



POST-HARVEST LOSSES OF EGGPLANT IN GHANA

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Abstract

Eggplant (*Solanum* spp.) is susceptible to post-harvest loss because of its perishable nature. The project was undertaken to assess post-harvest loss in eggplant production. Five communities mainly involved in eggplant production in the Atebubu district of the Bono Ahafo Region, Ghana, were chosen. Sixty (60) from 200 farmers involved in eggplant production were randomly selected and interviewed with another 80 farmers interviewed two months later. Five middlemen/women and ten retailers were randomly interviewed. Respondents were interviewed using a semi-structured and open-ended questionnaire. The study indicated that there is a year-round demand for eggplant, and it is potentially profitable for farmers to grow. However, unavailable storage facilities and poor agronomic practices and frequent use of agro-chemicals results in post-harvest loss, making farmers not achieve the desired profits. It is therefore important to prioritize efforts into research in eggplant production to boost nutritional and food security in both tropical and non-tropical areas as they are consumers of eggplant fruits.

Keywords: *Agro-chemicals, food security, production, consumption, cultivation and insect pest and diseases*

Introduction

Eggplant (*Solanum melongena* L) is an important source of income for rural farmers (Alam *et al.*, 2003). In Ghana, eggplant is marketed in cities and rural areas with small amounts exported to Europe (Horna and Gruère, 2006). Statistics by the United States Agency for International Development and the West Africa Trade Hub (USAID and Wath, 2005) indicate that export of eggplant from Ghana increased from under <500 to 1, 867 metric ton from 1996 to 2003. Food security is near crisis levels in several countries, especially Africa. The UN Food and Agriculture Organization estimates that the world's food productivity must increase by 60% by 2050 based on food production in 2005 (Alexandratos and Bruinsma, 2012) to feed a projected 9 billion people. The projected production goal is far from being achieved, since a good portion of the crop is lost through post-harvest transportation, spoilage, and a poor distribution network. According to the Food and Agriculture Organization of U.N., annually, about 1.3 billion tons of food is wasted globally (Gustavasson *et al.*, 2011). Ghana loses about GHC700,000 annually, (GHC is Ghanaian currency, 1\$US = 4.27 GHC), to deficient post-harvest losses (Baafi, 2017; The Independent, 2013). About 95% of research investments during the past 30 years has been targeted at increasing agricultural productivity with 5% directed to

reducing post-harvest losses (Kader 2005; Kader and Roller, 2004; World Food Logistics Organisation, 2010). Food losses reduce food available for human consumption and increase costs to society for waste management and loss of resources used in production (Gustavasson *et al.*, 2011). Eggplant (*Solanum* spp.) is well grown and known in tropical and sub-tropical areas (Concellón *et al.*, 2007) and the most vital horticultural crop. Eggplants are relatively easy to grow, high yielding and of considerable economic and nutritional values the world over. Throughout Africa local garden eggs are very popular and play an important part in many diets. They are vital to local cuisines, local economies, and local cultures. They provide a reliable source of income for several farmers, most of whom are women. They are vital to local cuisines, local economies, and local cultures (FAO, 2013; Okmen *et al.*, 2009; NRC, 2006).

This crop is mostly grown on drained soil, or raised beds. Seeds are proliferated, through broadcasting or drilling directly in soil which takes about a week. After a month, seedlings grow up to 5-10 cm high and are transplanted after which they take another month to establish. Though less vulnerable to pest and disease, the crop can be attacked by a fungal leaf spot and insect pests, such as moth larvae, leaf beetle, bud borer, and

