Horti Nigeria

BUILDING A SUSTAINABLE & INCLUSIVE HORTICULTURE SECTOR

SCOPING AND MAPPING OF POSTHARVEST LOSSES

AND TUTA ABSOLUTA RELATED LOSSES, AND THE TECHNOLOGIES FOR COMBATING THE LOSSES

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EXECUTIVE SUMMARY

Vegetable production is a very important business all over Nigeria. For this reason, vegetables have specific importance in providing a balanced and healthy diet to people. Due to their soft texture, they are easily bruised or wounded as a result of harvesting, and other postharvest handling operations such as packaging, transportation, and storage. No matter how any intervention(s) tries to work on increasing vegetable production, if nothing is done on the postharvest handling part, the production will always be inadequate. About 30% vegetables are rendered unfit for consumption due to spoilage after harvesting. This is a huge loss of valuable food even when the minimum food requirement of the population is not met. Therefore, it is important not only to grow more, but also to save what is grown. Reducing postharvest loss of vegetables and adding value to the final produce will be a complementary means for increasing production and marketing value.

Tomato remains a priority crop for vegetable farmers and consumers alike. This vegetable is consumed by every household in Nigeria. In terms of production, the country is ranked 14th among tomato producing countries in the world and 2nd in Africa, with 3.9 million tonnes produced on average every year. The estimated potential production yield is relatively high, at about 20-25mt/ha. There exist a large domestic and regional market unmet demand for tomatoes in the country and Nigerians alone consume an estimated 2.3 million tonnes of tomatoes annually. The massive postharvest losses have contributed greatly to the gap. Data on the quantities or percentages of tomato losses are staggered and vary from researcher to researcher. Thus, there is a need to generate accurate and up-to-date data on the percentage losses, hotspots for losses and technologies adopted by stakeholders to reduce loss.

In addition, tomato is highly susceptible to pest/diseases and abiotic stress. Recurrent pest and diseases also contribute significantly to tomato losses among farmers. In 2015/2016, the tomato value chain in Nigeria experienced huge losses occasioned by the disease '*Tuta absoluta*,' locally known as 'Tomato Ebola,' which resulted in up to 80 percent yield loss. A mapping exercise conducted around 2016 showed that the pest had spread to 360 out of the 528 locations that were investigated.

The current work was conducted within the HortiNigeria program. The program aims to facilitate a sustainable and gender- and youth-inclusive horticulture sector that will contribute to food and nutrition security in Nigeria. The program is also designed to identify and promote innovative agricultural technologies that are commercially viable, environmentally sustainable, and proven to work.

Based on this background, HortiNigeria engaged the services of the National Horticultural Research Institute (NIHORT) to conduct a scoping on postharvest handling and value addition technologies in Oyo and Ogun States with focus on the program's major crops (Tomato, Pepper, Okra and Onion) and map postharvest loss in selected states in Nigeria. HortiNigeria also sought to know the current efforts expanded on *Tuta absoluta* especially how from the various research already done by NIHORT and others is translating to the market end of producing marketable products to address *Tuta absoluta* challenges. Furthermore, the program through the engagement sought to reconvene the National Tomato Stakeholders Committee (NTSC) to identify and provide solution options to current and enduring issues restraining progression in the tomato value chain in Nigeria

The study was carried out in three phases. Phase 1 involved an intensive literature search of studies on postharvest technologies conducted in Nigeria and a review of *Tuta absoluta* control strategies. In the second phase, a survey of available postharvest technologies through key

informant interviews was carried out to validate the findings of the desk review in Oyo and Ogun State. This targeted stakeholders in tomato, okra, pepper and onion value chains in Ogun and Oyo States. A mapping of tomato postharvest and *Tuta absoluta*-related losses in Oyo, Ogun, Kano and Kaduna states was conducted in the final phase using a face-to face interview method. In addition, the National Tomato Technical Stakeholders committee meeting was convened, and a communique developed.

This study identifies the postharvest practices of farmers, processors, marketers and transporters in mitigating tomato postharvest loss along the value chain. It analyses the percentage losses, identifies the hotspots for losses and technologies used in mitigating losses and in the control of Tuta absoluta. The result confirms that the tomato value chain in the country is still evolving in terms of postharvest technologies and the control of insect pests, particularly Tuta absoluta. Percentage losses vary across the value chain and are caused by multiple factors. Stakeholders reported tomato losses ranging from 12% among transporters to 27% among producers.

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The result confirms that the tomato value chain in the country is still evolving in terms of postharvest technologies and the control of insect pests, particularly *Tuta absoluta*. Percentage losses vary across the value chain and are caused by multiple factors. Stakeholders reported tomato losses ranging from 12% among transporters to 27% among producers. The hottest spots for losses are during production and harvesting, and at market level. Cooling, grading, sorting, use of solar dryers, evaporative cooling chambers and returnable plastic crates were used by stakeholders to reduce losses. The study recommends adopting innovative technologies that can significantly reduce postharvest losses. For instance, the use of low-cost solar dryers and evaporative coolers can extend the shelf life of tomatoes, enabling farmers to store and transport their produce more effectively. Enhancing cottage processing industries sited close to producing areas will ensure that produce do not waste during bumper harvest. Furthermore, implementing pest-resistant varieties, biocontrol methods, and good agricultural practices can help mitigate losses caused by pests and diseases. Enhancing the knowledge and skills of farmers, extension workers, and other stakeholders is vital for

reducing postharvest losses. A holistic strategy that combines the concerted efforts of chain actors and influencers to address postharvest losses in the country is necessary.

INTRODUCTION

The postharvest chain involves a series of interconnected activities from the time a crop is harvested to the point at which delivery is made to the consumer. As crops move along the chain, they are exposed to quantitative losses such as weight loss and qualitative losses such as loss of colour, taste, and important nutritional qualities. Postharvest losses have a negative impact on the economy, environment, nutrition and health; this brings the issue to the forefront of development interventions. Reducing postharvest losses is more sustainable and economical than increasing production to make up for these losses. Identification, selection and scale-out of available postharvest technologies that are affordable, effective and gender friendly will ensure that we do not neglect valuable traditional and improved technologies and get carried away with the introduction of modern technologies. This will also be readily adopted by stakeholders.

Globally, agriculture employed 27% of the workforce in 2021 (FAO State 2022). About 22% of the Gross Domestic Products in Nigeria was contributed by agriculture in 2021; this was achieved only in the first three months of the year (Statista 2023). This shows the great potential of agriculture to liberate the country from poverty. Horticulture as an arm of agriculture generates twice the number of employments per hectare of production compared to cereal crop production (Ali *et al*., 2002). In 2021, vegetables primary production for Nigeria was 15.8 million tonnes (FAO Stat, 2022). Statistics indicates that fresh tomato production is growing in Nigeria. In 2018, Nigeria was the 12th largest producer and the second largest producer in Africa after Egypt (FAO 2019.). Estimates of vegetable production is staggering for Nigeria, 1,378,493 tonnes of onions, 3,575,968 million tonnes of tomatoes were produced in 2021 (World Data Atlas 2021). Between 1972 and 2021, vegetables primary production of Nigeria

grew substantially from 2.99 million to 15.8 million. With the increasing population, estimated to reach 400 million by 2050 (FAO, 2023), there is an urgent need to identify existing technologies that are effective and adaptable so as to tackle the menace of postharvest loss and achieve food security and nutrition.

Horticulture is being hampered by many challenges, thus its potential in achieving food and nutrition security has been inconsequential. Postharvest loss being a major challenge, needs to be given a priority. Thus, this scoping study was carried out to identify the existing postharvest technologies in horticulture with a focus on tomatoes, peppers, okra and onions, also paying attention to their frugality, sustainability, and improved profit.

Tomato

Tomato (*Solanum lycopersicum*) production has continued to increase in Nigeria over the years, but this has not contributed meaningfully to improved livelihoods nor food security due to the matching increase in postharvest losses. Thus, this country still must import tomato paste to meet local demands; an importation worth about USD 60 million annually has been reported (FAO 2018a). Tomatoes rank second only to potatoes in global production of all horticultural produce (Arah *et al.,* 2016). Nigeria is a major producer of tomatoes in Africa with about World (Data Stat, 2021, FAO 2019).

Tomato is one of the most important vegetables in the world. It tops the list of vegetables that Nigerians consume (Oke *et al*., 2020). It is a very important source of vitamins and minerals which are essential for human health. It is also considered an important cash and industrial crop in many parts of the world (Babalola *et al*., 2010). It is grown in many states in Nigeria but more concentrated in the northern part of the country.

Tomato losses are encountered during harvesting, handling, storage, processing, packaging, transportation and even during the marketing of the fruit (Sibomana *et al*., 2016). This can be attributed to inadequate processing and storage facilities, leading to qualitative loss and in most cases, a loss in quantity. Studies have further identified causes of tomato loss after harvest to involve; longer distance from farm to market (Babalola *et al*., 2010), type and quality of labour used in harvesting (Mujib *et al*., 2007), rot and bruises caused by poor handing, diseases and pest attack (Aidoo *et al*., 2014) and constraints like poor postharvest technologies used in processing and storing (Abdul *et al*., 2020). Experts have primarily attributed the cause of tomato postharvest damage in Nigeria to handling and packaging during distribution and processing (Arah *et al*. 2015; Sinha *et al*. 2019, Idah *et al*. 2007; Gustavsson *et al*. 2013). For instance, Babarinsa *et al.* (2018) reported an average of 41% losses in tomatoes transported in raffia baskets from Kano to Lagos State.

A measurable degradation in the quality and quantity of tomato from its point of harvest to the point of consumption is termed postharvest loss (Ayandiji *et al*., 2011). Due to its perishable nature and short shelf life of averagely one week at ambient temperature (Znidarcic and Pozrl, 2006), farmers have had to utilize different storage and preservation methods to keep the harvested fruits in edible condition for a period of time (Ayomide *et al.,* 2019). In Nigeria, woven raffia baskets are traditionally used for packaging tomatoes and transported in open trucks from production sites to the market making them highly susceptible to mechanical, climatic and microbial stress.

Postharvest losses in the tomato value chain in Nigeria have been a longstanding issue, with significant percentages of harvested tomatoes going to waste before reaching the consumers. Specific data vary across different regions and time periods. Existing data put postharvest loss

in the range of 25%-50% (Korie *et al* 2023, Sure Chain 2021, Ojimi, *et al* 2021, Kuranen-Joko and Dzahan 2017, Adeoye *et al* 2009). The following percentage of postharvest losses at various stages of the tomato value chain in Nigeria have been reported:

1. Harvest and Handling: It is estimated that postharvest losses at the farm level can be up to 40% (Kitinoja, *et al* 2019). These losses occur due to improper harvesting techniques, inadequate handling, and lack of appropriate packaging.

2. Transportation: During transportation from farms to markets, postharvest losses can range from 10% to 20%. Poor road conditions, long distances, and insufficient refrigeration facilities contribute to the deterioration of tomato quality and increased wastage ((Ugonna et al 2015, Kitinoja, *et al* 2019), Korie, *et al* 2023).

3. Processing and Storage: In the processing and storage stages, losses can vary from 5% to 15%. Factors such as inadequate processing facilities, lack of proper storage infrastructure, and limited access to technologies for tomato preservation contribute to these losses (Ugonna *et al* 2015, Kitinoja, *et al* 2019),

4. Market and Retail: At the market and retail level, postharvest losses can be as high as 10% to 30%. Challenges include inadequate market infrastructure, improper handling by vendors, and limited knowledge of postharvest management practices ((Adeoye *et al* 2009, Kitinoja, *et al* 2019, Odeyemi *et al* 2022).

Some common postharvest handling practices that result in huge losses are shown in the figure below

Dehydration of tomato on bare ground

Loading/overloading of tomatoes in raffia baskets and trucks/tankers

Onions

Nigeria produces a little above 1.3 million tonnes of onions per annum which places the country in the topmost position among onion producers in Africa (FAO, 2019, World Data Stat 2021). The major onion producing states are Borno, Sokoto, Kebbi, Jigawa, Zamfara, Kaduna and Kano (Agricultural Extension Research and Liaison Services, 1985), with estimated revenue of N 206.7 per bag in 2004 (Abduljabar, 2004). Postharvest losses in onions are up to 50% of harvested onions (World Vegetable Centre, 2018)

Onions (*Allium cepa L.)* are bulbous vegetables that are highly valued for their flavor, nutritional value and medical properties. It is only exceeded by tomatoes and cabbage in terms of importance in the global weight production of vegetables (FAO 2015). Onions have a unique aroma, taste and lachrymatory effects, which make them important in the industries as constituents for moth repellents, beverages, expectorants as well as ingredient in biscuits (Sharma *et al*., 2005).

Onion is a delicate crop that requires care during storage due to its high moisture content. Although, it is moderately perishable, its storage is not easily achieved by producers in developing countries. A 75% of the total postharvest losses in the onion value chain in Nigeria

has been attributed to inadequate storage facilities (Salisu *et al.* 2019). The various methods employed by farmers include storing on the roof, using of baskets and hanging method, spreading on the floor and spreading under trees. A temperature of 0-50C and 25-300C are good for storing onions at a relative humidity of 55-70% depending on the cultivar and other treatments applied. (Chope, 2006 and Kukanoor, 2005). For countries with hot tropical climates like Nigeria, a temperature range of 25- 31°C is recommended. Storing onions at a temperature range between 20 - 25° C predisposes them to a range of disease causing bacteria and fungi. The optimum temperature for long- term storage (about 12 months) of onions is 0°C with 65- 70% relative humidity (Agblor and Waterer, 2001). Traditionally, onions are packaged inside a jute bag, basket or crate to allow adequate air flow before being stored in a dry, well ventilated and dark environment. To achieve this, farmers use a cool ventilated environment. For large- scale commercial storage, onions are usually stored under refrigeration and the most commonly recommended conditions are 0°C with 70-75% rh.

Pepper

Peppers are important agricultural crop with significant economic importance and nutritional benefits. It is a rich source of vitamins A and C, and phenolics. They are highly perishable and easily susceptible to deterioration due to water loss, wilting, shrivelling and fungal infestation. Selection of the optimum storage temperature is very important for storage of the peppers. Optimum storage temperature range for the peppers is reported to be between 7 °C to 13 °C for 2-3 weeks (Rico *et al.* 2002). Storage at temperatures lower than 7 °C exposes them to chilling injuries while temperatures higher than 13 °C. Dried peppers have to be protected from rehydration to prevent discolouration and loss of flavour (Afam-ezeaku *et al* 2021)

Okra

Okra (*Abelmoschus esculentus*) is an important vegetable that is largely cultivated in tropical and warmer regions. It has huge nutritive, health, and economic benefits. Okra is consumed either as a fresh vegetable, cooked vegetable or as an additive in stews, soups, and salads (Agarry *et al.* 2021). Its stringy, gum-like consistency is particularly desirable in soups. In addition to supplying vitamins and minerals, okra is believed to be a significant source of protein. It is also a good source of fibre as indicated in the treatment and prevention of illnesses of the digestive system such as colon cancer.

It is also a highly perishable crop, containing about 80% moisture which makes storage challenging. Okra left for more than two days tends to become fibrous and unsuitable for direct use. Thus, proper packaging and storage allows for a better quality and extend shelf life for some days (Schippers, 2000). The common methods for preserving okra are canning, dehydration and freezing.

DESK REVIEW OF AVAILABLE POSTHARVEST TECHNOLOGIES

An intensive literature search of studies on postharvest technologies conducted in Nigeria was performed on Google Scholar, Academia, Semantic Scholar, Web of Science, Science Direct, Scopus, Taylor and Francis online and grey literature. Postharvest technology, postharvest loss, preservation, storage, processing, tomato, onions, pepper, okra, horticultural challenges, Nigeria, etc. were a few of the search words used. These words and phrases were also used in different combinations and looked for in title, abstract and full text. In addition, a secondary search was conducted through the reference lists of identified articles. Using a systematic approach, relevant literature that may help in understanding the effectiveness of postharvest technologies on tomato, pepper, okra and onion value chains in Nigeria was selected. Each study included in the review reported at least one postharvest technology used in the value chain of the target crops.

Telephone interviews and field visits were carried out among stakeholders in horticulture in Ogun and Oyo States. A semi-structured questionnaire was used to elicit information from the stakeholders. Seventy respondents were targeted but only 51 were interviewed fully because some did not respond to phone calls and some declined participation in the course of the interview. Information solicited from respondents included among others socioeconomic characteristics of respondents, postharvest handling practices, profitability and sustainability of the practices, causes and control for postharvest losses, as well as the challenge and control of *Tuta absoluta*. Each interview lasted between 30-40 minutes.

Postharvest Technologies/Practices Identified

Cultivar selection: Onions with long dormancy and thick outer skin are best suited for storage. Studies have shown that the brown and red-skinned cultivars have good storability.

Selective harvesting time: It is recommended that vegetables be harvested during the cool hours of the day, that is in the morning or evening when the temperature is relatively low. Ajagbe et al (2014) reported that 62% of tomato farmers in Ogun State picked tomatoes in the evening and prepare them for transportation to the market the following day.

The other farmers who harvested their produce in the morning transported them to nearby markets (Ajagbe *et al* 2014). In kano, a varying percentage of 56-92% harvested their tomatoes in the morning (Awagu *et al.* 2014, Dunama *et al.* 2020). Harvesting when the crop is fully mature and still green is recommended, this is particularly important when fruits are going to be transported over a long distance or when they are not going to be used immediately (Mary 1997). However, Awagu *et al.* (2014) reported that 81.5% of farmers harvested their tomatoes and peppers at fully ripe stage and move them to the market immediately.

Harvesting of onions is best done when the bulb is mature and the weather is dry; harvesting after a rainfall, or when the humidity is high increases susceptibility to post-harvest disease. Immature bulbs develop a thick neck, which aids disease occurrence in storage.

Ventilated shed: Even through tomatoes are harvested during cool hours, there is still some field heat that must be removed to improve the shelf life of the fruits. Ventilated sheds are structures constructed with wood and tach roofs and are used for conditioning fruits. It can also serve as collection centre for onward transportation to the market.

Packhouse*:* A more permanent structure is used when there is a need for complex grading, sizing and sorting operations, particularly for export. This may also be necessary if produce is to be kept for a long period of time. A packhouse with a bamboo frame, grass tached roof are used in rural area while a more elaborate packhouse made with bricks with water and electricity services are available at more advance levels.

***Sorting and grading*:** This are an important postharvest process that contributes significantly to the preservation of harvested crops. Removing rotten and damaged fruits from healthy ones reduce the exposure of awesome fruits to spoilage microorganisms. Grading is done based on different factors such as stage of maturity, colour, size. These two processes are important in maintaining quality.

For onions, the initial quality is important for sorting. Mature and undamaged bulbs should be sorted out and stored. Proper grading prior to storage is necessary. If this is not done properly, up to half of onions stored are likely to decay or shrivel.

Curing: Onions are cured before storage. This involves drying of the neck and the outer skin in a room at 20-300C and 70% humidity for 12 -24 hours. In the absence of a drying room, curing can be done under a shed at the production site as long as the bulbs are protected from sunlight. It takes 2-3 weeks for the neck and the outer skin to completely dry and get crispy. Curing decreases the incidence of neck rot, reduces water loss during storage, prevents microbial infection, and is desirable for the development of good scale color (Balaraba 2019).

***Rectangular woven basket*:** It is customary to save tomatoes in baskets to allow for ventilation and as a tool for grading (Obekpa, 2019; Komolafe *et al.* 2015). There are two types of rafia baskets in use: the conical and the rectangular ones. While the conical raffle basket incurs a loss of tomatoes (Ajagbe et al. 2014), the rectangular raffle basket has been shown to reduce the tomato loss compared to the conical basket. It also reduces the cost of tomato transportation thereby increasing the income of tomato farmers and increasing the availability of tomatoes to consumers when compared to the conical raffle basket (Abubakar and El-Okene, 2015). Woven raffia baskets occur in different sizes ranging from 25 to 75kg for tomato packaging (Ajagbe et al. 2014). In Ogun State, only about 80% of tomato farmers used raffia baskets while only 20% used plastic crates. Wooden baskets and jute bags were not found in use among tomato farmers in Ogun State (Ajagbe et al 2014). In addition, Abubakar and El-Okene (2015) recorded a 3.58% loss in tomatoes transported in rectangular shaped woven basket from Mairuwa village in Katsina to Ibadan in Oyo State, as against the 13.22% recorded for tomatoes transported in conical baskets. The rectangular basket was 500mm in length, 400mm in width and 200mm in depth with filling capacity of 25kg of tomatoes while the conical basket had a top diameter of 550mm and a bottom diameter of 340mm with a capacity of 40kg of tomatoes.

Plastic Crate: The use of plastic crates for tomato packaging for long distance transportation has great benefits for marketers in reducing mechanical damage to transported tomatoes (Babarinsa et al. 2018; Babarinsa and Omodara, 2011; Idah et al. 2007).

The plastic crate is a veritable tool for handling tomatoes, due largely to drastic reduction in losses, improved fruit ventilation and increased income amongst others. Shallow plastic crates were used for tomatoes due to the softness of the fruits (Babarinsa and Omodara, 2011; Kiaya, 2014). Plastic crates are made of plastic material which confers on it the re-usability and longevity characteristics. It is rigid and can stand all weather conditions. They are cost effective even though the initial cost may be high. Babarinsa *et al* (2018) reported an average of 41% damage to tomatoes in raffia baskets and an average of 5% damage to tomatoes in plastic crates during transportation over 998 km from Kano State to Mile 12 Market in Lagos. Aghadi et al. (2020) indicated that traders who adopted the use of plastic crates were able to earn more profit. Packaging adds value and increases the lifespan of harvested tomatoes. Well-packaged tomatoes are less prone to damage, seen as more desirable by consumers, and fetch better prices for the farmer (Komolafe et al. 2015).

However, the drawback is the huge initial capital investment, the additional cost of return after use and the poor stack ability and the maintenance cost is high.

Carton crate: During transportation, both the vegetable and the package are exposed compression and vibration which leads to mechanical damage of the vegetable. The need for packaging materials that can withstand pressure while keeping the vegetable fresh led Onu and colleagues (2021) to test the effectiveness of carton boxes as a packaging material for tomatoes. The study identified carton crate as the most suitable packaging technology for handling and transportation of fresh tomato fruits, in terms of both technical and economic feasibility (Onu *et al*. 2021). Corrugated fibreboard is the most frequently used for packaging for local distribution and export due to its handling and storage requirements for strength, lightness and economy (Babarinsa and Omodara, 2011). Though the durability of the plastic crate and wooden crate was higher than that of the carton crate in Babarinsa and Omodara's study, the damage to tomato fruits in the plastic packages was higher as compared to the fiber boxes. The ultimate advantage of the carton crate is its ability to protect tomatoes from disease organisms, predators, moisture loss, high temperatures, crushing, and damage during transport (Farm Radio International, 2019).

Evaporative Cooling Systems: Refrigeration requires a huge initial capital investment in infrastructure and maintenance and operational cost that is unaffordable by most small-scale farmers, retailers and wholesalers in developing countries. Evaporative cooling is a locally adaptable storage technology that is usually employed in rural areas.

Evaporative cooling systems utilize water evaporation to produce a drop in air temperature and rise in relative humidity in the chamber. It is an ancient and effective cooling method. There are different cooling chambers that have been in use; pot-in-pot, brick-in-brick and metal-in- block cooling chambers. Ogbuagu *et al.* (2017) used stainless steel, plywood and wire gauze to construct a cabin with a cavity in the middle with a 24V DC, 0.37kW fan attached to the back of the cabin, Olaiya *et al* (2013) used a galvanised steel insulated with lagging materials from polystyrene foam to reduce heat transfer. The cavity in-between the two layers is usually filled with riverbed sand and other materials and kept moist. The efficiency of the cooling system is influenced by the rate of evaporation from the cavity material, the air velocity and water holding capacity. Previous studies have used different materials. Abdalla *et al.* (1995) used palm leaves, Olosunde *et al.* (2009) used jute material, Ogbuagu *et al* (2017) used a composite material consisting of jute bag and charcoal. Jahun *et al* (2014) constructed a cooling chamber in a drawer shape. The trays of the drawer were made with wire mesh with wooden edges. The frame of the drawer was cover with jute bag and water troughs were placed under and at top in order to provide water for the continuous wetting of the jute bag by gravity and capillary action. All the researchers reported a significant drop in temperature and a rise in humidity which extended the shelf life of tomatoes up to 10-21 days.

