GMOs), are monitoring the media to determine and understand the public's reception of developments in biotechnology.

Even with published supporting studies and statements of assurance from prominent scientists on the safety of *Bt* technology, numerous articles claiming negative effects of *Bt* eggplant to human health and the environment continue to circulate (Navarro et al., 2011, as cited in Panopio and Mercado, 2013). It is thus necessary to continue to educate the media, farmers, consumers, and other stakeholders on the benefits of *Bt* eggplant commercialization.

The University of the Philippines Los Baños (UPLB) believes that environmental and human safety issues are properly managed in the academic and potentially beneficial biotech research. It emphasized that the concluded *Bt* eggplant field trials had generated scientific data that are very valuable in further developing the technology. UPLB has always been and will always uphold the safe and responsible use of modern biotechnology for the attainment of food security and a sustainable and safe environment (UPLB, 2013).

Amidst moves against biotech products and the media being flooded with negative press releases on major dailies, the Food and Drugs Administration Advisory No. 2013–014 dated June 24, 2013 has declared that "all food derived from GM crops in the market have met international food safety standards and are as safe as and as nutritious as the food derived from conventional crops for direct use as food, feeds and, for processing."

If the *Bt* eggplant technology would be approved for commercialization, after passing the stringent regulatory system and assuring safety to the environment and human and animal health, emerging concerns will relate to its prospects in both the seed and food markets in the Philippines. This study was conducted as an initial response to these emerging market concerns. More specifically, the study determined the knowledge, perception, and willingness of (i) seed companies, distributors, and dealers to sell *Bt* eggplant seeds; (ii) farmers to adopt *Bt* eggplants; (iii) traders to market *Bt* eggplants, as well as the factors affecting their marketing decisions; and (iv) consumers to buy *Bt* eggplants. The study also examined the policy and institutional environment influencing the eggplant market in the Philippines and provided recommendations for policy interventions.The findings could help chart the future directions of national policies and programs to realize the potential benefits of the *Bt* eggplant technology in the Philippines.

Methodology

Conceptual Framework

The market prospects of *Bt* eggplant crucially depend on the response of major actors in the market for its seed as planting material and its fruit as a food commodity. The seed market involves the potential suppliers (seed companies, distributors, and dealers) and potential adopters (eggplant farmers). The food market included eggplant traders and consumers (Figure 1). The study examined the perceptions and attitudes toward *Bt* eggplant of these market players, as well as the policy and institutional environment that will harness the technology's market potential, once commercialized. The market potential of *Bt* eggplant will be determined by the willingness of seed suppliers to sell its seeds; of farmers to adopt the technology; of traders to market *Bt* eggplants; and of consumers to buy and eat the product. The willingness of these actors depends on their knowledge and perception, and on the macro and micro environments that influence the actors' production, marketing, and/or consumption decisions.[1]

If *Bt* eggplant is approved for commercialization, the response of seed suppliers would depend on their perception of the technology's importance,

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[1] The macro environment refers to the sociocultural, political, institutional, technological, environmental, and economic landscape that may support or constrain the market for *Bt* eggplant. Government policies, programs, and regulatory mechanisms (e.g., food safety standards, and information, education, and communication (IEC) or extension programs) serve the varying concerns of these market players. Micro environment may include marketing arrangements including pricing and market support system, and local level interventions that also address market inefficiencies.

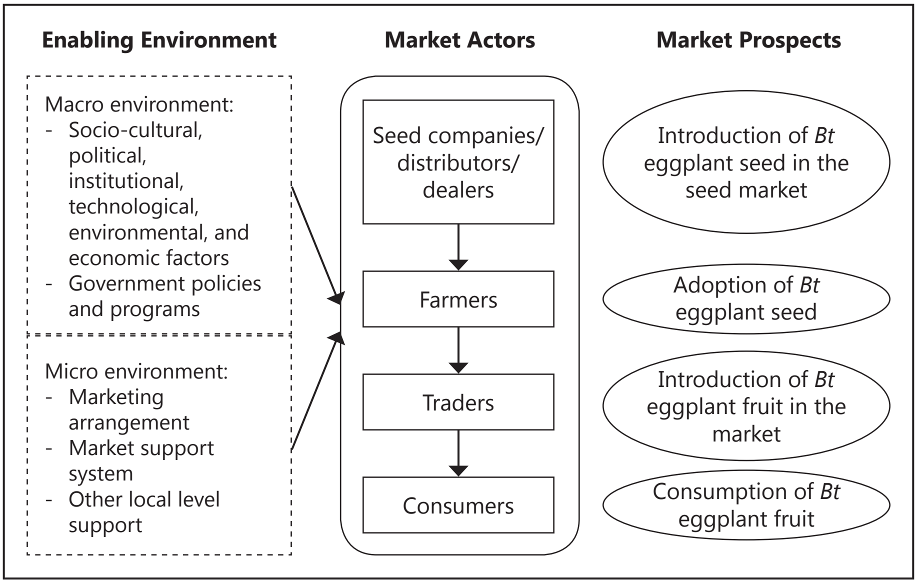

Figure 1. Conceptual framework

potential profits, farmers' demand for the technology, and social acceptability. Farmers' demand would depend on their perceptions and attitude toward adopting the *Bt* eggplant technology; accessibility, affordability, and timeliness of adopting the technology; promotional strategies of seed suppliers; and government policies and programs. The extent of farmers' demand for seeds would influence the potential farm size planted to *Bt* eggplant and consequently, the total eggplant production in the country.

The volume of *Bt* eggplant fruits in the market would mainly be determined by the number of traders who would buy and sell them, and the response of farmers and traders to price changes. Consumers' demand will depend on their response to market price, income and consumption pattern, and concern with product quality including food safety.

Data Collection and Analysis

Methods and Respondents. The study used primary and secondary data and employed an extensive review of literature on eggplant production, marketing, and demand. Primary data were collected through key informant interviews, consultations and/or surveys of stakeholders in the Philippine eggplant industry: seed suppliers (seed companies/distributors/dealers), farmers, traders (local wet market wholesalers, wholesaler-retailers, retailers, supermarkets), and consumers (households and commercial). Relevant staff members of the Office of the Provincial Agriculturist (OPAg) and Municipal (or City) Agriculturist Office (MAO/CAO) were also interviewed to assess the micro environment influencing the market potential of *Bt* eggplant.

Secondary data on eggplant production, area, yield, prices (farm, wholesale, and retail), and other relevant information were obtained from the Bureau of Agricultural Statistics (BAS) and published or unpublished documents. Other secondary area-specific information (number, names, and addresses of eggplant farmers and traders) were collected from concerned local government units (LGUs) (OPAgs, MAOs, and CAOs).

Simple descriptive analyses and statistical techniques (i.e., summations, averages, frequency counts, and percentages) were employed in processing the primary data and secondary information obtained in the study.

Survey Areas. This study was conducted in the major eggplant-producing provinces of Pangasinan (Ilocos region), Quezon (CALABARZON), Cebu (Central Visayas), and Iloilo (Western Visayas). During 2007-2011, Pangasinan consistently ranked first in terms of area planted and volume of eggplant production, accounting for 19% and 33% of the national parameters, respectively.

In each province, three major eggplant-producing municipalities/cities were identified, from where a total of 30 farmers, 30 traders, and 30 consumers were surveyed. The specific survey areas were identified in consultation with the Provincial and Municipal/City Agriculturist and selected purposively based on area planted to eggplant. The municipalities/cities in each province were: Cebu City, Catmon, and Carcar in Cebu; Sta. Barbara, Miag-ao, and Leon in Iloilo; Sta Maria, Asingan, and Villasis in Pangasinan; and Dolores, San Antonio, and Tiaong in Quezon.

Thirty farmers were drawn from each province equally distributed among the municipalities. The trader-respondents, totalling 130, included those with stalls in the local public markets as well as in the major trading or "bagsakan" centers such as the *Sentrong Pamilihan ng Produktong Agrikultura ng Quezon Foundation Inc.* (SPPAQFI) in Sariaya, Quezon; the Carbon Public Market in Cebu City; and the "bagsakan" in Iloilo City and Leon, Iloilo. An additional 10 traders were interviewed in Divisoria market in Metro Manila. The consumer survey was done in the local public markets and supermarkets in the four provinces. In each province, 20 consumers buying eggplants in the public market and 10 consumers buying eggplants in the supermarket were surveyed. The Provincial Agriculturists and Municipal/City Agriculturists in the study areas were likewise interviewed.

Based on their presence and availability in the study sites, three seed companies, sixteen seed dealers, and eight seed distributors were interviewed (Table 1). These seed suppliers were either 50% or more than the number of seed suppliers in the study sites. The three seed company respondents were East-West Seed Company, Inc. (based in Bulacan but their representatives were interviewed in Pangasinan), Pilipinas Kaneko Seed Corporation (in Lipa City, Batangas), and Ramgo International Corporation (in Metro Manila). There were a total of 27 key informants.

The following paragraph from Agricultural Biotechnology Support Project II (ABSPII) (2011) was used in describing the *Bt* eggplant technology to the respondents, especially to those not familiar with it.

"Bt eggplant is a new variety of eggplant that has been developed to combat the problem on fruit shoot borer (FSB) infestation. With this new technology, the plant will be resistant to FSB, thus farmers would expect higher volume of production and better-quality eggplant. Cost of production would also be minimized as insecticides would no longer be applied to control FSB. Bt eggplant has to pass through a strict regulatory biosafety compliance to assure its safety to human and animal health and environment before it is commercialized."

Willingness of Seed Suppliers to Handle *Bt* Eggplant

Eggplant Seed Varieties Sold by Seed Suppliers (Companies, Distributors, and Dealers)

A total of 13 eggplant seed varieties, all hybrid, were sold by the seed dealers and seed distributors. Among the varieties sold, Morena was the most popular, followed by Casino (Table 2), both of which are produced by the East-West Seed Co., Inc. This seed company was the major source of eggplant seeds by 67% of the seed dealers and seed distributors interviewed. The seed companies also sold open-pollinated varieties (OPVs), which were mostly bought by the LGUs for their seed dispersal program.

Table 1. Number of seed companies, distributors, and dealers interviewed by province/study site, Philippines, 2013

Category	Batangas	Cebu	Iloilo	Metro Manila	Panga-sinan	Quezon	Total
Seed company	1	0	0	1	1	0	3
Seed distributor	0	1	1	0	2	4	8
Seed dealer	0	3	4	0	4	5	16
Total	*1*	*4*	*5*	*1*	*7*	*9*	*27*

Table 2. Eggplant seed varieties sold by seed companies, distributors, and dealers, Philippines, 2013

Variety	Seed Dealer (n=16)	Seed Distributor (n=8)	Total (n=24)	
	No.	No.	No.	%
East-West Seed Company, Inc.				
Morena	16	8	24	100
Casino	10	8	18	75
Fortuner	0	3	3	12
Banate King	1	1	2	8
Gwapito	0	1	1	4
Pilipinas Kaneko Seeds Corporation				
Checkmate	2	0	2	8
Purple Star	1	0	1	4
Allied Botanical Corporation				
Spitfire	2	0	2	8
Lightning	1	0	1	4
Warhawk	1	0	1	4
Ramgo Seeds International				
Maharlika/Sikat	6	0	6	25
Seminis Vegetable Seeds (Phils.), Inc.				
Cluster King	1	0	1	4
Prolifica (introduced in 2013)	0	1	1	4

Eggplant seeds are packaged in pouches, cans, and packs, which differ by number of seeds and weight. Prices vary by packaging type and by company or source. For instance, prices ranged at PhP830-PhP1,260/can of 50 grams; PhP45-PhP65/pouch of approximately 3 grams; and PhP21,500-PhP 22,940/kg.[2] OPV seeds were cheaper than hybrid seeds.

Fifty-two percent of the respondents reported changing the price of eggplant seeds once, and 15% do it twice, within a year. Prices usually become higher during planting season and when a new batch of seeds is delivered.

Contribution of Eggplant Seed Sales to Total Seed Sales

Eggplant seeds contributed 6%-20% of the company's seed sales and 1%-5% of sales for half of the seed dealer-respondents. The share of eggplant seed sales to their total seed sales ranged widely for seed distributors, from less than 1% to 41%-50%. Across all these respondents, 30% reported that 1%-5% of their total seed sales comes from eggplant seeds, and another total 30% estimated that it was at least 11% (Table 3).

One seed company claimed that eggplant seeds ranked second in terms of contribution to their earnings; the two other companies said 10th and 15th, respectively. For most of the seed distributors (75%) and seed dealers (38%), eggplant seeds contributed most to their earnings. Across types of respondents, eggplant seeds ranked first (44%) and second (19%) among all the seeds they sell.

Mode of payment was either cash or credit basis, and there are different payment arrangements depending on the type of buyer. For instance, seed dealers or distributors can buy seeds on credit for payment ranging from 1 week to 60 days without interest. Post-dated checks may be issued to the company or dealer/distributor. While seeds may also be sold on credit to farmers for payment in a period of 30-120 days, or after harvest, sale transactions with farmers are generally in cash upon purchase or on delivery.

All the three seed companies, 38% of the seed distributors, and 50% of the seed dealers promote the products that they sell. Twenty percent of the respondents use commercial demos/harvest festivals/convergence techno-demos as a promotion strategy, 15% conduct meeting with farmers, and 10%

[2] US$1.00=PhP43.00 at the time of the study.