sucking bugs. Cantewell and Suslow (1997) stated that diseases such as *Alternaria* (Black Mold Rot), *Botrytis* (Gray Mold Rot), *Rhizopus* (Hairy Rot), and *Phomopsis* Rot are a contributory factor of postharvest loss. A perfectly matured eggplant is harvested in about 70-90 days after transplanting at which stage when the skin is glossy and firm, and the flesh white, and the seeds tender and edible (NRC, 2006; Gross *et al.*, 2014). Harvesting is done over 8-10 weeks and yields can be up to 10kg per 1m x 4m plot (NRC, 2006). Recent data from the Food and Agriculture Organization (FAO), indicated that the global production of eggplant was 48MT per 1,853,023 ha of land (FAO, 2013). Fresh vegetables have life in them and continue to be active even after harvest (Gajewski *et al.*, 2009; Kader and Rolle, 2004). Quality is compromised if not appropriately handled along the supply chain. Eggplants are extremely perishable and can be stressed in varied ways in the postharvest handling process if temperatures are not good. Thus quality and quantity can be greatly compromised leading to losses (Gajewski *et al.*, 2009; Ghidelli *et al.*, 2014). A major challenge in handling eggplant is rapid browning of the skin after harvest. This is minimized by growers by picking fruits gently and when temperatures are down during the day of the harvest to avoiding exposure to the sun (NRC, 2006).

Storage of eggplant cannot extend more than 14 days in uncontrolled environment as visual and sensory qualities will rapidly deteriorate. Controlled or modified atmosphere storage offer little benefit to eggplant quality. Concellón *et al.* (2007) and Kader (2002) argues that high temperature can be unfavourable for quality of fruits and vegetables. Cantewell and Suslow (1997) suggest that by cutting the calyx-stem free from the plant rather than by tearing during harvesting could be helpful. According to Luning and Marcelis, (2009) major environmental influences that affect the quality of foods include the temperature, the humidity and the direct sunlight. However, cold storage facilities are limited and below the required capacity in tropical countries. Again, fruits and vegetables do not do well in long-term storage (Smith *et al.*, 2000; Van Dijk and Trienekens, 2012) if cold storage is considered an option. Eggplants has about 92 percent water, some amount of protein, vitamins, minerals, starch, some source of beta-carotene, B vitamins, and C, calcium, iron and potassium. The leaves are excellent sources of vitamins A and B, calcium, phosphorus, and iron. They contain about 5 percent of a protein containing significant amounts of methionine, one of the essential amino acids which is hard to find in plant-based foods. Eggplant leaves are toxic because they are high in solanine, but, when cooked it renders them not hurtful (NRC, 2006). An increased intake of fruit and vegetables is recommended in the International and national dietary guidelines. For example, it has been recommended by the World Health Organization and the Food and Agriculture Organization that individual, eat at least 400 g of fruit and vegetables per day (USDA, 2010). A benefit of a diet comprising of high portions of fruit and vegetables could reduce weight gain over time.

Fruit and particularly non-starchy vegetables are low energy density and hence may aid in checking weight gain (Mozaffarian *et al.*, 2011).

Materials and Methods

The study was to assess post-harvest loss in eggplant production. Knowledge on reasons for post-harvest loss and quantities of loss from farm to the market and the table was obtained through semi-structured interviews, focus group discussions and observations. Questionnaires for interviews were semi-structured and open ended, this was appropriate to properly understand and appreciate respondent opinions and the import of their practices. Consent was obtained from all individuals who participated in the study in that respondents did not participant against their will. The questionnaire was used to gather information on eggplant cultivation, land tenure, pesticide use, challenges and benefits in eggplant cultivation, expenses incurred in eggplant cultivation, postharvest loss in eggplant and the sale and demand for eggplant. Focus group discussions involved four groups of farmers and two groups of marketers consisting of up to ten persons in each group. Similar questions to those asked during the individual interviews were used. Farmers who had been cultivating eggplant for the past five to ten years were included to ensure accuracy in data collection and for participants to provide accurate and consistent information. Observations were made on seven farm households in the study area. The observations were structured to capture activities pertaining to eggplant production. Activities on the farm and activities that pertain to harvesting, transporting, and marketing the produce were observed, while observing the quantities that went waste along the production and supply chains. The Atebubu district was selected based on the amount of eggplant production. Five from ten communities involved in eggplant production in the Atebubu district were chosen from which 140 of 200 farmers involved in eggplant production were randomly selected and interviewed. Five middlemen/women and ten retailers were randomly interviewed. In total, 222 respondents were interviewed and observed (see table 1 above). Semi-structured and open-ended questionnaires were used with respondents in the months of September and October 2012. Questionnaires were administered by face-to-face contact. The data was analysed mostly using descriptive statistics.

