ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9
November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

*Afr. J. Food Agric. Nutr. Dev*. 2022; 22(8): 21694-21712 https://doi.org/10.18697/ajfand.114.22050

# USE OF POLYURETHANE INSULATED CHAMBERS TO REDUCE POST-HARVEST LOSSES OF FARM PRODUCE FOR THE NIGERIAN MARKET

**Oluwatobi EA[1]*, Kehinde A[1] and M Adeyemi[1]**

**Oluwatobi Elijah Akindele**

*Corresponding author email: tobjah24@gmail.com

[1]Research & Development Department, Vitapur Nigeria Limited, Lagos, Nigeria

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9
November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

## ABSTRACT

General metabolic activity rises with increasing temperature in farm produce, which commonly leads to post-harvest losses. In recent times, control of temperature has been used successfully to control deterioration and maintain viability of these farm produce. This study focused majorly on post-harvest losses which are a recurring issue in Nigeria's agricultural sector, especially in the heat of COVID-19 pandemic. It also focused on the driving factors and the proactive measures that were adopted to tackle the problem. Losses of agricultural produce can occur before, during, or after harvesting. Post-harvest losses focus on the latter and are of great concern to the agricultural sector. Preservation of these produce can be achieved using a regulated and temperature-controlled storage area. Rigid polyurethane (PU), commonly used for insulated chambers, has a very low thermal conductivity coefficient of 0.023W/m.K at 10°C with an average K-value of 1.14m$^2$ k/W per inch, depending on the formulation density. Rigid PU exhibits very good dimensional stability between -180 °C and +140 °C, making it a suitable storage technology to forestall and reduce post-harvest losses of agricultural produce. Nigeria has experienced an unimaginable food loss since the outbreak of the COVID-19 pandemic, threatening food security and precipitating massive importation. This has led to a surge in the country's post-harvest losses, currently estimated at $9billion (₦3.4 trillion based on the current official exchange rate of ₦380) by the Federal Ministry of Agriculture. Post-harvest losses in Africa's most populous nation have been estimated to range between 5% and 20% for grains, 20% for fish and as high as between 50% and 60% for tubers, fruits and vegetables. Losses can be the result of reduction in quality and safety. In the absence of quality packaging and refrigeration systems for controlled temperature, farm produce deteriorate faster while the farmer waits to sell. Vitapur Nig. Ltd., a PU insulation company developed a PU-insulated chamber with a tricycle as its carrier to help forestall post-harvest losses. The designed regulated, PU-insulated chamber helps to preserve the quality of farm produce and the transportation problem is solved using the tricycle as the carrier. The study showed that the PU-insulated chamber, a composite that comprises majorly of rigid PU systems (Polyol and Isocyanate) and chromadek sheets as the facer can help reduce post-harvest losses by almost 27%, depending on the specific design used.

**Key words:** post-harvest, food safety, farm produce, polyurethane, quality, insulated, chamber, temperature



https://doi.org/10.18697/ajfand.114.22050

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9
November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

## INTRODUCTION

Food waste and loss is a big and increasing problem which is particularly severe in developing countries like Nigeria where it reduces incomes by at least 15% for the 470 million smallholder farmers and downstream value chain actors, most of whom are a part of the 1.2 billion people who are food insecure [1]. Reports by Food and Agriculture Organisation (FAO) indicate that, yearly, one-third of the food produced globally (about 1.3 billion tons) worth approximately $1 trillion is lost during post-harvest operations [1]. Also, FAO puts food losses at around 14% beginning from the post-harvest stage to, but excluding, the retail stage [1]. This has led to a surge in the country's post-harvest losses currently estimated at $9billion (₦3.4 trillion based on the current official exchange rate of N380) by the Federal Ministry of Agriculture. Post-harvest losses in Africa's most populous nation have been estimated to range between 5 and 20% for grains, 20% for fish and as high as between 50 and 60% for tubers, fruits and vegetables, according to experts [2].

Since the outbreak of the COVID-19 pandemic in Nigeria, the country has experienced an unimaginable food loss, threatening food security and precipitating massive importation. According to data from the National Bureau of Statistics (NBS), this has led to Nigeria's food import bill of about ₦261 billion within the first three months of the year, showing that the country is largely dependent on external sources to augment local production [2]. The value of imported agricultural goods for the period was 12% higher than in the fourth quarter of 2019 and 10.6% higher than the corresponding quarter of 2019. The interstate lockdown further compounded the problem, as fresh produce from the north spent more time in transit to the south where the majority of the consumers are located [2].

