Integrated Quality-Control Management Strategies in Banana Production, Packaging, and Marketing

E. Greg Fonsah

Globally, banana and plantain is the fourth most important crop in terms of food value. In some Central American and Asian countries banana production has become a major source of export earnings. Some countries, especially the Francophone West Africa, have acknowledge its commercial importance and capitalized on the special relationship accorded them by the Lomé Convention to produce and export bananas to France and other EU markets concomitantly. The endemic banana quality problems reported by customers in the EEC and other markets around the world are scarring, bruising, knife injuries, crown rots, sooty mould, finger rots, speckling, under-peel discoloration, etc. These defects are complete turn-offs to the end users and have a significant negative impact on consumer satisfaction and sales volume. The objective of this research is to study the origin of these defects, from the plantation through the packaging station to the market place, and to implement strategies aimed at alleviating them. The reject conveyor sampling analysis (RCSA) and the Eight Quality Control Check Points (8QCCPs) models were utilized.

The major achievement of the Uruguay rounds of the GATT talks was the integration of the traditional "sensitive" sectors (agriculture, textiles, and clothing) and the liberalization of the market (Kirmani 1994). This means Cameroon and the other ACP countries are on the verge of losing the privileges accorded them by the Lomé convention (Proctor 1991; CTA 1993). The advantage of a liberalized market is that every producer has an equal chance of entry or exit as long as the supplier can withstand the fierce competition and maintain the highest quality (Bradbury 1995). The disadvantage however, is that smaller nations and/or growers, especially the Developing and Less Developed Countries (LDCs) see these regulations as technical barriers to trade (TBT). These barriers, whether justified or not, do indeed hamper trade flows, especially from nations and small-scale producers with less financial capability.

Quality requirements for the EEC, Japanese and U.S. markets are increasing on a daily basis because of increasing consumer awareness of environmental and public health issues, reliability of supply, volume and delivery schedules (Robinson 1996; Proctor 1991). Increasing or capturing market share in these markets requires strict compliance with quality, packaging, labeling, standards of identification, conformity assessments, and sanitary and phyto-sanitary (SPS) regulations on plants (Heri, 1991; Mulandi, 1991; Robinson, 1996).

E. Greg Fonsah is assistant professor and extension economist, University of Georgia, RDC, Tifton, GA.

Engineer Rey Galindo assisted in sketching the 8QCCP Flow Chart in the Modern Banana Packing Station.

Export Trends

Latin America (LA) continues to dominate the export market. Figure 1 shows that export volume from LA alone rose from 7.9 million tons in 1991 to 9.2 million tons in 2000, with a peak of 10.1 million tons in 1997. In 2000, Latin American countries contributed 77% of total world export bananas. Among the LA countries, 42%, 20%, 16%, and 7% of total exports in 2000 came from Ecuador, Costa Rica, Colombia, and Guatemala, respectively. Ecuador has consistently been the export leader in this region. Other significant contributors in this region include Honduras, Panama, Mexico, Nicaragua, Suriname, Venezuela, Brazil, and Belize.

The Far East, which includes of Philippines, China, Malaysia, Vietnam, Thailand and Pakistan, contributed 14.5% of total world exports in 2000. The Philippines is the clear export leader, with almost 90% of the total regional export in 2000. Africa and the Caribbean regions made a modest contribution of 4% and 1.4%, respectively, of total world exports in 2000. Cote d'Ivoire leads the African region, followed by Cameroon. The former Windward Islands lead the Caribbean region, followed by St. Lucia, St. Vincent and Grenadines, Jamaica, and the Dominican Republic.

