



THE 1st ALL AFRICA POST HARVEST CONGRESS & EXHIBITION

Reducing food losses and waste: Sustainable solutions for Africa



Book of Abstracts

28th - 31st March 2017 | Safari Park Hotel, Nairobi, Kenya

Strategic Partner



University of Nairobi



REPUBLIC OF KENYA
Ministry of Agriculture,
Livestock and Fisheries



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FOREWORD

Dear Reader,

We have the pleasure of presenting to you the Book of Abstracts of the 1st All Africa Postharvest Congress and Exhibition. The congress theme is **“Reducing Food Losses and Waste: Sustainable Solutions for Africa”**. To better elaborate on the congress theme, this was unpacked into five subthemes based on five key sub-sectors in Agriculture that include:

1. Perishable food crop commodities (fruits, vegetables, roots & tubers, edible fungi)
2. Perishable livestock and fish food products (including milk, meat, eggs, fish)
3. Non-perishable food commodities (grains, including cereals and pulses, processed foods)
4. Capacity Development including training, research and extension programs
5. Gender, Youth, Policy and Governance issues affecting postharvest management

The accepted abstracts under each of the subthemes were further divided into eight (8) more specific work streams. This Book of Abstracts consisting of 160 peer-reviewed abstracts has been organized based on the flow from lead papers presented in plenary sessions followed by the papers presented in work streams as follows:

Plenary sessions

- 1) Role of Postharvest Management in Africa’s Economic Transformation and Food Security Agenda
- 2) Best Practices in Postharvest Management
- 3) Capacity Development Including Training, Research and Extension Outreach Programs: Addressing Skill Gaps in the Postharvest Sector

Parallel Work Streams

- 1) Agro-processing, value addition and valorization solutions for postharvest loss and waste
- 2) Postharvest handling and technologies for perishable commodities
- 3) Postharvest handling technologies and storage solutions for grains
- 4) Aflatoxin management, food safety and Nutrition
- 5) Policy, youth and gender angles in postharvest Management
- 6) Food loss and waste assessment in agricultural value chains – the Metrics
- 7) Innovative strategies, practices, approaches towards postharvest loss management
- 8) Postharvest handling and technologies for livestock products

The published abstracts from authors around the world present a rich mix of basic science and applied research covering all the food value chains. During the peer review process, preference was given to papers that presented practical and innovative ideas for postharvest loss (PHL) reduction. The big question is how much of these promising research findings/products have been translated into tangible and practical solutions for PHL reduction.

I wish to thank and congratulate all the authors for preparing and submitting their abstracts for this inaugural congress.

I would like to wish you all an informative interaction with the Book of Abstracts.

Yours Sincerely,

Dr. Jane Ambuko
Chairperson, Local Organizing Committee
1st All Africa Postharvest Congress and Exhibition



ACKNOWLEDGEMENT

I would like to thank the members of the abstract review and management team which was drawn from various institutions universities, research and development organizations. The team members included the following:

Prof. Margaret Hutchinson
Dr. Maina Mwangi
Dr. Peter Kahenya
Dr. Joseph Onyango Gweyi
Dr. Catherine Kunyanga
Dr. Maina Muiru
Dr. Jane Ambuko
Dr. Judith Mbau
Dr. Rawlence Bett
Mr. John Macharia
Ms. Esther Karithi
Ms. Charity Gathambiri
Prof. Willis Owino
Dr. Joyce Maina
Dr. Charity Mutegi
Dr. Arnold Opiyo
Prof. George Chemining'wa
Prof. Joshua Ogendo
Dr. Joshua Amimo
Prof. Charles Gachuiru
Ms. Joyce Chepngeno

I am grateful to the University of Nairobi management for accepting onerous task of hosting this inaugural congress and for overall institutional support throughout the organization process. This publication would not have been possible without the funding from our partners and sponsors. They include the Rockefeller Foundation (strategic partner); International Institute of Tropical Agriculture; SNV World; Horticulture Innovation Lab - USAID; Swiss Agency for Development and Cooperation; International Development and Research Center; East Africa Trade and Investment Hub - USAID; Postharvest Education Foundation; Global Cold Chain Alliance; Eastern Africa Grain Council; Alliance for a Green Revolution in Africa; Global Alliance for Improved Nutrition; AgResults, AgriProFocus; Compatible Technology International.