Results and Discussion

In Ghana eggplants are largely cultivated on small, family-owned farms and generally sold weekly. Eggplant could be an important crop for farmers, especially now that the Strategic Development Goals encourages countries to develop strategies to make agriculture resilient to changing climate (Osborn, Cutter and Ullah, 2015). Eggplants planted in the study area were the same species (*S. melongena* L.) and were of the same size, shape, and colour. Generally, the cultivar (*S. melongena* L.) of eggplant cultivated in the study area was whitish and gradually turns reddish when fruits are

over matured. Plants were on average 76.2cm tall and produced numerous fruit which are smooth and glossy. Internal tissue is off-white with numerous centrally arranged small, soft seed. Fruits are generally harvested when they are just short of full ripeness. Eggplant is available mostly all year around. The fruit have a bitter taste when picked under ripe or overripe; harvesting at the right time is important at which time the flesh was hard and the seed small. If over mature seed are large, tough, and bitter. A spacing of 90 cm-1.2 m is recommended for commercial production, depending on the degree of branching of the cultivar (Blay, 1991) and the crop may take seven to eight weeks for the canopy to close after transplanting. In the study, spacing was not homogeneous as every farmer spaced according to what they thought was correct. Due to the short maturity period farmers cropped eggplant close to four times a year depending on land use. About 50% of farmers cultivated eggplant twice a year, 28% cultivated it three times in a year, and the remaining 22% cultivated it four times a year as in table two. Those who cultivated it twice annually also used the land after cultivating eggplant to plant maize. Thus, land is put into alternative uses depending on which crop fetch more income at the time of the year. This could be considered a good strategy for eggplant growers to emulate to maximize profits to land use. It is important to note that this is applicable to areas where there are two rainy seasons in a year (the minor and major rainy seasons). At the time of the eggplants cycle where fruits yield is poor, the Eggplants are usually uprooted, and new seedling planted. Despite being on family-owned land 65% out of the 140 farmers interviewed were women. The land was owned by the family and women only had access to parcels that were not fertile enough to be cultivated by male members of the family. This is because men have the responsibility to cultivate land that will yield crops for the family all year round. The parcels would be wasted if given to female members of the family who wish to farm. However, some women can rent land from other families/clans to farm. In this case such women are most likely single women.

Eggplant seeds were produced by farmers themselves and nursed for transplanting. Farmers recycled seeds over and again without any knowledge of the importance of certified seed. As a result, eggplant fruit generally were not of good quality according to observations made on-farm. Despite not using certified seed, eggplant thrived well in this region (tropical) thus enabling farmers to make some profits. Results showed that farmers produced their own seed with just about ten percent of the farmers interviewed buying from other farmers who produce more seed than required and 90% using seed produced from the previous season. Farmers who want to start cultivating eggplants would usually buy seed from a colleague who had cultivated eggplant the previous year. Farmers, rather than buy from a certified seed seller prefer to use their own seeds. It was noted that certified eggplant seed proved to be expensive and sometimes difficult to find by farmers.

Certified seeds are controlled, tested, processed, and declared good in accordance with the Law on seeds. With only a few countries making maximum use of them, certified seeds are produced from known genetic sources and of genetic purity (Bogdanović *et al.*, 2015). According to Bogdanović *et al.*, (2015) farmers who use certified seed achieve between 10-30% higher yields. Numerous plant diseases are transferred via seed. The use of certified seed prevents the spread of weed species and diseases through seed, thus reducing the number of herbicide and pesticide treatments eventually reducing the cost of production. Seed that is not properly treated with seed treatment regimes, when planted suffer from more diseases and insect occurrences (Bogdanović *et al.*, 2015). Meaning farmers who use non-certified seed will have lower yields than expected and must use more pesticides than usual. They could suffer post-harvest losses due to their inability to store crops produced from uncertified seeds for long due to on-farm and off-farm pest and diseases. This is the case for most of the eggplant producers in the study area and could be for other eggplant growing areas that are likely not to use certified seed. This eventually increases the incidence of post-harvest loss and increases food and nutritional security.