The producing and/or exporting country has to guarantee the best quality, respect all quality norms and specifications—e.g., minimum and maximum

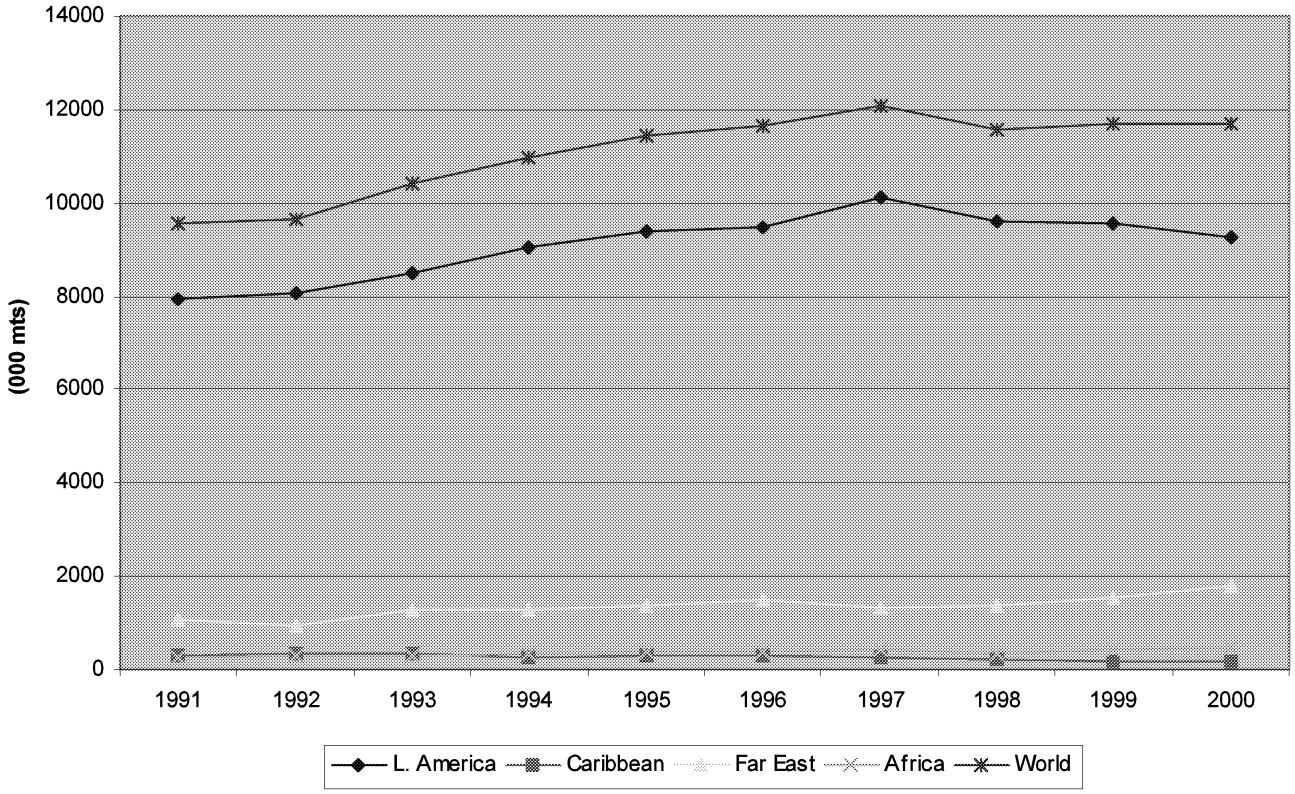


Figure 1: World Gross Banana Export By Region: 1991–2000.

Source: FAO (2001).

finger calibration for each category, minimum and maximum finger length—and be willing and capable of increasing exportable yields. These quality norms are considered by some trade specialists and countries as technical barriers to trade (TBT), which have an adverse effect on the Less Developed Countries (LDC) export and competitive potentials. Only those producers who adopt and continually maintain the EEC, U.S., Japanese, and other potential net-importing countries' market pressures are bound to survive. Scarring, bruising, knife injuries, etc., have been endemic problems at the farm level and packing houses. Crown rots, sooty mould, finger rots, speckling, under-peel discoloration (UPD), etc., have also been major problems at the market level. It is imperative that the sources of these defects be diagnosed before curative and/or preventive measures be implemented, which is the primary objective of this research.

World Banana Import Trend

The world banana import trend increased steadily from 1991 to 2000, except for a slight drop in 1998 (Figure 2). There was a 6.7% increase in the 1999 import volume compared to 1998 and a 2.2% decrease in 2000 compared with 1999. Although North America remains the largest net importer of banana on a regional basis, the U.S. is still the largest importer and consumer of bananas in the entire world—it purchases 31.1% of the total world import. This is equivalent to 3.6 million tons (7.9 billion pounds). Canada only imported 3.4% of the world total (FAO 2001). During the past three years, U.S. companies spent approximately $1.1 billion per year on banana imports alone, and this figure is expected to increase to $1.2 billion per year in 2002 and 2003 (Gowen 1995; Whitton and Carter 2002).