Table 3. Share of eggplant seed sales in total seed sales, Philippines, 2012

Share in Total Seed Sale (%)	Seed Company (n=3)		Seed Dealer (n=16)		Seed Distributor (n=8)		Total (n=27)	
	No.	%	No.	%	No.	%	No.	%
Less than 1	0	0	1	6	2	25	3	11
1-5	0	0	8	50	0	0	8	30
6-10	2	67	2	12	2	25	6	22
11-20	1	33	0	0	0	0	1	4
21-30	0	0	1	6	1	12	2	7
31-40	0	0	1	6	0	0	1	4
41-50	0	0	0	0	1	12	1	4
Greater than 50	0	0	2	12	0	0	2	7
No idea	0	0	1	6	2	25	3	11
Total	*3*	*100*	*16*	*100*	*8*	*100*	*27*	*100*

provide coupons, give-aways, and raffles. Specifically for eggplant seeds, 11% of the respondents use meeting with farmers as a promotion strategy. One seed company conducted an eggplant festival/cooking demonstration/competition to promote the seeds.

Client Feedback on Eggplant Seeds Procured

Clients usually provide feedbacks—some positive, others negative—regarding the eggplant seeds bought from suppliers (Table 4). For OPVs, usual positive feedback include: cheaper seeds, good germination rate, and good yield. The negative feedbacks meanwhile may include: low germination rate, highly susceptible to FSB, and late maturing. Seeds of hybrid eggplant were noted as high-yielding, with big and smooth fruits, but of poor germination rate and expensive.

To address the negative feedbacks of clients, the seed suppliers inform the source of seeds or the company's complaint handling section. Some seed suppliers also verify the complaints.

Knowledge/Perceptions about *Bt* Eggplant

All the seed company-respondents had knowledge of *Bt* eggplant (Table 5). Majority of the seed distributors and seed dealers, however, were not aware

Table 4. Share of eggplant seed sales in total seed sales, Philippines, 2012

Feedback	Seed Company (n=3)		Seed Dealer (n=16)		Seed Distributor (n=8)		Total (n=27)	
	No.	%	No.	%	No.	%	No.	%
OPV seeds: Positive feedback								
Cheaper seeds	1	33	0	0	0	0	1	4
Good germination rate (>85%)	1	33	0	0	0	0	1	4
Good quality fruits/high yielding	1	33	2	12	0	0	3	11
OPV seeds: Negative feedback								
Highly susceptible to FSB	1	33	0	0	0	0	1	4
Late maturing	1	33	0	0	0	0	1	4
Low germination rate	1	33	1	6	1	12	3	11
Hybrid seeds: Positive feedback								
Early maturing	1	33	0	0	0	0	1	4
Uniformity of fruits	1	33	0	0	0	0	1	4
High germination rate (>98%)	1	33	0	0	0	0	1	4
High-yielding	2	67	9	56	4	50	15	56
Less susceptible to FSB	1	33	0	0	0	0	1	4
Big/smooth fruits	0	0	2	12	0	0	2	7
Hybrid seeds: Negative feedback								
High price of seeds	3	100	0	0	1	12	4	15
Low market price of fruits	0	0	1	6	0	0	1	4
Infested by insects	0	0	1	6	0	0	1	4
Poor germination	0	0	6	38	3	38	9	33

Table 5. Awareness on *Bt* eggplant of seed companies, dealers and distributors, Philippines, 2013

Response	Seed Company (n=3)		Seed Dealer (n=16)		Seed Distributor (n=8)		Total (n=27)	
	No.	%	No.	%	No.	%	No.	%
Aware	3	100	4	25	1	12	8	30
Not aware	0	0	12	75	7	88	19	70
Total	*3*	*100*	*16*	*100*	*8*	*100*	*27*	*100*
Source of information								
Agricultural technician	0	0	1	6	0	0	1	4
Farmers	1	33	0	0	0	0	1	4
Former colleagues from UPLB	1	33	0	0	0	0	1	4
Friends	0	0	1	6	0	0	1	4
Seed companies	1	33	1	6	0	0	2	7
Media	0	0	2	12	1	12	3	11

of the technology. Those who were aware sourced information mainly from the media and seed companies.

The respondents who know or are somehow familiar about *Bt* eggplant said that this new variety is FSB tolerant, could help farmers save on pesticide cost, and has higher yield.

Willingness to Sell *Bt* Eggplant Seeds

Majority (81%) of the respondent seed companies, dealers, and distributors would be willing to sell *Bt* eggplant seeds (Table 6). Of these, about 15 suppliers would just like to test the *Bt* eggplant seed's saleability to farmers. The one seed company not willing to sell reasoned out that if the price of *Bt* seeds would be high, farmers may not be able to afford it, and that this variety may be needed only in areas highly infested with FSB.

Most seed suppliers would prefer to sell *Bt* eggplant hybrid varieties as majority of farmers prefer hybrids, with their better and bigger fruits and high yields, giving farmers higher income. In case only open-pollinated *Bt* eggplant varieties would be available, 44% of the respondents would be willing to sell; 11% not willing; and 44% were not sure if they would sell it or not (Table 6).

Marketing *Bt* Eggplant Seeds

Selling Price for Bt Eggplant Seeds. Most seed suppliers believed that, while the price of *Bt* eggplant seeds would depend on the pricing system or mark-up set by the company/distributor, it should be cheaper than existing varieties. Should *Bt* eggplant seeds be priced twice that of existing varieties, 41% of the supplier-respondents would be willing to sell them (Table 7). Seed suppliers would also be willing to sell as long as farmers will accept and buy the product, and as long as food safety is assured. They added that marketing *Bt* eggplant seeds would most likely follow their current arrangements or practice with the dealers and distributors (although some expressed preference for consignment).

Sales Strategies in Introducing New Seed Varieties. To introduce new varieties in the market (would include *Bt* eggplant seed once this is commercialized), seed companies conduct farm demonstrations and harvest festivals, product launching, and farmers' meetings to promote the variety; give brochures, flyers, and catalogues written in different dialects; and provide sample seeds and give-aways.

Table 6. Type of *Bt* eggplant seeds preferred to be sold by seed suppliers, Philippines, 2013

Item	Seed Company (n=3)		Seed Dealer (n=16)		Seed Distributor (n=8)		Total (n=27)	
	No.	%	No.	%	No.	%	No.	%
Willingness to market *Bt* eggplant seeds								
Willing	2	67	13	81	7	88	22	81
Not willing	1	33	0	0	0	0	1	4
Do not know	0	0	3	19	1	12	4	15
Total	*3*	*100*	*16*	*100*	*8*	*100*	*27*	*100*
***Bt* eggplant variety**								
Hybrid	2	67	8	50	7	88	17	63
OPV	0	0	1	6	0	0	1	4
Both hybrid and OPV	0	0	4	25	0	0	4	15
Do not know	1	33	3	19	1	12	5	19
Total	*3*	*100*	*16*	*100*	*8*	*100*	*27*	*100*
Willingness to sell if only OPV *Bt* eggplants would be available								
Willing	2	67	3	19	7	88	12	44
Not willing	1	33	2	12	0	0	3	11
Do not know	0	0	11	69	1	12	12	44
Total	*3*	*100*	*16*	*100*	*8*	*100*	*27*	*100*

For the *Bt* eggplant seed variety, seed company-respondents recommend establishing demonstration farms (23%), giving free seed samples (19%), distributing brochures, flyers, catalogues written in different dialects (12%), and conducting farmers' meetings/trainings (12%).

Willingness of Farmers to Adopt the *Bt* Eggplant Seeds

Knowledge and Perception of *Bt* Eggplant

Ninety-five (about 80%) of the total 120 eggplant farmers interviewed had no previous knowledge of *Bt* eggplant. All farmer-respondents in Quezon and 93% of those in Cebu were not aware of *Bt* eggplant (Table 8).

Farmers learned about *Bt* eggplant from agricultural technicians, seed company representative, fellow farmers, print media, television, and radio.

Table 7. Suppliers' perception of selling price of *Bt* eggplant seeds, Philippines, 2013

Response	Seed Company		Seed Dealer		Seed Distributor		Total	
	No.	%	No.	%	No.	%	No.	%
Setting the selling price of *Bt* eggplant seeds								
Cheaper than existing varieties	1	50	2	12	3	38	6	23
Depends on the price/mark-up set by the company/ distributor	0	0	4	25	3	38	7	27
Comparable to/same as existing varieties	0	0	2	12	0	0	2	8
Higher than existing varieties	1	50	1	6	1	12	3	12
10%-15% mark-up for suppliers	0	0	1	6	0	0	2	8
Do not know	0	0	5	31	1	13	6	23
Total	*2*	*100*	*16*	*100*	*8*	*100*	*26*	*100*
Willingness to sell *Bt* eggplant seeds if price is twice that of existing varieties								
Willing	2	67	4	25	5	62	11	41
Not willing	1	33	6	38	2	25	9	33
Do not know	0	0	6	38	1	12	7	26
Total	*3*	*100*	*16*	*100*	*8*	*100*	*27*	*100*

Table 8. Farmer knowledge and perception of *Bt* eggplant, by province, Philippines, 2013

Response	Cebu		Iloilo		Pangasinan		Quezon		Total	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Setting the selling price of *Bt* eggplant seeds										
Aware	2	7	9	30	14	47	0	0	25	21
Not aware	28	93	21	70	16	53	30	100	95	79
Total	*30*	*100*	*30*	*100*	*30*	*100*	*30*	*100*	*120*	*100*
Farmers' willingness to adopt *Bt* eggplant, by gender										
Willing	*30*	*100*	*27*	*90*	*30*	*100*	*28*	*93*	*115*	*96*
Male	20	67	15	50	30	100	18	60	83	69
Female	10	33	12	40	0	0	10	33	32	27
Not willing	*0*	*0*	*3*	*10*	*0*	*0*	*0*	*0*	*3*	*3*
Male	0	0	2	7	0	0	0	0	2	2
Female	0	0	1	3	0	0	0	0	1	1
Do not know/ undecided	*0*	*0*	*0*	*0*	*0*	*0*	*2*	*7*	*2*	*2*
Male	0	0	0	0	0	0	1	3	1	1
Female	0	0	0	0	0	0	1	3	1	1

There are programs related to agriculture on TV or local radio stations in the area. Farmers read magazines, brochures, pamphlets, or printed advertisements of seed companies. They knew that *Bt* eggplant is resistant to fruit and shoot borer, thus can reduce pesticide application costs. Farmers also deem that *Bt* eggplant will have better fruit quality and provide higher yield.

Ninety-six percent of all farmer-respondents were willing to adopt *Bt* eggplant, and majority of them were male (Table 8). (There were 86 male [72%] and 34 [28%] female farmer-respondents.) All Cebu and Pangasinan farmer-respondents (all male) were willing to adopt *Bt* eggplant. In Iloilo, 10% of the sample farmers were not willing to adopt the technology, while over 6% of those in Quezon could not decide yet. They wanted to first see the results of technology demonstrations (techno-demos) and check if the fruit quality is comparable to the variety they are currently growing.

Majority (96%) of the farmer-respondents were also willing to eat the fruit of *Bt* eggplant. They have faith on the expertise of the technology's developers from UPLB and also cited the case of *Bt* corn. The very few who were not willing to eat *Bt* eggplant were practicing organic farming and not sure if it would be safe. These farmers have no prior knowledge of *Bt* eggplant, except for one farmer who heard on the radio about its alleged potential negative effects on health.

The farmers' interest in *Bt* eggplant stems from their concern with FSB damage on their eggplant production. Majority of the farmers (80% of potential adoptors in Pangasinan, and over 60% in the other three provinces) observed that FSB infestation has worsened over the years, especially during the rainy season.

While chemical pesticide application is the main strategy to minimize crop damage from FSB, 53% of potential adoptors in all study sites reported that the eggplant FSB has developed resistance and has become immune to insecticides, thus requiring higher pesticide dosage.

Meanwhile, farmers who were not willing to adopt *Bt* eggplant were not spraying pesticides or were into organic farming. They follow other cultural or management pest control practices such as manual removal of damaged shoots and fruits and host weeds; crop rotation (i.e., planting different crops on the same area in different cropping seasons, e.g., string beans, corn after eggplant); and intercropping (planting eggplant with other crops on the same area, at the same cropping season). Planting the same crop in the same area every season will increase pest pressure or will affect soil quality. Some farmers also practice smudging to control pests.

Farmers' Socio-demographic Background

On average, potential adoptors have been growing eggplant for almost 15 years, compared to 9 years of those not willing. The farmer-respondents were on average 50 years old, with those in Quezon and Pangasinan relatively younger than those in Cebu and Iloilo. Those who were not willing to adopt were, on average, older by one year than those willing to do so. Those who were not yet decided were much younger by around 8 years (Table 9).

Potential adoptors of *Bt* eggplant generally attained elementary and secondary levels of education. Iloilo had the most potential adoptors with college education, 11% of whom had a degree not related to agriculture (e.g., nursing) (Table 9). Those who went to vocational school took courses also not related to agriculture (e.g., electronics).

If *Bt* eggplant would be available in the market, around 59% of the farmer-respondents who were willing to adopt *Bt* eggplant intend to plant it immediately, i.e., would be the early technology adoptors. More farmers (77%) in Cebu than in Iloilo (59%), Pangasinan (57%), and Quezon (43%) could be characterized as early adoptors. Around 35% would wait after one cropping season or 1 year and observe first the performance of *Bt* eggplant in other farms (Figure2).

Across all provinces, majority (60%) of potential adoptors intend to plant *Bt* eggplant on the same land area they are currently using, which averaged at 0.57 ha (Table 10). Around 24% of the farmers are very optimistic about *Bt* eggplant and would even increase the farm area devoted to eggplant by 75%. The rest are more conservative farmers who first will observe the performance of *Bt* eggplant, and hence plan to reduce the current eggplant farm area. One can say that these farmers need to be assured first of the gains from *Bt* eggplant adoption.

