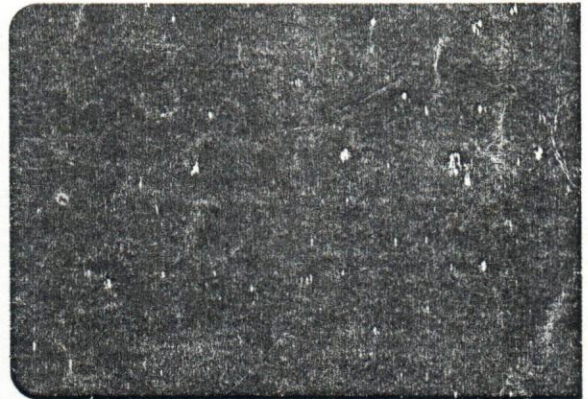
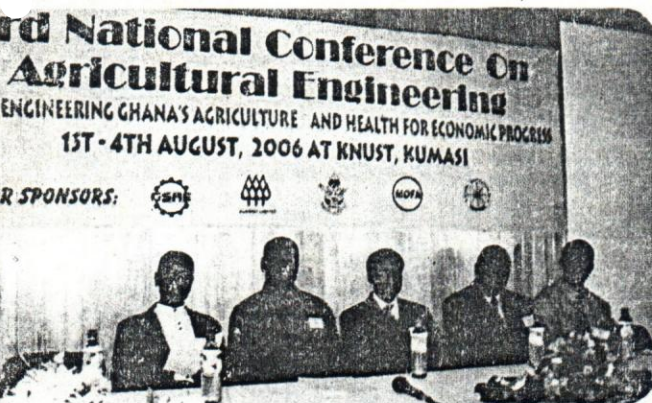




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## ENGINEERING GHANA'S AGRICULTURE AND HEALTH FOR ECONOMIC PROGRESS



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## PACKAGING AND HANDLING OF FRESH TOMATO FROM TONO IRRIGATION PROJECT SITE

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### ABSTRACT

Tomato is an important vegetable in the diet of the people of Ghana. Large quantities of fresh tomato are produced at Tono Irrigation Project site in the Upper East Region, whilst the major marketing centres are located in the southern parts of the country, quite a distant away from this production centre. To retain produce quality and to reduce risk of handling damage, appropriate packaging is necessary to ensure the produce reaches the consumer in an acceptable quality. The study showed that wooden boxes (crates) which are used, generally for packaging in the fresh tomato trade provided some degree of protection for the produce against bruising. External factors however were observed to contribute to produce quality deterioration during packaging and handling. The use of boxes as measuring units (volume rather than weight) gives room to manipulation by traders as they try to overfill the boxes. This was identified as a major cause of squashing and bruising of the produce.

### INTRODUCTION

Tomato is an important vegetable in the diet of the people of Ghana and it is the most important cultivated vegetable at the Tono Irrigation Project site located in the Upper East Region of Ghana. The project covers a total area of 3860 hectares (ha) with 2490 ha developed for irrigation (ICOUR, 1995) and has the potential for the production of a variety of vegetables all year round. The average annual land area for the cultivation of tomato at the site is 438.58 ha cultivated by about 626 farmers out of a total of 3000 farmers of the project area (ICOUR, 2002).

This production area is far away from the urban and major marketing centers, which are mostly located in the southern parts of the country. With the increasing remoteness of production areas from marketing centres, the time to carry the produce from farm to market can be considerable. It takes about two (2) days for fresh tomato produce harvested at Tono to arrive in Accra, the capital city of Ghana, a distance of approximately 870 km. This necessitates the need to adopt an appropriate and pragmatic post-harvest technique (including packaging) that allows quality of produce to be retained during this period before the produce reaches the consumer.