This study provides an alternative storage facility for tomatoes. Although the performance of the Zero Energy Cooling Chamber (ZECC) facility fell slightly short of expectations, it can be used to prolong the storage life of tomatoes better than keeping the produce in ambient air conditions (Ogbuagu, et al. 2017). Produce quality shows a delay in colour change and shrivelness when compared with produce kept at ambient conditions and reduce postharvest losses and also generate more income for farmers (Ogbuagu, et al. 2017; Ayomide et al. 2019; Olaiya et al. 2013).

The ZECC as effective for maintaining fruit firmness and fruit colour over time, extending shelf life and reducing disease incidence, maintenance of acceptable tomato fruit quality for marketers and consumers (Aromiwura et al. 2016; Ayomide et al. 2019). This review also revealed that maintaining lower temperature and higher relative humidity during storage combined with selected cultivars having a long shelf life could maintain fruit quality and reduce loss (Jahun et al. 2013; Liberty et al. 2013). Although evaporative coolers are economical for the storage of fruit, it is largely dependent on the condition of the environment in which it is developed (Ayomide et al. 2019). The awareness of the technology is very low among farmers and marketers (Aromiwura, 2016).

Cooling Van*:* The vehicles used in transporting horticultural produce are inappropriate. Report has also shown that most transporters do not own the vehicles they use. The search for vehicles and the need to wait to get one contribute significantly to the decay of the product (Idah *et al* 2007). For large scale commercial operations, it is important to maintain the cold chain from the production site to urban markets and processors.

Liners for rough packages: Lining the hard and rough surfaces of wooden and raffia baskets have been shown to reduce losses. Soft materials such as newspaper or paper waste, corrugated paper or thin polyester foam are used to provide a cushioning effect. These materials are able to reduce shocks, drops, compression and adverse climatic conditions.

Waxing: The inner surfaces of corrugated fiber boxes used for shipping horticultural produce are usually waxed with wax-based or polyethylene emulsion products which are able to reduce the absorption of humidity. This provided an extended shelf life during shipping of the crop over the sea.

Tomato Slicing Machine: Oriaku *et al.* (2014) developed a tomato slicing machine to facilitate the drying of tomatoes. The ripped tomatoes after slicing will reduce wastages, labour cost if merged with efficient means of drying and packaging to prolong storage. Based on the slicing rate of the machine, high productivity in slicing is achieved and the slicing efficiency is very high and to upward of 90%. The machine is useful in minimizing waste and improving the shelf life of ripped tomatoes (Oriaku *et al.* 2014).

***Dryers**:* Food dryers otherwise known as dehydrators can extract moisture from fruits and vegetables without cooking the food thereby improving the storability of the product. Different dryers ranging from solar dryers, electric dryers and hybrid dryers have been employed in the dehydration of horticultural crops. Hybrid dryers could be solar-kerosine, solar-charcoal, solar- electric etc.

Dehydrators are post-harvest technologies equipped with thermostats to maintain a constant temperature to reduce the moisture content of vegetables, some come with adjustable timers and have been a successful conventional method used to produce tomato powder while reducing postharvest loss in the tomato value chain (Nwogu *et al.* 2017; Abdulmalik *et al.* 2014; Parnell
et al. 2004).

In Northern Nigeria, farmers sun dry tomatoes and peppers openly on their farms and the roadsides. The final product is infested with dirt and sand, making it unhygienic to consume.

In Kano, Dunama *et al.* (2020) reported that 89% of the farmers sun dried their tomatoes. Pieces of dried ginger are dropped in bags during the packaging of the dried tomatoes, this is believed to help in maintaining a good colour. This exposes the vegetable to contamination. The solar tray dryer is an enclosed drying chamber heated by trapping solar heat absorbed at the bottom plate (absorber) (Babarinsa and Omodara, 2011). The study observed that by drying, the moisture content of tomatoes can be considerably reduced to a level that makes it difficult for spoilage organisms to thrive, thus preventing deterioration (Babarinsa and Omodara, 2011; Weefar, 2017).

Ebuehi (2022) reported the use of spray drying method for processing tomato powder and concluded that spray drying was the most feasible way to produce tomato powder industrially based on the speed, simplicity of the process and the low labour required. The spray dryer consisted of 5 major components namely the drying chamber, hot air supply system, feed supply system, atomizing device, and powder recovery cyclone. Conventionally, spray drying involves atomization of feed into the droplet, spray-air contact, drying droplets, product recovery, and final air treatment (Muzaffar, 2015).

Fashanu *et al.* (2019) used a solar tent dryer to produce acceptable dry onion chips. The quality of the chips was better when compared to oven dried chips. There have been attempts to use more technical methods for the drying of onions in recent times. The key factor in drying of onions is the retention of the colour, taste, and pungent flavour, while maintaining the desired moisture content. Sobowale *et al.* (2020) used the thin layer drying technique to produce onion dry slices. The optimum desirable colour was obtained at 50oC with 2 mm thick onion slices.

Cottage Processing: To prevent postharvest losses, initiatives mostly adopted were sun- drying into chips, storing as whole peeled tomato preserves, fresh refrigeration, purring and sealing with oil into jars. (Akangbe *et al.* 2014; Babarinsa and Omodara, 2011). Tomatoes can also be processed into various products that can be used in different forms to improve shelf life including tomato paste, puree, juice, jam, and powder (Babarinsa and Omodara, 2011). The value chain approach could be used to improve tomato production through an improved process technology to reduce the losses arising due to the perishability of the harvested product (Ugonna *et al.* 2015). The Yieldwise team supported cottage processors, including individuals and cooperative in capacity building and award of grants. The participants of this project were able to process fresh tomatoes into puree, paste, ketchup and dried forms; producing 500 to 1,000 metric tons annually which is higher than the capacity of medium-scale industrial processors (Technoserve). This helps to mop-up the excess tomatoes during glut and provide jobs for rural women and youth. About 10 employees were engaged by each processor, with an average wage of $5.55 to $13.80 daily.

To reduce post-harvest loss in onions, it can be processed into a wide variety of products including ready to use or ready to cook fresh onions, onion paste, dehydrated onion flakes, onion powder, onion oil, onion vinegar, onion sauce, pickled onions, onion wines, beverages and others.

Existing cottage and big industries involved in value addition of tomatoes, onions, and peppers were identified through search in the database of the National Food and Drug Administration and Control (NAFDAC) alongside other literature and market visits. The table below displays some of the processing industries in Nigeria.

Table 1: Some companies involved in value-addition of tomato, peppers, and onions in Nigeria

Name of Company	Products	Brand Name
Sonia Foods	Tomato Paste	Sonia
Tomato Jos	Tomato Paste	Tomato Jos
Dangote	Tomato Paste	Dangote Tomato Paste
Oriental Food Ind. Ltd.	Tomato Paste	Luna
Hebei Global Ltd.	Tomato Paste	Hebei
GB Foods	Tomato Paste	Gino
Olam	Tomato Paste (Tasty Tom)	Tasty Tom
H.J Heinz Co. Ltd	Tomato Ketchup	Heinz Ketchup
Troli International Limited	Sauce	Pepperetti Sauce
Emy Cargo Nigeria Limited	Tomato paste	Five Star Tomato Paste
Lionseal Industry Limited	Tomato Paste	O'YES Tomato Paste
Plon Projects Ltd	Tomato Paste	Tomafresh
Crosslink International Froid Limited	Tomato Paste	Sunripe
Sunola Foods Ltd	Tomato Paste	Mom's Tomatoes Paste
Olanrewaju Foods	Pepper Powder	Hot Pepper Powder
OBE	Quick Stew	Obe Sauce
Nochiz Food Limited	Quick Stew	Quick Stew Tomato-Pepper Paste
AACE Food Processing and Distribution Company	Pepper Powder	Aace Foods Chilli Pepper
VOC Foods	Chili Pepper	Silverjay Chilli Pepper Powder
Okoti Enterprises Nigeria Limited	Tomato Paste	Rizzoto Tomato Paste
Planetbiz Nigeria Limited	Prochef Tomate	Prochef Tomate
Ali and Abdulkarim Trading CO. (AATCO).	Tomato Ketch Up	Golden Led Tomato Ketchup
Ejima Ogbadu Strategic Farms Ltd	Pepper Powder	Eji Pepper Powder
Laura Food Ltd	Quick Stew	Laura Food Stew
Erisco Foods Limited	Tomato Paste and pepper powder	Ric-Giko Red Pepper Powder, Tomato Paste
Arch Lake Resources Limited	Onion Flakes, Onion Powder, Pepper Powder	Bex Spices

Fresh Farm Integrated Concept Limited	Chili Pepper Powder	Food Basket Chili Pepper
Haycountry Food Processing and Confectionery	Chili Pepper Powder	Haycountry Chillli Pepper
E.Okenwa Global limited	Pepper Powder	Ground Pepper Sha-Sha Tasty Pepper Soup Powder
Benchmark Foods and Spices Limited	Pepper Powder	Havana Hot Pepper Powder
Yeschili Limited	Sauce	Yeschilli Hot Pepper Sauce
Solanik Nigeria Ltd.	Tomato Paste	Supplier of Derica tomato
Red Morsel	Dehydrated pepper	Red Morsel pepper
Marvico Foods	Onion Flakes	Dehydrated Onion Flakes
Iyi Foods	Pepper, Onion	Pepper and Onion mix
OGIA Company	Pepper powder	Grandma's mixed dry pepper
Vitapepe	Tomato, pepper and onion paste	Vitapepe paste
Pees	Tomato paste	Crushed tomatoes
Smiley's Kamaza	Tomato, pepper and onion	TomatoandTatashe
Zaika Foods Limited,	Ketchup	Forlic Tomato Ketchup
Apple and Pears Limited	Ketchup	Laziz Tomato Ketchup
Vital Products PLC	Ketchup	Vitali Tomato Ketchup
Sweet Nutrition Limited	Hot pepper powder	Mom's Pride Delicious
Pabod Unique Enterprises Limited	Ground Chili Pepper	Becouc Natural Food Spices
Sweet Nutrition Limited	Ginger-Onion-Garlic Spice	Mr. Chef
Vegeta	Red Onion	Shallot (Red Onion)

***Low Density Polyethylene Bags**:* Tomatoes stored in perforated polyethylene bags have been shown to have longer shelf lives than unpackaged ones. Mordi and Olorunda (2003) stored tomatoes in perforated and unperforated polyethylene films of thickness 0.05mm. A batch was kept in an evaporative cooler and another batch was kept under ambient conditions. The shelf life of tomatoes stored in the evaporative cooler was 11 days, 18 days and 8 days while those kept at ambient conditions were 4 days, 13 days and 6 days for tomatoes that were unpacked, packed in perforated films and packed in unperforated films respectively.

This confirms the effectiveness of perforated polyethylene films in keeping tomatoes longer. Agarry *et a.l* (2021) recommended polyethylene films for the storage of dried okra due to their ability to serve as a barrier to moisture loss. In their study, polyethylene packages preserved the quality of dried okra better than cotton bags and other packages. Babarinde and Fabunmi (2009) similarly confirmed that okra stored in low density polyethylene bags and kept in a plastic sieve container was able to slow down weight loss and senescence significantly.

***Postharvest Treatments*:** During harvesting, there is an accumulation of field heat in the fruits which can lead to increased metabolic activity and consequently rapid deterioration of the crop. Precooling can reduce the rate of ripening, loss of water, and deterioration, thereby extending the shelf life of harvested tomatoes. Dipping tomatoes in cold water containing disinfectants such as thiabendazole and sodium hypochlorite is effective in removing field heat while reducing microbial loads (Workneh *et al.* 2012). However, it is important to use clean water to prevent the exposure of the fruits to microbes. This may explain the unpopularity of this method in Nigeria, where access to portable water at production sites is a major challenge.

***Blanching*:** Pre-treatment of tomatoes and okra in hot water or steam before dehydration has been shown to improve the quality in terms of colour and retention of nutrient composition. It is an old practice that has remained relevant today. Blanching vegetables involve dipping in hot water for3-5 minutes or in steam for 5 minutes (Aworh *et al.* 1980).

Amber Colour Packaging for Vegetable Powders: Bala *et al.* (2021) produced onion powder by blanching in normal saline solution for 5-10 minutes, slicing to 2mm thickness and drying at 60oC for 24 hours and they explored the nutritional composition of the onion powders stored in amber-coloured jars; they concluded that storing onion powder in amber coloured jars retained the nutritional composition better than transparent coloured jars after a 6 month storage period.

Controlled Atmosphere Packaging: Controlled atmosphere involves the reduction in the rate of respiration of a fruit by altering the normal air composition of 78% nitrogen, 21% oxygen, 0.93% argon and 0.04% carbon (iv) oxide and variable quantity of water vapour. This is achieved by reducing the amount of carbon (iv) oxide and the oxygen level in an enclosed package. This storage method is viable for storing tomatoes if used alongside temperature and humidity control methods (Babarinsa *et al.* 2015).

Rudu: This is a traditional structure made with straw, it provided the cool and dark environment needed for storing onions, such as structure shaded from sunlight. With adjustments in its design to enhance proper ventilation, it can store onions for up to six months (WVC, 2018).

Falayi and Yusuf (2014) constructed a modified rudu and reported that the structure placed at 1.3m above the ground possessed the best storage properties with an average weight loss of 6.69%, low incidence of greening and black spots on the bulb after storing onions for 9 weeks. Wood was used to construct the storage cabin with a dimension of 2000mm by 1800mm by 1900 mm while asbestos was used for the roof. The columns and beams were made from softwood, while wire mesh was used as side walls. A thick wire mesh was used for the construction of the storage compartments to allow a uniform flow of air around the onions during storage.

Figure1: Traditional rudu for storing onions
Source: https://avrdc.org/building-an-improved-onion-storage-facility-in-sokoto/

REVIEW ON *TUTA ABSOLUTA* INFESTATION TECHNOLOGIES AND AVAILABLE FOR ITS CONTROL ON TOMATO

Nigeria is the largest producer of tomato in Africa and significantly contributes to the production of other major agricultural commodities (FAO 201). It was reported that *Tuta absoluta* causes more than 80% yield loss in Nigeria (Borisade *et al.,* 2017). This had caused price hikes of up to 400% in three months as *T. absoluta* destroyed the annual harvest affecting entire tomato farms across northern states in the country (Sanda *et al.,* 2017). The incident resulted in tomato shortage at the then newly commissioned Africa's largest tomato processing company (Dangote Farms Tomato Processing Factory in Kano, Nigeria). Nonetheless, Tuta resurfaced in 2017 and spreads to the northeastern states especially Gombe state (Bello *et al.,* 2016).

Major Challenges; *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) popularly known as tomato leaf miner is native to South America (Peru) and was declared a major pest of tomato in 1964 in Argentina (Cook *et al.,* 2011). It was first noticed in Spain in 2006; since then, *T. absoluta* has spread across Europe, Middle East and continues to spread rapidly across African countries. It is found everywhere across the world including Nigeria. In Nigeria, it is commonly called "tomato Ebola or Sharon". In Nigeria, Tomato leaf miner had become widespread and an important pest throughout the tomato growing regions (NAPPO 2012). However, the root cause of *T. absoluta* introduction to Nigeria is unknown and has become the most devastating pest with severe destructions in tomato producing areas (Bello *et al.,* 2016). Huge economic losses and rapid spread of the devastating pest have been recorded in recent years. The larvae penetrate the apical buds, flowers, fruits, leaves and/or stems immediately after hatching. Leaf damages are often due to the feeding habit on the mesophyll tissue which forms irregular mines on leaf surfaces and later become necrotic. Moreover, sometimes the larvae form large galleries on the stem and fruits which alter plants' general development and it also develop open wounds that serve as entry points for pathogens leading to secondary infections (Harizanova 2009).

Biology and Life cycle: *Tuta absoluta* is an important invasive pest of tomato that is almost always active at night. It mates and lays eggs during the night period. Adults are spackle brown or silver-colored with black spotted wings. The adults are often 5-7 mm long; with wing length of 8-10 mm. *T. absoluta* is a holo-metabolous insect with high reproduction rate. Females can lay up to 260 - 300 eggs leading to 12 generations per year depending on environmental conditions (Cook 2011). They undergo complete metamorphosis involving four developmental stages which are larva, pupa and adult stages that are completed within 24-30 days at favorable environmental conditions (*Tuta absoluta* 2017). The newly emerged female adults release sex pheromone that attracts the male during mating (Biondi *et al*., 2015). Females usually deposit their eggs (which are elliptical in shape, measuring up to about 1mm) on tomato leaves within 7 days of mating. The egg color varies from creamy white to bright yellow. The emerging larvae burrow into the leaves where they feed on the mesophyll tissues and develop eggs within 7-11 days (Aynalem 2018). The larvae (caterpillars) appear creamy in the first stage before turning greenish and pinkish in the final stage. They measure from 0.6 mm to 0.8 mm in length in their first larval stage and 7.3 mm to 8mm in the fourth stages. The caterpillars possess two narrow black bands on the head, one lateral and the other ventral. The pupa (Chrysalis) measures 4mm to 5 mm in size and is initially green in color before turning brown. Pupation lasts for 10 – 11 days in the soil to get rid of chemicals and strong heat. However, *T. absoluta* was reported to exhibit different pupation behaviors depending on the environment and can survive the winter as an egg, larva or adult depending on the environmental conditions (Vercher 2007).

The National Horticultural Research Institute (NIHORT) efforts in the Management of *Tuta absoluta* / Developed Technologies Complete eradication of Tuta absoluta might be very difficult but the adoption of Integrated Pest Management (IPM) strategies will best manage the infestation. These involve the use of modern methods such as Tray Trap Technology (TTT) and biological control methods such as the use of parasitoids and predators, as well as minimized synthetic chemical usage which results in the development of resistance. Recently, the National Horticultural Research Institute, Nigeria (NIHORT) developed, tested and patented two indigenous bio-pesticides for the management of Tuta and Fall Army Worm (Spodoptera frugiperda) of maize: NIHORT-Raktin and NIHORT-Lyptol, (Oke 2015).

NIHORT-Raktin and NIHORT-Lyptol: The two biopesticides are products of scientific research by the Integrated Pest Management Technology Development Center of NIHORT. The two biopesticides are of plant origin and have proven very effective against the management of the larval stages of *Tuta absoluta* which is the most destructive stage of the moth that causes great injury to tomato plant.

The Tuta Trap Tray was perfectly designed to manage the adult stage of the moth; it has effectively proven to trap large population of the nocturnal adult invasive pest. Over 1500 and 2000 adult *Tuta absoluta* was reported to be trapped over night on farmer field in beri-beri and bomo respectively (Oke 2015).

O-Ruptur: is a plant-based soil drenching biopesticide targeted at the pupa stage of *Tuta absoluta*. Pupa have also been discovered to hibernate in the soils where infestation have occurred. Thus, it is very important to prevent the pupation phase of the moth so as to reduce the population of emerged adults.

IPM technologies developed by NIHORT to manage *tuta absoluta*

NIHORT-Raktin NIHORT-Lyptol O -RUPTUR

Old Recharge Light Tuta Trap Tray New Solar Powered Tuta Trap Tray

Biopesticide Processing Plant *LPG 15 Spray Dryer*

LPG-15 Spray Dryer: The dryer is another landmark achievement of NIHORT in improving the quality of the two biopesticides. The dryer has the capacity of converting the liquid biopesticide into powder thereby reducing the labour and cost incurred in the transportation of these products. The machine has the capacity of processing about 3000 litres of the product into powder

Challenges in producing Tuta absoluta Products:

1. One of the major challenges faced with the production of the Tuta Trap Tray is the difficulty in importing of solar lamp component of the insect trap coupled with the high cost of purchase which eventually tends to put the unit price of the device on a high side.
2. The customized plastic kegs for packaging the liquid biopesticides have become so expensive due to rising cost of items, it has also negatively contributed to the total unit cost of the biopesticide.

Opportunities in Producing Tuta absoluta Products:

There are a lot of direct and indirect benefits or opportunities the production of management packages will bring about.

1. In the past few years, the Integrated Pest Management Technology Development Center has continuously engaged over 40 daily paid staffs for various activities that brings about the NIHORT-Lyptol, NIHORT-Raktin biopesticide and the Tuta Trap Tray (TTT). Youth and women are engaged in the harvesting of plant materials, bagging, scaling, loading, off-loading, grinding, bagging of grinded leaves, soaking of samples, filtering, bottling, corking and storing. Every stage of production employs labour who gets paid daily. The production of these biopesticide will create employment opportunities.
2. The over dependency on imported synthetic insecticides will be greatly reduced thereby strengthening local cottage biopesticide factories.
3. The production of healthy tomato fruits will be achieved with the production of *Tuta absoluta* products. More farmers will be willing to cultivate more hectarage of tomato farm with the assurance of the efficacy of the products. There is an assurance of improved living conditions for the tomato farmers as a result of increased yield due to the availability of Tuta control packages for any eventual infestation.
4. The development and availability of Tuta control packages will guarantee more raw material for the tomato processing factories, which will also generate more employment.

Ways of scaling up the available products in commercial quantities:

The private sector needs to partner with the National Horticultural Research Institute in this regard, some of these developed technologies and products need to be commercialized and made into a full business, there are lots of stakeholders in this value chain that stands to benefit from this product of research. Nigeria Agric Business Group (NABG), Agro- chemical companies, private farm owners, Russell IPM and the Federal Government. Investing to scale up these products will surely reduce production cost and expand the market base of these products. Its visibility has been limited to few parts of the country because it has not been commercialized. Partnerships for mass production of these products should be a smooth process with the fact that they have all been registered and patented by the relevant Federal Government agency.

Identify the market actors responding to these market opportunities:

The major actors identified are the private sectors, these products can only be scaled up for business. When the commercial aspect is allowed to be driven by Nigeria Agric Business Group (NABG), Agro chemicals Industries, Seed Companies, Russell IPM, Private farm owners and a host of other business minded individuals with the Federal Government making policies and regulating prices, more funding can then be channeled towards research.

Other technologies available for controlling Tuta absoluta

KOPPERT Biological Systems, Netherlands

Tutasan Pheromone tray

Sex pheromones are chemical signals released by an organism to attract an individual of the same species of the opposite sex for mating. Among the 120,000 or so known moth species, the preponderant system for finding a mate is upwind flight by the male toward an attractant sex pheromone released by the female (Cardé *et al.*, 1995). The majority of female sex pheromones identified in Lepidoptera consist of a mixture of two or more compounds, which not only evoke long-range male attraction but also elicit courtship behavior (Linn *et al.*, 1987). As an example, the female sex pheromone of *T. absoluta* consists of two components.

Sex pheromones have been widely used to monitor, forecast or control populations of moth pests (Prasad *et al.*, 2012). The most widespread and successful applications of sex pheromones concern their use in detection and population monitoring (Witzgall *et al.*, 2010).

They are also used to control insect populations, which is achieved by two main techniques: mass annihilation and mating disruption (Witzgall *et al.*, 2010). Sex pheromone management strategies are based on the sexual reproduction of the targeted pest. A study by Caparros Megido *et al.* (2012) recently confirmed that *T. absoluta* females were also able to reproduce without mating (i.e. parthenogenetically). Asexual reproduction as well as the polygynic nature of *T. absoluta* males could have strong implications for the efficiency of sex pheromone management strategies and must be considered in further studies on these control strategies (Silva, 2008; Caparros Megido *et al.*, 2012).

Challenges with Koppert Tutasan Tray

The pheromone used as for attracting the insects to the tray needs a cold chain throughout its supply chain. This has been difficult to maintain in the Nigerian environment. Thus, this product has not been consistently available in the market

Mirical

Mirical

Mirical (Macrolophus pygmaeus) is used for biological pest control of certain whiteflies and is also effective in controlling Tuta absoluta . It contains predatory bug nymphs.

Horiver tuta traps

In young crops, the sticky traps need to be hung up vertically, just above the ground surface (15-25 cm). In mature plants, the traps may be hung slightly higher if appropriate (approximately 50 cm above the ground surface). For prevention, it is recommended to use one sticky trap per 500 m2 while one trap per 100 m2 is recommended for curative. Sticky traps are essential in the detection and partial elimination of many species of flying pests.