Farmers' tenure status may also explain their decision to increase, reduce or retain land area for growing *Bt* eggplant. Across the four provinces, about 27% of all potential adoptors are landowners who can readily make farming decisions. Around 55% of all potential adoptors were leaseholders and tenants who may still need the landowner's consent on the use of land

Table 9. Farmers' demographic characteristics according to willingness to adopt *Bt* eggplant, by province, Philippines, 2013

Item	Cebu		Iloilo		Pangasinan		Quezon		Total	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Farmers willing to adopt										
Average age (years)	51		53		50		48		50	
Below average	19	63	14	52	16	53	13	42	59	54
Above average	11	34	13	48	14	47	15	58	53	46
Educational attainment										
Elementary level	12	40	5	18	6	20	14	50	37	32
High school level	13	43	7	30	15	50	8	28	43	37
College level	4	13	9	33	7	23	5	18	25	28
Vocational graduate	1	3	6	22	2	7	1	4	10	9
Total	*30*	*100*	*27*	*100*	*30*	*100*	*28*	*100*	*112*	*100*
Farmers not willing to adopt										
Average age (years)	-		52		-		-		52	
Below average	-	-	1	33	-	-	-	-	1	33
Above average	-	-	2	67	-	-	-	-	2	67
Educational attainment										
High school level	-	-	1	33	-	-	-	-	1	33
College level	-	-	2	67	-	-	-	-	2	67
Total	-	-	*3*	*100*	-	-	-	-	*3*	*100*

Table 9. Farmers' demographic characteristics according to willingness to adopt *Bt* eggplant, by province, Philippines, 2013

Item	Cebu		Iloilo		Pangasinan		Quezon		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Farmers who are undecided										
Average age (years)	-		-		-		44		44	
Below average	-	-	-	-	-	-	1	50	1	50
Above average	-	-	-	-	-	-	1	50	1	50
Educational attainment										
Elementary graduate	-	-	-	-	-	-	1	50	1	50
High school level	-	-	-	-	-	-	1	50	1	50
Vocational graduate	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	*2*	*100*	*2*	*100*

- means no information.

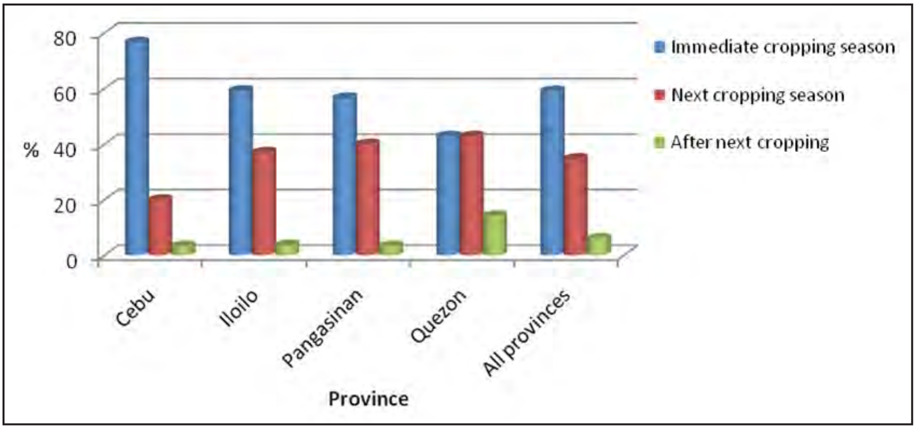

Figure 2. Distribution of potential farmer-adoptors by timing of planting *Bt* eggplant, by province, Philippines, 2013

and technology (Figure 3).These farmers could also look for other areas to be leased or tenanted, which would be an easier and less costly option than purchasing land. The market value of agricultural land ranged from over PhP866,000/ha (in Quezon) to PhP2.2 million/ha (in Pangasinan). Lease ranged from PhP11,000/ha in Quezon and Iloilo to PhP21,000/ha in Cebu and Pangasinan.

By province, Iloilo and Pangasinan had more owner-cultivators (Figure 3). Land ownership is very low in Quezon as farmers tend to move from one farm to another every cropping. They cannot plant eggplant in two consecutive seasons on the same piece of land because the soil becomes acidic. Farmers also practice crop rotation on the same land but change the spot to be planted to eggplant.

Use of land is very critical to eggplant production. Like in growing many other vegetables, crop rotation is an important practice in eggplant production because it helps protect the land from serious weed problems. Eggplant should not be planted consecutively on the same land, nor should it follow other solanaceous crops, such as tomatoes and peppers. Moreover, eggplant should not be used as a rotation crop on land that has been treated with herbicides to which eggplant may be sensitive (Granberry, 1990, as cited in USDA, 1996).

Table 10. Planned land use for *Bt* eggplant by potential adoptors, by province, Philippines, 2013

Item	Cebu		Iloilo		Pangasinan		Quezon		Total	
Average eggplant farm area (hectares)	0.38		0.31		0.54		1.05		0.57	
Land use decision	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Will reduce eggplant farm area by										
<25% - <50%	0		2		2		2		6	
50% - 75%	2		2		4		4		12	
Total	*2*	*7*	*4*	*15*	*6*	*20*	*6*	*21*	*18*	*16*
Will increase eggplant farm area by										
<25% - <50%	0		4		1		1		6	
50% - 75%	0		7		8		7		22	
Total	*0*	*0*	*11*	*41*	*9*	*30*	*8*	*29*	*28*	*24*
Will plant same egg-plant farm area	28	93	12	44	15	50	14	50	69	60
Total	**30**	**100**	**27**	**100**	**30**	**100**	**28**	**100**	**115**	**100**

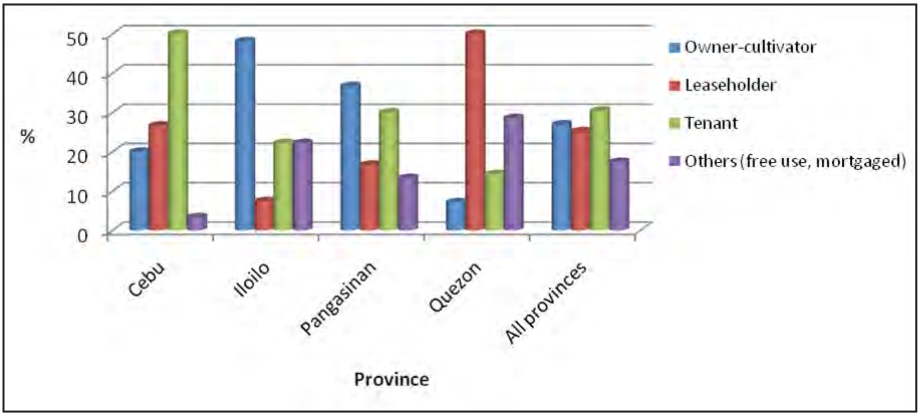

Figure 3. Distribution by tenure status of farmers willing to adopt *Bt* eggplant, by province, Philippines, 2013

Farmers' Preference for *Bt* Eggplant Variety

Eggplant varieties are classified as hybrid or OPV. Hybrid seeds, usually purchased from seed dealers in the area, cannot be saved for the next cropping as its performance will not be the same as that of the F1 seeds. In contrast, OPV seeds can be saved and replanted, with similar (yield) performance. Farmers' choice of seeds, whether hybrid or OPV, is usually based on marketability of the fruits as reflected in consumer preferences such as fruit color, shape, and size.

Majority (85%) of potential adoptors prefer hybrid *Bt* eggplant since they have been using hybrid eggplant seeds (Table 11 and Figure 4). They also claim that OPV eggplant has smaller fruits and lower yield. Farmers currently using OPV eggplant, such as the native variety and Dumaguete Long Purple, were mainly from Iloilo (44%) where there is a community seed bank. Farmers who preferred OPV *Bt* eggplant believe that the seeds can be saved and replanted, and will be cheaper. Farmers who were practicing organic farming or applying low level of pesticides also prefer OPVs. In case OPV *Bt* eggplant would be available, 35% of all farmers who expressed interest in *Bt* eggplant would adopt the new technology. However, eggplant farmers from Quezon are least likely to adopt it.

Willingness to Pay for *Bt* Eggplant Seed

The potential adoptors' preference for *Bt* eggplant variety is directly

Table 11. Seed variety currently used and preferred by potential adoptors of *Bt* eggplant seed, by province, Philippines, 2013

Item	Cebu		Iloilo		Pangasinan		Quezon		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Current variety used										
Farmers willing to adopt										
Hybrid	29	97	16	56	30	100	28	100	103	91
OPV	1	3	11	44	2*	7	0	0	14	12
Farmers not willing to adopt										
Hybrid	0	0	2	67	0	0	0	0	2	67
OPV	0	0	1	33	0	0	0	0	1	33
Farmers who do not know/are undecided										
Hybrid	0	0	0	0	0	0	2	100	2	100
OPV	0	0	0	0	0	0	0	0	0	0
Type of *Bt* eggplant preferred by potential adoptors										
Hybrid	25	83	16	59	29	97	28	100	98	85
OPV	5	17	11	41	1	3	0	0	17	15
Total	*30*	*100*	*27*	*100*	*30*	*100*	*28*	*100*	*115*	*100*
If *Bt* eggplant is OPV										
Willing to adopt	10	40	7	44	12	41	5	18	34	35
Not willing to adopt	14	56	9	56	17	59	21	75	61	62
It depends	1	4	0	0	0	0	2	7	3	3

*Note: Two farmers planting OPV in Pangasinan also plant hybrid.

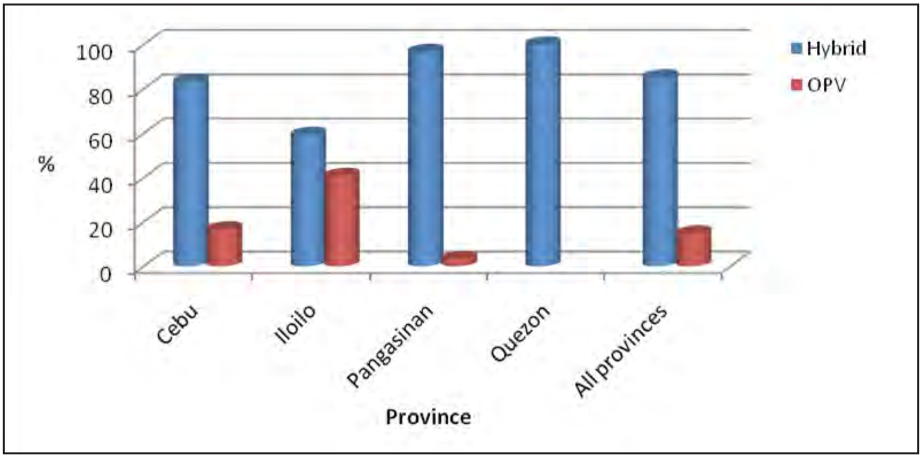

Figure 4. Distribution of potential farmer adoptors by preferred variety of *Bt* eggplant, by province, Philippines, 2013

associated with current varietal use and their willingness to purchase at a given price premium. Considering the costs involved in commercializing *Bt* eggplant, farmers were asked of their willingness to buy the seed if its price would be double that of their current variety. Similar to the case of genetically modified (GM) corn, there would be costs of compliance with government policies and regulations, e.g., biosafety assessment, before *Bt* eggplant comes out in the market.

Majority (74%) of all farmers interested to adopt *Bt* eggplant seed were willing to pay the 100% increase in seed price, equivalent to about PhP1,000/50-gram can, since it will anyway substantially reduce expenditures on pesticide. Based on the average price they are willing to pay, Cebu farmers would accept up to a 115% increase in price from that of conventional hybrid eggplant. In contrast, potential adoptors from Iloilo and Pangasinan would only accept an increase of 59% and 61%, respectively (Table 12). On average, the price farmers are willing to pay for *Bt* eggplant seed comes close to PhP1,800/50-gram can.

Among farmers who prefer OPV *Bt* eggplant, 45% are willing to pay the doubled price; the other 45% are not willing; and the rest cannot decide yet. The OPV seeds farmers are currently using are much cheaper than hybrids at an average cost of around PhP336/50-gram can. Some farmers

Table 12. Potential adoptors' willingness to pay for *Bt* eggplant seed, by province, Philippines, 2013 (PhP/50-gram can)

Item	Cebu	Iloilo	Pangasinan	Quezon	Total
Price of eggplant seed currently used by farmers					
Hybrid	940.83	1,048.33	1,067.41	952.83	995.24
OPV	-*	336.36	-*	-*	336.36
Price farmers are willing to pay for *Bt* eggplant					
Hybrid					
Mean	2,026	1,666	1,718	1,678	1,779
% increase in price	115	59	61	76	79
Median	2,000	1,700	1,800	1,900	1,900
OPV					
Mean	1,230	583.25	1,100	1,000	802.58
% increase in price	-	42	-	-	140
Median		500.00			

Note: *Provinces without entries indicate that none of the farmers interviewed was using OPV or that the OPV farmers used saved seeds. Dealers' price of OPV ranged from PhP315/50-gram can to PhP350/50-gram can.

usually saved OPV seeds, thus not incurring seed expense. In Iloilo, farmers are willing to accept an average price increase of only up to 42% from the price of conventional OPVs that they are using. In the other three provinces, farmer-respondents who were not using OPV eggplant but prefer OPV *Bt* eggplant quoted a higher willingness to pay ranging from PhP1,000/50-gram can to PhP1,230/50-gram can. With current dealers' price of OPVs (e.g., Bulakeña, Long Purple) around PhP350/50-gram can in Quezon and PhP315 in Pangasinan, this implies that farmers are willing to pay more than double the current price of OPV eggplant seeds in the market.