### Factors Contributing to Post-harvest Losses

Various factors are responsible for post-harvest losses in Nigeria, losses which occur from harvesting down to the processing stage and at the level of the consumer. These factors include mechanical, physical, hygienic, and physiological conditions. As a result of these factors, a substantial percentage of loss occurs between harvesting and consumption of the produce [3,4]. However, among the causes, pathological rots are the most significant, followed by mechanical injury. Pathological rots in combination with mechanical damage cause considerable damage to the perishables [5, 6]. Environmental factors such as oxygen balance, temperature and relative humidity are also responsible for considerable damage, especially during storage. Also, these environmental conditions are responsible for rendering farm produce susceptible to pathological attacks. That said, biochemical and physiological causes of food damage are closely interrelated [4, 7].

The primary factors of post-harvest loss of farm produce are mainly caused by mechanical physiological, pathological or environmental factors [8]. Environmental factors like humidity, temperature, and the composition and proportion of gases in controlled atmospheric storage play a critical role in the post-harvest loss of farm produce [9]. High levels of temperature and relative humidity favour the growth of micro-organisms which result in serious damage to the produce. High temperatures also increase the rate of respiration of farm produce which subsequently results in the breakdown of the inner tissues. Also, elevated temperature and relative humidity increase the decaying of farm produce, while low temperatures – especially those below 5°C – will slow down the rate of microbial attack on different crops. Chilling injury which is caused by low but not freezing temperature is mainly observed with tropical and subtropical farm produce. The symptoms of chilling injury may not be evident while the farm produce are held at chilling temperature, but may become visible only when the farm produce are transferred to room temperature (37°C) [9].

In the post-harvest environment, the role played by relative humidity (RH) is as important as that played by temperature. The effects of temperature and relative humidity are mainly comparable and interrelated because the capacity of air to hold moisture varies with the temperature. The aeration in the storage containers or in stores has its bearing on RH and hence indirectly on disease development. The effects of high RH on decay are also closely related with the effects of temperature and, for many farm produce, relative humidity near saturation results in lower decay losses only if the temperature is near 0°C. RH below 90% does not, however, permit micro-organisms to grow on the surface of farm produce [10]. Therefore, all farm produce have their own specific heat requirements during processing. Excessive or insufficient heat supply during processing, improper cold storage temperature, and un-desirable gaseous composition of controlled atmosphere of storage lead to physical damage due to tissue break down [11].

The magnitude of post-harvest loss in farm produce can be reduced by proper cultural operations, harvesting, transportation, storage and pre- and post-harvest treatments. Pre-cooling prevents premature ripening and ageing of the fresh produce. Therefore, it is important to remove field heat of the harvested vegetables, especially when the harvesting is done during hot weather. Cooling, therefore, conserves weight of the fresh produce which gives an added advantage during the extended storage period. In fruits like tomatoes, pre-cooling during storage can reduce physiological loss of weight from 6 to 2.9%, while in vegetables, which deteriorate very fast, good cooling can reduce storage losses

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9
November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

[7]. Sometimes, the stage of ripening and the level of field heat also determine the need of pre-cooling. Effective pre-cooling can be accomplished by (1) placing ice in water and then passing through a spray of cool water, (2) placing ice in packages, (3) passing through vacuum cooling, or (4) placing the produce in refrigerated trucks with forced humidified air circulation [9]. In Nigeria, the transportation of perishable commodities is the most precarious stage [12]. In the local markets of Nigeria, the produce is brought either by trolley, bus, motorcycle, or tricycle. Long-distance transportation, which is very costly, is mainly by trains and trucks. However, road transportation by trucks is the more preferred of the two mainly because it is faster. For successful marketing and maintenance of good quality, quick transportation of fruits and vegetables is important. Most of the losses which occur during transportation occur due to physical and mechanical injury and uncontrolled conditions, mainly temperature and RH [13].

**Storage at Low Temperature**

The main objective of storage is to extend the shelf-life of farm produce and increase their period of availability. A substantial quantity of farm produce goes to waste in Nigeria and other developing countries due to lack of proper storage facilities [3, 10]. It should be noted that fresh produce are living entities that continue to carry out all the vital physiological activities even after they have been harvested. The primary purpose of storage is to control the rate of respiration, transpiration, ripening and any undesirable bio-chemical changes and disease infection. To a greater extent, by controlling the post-harvest environmental conditions of temperature, RH and atmospheric concentration of certain gases, post-harvest loss farm produce can be minimized [10].