The EC countries are the runners-up, import-

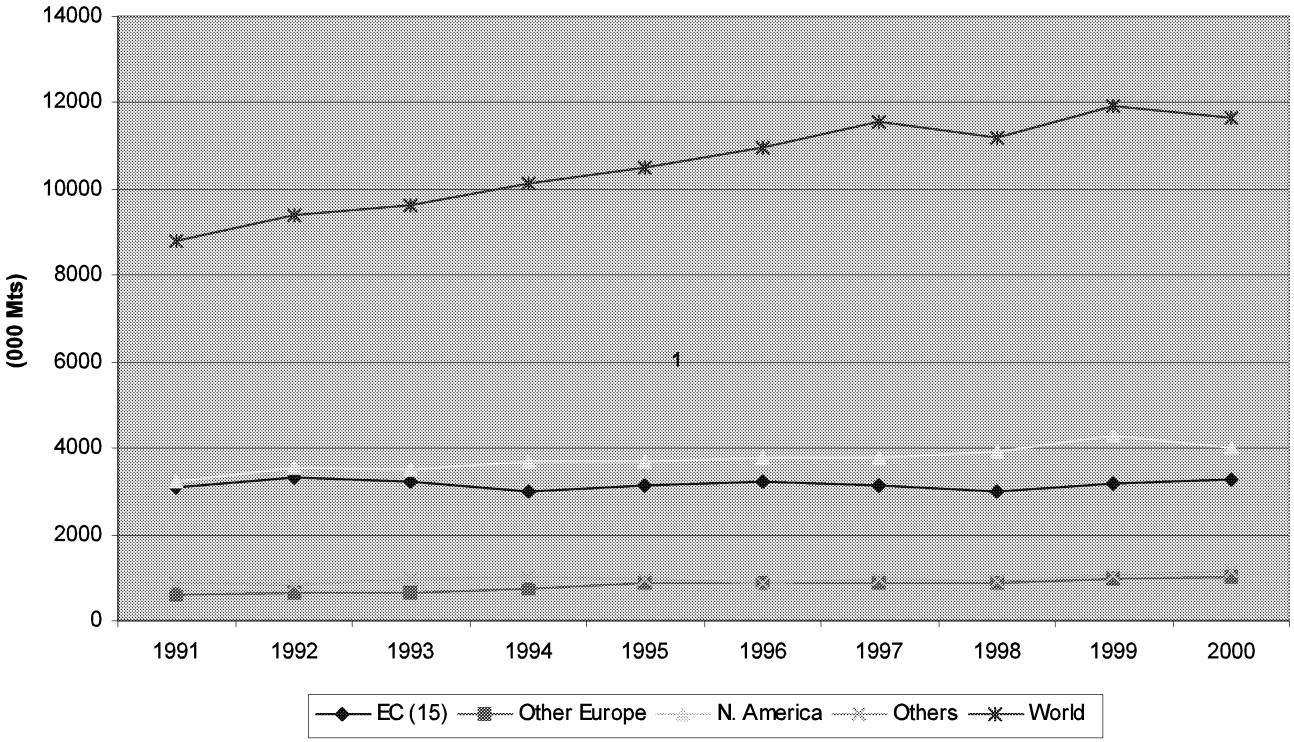


Fig. 2: World Banana Net Imports By Region: 1991–2000.

Source: FAO (2001).

ing 27.8% of the total world import—3.2 million tons (7 billion pounds). Other European countries include Bulgaria, Czechoslovakia, Czech Republic, Slovakia, Hungary, Iceland, Malta, Norway, Poland, Romania Switzerland, and the former Yugoslavia. These countries, altogether imported 0.9 million tons (1.9 billion pounds), equivalent to 8.6% of world total import in 2000.