Eggplant contains carbohydrates, dietary fibre other nutrients and are low in fat. Vegetables in general provide health benefits to the body reducing the risk of some chronic diseases. The study found that most people believe in the nutritional value of vegetables thus consumption levels are upped, and vegetables farmers are earning much more income than they used to. Horna *et al.* (2008) reported that eggplant is the most important vegetable crop in West Africa and probably the third most consumed vegetable in Ghana. About 65% of all food consumed in the study area has some amount of eggplant, more especially in soups.

There is high demand of eggplant and thus farmers leverage on that for more cultivation. Eggplant cultivation provides weekly income compared to maize (*zea mays* L.), cassava (*manihot esculenta* syn. Crantz) and yam (*dioscorea* spp.) due to the demand. Thousands of kilograms of eggplant were transported weekly from the study area. This was verified by interviews with market women who indicated that demand from consumers was high and they make sure the supply to the market was frequently met. For studies like this it is important to check actual weights. This is because, in Ghana people generally do not sell according to weight; sale is by the container, usually five litres. Data from the study showed that the Atebubu district in the Bono Ahafo region competes with the Ashanti and Volta regions in eggplant production. Production starts in March and continues through December or January. Due to the demand for eggplants, about 90% of household in the study communities produce an average of 0.4 hectares of eggplant. Farmers can meet the demand, but some factors are hindrances and farmers operate at a loss. It was estimated that when eggplant is in season, a farmer who have 0.5-0.8 hectares of land on average could harvest about 540 kg

of eggplant per week. For the 200 eggplants farmers in the study area, 108 metric ton of eggplant could be produced per week. A focus group discussion with eggplant retailers in urban markets indicated that 40 kg of eggplant could be purchased from individual sellers daily. Most of the eggplant produced are lost in post-harvest due to lack of transportation, insect pest infestation and inadequate knowledge on the correct storage methods (Osborn *et al.*, 2015). Farmers, middlemen/women, and retailers lacked the requisite skill to store eggplant and do not have much knowledge on what facilities prolonged eggplant storage during its short shelf life. Here, it is important to prioritize research into educating farmers on the proper use of agro-pesticides in eggplant production, developing appropriate storage practices/facilities to prolong shelf life. This is important especially when eggplant is a produce of tropical regions where weather conditions are warm and yet consumed widely.

Eggplants are infested by several insect pests including whiteflies (*Bemisia tabaci* Gennadius), *Aphis gossypii* (Glover), *Thrips tabaci* (Lindeman), *Luecinodea orbonalis* (Gueneé), dudworms (*Chroristoneura heliaspis*, Meyrick), Epilachna beetles (*Epilachna chrysolina* (Mulsant) and the eggplant fruit and shoot borer (*L. orbonalis* Gueneé) (Owusu-Ansah *et al.*, 2001; Srinivasan, 2009; Mochiah *et al.*, 2011; MoFA, 2011). According to Horna *et al.* (2008), infestation by some of these pests increases the probability that farmers would apply insecticides (Botwe *et al.*, 2011). Depending on environmental conditions, the potential for insect pest damage on eggplant varies from year to year. Farmers reported the incidence of various pest and diseases on the farms (see Table 3). Every farmer reported the incidence of two or more insect pest on their eggplants which were more susceptible when temperatures were warmer thereby reducing yield considerably.