**Refrigeration**

The principle of refrigeration is to bring in cool air and take out heat from the produce. In mechanical refrigeration, the refrigerated gas, for example ammonia, takes out the heat from the chamber or store as it expands. The expanded gas is then compressed to remove the heat from the compressed air over the tubes containing the hot gases. The gas is liquefied, and the cycle is then repeated. That way, farm produce can be safely kept for a long period through refrigeration [10].

**Cold Storage**

The most suitable condition for fresh farm produce in storage is the lowest temperature, which does not cause chilling injury to the fresh produce [12]. Any variation from the desired condition is detrimental. Relative humidity of the store rooms also has a considerable bearing on the keeping quality of the fresh produce. Yet, control of moisture in air is very difficult [10]. The rate of respiration has direct correlation with temperature, as the temperature is high, the rate of respiration will be high as well as multiplication of decay organisms. It should be noted that the temperature and relative humidity requirements differ for different farm produce.

One of the most important contributions to storage technology is the Controlled Atmosphere (CA) storage, where low levels of Oxygen ($O_2$) and high levels of Carbon Dioxide ($CO_2$) are maintained. CA storage when combined with refrigeration results in retardation of the respiratory processes and this has the capacity to delay yellowing, softening, quality changes, and other deteriorative processes [8]. Nevertheless, the significant factor in storage under CA is the adherence or susceptibility of the farm produce to the damage which results from reduced concentration of $O_2$ and increased $CO_2$. Therefore, the tolerance of individual produce differs considerably and is mainly dependent on morphology, age, temperature and anatomy of the produce. The first step in CA storage is a gas-tight envelope around the produce; the second is maintaining the concentration of $O_2$ and $CO_2$ at preferred levels [8, 13].

The benefits derived from CA storage are (i) reduction in the incidence of disease-causing pathogens like fungi, bacteria, pests and insects in fresh produce, (ii) by regulating the process of respiration and senescence, shelf-life of perishables would be extended, and (iii) ethylene sensitivity reduction. Storage under CA was found to be effective for farm produce which rapidly deteriorate and those where ripening is complete after harvest [8].

The aim of this study is to show that the PU-insulated chamber, a composite that mainly comprises rigid polyurethane systems (Polyol and Isocyanate) and chromadek sheets as the facer can help reduce post-harvest losses, depending on the specific design used, by helping to mitigate against factors that cause post-harvest losses in the Nigerian market.

## MATERIALS AND METHODS

Chromadek steel sheet for sandwich panel was procured from Insist Steel Co. Ltd, Hebei, China. Stainless profile angles were sourced from NIGALEX Ltd., Lagos, Nigeria. The polyol used for the foaming of the sandwich panel was Elastopor H1102/21 from BASF, Germany, and 4,4-diphenylmethane diisocyanate for foaming of sandwich panel was Cosmonate MDI-200 from UNID Global Corporation, Korea.

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9
November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Foaming of 75mm thickness sandwich panel for the PU-insulated chamber and construction of the chamber were performed by Vitapur Nig. Ltd. A 3-wheeler tricycle (Galaxy) was procured from Boulos Enterprise Nig. Ltd.

**Fabrication**

Fabrication of PU-insulated chamber with dimensions 1700mm (length) by 1225mm (breadth) by 1150mm (height) was carried out according to specified technical diagram as shown in Figure 1.