The farmers' willingness to adopt *Bt* eggplant at a price higher than that of conventional eggplant varieties indicates a significant potential for developing the market for *Bt* eggplant (Figures 5 and 6). Although hybrid *Bt* eggplant is more widely preferred over OPV *Bt* eggplant, these two varieties need not compete in the market but can target different groups of farmers across locations. The variation in farmers' response to price increases indicates that market development for *Bt* eggplant must include effective information dissemination so that farmers would be better aware of the price premium that goes with the new technology.

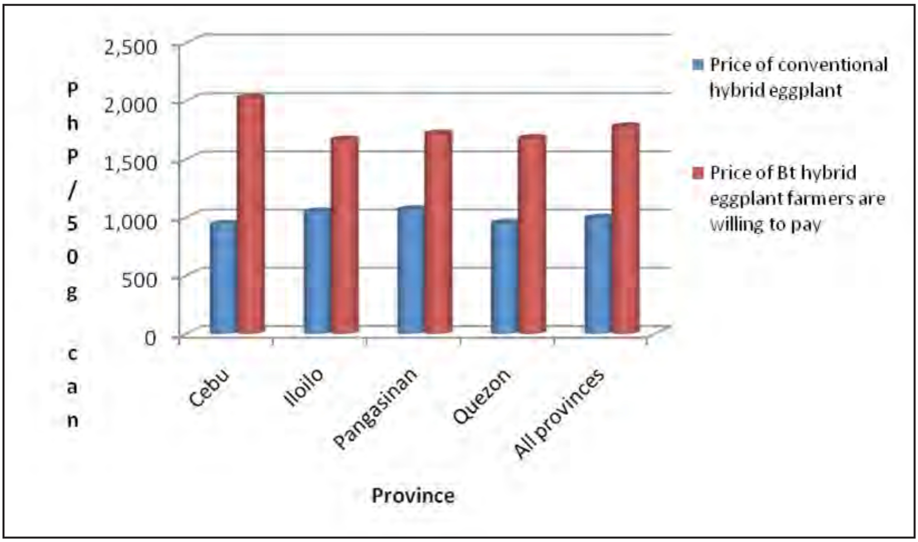

Figure 5. Price of conventional hybrid eggplant vs. price farmers are willing to pay for *Bt* hybrid, by province, Philippines, 2013 (PhP/50-gram can)

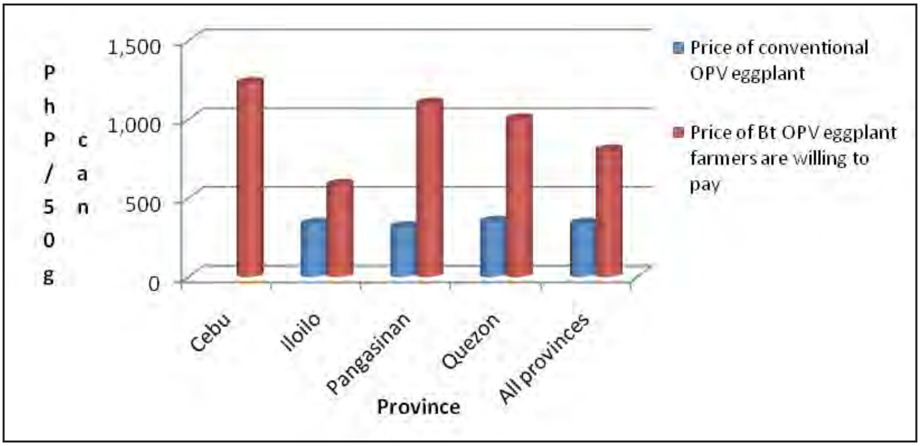

Figure 6. Price of conventional OPV eggplant vs. price farmers are willing to pay for *Bt* OPV, by province, Philippines, 2013 (PhP/50-gram can)

The commercialization of GM corn (*Bt*, herbicide-tolerant [HT], and stack traits [ST]) could illustrate how GM corn was widely adopted despite its higher price. Average price of ST corn, for example, ranged at PhP3,000-PhP4,000 per 9-kg bag, almost twice the price of conventional hybrid corn. Seed dealers reported that biotech corn has become popularly preferred by farmers. The vigorous information campaign through product launching, strategic farm demos, and harvest festivals of the private sector, e.g., seed companies, has been instrumental to the creation of the biotech corn market niche (Peñalba et al., 2012).

Based on the principle of supply and demand, the adoption of *Bt* eggplant may increase production of good quality eggplant but lower the market price. With an effective integration of markets, however, benefits could still be high. The establishment of farmers groups could contribute to the integration of markets, since farmers currently exert efforts and use their own resources in scanning the market. For example, Miag-ao, Iloilo has the Oyungan Eggplant Planters' Association and Oyungan Ubos Irrigators' Association, and Carcar, Cebu has the Dapdap United Farmers Association. Quezon farmers also have their cooperative. These farmers associations could work towards connecting with alternative markets and improving their position in the pricing system. The local government units could also provide assistance in market matching.

The high production costs (with the farmers' heavy dependence on pesticides), farmers planting at the same time leading to oversupply of eggplant and low prices, poor eggplant quality, erratic climate, and poor farm-to-market roads were cited as problems of the eggplant industry. The need for capital for the production and marketing of eggplant, organic farming, price monitoring, techno-demo and more trainings, developing eggplant varieties for any type of climate, developing good seeds with higher germination rate and yield, and making production of eggplant less costly were likewise mentioned.

The survey showed that only 25% of all farmer-respondents have received assistance, generally concerning production technologies such as organic farming and pest control practices, e.g., integrated pest management. Farmers did not report having received marketing assistance from any sector.

Willingness of Traders to Market *Bt* Eggplant

Aside from the farmers, the major players in eggplant marketing were the assembler-wholesalers, assembler-wholesaler-retailers, wholesalers, wholesaler-retailers, and retailers. The general product flow was from the farmers to assembler-wholesalers, assembler-wholesaler-retailers, wholesalers, or wholesaler-retailers (Figure 7). From the assembler-wholesalers, the eggplant goes to wholesalers or to wholesaler-retailers; from the assembler-wholesaler-retailers, to wholesalers, wholesaler-retailers, and consumers. From the wholesaler-retailers, the eggplant goes to retailers and consumers; and from the retailers, the eggplant finally goes to the consumers.

This study interviewed a total of 130 traders, composed of 15 assembler-wholesaler-retailers, 19 assembler-wholesalers, 5 wholesalers, 33 wholesaler-retailers, and 58 retailers. Across all study sites, the trader-respondents were generally female (82%), married, on average 46 years old, and had been trading eggplants for 13 years. Most of the respondents (34%) finished secondary education and 28% elementary schooling; only 5% were college graduates while 3% completed vocational courses.

Overall, the trader-respondents would prefer eggplant that has shiny and smooth skin and no pest damage; and is long, purple, delicious with no chemical pesticides, and safe to eat. Most traders would prefer hybrid (41%) or any variety (35%) as long as it will be saleable or sold to consumers. Longer shelf life of two or more days for eggplant and high yielding were also mentioned.

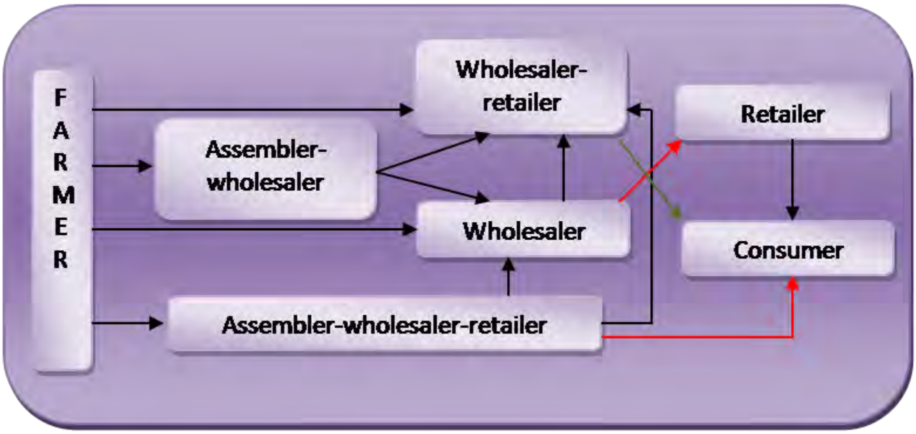

Figure 7. General product flow

Volume Traded of Eggplant and Eggplant Prices

Apparently, hybrid varieties of eggplant were more available in the market place than OPVs at any time of the year (Table 13). Eighty-two percent of the trader-respondents were selling hybrids from January to December compared to only 59% who were selling OPVs in the same period. In 2012, 91% of the respondents sold hybrid eggplants while only 60% sold OPV eggplants. Among the study sites, Divisoria, Metro Manila had the lowest proportion of trader-respondents who sold OPVs (20%) and Pangasinan the highest (90%). On the other hand, Cebu had the lowest proportion of respondents who sold hybrids with 77%; it was 87% in Iloilo, 97% in Pangasinan, and 100% in both Quezon and Divisoria. The decision to market OPVs and/or hybrid varieties of eggplant mainly depends on the preference of buyers for these varieties and availability of products or accessibility of source. The findings indicate the popularity of hybrid varieties among traders and consumers in the study sites.

The trader-respondents sourced the OPVs and hybrid eggplants for sale based on availability/accessibility/convenience, regular sales relation (“suki”), and low price offered. Similarly, traders chose market outlets based on length of time present in the place, accessibility and convenience, number of regular customers (“suki”), and number of buyers.

About 76% (for retailers) to 86% (for assembler-wholesaler-retailers) of the volume of eggplants handled by these traders were hybrids (Table 14). Among the traders across the study sites, only the retailers of Pangasinan marketed more OPVs (56%) than hybrids (44%). Quezon registered the lowest proportion, by volume traded, of OPVs. OPVs were mostly grown in Pangasinan where “pakbet” or “pinakbet” is a popular local dish that uses native eggplant, an OPV. The hybrid varieties were mostly popular in Quezon as the Tagalogs (people from Southern Tagalog provinces) are fond of eating eggplant omelette (“tortang talong”), fried eggplant, and broiled eggplant.

In 2012, the average buying and selling prices of OPV and hybrid eggplants were almost the same for all trader-respondents. Average buying price of OPVs or hybrid varieties was PhP18/kg for assembler-wholesalers; and PhP16/kg and PhP18/kg of OPVs and hybrid varieties, respectively, for assembler-wholesaler-retailers. At the wholesalers and wholesaler-retailers levels, the average buying prices for OPVs were PhP22/kg and PhP23/kg, respectively, higher than those for hybrid varieties (PhP21/kg for both types of traders). For retailers of OPVs and hybrid eggplants, the average buying prices were the same at PhP24/kg.

Table 13. Number of trader-respondents marketing eggplant, by month and province/study site, Philippines, 2012

Item	Cebu		Iloilo		Pangasinan		Quezon		Divisoria		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Kind of eggplant marketed												
Hybrid and OPV	6	20	16	53	26	87	16	53	2	20	66	51
Hybrid only	17	57	10	33	3	10	14	47	8	80	52	40
OPV only	7	23	4	13	1	3	0	0	0	0	12	9
Total	*30*	*100*	*30*	*100*	*30*	*100*	*30*	*100*	*10*	*100*	*130*	*100*
Months marketed												
OPV												
January-December	12	40	20	67	27	90	16	53	2	20	77	59
November-June	1	3	0	0	0	0	0	0	0	0	1	1
Not selling	17	57	10	33	3	10	14	47	8	80	52	40
Total	*30*	*100*	*30*	*100*	*30*	*100*	*30*	*100*	*10*	*100*	*130*	*100*
Hybrid												
January-December	21	70	25	83	25	83	26	87	9	90	106	82
August-January	0	0	0	0	0	0	3	10	0	0	3	2
December-March	0	0	0	0	1	3	0	0	0	0	1	1
July-January	0	0	0	0	0	0	1	3	0	0	1	1
November-January	0	0	0	0	1	3	0	0	0	0	1	1
November-March	0	0	0	0	1	3	0	0	0	0	1	1
October-April	0	0	1	3	0	0	0	0	0	0	1	1
Cannot remember	2	7	0	0	1	3	0	0	1	10	4	3
Not selling	7	23	4	13	1	3	0	0	0	0	12	9
Total	*30*	*100*	*30*	*100*	*30*	*100*	*30*	*100*	*10*	*100*	*130*	*100*

Table 14. Volume (tons) of eggplant traded by type of trader by province/study site, Philippines, 2012

Type of Trader	Cebu		Iloilo		Pangasinan		Quezon		Divisoria		Total	
	OPV	Hybrid	OPV	Hybrid	OPV	Hybrid	OPV	Hybrid	OPV	Hybrid	OPV	Hybrid
Assembler-wholesaler												
Number	1	2	1	1	4	4	4	11	0	1	10	19
Mean (tons)	6.2	9.2	27.4	119.5	332.2	461.4	54.8	308.3	0	365	158.1	301.6
Total (tons)	6.2	18.4	27.4	119.5	1,328.6	1,845.8	219.0	3,391.0	0	365	1,581.2	5,729.7
%	25	75	20	80	42	58	6	94	0	100	22	78
Assembler-wholesaler-retailer												
Number	1	3	6	7	1	1	2	4	0	0	10	15
Mean (tons)	2.1	30.0	86.6	130.3	18.2	47.4	49.2	660.9	0	0	63.8	246.2
Total (tons)	2.1	90.0	519.6	912.4	18.2	47.4	98.4	2,643.7	0	0	638.3	3,693.6
%	2	98	36	64	28	72	4	96	0	0	14	86
Wholesaler												
Number	0	0	0	0	1	1	2	3	0	1	3	5
Mean (tons)	0	0	0	0	22.8	42.0	52.1	191.1	0	43.8	42.3	131.8
Total (tons)	0	0	0	0	22.8	42.0	104.2	573.2	0	43.8	127.0	659.0
%	0	0	0	0	35	65	15	85	0	100	16	84
Wholesaler-retailer												
Number	5	6	2	5	8	10	1	4	2	5	18	30
Mean (tons)	8.0	103.8	1.2	5.1	32.1	87.2	4.3	49.1	203.7	338.0	39.5	113.6
Total (tons)	40.0	623.0	2.3	25.5	256.6	872.4	4.3	196.6	407.4	1,690.0	710.9	3,407.5
%	6	94	8	92	29	71	2	98	19	81	17	83
Retailer												
Number	6	12	11	13	13	13	7	8	0	3	37	50
Mean (tons)	3.8	5.9	1.3	1.9	5.7	4.5	3.3	6.6	0	72.4	3.6	8.5
Total (tons)	22.8	70.8	14.1	24.9	73.9	58.8	23.0	52.5	0	217.2	133.7	424.2
%	24	76	36	64	56	44	30	70	0	100	24	76

The assembler-wholesalers and assembler-wholesaler-retailers added PhP2/kg to PhP6/kg, while wholesalers and wholesaler-retailers added PhP4/kg to PhP10/kg, to their buying prices to come up with their selling prices at wholesale. At the retail level, assembler-wholesaler-retailers and wholesaler-retailers set a mark-up of PhP6/kg to PhP10/kg and PhP7/kg to PhP25/kg, respectively. At the retail market, the retailers apply an average mark-up of PhP6/kg to PhP15/kg to their buying price.