Objectives

The primary objective of the research is to adopt the integrated quality-control management strategies to resolve the endemic quality problem in banana production, packaging, and marketing. The specific objectives are to determine and trace the sources of the main quality defects that are turn-offs to end users of importing countries and to derive strategies aimed at either partially or completely alleviating the identified defects, so as to guarantee the best-quality products to consumers.

Material and Methods

In order to successfully identify and trace the sources of quality defects from the banana plantation, the packing station, and the market, it was imperative to have well-trained and skilled human resources. Four production, marketing, and quality-assurance experts were sent to Europe to diagnose quality defects at supermarkets in the UK and France. They also surveyed arriving banana vessels at Dover port in Britain. Their goal was to trace back the sources of the identified quality defects.

Furthermore, twenty people were selected based on the number of Advanced Level papers passed (high school); mathematics and other quantitative subjects such as statistics and accounting were pre-requisites. Personality and communication skills were considered. Both sexes were eligible, although no females applied.

The twenty candidates selected were put through an intensive training program for six

months. The trainees were evaluated every two months; those who were not coping well with the training program were terminated, since the major objective was to maintain only 50% of the total candidates employed. This condition was vividly explained to candidates during the hiring process. The training program consisted of two phases: field operations and packing-station operations. At the field level, candidates were trained on the following quality-related operations: bagging and propping, de-leafing, fruit care and obstacle removal (F.O.R.), determination of fruit age based on ribbon colors, field deflowering, harvesting, transportation to the packing station via cableway, and various cultural practices directly or indirectly affecting fruit quality. The second phase of the training covered all the aspects of the packing-house operation, from the sampling shade to the fruit patio: de-handing and selection tanks, traying and weighing/labeling, packaging, palletization, loading, inland transportation, and the port quality inspection.

For bagging and propping operations, each of the twenty trainees was given bamboo ladders, propping pins, bolos (machetes), knives, fifty ropes, tree bags, and ribbons. The number of twines, tree bags, and ribbons was gradually increased to one hundred as the training progressed. For de-leafing and fruit care (F.O.R.) operations, each trainee was given a curved 2.5cm long knife. Furthermore, exercise books, pens, and pencils were given to each participant for note taking, as they were also introduced systematically to vegetative morphology and physiology; flower and fruit development; climatic, weather, and yield determination; cultivation systems; pest, diseases, and disorders; and plantation and general farm-management operations.

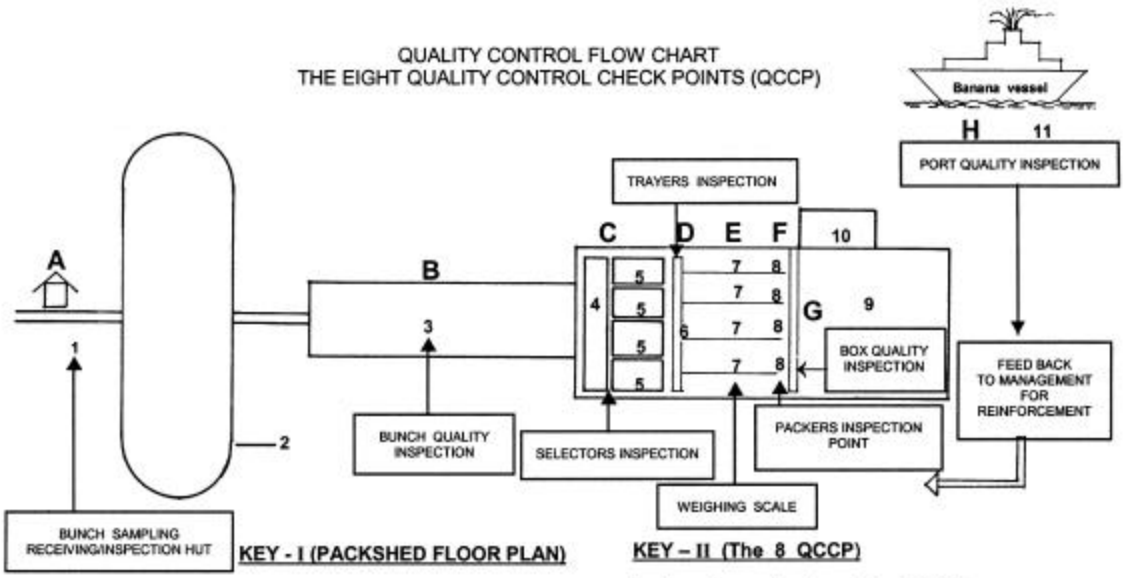
By the end of the six months, seven candidates had been eliminated. Ten of the remaining thirteen were retained as quality inspectors after succeeding in the written, practical, and oral tests. Eight were later posted to the four existing packing stations (two per packing station) and two at the port. The other three were assigned to other operations as lead-men to be used in reserve as quality inspectors when the need arose. Additionally, a sampling shade was built at the entrance of each station to facilitate field data collection.