I highly appreciate the support of the World Food Preservation Center (WFPC) in the organization of the congress and solicitation of abstracts from the international/global partners and experts in the postharvest management.

Thank you all for your support that made it possible to us to prepare and publish this Book of Abstracts.



Lead Papers



Community of Practice (Cop) On Food Loss Reduction: A Global and Dynamic Platform for Solutions Sharing.

Francesca Gianfelici, UN FAO consultant, Corresponding author,
(mail to: francesca.gianfelici@fao.org)
Mireille Totobesola-Barbier, UN FAO Project manager
(mail to: mireille.totobesola@fao.org)

Abstract

To meet the needs of a consolidated and enlarging community of Post-harvest losses/management (PHL/M) experts, FAO and partners have joined forces to develop efficient approaches to facilitate exchange of the expertise generated in the recent decades and networking, and mobilized resources. In October 2014, the Community of Practice (CoP) on food loss reduction was launched in the framework of UN Food and Agriculture Organization (FAO), the International Fund for Agricultural Development (IFAD) and World Food Programme (WFP) joint project funded by the Swiss Development and Cooperation agency. The project aims to improve food security and income generation opportunities through the reduction of food losses in food grains and pulses value chains. The CoP serves as a global convener and an integrator of knowledge related to post-harvest loss (PHL) reduction. It offers a platform to facilitate linkages and information sharing amongst stakeholders and networks, projects and programs. The CoP disseminates information on post-harvest and food loss reduction solutions produced and piloted by stakeholders and partners, and on related policies. The CoP website shares information, relevant news, events, online discussions, resources, and links to partners. It is a dynamic platform that facilitates information sharing and coordination. Enriched with updated information on a regular basis, it has over 600 registered members worldwide and has recorded an average of 1500 hits per month. Members are informed on projects and programs on food loss reduction and post-harvest management, can participate in online discussion in the CoP Forum, and stay tuned on relevant news and events. In getting involved, members become part of the global mobilization of stakeholders to help reduce food losses and waste. Registered members belong also to the SAVE FOOD global initiative on food loss and waste reduction .

Key words

Knowledge sharing, post-harvest food loss reduction, post-harvest solutions, community of practice, networking, partnerships



Strengthening African Postharvest Extension and Advisory Services

Author: Lisa Kitinoja, The Postharvest Education Foundation
PO Box 38, La Pine, Oregon 97739, USA
Corresponding author email: kitinoja@postharvest.org

Abstract

During the past 5 years, extension and advisory services (EAS) in Africa have begun to incorporate a variety of postharvest training and capacity building. Examples include the Ministries of Agriculture in Tanzania (MAFSC), Ethiopia (MoA) and Rwanda (MINAGRI) and Universities with international donor support in many countries. The African Development Bank and IFAD have funded value addition training centers and market infrastructure. The UN FAO has provided support for postharvest workshops, food loss assessments and value chain development for staple crops and perishable foods (milk, meat, fish and horticultural crops) in Kenya, Cameroon, Burkina Faso, Ethiopia and many other countries. The USAID funded Horticulture Innovation Lab has funded Postharvest Training and Services Centers with outreach programs for smallholder farmers in Tanzania and Rwanda.

The keys to strengthening the postharvest technology aspects of EAS systems in African countries include the following five components:

- Baseline assessments of national food losses for key crops
- Baseline assessments of local postharvest training needs
- Training of trainers and postharvest extension specialists in food loss reduction practices
- Implementing outreach efforts, extension programs and advisory services promoting the utilization of cost effective improved technologies and best practices for postharvest handling to reduce food losses
- Monitoring and evaluation to assess outreach program outcomes

This presentation will provide examples of each of these five components, based on the speaker's work as a postharvest consultant and extension training specialist in North Africa and Sub-Saharan Africa. Any country that aims to build postharvest expertise and local capacity must make investments in these five components in order to implement annual assessments, conduct training programs for staff and local clientele and perform regular monitoring and evaluation to strengthen their national EAS system.