The buying prices per kilogram ranged at PhP3-PhP45 for assembler-wholesalers and assembler-wholesaler-retailers, PhP5-PhP50 for wholesalers, PhP8-PhP70 for wholesaler-retailers, and PhP5-PhP60 for retailers. Among the study sites, prices were generally highest in Divisoria. Eggplants sold in Divisoria often came from the major producing provinces in Luzon, including Pangasinan, Quezon, and Nueva Ecija.

Most trader-respondents reported that prices could change either daily, weekly, or monthly. The prices were often high during the third and fourth quarter of the year, because of limited or low supply in the market, which in turn can be due to crop damage by monsoon or typhoons. At the same time, demand is higher as schools are open and students eat more eggplant at home or in school canteens. In contrast, eggplant is cheaper during the first half of the year because of high production.

Majority (86%) of the trader-respondents paid cash to their sources of eggplants; the few others obtained the product either on 1-day or 14-day credit. Likewise, the buyers mostly paid the trader-respondents in cash (92%), with some given a 1-day or up to a 30-day credit. One eggplant trader in Cebu had a consignment marketing arrangement with his supplier.

Across all trader-respondents, average contribution of eggplant sales to total vegetable sales was 29%, indicating its popularity among consumers and economic importance to traders. Most trader-respondents in the study sites asserted that, among the vegetables they sold, eggplant ranked first in terms of earnings (57%).

More specifically, eggplant sales accounted for 21% of total vegetable sales of retailers, on average, and for 58% for the wholesalers. It was lowest for the retailers because these traders handle various kinds of vegetables, usually in small quantities. In contrast, the wholesalers, assembler-wholesaler-retailers, and assembler-wholesalers carry limited kinds of products in larger volumes.

Awareness/Perception on *Bt* Eggplant

Only 7% of the traders interviewed were aware or have heard of *Bt* eggplant with the highest proportions noted in Divisoria (20%) and Pangasinan (13%) (Table 15). (Pangasinan was one of the sites for the multi-location field trials for *Bt* eggplant being done by UPLB researchers.) The traders in Divisoria heard about *Bt* eggplant while watching TV or listening to the radio. Pangasinan traders learned about *Bt* eggplant from farmers, agricultural technicians, and seminars given to farmers. The lone Cebu trader and the two Iloilo traders received *Bt* eggplant information from the Department of Agriculture (DA) and friends. These traders perceived *Bt* eggplant as insect-tolerant, requiring no spray of insecticides or chemicals, and saves cost on pesticides. One trader even mentioned that *Bt* eggplant is similar to *Bt* corn in that insecticide application is no longer needed to control insect pests.

Willingness to Buy and Sell *Bt* Eggplant

If *Bt* eggplant would be commercially available, a high percentage (95%) of the traders interviewed would buy and sell the produce (Figure 8). Their interest stems from the potential significant profit that *Bt* eggplant presents, especially if its fruits would be of better quality than those of existing varieties in the market. Some traders were in fact already enthusiastic to see *Bt* eggplant in the market place. Most traders would prefer *Bt* eggplant as hybrid (49%); 35%, both hybrid and OPV; and 12% as OPV.

Two percent of the trader-respondents would not market *Bt* eggplant while the rest were not yet sure. These trader-respondents stated that they first would like to look at the product quality (absence of pest damage, good appearance), marketability, profitability, and consumer safety of the said variety.

Across all trader-respondents, 48% would be willing to buy *Bt* eggplant at the same price they are paying for non-*Bt* eggplant (Table 16). Forty-one percent would want the price of *Bt* eggplant to be lower (by about 23%) than that of non-*Bt* eggplant. Very few would be willing to pay a higher price (by about 20%). The reference prices used for non-*Bt* eggplant were PhP20/kg, which is near the average buying price of most traders and PhP40/kg, which is near the average selling price of wholesaler-retailers and retailers.

The trader-respondents opined that the price of *Bt* eggplant should be the same as that of non-*Bt* eggplant to make it competitive and affordable

Table 15. Traders' awareness of *Bt* eggplant by study site, Philippines, 2013

Item	Cebu		Iloilo		Pangasinan		Quezon		Divisoria		Total	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Aware or have heard of *Bt* eggplant before												
Yes	1	3	2	7	4	13	0	0	2	20	9	7
No	29	97	28	93	26	87	30	100	8	80	121	93
Total	*30*	*100*	*30*	*100*	*30*	*100*	*30*	*100*	*10*	*100*	*130*	*100*
If yes, source of information												
Friends	0	0	1	50	1	25	0	0	0	0	2	22
TV/radio	0	0	0	0	1	25	0	0	2	100	3	33
Seminars for farmers	0	0	0	0	1	25	0	0	0	0	1	11
Fellow farmer and technicians	0	0	0	0	1	25	0	0	0	0	1	11
Department of Agriculture (DA)	1	100	1	50	0	0	0	0	0	0	2	22
Total no. reporting	*1*	*100*	*2*	*100*	*4*	*100*	*0*	*0*	*2*	*100*	*9*	*100*
Knowledge/perception about attributes of *Bt* eggplant												
Insect tolerant	0	0	0	0	2	50	0	0	1	25	3	27
Saves cost on pesticides	0	0	0	0	1	25	0	0	1	25	2	18
No need to spray insecticides/ chemicals	0	0	0	0	1	25	0	0	2	50	3	27
Do not know	1	100	2	100	0	0	0	0	0	0	3	27
Total no. of responses	*1*	*100*	*2*	*100*	*4*	*100*	*0*	*0*	*4*	*100*	*11*	*100*

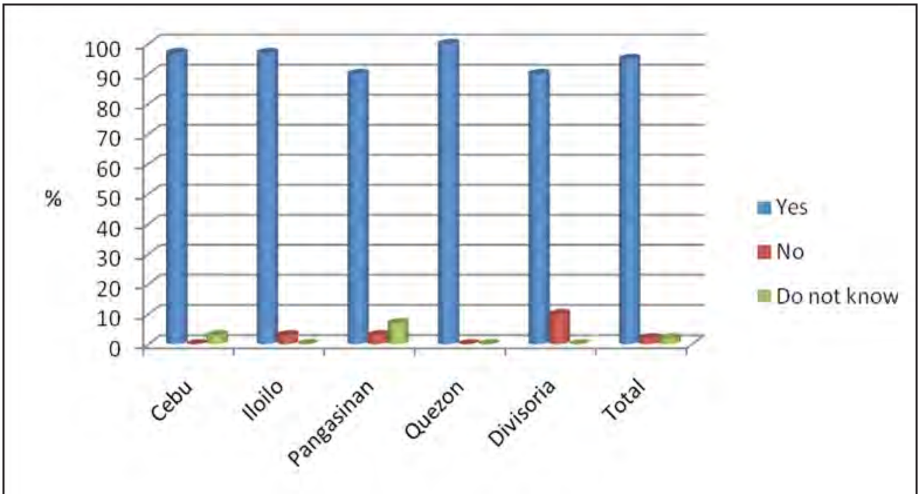

Figure 8. Proportion of trader-respondents by willingness to buy and sell *Bt* eggplant, by study site, Philippines, 2013

to consumers. Prices lower than that of non-*Bt* eggplant would make *Bt* eggplant affordable to consumers (64%) and easily known and sold (26%). Other traders asserted that *Bt* eggplant should be cheaper as its production cost would be lower because of the savings on pesticides.

Traders are willing to pay a price premium for *Bt* eggplant since it would be a healthier vegetable with no or less spray of pesticides. Others opined that if *Bt* eggplant is really a good commodity, making its price high would mean better incomes for traders.

If *Bt* eggplant would be available and priced same as that of non-*Bt* eggplant, the wholesalers, would on average, have 43% of the total eggplant volume traded as *Bt* eggplant and 54% for the wholesaler-retailers. If *Bt* eggplant would be cheaper than the non-*Bt* eggplant, the volume handled would be high, ranging from 50% for assembler-wholesaler-retailers to 62% for wholesaler-retailers. However, if it would be more expensive than the non-*Bt* eggplant, the volume of *Bt* eggplant handled would be low, ranging from 27% for the wholesalers to 45% for the wholesaler-retailers. It is interesting to note that some traders would be willing to sell only *Bt* eggplant whatever will be its price relative to that of non-*Bt* eggplant.

Table 16. Price level of *Bt* eggplant trader-respondents would be willing to pay by study site, Philippines, 2013

Price level of *Bt* eggplant	Cebu		Iloilo		Pangasinan		Quezon		Divisoria		Total	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Same as price of non-*Bt* eggplant	17	57	10	33	16	53	12	40	8	80	63	48
Higher than the price of non-*Bt* eggplant	1	3	3	10	2	7	5	17	1	10	12	9
	(18% higher)		(26% higher)		(23% higher)		(13% higher)		(38% higher)		(20% higher)	
Lower than the price of non-*Bt* eggplant	11	37	17	57	11	37	13	43	1	10	53	41
	(18% lower)		(24% lower)		(19% lower)		(29% lower)		(6% lower)		(23% lower)	
Do not know	1	3	0	0	1	3	0	0	0	0	2	2
Total	*30*	*100*	*30*	*100*	*30*	*100*	*30*	*100*	*10*	*100*	*130*	*100*

* Figures in parentheses are the percentage price differences that traders are willing to pay for *Bt* eggplant. The reference prices used for non-*Bt* eggplant were PhP20/kg, which is near the average buying price of most traders and PhP40/kg, which is near the average selling price of wholesaler-retailers and retailers.

In marketing the commodities, 93% of the trader-respondents would separate the *Bt* eggplant from the non-*Bt* eggplant to (i) distinguish *Bt* eggplant as a new product (which would most likely command a different price) and (ii) easily determine which eggplant would be more or most saleable. The few traders who would combine the *Bt* eggplant with the non-*Bt* eggplant during marketing would do so for additional income and as long as the features and prices of the eggplants are the same.

Upon inquiry, majority (92%) of the trader-respondents will eat *Bt* eggplant once it becomes available. A few respondents will not do so since they do not know yet the taste. Some traders would also like to first observe the effects on other consumers.

Marketing Problems and Recommendations

Problems encountered by traders in marketing eggplant were mostly the FSB/worms inside the eggplant fruit, rejects/deformed eggplants, and rotting of packaged eggplant when it gets damp/wet after fertilizer application. The traders also complained of poor marketing practices by some farmers and traders (e.g., mixing poor quality fruits with good quality ones), poor sales, bitter taste of eggplants due to heavy pesticide application, non-payment of the eggplants sold to buyers, and inadequate supply.

Meanwhile, the traders opined that once available, *Bt* eggplant could flood the market (because of its potential high production) and lower the market price, yet initial sales would be slow because it is new in the market.

In response to the above marketing problems, the traders recommended that eggplant varieties, such as *Bt* eggplant, which would lessen farmers' dependence on pesticides, should be given utmost attention. Another suggested solution was further research into "safer" pesticides that will eradicate the FSB, worms, and other pests of eggplant, especially since the pests have seemingly developed resistance to currently-available pesticides.

Willingness of Consumers to Buy *Bt* Eggplant

This study interviewed a total of 120 consumers, who averaged 45 years old, mostly female (80%), married (61%), and had an average household size of five members. More than half of the consumer-respondents (58%) graduated from college; 14% reached college level; and 5% had post-graduate education. Most respondents (56%) were professionals working in public or private offices, followed by vendors/retailers (15%), businessmen (6%), other workers (6%), and plain housewives (6%). Monthly household income ranged from less than PhP5,000 to more than PhP60,000 and averaged at PhP21,606. More than half (54%) of the consumer-respondents had a household income ranging from PhP5,001 to Ph15,000/month.

Consumption Pattern

Frequency and Quantity of Eggplant Purchased and Consumed. The respondents' purchase and consumption of eggplant was as frequent as daily (1%) and as seldom as monthly (13%). Most of the respondents purchased and consumed eggplants from once a week (31%) to three times a week (31%), indicating strong consumer preference for the vegetable.