Tomato is susceptible to handling damage, producing effects that are not easily seen or understood. The tomato is handled several times and at each point there is the risk of damage. Appropriate packaging is therefore needed to reduce the risks of the various types of handling damage throughout the post harvest chain. Apart from lowering the quality of the produce, poor handling also reduces the shelf life of the vegetable. It is also realized that faulty handling practices can also cause large losses of produce that require large inputs of labour, materials and capital to grow. According to Rice et al (1993), a well presented, uniform produce will always attract the best prices and an extra effort given to handling and care in transportation and presenting produce will often be well repaid. Therefore, appropriate packaging in particular and good post-harvest handling in general will not only benefit traders but farmers and consumers alike.

Packaging is the art and technology of preparing a commodity for convenient transport, storage and sale. Packaging is important for fresh fruit products throughout the post-harvest chain. Packaging has been practiced for as long as fresh produce has been traded. The earliest packages were mostly constructed of plant-materials, such as woven leaves, reeds and grass stems, which were designed to be carried by man (Wills et al., 1998). Produce is transported and sold these days in a range of packages constructed of wood, fibreboard, jute or plastics.

Packaging fulfils several functions including containment, facilitating transportation, protection of produce against further damage, provision of favourable environment for product storage, and facilitating marketing and stock control (Studman et al, 1999). However, it has been observed that not all of these functions are accomplished when the produce eventually arrives at the marketing centre.

According to Wills et al., (1998), modern packages and packaging for fresh produce must meet a range of basic requirements, which include:

- Sufficient mechanical strength to protect the contents during handling and transport, and while stacked;
- The package must not be affected in terms of mechanical strength by moisture content when wet or at high relative humidity;
- Stability and security of the products must be ensured against movement within the package during handling;
- The package must not contain chemicals that could become transferred to the produce and taint it or be toxic to the produce or to humans;
- The package must meet handling and marketing requirements in terms of weight, size and shape;
- The package must be cost effective in relation to the value and the required extent of protection of the contents.

In Ghana, fresh fruits of tomato are often packaged and transported in wooden boxes (crates). At the final destination of the produce (market), there are always varying degrees of quality deterioration of the product as a result of packaging and transportation. It is therefore important to study the performance of these wooden containers used in the handling of tomato in order to make appropriate recommendations to reduce damage to the produce and to curtail post-harvest losses generally.

Primarily, the study objective is to evaluate the effect of the packaging on the quality of tomato traded from the Tono Irrigation Project site.

**MATERIALS AND METHODS**

Data for the work was obtained through primary and secondary sources. Primary data was obtained through discussions with farmers and traders, and through the administration of semi-structured questionnaires on farm. The secondary data was obtained from the management of ICOUR (Irrigation Company of Upper Region), the institution responsible for the management and maintenance of the irrigation facilities at the Project site. ICOUR offers agricultural extension and advisory services as well as credit and marketing services to the farmers. In all five (5) farmers and twenty-five (25) traders were randomly selected for the exercise. A visit was also made to a marketing centre to observe the quality, as the boxes are off-loaded.

Both quantitative and qualitative data were obtained. The quantitative data are numerical in form showing the size of crates, distance of production area from marketing centers and time taken to reach marketing centres during transporting. The qualitative data are descriptive in form, including activities carried out by farmers during and after harvesting, and the opinions of traders regarding causes of fruit damage during transportation. Table 1 shows the trend of tomato production at the study area from the year 1991 to 2001. The yearly yield marketed is far below the annual targeted yield of 21t/ha.

**Table 1: Tomato Production at Tono**

Year	Land Area (ha)	Targeted Yield (t/ha)	Yield Marketed (t/ha)
1991	169.50	21	7.1
1992	255.00	21	12.5
1993	291.75	21	8.8
1994	250.05	21	8.8
1995	378.00	21	7.5
1996	383.25	21	8.2
1997	614.25	21	7.9
1998	419.25	21	6.1
1999	603.75	21	8.1
2000	800.25	21	9.9
2001	659.25	21	9.8

Source: ICOUR, 2002)

**Table 2: Types of wooden box (crate) for tomato packaging**

Name of Box	Dimension (cm)	Av. net weight of tomato (kg)
Adaka	65x46x46	108
Adakaba	54x42x42	74
Adakanana	42x36x36	43
Adakawofase	22x21x21	8

(Source: ICOUR, 2002)

Table 2 shows the types of wooden boxes (crates) used by the traders for measuring and subsequent purchase of tomato from the farmers at the project site. The widely used one amongst the boxes is the 'Adaka', the recognized standard box for the tomato trade.