Eight Quality-Control Check Points (8 QCCP)

The eight quality-control check points (8 QCCP) illustrated in Figure 3 were adopted: the bunch sam-

Figure 3. Quality-Control Flow Chart in a Modern Banana-Packing House.

QUALITY CONTROL FLOW CHART
THE EIGHT QUALITY CONTROL CHECK POINTS (QCCP)



KEY - I (PACKSHED FLOOR PLAN)

1. Bunch sampling/receiving hut
2. Cableway entrance to packing station
3. Fruit patio
4. Dehanding tank
5. Floatation tank
6. Traying conveyors / gravity
7. Stickers / weighing scale
8. Packers
9. Box quality inspection
10. Palletization area
11. Port quality control

KEY – II (The 8 QCCP)

A. Bunch sampling / receiving QCCP
B. Bunch rejection QCCP
C. Hand / clusters selection QCCP
D. Cluster / fingers QCCP
E. Weighing scale QCCP
F. Packers QCCP
G. Box QCCP
H. Port QCCP → Feed back

BY DR. ESENDUGUE GREG FONSAH

pling/receiving QCCP, the bunch-quality QCCP (fruit patio), clusterization and de-handing QCCP (de-handing tank), traying QCCP (floatation tanks), weighing/labeling QCCP (scale), packaging QCCP, box-inspection QCCP and port QCCP (wharf). The 8 QCCP were strategic points whereby most of the major and minor quality defects and their sources were easily identified and diagnosed for immediate corrective measures.

Reject-Conveyor Sampling Analysis (RCSA)

A reject-conveyor sampling analysis was also developed. This analysis was based on a random collection of bananas from the reject conveyor using a ten-kg bucket. The defect on each finger or cluster of bananas was scrupulously sampled to determine the sources. Thereafter, the percentage of each defect based on the source was computed and the summary sent to higher management for decision-making. The sampling was done at crucial times of each packing day—8:00 a.m., 11:30 a.m., 2:00 p.m., and 5:30 p.m.—when, empirically, workers are prone to make common mistakes.

Data Aanalysis

Basic descriptive statistics such as percentages, bar graphs, and histograms were used for data analysis. The results of the analysis were submitted to higher management for decision-making and implementation. These results were considered a top priority, as the company's policy and objective was to be proactive and provide the best commodity to its clientele worldwide and maintain its reputation.

Results and Discussions

The results of the supermarket and ports quality survey revealed the following defects: gray shadow, scarring and bruising, red rust and sooty mould, nipple apex, neck injury, congealed latex stains, and uneven ripening.

Gray shadow discoloration: Most of the fruits exhibited a grayish shadow discoloration at both the green and yellow (ripening) stages of the fruits. This discoloration was a complete turn-off to customers. The implementation of the micro-perforated tree bags and loop-bagging technique to protect the bunch from snail attack, was blamed for this defect. It was also the culprit for other defects diagnosed, as it created a favorable atmosphere for various fungal attacks

Scarring and bruising: Rough handling at both the departure and arrival ports and rough packaging were all blamed for these defects. The vessel crewmen walked on top of the boxes and the stevedoring company crewmen were unscrupulous during loading operations etc.

Red rust and sooty mould: These epidermal defects affected the overall cosmetic appearance (OCA) of the fruits, especially when the defect surpassed the tolerance level. The red rust defect was directly caused by the presence of thrips in the orchard, but could have been avoided at the packing station. The causal agent for sooty mould is *Cladosporium cladosporioides* that survives on honeydew deposited by aphids and mealybugs (Snowdon 1990).