Horiver tuta sticky traps

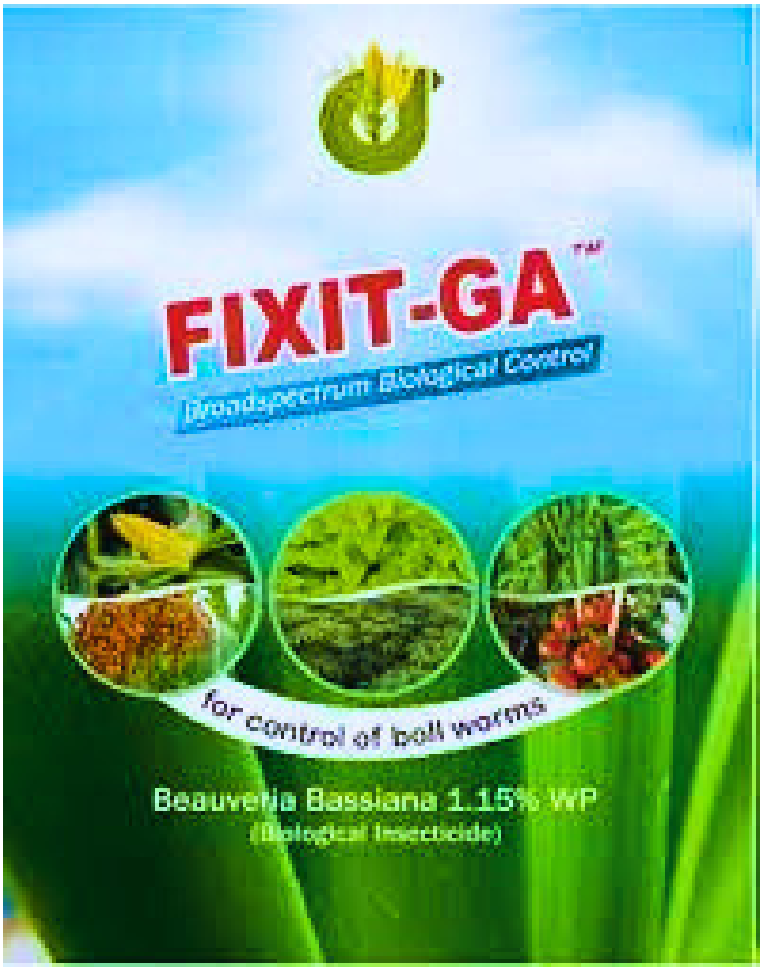
Horiver tuta sticky cards

Factors responsible for the effectiveness of Tuta sex Pheromone

1. The attractant sources
2. Trap position (Trap height and position with respect to vegetation)
3. Trap density
4. Level of infestation

Contec Agro Technology

This has also been a major player in the fight against *Tuta absoluta* in Nigeria, the company has also come up with a bio-product called Fixity GA which was used alongside some other biopesticides on farmers field in Kura Local council in Kano state in 2016. The product is a broad-spectrum biological insecticide.



FIXIT- GA for control of Tuta by Contec Agro Technology

Other Pesticides

Tihan Insecticide is one of the insecticides sold by Bayer in Nigeria. It contains Spirotetramat 75 g / L + Flubendiamide 100 g / L. It acts by contact and ingestion. Tihan insecticide is formulated as dispersible oil which makes it stick better and longer on the surface of leaves and other parts of a plant. This is an advantage as it ensures that the insects and parasites cannot escape the insecticide. It has been recommended that 0.2 litres to 0.4 litres of Tihan insecticide should be used per hectare and treatment should commence upon sighting the infestation of insects. This should be followed by 2-3 treatments within 14 days.

Tihan insecticides

Tutaforce is a systemic fungicide for controlling a wide range of diseases in vegetables, fruits and field crops. It contains 36% Chlorfenapyr. Chlorfenapyr is a pesticide that can disrupt the production of ATP, cellular death, and ultimately organism mortality. It is derived from a class of microbially produced compounds known as halogenated pyrroles. It is distributed by Jubaili

Tuta force

Table 1:

Available Technologies on *Tuta absoluta*	NIHORT	KOPPERT AND OTHER COMPANIES
1.	IPM; The Integrated Pest M anagement of *absoluta* must focused on realizing the following national goals: 1) to contain the economic damage of leaf miner, 2) to prevent the development of resistant strains of *T. absoluta* and 3) to prevent the accumulation of	Pheromone; Sex pheromones are powerful chemicals secreted by female insect to attract the male counterparts for mating. It is detected by the males, assisting them in locating the females for mating. The female sex pheromone of *T. absoluta* for instance, consists of two

	insecticide residues in the food chain. Therefore, these management strategies can be categorized as follows; i) Chemical control ii) The use of pheromone traps and mass trapping (Tuta trap tray) ii) Cultural control iv) Biological control v) Resistant varieties and vi) Biopesticides.	components. The major component, which represents about 90% of the volatile material found in the sex gland of calling females was (3*E*, 8*Z*, 11Z)-3,8,11 tetradecatrien-l-yl acetate or TDTA [Roditakis *et al.,* 2015]. Sex pheromones have been widely used to monitor, forecast or control populations of moth pests [Linn *et al.,* 1987]. To monitor *T. absoluta*, pheromone lures are principally coupled with Delta traps [Hassan 2010]. Various companies such as ISCA Technologies (United States), Russell IPM Ltd. (United Kingdom), Koppert Biological Systems (The Netherlands) and PRI Pherobank (The Netherlands) had manufactured different kind of these traps for *T. absoluta*

		manageme (Harizanova, nt 2009).
2.	Tuta Trap Tray and Tray Trap Technology (TTT); NIHORT developed simple, effective, efficient and sustainable technology known as Tray Trap STechnology (TTT) that can attract, trap and kill more than five thousand adults per tray [Oke 2015]. This control measure employed and recorded massive successes in curtailing the menace of leaf miner pest in Nigeria, Methodology; The tool is sold to local farmers at affordable rates within the outbreak areas.Moreover,the technology consists of a tray filled with water containing small amount of detergent (without foam). A lamp is placed on a solid support at the center but not completely dipped into the water. The whole system is placed in the farm but away from canopies and the lamp	Some microbial have been registered by several companies as biopesticides including *Trichoderma harzianum* traded by Koppert® as Trianum®, Bt products by Monsanto, neem plant extracts by Organix Ltd and Amiran Kenya Ltd among others (Dunham, 2016; Infonet-Biovision, 2015). Genes of some of these microbes are inserted into plants and are used to enhance defense mechanisms of the plants against diseases or could help the plant to produce substances that are harmful to the pests or pathogens (Srijita, 2015).

	attracts adult *T. absoluta* pests during nights. The adults flap around the light and suddenly fall into the solution and remain captive.	
3.	Bio-pesticidal control; Bio-pesticides have the ability to balance between environmental safety and enhanced agricultural productivity. NIHORT developed three new biopesticides for the control of *T. absoluta* at different stages. These are the NIHORT Raktin, NIHORT Lyptol and O-Ruptur. The NIHORTRaktin is an emulsifiable suspension from Neem tree that contains Azadirachtin as the primary active ingredient. NIHORT-Raktin is a natural extract that controls such insects as *T.absoluta,* army worm. NIHORT-Raktin is sprayed on.	Agricultural extension approaches can be used to convey practical agricultural solutions to farmers and the use of breeding and molecular approaches in order to bring forward resistant varieties could be the most sustainable control strategy. Implementing an IPM approach with farmers using predatory mirid *Macrolophus Pygmaeus* (MIRICAL) and the pheromone trap systems, in which it is hoped that such a strategy result in

FIELD SURVEY OF AVAILABLE POSTHARVEST TECHNOLOGIES

Data were collected from stakeholders in horticulture in Ogun and Oyo States through the aid of structured questionnaire which was administered via the telephone. Seventy respondents were targeted but only 51 were interviewed fully due to the fact that some respondents did not respond to phone calls while some declined participation in the course of the interview. Information solicited from respondents included among others socioeconomic characteristics of respondents, postharvest handling practices, profitability and sustainability of the practices, causes and control for postharvest losses as well as the challenge and control of *Tuta absoluta*. Each interview lasted between 30-40 minutes

Socio-economic characteristics of respondents: Majority of the respondents were male, within the age range of 31-40 years and married (Table 2). All the respondents were educated up to the tertiary level and are mostly producers followed by development agencies and those offering logistic services. More than 50 percent of the respondents have between 1-10 years' experience in horticulture. A larger percentage does not have access to credit facilities (74.5%) and extension services (58.7%) and are not members of any horticulture related association.

Crop production: As shown in Table 3, not less than 80 percent of the producers cultivate tomato and pepper, a little below fifty percent cultivate okra, while only very few cultivate onions in the study area. Most of the farmers interviewed planted hybrid seeds of tomato, pepper, okra and onion, while very few cultivate local and open pollinated varieties. Majority of the farmers cultivate between 0.5 – 5 acres of land, while the mean land size cultivated was 24.30 acres.

Table 2: Socioeconomic characteristics of respondents

Variable Gender	Frequency	Percentage
Male Female		
	41	80.4
	10	19.6
Age (years)		
≤ 30	12	23.5
31-40	22	43.1
41-50	9	17.7
>50	8	15.7
Mean	40.00	
Marital status		
Single Married	33	64.7
	18	35.3
Level of education No formal	-	-
education Primary	-	-
Secondary Tertiary	- 51	- 100.0
Position in value chain		
Producer/marketer Logistic services	45	86.3
Agro dealer Development agency	2	3.9
Processor	1	1.9
	2	5.9
	1	2.0
Experience in horticulture (years)		
1-5	24	47.1
6-10	15	29.4
11-15	6	11.8
>15	6	11.8
Mean	7.69	
Access to credit facilities		
Yes No	13	25.5
	38	74.5
Access to extension services	19	41.3
Yes No	27	58.7
Association membership	20	39.2
Yes No	31	60.8

Source: Survey, 2022

Table 3: Distribution of farmers cultivating the target crops

Variable	Frequency	Percentage
Crops grown		
Tomato	40	88.8
Pepper	36	80.0
Okra	22	48.9
Onions	7	15.6
Type of variety		
Tomato		
Hybrid	37	82.2
Local	1	2.2
Both hybrid and local Open pollinated (OPV)	2	4.4
Pepper	1	2.2
Hybrid	33	73.3
Local	1	2.2
Both hybrid and local Open pollinated (OPV)	1	2.2
Okra	-	-
Hybrid	20	44.4
Local	1	2.2
Both hybrid and local Open pollinated (OPV)	-	-
Onion	-	-
Hybrid	8	17.8
Local	-	-
Both hybrid and local Open pollinated (OPV)	-	-
Land size (acres)	24	53.3
≤ 5	8	
6-10	5	17.7
11-20	4	11.1
≥20	24.	8.9
Mean	30	

Postharvest handling techniques practiced by stakeholders: The results in Table 4 reveals the postharvest activities carried out by the stakeholders. Harvesting is mostly done manually by handpicking the vegetables in the morning and evening when the atmospheric temperature is low. Majority of the farmers sort their produce based on size in order to increase the market value by making it attractive to customers. The fresh produce is usually packaged to market in plastic crates. According to the respondents, plastic crates prevent damages of the produce and also allows proper aeration during transportation. Other packaging materials identified were raffia baskets, jute bags, carton boxes and polythene bags. Produce are rarely stored beyond 24

hours due to their perishable nature but when there is need to store in the case of delayed logistics, they are kept at room temperature or under shade. Almost all the respondents target the fresh market and therefore do not process their produce except for few who slice, juice or dry. The produce are mostly sold in the open food market in Lagos city except for very few who target premium markets such as supermarkets, food restaurants/eateries/fast food joints. The commonest means of transporting produce to market is via cars followed by trucks. The following photos display the technologies sighted during field visits

Packaging of dried pepper into Polyethylene bags

Stacked plastic crates

Scaling of tomatoes

Use of plastic crates for packaging tomatoes

Cold room of different sizes

Cooling van

Postharvest loss: As shown in Table 5, majority (66.7%) of the farmers had experienced postharvest losses at one point in time between 1-25% of their harvest and the crop that was mostly affected by postharvest loss is tomato (28.9%) due to its high perishable nature. The loss is mostly experienced at the market level and at the point of harvest (40.0% and 24.4%, respectively). Furthermore, respondents identified poor storage (22.2%), poor transportation system (11.1%), type of variety grown (8.9%) and inadequate knowledge of postharvest handling as major causes of postharvest loss. Major effort made so far by the respondents to reduce postharvest losses are enhancing their accessibility to market information (13.3%), cultivating improved variety (8.9%) and targeted harvest (8.9%). Targeted harvest saves farmers from taking produce to market when there is glut. In order to prevent postharvest loss, respondents need support in the area of training, credit facilities, extension services and improved technology, while technologies such as cold storage, green and packing houses need to be scaled-up.

Table 4: Postharvest handling activities

Variable	Frequency	Percentage
Postharvest technique		
Harvesting	43	95.6
Cooling	14	31.1
Sorting	42	93.3
Grading	34	75.6
Storage	20	44.4
Period of storage:		
Less than 24 hours	6	13.3
24 hours and above	7	15.6
Processing:	3	6.7
Drying	2	4.4
Juicing	2	4.4
Slicing		
Packaging materials:		
Raffia basket	7	15.6
Jute bag	2	4.4
Plastic crate	23	51.1
Basket and crate	4	8.9
Polythene bag	1	2.2
Mode of transportation:		
Car	36	80.0
Truck	4	8.9
Motorcycle	1	2.2
Marketing:		
Online	1	2.2
Open market	22	48.9
Both	16	35.6

Table 5: Information on causes and prevention of postharvest loss

Variable	Frequency	Percentage
Postharvest loss experience:		
Yes	30	66.7
No	15	33.3
Crops mostly affected		
Tomato	13	28.9
Pepper	4	8.9
Okra	-	-
Onion	-	-
Percentage loss:		
1-25%	11	24.4
26-50%	9	20.0
51% and above	10	22.2
Point of loss:		
At harvest	11	24.4
After harvest	1	2.2
Transportation	8	17.8
Market level	18	40.0
Causes of postharvest loss:		
Poor variety	4	8.9
Untimely harvest	3	6.7
Long distance to market	1	2.2
Poor storage	10	22.2
Poor transport system	5	11.1
Inadequate processing and storage	1	2.2
facilities Inadequate knowledge	4	8.9
Effort to prevent postharvest loss:		
Application of pesticides/insecticides	2	4.4
Acquisition of more knowledge	2	4.4
Access to market information	6	13.3
Timely harvest	2	4.4
Targeted harvesting	3	6.7
Cultivating of improved variety	4	8.9
Use of improved technology	2	4.4
Use of good packaging materials	3	6.7
Water reduction	2	4.4
Support need for postharvest loss prevention		
Credit facility	8	15.7
Training	9	17.6
Extension service	4	7.8
Market accessibility	2	3.9
Improved technology	4	7.8
Viable seeds	1	2.0
Good drainage system	1	2.0
Technologies to be scaled up		
Green house	7	13.7
Packing house	4	7.8
Cold storage	18	35.3
Chain technology	1	2.0
Processing	1	2.0

Irrigation	1	2.0
Plastic mulching Ready market	1	2.0
	1	2.0

Tuta absoluta experience: Results in Table 6 reveal that most of the respondents are aware of the existence of *Tuta absoluta* and got to know of it mostly through personal experience (23.5%), colleagues (19.6%) and the media (15.7%). More than 70.0% have not experienced it at all and the pest is mostly controlled with pheromones, *Tuta* trap, *Tuta* force, *Tuta* absolute and NIHORT bio- pesticide among others. However, NIHORT bio-pesticide is not yet known to most of the respondents and of the few who are aware of it, they got to know about it through extension workers and staff of NIHORT. Only one respondent indicated that he had used NIHORT bio- pesticide and found it very effective.

Table 6: ***Tuta absoluta awareness and control***

Variable	Frequency	Percentage
Are you aware of *Tuta absoluta*		
Yes	34	66.7
No	14	33.3
Source of information		
Personal experience	12	23.5
Fellow farmers	11	19.6
Media	8	15.7
Friends	1	2.0
Have you encountered *tuta* on your field	15	29.4
Yes		
No	36	70.6
Tuta control		
Use of insecticide/pesticide		
Products used for total control	1	2.0
Pheromone	2	3.9
Tuta trap	3	5.9
Tuta force	1	2.0
Tuta absolute		2.0
NIHORT pesticide	1	47.1
Other insecticides	24	9.8
Have you heard of NIHORT bio-pesticide		
Yes	5	90.2
No	46	
How did you get to know NIHORT bio-pesticide		
Co-farmers		-
Friends	-	3.9
Ministry of agriculture	2	-
Extension workers	-	3.9
Media	2	-
Have you used NIHORT bio-pesticide	-	
Yes		2.0
No	1	98.0
Effectiveness of NIHORT bio-pesticide		
Very effective	50	
Effective	1	
Neutral	-	
Ineffective	-	
Very ineffective	-	
	-	

MAPPING OF POSTHARVEST AND *TUTA ABSOLUTA* - RELATED LOSSES

Although tomatoes are commonly produced almost in all states (24 out of the 36 States of Nigeria), Kano and Kaduna states jointly produce more than 50 percent of all the tomatoes in the country and this is why tomato actors in the two states were purposively selected and interviewed. Oyo and Ogun State are major producing states in the South; thus, they were included in the study. Lagos State was also included because it houses a major market for tomato in Nigeria Secondary data and information were collected through desk reviews of published literatures and primary data collected with the aid of semi-structured questionnaires administered by the researchers from the National Horticultural Research Institute.

One hundred and seventy-five (175) key actors in tomato value chain (93 from the north and 82 from the south) were purposively selected from NIHORT and IFDC database, and recommendations from existing contact. Stakeholders who were actively involved in the value chain were targeted. Visits were made to their locations to validate their active participation in tomato production, processing, transportation, or marketing. Key informant interview was conducted one-on-one. Tomato farms, major markets, haulers who transport produce were the major stakeholders identified and interviewed in this study.

Results

The results of tomato mapping in the study areas are presented and discussed in this section. The states are grouped into two; north and south. The north comprises both Kano and Kaduna states while Ogun, Oyo and Lagos states represent the southern part of the country

Table 1 A : Socioeconomic characteristics of Respondents

Characteristic	Mean North	Mean South
Average Age of Farmers (years)	36.00	38.00
Average Age for Marketers (years	36.00	42.00
Average Age for Processors (years)	44.00	35.00
Average Age for Transporters (years)	44.00	44.00
Number of years in School		
Farmers	12.00	13.00
Marketers	12.00	12.00
Processors	13.00	12.00
Transporters	13.00	13.00
Years of Experience		
Farmers	25.00	16.00
Marketers	17.00	11.00
Processors	15.00	8.00
Transporters	15.00	9.00

The socio- economic characteristics of the respondents is presented in table 1A. The mean age of tomato farmers in the northern part of the country (Kano and Kaduna states) was 36 years while that of farmers from the South (Oyo, Ogun and Lagos states) was 38 years. This mean age shows that the tomato farmers are in the economically active age group and this is an advantage for the productivity of the crop. Similarly for tomato marketers, the average age of respondents in the north was 36 years while the marketers from the south were a bit older, at a mean age of 42 years. For both the north and south, the mean ages fell within active years. The processors and transporters in both the north and south were also relatively young, and this may enable them to perform well in the value chains where they belong.

With respect to the number of years spent in school, the tomato actors in both the north and south spent an average of 12 - 13 years in one form of educational institution or another. This implies that these actors should be able to understand and adopt improved farming, marketing and processing technologies as may be required.

The years of experience on the job was also captured. The tomato farmers in the north had more years of experience in tomato farming with a mean of 25 years while those in the south had a mean of 16 years of experience in tomato farming. Tomato marketers in the north had an average of 17 years in the marketing business while their counterparts in the south had 11 years tomato marketing experience on the average. The processors in the northern part of the country had an average of 15 years' experience in processing of tomato while those from the south had an average of 8 years in tomato processing. With respect to transportation, the transporters in the north have been in the business for an average of 15 years while those in the south had an average transport experience of 9 years.

Table 1B : Socioeconomic characteristics of Respondents

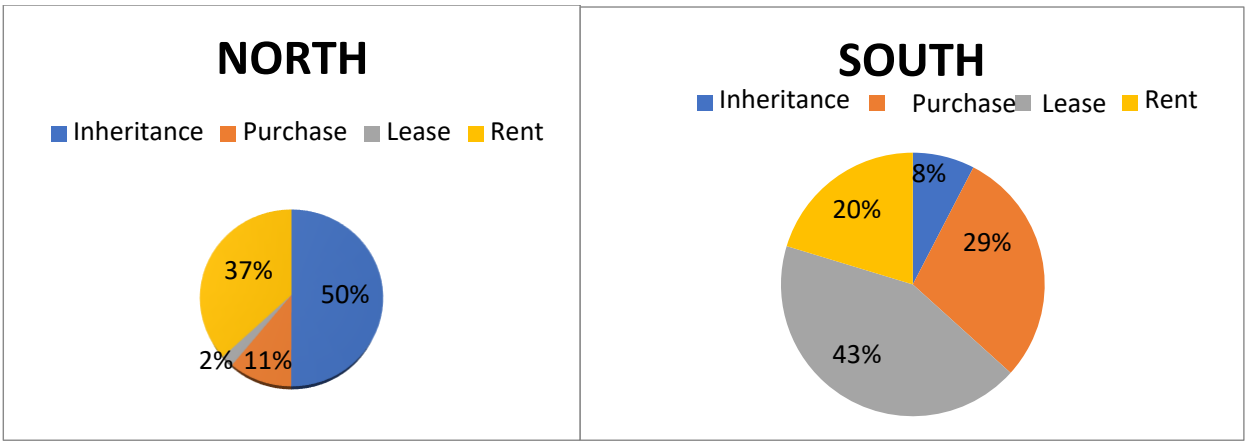
Characteristic	No (%)				No (%)			
	North				South			
	Farmer	Marketers	Processors	Transporters	Farmer	Marketers	Processors	Transporters
Sex								
Male	45(91.8)	9(64.3)	9(69.2)	17(100)	66(83.5)	18(90.0)	20(66.7)	17(100)
Female	4(8.2)	5(35.7)	4(30.8)	0(0.0)	13(16.5)	2(10.0)	10(33.3)	0(0.0)
Educational Status								
Quranic	12(24.5)	0(0)	2(15.4)	3(17.6)	1(1.3)	0(0)	0(0)	3(17.6)
Primary	4(8.2)	4(28.6)	4(30.8)	2(11.8)	11(13.9)	0(0)	0(0)	2(11.8)
Secondary	28(57.1)	6(42.9)	6(46.2)	0(0)	12(15.2)	10(85.0)	15(50.0)	5(29.4)
Tertiary	4(8.2)	4(28.6)	1(7.7)	7(41.2)	51(64.6)	0(0)	1(50.0)	7(41.2)

Table 1B describes the sex and educational status of the respondents in the study area. These variables have implications on technology adoption as well as post-harvest practices. The results shows that there were more male tomato farmers in the north (91.8%) than females. There were also more male marketers and processors in the north and the transporters were all males. This distribution shows the gender roles in the region as male involvement in the tomato value chain was higher than those of the females.

In the south, there were also more male farmers than females, but more female (90%) marketers than males. There were also more male processors than female ones and all the transporters were males.

With respect to educational status, tomato farmers, marketers and processors in the north had primary and secondary school education in addition to quranic education. In the south, all actors had at least a secondary school education with marketers having the highest percentage (85%) of educated members followed by processors (50%). A few of the actors had tertiary education in the north whereas tomato value chain actors with tertiary education were more in the southern part of the country.

Figure 1 : Land ownership structure

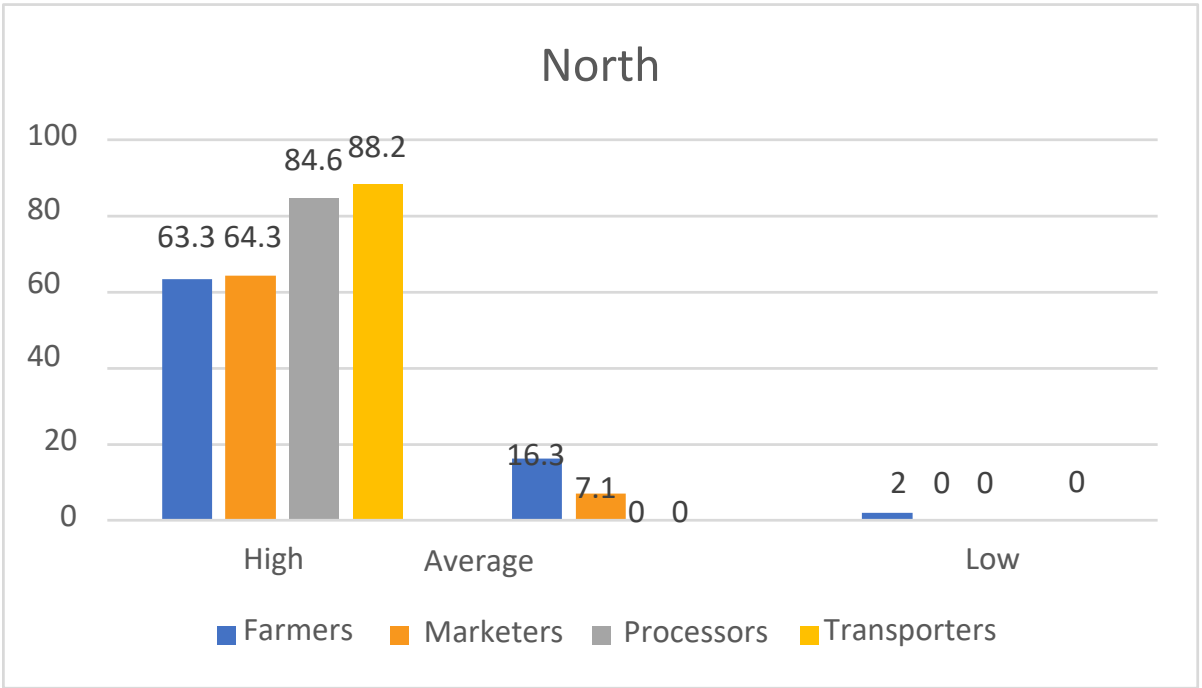


Land is a very important input factor of production in agriculture. The land ownership structure of tomato farmers in the study areas is shown above.