## **RESULTS AND DISCUSSION**

### **Tomato variety**

Tomato varieties widely grown at the Tono Irrigation site are Vis, Petomech, Heinz and Caribo. These varieties are recommended by the management of ICOUR due to the relatively higher resistance of the fruits to handling damage. Whilst some farmers grow a single variety of tomato on their plots, others cultivate two or three varieties on the same plot of land. The survey showed that 40% of the farmers in the project area cultivate the variety Vis, 20% grow Petomech, another 20% of the farmers normally intercrop Vis and Petomech, whilst the remaining 20% favours cropping on the same plot the three varieties Vis, Heinz and Caribo. It was observed that neither Heinz nor Caribo was cultivated as a monocrop on a plot. The variety Vis was the most favoured amongst the farmers.

### **Harvesting**

It was evident farmers do not keep to any specific maturity index for harvesting. The crop is harvested at different stages of ripening depending, more often on when a purchasing order is received. At fully ripen stage farmers, however are compelled to harvest their produce. The study showed that 60% of the farmers harvest their produce at any time during the day irrespective of the temperature whilst the rest 40% indicated that they undertake harvesting in the mornings (between the hours of 05.30 and 11.00).

### **Handling**

The study indicated that produce with varying quality (shape, colour, size, apparent defects) is put together during harvesting. Thereafter the produce is sorted out into different size grades. It was noted that three out of five farmers carried out the sorting of their fruits. Fruits are not pre-cooled despite the bulk of them being harvested in the hot sun. Grass and leaves are however used to cover the fruits in an attempt to prevent further heating and sun scorch.

### **Packing**

The wooden boxes (crates) serve dual functions: as a medium for packaging the tomato and as a unit of measure in the trade. These boxes though have no protruding nails; the inner finish is normally rough. Jumble packing is the general mode of packing tomato into these crates. The tomato fruits are poured into the boxes and shaken to obtain a tight pack. Because the package (the box) serves as a measuring unit, traders often overfill the boxes apparently to have the worth of their monies and also to increase their profit margins. This however, leads to difficulty in stacking, and produce in lower layers of the truck is often subjected to compression injury.

### **Transportation**

The mode of transportation for moving the tomato to the various destination markets in the south of the country is mostly five-ton single axle trucks. Each truck carries on average 87 boxes, stacked in columns of 3-4 tiers. The fourth tier usually comprises some few boxes and does not make a complete tier. The boxes are arranged in rows of four (4) across the width of the truck and seven (7) rows along the length of the truck. Loading of the tomato into the truck is undertaken by four labourers, two on the ground to lift the boxes with the produce, whilst the other two on the truck receive the

produce to arrange them in a predetermined manner. There is no scheduled time for departure of the produce from the production site. Due to the perishability of the produce and the distances to the destinations, the trucks with their loads set off on the journeys as soon as the purchasing deals and loading of trucks are completed. It takes between 12-24 hours for the tomato to arrive at their destinations, often Kumasi and Accra, which are respectively 569 and 873 kilometres from Tono. The roads from the production site to these marketing centres are generally good; however there may be bad sections occasionally due to the weather and other technical factors.