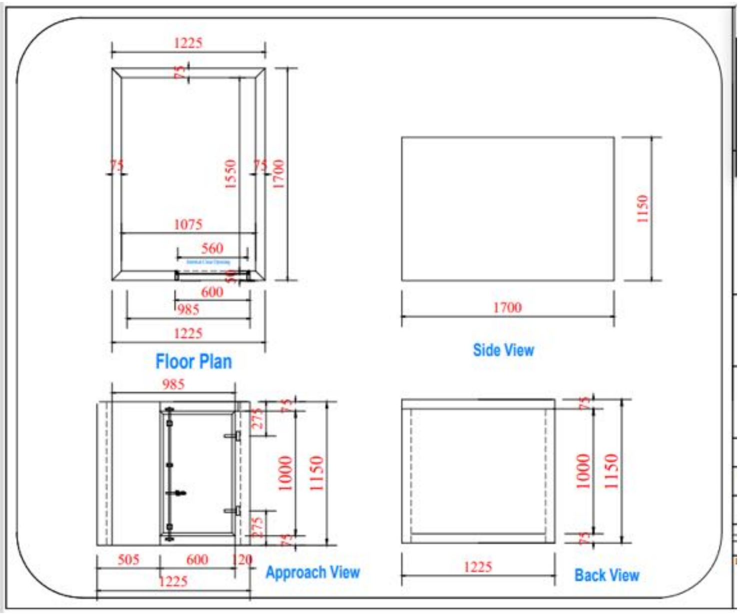


**Figure 1: Technical diagram of PU-insulated chamber**

3-Wheeler Tricycle

The 3-Wheeler tricycle has the specifications as listed in Table 1.

**Figure 2: Construction of insulated chamber**

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

**Freezer and Chiller**

The voltage of the tricycle fitted with a PU-insulated chamber was DC12V/24V, the tricycle refrigeration was electric system which is driven by a battery (DC) directly while the cooling unit is an integrated system. It was used for short-distance transportation, especially within-city distribution of meat, fish, fruits, tomatoes, chicken, ice cream, mango, red bell pepper, and bonney pepper. It comes as Freezers or Chillers depending on its application as shown in Table 2.

## METHODOLOGY

Post-harvest losses for the farm produce were determined using two different methods and percentage loss was calculated using the formula stated below. The first method involved the use of two un-insulated trucks (A and B) which was used to transport different fixed amounts of farm produce as stated in Table 2 (Truck A – meat, fish, chicken, and ice-cream; Truck B – mango, tomato, red bell pepper, and bonney pepper). The farm produce in plastic crates were loaded into the trucks and standard deviation temperature of Truck A was 26.8°C while that of Truck B was 26.4°C. The second method involved the use of a tricycle fitted with a PU-insulated chamber (Freezer and Chiller chamber) to transport the same amounts of the same farm produce as in the un-insulated truck and as stated in Table 2 (Freezer chamber – meat, fish, chicken, and ice-cream; Chiller chamber – mango, tomato, red bell pepper and bonney pepper). The farm produce were also packed in plastic crates as in the case of the un-insulated trucks and the standard deviation temperature of Freezer chamber was -6.4°C and that of the Chiller chamber was 1.3°C. The farm produce in Truck A and PU-insulated freezer chamber were transported for approximately 3.9 km while the farm produce in Truck B and PU-insulated chiller chamber were transported for approximately 6.1 km.

**Formula for Percentage loss for Un-insulated trucks:**

Percentage loss on Truck A or B (%) = (Loss (kg) / Quantity supplied (kg)) X 100

Total loss on both trucks (kg) = Loss in Truck A + Loss in Truck B

Percentage loss on Truck A and B (%) = (Total loss (kg) / Total quantity supplied (kg)) X 100

**Formula for Percentage loss for PU insulated chambers:**

Percentage loss on Freezer chamber/Chiller chamber (%) = (Loss (kg) / Quantity supplied (kg)) X 100

Total loss on PU insulated chambers (kg) = Loss in freezer chamber + Loss in chiller chamber

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9
November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Percentage loss on PU insulated chambers (%) = (Total loss (kg) / Total quantity supplied (kg)) X 100

Percentage reduction in loss after using PU insulated chamber (%)
= (Percentage loss using un-insulated truck A&B – Percentage loss using PU insulated chambers) / Percentage loss using un-insulated truck A&B

**Figure 3: Constructed insulated chamber**

**Figure 4: Dispatch of PU-insulated chamber tricycle carrying farm produce**

## RESULTS AND DISCUSSION

### Use of un-insulated truck for transportation of farm produce

A fixed quantity of farm produce was distributed to consumers using an un-insulated truck. Quantity supplied and quantity finally accepted by consumers are recorded in Tables 5 and 6 and the calculation is as indicated below. Truck A was


https://doi.org/10.18697/ajfand.114.22050

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9
November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

used to transport the farm produce for approximately 3.9 km and time taken to reach destination was 14 minutes while Truck B was used to transport the farm produce for approximately 6.1 km and the time taken was 31 minutes.