In the northern states of Kano and Kaduna, land purchase and leasing were not so common as many (50%) farmers acquired their farmland through inheritance and rentage (37%). This partly explains why the bulk of tomato comes from the north where land is readily available. This form of ownership structure also allows for some degree of freedom in production decisions as well as adoption of technologies.

In the southern part of the country however, ownership of land by inheritance is uncommon as only 8% of farmers cultivated on inherited land. Thus, land used for agricultural activities is acquired through leasing (43%), purchase (29%) and rentage (20%). Most of the land is being used for housing or companies as these states in the south are peri-urban or urban. So, the lands are only released and made available for agricultural activities in the short and medium term only. Thus, the production of tomatoes in the south is relatively small when compared with the quantity of tomatoes from the northern part of Nigeria.

Figure 2: Knowledge of Tomato Post Harvest Loses



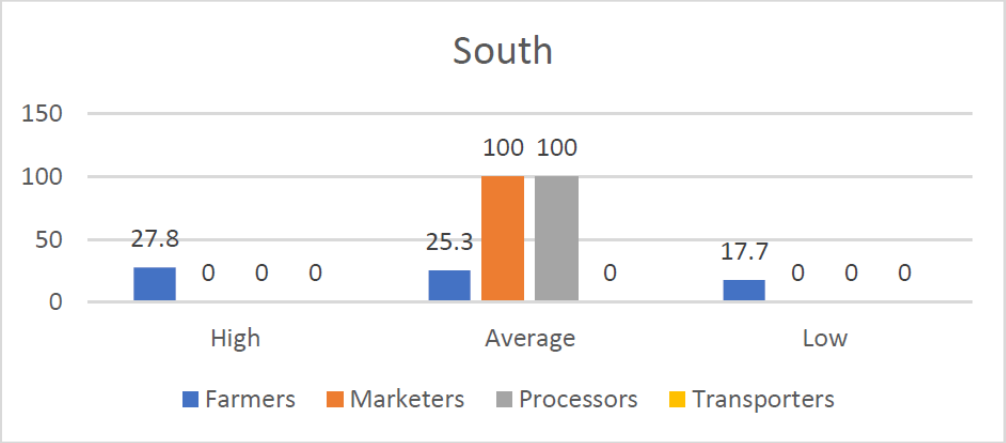
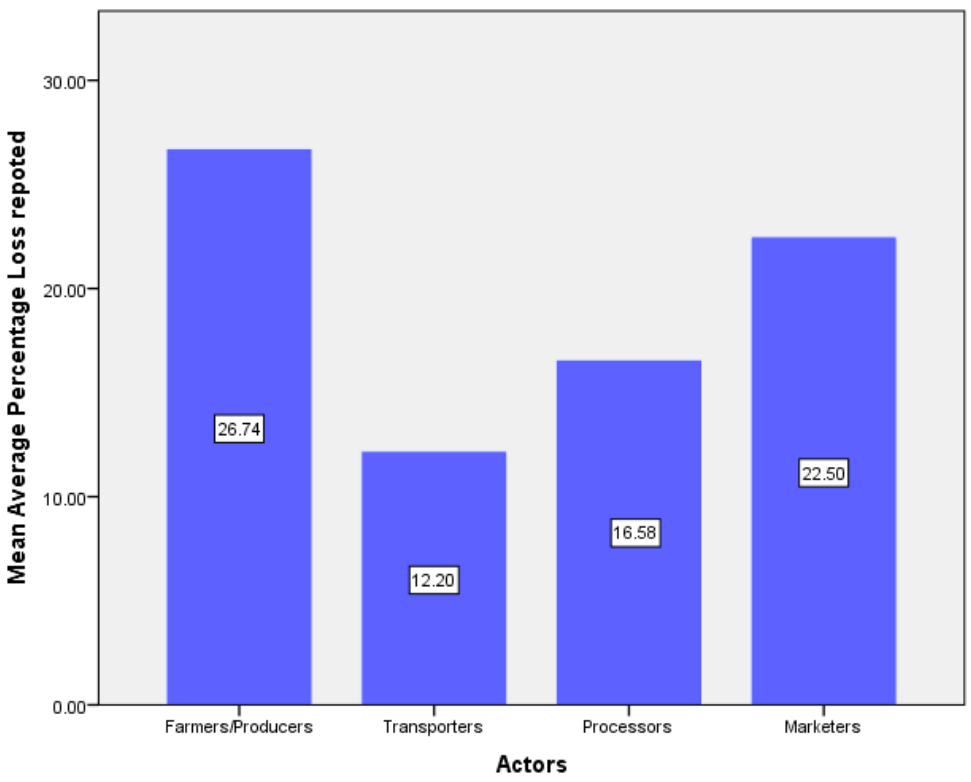


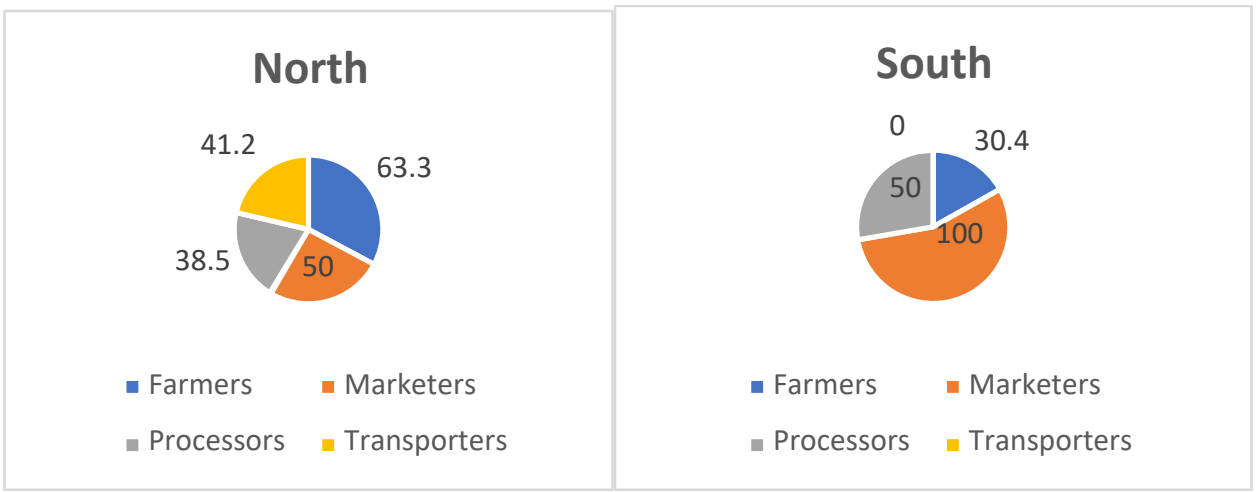
Figure 2 depicts the knowledge of the different value chain actors on postharvest losses of tomato. In the north, knowledge of postharvest losses in tomato was quite high generally. More than 80% of processors and transporters were aware of the huge losses in tomato after harvest. Similarly, postharvest knowledge of losses among tomato farmers and markers was high at over 60%. In the south however, knowledge of tomato postharvest losses was on the average among marketers, processors and even farmers.

Figure 3 Percentage postharvest loss experienced by different group of actors



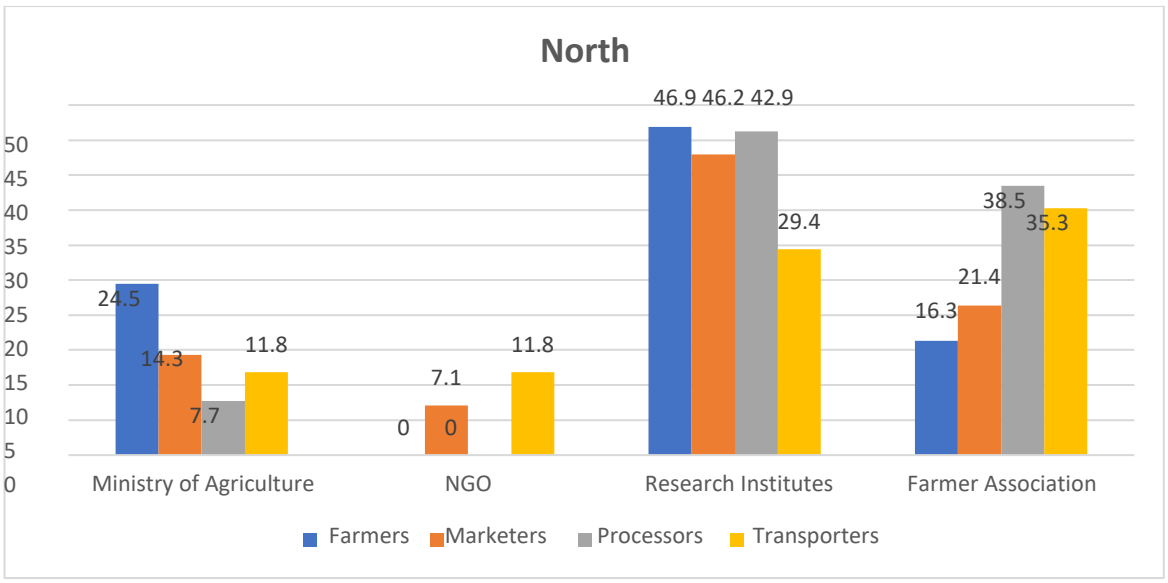
The level of losses reported by actors in tomato value chain is displaced in figure 3. Producers reported the highest level of loss (26.74%), followed by marketers (22.5%), processors (16.58%) while transporters reported only 12.2% losses.

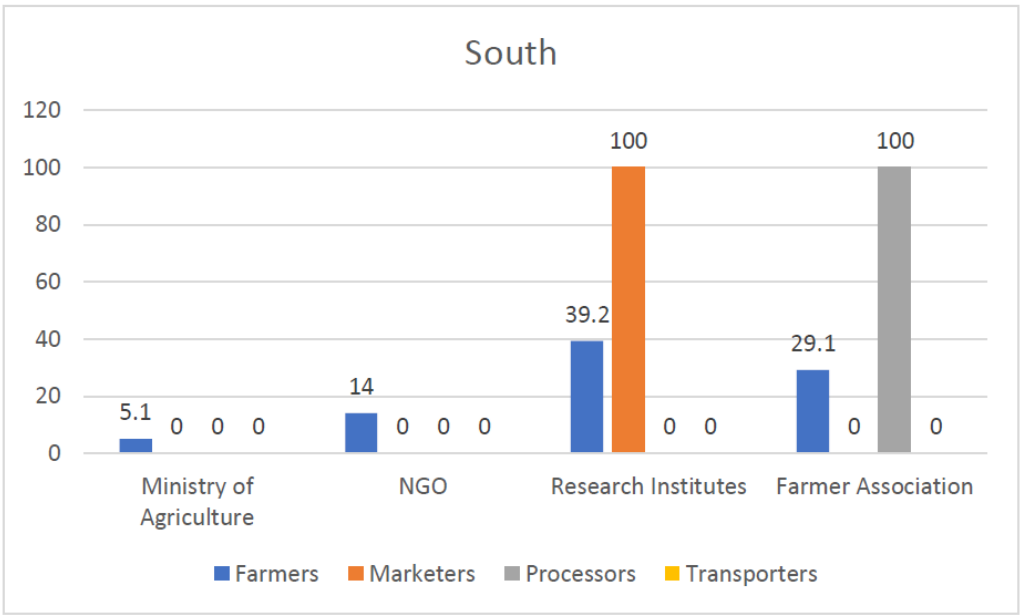
Figure 4: Awareness on intervention to Mitigate Tomato Loss



The level of awareness, among value chain actors, on measues to mitigate tomato losses is captured in figure. 4. In the north , there was general awareness amongst all actors. Awareness was relatively high among farmers (63.3%) , marketers (50%) and 41% among transporters. The processors were the least (38.5%) aware of tomato losses mitigation interventions. Awareness levels on tomato losses interventions programmes was highest amongst markerters, followed by processors and farmers.

Figure 5: Tomato-post harvest losses Intervention

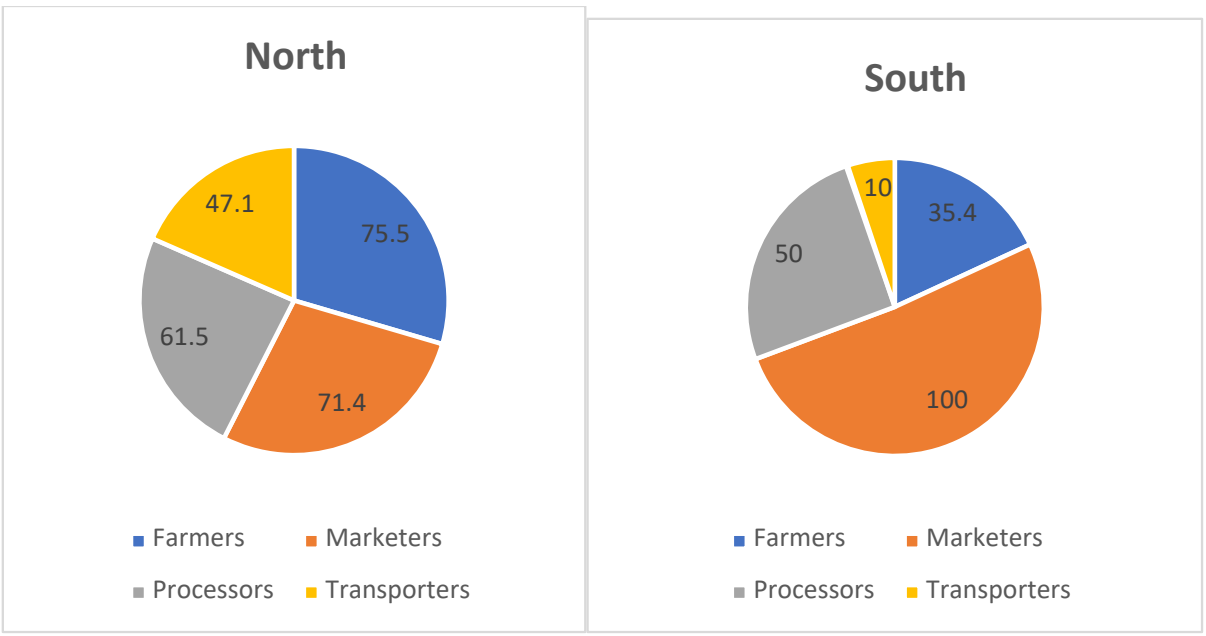




The facilitators and technical actors who carry out interventions in tomato value are shown in figure 5. For respondents in the north, the Federal Ministry of Agriculture and Rural Development built capacities of farmers, marketers as well as processors of tomatoes. Some NGOs were also reported to have built the capacities of marketers and transporters. Intervention was also done by research institutes for all categories of actors across board. Finally, farmer groups and associations also trained their members on how to handle losses of tomato. These

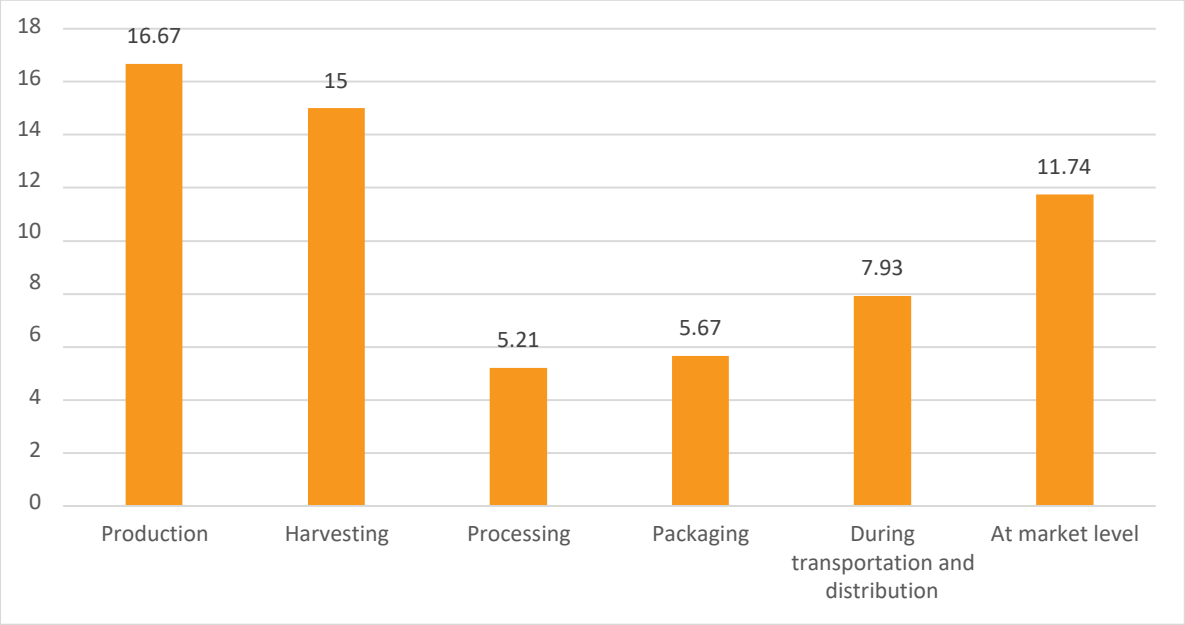
association's activities or programs were targeted mostly at tomato farmers (29%) and processors (100%). This may explain the high level of knowledge observed among actors in the north.

Figure 6: Participation in Tomato Post-harvest Programs/Intervention



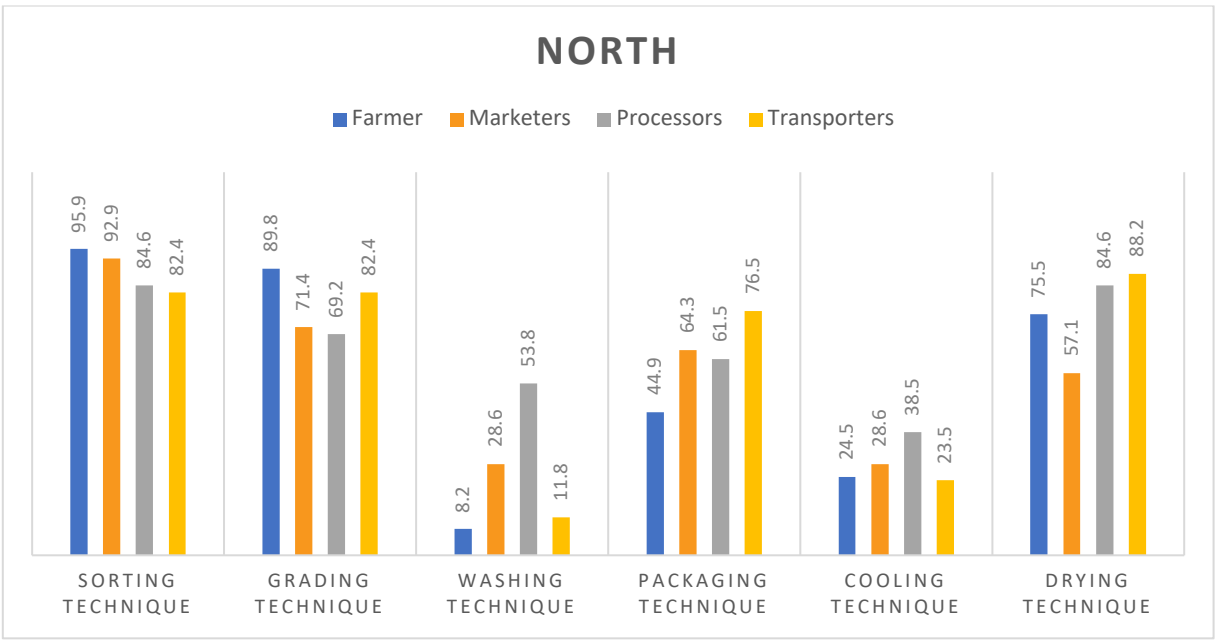
In figure.6, the rate of participation of value chain actors in tomato-postharvest programs was analyzed. Participation rates are generally high in the north among farmers, marketers, processors as well as transporters. This is probably due to the fact that huge tomato production is done in the north. Similarly in the south, participation in postharvest programs is highest among tomato marketers. This is followed by processors and then farmers. Transporters of tomatoes in the south participate in the least at postharvest programs.

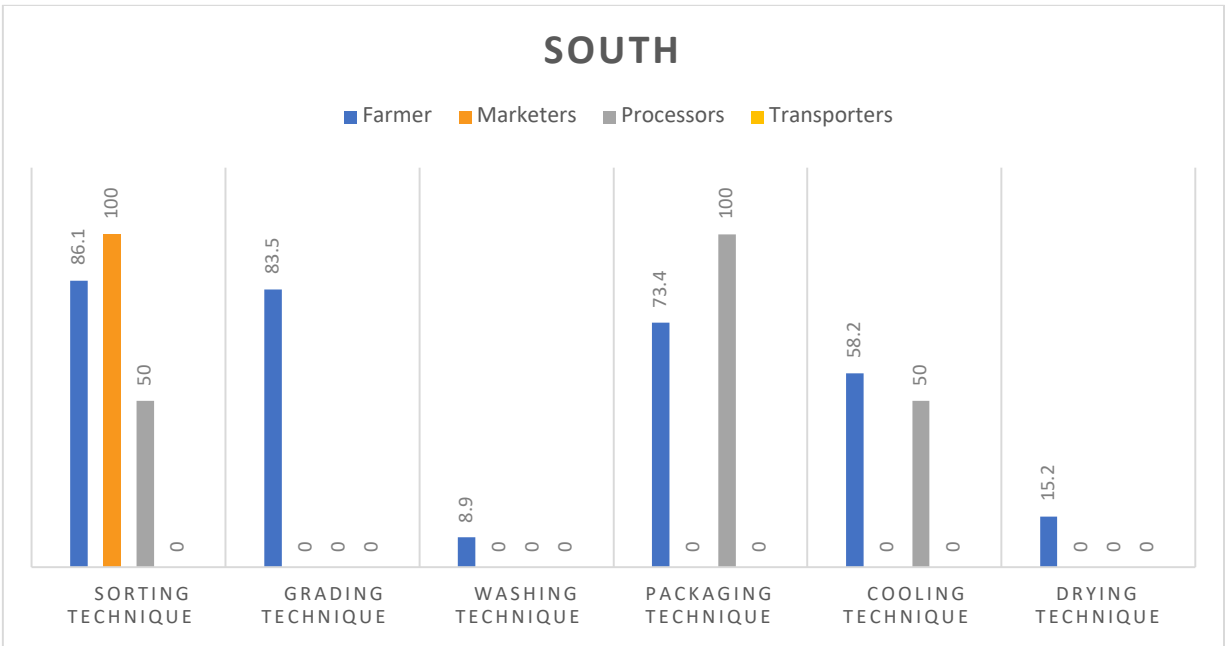
Figure 7: Hotspots for losses.



Tomato post-harvest hot sports is captured in figure 7. Losses in tomato is highest at the farm/production and harvesting stages. This is probably due to poor production and management practices, and the effects of pest and diseases. The method of harvesting could also result in losses as tomatoes are vegetable fruits with delicate skin coat that gets easily damaged when not properly handled. The losses at the market level are also relatively high. Damages at this stage could be from poor packaging, mechanical injury during loading /offloading and lack of storage infrastructure. During transportation and distribution, losses are also experienced. Delays in delivery due to bad roads and long queues at destination markets all contribute to tomato fruit losses as highly perishable vegetables. Finally, some losses are experienced during value addition in the form of processing and packaging.