Key words:

Outreach, capacity building, postharvest extension



Rationale for Establishing the World Food Preservation Center® LLC

¹ Founder, World Food Preservation Center® LLC, Shepherdstown, West Virginia USA

Abstract

The World Food Preservation Center® LLC was established in response to a pending global food shortage that is destined to increase world hunger if not sustainably addressed. The world's food supply is being shrunk by a rapidly expanding world population and a deteriorating agricultural environment. Now global warming has come on the scene and portends to further restrict crop yields. It is clear that the global food shortage crisis will not be addressed by simply producing more food as happened during the "Green Revolution." Even with the most advanced food production technologies there will be a significant shortage of food. One third of the food that is currently produced globally is lost annually between harvesting and consumption, which is enough to feed two billion people. Therefore, it is apparent that more of the food that is produced must be saved to avoid escalating world hunger.

Because few agricultural resources (5%) have been invested in the postharvest preservation of food as opposed to food production (95%), significant postharvest skills and technology gaps remain in agricultural institutions of higher learning particularly in developing countries. The World Food Preservation Center® LLC was formed to address the intellectual postharvest gaps in developing countries by: (1) promoting the education (M.S. and Ph.D.) of young student/scientists in developing countries; (2) supporting young student/scientists in developing countries conduct research on much needed new postharvest technologies adaptable to their native countries; (3) organize continent-wide postharvest congress and exhibitions; (4) publish much needed new texts/reference books on postharvest technologies and methods for developing countries; and (5) develop a comprehensive database on all postharvest knowledge relative to developing countries with access portals for researchers, students, administrators, industry, businesses, and farmers.

Key words

postharvest loss, developing countries, postharvest education, postharvest research.



A Sustainable Path To “Zero Hunger”

Charles L. Wilson, Founder

World Food Preservation Center® LLC, Shepherdstown, West Virginia, USA
worldfoodpreservationcenter@frontier.com

Abstract

The World is proceeding toward a global food shortage crisis and we are not on a sustainable path to address this problem. The “Zero Hunger Challenge” was launched by the United Nations’ Secretary-General Ban Kimoon in 2012. His ambitious goal envisioned a world free of hunger by 2030. A multifaceted program was proposed to reduce world hunger based on the Sustainable Development Goals (SDG) of the United Nations. Subsequent to this the African Union Commission (AUC) and other international and national organizations have set their own goals toward reducing postharvest food losses and world hunger. There are mixed reports on whether global hunger is increasing or decreasing in spite of all the new initiatives. Agreement does exist that world hunger is set to increase dramatically if we remain on the present path toward meeting a pending world food shortage crisis. The world’s population is expected to reach 9.6 billion people by 2050.

By remaining on our present path toward reducing world hunger we are going to fall far short of the food required to feed the world’s exploding population. Because we have invested much fewer of our agricultural dollars in the preservation of food (5%) as opposed to food production (95%) a major postharvest “skill gap” and “technology gap” exists in our higher education systems particularly in developing countries. To meet these challenges, the World Food Preservation Center® LLC (a consortium of twenty-five major agricultural research universities and two major agricultural research institutes on six continents) has launched a “Food Preservation Revolution™,” that is fighting to correct this imbalance through education, innovation, and advocacy. This consortium of universities and major research institutes is expanding its existing educational programs and research priorities to place a greater emphasis on the postharvest preservation of food. The universities associated with this program are establishing and enhancing M.S. and Ph.D. degree programs in postharvest preservation, and their research teams are pioneering safe, natural, and sustainable technologies for preventing food loss along the food chain from harvest to consumption.