**Calculation**

Percentage loss on Truck A (%) = (Loss [kg] / Quantity supplied [kg]) X 100
= (34/450) X 100
= 7.56%

Percentage loss on Truck B (%) = (Loss [kg] / Quantity supplied [kg]) X 100
= (72.8/450) X 100
= 16.18%

Total loss on both trucks (kg) = Loss in Truck A + Loss in Truck B
= 34 + 72.8
= 106.8 kg

Percentage loss on Truck A&B (%) = (Total loss [kg] / Total quantity supplied [kg]) X 100
= (106.8 / 900) X 100
= 11.87%

Use of a tricycle fitted with a PU-insulated chamber for transportation of farm produce

A fixed quantity of farm produce was distributed to consumers using the tricycle. Quantity supplied and quantity finally accepted by consumers are recorded in Tables 7 and 8 and the calculation is as below. The tricycle with a PU-insulated freezer chamber was used to transport the farm produce for approximately 3.9 km and time taken to reach destination was 8 minutes, while the tricycle with a PU-insulated chiller chamber was used to transport the farm produce for approximately 6.1 km and the time taken was 19 minutes.

**Calculation**

Percentage loss on Freezer chamber (%) = (Loss [kg] / Quantity supplied [kg]) X 100
= (19.2/450) X 100
= 4.27%

Percentage loss on Chiller chamber (%) = (Loss [kg] / Quantity supplied [kg]) X 100

= (58.4/450) X 100
= 12.97%

Total loss on PU-insulated chambers (kg) = Loss in freezer chamber + Loss in chiller chamber
= 19.2 + 58.4
= 77.6 kg

Percentage loss on PU-insulated chambers (%) = (Total loss [kg] / Total quantity supplied [kg]) X 100
= (77.6 / 900) X 100
= 8.62%

Percentage reduction in loss after using PU-insulated chamber (%)
= (Percentage loss using un-insulated trucks A & B – Percentage loss using PU-insulated chambers) / Percentage loss using un-insulated trucks A & B
= (11.87 – 8.62) / 11.87 (%)
= 27.38%

From the above results, it was observed that 34 kg of farm produce were lost while using un-insulated truck A, which translated into a 7.56% loss of what was supplied. 72.8 kg of farm produce were lost while using un-insulated truck B, which translated into a 19.18% loss of what was supplied. The total loss of farm produce using the two un-insulated trucks was 106.8 kg which resulted in a total loss of 11.87% of what was supplied to consumers.

Using PU-insulated freezer chamber, 19.2 kg of farm produce were lost, which translated into 4.27% loss of what was supplied. 58.4 kg of farm produce were lost while using the PU-insulated chiller chamber, which translated into a 12.97 % loss of what was supplied. The total loss of farm produce using the PU-insulated chambers was 77.6 kg, which translated into a total of 8.62% of what was supplied. When comparing the use of PU-insulated chambers with the use of un-insulated trucks, a 27.3% reduction in post-harvest loss was observed while supplying consumers. It was also observed that using tricycles reduced farm produce delivery times drastically as the tricycles were better able to manoeuvre congested city roads. Traffic congestion tends to increase delivery time and contribute to post-harvest losses.


https://doi.org/10.18697/ajfand.114.22050

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9
November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

## CONCLUSION

Inadequate storage facilities at production or marketing centres expose farm produce to the natural causes of losses, that is, damage by micro-organisms, respiration, transpiration and other biochemical reactions. On the other hand, proper or CA storage creates conditions unfavourable to these natural causes. The use of PU-insulated chambers has been shown to be very effective in reducing post-harvest losses by almost 27 %, depending on the specific design used. Transportation and distribution of farm produce are very important stages for post-harvest loss because physical and mechanical damage occur during transportation and distribution; this was observed as longer shipment and distribution times eventually contributed to significant losses as in the case of using un-insulated trucks. Conversely, the use of tricycles with PU-insulated chambers reduced the shipment times considerably. The earlier the harvested produce is consumed, the minimum is the loss as the period of senescence and organism invasion, multiplication, and damage is shortened. All this can be achieved by using the PU-insulated chambers, which have been used in other applications, including freezer rooms for storing food items at 0°C in large stores, cooling rooms for storing consumable materials at regulated temperatures in manufacturing plants and clean rooms in pharmaceutical industries. All these have been serving as a good storage technology and helping preserve the quality of farm produce through the supply chain.