The consumers bought eggplants at an average of 1 kg per transaction, with 42% buying less than 1 kg and 48% buying at 1 kg-1.99 kg. Majority of these respondents purchased eggplants from the local public market (64%); 18%, supermarket; 11%, local public market and supermarket; 2%, local market and farm; and 2%, at the farm.

The buying price of eggplant ranged from PhP3/kg to PhP80/kg.The lowest price observed by respondents averaged at PhP19/kg while the highest price averaged at PhP42/kg. Majority (59%) of the consumers did not buy more eggplant when the price was low but bought less when the price was high.

Factors Considered in Buying Eggplant. In purchasing eggplant, the consumer-respondents ranked fruit appearance as the most important factor, followed by product-eating experience (as to flavor, tenderness, juiciness, and ease of preparation), price, product effects (health, nutritional value, food safety, and effects on the environment), availability, convenience of purchase, and lastly, accessibility. The color, shape, size, and freshness are some of the traits subsumed under product appearance.

Knowledge and Perceptions about *Bt* Eggplant

The consumers' knowledge about *Bt* eggplant will influence their perception towards the new variety and on their willingness to buy or consume the product. Only 22% of the consumer-respondents were (somehow) aware of the *Bt* eggplant. They learned it from the media, including magazines and information materials (46%), friends (31%), and seminars and fora (12%). Most respondents perceived that *Bt* eggplant has less or no chemical pesticides, would be non-toxic and safe to eat, and hence would also be beneficial to consumers.

Willingness to Consume *Bt* Eggplant

Given the perceived benefits of the *Bt* eggplant, respondents were asked of their willingness to buy and consume it. Figure 9 indicates that, across the study sites, most of the consumer-respondents (77%) would be willing to consume *Bt* eggplant, with Pangasinan posting the highest number of willing consumers.

Of those willing to consume *Bt* eggplant, 35% would just like to try and taste the *Bt* eggplant. Other reasons cited by other consumers were that they believe that the new variety will have no or less chemicals, safer than existing varieties, has no worms or holes, and will be healthier. Consumers not willing to eat *Bt* eggplant were wary of its possible negative human health effects, since it is a genetically modified product.

Perceived Acceptable Market Price for *Bt* Eggplant

If the price of eggplant in the market is PhP30/kg, 49% of the consumer-respondents opined that *Bt* eggplant should be priced at PhP30/kg-PhP39/kg (Table 17). Twenty-three percent of the respondents said that *Bt* eggplant should be sold cheaper than the existing varieties at PhP20/kg-PhP29/kg.

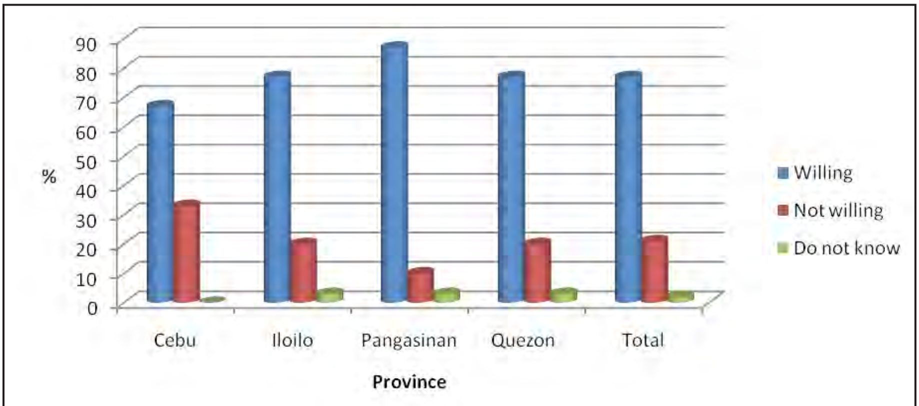

Figure 9. Distribution of respondents by willingness to consume *Bt* eggplant, by province, Philippines, 2013

Table 17. Consumers' willingness to pay for *Bt* eggplant, by province, Philippines, 2013

Price (PhP)	Cebu		Iloilo		Pangasinan		Quezon		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
If current price of other varieties is PhP30/kg										
10-19	0	0	3	12	3	12	3	10	9	9
20-29	4	17	7	27	7	28	6	20	24	23
30-39	15	65	12	46	10	40	14	47	51	49
40-49	3	13	3	12	3	12	7	23	16	15
50 and above	1	4	1	4	2	8	0	0	4	4
Total	*23*	*100*	*26*	*100*	*25*	*100*	*30*	*100*	*104*	*100*
Mean (PhP)	*31*		*28*		*29*		*30*		*30*	
If current price of other varieties is PhP60/kg										
30-39	2	10	8	36	3	12	3	10	16	17
40-49	4	20	2	9	4	17	2	7	12	13
50-59	2	10	3	14	3	12	7	24	15	16
60-69	10	50	6	27	6	25	10	34	32	34
70-79	2	10	2	9	6	25	6	21	16	17
80 and above	0	0	1	4	2	8	1	3	4	4
Total	*20*	*100*	*22*	*100*	*24*	*100*	*29*	*100*	*95*	*100*
Mean (PhP)	*54*		*48*		*57*		*56*		*53*	

They reasoned that *Bt* eggplant should be cheaper since production cost is lower (with less pesticide expense) and to make it affordable to consumers. Meanwhile, 19% of the respondents believed that *Bt* eggplant should be sold at a minimum of PhP40/kg, a higher price than those of existing varieties, since it is a better, safer, and healthier variety. On average, all consumer-respondents were willing to pay PhP30/kg for *Bt* eggplant when non-*Bt* eggplant are sold at PhP30/kg.

On the other hand, if the price of non-*Bt* eggplant varieties is PhP60/kg, 34% of the consumers thought that the price of *Bt* eggplant should range at PhP60/kg-PhP69/kg (Table 17). Twenty-one percent viewed that *Bt* eggplant should be sold at least PhP70/kg, which is much higher than the price of existing varieties. Others perceived that *Bt* eggplant should be sold at the same price as the other varieties while some consumers opt for a price lower than that of the other varieties (46%). When the price of eggplant is PhP60/kg, consumer-respondents were willing to pay an average of PhP53/kg for *Bt* eggplant, i.e., at a price lower than that of non-*Bt* eggplant.

Eggplant Consumption Issues

Most respondents (51%) commonly encountered problems in consuming eggplant such as: (i) numerous worms and holes inside very nice-looking eggplants, (ii) hard flesh or uneven cooking, (iii) short shelf-life and easily spoils, (iv) poor or bitter taste, and (v) causing itchiness or allergy. In this regard, the consumer-respondents deemed it best to make the pesticide-free *Bt* eggplant available in the market. A quarter of the group showed interest in eggplant varieties that will be safer to eat and with uniform size, less seeds, more tolerance to pests and diseases, longer shelf-life, more nutrients and better taste. While 13% of the respondents preferred organically-grown eggplants, about 7% suggested that it will be better to develop eggplant varieties requiring no or very minimal chemical application to control pests.

Willingness of the Local Government Units to Promote *Bt* Eggplant

Eggplant varieties grown in the study sites were mostly hybrid, with native varieties grown only in Sta. Barbara and Villasis, Pangasinan and Miag-ao, Iloilo. Among the vegetables grown in the study sites, eggplant generally ranked first in terms of area planted and production.

Eggplant fruit and shoot borer (FSB) was considered the major pest occurring throughout the growing period, starting 2 weeks after planting and peaking in July to December especially during heavy rains. Yield loss due to FSB was estimated at a high of 90% if no pesticide application was done and about 30% if pesticides were applied. According to the majority (69%) of the local government unit (LGU) officials interviewed, farmers sprayed chemical pesticides frequently—from 2-3 days to as many as 75-85 times per season—to control FSB infestation. Only the LGUs of Leon, Iloilo and Dolores, Quezon mentioned using *Trichogramma* to control FSB. Most (69%) of the LGU officials interviewed have likewise observed that FSB infestation had been worsening over time.

LGU Programs, Policies and Assistance for Eggplant Farmers

All the municipal/city and provincial agricultural offices in the study sites provide technical and marketing assistance to eggplant farmers. For one, the Department of Agriculture–Regional Field Units (DA-RFUs) provide farmers subsidized or free seeds through the municipal agricultural offices (MAOs) to address their concern on high seed costs. The municipal LGUs gave small farmers as much as 1 teaspoon of free seeds each and 200 grams each to commercial-scale farmers. They also provide other services such as soil analysis and trainings on eggplant production and crop protection. The use of *Trichogramma* against borers was being promoted in Quezon, and organic eggplant farming was demonstrated in Carcar, Cebu.

Some LGUs helped eggplant farmers sell their produce by providing them price information through the Price Monitoring Board and by linking them to market outlets. Some LGUs supported farmers in planting other crops (crop diversification) when eggplant prices were low. Others recommended programming eggplant planting within an area to avoid oversupply and hence price fluctuations or decline. There was also the Cebu Office of the Provincial Government's PhP10 million budget appropriation for the agri-fishery sector (crop and life insurance of eggplant farmers included) for 2013 in partnership with the Philippine Crop Insurance Corporation (PCIC). This fund can be accessed through the MAOs and the OPAg. A similar program has been implemented since 2010.

In addition, the University of the Philippines Los Baños (UPLB) assisted the LGUs in Sta. Maria, Pangasinan (where multi-location trials of *Bt* eggplant were done) with farm inputs and technical and economic study, and the Tiaong, Quezon eggplant farmers with pest and disease inspection and crop protection advice.

LGUs' Awareness on *Bt* Eggplant

Except in Miag-ao, Iloilo, all LGUs particularly the MAOs in Sta. Maria and Asingan, Pangasinan were aware of *Bt* eggplant and their characteristics, having received information from UPLB, DA regional offices, and Southeast Asian Regional Center for Graduate Studies and Research in Agriculture (SEARCA), and/or through radio, TV, and magazines.

The Cebu provincial agriculturist learned about the *Bt* technology in a biotechnology seminar during a national corn congress held in Isabela

(Region II). The Iloilo OPAg Provincial Coordinator learned about it when he attended a biotechnology training at UPLB in January 2013. From these seminars, they understood that *Bt* eggplant is FSB/insect-tolerant, high-yielding, has better fruit quality, and that farmers can save on pesticide use.

The rest of the LGUs learned about *Bt* eggplant from seed companies, agricultural technician, internet, and magazines.

Willingness to Promote *Bt* Eggplant

Majority of the LGUs would be willing to promote *Bt* eggplant because of its potential higher yield, expected higher returns and reduced costs of production, benefits to both farmers and consumers, and human health benefits (Table 18). However, as with any other new technology, *Bt* eggplant should first be thoroughly explained. One OPAg expressed hesitation to promote it since there were highly technical matters not yet fully understood about the new food-related *Bt* commodity.

The OPAg in Cebu emphasized that they would promote *Bt* eggplant as long as it can pass the stringent regulatory system and is not hazardous to health. On the other hand, the OPAg in Quezon opposed it as they wanted to promote organic agriculture. In Tiaong, Quezon, majority of the farmers did not know about *Bt* eggplant yet, hence the municipal agriculturist could not tell whether they would promote it or not. The LGU nevertheless expressed willingness to promote *Bt* eggplant if the farmers have been informed of its potential benefits as well as health hazards and disadvantages (if any).

Most (45%) of the LGU officials would prefer *Bt* eggplant seeds as OPV; 36% would prefer it as hybrid; and 18%, either hybrid or OPV. They feel that OPV *Bt* eggplant would be more economical for farmers since the seeds can be saved for use in the next planting. Hybrids yielded more and better fruits, hence earned higher returns, than the OPVs or native variety. Growing non-*Bt*

Table 18. LGUs' willingness to promote *Bt* eggplant, Philippines, 2013

Item	Provincial LGUs		Municipal LGUs	
	No.	%	No.	%
Willing	1	25	8	67
Not willing	1	25	1	8
Do not know	2	50	3	25
Total	*4*	*100*	*12*	*100*

hybrids can be costly since production often requires heavy use of pesticides to attain the yield potential and the farmers also need to buy the hybrid seeds every planting season.

To address the need for intensive and extensive information campaigns on biotechnology in general and *Bt* eggplant in particular, the LGUs emphasized the merits of establishing technology demonstration (techno-demo) areas within key eggplant production sites. Other recommendations that could help promote *Bt* eggplant adoption were trainings, seminars, and distribution of information, education, and communication (IEC) materials to farmers, as well as to the wider community. Product launch by seed companies and field trials demonstrating higher yields with minimal use of chemical spray would convince farmers to adopt *Bt* eggplant.

Summary, Conclusions, and Recommendations

This chapter presents results of the assessment on the market prospects of *Bt* eggplant at the seed market and food market levels using relevant secondary data from the Bureau of Agricultural Statistics and the LGUs, as well as primary information generated via stakeholder consultations, key informant interviews, and socioeconomic surveys. The study was conducted in four major eggplant-producing provinces/regions, namely Pangasinan, Quezon, Cebu, and Iloilo.

A total of 30 farmers, 30 traders (with additional 10 traders in Divisoria, Metro Manila), and 30 consumers were interviewed from each province. For the potential suppliers of *Bt* eggplant seeds, 3 seed companies, 8 distributors, and 16 dealers who were supplying eggplant seeds in the study sites were surveyed.