Key words

postharvest loss, world hunger, food preservation, agricultural investments



Work Stream 1

Agro-processing, value addition and valorization solutions for postharvest loss and waste



O1-1.Fresh-Cut Markets and Opportunities for Income and Nutrition Security

Francisca Aba Ansah¹, George Opare Asare² and Maria Luisa Amodio³

*^{1,3}Department of Science in Agriculture, Food and Environment, University of Foggia, Via Napoli, 25 - 71122 Foggia, Italy;

²Genuine Products and Services Limited
Email: francisca.ansah@unifg.it

Abstract

Fresh-cut processing, presents an additional opportunity to reduce loss, enhance nutrition security and increase sales of fruits and vegetable in Ghana. Vending of fresh-cut fruits began mainly with export excess or rejected fruits as a means to curb losses by selling them locally, but now this processing method has spread throughout urban centres and markets of fruits and vegetables. This study aimed at highlighting opportunities for producers mainly small scale farmers, fresh processing; nutrition and income security. Using the simple random sampling approach, a survey was conducted on 130 respondents, made up of 40 producers, 60 consumers, 20 street vendors and 10 stall operators via focus group discussion, online questionnaires and one-on-one interviews. Results showed that, fresh cut processing of fruits and vegetables has created market opportunities.

Marketers surveyed, accrued positive and reasonable margins of 32% to 70% per annum with benefit-cost ratio ranging from 1 to 4. Fresh-cut okra and fruit salad provided the maximum sales benefits while sliced papaya and vegetable salad were the minimum. In spite of some production challenges, producers accrued reasonable net profits ranging from 41% for papaya to 46% for cabbage per acre; with the increased sales observed, there is a potential supply opportunity for small-scale farmers in this sector. Furthermore, two-thirds of consumers surveyed, purchased fresh cuts due to their nutritional benefits and ready to eat attributes. Addressing hygienic issues especially in the case of fresh processing in the open-market will contribute to alleviating post-harvest losses, create employment opportunities and improve nutritional security of urban consumers.

Key words

Fruits and vegetables, fresh-cut, consumers, producers, marketers



O1-2. Selection of Appropriate Chilli Drying Technologies Using Analytical Hierarchy Process: A Case of Northern Uganda.

By Florence Agwang¹, Peter Okidi-Lating²

¹Graduate Researcher, North East Chilli Producers Association, P.O.Box 670, Lira, Northern Uganda.

² Professor, Makerere University, P.O.Box 7067, Kampala, Uganda.
Corresponding author agwangflorence@yahoo.com

Abstract

Kawanda Agricultural Research Institute estimates crop post-harvest losses at 5-15% for cereals and legumes, 20-25% for roots and tubers and over 35% for fruit and vegetables. Specific to NECPA Chilli farmers, the loss is up to 35% because of the use of rudimentary technologies for drying. This study was conducted with the aim of selecting appropriate drying technology to reduce the post-harvest losses. Analytical Hierarchy Process Methodology was used. The survey in the study involved stakeholders who rated the technologies depending on Cost of the technology, Time it took for Chilli to dry using the technology and Cleanliness of the product. The research study found that 91% of farmers interviewed used open air drying method (plastic carpet-2%, papyrus mats-58%, sun tables-5%, black polythene sheet-10%, cow-dung smeared floor-9%, tarpaulins-12%, Iron sheets-4%) leaving only 9% using improved. Ultra violet solar dryer (the UV polythene sheet dryer). The major loss to Chilli farmers is because of the use of open air drying methods. The Ultra Violet Solar dryers were found to be the most appropriate post-harvest technology for the Chilli farmers.

Keywords:

Analytical Hierarchy Process, Case Study, Chilli, Northern Uganda, Open Air Drying, Post-Harvest Handling, U.V Polythene Sheet Solar Dryer



O1-3. Effect of Harvesting and Postharvest Processing Methods on The Quality of Hararghe Coffee (*Coffea arabica L.*) In Eastern Ethiopia

Mohammedsani Amin^{1*}, Wassu Mohammed², Tesfaye Shimber³

¹Mechara Agricultural Research Center, Coffee Research Case Team,

P. O. Box: 19, Mechara, Ethiopia

²Haramaya University, School of Plant Sciences, P. O. Box: 219, Dire Dawa, Ethiopia

³Ethiopian Institute of Agricultural Research, P. O. Box: 30708, Addis Ababa, Ethiopia

*Corresponding author: Email: mamasaniamin@yahoo.com; Tel: +251913420206;