Figure 8: Tomato post-harvest technologies.





The common technologies employed by respondents to reduce post-harvest losses in tomato is shown in figure.8. These include sorting, grading, washing, packaging, cooling and drying. Sorting and grading is intensively carried out by farmers and marketers, relatively done by processors too. For washing, this is done mostly by processors, followed by marketers and

sometimes by farmers. Cooling is done by all actors-farmers, marketers, processors and even transporters. The farmers store the fruits under shed and cover with leaves. The marketers also cover with leaves to conserve moisture and as a way of cooling. Transporters cover tomatoes with leaves during transportation to shield the fruits away from direct sunrays and also cooling.

Figure 9 : Opinions on use of electricity powered cold rooms

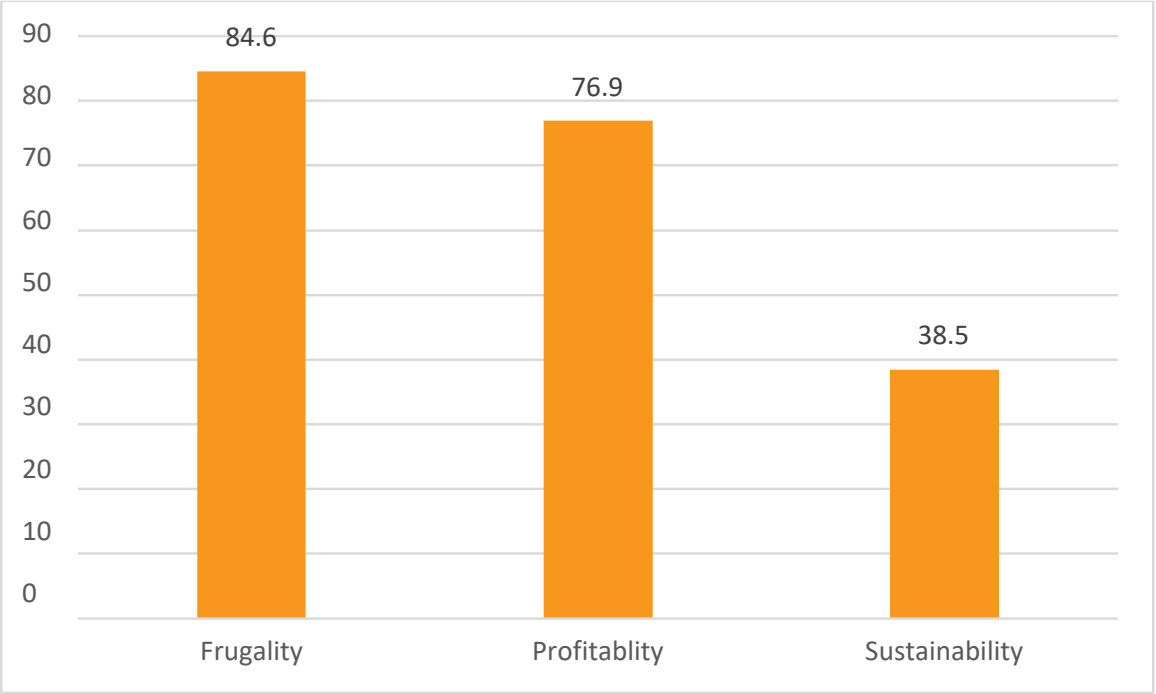
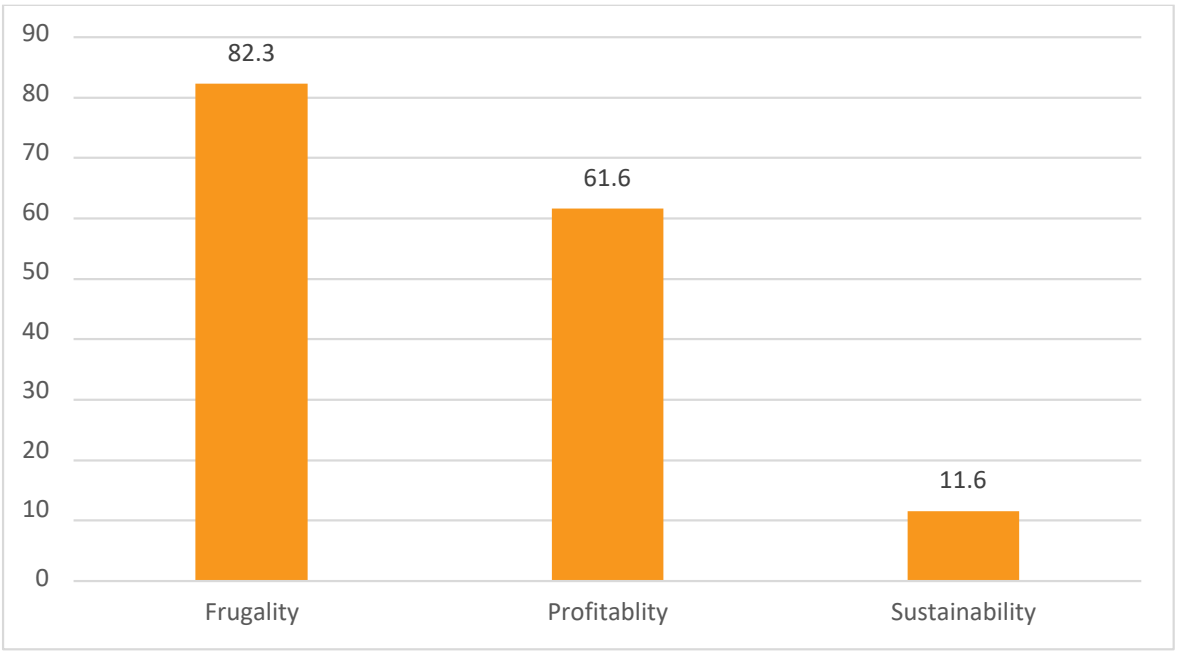


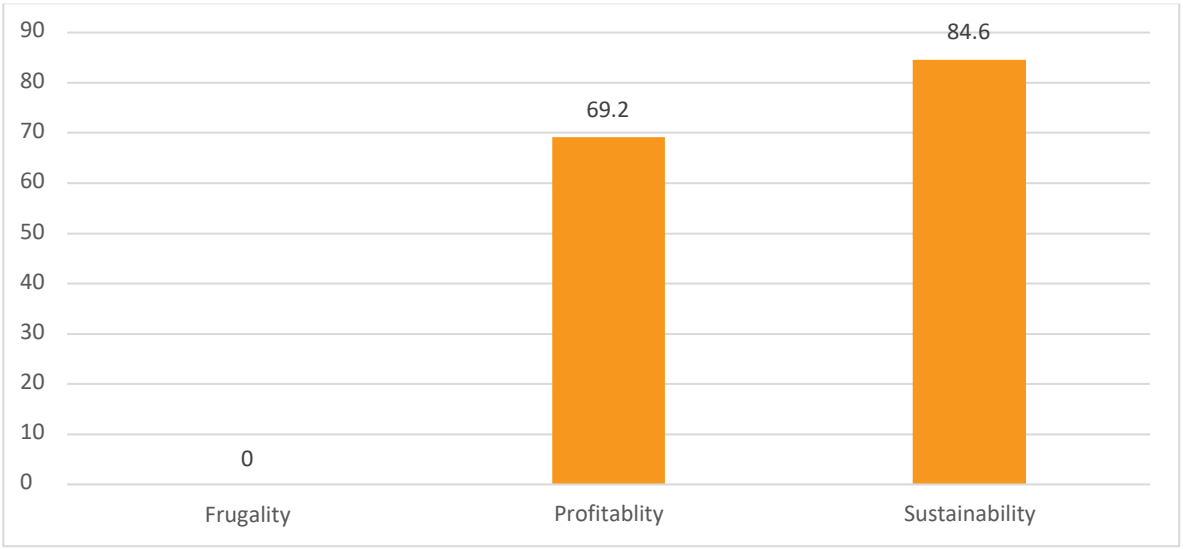
Figure 9 represents the opinion or perception of processors, marketers and farmers on the use of electricity powered cold room as a post-harvest technology. The technology was considered affordable), and profitable, but the sustainability of the technology was reported to be shaky because of the erratic power supply of electricity which is still a major problem in the country.

Figure 10 : Cooling vans/refrigerated trucks for transportation



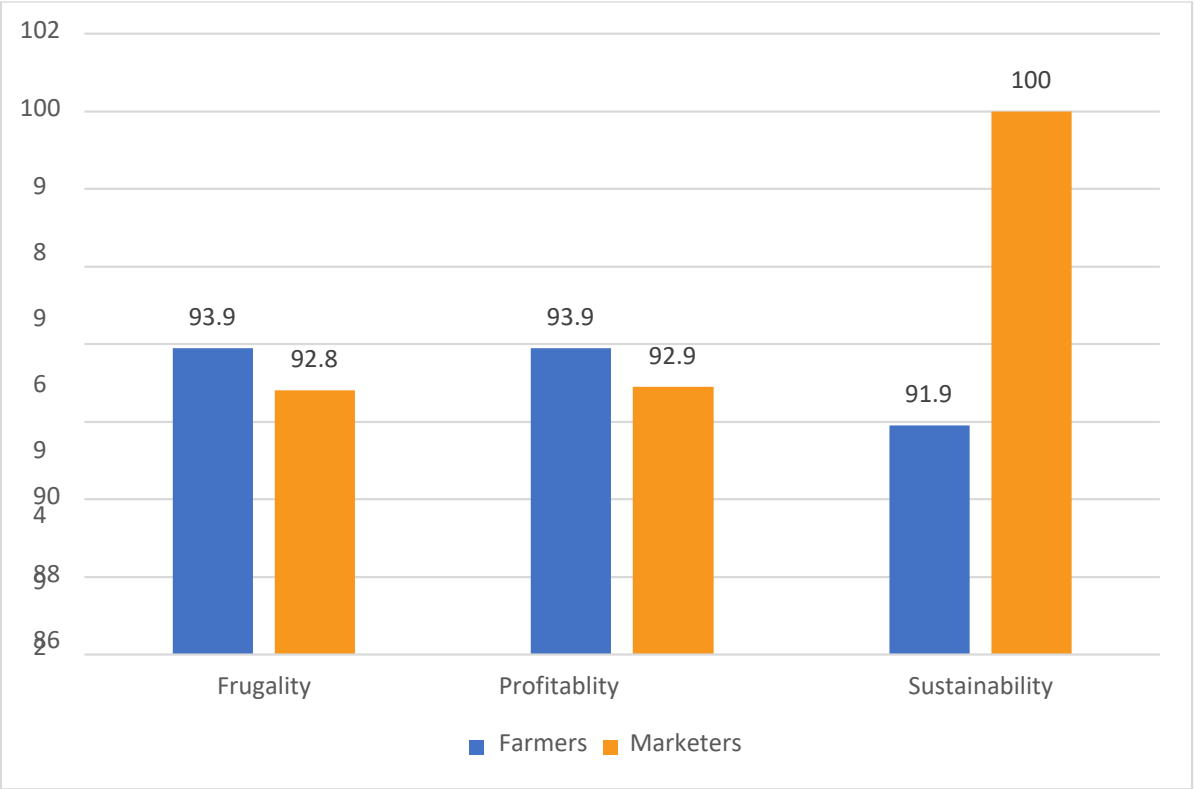
The perception of actors on the use of cooling van /refrigerated trucks as a post-harvest technology for tomato transportation is shown in figure 10. The actors all perceived the technology as an economical and profitable one but with low sustainability (11.6%).

Figure 11 : Solar powered cold rooms



The perception of processors, farmers and marketers on the use of solar -powered cold room is captured in figure 11. The actors opined that this technology may not be affordable even as they perceived it is a profitable technology which can stand the test of time.

Figure 12 : Plastic Crates



The use of plastic crates as an improvement over the raffia baskets in packing and transportation of tomato was examined. The view of farmers and marketers who use these crates is shown in figure.12. Both actors found the use of plastic rates economical and affordable, improves profitability and the technology was also reported to be a sustainable one.

Figure 13 : Solar dryer

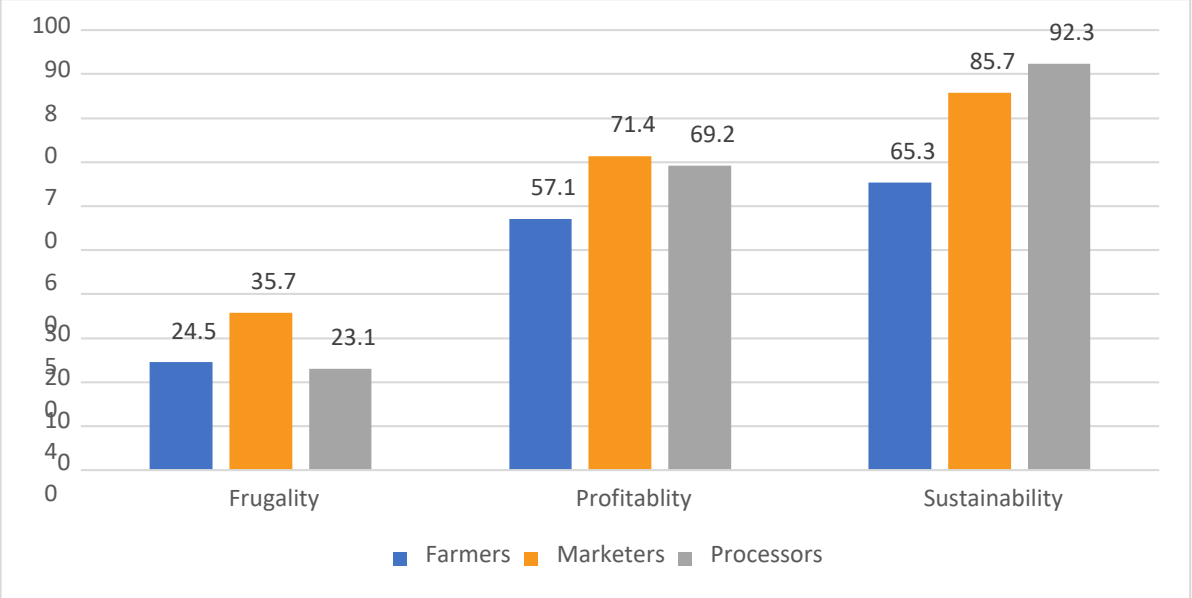
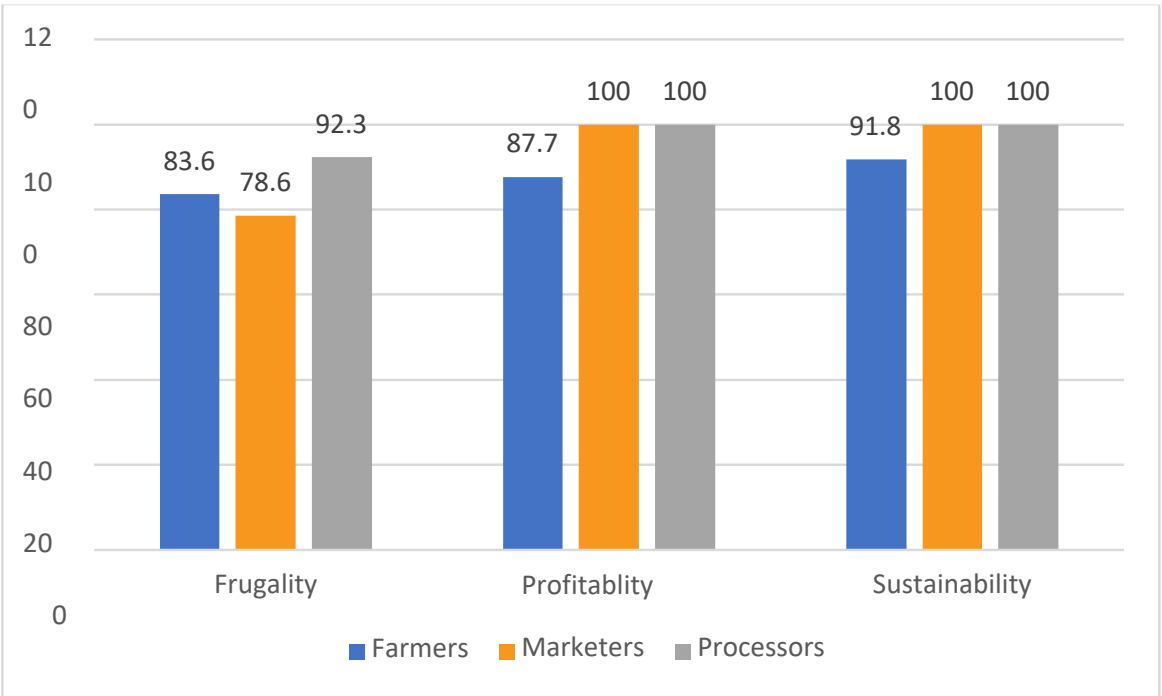


Figure 13 captures the use of solar dryer as a post-harvest technology. Farmers, marketers and processors all believed that the technology is relatively affordable, highly profitable and sustainable. The technology will be particularly good and accepted in the northern part of the country where there is a longer and higher sunlight for most part of the year.

Figure 14: Processing into dry form



Processing of tomato fruits into dry form is also a technology identified and analyzed. The opinion of actors about this technology is captured in figure 14. Farmers, marketers and professors were unanimous in their submission that this technology is economical and affordable. It is also profitable and sustainable.

Figure 15: Processing into paste

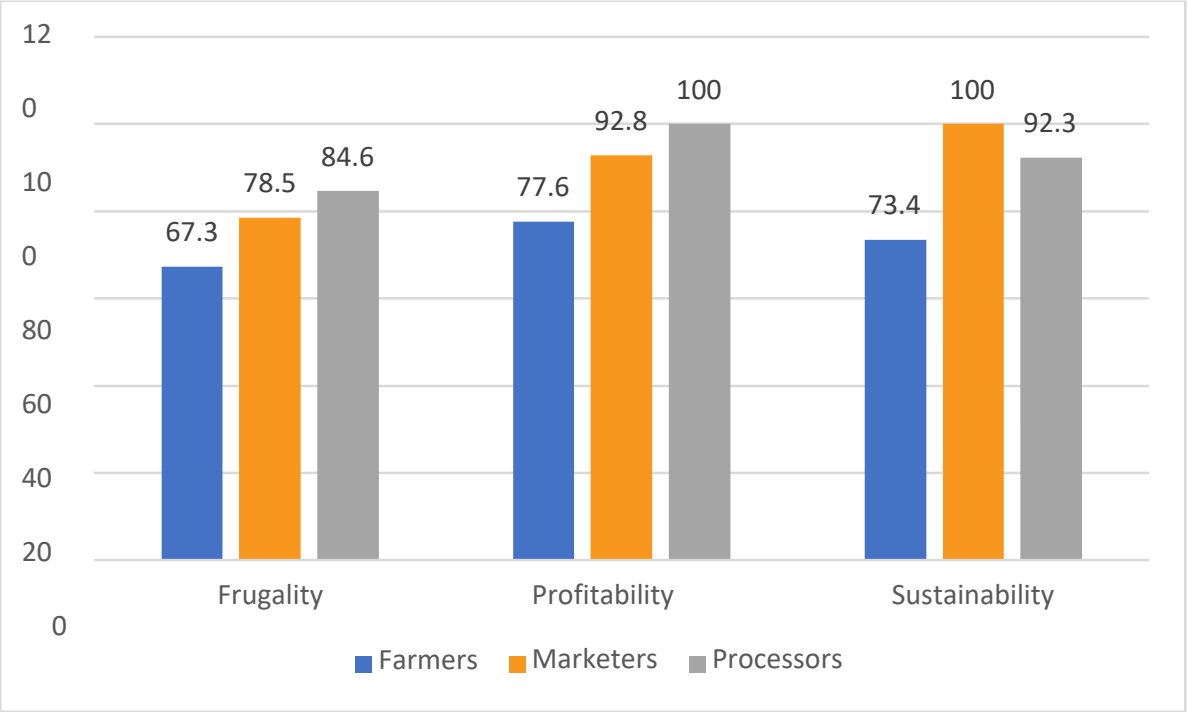


Figure 15 Reflects the view of actors on processing of tomato into paste. This technology was generally acknowledged to be affordable, profitable and sustainable.

Figure 16: Awareness on *Tuta absoluta*

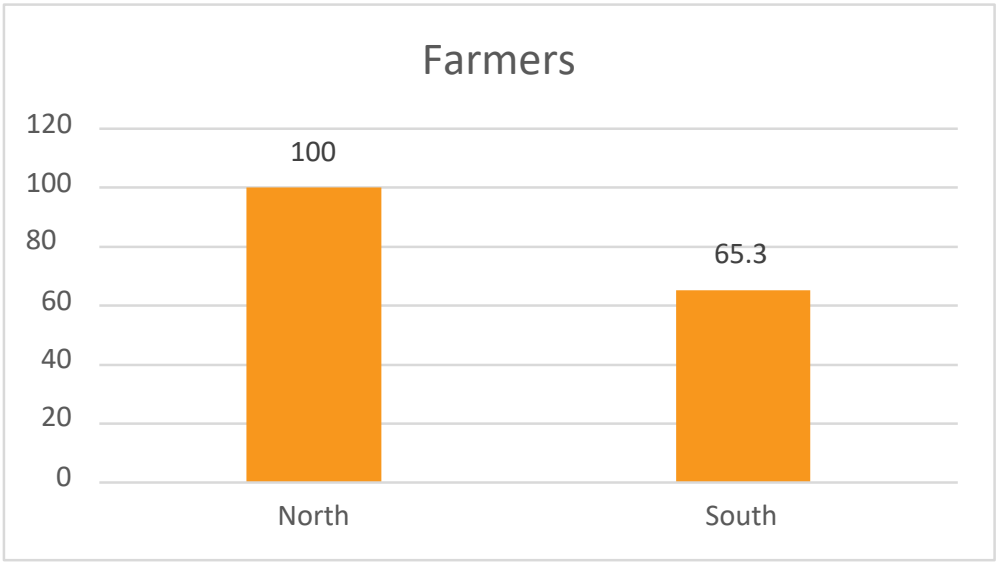
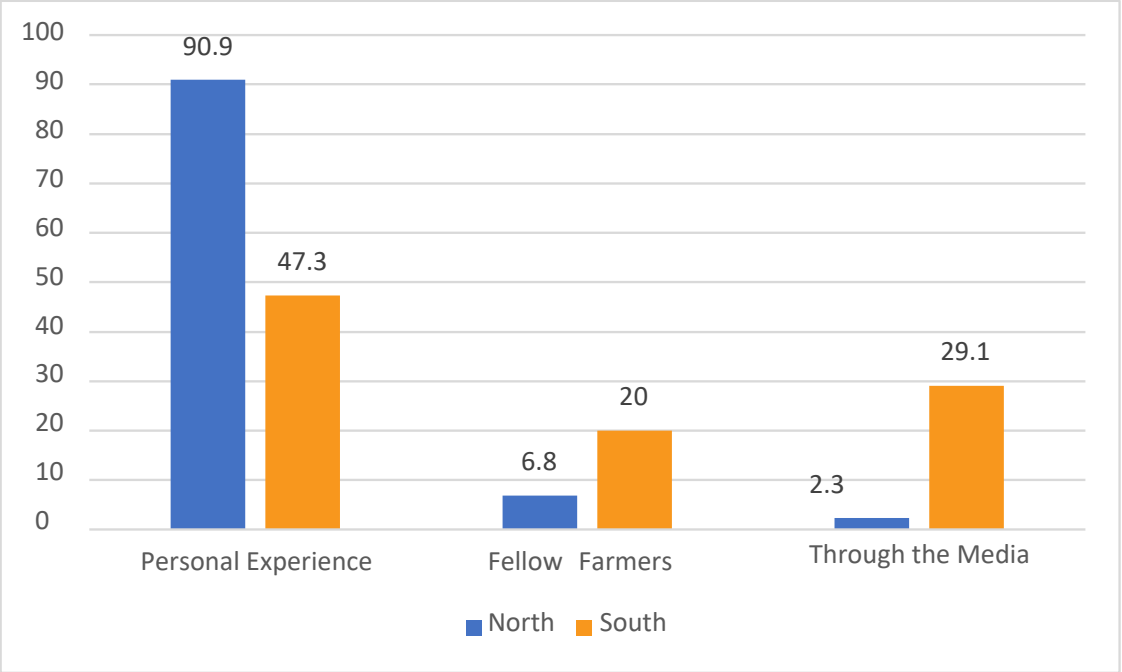


Figure 16. Depicts farmers awareness on the *Tuta absoluta* pest. Result from the field shows that awareness level about the pest infestation is higher among tomato farmers in the northern part of the country compared with those from the south. This is expected given the fact that the incidence of *Tuta absoluta* is higher in the north.