Regular pest-scouting of eggplant is often helpful to growers to determine when pests are present and whether insecticide applications are needed (Brust, 2008). The study noted that there was routine pesticide use which eggplant farmers holistically used. Insect pest such as whiteflies, shoot borers, aphids and budworms were reported to have been the reason for eggplant farmers' frequent use of insecticides. Eggplant producers noted that with time, insect pest such as whiteflies, thrips, budworms, and fruit borers were increasingly becoming resistant to pesticides due to their continual use. As a result, large doses of fertilizer, pesticides and herbicides were used bi-weekly on eggplants. Vegetable farming was therefore becoming more expensive. Use of synthetic insecticides for control of insects, pest and diseases has become a standard practice though an increasing awareness of environmental hazards associated with insecticide use is intensifying. Vegetable cultivation is becoming more costly due to increasing use of purchased inputs such as pesticides and fertilizers to sustain production levels. These inputs are a cause for concern due to their deleterious effects on human health and the

environment (Alam *et al.*, 2003). Researchers developed pesticide spray regimes that involved calendar spraying whether pests were present (Srivastava and Butani, 1998). This approach accounts for increased dependence on pesticides by farmers and consequently high costs of production and environmental pollution (Pimentel *et al.*, 1980; Schmutterer, 1981; Sighamony *et al.*, 1990). In the study area, farmers rely exclusively on application of pesticides to control pest and diseases to produce appealing eggplant fruit. Use of pesticides is considered the most reliable measure for pest and diseases control. Some of these applications are done a day before harvest to obtain a good looking and attractive vegetable. Repeated application of insecticides at short intervals, in disregard of pre-harvest intervals, exposes the environment, consumers and farmers to toxic residues that can persist even after processing (Bull, 1992) and increases production cost and consequently reduces profits. This practice can impact on exportation of vegetables because vegetables with chemical residue will not be allowed into other countries.

Where there is sustainable agriculture, agriculture should be done in a way that is environmentally acceptable, productive, and profitable to farmers. In using chemicals, about 90% of those interviewed who could not read and write used the chemicals they deem right. Proper instructions were not followed nor were protective clothes worn. As a result, the farmers and consumers health are at risk. Most agrochemicals are not accompanied by literature in the local dialects, which a few farmers can read, but rather in English. If these labels/instructions are in the local dialects, farmers overdosing crops would be reduced. This reduction will lead to reduced production costs and health hazard of eggplant cultivation.

For 58% of farmers, heavy use of fertilizers, herbicides and pesticides also account for post-harvest losses in eggplant production. When a lot of chemical pesticides are used during eggplant cultivation, farmers tend to put in a lot of effort after harvest to preserve for the required number of days, which usually will last between five and seven days as in table 4. Where preservation is not possible, coupled with high temperatures, eggplant ripens before reaching the final consumer reducing its value. Overuse of chemical pesticides and fertilizers in the production of eggplant reduces shelf-life (see Table 4).

Here again, where chemical pesticides and fertilizers are not used, farmers will not have good harvest (See Table 5). As a result, eggplant cultivation is not an easy task. Farmers thought it was easy to grow vegetable but as they ventured into eggplant production, they noticed issues with insect pest and disease control and post-harvest storage made vegetable production cumbersome than they had imagined.

Consumers are increasingly becoming more concerned about safety of food and food products according to a

focus group discussion with eggplant sellers at the Mokola market in Accra. About 10% of eggplant consumers want to know if chemicals were used at the source of production. Because retailers do not have direct contact with farmers, they are not able to tell the final consumer the actual situation on the farm. Consumers may never know the extent to which chemicals are used on eggplants. Schifferstein and Oude Ophuis (1998) reported that this concern goes together with consumer awareness of the relationship between production practice and quality of food products. Increased awareness of the importance of a healthy diet and positive perception of vegetable has contributed to increasing demand of vegetables, especially organic vegetables (Lambert, 2001). Studies in Ghana (Oboubi *et al.*, 2006), found that vegetables produced in, and around, peri-urban centres had chemical residues. Despite the issues of having to buy, and use, heavy doses of agrochemicals, farmers in the study area are faced with huge post-harvest losses. It is therefore important to have strict policies on vegetable production thereby having farmers provide information to middlemen/women on conditions under which their produce was produced to enable consumers comfortably buy and consume their produce.