Fax: +251255570301

Abstract

A study was conducted to evaluate the effect of harvesting and postharvest processing methods on the inherent quality characteristics of a Hararghe coffee genotype. Two harvesting (selective and strip harvesting) and six postharvest processing (dry processed dried on bare, cemented and plastic sheet ground floor, and dry, wet and semi-washed processed dried on raised mesh wire) methods evaluated in completely randomized design with three replications. The coffee samples were prepared from one promising Hararghe coffee genotype (H-622/98) planted at Mechara Agriculture Research Center. A team of internationally certified panelists at Jimma Agriculture Research Center did the raw, roast and organoleptic quality evaluation. The results indicated that the combined effect of harvesting and postharvest processing methods significantly influenced bean size and roast volume change. The main effects of harvesting and postharvest processing methods highly significantly influenced most quality attributes. Selective harvesting was better than strip harvesting as it produced the highest (above 80%) overall coffee quality that could be categorized under specialty coffee grade. Dry processing (natural sun-dried) method coupled with drying coffee on raised mesh wire and plastic sheet ground floor was best in producing coffee beans with highest total raw quality (32.33%) and clean to fair clean cup cleanness and medium to full body compared to wet processed coffee. However, wet processing method was better in producing pointed acidity and good flavor with the highest (44.88%) total cup quality. In contrast, dry processing using bare ground produced inferior coffee for all raw and cup quality attributes. In general, the highest overall coffee quality value (75.21%) was recorded for wet processed coffee followed by dry processed coffee dried on mesh wire which had a quality value of 73.71%. Thus, it can be concluded that like wet processing, dry processing of coffee that is selectively harvested and dried in raised mesh wire table can produce superior quality coffee thereby reducing crop loss due to improper harvesting and postharvest handling practices. This indicates the importance of natural sun-dried coffee type in Hararghe where 100% of coffee is prepared by this natural method.

Key words:

harvesting methods, postharvest processing methods, quality attributes



O1-4. Assessment of Pre- and Post- Harvest Challenges Facing Mango Farmers in Eastern, Coast and Nyanza Regions of Kenya

Okoth E. M.^{1*}; Sila D.N¹; Onyango C. A²; Mathooko F.M³ and Owino W.O¹

¹Department of Food Science and Technology, Jomo Kenyatta University of Agriculture and Technology, P. O. Box 62000-00200, Nairobi- Kenya

²Taita Taveta University College, P.O. Box 635-80300, Voi, Kenya

³Department of Food Science and Technology, Machakos University College, P.O. Box 170-90200, Machakos- Kenya

*Corresponding author e-mail: muyajica@yahoo.com

Abstract

Mango (*Mangifera indica* L.) is one of the most important fruit crops in tropical and sub-tropical regions of the world. In Kenya, it's the second most important fruit being produced on 57,021 hectares of land, with an output of 2.8 million tonnes (MT) and revenue returns of 130 million US Dollars. The aim of this study was to identify the specific challenges along the mango value chain in Eastern, Coast and Nyanza regions that contribute to postharvest losses. The tools employed in data collection included desktop review and field survey through structured interviews. The challenge magnitude was rated in percentage (%) as 10% (mild challenge) to 100% (most grievous challenge). Poor economic status of farmers and in-accessibility to credit facilities in the three regions had the highest rate of 70%. Small farm sizes (< 5 ha) under mango production which produced uneconomical yields rated highest in Nyanza region (70%) compared to Eastern (60%) and Coast (20%) regions. Huge mango trees aged >25 years which gave low quality and yield was rated highest (60%) in Coast region. Lack of refrigerated transportation facilities (90%) and improper modes of transportation of mango fruits (80%) were rated similar in the three regions. Poor storage facilities and poor markets access challenges were rated at 80% in each of the three regions. High losses through pest infestation and diseases infection were rated higher in Coast and Nyanza regions (50%) than in Eastern region (40%). There is a need to address the challenges identified in order to optimize revenue returns from mango farming and improve the economic livelihoods of the mango farmers and processors in the regions of study and in Kenya as a whole.