Figure 17: Channel of awareness on *Tuta absoluta*



The channel through which farmers got to know about the tomato pest- *Tuta absoluta* is captured in figure 17. Result shows that the largest percentage of farmers, both in the North (90.3%) and

the South (47.3%) became aware of the pest from personal experience on their farms. Some (29.1%) got to know through the media as well as through the experience of fellow farmers.

Figure 18: Incidence of *Tuta absoluta*

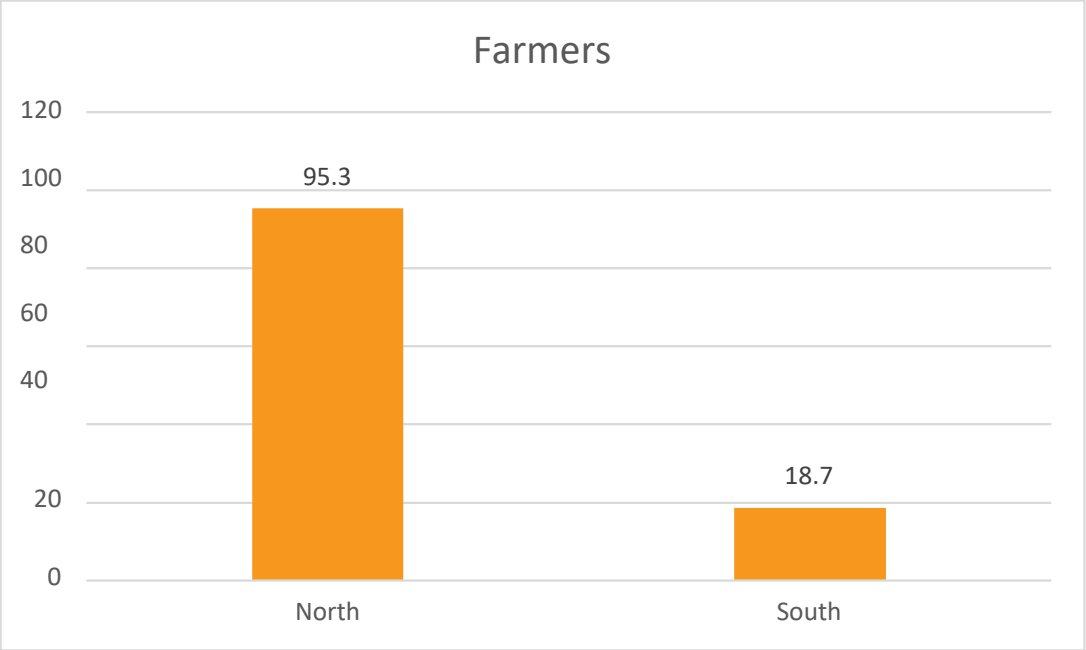
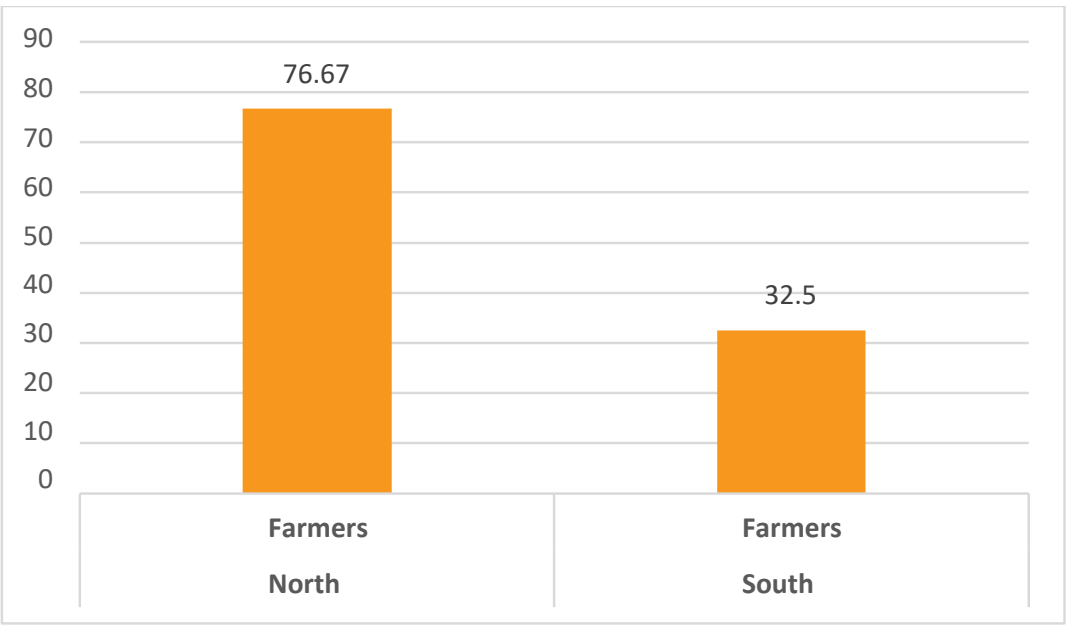


Figure18 depicts the degree of *Tuta absoluta* infestation amongst farmers. In the northern part of the country, the incidence of the pest is rated at 95.3% while incident rate in the South is much lower at 19.7%.

Figure 19: Tomato losses due to *Tuta absoluta* infestation.



The percentage loss in tomato due to *Tuta absoluta* is shown in figure.19. As the incidence of the pest is higher in the northern part of the country compared to the south, so also the mean percentage loss in tomato fruits is much higher (76.67%) in the northern states of Kano and Kaduna than losses experienced (32.5%) in the south (Oyo, Ogun and Lagos States).

Figure 20: Method of control of *Tuta absoluta*

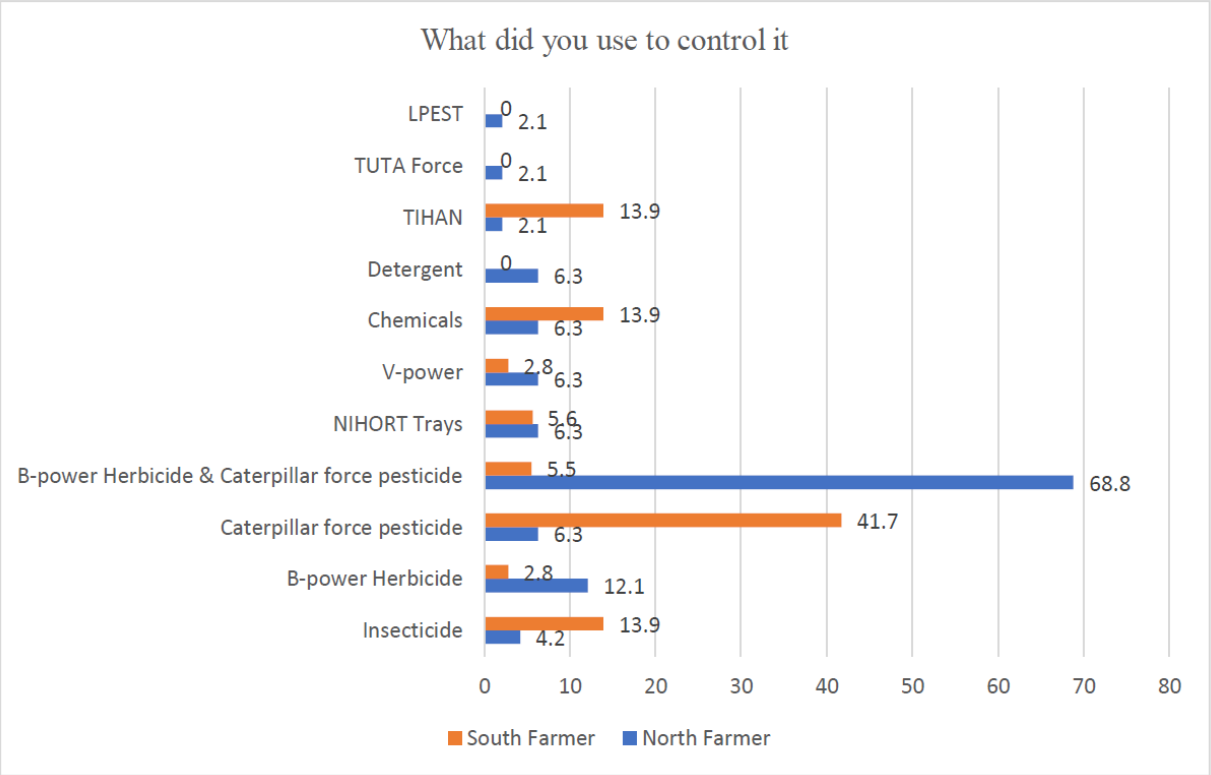
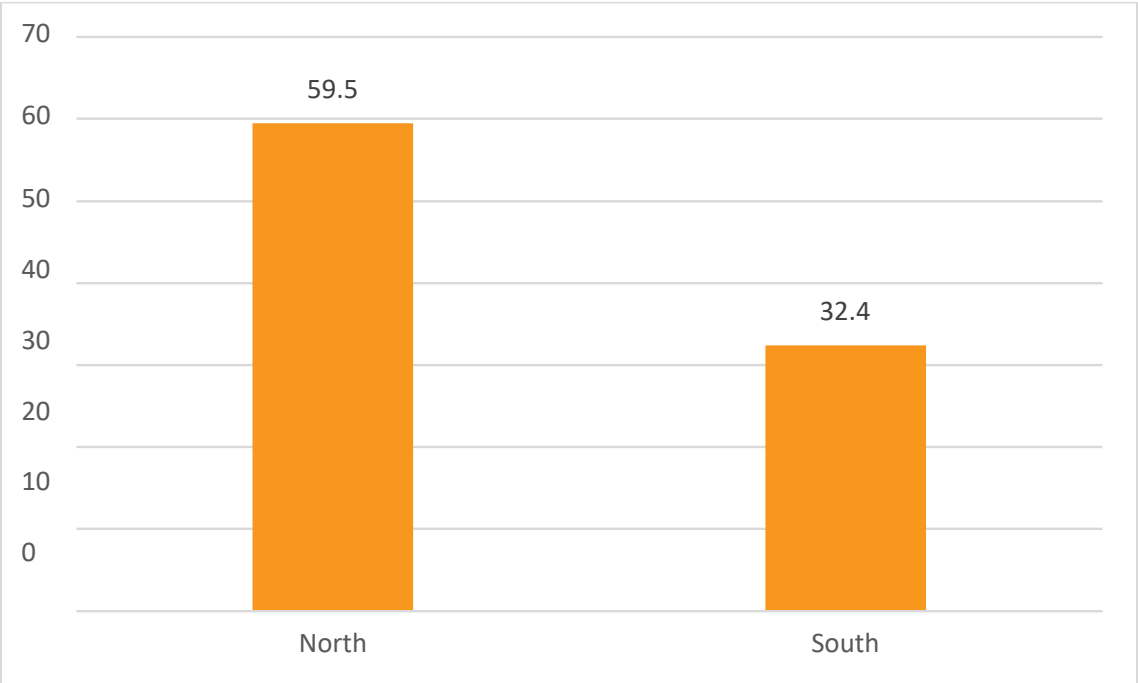


Figure 20 shows the different chemicals deployed by farmers in controlling the *Tuta absoluta* pest. The most common pesticide used in the control of the *Tuta absoluta* pest in the north was named B-power Herbicide and Caterpillar force while tomato farmers in the south used mostly Caterpillar force pesticide

Figure 21: Awareness on NIHORT's biopesticide for *Tuta absoluta* control.



The popularity of NIHORT's biopesticide for the control of *Tuta absoluta* pest was captured and result is as shown in figure.21. Result shows that awareness about the biopesticide is grater (59.5%) in the north as compared with the south (32.4%). There is however still room for improvement in awareness even in the north where incidence of the pest is high.

Figure 22: Channel of awareness on NIHORT's biopesticide for *Tuta* control.

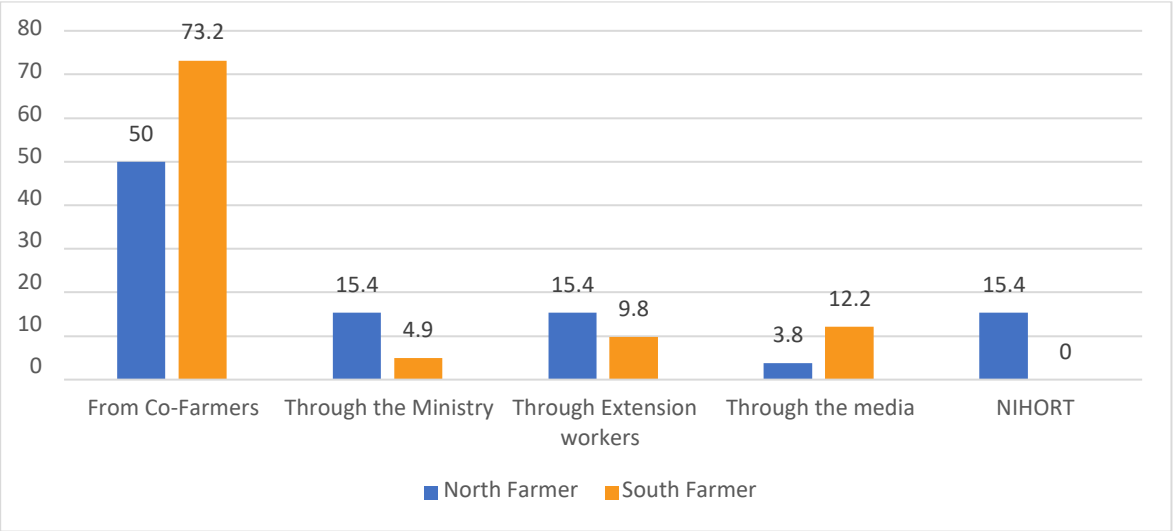
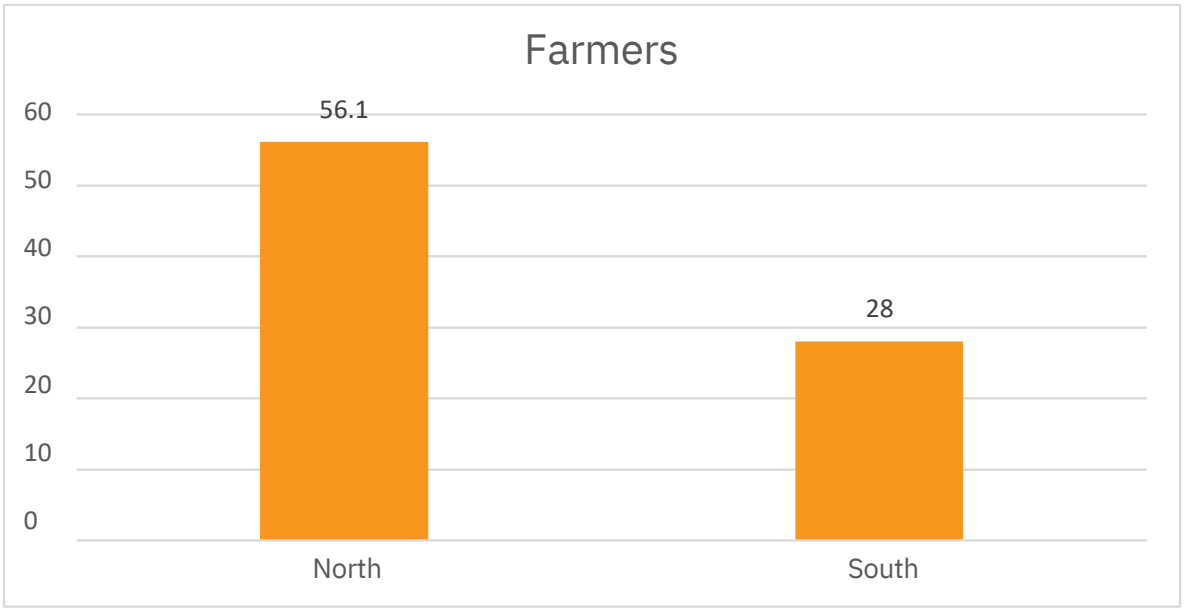


Figure 22 reveals the different channels through which farmers got to know about NIHORT's biopesticide. Most farmers in the south (73.2%) and the north (50%) got informed from their co- farmers. Tomato farmers in the north (15.4%) in particular, got the information about the biopesticide through the Institute herself. Other sources include Federal Ministry of Agriculture and Rural Development (FMARD), through extension officers as well as through the media

Figure 23: Adoption of NIHORT's biopesticide for *Tuta* control.



The adoption of the NIHORT's biopesticide for *Tuta absoluta* control amongst farmers is as shown in figure23. Adoption rate was higher among tomato farmers in the north (56.1%) compared to farmers in the south (28%). This is probably because the incidence of the peats is higher in the north.

Figure 23: Effectiveness of NIHORT's biopesticide for *Tuta* control.

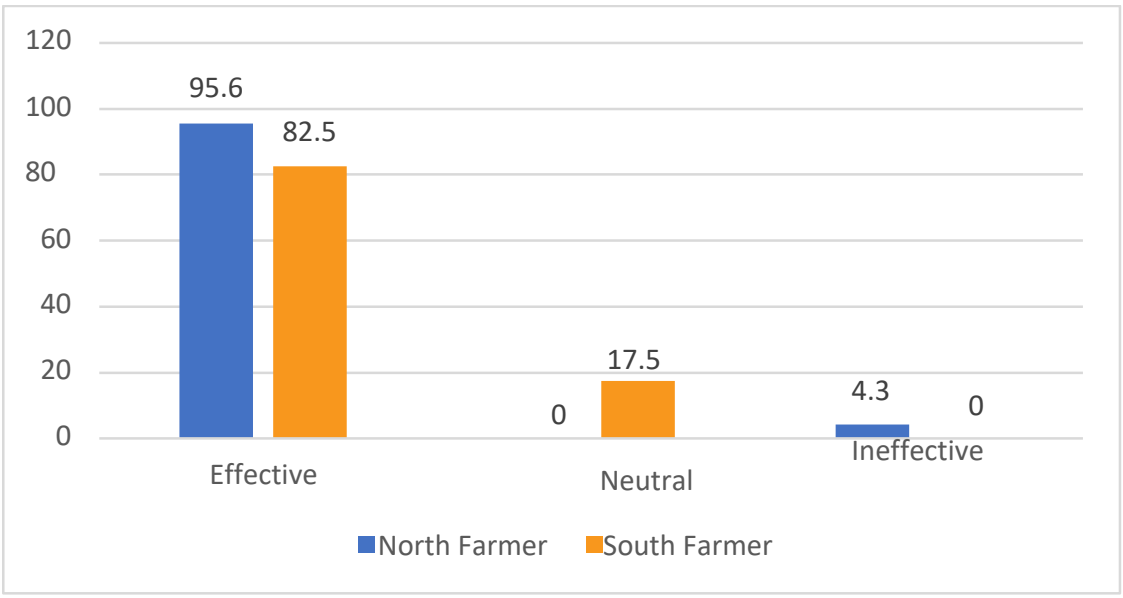
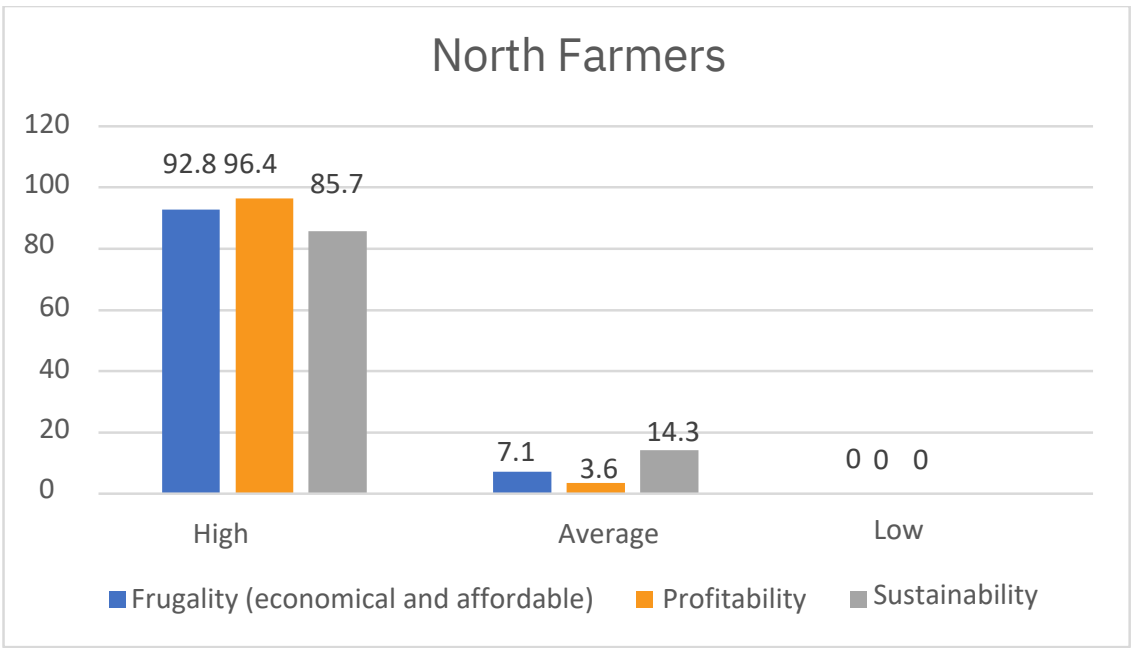
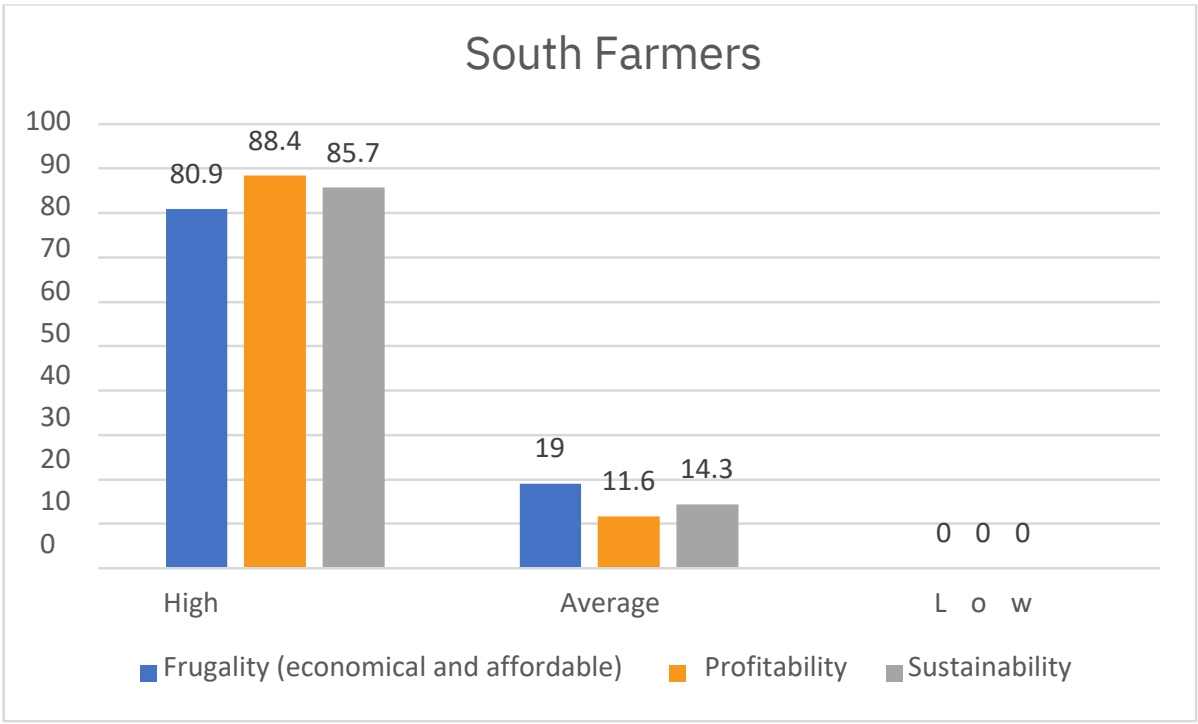


Figure 24 Shows the ratings of tomato farmers on the effectiveness of NIHORT's biopesticide for *Tuta absoluta* control. The biopesticide is generally rated to be very effective by most farmers from both the northern and southern part of the country.