Farm produce are characterized by their level of spoilage and perishability, but increased shelf-life, especially for fresh vegetables and fruits, can be achieved by control of temperature as shown by this study. However, further studies can be carried out for feasibility and effectiveness of this technology by:

a) Expanding the scope of use of the technology to other farm produce
b) Carrying out studies on measurement of more parameters such as humidity, distance, and duration of use.

Cold storage and cooling are very expensive and energy-intensive undertakings that require supply of reliable electricity. Unavailability of this condition generally leads to increased capital and running costs for farmers in developing countries. Hence, the use of appropriate cold storage facilities and unbroken cold chains are not usually accessible to medium and small-scale farmers. However, with the use of this technology, further studies on cost-benefit implications and its sustainability with medium and small-scale enterprises can be done by:


https://doi.org/10.18697/ajfand.114.22050

a) Considering other sources of renewable energy that are compatible with this technology such as solar energy
b) Partnering with private, government, and international agencies with available funding and management programs.

## ACKNOWLEDGEMENTS

We are grateful to Vitapur Nig. Ltd. for funding this research work.

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9
November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

**Table 1: List of specifications**

| | |
|---|---|
| Engine Type | 200CC AIR-COOLING KING |
| Bore x Stroke | 63MM x 64.5MM |
| Compression Ratio | 9:0:1 |
| Max Power | 10.5KW/7500RPM |
| Max Torque | 15.5N.M/5500RPM |
| Idle Speed - | 1500± 150R/MIN |
| Leaf Spring | 16KG ONE PCS (HEAVY DUTY) |
| Rear Carrier Size | 1.25M x 1.7M |
| Brake Way | DRUM BRAKE |
| Tire Size | 5.0-12 (TNT SUPPLIER) |
| Front Shock Absorber | 50MM DIAMETER STYLE WITH REINFORCEMENT PLATE |
| Rear Bridge | 5 BOLT TS SEMI-SUSPENSION STYLE |
| Foldable Long Seat | WITHOUT |
| Maximum Loading Weight Capacity | 600KG |
| Fuel Tank Capacity | 17 LITERS |

**Table 2: Classification of farm produce and quantity used**

| Freezer (-8ºC) | Quantity | Chiller (0ºC) | Quantity |
|---|---|---|---|
| Meat | 80kg | Mango | 110kg |
| Fish | 120kg | Tomato | 150kg |
| Chicken | 100kg | Red bell pepper | 95kg |
| Ice cream | 150kg | Scotch bonnet (Ata rodo/Bonney pepper) | 95kg |


https://doi.org/10.18697/ajfand.114.22050

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9
November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

**Table 3: Freezer specification**

| | |
|---|---|
| Cabin size (Volume) | 1.7m * 1.25m * 1.0m (2.125 $m^3$) |
| Temperature | (-8ºC) |
| Insulation | 75mm thick Polyurethane foam |
| Structural Pattern | Integrated Unit |
| Cooling capacity | 800~1500W(0ºC) |
| Power Consumption | 500~1000W |
| Condenser | Parallel flow |
| Refrigeration unit Voltage | DC12/24V |
| Evaporator | copper pipe |
| Compressor | YWXD18 (18cc/r) |
| Compressor Voltage | DC/24V/48V/60V/72V |
| Refrigerant | R404a 0.5~0.6 Kg |
| Dimension (mm) | 925×842×260 |
| Source of Power | DC |
| Engine capacity of Tricycle | 200CC |


https://doi.org/10.18697/ajfand.114.22050

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9 November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

**Table 4: Chiller specification**

| | |
|---|---|
| Cabin size (Volume) | 1.7m * 1.25m * 1.0m (2.125 $m^3$) |
| Temperature | (0ºC) |
| Insulation | 75mm thick Polyurethane foam |
| Structural Pattern | Integrated Unit |
| Cooling capacity | 600~1000W(0ºC) |
| Power Consumption | 300~500W |
| Condenser | Parallel flow |
| Refrigeration unit Voltage | DC12/24V |
| Evaporator | copper pipe |
| Compressor | BYC075/135 (7.5/13.5cc/r) |
| Compressor Voltage | DC12V/24V/48V/60V/72V |
| Refrigerant | R134a 0.5~0.6 Kg |
| Dimension (mm) | 925×842×260 |
| Source of Power | DC |
| Engine capacity of Tricycle | 200CC |