Nipple apex: Most of the fruits had elongated apices, which were mistakenly identified by customers as cigar-end disease. However, the presence of black *sigatoka* disease in the banana plantation, caused by *Mycosphaerella fijiensis* (Fonsah 1993; Fonsah and Chidebelu 1995; Gowen 1995; Stover and Simmonds 1987), excessive rainfall, and inadequate sunshine which inhibited plant growth rate, photosynthesis, and the pulp-filling process, was partially blamed for this defect.

Neck injury and congealed latex: The neck injury was caused by high pack at the packing station. There were also fresh latex stains that oozed from some severe neck-injured clusters. Most of the congealed latex occurred in the field and the fruits did not spend enough time in the de-handing and flotation tanks.

Uneven ripening: This problem was associated with the age disparity of the fruits and the presence of black *sigatoka* disease (Fonsah, 1993; Fonsah and Chidebelu, 1995; Gowen, 1995; Robinson, 1996; Stover and Simmonds, 1987).

Reject-Conveyor Sample

The principal quality defects diagnosed were traced from two main sources: the field and at the packing station. Figures 4 and 5 show the main defects originating from the banana field and packing station, including over-calibration (fruits with diameters greater than the required quality specification),

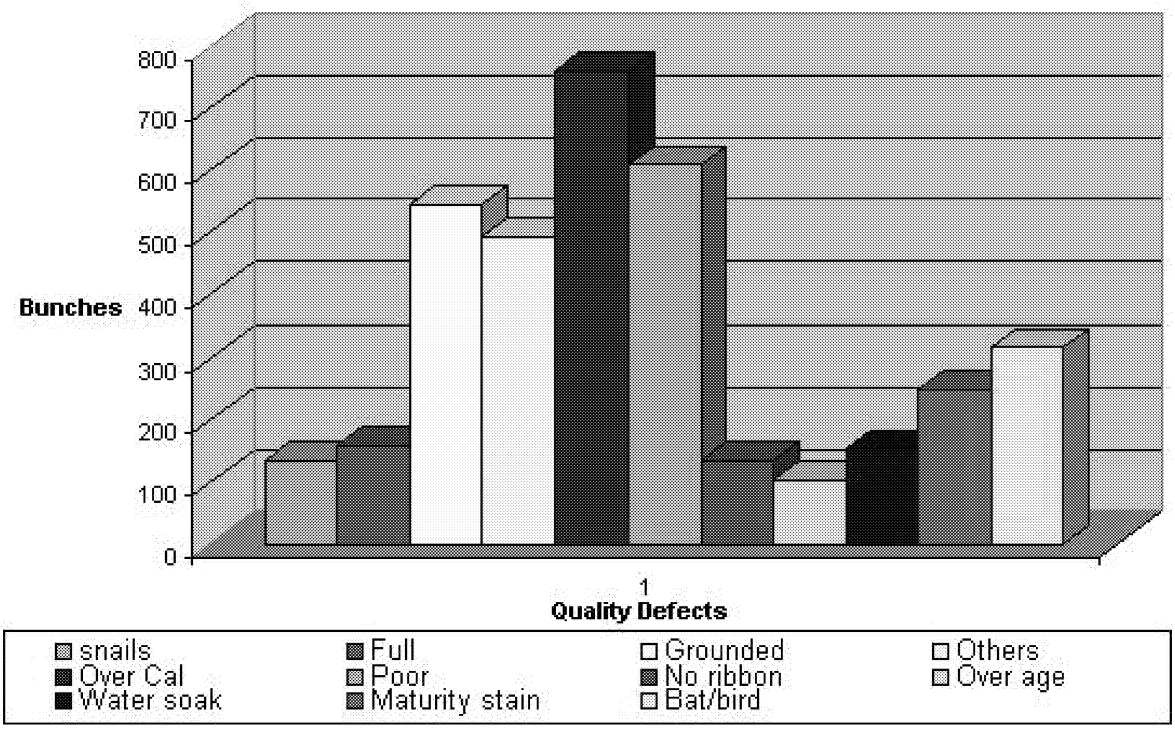


Figure 4. Principal Defects Originating From The Banana Field.