Figure 25: Economic and Sustainability Rating of NIHORT's biopesticide for *Tuta* control.





Tomato farmers also rated NIHORT's biopesticide for *Tuta absoluta* control in terms of affordability, profitability and sustainability. Their response is captured in figure. 25. As compared with other synthetic pesticides used in the control of *Tuta absoluta*, most tomato farmers in both the northern and southern parts of the country rated the biopesticide high with respect to it being affordable, profitable and sustainable.

Figure 26: Awareness of interventions /programmes/ training to mitigate tomato Ebola losses.

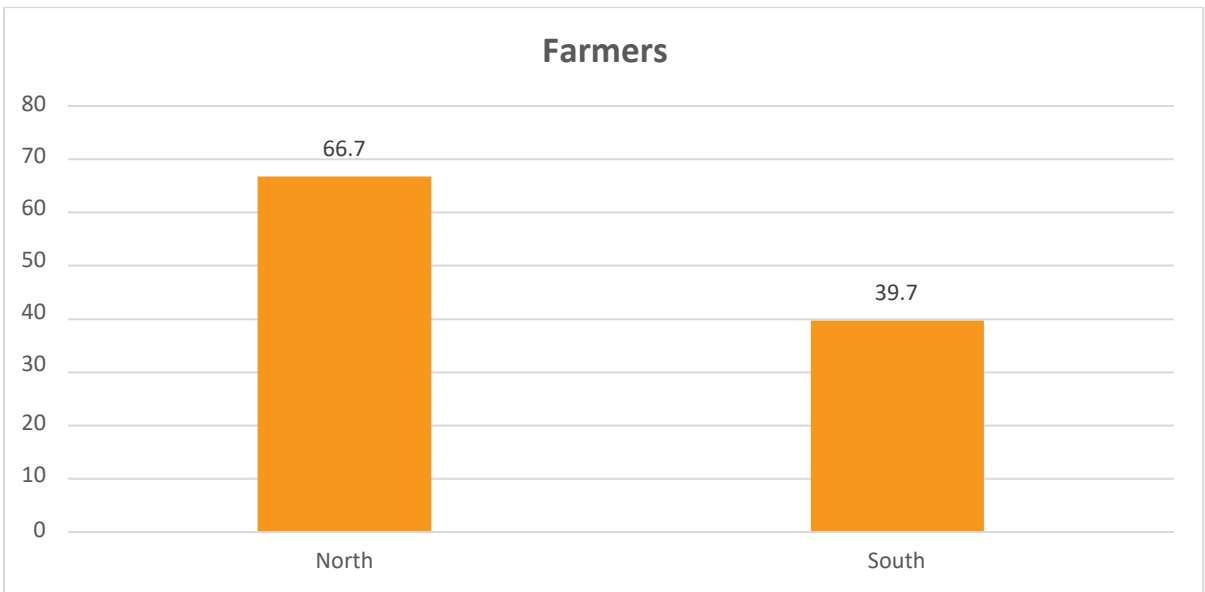
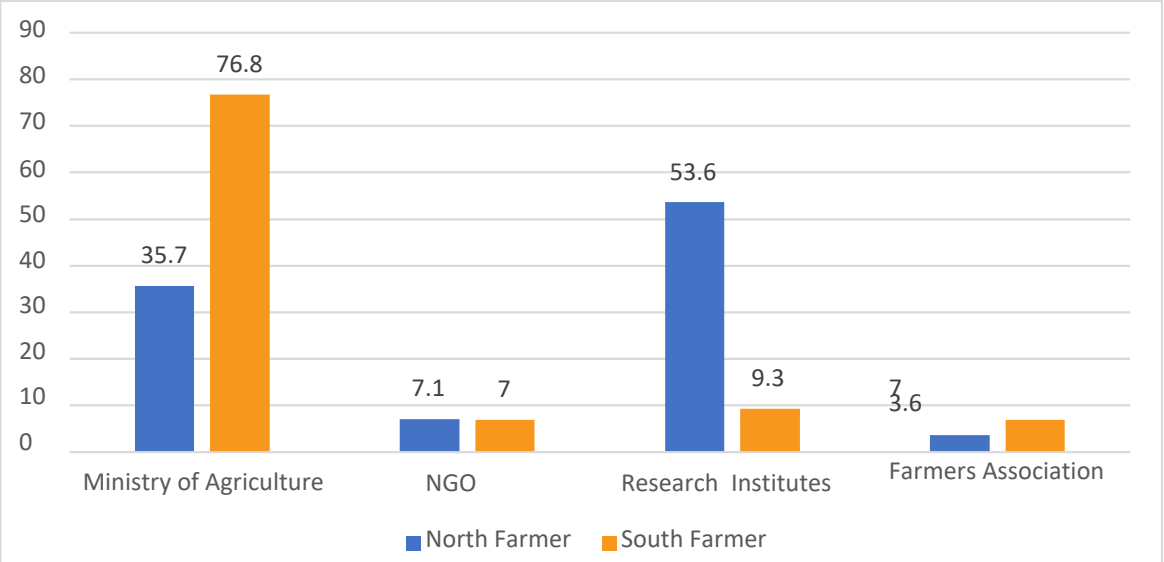


Figure 26 depicts the awareness of farmers on trainings to control *Tuta absoluta* pest. Most (66.7%) tomato farmers in the north are aware of trainings on the control of *Tuta absoluta* whereas the awareness amongst farmers in the south is relatively lower (39.7%) probably because the infestation is lower.

Figure 27: Facilitators of *Tuta absoluta* control training programmes



The facilitators of *Tuta absoluta* trainings are captured in figure.27. The trainings on the pest infestation were mostly done by the Ministry of Agriculture and Research Institute (NIHORT). Farmers association and NGOs also conducted some trainings.

Figure 28: Participation in *Tuta absoluta* control training programmes

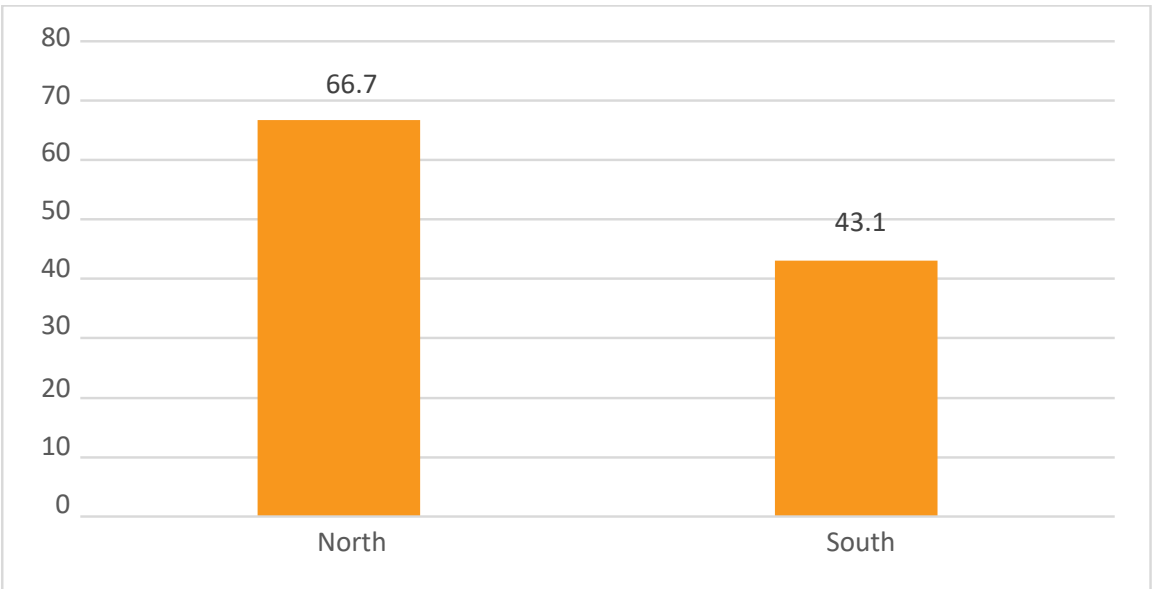
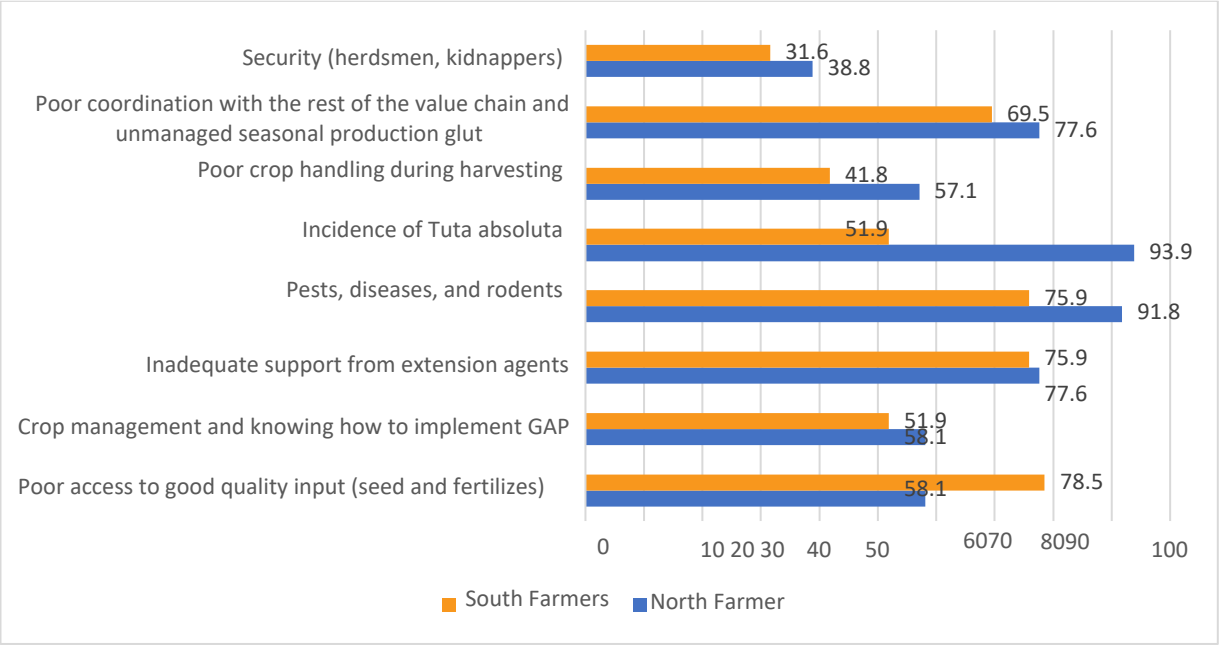


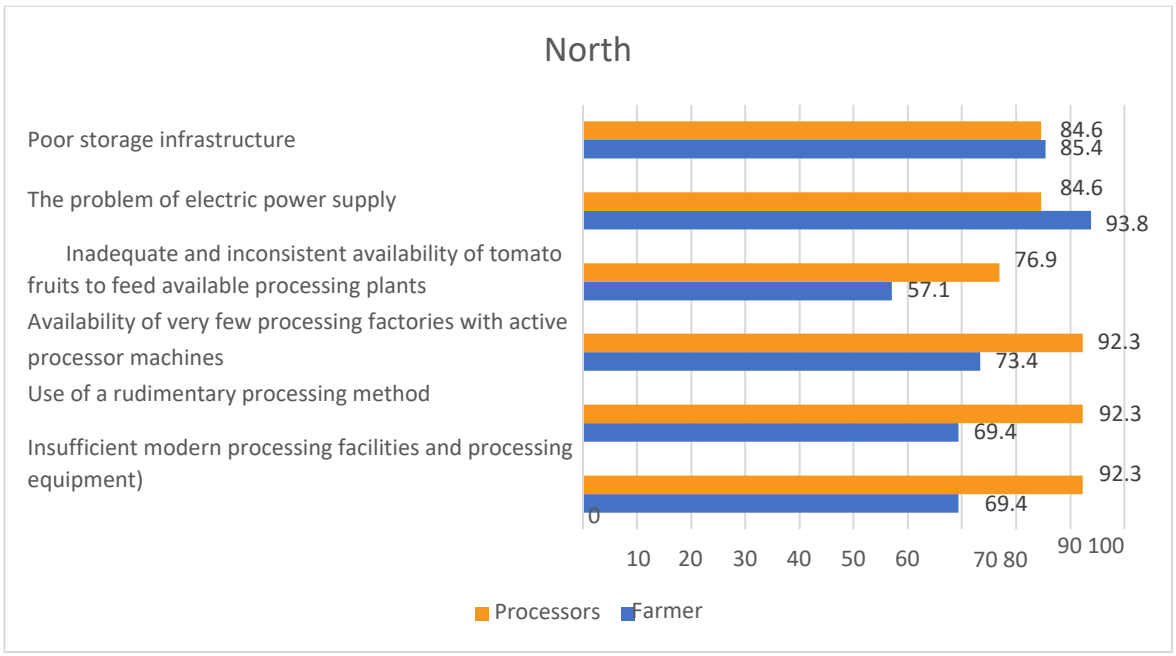
Figure 28 captures the participation of farmers in the trainings on the control of *Tuta absoluta.* The attendance of tomato farmers from the northern part of the country is higher (66.7%) than farmers from the south (43.1%). This is probably because the infestation is much in the north and there was a felt need for the training.

Figure 29: Production Constraints



The production constraints faced by tomato farmers is captured in figure 29. Generally, the northern farmers are more affected by the identified constraints than tomato farmers in the southern parr of the country. The only exception is accessibility to seed and fertilizer the northern farmers face lesser constraints compared to their counterparts in the south. The constraint of *Tuta absoluta* is a major production challenge especially for tomato farmers in the north. Thus, the northern part of the country is the hotspot of tomato losses caused by the pest, *Tuta absoluta.*

Figure 30: Processing constraints



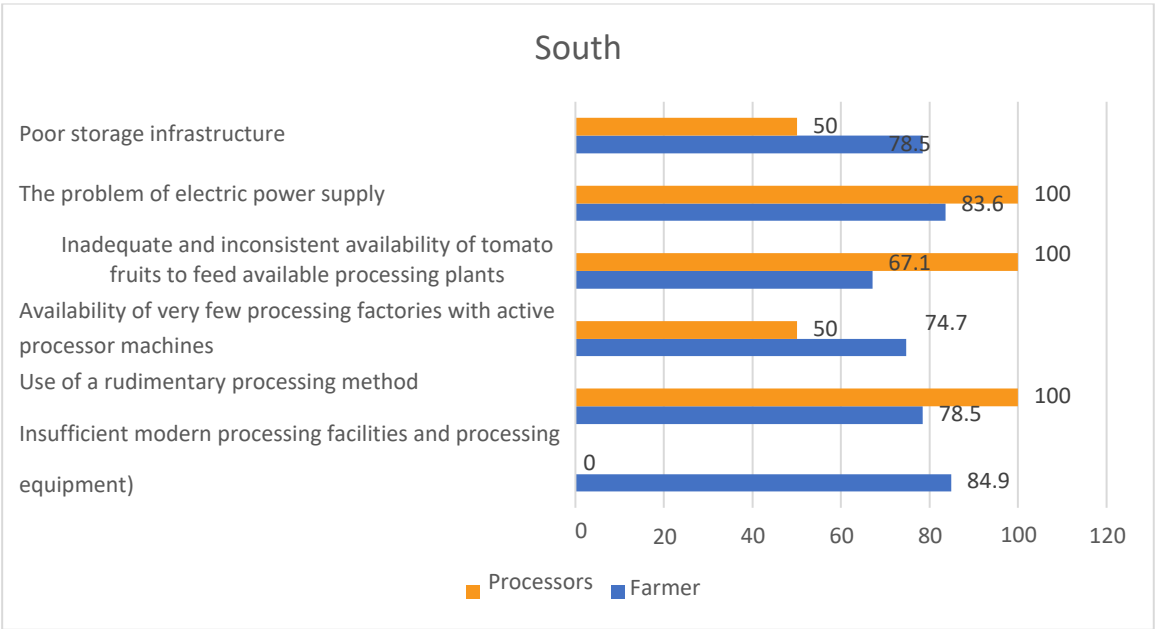
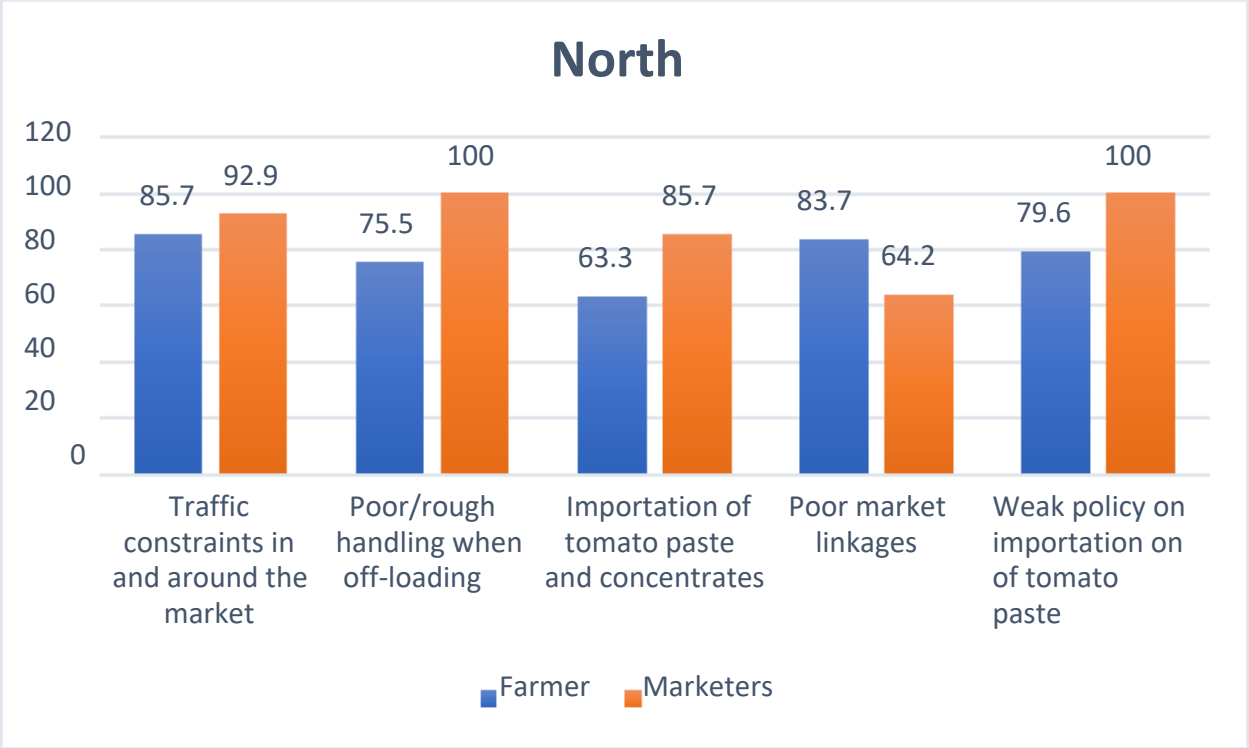
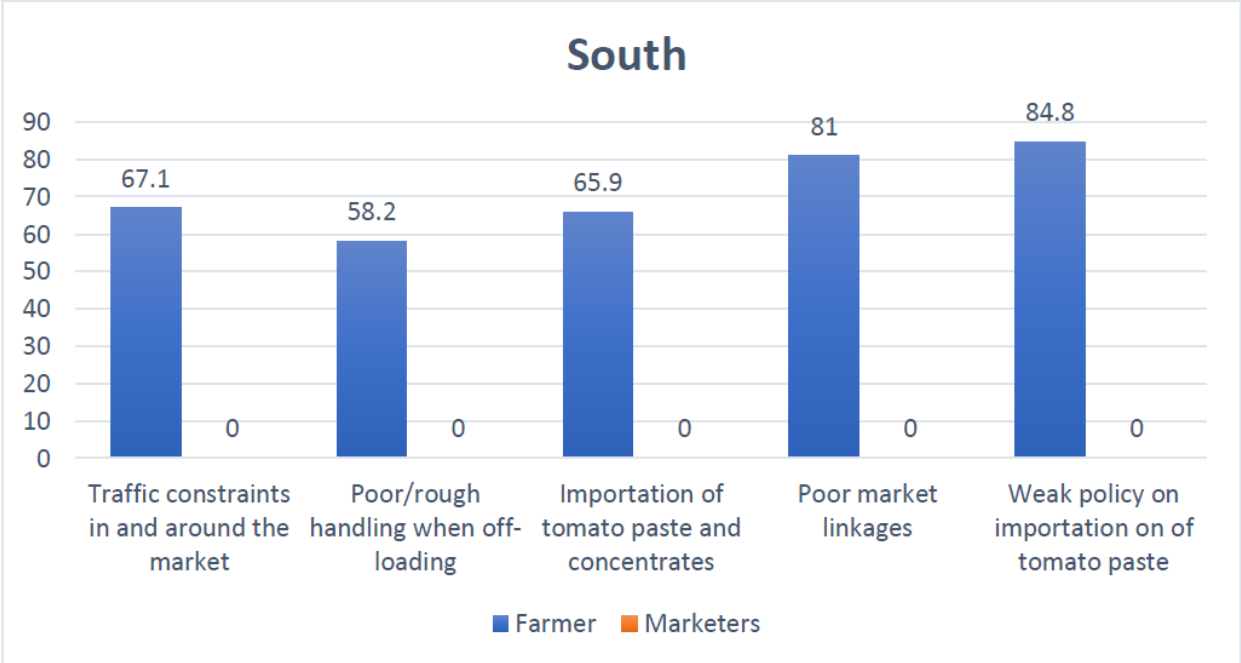


Figure 31: Marketing Constraints





The constraints experienced by marketers of tomato who are sometimes farmers themselves, is captured in figure.31. The highest constraints to tomato marketing expressed by northern tomato marketers and farmers are the weak policy on tomato paste importation and poor handling when offloading in the market which results into wastages. Others are poor traffic constraints around

the market, and poor market linkages. In the south, farmers also experience similar constraints as those experienced in the north.

Figure 32 : Constraints as perceived by transporters

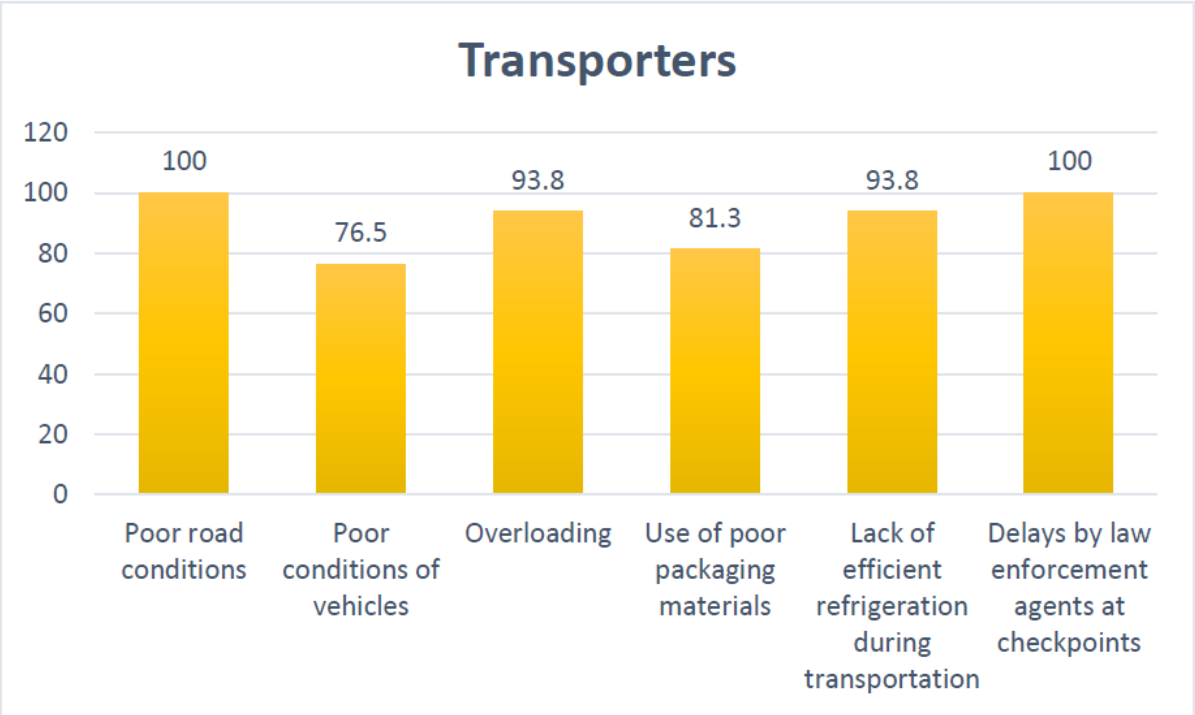


Figure 32 captures the constraints of transporters of tomato across the country. Poor road network and delays by the enforcement agents at checkpoints are the highest challenges faced in the transportation of tomatoes across the country. These two constraints are closely followed by lack of efficient refrigeration during transportation, resulting into spoilage and wastage before arriving at destination markets. Other challenges which are equally significant include poor conditions of vehicles that causes break down and longer travel time as well as use of poor packaging materials which contributes to spoilage.