Key words:

Diseases, mango, pests, postharvest losses, storage facilities



O1-5. Development of A Protein Fortified Mango Fruit Bar

Okoth E. M.^{1*}; Sila D.N¹; Onyango C. A²; Mathooko F.M³, Owino W.O¹

¹Department of Food Science and Technology, Jomo Kenyatta University of Agriculture and Technology, P. O. Box 62000-00200, Nairobi- Kenya

²Taita Taveta University College, P.O. Box 635-80300, Voi, Kenya

³Department of Food Science and Technology, Machakos University College P.O. Box 170-90200, Machakos- Kenya

*Corresponding author e-mail: muyajica@yahoo.com

Abstract

Value addition of fresh mango fruits can be done to minimize postharvest losses of mango fruit. The aim of this study was to develop protein fortified mango fruit bars. Four mango fruit bars were made as follows: (i) mango pulp (control); (ii) mango pulp and skimmed milk powder (SMP) as a source of protein; (iii) mango pulp and processed soy protein isolate (SPI) to provide an alternative cheaper source of protein and (iv) use of mango pulp and starch as a stabilizer. Pectin was used as a stabilizer in the first three bars. The mango pulp, sweeteners (sugar and glucose), stabilizers (pectin and starch), protein source ingredients, ascorbic acid and preservative were added and homogenized. The mixture was dried at 60°C for 6-8 hrs. The fruit bars had an acceptable moisture content of between 13.53% (control bars) and 14.44% (starch bars). The SMP mango fruit bars had a Hue angle of 81.31°, significantly different ($P \leq 0.05$) from the rest of the bars and closer to that of the mango flesh (85.16°). The SPI and SMP mango fruit bars had significantly different ($P < 0.05$) protein contents of 4.68% and 4.55%, respectively, which were higher than control (0.35%) and starch (0.30%) bars. The bars were energy dense with SMP bars having significantly ($P < 0.05$) lower amounts (299.66N) than the rest which had ≥ 322.44 N. Both vitamin C and B-carotene decreased with storage; however, 63% of vitamin C and over 50% of B-carotene were retained by the end of the three months of storage. The four bars ranked excellently overall by the end of storage period in sensory evaluation with starch bars having the least score of 7.15, significantly different ($P \leq 0.05$) from SMP bars (7.55). The bars were pathogen free and microbiologically safe and stable on storage. The total plate count, yeast and mould content were far much lower than the minimum amounts recommended by the Kenya Bureau of Standards. This is a simple processing technique which could be easily adopted by the farmers and processors to make protein and energy rich mango products. This would in turn reduce mango fruit postharvest losses, enhance nutrition security and economically empower the community.

Key words:

Food and nutrition security, mango fruit bar, skimmed milk powder, soy protein isolate



O1-6. Processing and Value Addition as a Mitigator of Postharvest Food Losses: The Kenya Status

Willis O. Owino

Department of Food Science & Technology, Jomo Kenyatta University of Agriculture & Technology

P. O. Box 62,000 Code 00200 Nairobi KENYA. Email: willis@agr.jkuat.ac.ke

Abstract

Food processing and value addition contributes about 73% of the production turnover in the Agro processing subsector. Notwithstanding, currently substantial volumes fresh food products produced in Kenya go to waste owing to improper postharvest handling operations, and lack of processing and value addition. This contributes to considerable gap between total food production and net availability to the consumer. This paper discusses the status, constraints and prospects of food processing and value addition and the need of capacity building initiatives. The Kenyan food processing industry is mainly dominated by bakery, tea, flour milling, cooking oil and fat, dairy, alcoholic and non-alcoholic beverages, sugar milling, coffee processing, fruit and vegetable processing and water bottling among other industries. In terms of composition of the total number of registered food processing enterprises, Bakery leads with 27% whereas spices only account for 2%. As regards scale of enterprises, Food processing industry ranges between large scale as in beverage, sugar milling, flour milling, tea and dairy, while the others are of mid-size to small, micro scale and even cottage. Kenya's burgeoning and health conscious middle class, urban population and change in food habits has provided an ever- growing market for processed and value added food products. However, the food processing industry faces a number of constraints which includes but are not limited to: capital intensive nature of the industry; raw materials supply fluctuates between under-supply, unavailability, poor quality and over-supply; post-harvest losses due to poor handling, transport and storage infrastructure; intrusion of cheap imports; Weak enforcement system for quality standards; and lack of interaction on food product research and development between the academia and industry. To take advantage of the opportunities in this sector there is need to develop capacity in terms of human resources and infrastructure to curb the postharvest losses.