Post-harvest food loss is defined as measurable qualitative and quantitative food loss along the supply chain, starting at the time of harvest until its consumption or other end uses (De Lucia and Assennato, 1994; Hodges *et al.*, 2011). The Food and Agricultural Organization defines post-harvest losses simply as a measurable quantitative and qualitative loss in each product (De Lucia and Assennato, 1994). The post-harvest sector includes all points in the value chain from production in the field to the food being placed on a plate for consumption. Post-harvest activities include harvesting, handling, storage, processing, packaging, transportation, and marketing (Mrema and Rolle, 2002). In the study indicated that post-harvest loss occurs in all stages in the value chain to the consumer. Being able to transport produce is in two phases. First it is necessary to have access to sacks used to bag the product, and second the availability of transport to market. If transportation is delayed 2 days, farmers consider their produce as being post-harvest loss because no middleman would buy them. This is because the final consumer wants the produce fresh. Sometimes products will rot on farm due to lack of transportation. In the study harvest was done weekly to coincide with market days where farmers have access to transportation. If a market day is missed post-harvest losses occur as it becomes difficult to transport the produce due to poor transport networking and bad roads.

Storage of eggplant is usually problematic. Data showed that the inability of the farmer to store, or preserve, eggplant to sell later contributes to post-harvest loss in eggplant production. Due to farmers' inability to store and preserve eggplants there is excessive waste. About one-quarter of eggplant produced in the study area never gets to the consumer and the effort and money used to

produce it are lost. Estimates of production losses are difficult to calculate however; from this study about 30% of the harvest was lost to post-harvest losses, with 19% lost through farmers activities, and the remaining 11% lost through middlemen and retailers. Mall *et al.* (1992) reported that average loss in the field is close to 13%. Though eggplant is not a major food crop, it plays a major role in feeding the world and at the same time proving it with nourishment. As a prolific plant, eggplant is widely eaten and can be exported to provide ready income for the poor farmers and essential nutrients for eggplant consumers (NRC, 2006). Thus, encouraging eggplant production and consumption will reduce the incidence of obesity and diseases that develop due to lack of essential nutrients in human bodies (NRC 2006). Proper cultivation, storage and marketing of eggplant will decrease the price and increase consumption rate thus ensuring a larger group of people are consuming it and for that matter reduce food and nutrition security issues. The following analysis was arrived at by tracking one week harvest of two farmers to determine how the produce was harvested, transported, and retailed to consumers.

Cost benefit analysis of eggplant production at the farm level indicated that, on average, farmers spend about \$140 on labour·ha⁻¹ of which \$42 is his/her own labour by way of planting, weeding, herbicide, pesticide, and fertilizer application and harvesting. Other costs incurred were \$105 for pesticides, herbicides, and fertilizers. The overall cost of a hectare of eggplant would have been \$245, of which \$140 is for labour. On average, farmers harvest 4.5 tonnes of eggplants·ha⁻¹ in a season. Throughout the year on average a 25 kg of eggplant cost \$3.84, with 4.5 tonnes, farmers would average \$684·ha⁻¹ in a season and a profit of \$439 (see table 6). For farmers cultivating eggplant throughout the year the return would be \$1,756·ha⁻¹ in a year. A farmer who uses no agro-chemicals would make \$8.6 per season/cultivation or \$34.4 per year as in table 6 below. This shows that farmers cannot do away with agro-chemical use in eggplant cultivation if they want to make some profits. This also explains why farmers keep dosing eggplants with agro-chemicals to ensure they attain maximum yields. The Ghanaian Ministry of Food and Agriculture (2010), estimated yield for eggplant in 2010 was 8 tonnes/ha⁻¹ in a year though it had previously been estimated at 15 tonnes/ha⁻¹ in a year (MoFA, 2010). This is not quite different from average yields in the study area as climate change, increased insect/pest emergence and soil fertility degradation over the years, would have led to decreased yields.