Seed Companies, Distributors, and Dealers

While the three seed companies interviewed have already heard about *Bt* eggplant, majority of the seed distributors and dealers were however not yet aware of the new technology. With the perceived benefits from *Bt* eggplant—insect (FSB) tolerance, no or less use of pesticides, and higher yield—more than 80% of the respondents were willing to sell *Bt* eggplant seeds, preferably as hybrid varieties, as long as there is demand. The price of *Bt* eggplant seeds would be lower than that of currently sold eggplant seeds, but may still depend on the mark-up set by the company and on the final marketing arrangement. The seed suppliers should establish demonstration farms; distribute free seed samples, brochures/pamphlets, and other IEC materials; conduct farmers' meetings; and provide give-aways in launching the *Bt* eggplant variety.

Eggplant Farmers

The farmer-respondents reported that FSB infestation has seemingly worsened over the years, with the pest having developed resistance to pesticides. Majority of these eggplant farmers had no prior knowledge of *Bt* eggplant yet expressed interest to adopt it when informed of its FSB resistance. Some respondents could be potential early adoptors who would grow *Bt* eggplant in the immediate cropping season after commercialization. Others were either late adoptors who would plant it in the next cropping season or following year, or undecided with the 'wait and see' learning attitude. Being used to the proven performance of current eggplant varieties, these farmers apparently did not want to deal with any perceived uncertainty with *Bt* eggplant.

Since they were using hybrid eggplant, majority of the farmer-respondents prefer *Bt* eggplant to be commercialized as hybrids. Still others prefer *Bt* eggplant to be released as OPVs. As such, the development and marketing of hybrid and OPV *Bt* eggplant have to address various farmer groups across different geographical locations. The specific technology to be introduced must, from the potential adoptors' perspective, at least equal if not surpass the attributes of currently-used products.

Majority of the potential farmer-adoptors were willing to pay for *Bt* eggplant at a price higher than that of current conventional eggplant varieties. This indicates a significant potential for developing the market for the *Bt* eggplant, including effective information dissemination campaigns to make farmers better aware of the price premium that goes with the new technology. Based on the experience with GM corn, the role of the private sector, particularly the seed companies, could be harnessed to create a market niche for *Bt* eggplant.

Traders

Majority of the trader-respondents were selling eggplant throughout the year, but more of the hybrid varieties than OPVs, at comparable average buying and selling prices. On average, eggplant sales gave traders the highest earnings and contributed 29% to their total vegetable sales.

Although 93% of the traders interviewed were have not yet heard about *Bt* eggplant, a huge majority would be willing to buy and sell *Bt* eggplant given its potential marketability and significant profitability. Similar to the seed suppliers and eggplant farmers, most traders prefer to have *Bt* eggplant as a hybrid. Traders who would not engage, or were uncertain of engaging, in *Bt* eggplant marketing expressed that the technology's marketability, quality, safety, and contribution to profits, once proven, may reverse their current stand.

Most traders would be willing to acquire *Bt* eggplant at a price same as or lower than that they are paying for non-*Bt* eggplant. This would make the *Bt* eggplant saleable and affordable to consumers. If the prices of *Bt* eggplant and non-*Bt* eggplant would be equal, traders would handle comparable volumes of the two types of eggplant. With price differences, traders would handle a bigger volume of the cheaper eggplant and hence conversely a smaller volume of the more expensive one. If it would be cheaper than the non-*Bt* eggplant, the *Bt* eggplant would comprise 50% of the total volume handled by assembler-wholesaler-retailers and 62% of that by the wholesaler-retailers. If *Bt* eggplant prices are higher, the volume handled would decrease to 27% for the wholesalers and to 45% for the wholesaler-retailers.

Problems of the industry were mostly the FSB/worms and other pests, eggplant rejects, the heavy spray of pesticides which is not good to health, oversupply and low prices, and erratic climate, among others. As to problems foreseen in marketing *Bt* eggplant, two traders mentioned that initial sales would be low because *Bt* eggplant is new in the market. Another trader said that there could be oversupply of eggplant in the market once *Bt* eggplant becomes available.

Traders recommended the development of eggplant varieties (including *Bt* eggplant) which would eliminate farmers' dependence on pesticides and which would be suitable to any type of climate. Other recommendations were organic farming, techno-demo, and more training programs on production and marketing, and developing good seeds with higher yield/germination rate.

Consumers

Eggplant consumption was mostly once to three times a week, at an average of 1 kilogram per purchase, most commonly from the local/public market. The factors considered in buying eggplant were appearance, eating experience, price, product effects, and availability.

While majority of the consumer-respondents were unaware of *Bt* eggplant, those familiar with the technology learned of it from friends and media. Nevertheless, most of the respondents perceived safety from pesticide chemicals as the major consumer benefit from *Bt* eggplant and would be willing to buy and consume it. In general, however, the consumers would prefer *Bt* eggplant to be offered at a retail price cheaper than the currently available varieties. They deem that *Bt* eggplant would have lower farm production costs and, as a new variety, should have a low introductory market price.

Local Government Units

The LGU officials observed that FSB infestation of eggplant had been worsening overtime, with yield loss estimated at a high of 90% when no pesticide application was done. Majority of them were willing to promote *Bt* eggplant, especially with its promise of higher outputs, lower production costs, and higher farmer incomes. The new technology should also pass the stringent regulatory system and pose no hazard to human health and the environment. As farmers in some areas were still unaware of *Bt* eggplant, the MAO would only promote it if the advantages and disadvantages of the technology have been observed in field trials.

The LGUs stressed that the establishment of the techno-demo area is the best strategy to promote *Bt* eggplant. Other recommendations that could help promote *Bt* eggplant adoption were trainings, seminars, distribution of IEC materials to farmers, and product launching by different seed companies. Higher yields with minimal use of chemical spray would convince farmers to use *Bt* eggplant.

General Industry Concerns and the Potential Role of *Bt* Eggplant

The various eggplant industry stakeholders who participated in this study shared a whole range of production and marketing concerns. Seed suppliers mentioned low shelf-life of seeds, poor germination rate, price differences and fluctuations, and unreliability of supply from source. The farmers reported receiving minimal technical assistance in production and no marketing assistance from any sector. Similar to the seed suppliers, the eggplant traders observed, on the production side, FSB/worms inside the fruits, product deformities, and poor shelf-life; and unreliable supply and/or markets, low prices, poor sales, and bad debts, on the marketing side.

A significant majority of the stakeholder-respondents expressed interest in the potential availability of *Bt* eggplant, given its potential to sustainably address some of the abovementioned concerns. Seed suppliers perceived the marketability of *Bt* eggplant seeds; farmers, the potential reduction (if not elimination) of FSB infestation in their farms; the traders, the anticipated profits in marketing the new variety; the consumers, the joy of eating better-quality and pesticide-free eggplant; and the LGUs, the higher yields, lower costs, and increased returns for eggplant farmers. The various eggplant industry stakeholders nevertheless need to be assured of the safety of *Bt* eggplant to humans and the environment and that its potential positive attributes would be realized. Massive dissemination of information on the *Bt* eggplant technology through techno-demos, distribution of IEC materials, and conduct of trainings and seminars (especially for the LGUs and farmers), as well as active promotion and marketing strategies are imperative. These would reduce unfounded biases against and improve the level of stakeholder knowledge on the potential benefits from adopting the *Bt* eggplant seed variety, thereby increasing the potential market demand and client base. The public and private sectors should thus work together towards achieving the promises offered by the *Bt* eggplant technology for the good of all stakeholders within the industry.

References

Agricultural Biotechnology Support Project II. 2010. Fruit and Shoot Borer Resistant (FSBR) Eggplant. *Project Profile.* www.absp2.cornell.edu/projects/project.cfm?productid=2. July 27.

Chupungco, A., D. Elazegui, and M.R. Nguyen. 2011. Seed System, Production and Marketing of Eggplant in Three Major Producing Provinces in the Philippines. *The Philippine Journal of Crop Science* 36 (2): 37-47.August.

Christensen, P. 2012. M.S. Swaminathan and the rejection of *Bt* eggplant in India. Seed in Context Blog (www.intlcorn.com/seedsiteblog/?p=513. May 28) (Accessed 13 June 2013).

FA2013–014. The safety of genetically-modified food produced through modern biotechnology. www.fda.gov.ph/advisories/food79847-fda-advisory (Accessed 28 June 2013).

Francisco, S. 2009. Costs and Benefits of *Bt* Eggplant with Resistance to Fruit and Shoot Borer in the Philippines. In Norton, G.W. and D.M. Hautea (eds.). 2009. *Projected Impacts of Agricultural Biotechnologies for Fruits and Vegetables in the Philippines and Indonesia*. International Service for the Acquisition of Agri-biotech Applications (ISAAA) and SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA). College, Laguna, Philippines.

Granberry, D.M. 1990. Eggplant: Commercial Vegetable Production. Circular 812. Cooperative Extension Service. The University of Georgia College of Agriculture. Athens, Georgia. January. In USDA (US Department of Agriculture). 1996. In USDA (US Department of Agriculture). 1996. *Eggplant: An Economic Assessment of the Feasibility of Providing Multiple-Peril Crop Insurance*. Prepared for the Federal Crop Insurance Corporation.

Hautea, D.M. and J.O. Narciso. 2007. *Questions and Answers on the Development of Fruit and Shoot Borer Resistant Eggplant in the Philippines*. IPB-UPLB-ABSPII.

Kumar, S., P.A. Lakshmi Prassana, and S.Wankhade. 2011. Potential benefits of *Bt* brinjal in India–An economic assessment. *Agricultural Economics Research Review* 24 (January–June): 83.

Maghirang, R.G. 2001. *Organikong Gulayan: Pagtatanim ng Organikong Talong*. www.bar.gov.ph/veggies today.Vol.2-3.htm. (Accessed August 5, 2010).

Nuevo, P.A. undated. Improvement of the Handling System of Eggplant. www.bar.gov.ph/vegrde/VeggiesTodayVol2-.htm (Downloaded July 23, 2010).

Panopio, J. and S. Mercado. 2013. Communication Strategies for Fruit and Shoot Borer Resistant *Bt* Eggplant Outreach. *ISAAA Brief 45. From Monologue to Stakeholder Engagement: The Evolution of Biotech Communication*. No. 45. p. 24.

Panopio, J. and S. Mercado. 2012. FSBR/*Bt* eggplant: a safer, more profitable biotech innovation. *Biotechnology Information Resource No. 1*.

Peñalba, L.M., D.D. Elazegui, M.M. Paunlagui, E.E. Dumayas, and Rd.T. Baconguis. 2012. Supporting Biotechnology Regulatory Policy Processes in the Philippines. In Supporting Biotechnology Regulatory Policy Processes in Southeast Asia, Project Report, International Development Research Centre.

PhilRice (Philippine Rice Research Institute). 2007. *Ex-Ante* Economic Impact Assessment of *Bt* Eggplant Crop Production in the Philippines.

Quicoy, C.B. 2010. Productivity and Technical Efficiency of Eggplant Production in Selected Provinces in the Philippines: Stochastic Production Function Approach. Presentation delivered at the SEARCA Agriculture and Development Seminar Series, August 24.

Tan, T.J. 2007. Analysis of the marketing system of eggplants produced in selected towns of Batangas. Unpublished undergraduate thesis, College of Economics and Management, University of the Philippines Los Baños, College, Laguna.

UPLB Office of the Chancellor. 2013. Circular/Position Paper for the information of the UPLB community: UPLB will ask the Court of Appeals to reconsider its decision to stop the field trials of *Bt* talong (Accessed July 18, 2013).

USDA (US Department of Agriculture). 1996. Eggplant: An Economic Assessment of the Feasibility of Providing Multiple-Peril Crop Insurance. Prepared for the Federal Crop Insurance Corporation.

Chapter 10

Challenges and Policy Implications

Panfilo G. de Guzman

Eggplant production accounts for nearly one-third of the total volume of the top vegetables grown in the Philippines. Current productivity, however, is about only half of the average yield in Asia and the world, mainly due to the devastating damage caused by the eggplant fruit and shoot borer (FSB).

In 2003, the Institute of Plant Breeding of the University of the Philippines Los Baños (IPB-UPLB) initiated and led local research and development of a biotech eggplant, *Bt* eggplant, with built-in resistance to FSB. Promising varieties of *Bt* eggplant are currently under advanced stage of evaluation for horticultural performance and biosafety.

A comprehensive biosafety assessment of crops improved through genetic modification forms an integral part of the Philippine regulatory system for the approval and commercial use of biotech crops. In addition to agronomic performance, science-based assessments for food and environmental safety are performed at various stages of research and product development. The country's biotechnology regulatory system serves as a model among Asian countries (Cabanilla, 2007) and widely recognized as science-based, thorough, and transparent (USDA GAIN Report, 2013). Biosafety assessments are conducted in accordance with internationally accepted standards and guidelines, particularly of the Cartagena Protocol on Biosafety and the Codex Alimentarius.

Despite the availability of comprehensive and conclusive science-based studies (Nicolia et al., 2013) underscoring the safety of biotech crops to human health and the environment, demands to ban the commercial use and field trials of genetically modified (GM) crops are made now and then by anti-GMO (genetically modified organisms) groups and advocates. The recent experience with the Writ of Kalikasan[1] case against the field trial of *Bt* eggplant in the Philippines points to the diversionary tactics of anti-GMO groups ignoring the merits of credible scientific studies on the safety of biotech crops. The current battleground seems to focus not on safety considerations but rather on socio-political concerns and credibility of the regulatory system allowing research and development on biotechnology.

The widely criticized court decision granting the petition of Greenpeace to halt the conduct of field trials of *Bt* eggplant effectively slowed the final approval process towards the commercialization of this biotech eggplant in the country. Study suggests, however, that the cost of forgone benefits stemming from even a relatively brief delay in the release of biotech products far outweigh both direct research and regulatory costs (Bayer, Norton and Falck-Zepeda, 2010).