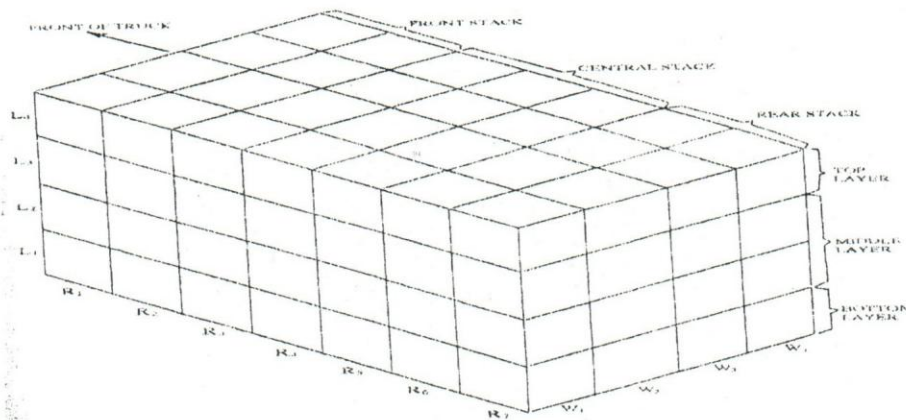


Figure 1. Typical stacking scheme for boxes of tomato in a truck

### Produce Damage

Physical damage to produce varied from box to box, depending on the location/position of the box within the stack. Figure 1 is an illustration showing the stacking of boxes of tomato in a truck. The letter 'L' from L1 to L4 designates the layers, from the bottom to the top. R from R1 to R7 designates rows along the length of the truck. And W, from W1 to W4 designates columns along the width of the truck.

Visual observation of produce showed different levels of damage depending on the layer. The bottom layers L1 and L2 suffered most from heat stress, compression and vibration injuries. The fruits in these boxes were the most susceptible to crushing in situations of overfilling of boxes. Produce in L4, which is the top layer of the stack suffered from direct scorching from the sun if the truck travelled in the day. Because of the heat build-up within the stack due to produce metabolism, transportation of the produce is generally by open trucks. However, produce in L4 was the least susceptible to crushing or compression injury.

Boxes within the locations L1R5W1 to L1R5W4, and L1R6W1 to L1R6W4 are generally exposed to tyre vibration shocks.

### CONCLUSION

From the study it can be inferred that the packaging provides some degree of protection for the produce against bruising. However, there are external factors that must be considered in order to maintain or improve the quality of the produce throughout the period that it is packaged till it gets to the

consumer. Factors, which contributed to the deterioration of quality in the course of packaging and handling of the tomato, included the following:

- Fruits were harvested when they were fully ripe, thus making them susceptible to handling damage.
- Fruits are not pre-cooled and field heat after harvest is always high. The exposure of the produce to the sun during transportation adds up to increase the metabolic activity and enhances the rapid deterioration of the produce.
- Jumble packing of the produce also results in bruised and squashed fruits.

### RECOMMENDATIONS

As long as production sites continue to be away from marketing centres and in the absence of advanced postharvest treatment technologies, it is prudent to recommend the following measures in order to reduce postharvest deterioration of tomato.

- Sale of tomato to traders should be based on weight rather than by volume, to eliminate the use of boxes as measuring units, which currently gives room to manipulation by traders as they try to overfill the boxes to get "a good worth" for the money spent.
- Harvesting of produce should be planned for early hours of the day (between 05.00 – 10.00hrs) and in the evening (between 16.00 – 19.00hrs). Morning harvests must be kept in the shade immediately whilst evening harvest could be left in the open to cool down during the night.
- For the current mode of transportation (in open trucks), it is more suitable to undertake the transportation at night or at dawn to expose the produce to cool temperatures and to offset the heat build-up within the stacks.

### REFERENCES

- ICOUR (1995). ICOUR Information Handbook, p10
- ICOUR (2002). ICOUR Information Handbook, pp7-8
- Rice, R.P., Rice, L.W. and Tindall, H.D. (1993). Fruit and Vegetable Production in Warm Climates. The Macmillan Press, London.
- Studman, J.C. (1999). Handling Systems and Packaging. In: Agro-Processing Engineering, ed. F.W.Bakker-Arkema, CIGR Handbook of Agricultural Engineering, volume IV, ASAE, St. Joseph, USA, pp. 318-324
- Wills, R., McGlasson, B., Graham, D. and Joyce, D. (1998). Postharvest: An Introduction to the Physiology and Handling of Fruit, Vegetables and Ornamentals, Cab International, Wellingford, Oxon, UK, pp214 - 222