It was estimated that a farmer will lose an average of 19% of eggplant due to post-harvest loss. This means the average income·ha⁻¹ after post-harvest loss is about \$554.04, making a profit of \$309.04·ha⁻¹ in a season. If this is the only cash crop the farmer produces, he and his family would have to depend on that to meet other non-food household expenses. For the 140 farmers involved in this study, each farmer would have been losing \$129.96·ha⁻¹ in a season totalling \$18194.4 per season.

If farmers cultivate eggplant more than once a year the loss will double. Food availability and accessibility can be increased by increasing production, improving distribution, and reducing post-harvest losses. Reduction of post-harvest loss is critical to ensuring future food security in Ghana and the world over. Post-harvest loss in the supply chain could be alleviated by providing enhanced agricultural production technologies, food processing and preservation innovations, and food distribution capabilities within each community. Reduction in waste, particularly if it can economically be avoided, would be of great significance to growers and consumers. Food is lost mostly at the early and middle stages of the food supply chain; much less food is wasted at the consumer level. This impacts food insecurity and livelihoods at the farm household level; farmers' incomes will not increase unless waste is stopped.

Although synthetic pesticides remain a primary measure for agricultural pest control for the foreseeable future, it is evident that communities cannot continue to tolerate the way farmers use conventional chemicals. Current pesticide use is non-sustainable, and if continued, will adversely affect eggplant production. This situation can be avoided by developing pest management systems based on judicious application of insecticides. There is a need to develop alternative control strategies.

Conclusion

Analysis from data collected during the study indicates that eggplant production can be profitable and should be encouraged. To meet food security levels as per Sustainable Development Goals, it is important to consider storage, preservation, and marketing issues of perishable commodities. If perishable commodities can store for long farmers could determine the price of their farm produce and overcome transportation concerns.

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Table 1: Data Sources

Source	Number of Participants
Farmers	140
Middlemen/women	5
Retailers	10
Focus group discussions	60
Observation	7
Total number of participants	222

Source: Field survey, 2018

Table 2: Year-Round Eggplant Cultivation

	Number of Times Cultivated per Year		
	2	3	4
Frequency (%)	50	28	22

Source: Field survey, 2018

Table 3: Incidence of Insect Pest on Eggplant Farms

Disease/Pest	Frequency (%)
Whiteflies	75
Thrips	84
Budworm	89
Beetles	59
Fruit and Shoot Borer	45

Source: Field survey, 2018

Table 4: Chemical/Fertilizer Use on Number of Days Eggplants can be Stored by Farmer

	Number of times pesticides/fertilizers are used /season		
	10-20	20-40	40-60
Number of Respondents	19	84	37
Maximum number of days stored by farmer	7	5	4

Source: Field survey, 2018

Table 5: Pesticide/fertilizers/herbicide use on yields

Number of Respondents	19	84	37
Number of times pesticides/fertilizers*/herbicides are used /season in the study area	10-20 (times Lower use)	20-40 (times=Average input use)	40-60 (times maximum input use)
Maximum harvest per season (metric tons)	3.2	4.4	5.9

**Fertilizers are applied twice in the production cycle and herbicides once*

Source: Field survey, 2018

Table 6: Cost: Benefit/Analysis of Eggplant Production Using Average Amounts of Inputs/Ha

	With Maximum inputs	Without inputs
A. Yield/ha/Season		
1. Yield in tonnes	4.5	0.8
2. Price/25 kg (\$)	3.8	3.8
3. Gross returns (\$)	684	121.6
B. Variable Cost (\$)		
1.Hired labour (tilling/weeding)	98	98
2.Own labour (agro-chemical application and harvest)	42	15
3.Herbicides/pesticides/fertilizer	105	
4.Total Variable Cost/ha	245	113
Net benefit (gross returns minus total variable cost)	439	8.6

Source: Field survey, 2018