CONCLUSION

The percentage losses of tomato across the vale chain differs. The highest hot spot of losses is at the production stage or farmers level (27%) and during harvesting. This is closely followed by losses experienced during transportation (22%). Other spots were tomato losses take place are

during marketing and processing. Postharvest technologies mostly utilised by stakeholders are returnable plastic crates, dryers and processing. The technologies for controlling Tuta absoluta are not well known by farmers in the South but the Northern farmers who know about technologies such as traps and biopesticides do have them readily available. Ongoing effort to address tomato postharvest losses in the country include capacity building, awareness creation and the tomato policy which is aimed at boosting tomato processing and the agro-processing zones programme to curb wastages. Chain supporters and influencers in Nigeria are yet to incorporate a holistic view when proposing interventions to tackle post-harvest losses.

RECOMMENDATION

This study recommends a holistic strategy (hat combines the concerted efforts of chain supporters and influencers in addressing tomato post-harvest losses in Nigeria. Such strategy should focus on interventions that should include all of the following, amongst others:

i. Institutional arrangements and reforms to facilitate access of private sector investment for improved production and value-added processing.

ii. Organisation of the value chain so that the strengths of actors can be harnessed while reducing weakness

iii. Promotion of technologies that are considered frugal, profitable and economical

iv. Cottage processing: The structure of tomato production in Nigeria supports cottage processing better than large scale processing. Cottage processing units with capacity to process small quantities like. 2–5 tonnes daily

v. Capacity building/ training on post -harvest and pest control technologies along the value chain particularly at farm level, processing sites as well as during transportation.

vi. Investments to support SME processing companies to improve their factory capacities

vii. Proper implementation of tomato policy to boost processing activities in the country.

viii. Implementation of the agro-processing zones programme to curb wastages.

ix. Infrastructural developments to improve roads, energy supply as well as the machinery used in the tomato value chain.

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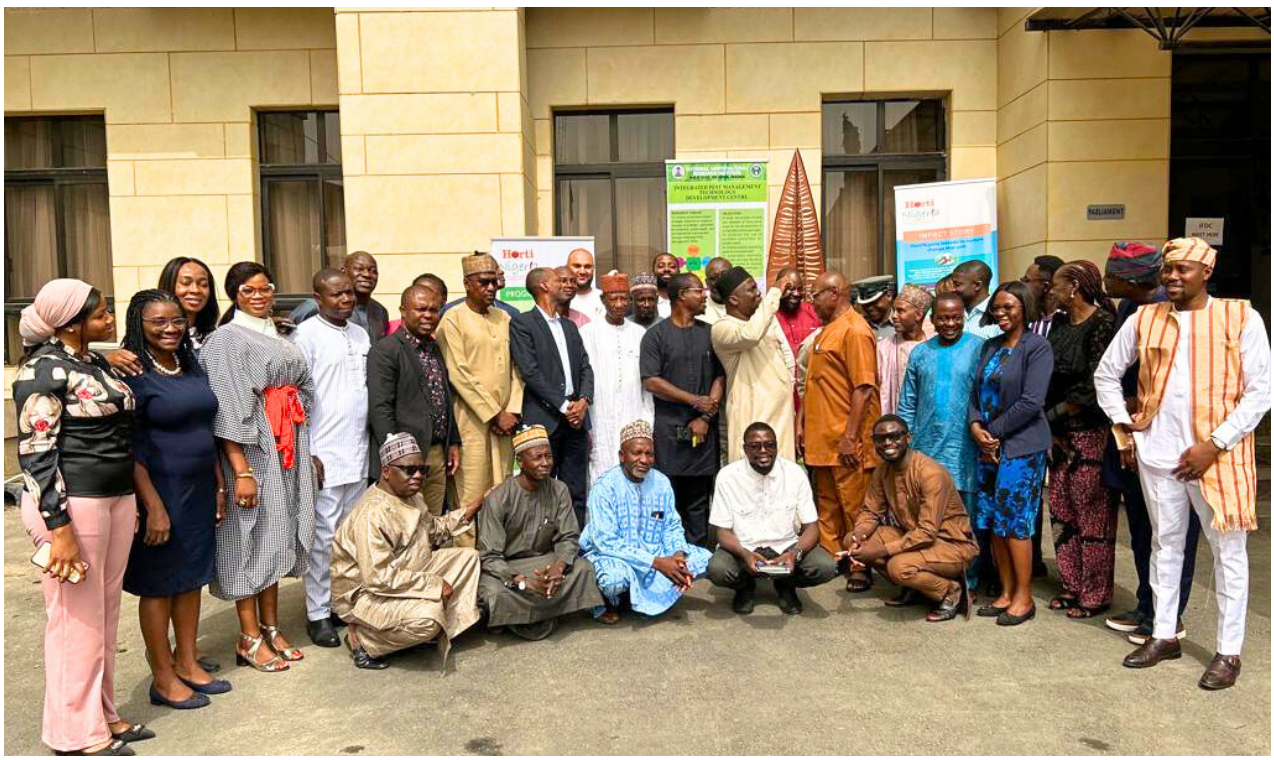
REPORT OF THE NATIONAL TOMATO TECHNICAL COMMITTEE STAKEHOLDERS MEETING

Venue: Bolton White Hotel, Area 11 Abuja Date 22nd February 2023 (1 day)



NIHORT Background

The National Horticultural Research Institute (Headquarter); located in Ibadan was established in 1975 with the assistance of United Nations Development Programme in conjunction with food and Agricultural Organization as fruits and vegetables research and demonstration centre.

Since its establishment, NIHORT has conducted research into the genetic improvement, production, processing, storage, utilization and marketing of tropical fruits, vegetables, spices, and ornamental plants. The institute has a wide array of horticultural crops currently researched upon, from which a myriad of technologies has been generated through its major research programs which includes product development program, vegetable improvement program, citrus improvement program, fruits improvement program, spices improvement program, floriculture improvement program and extension research program. NIHORT offers a wide range of horticultural orchard services, from the growing to the processing and the export of specific orchard produce. One of the groundbreaking technologies are NIHORT Tuta Trap Tray, NIHORT- Lyptol and NIHORT-Raktin which were deployed in integrated pest management strategy to combat the menace of Tuta absoluta “tomato ebola”. Additionally, three tomato varieties which are high yielding, tolerant to fusarium wilt and of good nutritional qualities were released recently to boost production, improve the livelihood of smallholder farmers, and ultimately enhance the tomato value chain in Nigeria.

HortiNigeria Program Background

IFDC and its consortium partners have secured funding from EKN Nigeria to implement a transformational horticultural project in Nigeria by introducing innovative, sustainable, and profitable horticultural productivity and resilient market system value chain approaches leading to a sustainable transition of Nigeria's food system; thus, from a system based on food imports, low productivity and depletion of natural resources, to an integrated sustainable food system, capable of providing sufficient, healthy and nutritious food to a growing (urban) population. The goal of the program is to facilitate the development of a sustainable and inclusive (gender and youth) horticulture sector that contributes to food and nutrition security in Nigeria.

IFDC Background

The International Fertilizer Development Center (IFDC) is a non-profit, Public International Organization (PIO) established on October 7, 1974, with its headquarters in Muscle Shoals, Alabama, United States of America. IFDC strives to improve the livelihood of people in developing countries throughout the world by facilitating the sustainable improvement of agricultural productivity through the development and transfer of effective and environmentally sound plant nutrient technology and agricultural marketing.

NTSC

The first National Tomato Stakeholder Committee summit was organized by Grow Africa and the *Nigeria* Agribusiness Group (NABG) in 2019. It highlighted the new direction of the tomato value chain following the commencement of the implementation of the new tomato production policy, addressed some key factors limiting investment in the tomato industry in Nigeria, proffered actionable solution options to pre and postharvest losses and other production challenges faced by farmers. However, the outbreak of COVID-19 pandemic stalled subsequent convenance of the meeting thereby hindering the consolidation of the achieved successes with tremendous resultant negative impact on the tomato value chain in Nigeria.

In view of the above, the International Fertilizer Development Center in a cooperation agreement with the National Horticultural Research Institute revitalized the NTSC to its

functional status. - ensuring the implementation of policies and initiatives that improve the competitiveness of the entire tomato value chain, ensuring food security and positioning it as a key driver for growth in the Nigerian economy. Therefore, IFDC and NIHORT organized a one-day National Tomato Stakeholders Committee meeting in Abuja on Wednesday 22nd February 2023 with the theme “Tomato Value Chain: Emerging and Long-standing Challenges, and Sustainable Solutions”.

Meeting Objectives

The meeting sought to identify and provide solution options to current and enduring issues restraining progression in the tomato value chain in Nigeria particularly addressing the following specific objectives:

1. Identify and understand current existing policies on horticulture especially on tomatoes and other vegetables,
2. Identify areas of alignment with government policies and other key stakeholders with HortiNigeria program and to activate a platform that will continue to coordinate a national strategy for a response mechanism for pest and disease outbreaks, including *Tuta absoluta*
3. To review the policies and initiatives hindering the competitiveness of the tomato value chain
4. To review the policies and initiatives hindering the competitiveness of the tomato value chain
5. To implement a functional working committee within the group
6. To agree on periodic meetings of the group

Attendance: There were 49 participants who attended physically and 3 participants who attended virtually belonging to Government officials, HortiNigeria stakeholders, farmer representatives, research institution, Agriculture Development Program (ADP) officers, policy makers, industry leaders, development partners, agribusiness consultants, marketers, men of the press and all other stakeholders in the tomato value chain.

Activities

- The meeting started with an opening ceremony in which Mohammed Salasi, the HortiNigeria Program Director and Abdullahi Umar, the component 4 Lead gave their welcome addresses. Other dignitaries also had the opportunity to deliver goodwill messages.

- After a short break, stakeholders were divided into e groups and discussions were held in the groups. Each group came up with identified key issues hindering the tomato value chains and possible solutions to the problems

- Presentations were then made by representatives of each group

- This was followed by a harmonization session moderated by researchers from NIHORT. At the end of the meeting, a communique was developed and read out to all participants.

Group Discussions

Presentations by group representatives

Harmonization session

Achievements

- The loopholes and areas of summersault of existing policies were identified
- The different agencies represented were sensitize on the need to make necessary adjustments where necessary
- Stronger and more defined alignments of activities of concerned agencies were discussed
- The Nigeria Agri Business Group (NABG) agreed to work with HortiNigeria using the platform of the Presidential Round Table discussion to engage policy makers on the areas where review or commitment are needed
- A communique was developed and circulated

APPENDIX 1. List of Participating Organisations

	Name	Phone number	Company/Business name	Role
1	Adetokunbo		Livestock services konsult and agro allied ventures	producer
2	Joshua Peter	08130207064	Africa Steading Ltd	producer
3	Sedun Wasiu	08028071609	Fourlas Foods	Producer & Processor
4	Abiola Lawal	08087180617	Agrimat Agribusiness Hub	producer
5	Ogunde Adenike	08053850233	GPA_Farms	producer
6	Tola AMISU	08055220101	Agro Easy Enterprises	producer
7	Esson Akolo	08114126551	Tomato Jos farming and processing ltd	Producer/Processor
8	taofiq ahmed	08082655222	Feedthewestagroallied	producer
9	Alawiye Abdul-Azeez O.		Fruitieveggie Organic Farmacy	Producer
10	Ajose Oluwaseun		SAA Farms	producer
11	Adasonla olaniyi	08027314650	Rains Agricultural integrated services	producer
12	Jide Moshood	08146424047	89ideas Farms & Consult	producer
13	Okeowo Adewale	7039384919	Okeowo farms	producer
14	Ahmed Adedire	07033661808	Dayor Farms	producer
15	Kunle Ololade	08161254947 08023731456	Kernel sludge agroproccessing and farms	
16	Agboola Israel Oluwaseye	09035385801	Ceda Agro Farms	producer
17	AbleGod	08052411292	AbleGod Farms	producer
18	Taiwo	08032012941	Heavenly Dew Agro Limited	producer
19	Adu oyeyemi joseph	07033139778 08165394740	Plant Doctor Agro consult limited	producer
20	Dayo Anjorin	09034030199	Fofall farms	producer
21	Okeyinka Adekunle	08055175414	Osom Agro Services	producer
22	Dauida Abass Ademola	08060869313	folisac farms	producer
23	Peter Ogunde	08034106706	ALKHAIRY farms and supply	producer
24	Oladipo Olumide	09072325369	Global PetAd Farms	producer
25	Moshood Olawale	08026534448	Midstream Agro	producer
26	Samson ogbole	08080231911	JidMosh Farms and consult	producer
27	Owolabi Azeez	08034204339	Soilless farm lab	producer
28	Quadri	07037588158	Nateez farm	producer
29	Emmanuel	08134282787	Landpride	producer
30	Tunde	9062696877	Agabus garden	producer
31	Ekpenyong Lawrence	08188151428	-	producer
32			Dlaws Farms Ltd	producer

33	Alaba	08067908315		producer
34	Dauda Abass	08060869313	ALKHAIRY farms	producer
35	Ademola Jesse	07085583433		Processor
36	Ojo Azeez	09076725876		producer
37	Ademola	09033534392	Tohunique farms and consults	producer
38	Tolulope	09057917431		producer
39	Onome	08100148972	Mercy agro	producer
40	Olayinka	09034923595		producer
41	Kehinde Sharon	08023014512	Lake view Farms	producer
42	Dapo	8146424047		producer
43	Adeola faith	07019598635	Gougstar Farm	producer
44	Austin	08057241978	AA Farms	producer
45	Yemi Fasasi	08053535209	Emperor Integrated Farms	producer
46	Andy Victor			
	Olanrewaju Samuel Faleye			Processor
	Dr Adedeji	7033162355	Olanrewaju Foods Obe	
47	Engr Titus Kolade	7034328483	FOMSOD	Processor
48	Oluwadarasimi	08166908629	Simi Agro place	Input dealer
49	Adedap	08034229240	FruitieVeggie Organic Farmacy	Entreprenural farmer
50	Alawiye Abdul-Azeez		Awesome Fresh	
	Adetiloye Aiyeola	07051479418	Everything Popagule	OFFTAKER
51	Ogunbayo Esther	08062753737	My Seedling	TRANSPORTER
52	Okwara Peace	07037518401		INPUT DEALER
53	Temiloluwa Ajala	08109707710	Terian natural	Entreprenural farmer
54	Mr Wale Okeowo	08133154107	Okeowo Farms	Entreprenural farmer
55	Mrs Ogona Onyenorah	07033661808	WeGro Farms	Entreprenural farmer
56	Adisa Temidayo	0706 048 8162		Entreprenural farmer
57	Uchenna Okore	08067969972	SeedForthAgro	Marketer
58	Ogundiyi, Temitope	07038654036	Dvine universal synergy concept	Entreprenural farmer
59	Opeyemi	08036176507	Doxa Farms	Entreprenural farmer
60	Mrs Akinyemi Bolanle	08022759952	Toluwuyi Agro Allied	Entreprenural farmer
61	Mr. Kehinde Lawrence O.	08034101017	Agrofolab farms	Entreprenural farmer
62	Afolabi Ayuba Oyebanji	08167086291	OLED FARMS	Entreprenural farmer
63	Seyi Awolola	08038445847		Entreprenural farmer

64	Adebiyi Gideon Adelayo	07064848263	Oreagbe agro allied and farm input, Odeda	Input supplier
65	Olayinka Adesola	09152a418736	FarmVilla Agro Resource Centre	Entreprenural farmer
66	Alhaja Olayinka Bello	08037253657	Azemor Agribiz Ltd	Entreprenural farmer
67	Babajide Oluwase	0802 811 7382	Ecotutu Limited	TRANSPORTER
68				
68	Damilare Mebude	0803 816 1698	JQ Agritech	Entreprenural farmer
69	Ajibola Wasiu Opeyemi	08149698844	Agriwas Farm & Agro-business Consultancy	Entreprenural farmer
70	Shobande Oluwatobi	07068551193	Greenland Farms	Entreprenural farmer
71	Abisoye Taiwo Bisola Ahmed	0815 703 7355	Agricourt ventures	INPUT DEALER
72		0818 511 5434	Transporter	TRANSPORTER
73	Adegboyega Adewale	080 6496 5040	Ibrowalex Nigeria Enterprises	OFFTAKER
74	Fakunle Mayowa Daniel	08133440776	Upper view	Entreprenural farmer
75	Akinnitire Akintunde Ojo	0903 458 2337	works under Kartlos	Entreprenural farmer
76	Odeyemi Mayowa	07031088543	works under Kartlos	Entreprenural farmer
77	Adubiaro Hafiz Olamilekan	0813 690 3541	Adubiaro farms	Entreprenural farmer
78	Banjo Adetayo	08163802020	Heavenly Farms Agro Allied Ventures	Entreprenural farmer
79	Mofiyinfoluwa Olajolo	08081864269	Heths agro services	Entreprenural farmer
80	Joshua Ekene	08130207064	Yohanna farms and agro service	OFFTAKER
81	Adetomiwa Adedamola Olasunkanmi			Entreprenural farmer
	Samekpolo Miriam	09033390686	SUNDAM FARMS AMIDEE AGRO VENTURES	Entreprenural farmer
82	Mark Oluwafemi G	07068028774	Markfem Farms	Entreprenural farmer
83	Alex Eyitayo Oparinde	08032182408	TY-KLIZZ GLOBAL RESOURCES	Entreprenural farmer
84	Bolakale Nathaniel Oluborode	08060995744	Farmboy Enterprise	Entreprenural farmer
85	Alabi Saheed Abefe	08109467469	Allahu Lateef Transport services	TRANSPORTER
86	Ayedun Omodasola Mobolaji	08142541545	No business Name	Marketer
87	Oluwadamilola Awe	07037043432	Ddee Food and Support services	Entreprenural farmer
88		08029683044		

89	Olubiyi Kehinde C.	08034674692	CKB Farms	Entreprenural farmer
90	Kayode Ogundayomi	07039290924	Green Development and Agro allied services	FARMER
91	Talabi Olufolajimi	08131665289	Hybrid Virgin	Entreprenural farmer
92	Quadri Adeyemi	09051428027	Landpride Farms	Entreprenural farmer
93	Taofeek Ahmed	08082655222	Feed the West Agro	Entreprenural farmer
94	Osinowo Olowolabi Babatunde	0802 222 9981	Kartlos Farms	Entrepreneural farmer
95	Ifeoluwa Christie Oyeyemi	07061364728	FarmHelp Agro Stores	Input dealer
96	Adenitan Blessing Olatunde	07038034142	SOLOKAD Multiventures Ltd	Input Dealer

APPENDIX 2: Communique of the 2023 National Tomato Technical Stakeholders Committee Meeting

The one-day National Tomato Technical Stakeholders Committee meeting held on Wednesday 22nd February 2023 at Bolton White Hotel Abuja. It was jointly organized by HortiNigeria Program and the National Horticultural Research Institute (NIHORT).

Theme: Tomato Value Chain: Emerging and Long-standing Challenges, and Sustainable Solutions

Objective of the meeting: To identify current and enduring issues restraining progression in the tomato value chain in Nigeria, review the policies and initiatives hindering the competitiveness of the tomato value chain and provide solution options that will address these issues.

Attendance: There were 49 participants who attended physically and 3 participants who attended virtually belonging to Government officials, HortiNigeria stakeholders, farmer representatives, research institution, Agriculture Development Program (ADP) officers, policy makers, industry leaders, development partners, agribusiness consultants, marketers, men of the press and all other stakeholders in the tomato value chain.

OPENING:

The meeting started at 9.32am with recitation of the National Anthem
Introduction of guests: All guests introduced themselves individually.
Welcome address: The welcome address was delivered by Mohammed Salasi, the HortiNigeria Program Director. He gave an overview of HortiNigeria program. The program seeks to bridge the gap as Nigeria is unable to meet the local market demand for vegetables with an estimated supply gap of 13 million metric tonnes for just 3 major crops: tomato, onion, and okra. HortiNigeria program facilitates the development of a sustainable and inclusive horticulture sector that will contribute to nutrition security in Nigeria. Also, the program aims to increase investment by SMEs to solve value chain bottlenecks, create advocacy to improve enabling environment for horticultural value chains, strengthen and support existing sector platforms and broker business to business partnerships.

Mr. Abdullahi Umar, the Component 4 Lead of the Program also gave his presentation on the focus of the component which is to implement consultative policy review to resuscitate Tuta absoluta eradication initiative program in Nigeria.

Goodwill messages were given by representatives from various organizations like NIHORT. Nigerian Agribusiness Group (NABG), ADP Director and the Federal Ministry of Agriculture and Rural Development (FMARD).

TECHNICAL SESSION

Three groups were formed with members comprising of personnel from farmers' groups, processors, marketers, development partners, government agencies, men of the press. Each group was saddled with task to address the following specific objectives of the meeting:

1. Identify and understand existing policies favoring tomato production and review policies hindering the competitiveness of the tomato value chain.

2. Identify areas of alignment with government policies and other key stakeholders with HortiNigeria program and to activate a platform that will continue to coordinate a national strategy for a response mechanism for pest and diseases outbreaks including *Tuta absoluta*.

At the end of the breakout sessions, the issues raised in the groups were harmonized in a joint group discussion.

Policies identified included:

The 2017 tomato sector policy: Every stakeholder agreed that it has the potential to grow the tomato value chain in Nigeria. However, the policy was considered to have somersaulted due to poor implementation and weak of monitoring.

The review of the policy in 2021 without the involvement of all stakeholders that developed it was frowned at by farmer groups who expressed their pains on how this has affected the gains that were already been recorded.

Restriction on importation of fertilizers: Ban on importation of all NPK fertilizers and any other variants. Blanket restriction of fertilizers beyond the NPK especially the soluble fertilisers. This was considered as affecting crop yield negatively which is more pertinent to the vegetable production using the Green houses technologies.

Presidential Fertilizer Initiative (PFI) Policy and the National Fertilizer (Control) ACT.2019: The need for advocacy for crop specific fertilizers was highlighted

Zero Reject Policy, Agricultural Promotion Policy, Mechanization Policy, and Local content policy were also identified as one of the existing policies that has impact on vegetable value chains in Nigeria

NEXT STEPS/ RECOMMENDATIONS

The FMARD, farmer groups and researchers are to generate empirical data as evidence of the positive impact the 2017 tomato sector policy had or could have had so that this can be used to advocate for favourable policies, particularly a revert to the initial agreement of 2017.

Advocacy: Engage in round table discussions with policy makers to review some components of the 2017/2021 tomato policy.
Advocate for the establishment of Agriculture Trust Fund

Registration of more tomato products made locally in the international market
Strong synergy among government agencies and other stakeholders in the implementation and review of policies

Awareness should be created, and all stakeholders should be involved in policy formulations and review

Policy document must be shared among all stakeholders up to the grassroot level

Platform to address emerging pest and disease, especially *Tuta absoluta* should be established

Leverage on the platform of the NABG through the forthcoming Presidential Round Table discussion to engage policy makers on the areas where review or commitment are needed

CLOSING

The communique was read by Dr Akin-Idowu Pamela of the National Horticultural Research Institute and the meeting ended at about 1:45 pm with prayers.

Communique Drafting Committee
Dr Aderibigbe Olaide Dr
Akin-Idowu Pamela

Horti Nigeria

BUILDING A SUSTAINABLE & INCLUSIVE HORTICULTURE SECTOR

Scoping and Mapping of Post Harvest Losses

IFDC Developing Agriculture from the Ground Up

EAST-WEST SEED FOUNDATION

KNOWLEDGE TRANSFER

WAGENINGEN UNIVERSITY & RESEARCH

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#6 Ogbagi Street, Off Oro- Ago Crescent, Garki II, Abuja Nigeria

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