**Table 5: Quantity supplied by Truck A**

| Items | Quantity Supplied (kg) | Quantity Received by consumer (kg) | Loss (kg) |
|---|---|---|---|
| Meat | 80 | 76 | 4 |
| Fish | 120 | 112 | 8 |
| Chicken | 100 | 94 | 6 |
| Ice cream | 150 | 134 | 16 |
| Total | 450 | 416 | 34 |

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9
November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

**Table 6: Quantity supplied by Truck B**

| Items | Quantity Supplied (kg) | Quantity Received by consumer (kg) | Loss (kg) |
|---|---|---|---|
| Mango | 110 | 98 | 12 |
| Tomato | 150 | 128 | 22 |
| Red bell pepper | 95 | 77 | 18 |
| Scotch bonnet (Ata rodo/Bonney pepper) | 95 | 74.2 | 20.8 |
| Total | 450 | 377.2 | 72.8 |

**Table 7: Quantity supplied by Freezer chamber**

| Items | Quantity Supplied (kg) | Quantity Received by consumer (kg) | Loss (kg) |
|---|---|---|---|
| Meat | 80 | 77.6 | 2.4 |
| Fish | 120 | 115.8 | 4.2 |
| Chicken | 100 | 97 | 3 |
| Ice cream | 150 | 140.4 | 9.6 |
| Total | 450 | 430.8 | 19.2 |

**Table 8: Quantity supplied by Chiller chamber**

| Items | Quantity Supplied (kg) | Quantity Received by consumer (kg) | Loss (kg) |
|---|---|---|---|
| Mango | 110 | 103 | 7 |
| Tomato | 150 | 130.4 | 19.6 |
| Red bell pepper | 95 | 79.2 | 15.8 |
| Scotch bonnet (Ata rodo/Bonney pepper) | 95 | 79 | 16 |
| Total | 450 | 391.6 | 58.4 |

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

## REFERENCES


1. **Gustavsson J, Cederberg C, Sonesson U, Van Otterdijk R and A Meybeck** Global Food Losses and Food Waste; Food and Agriculture Organisation of the United Nations: Rome, Italy, 2011.

2. **Josephine O** Nigeria's post-harvest losses surge amid COVID-19 pandemic. 2020. Retrieved from: https://businessday.ng/agriculture/article/nigerias-post-harvest-losses-surge-amid-covid-19-pandemic *Accessed April 20, 2021.*

3. **Hayatu M** Post-Harvest physiological studies of some selected members of family Solanaceae. In: Master's Thesis, Department of Biological Sciences, Bayero University Kano, 2000: 2-25.

4. **Sani MY and SEL Alao** Assessment of post-harvest fungi of tomato and pepper in selected irrigation areas of Kano State. Nig. *Intl. J. of Res. in Biosci.* 2006; **1:** 53-56.

5. **Mustapha Y and SM Yahaya** Isolation and identification of post-harvest fungi of tomato *(L. esculentum)* and pepper *(Capsicum annum)* sample from selected irrigated sites in Kano. *Bio. & Env. Sci. J. for the Tropics.* 2006; **3:** 139-141.

6. **Food and Agriculture Organisation**. FAO Statistical-Database. Rome, Italy 2011.

7. **Williams CN, Uzo JO and WT Peregrine** Vegetables Production in the Tropics. In: Longman Scientific and Technical, England 1991: 179.

8. **Yahaya SM** Contribution of harvest to pathogenic and non-pathogenic losses of vegetables grown in Kano State- Nigeria. In: MSc. Thesis Bayero University, Kano 2005:1-4.

9. **Yahaya SM and AY Mardiyya** Review of Post-Harvest Losses of Fruits and Vegetables. *Biomed J. Sci. & Tech. Res.* 2019; **13(4):** 10109-10200.

10. **Danladi DK** Nigeria agriculture: The efficiency factor announce this article to your friends. 2000:1-3.

11. **Cho J** Winter diseases of lettuce. In: University of Hawaii, commodity fact sheet, Institute of Tropical Agriculture and Human Resource. 2008.

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

12. **Alao SEL** The importance of post-harvest loss prevention. In: Paper presented at graduation ceremony of school of food storage technology. Nigerian Stored Products Research Institute, Kano 2000: 1-10.

13. **Opadokun JS** Reduction of post-harvest losses in farm produce. In: Joint National Crop Protection Workshop, IAR, Zaria 1987: 3-26.