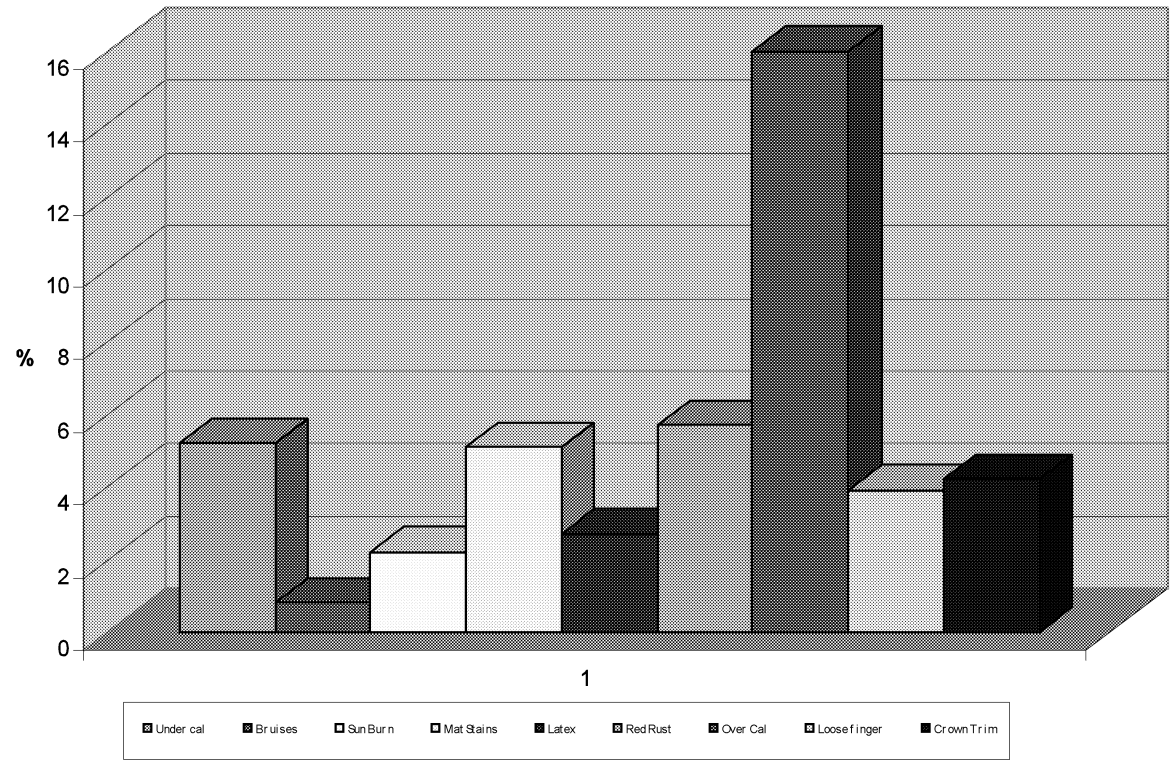


Fig. 5: Selected Defects Identified From the Eight Quality-Control Check-Point Analysis (8QCCP).

poor fruits (fruits that did not meet quality specifications because of various defects such as malformed finger, fused finger, under-calibration etc.), and grounded (fruits found toppled in the field and cannot be transported to the packing shed for processing).

Most of the mechanical defects such as scarring, old bruises, scratches, and minor defects such as crown trim, knife injury, neck injury, bruises, latex stain, under grade and over grade (Figure 5), were a result of human error. Physiological defects included fused fingers, maturity stains, sunburns, malformed, and over grade. Some of these defects—sunburns and maturity stains—were seasonal. The study further revealed that pests such as flower thrips cause water-soaked lesions. Snails, caterpillars, slugs, and peel-scarring beetles cause cosmetic damages to the banana peel. *Trachysphaera fructigena* and *Cladosporium cladosporioides* cause defects such as cigar-end, sooty mould, finger rot, etc. (Snowdon 1990).