Results of impact assessment studies presented in the previous chapters highlight the potential benefits that can be derived from *Bt* eggplant adoption. Farmers stand to gain higher net farm income with *Bt* eggplant than what can be obtained from using conventional varieties. Higher income can be attributed to increased marketable yield and savings from reduced expenses on insecticides and hired labor. In effect, *Bt* eggplant has the potential to reduce poverty incidence among eggplant farming households adopting the technology. In addition to increased income, the adoption of *Bt* eggplant could also provide significant health and environmental

[1] In April 2012, Greenpeace and supporters lodged a petition to the Supreme Court for the imposition of Writ of Kalikasan against the conduct of field trials of *Bt* eggplant. The petition was remanded by the Supreme Court to the Court of Appeals who heard the case. On 17 May 2013, the Court of Appeals issued a decision granting the petition for the Writ of Kalikasan against the *Bt* eggplant field trial, directing the respondents to cease and desist from conducting the field trials. The decision was principally anchored on the precautionary principle. Respondents filed a motion for reconsideration but on 20 September 2013, the Court of Appeals re-affirmed its earlier decision. Respondents filed an appeal to the Supreme Court and are currently waiting for the decision.

Writ of Kalikasan is a legal remedy under Philippine law which provides for the protection of one's right to "a balanced and healthful ecology in accord with the rhythm and harmony of nature" as provided for in Section 16, Article II of the Philippine Constitution.

benefits mainly through significant reduction in the environmental impacts of pesticides used in conventional eggplant production. Market prospects of *Bt* eggplant commercialization is encouraging as farmers, seed distributors and traders, and consumers in major eggplant-producing provinces are very much willing to adopt the technology.

The Role of Biotech Communication

Acceptance of products of advanced science technology is highly dependent on a receptive and appreciative society (Sinemus and Egelhofer, 2007). Providing the public with the right and comprehensible information on the direct relevance and benefits of the product will enable them to make the right judgement and decision on what is acceptable science (Escano, 2013). An improvement in the efficacy of biotech communication strategies could have a significant impact on the future of biotech crops.

Biotechnology communication case studies by Navarro and Hautea (2011) provide unique and rich examples of efforts at fostering greater awareness and understanding of crop biotechnology through science communication. Important lessons learned from these case studies are discussed below.

Bridge the divide between science and society

The continuing debate and discussions on contentious issues on biotechnology call for appreciation of science communication requiring knowledge sharing, deliberation, negotiation, and participation among different stakeholders. Science alone will not be able to advance the debate, and deliberate communication strategies are needed to ensure informed discussion. Science communication requires collaboration and interfaces between and among different entities from a multi-disciplinary and multi-sectoral environment. For example, academic communities and societies in China are actively involved in improving the public's understanding of science. Meanwhile, coordinated and strategic alliance of industry groups with government agencies resulted in greater success of biotechnology communication initiatives in Australia.

Enhance the capacity of science communicators

Building a strong and effective cadre of science communicators who can provide scientific information that is concise, accurate, and understandable to the general public is important. In this regard, the credibility of science communicators will also be important as the public highly trusts information coming from experts. Studies showed that university scientists are rated high on the credibility ladder (Juanillo, 2003; Torres et al., 2006). To effectively communicate science, science communicators must also be able to relate science to everyday life.

Identify stakeholder groups and champions

Stakeholders in the biotech debate have specific information needs and communication requirements. Important target groups for science communication objectives include policymakers, scientists, academics, regulators, farmers, and media. It is important to identify and nurture champions from these groups who can advance the cause of biotechnology among their peers. In particular, journalists play a crucial role in the biotech debate as they can influence public perception with the coverage and tone of their science writing. It is important to identify journalists who can write balanced and accurate articles.

Improve the availability of and access to information

Communicating balanced information in multimedia and interpersonal channels facilitate the access of different stakeholders to biotechnology information. In addition to proven models of communication, different medium and modality of information dissemination and knowledge sharing can be explored, without sacrificing accuracy, reliability and objectiveness. Internet media platforms[2] can be tested and developed. Internet has become the fastest growing communication medium and important channel for obtaining information and allowing direct exchange.

Focus on public values

Public attitude towards technology is often shaped by values more than the information itself. For instance, values that influence positively towards GM food include trust in science and the regulatory system, consumer consultation, and consumer benefits; negative values are things that are perceived to be unnatural, unnecessary, and unknown. Framing the biotech communication around values (e.g., those that address

[2] Popular social media platforms include Facebook, Twitter, YouTube, and blogs.

environmental concerns and food security) is more effective than framing the communication around the technology.

Improving Biotech Communication

Diverse viewpoints have made crop biotechnology a recurring and contentious public issue. Conflicting opinions of the proponents and opponents of the technology create confusion and polarization of stakeholders in the debate. In addition, the lack of scientific understanding has compromised and aggravated the quality of debates (Navarro and Hautea, 2011). The perceived risks of biotechnology products highlighted in the discourse by opponents of the technology create fear, uncertainties and doubts among the public.

Key to acceptance of biotechnology products is to take public concerns seriously, and at the same time provide an environment that encourages stakeholders to participate in dynamic discussions and decision making. For specific target groups, Weitze and Pühler (2013) recommend taking a more problem-oriented approach rather than technology-oriented approach to communication. Meanwhile, there is greater appreciation for information coming from credible and trustworthy individuals who are experts in the field.

Notably, public awareness on the benefits of biotechnology should be vigorously pursued. Sinemus and Egelhofer (2007) forwarded the idea of a "consumer benefits communication strategy" rather than a classical risks communication approach. End-users are more accepting of advanced technology when they are informed of its direct and tangible benefits (Escano, 2013). In the case of *Bt* eggplant, as highlighted in the previous chapter, important considerations for farmers to adopt the technology include yield advantages, profitability, and reduced pesticide use; consumers are more interested on the quality, food safety (e.g., pesticide-free), and affordability of the eggplant fruits. Proactive communication should therefore emphasize these benefits.

Operational framework for biotech communication followed at ISAAA (Navarro, Natividad-Tome, and Gimutao, 2013) can provide guidelines for an effective biotech communication (Figure 1). Each communication step is guided by a specific or combined objective(s). Priority stakeholders are identified, as well as their respective levels of understanding about biotech, concerns, and information needs. Key messages are developed

Figure 1. ISAAA's operational framework for biotech communication

based on issues that need to be addressed. A communication strategy is then formulated, and appropriate and complementary combination of interpersonal and mediated channels are determined based on best practices and channel preferences of stakeholders. Establishing linkages and partnerships with other stakeholders can contribute to attaining communication goals and objectives and maximizing resources. Feedback mechanism built into the system takes into consideration the strengths and weaknesses of the activity or process, as well as communication barriers. An alternative action is then considered and implemented to improve the process and make it responsive to changes and developments in the environment.

The Role of Policy

Government policies do play an important role in providing a conducive environment for the development and advancement of biotechnology. As articulated in the 2001 policy of the Philippine government[3], safe and

[3] Policy Statement on Modern Biotechnology signed by then President Gloria Macapagal-Arroyo on 18 June 2001.

responsible use of modern biotechnology and its products is seen as "one of the several means to achieve and sustain food security, equitable access to health services, sustainable and safe environment, and industry development". While the current Philippine regulatory system for biosafety assessment of biotech products is relatively robust, there are a number of institutional issues that need to be addressed to further strengthen the system (Peñalba et al., 2005). For one, the regulatory process could be streamlined to make biotechnology research and development (R&D) more cost-effective, without compromising the integrity of the process and the products.

The increasing intensive research into biotech crops and their growing commercialization globally require a paradigm shift in agricultural policy formulation, and perhaps even research priority setting, that can promote R&D on and sustainable intensification of biotech crops.

There is a felt need to review national and local policies that discriminate against the use of GMO products. For instance, Republic Act 10068 or the Organic Agriculture Act of 2010[4] explicitly excludes the use of GMOs in organic farming systems. Local government ordinances imposing blanket restrictions on the use of biotech products (or field testing of biotech crops) are also enforced in a number of provinces and municipalities[5] around the country. Concerns on how such policies constrain the farmers' freedom of choice are often ventilated in formal and informal discussions.

Farming in the Philippines varies as to crops, physico-climatic conditions, market access, and farmers' capacity in terms of capitalization, skills, and knowledge. There is greater potential to achieving food security and sustainability objectives if farmers are given freedom of choice to adopt proven crop technologies and production systems that can increase agricultural productivity. The more rational policy option is co-existence between GMO-based farming and organic agriculture, which is also in keeping with the democratic tradition of providing democratic space for everyone (Halos, 2010).

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[4] Section 3(b) of RA10068 defines organic agriculture as "including all agricultural systems that promote ecologically sound, socially acceptable, economically viable and technically feasible production of food and fibers". While it also includes the use of biotechnology, it explicitly stated that biotechnology "shall not include genetically modified organisms or GMOs".

[5] Provinces with anti-GMO ordinances include Bohol, Oriental Mindoro, Negros Occidental, and Negros Oriental; Sta. Barbara in Iloilo City, prohibits the conduct of *Bt* eggplant trials.

As argued by Gerpacio and Pingali (2007), it is important to recognize that technology – both simple and advanced – is not the only key to increasing productivity, improving the sustainability of intensified production systems, and improving the conditions of farmers. Substantial public investments should be made in rural infrastructure, agricultural training and extension, input and output distribution and marketing systems, and harvest and post-harvest facilities. The returns to farmer investments in high-yielding varieties, including *Bt* eggplant, can be better maximized if such facilities and services are provided and the overall policy environment made more conducive.

References

Bayer, J.C., G.W. Norton, and J.B. Falck-Zepeda. 2010. Cost of compliance with biotechnology regulation in the Philippines. *AgBioForum* 13(1): 53-62.

Cabanilla, L.S. 2007. Socioeconomic and political concerns for GM foods and biotechnology adoption in the Philippines. *AgBioForum* 10(3): 178-183.

Escano, M.T.R. 2013. *Bt* eggplant: A review of science communication approach in the Philippines. *The International Journal of Social Sciences* 11(1): 61-68.

Gerpacio, R.V. and P.L. Pingali. 2007. *Tropical and Subtropical Maize in Asia: Production, Systems, Constraints and Research Priorities*. Mexico, D.F.: CIMMYT.

Halos, S.C. 2010. Genetically modified organisms and organic agriculture: Productivity and harmony in co-existence. Paper presented in Seminar on Securing Food and Increasing Income through Biotechnology, Eurotel, Quezon City, 29 September 2010.

Juanillo, N. Jr. 2003. The Social and Cultural Dimensions of Agricultural Biotechnology in Southeast Asia: Public Understanding, Perceptions, and Attitudes towards Biotechnology in the Philippines. University of Illinois at Urbana Champaign, USA and International Service for the Acquisition of Agri-biotech Applications (ISAAA), Ithaca, New York, USA.

Navarro, M.J., K. Tome and K. Gimutao. 2013. From Monologue to Stakeholder Engagement: The Evolution of Biotech Communication. *ISAAA Brief No. 45*, International Service for the Acquisition of Agri-biotech Applications (ISAAA), Ithaca, New York, USA.

Navarro, M.J. and R.A. Hautea (eds). 2011. *Communication Challenges and Convergence in Crop Biotechnology*. International Service for the Acquisition of Agri-biotech Applications (ISAAA), Ithaca, New York, USA and SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), Los Baños, Laguna, Philippines.

Nicolia, A., A. Manzo, F. Veronesi, and D. Roselini. 2013. An overview of the last 10 years of genetically engineered crop safety research. *Critical Reviews in Biotechnology*. Published online 13 September 2013. http://informahealthcare.com/bty.

Peñalba, L.M, J.A. Fajardo, F.A. Sanchez, and A.O. Grande. 2005. Biotechnology Product Development, Biosafety Regulation and Environmental Risks Assessment in the Philippines. *EEPSEA Research Report No. 2005-RR13*. Economy and Environmental Program for Southeast Asia (EEPSEA), Singapore.

Republic Act 10068. An Act Providing for the Development and Promotion of Organic Agriculture in the Philippines and for Other Purposes.

Sinemus, K. and M. Egelhofer. 2007. Transparent communication strategy on GMOs: Will it change public opinion? *Biotechnology Journal*, 2: 1141-1146.

Torres, C., M. Suva, L. Carpio, and W. Dagli. 2006. Public Understanding and Perception of and Attitude Towards Agricultural Biotechnology in the Philippines. College of Development Communication, University of the Philippines Los Baños, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA), and International Service for the Acquisition of Agri-biotech Applications (ISAAA).
USDA GAIN Report. 2013. Philippine Biotechnology Situation Outlook. 17 July 2013.
Weitze, M.D. and A. Pühler. 2013. Improving biotechnology communication. *Biotechnology Journal* 8: 970-972.

ABOUT THE BOOK

Eggplant production accounts for nearly one-third of the total volume of the top vegetables grown in the Philippines. Current productivity, however, is about only half of the average yield in Asia and the world. Such low productivity is attributed to the devastating damage caused by the eggplant fruit and shoot borer. In 2003, research started in the development of a biotech eggplant, *Bt* eggplant, with built-in resistance to the fruit and shoot borer. Promising varieties of this biotech eggplant are currently under advanced stage evaluation for horticultural performance and biosafety.

This book presents the findings of completed *ex-ante* studies on the market prospects and potential economic, health, and environmental impacts of *Bt* eggplant in the Philippines. These analyses are complemented by studies on pesticide use, costs and returns of conventional eggplant production, and supply chains in eggplant marketing. All the studies were conducted in major eggplant-producing provinces in the country, and used both primary and secondary data and information.

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ISBN 978-971-93983-3-2

Cover Design:
Rochella B. Lapitan