Key words:

Food Production, Constraints, Prospects, Vision 2030



O1-7. Development of Africa Pearl Millet Sourdough Bread: Nutrition and Economic Implications

¹Adepehin, J.O., ²Odeny, D.A., ³Young, G.M., ¹Enujiugha, V.N., ¹Badejo, A.A.

¹Food Science and Technology Department, Federal University of Technology, Akure, Nigeria.

²Biotechnology Laboratory, International Crop Research for Semi-Arid Tropics, Nairobi, Kenya.

³Department of Food Science, University of California, Davis, California U.S.A.

Corresponding Author: d.odeny@cgiar.org

Abstract

The scourges of food insecurity and unstable economy that plague the African continent require holistic approach to be abated. African countries are known to be among world importers of gluten-rich wheat for baking and other uses, while millions of tons of indigenously grown, nutritious and gluten-free cereals are grossly underutilized and wasted. Creating a higher demand for these nutritious underutilized gluten-free cereals is capable of reducing their post-harvest losses and improve their utilization, especially among resource poor consumers. This paper is part of the findings of a pilot test to develop bread from underutilized, locally- sourced and readily- available cereals in the continent, through enhanced food processing techniques. Pearl millet grains obtained from ICRISAT-Nairobi were processed into flour and sourdough (1:2w/v, 37°C, 48 h). The proximate, anti-nutrient and pasting properties of the flour, sourdough and flour-sourdough blend (30% sourdough) were determined using standard laboratory procedures. Determination of the acidity and microbial dynamic were also done, and the bacteria present were identified. Sensory evaluation was done using a 9-hedonic scale. Sourdough fermentation reduced oxalate, phytate and saponin content of pearl millet by 18.75%, 31.12% and 8.89% respectively. The pH dropped from 6.1 to 3.9. Heterofermentative lactic acid bacteria (GRAS) were present in the sourdough. The crude protein, crude fat, crude fibre and ash content were significantly higher than that of conventional wheat bread. Specific loaf volume was 1.46cm³g⁻¹. Overall acceptability showed that the bread was moderately liked. Adoption of locally sourced and gluten- free cereals as raw materials for baking will reduce wastage and unemployment, strengthen industrialization and deliver more nutritious bread to consumers.

Keyword:

Sourdough bread, Pearl millet, Africa, Product development, Gluten- free



O1-8. Accessing Global Market Place through Post-Harvest Handling Technologies and Food Innovation: A case of sweet potato

Perez Ochieng
SACOMA GLOBAL FOODS INNOVATION
Correspondence: perez.sacoma@gmail.com

Abstract

Sweet potato is a widely grown root crop in Kenya and other parts of Sub-Saharan Africa as source of energy, anti-oxidant and Vitamins. In spite of its increasing importance as food and commercial crop sweet potato faces high post-harvest losses during transportation and storage, poor harvesting methods, handling, and packaging. There is no warehousing technologies to improve shelf life of harvested roots and increase opportunities for Bulk Trading. There is also limited skills, Knowledge and innovative food technologies for food products design to expand utilization of sweet potatoes into premium food products. There is a growing demand of exotic foods and innovative healthy premium food products by European supermarkets, this is estimated at 50% increase yearly for last 5years. Sweet potatoes is an attractive crop due to associated health benefits such as high beta carotene in orange fleshed compared to other vegetables and also a source of potassium and fiber. Healthy eating trends and national efforts to eat healthier in schools to reduce obesity have led to a larger consumption of sweet potatoes in developed countries such as the UK. SACOMA GLOBAL FOODS INNOVATION has taken advantage of these market opportunities through various interventions including 1) Food Innovation and Food Products Design technologies and packaging. The company provides and facilitates training on EU Food Standards and Knowledge Transfer Partnerships for building technical capabilities to add value, process, Advance-Manufacture, brand, package and niche-market the premium sweet potato products' access to European/Global markets, targeting health-conscious consumers for packaged food that is tasty, healthy and convenient to prepare based on palatability and preference. 2) Modern warehousing to extend shelf life of fresh sweet potato roots and assure sustainable supply. 3) Training farmers on harvesting methods, good agriculture practices and food health standards to ensure farmers are integrated in the supply chain, guaranteed fair price and increased incomes. These interventions will be discussed and modalities to replicate them in other crop commodities highlighted. The next big food ideas will come from Creativity and Innovation, food Technical knowledge and skills, backed by committed Entrepreneurs who want to create value-added products that global Market place wants and demands.