The reject-conveyor sampling analysis showed that defects such as old scars, bruising, neck injury, knife injury, and sunburn detected in the packing station occurred in the field during harvesting or during transportation to the packing station. Conversely, defects such as poor crown trim, knife injury, loose finger, fresh bruises, etc., were caused in the packing station by de-handers and clusterizers/selectors. Interestingly, Key I.8 and Key II.F of the 8QCCP Flow Chart reveal that despite all measures taken at each stage of the production to alleviate quality problems, the packers play an important role in this chain-operation process and are capable of creating more problems if not closely supervised (Fonsah, 1993; Fonsah and Chidebelu, 1995).

Exogenous Quality Problems

Exogenous factors that exacerbated the overall quality problem were a combination of *sigatoka* disease infestation, adverse weather conditions and the untimely adoption of the micro-perforated tree bags and loop-bagging technique aimed at combating snails, especially *Limicolaria aurora* and *Achatina fulica* (Fonsah 1993; Fonsah and Chidebelu 1995). During the research period there was a severe rainy season and insufficient sunshine and daily radiation required by the plants, which greatly reduced photosynthesis, hampering the growth performance. Furthermore, the combination of high humidity and the adapted cultural practices during the heavy rainy period created a favorable atmosphere for leaf fungi and other pathogens to survive.

Summary and Conclusion

This study examines the implementation of an integrated quality-control management strategy aimed at resolving endemic problems in banana production, packaging and marketing. Emphasis was placed on traceability of the main sources of quality defects and developing strategies to alleviate them. The 8QCCP and the RCSA were used for data collection and analysis. Additional information was obtained from the supermarket and port surveys.

The results of the study showed that gray shadow discoloration, scarring and bruising, red rust, sooty moulds, nipple apex, box quality, congealed latex, and uneven ripening were the major defects found in the port and supermarkets. On the other hand, over-calibration, poor fruit, grounded fruit, full, snails, bats/birds, maturity stains, water-soak, no ribbons, and over age were the principal quality defects coming from the field. There is a need to closely supervise packers, since they are the last to have direct contact with the product before shipment, so any error at that level is difficult to correct and consequently becomes a macro-problem. Finally, there was a significant increase in the total quality of all fruits processed as a result of the implemented 8 QCCP and RCSA.

References

Bradbury, G. K. 1991. "The Management of Crop Production to meet Demands of Volume and Quality." *CTA Proceedings* December:215-228. Arnhem, Netherlands.

Technical Center for Agricultural and Rural Cooperation (CTA). 1993. *Production of ACP Fresh Fruits and Vegetables for Export to the EEC.* Proceedings of a seminar organized by the Technical Center for Agricultural and Rural Cooperation, Arnhem, Netherlands, 2–6 December 1991. 207-247.

FAO. 2001. *Banana Statistics*. Committee on Commodity Problems, CCP: BA/TF01/2(Rev.1). In-

tergovernmental Group on Bananas and Tropical Fruits, Second Session, San Jose, Costa Rica, 4–8 December.

Fonsah, E. G. 1993. Economics of Banana Production and Marketing in Cameroon., Ph. D Dissertation, Dept. of Agricultural Economics, University of Nigeria, Nsukka, Nigeria.

Fonsah, E. G. and S. N. D. Chidebelu. 1995. *Economics of Banana Production and Marketing in the Tropics*. Minerva Press, London.

Gowen, S. 1995. *Bananas and Plantations: Inibap*. Chapman and Hall, New York.

Heri, S. T. 1991. "A Strategy For Quality Control: Case Study Zimbabwe." *CTA Proceedings* December:229-240. Arnhem, Netherlands.

Kirmani, Naheed. 1994. *International Trade Policies : The Uruguay Round and Beyond. Vol. II.* Principal issues, IMF, Washington, D.C.

Mulandi, M. A. S. 1991. "Quality Control: Minimum Requirements for fresh Horticultural Produce for Export." *CTA Proceedings* December:235-240. Arnhem, Netherlands.

Proctor, F. J. 1993. "Horticultural Crop Management within the Production and Marketing System: Demands and Constraints on Quality Assurance." *Production of ACP Fresh Fruits and Vegetables for Export to the EEC.* Arnhem, Netherlands.