Key words:

sweet potato, healthy foods, innovation



O1-9. Process Characterization and Optimization of Traditional Atifufui, a Maize Flour-based Crunchy Sticks from Ghana

Dzesi Kwame Torku¹, Richard Deih-Tanyedzi², Angela Parry-Hanson Kunadu¹,

¹Department of Nutrition and Food Science, University of Ghana, Legon,
P.O. Box LG158, Accra

²Agriculture Extensions Department, Cocoa Abrabopa Association,
P.O. Box KS5603, Adum-Kumasi

Corresponding author: Dzesi Kwame Torku, dkorku@gmail.com +233245673185

Abstract

Maize is a major staple in Ghana. A variety of traditional meals and snacks are made from whole grains, dehulled grains and maize flours. Atifufui is one such typical traditional maize snack consumed by both adults and children. Atifufui literally means "hard or crispy stick" in Ewe, a tribe in Ghana. It is traditional maize flour-based, hand molded, slender pointed deep fried stick that is dry, crispy and crunchy. It is often sold, unpackaged in various markets and streets across Ghana. Novel approaches in traditional atifufui production could serve as a vehicle for nutritional interventions and energy dense products through the incorporation of legumes and some spices. The objective of the study was to characterize and optimize the process of novel traditional atifufui production. Thirty (30) atifufui processors in Aveyime, Battor and Mepe in the Volta Region were identified through snowball sampling and convenient sampling. Direct observation, participatory observations, key informant interview and photographic documentation of manufacturing processes were used to collect data for the study. The results from the study showed that 3.3% of atifufui producers used a variant mode of preparation, which sought to market, introduce variation and enhance nutritional balance, hence the subject of study. Traditional process include adding boiled water to maize flour, stirring until stiff, addition of sugar and molding into sticks for deep frying. Composite flour consists of maize, rice, cowpea and soybeans. Spice blends of clove, ginger, aniseed, and Negro pepper also impart flavor, aroma, and overall acceptability of atifufui. The process flow chart of the preparation of atifufui, has been duly documented. Optimization, novelty and value addition of traditional processes when explored, will help alleviate food and nutrition insecurity.

Keywords:

process development, product characterization, atifufui, composite flour, nutrition security, Ghana



O1-10. Gambia Horticultural Enterprise Mango Out-Grower Scheme and Multipurpose Agro-Processing Centre – A Success Story

Gambia Horticultural Enterprises (GHE)
Momodou A. Ceesay
Correspondence: gamhort@qanet.gm

Abstract

Mango is the most common fruit tree grown in The Gambia. However, some 60% of the fruit goes to waste every year due to its highly perishable nature, glut during the peak season and lack of processing industries to add value to the fresh fruit. Nevertheless, opportunities exist for the growth of the mango sector as the agro-climatic conditions in The Gambia are highly favorable, the fruit quality is good, supply abundant and there is growing market and consumer demand. The Gambia Horticultural Enterprise (GHE Ltd.), an Agri-business Company engaged in the entire Horticulture Value Chain implemented two World Bank Matching Grant projects to provide market access and value addition for Gambian mangoes. These enabled GHE to establish a Mango Out-grower Scheme creating a reliable and sustainable mango supply base for exports and processing. Smallholders and commercial mango farmers were integrated into the mango value chains to improve productivity, quality and supply to support export market demands for fresh mangoes and for value additions. Also a Multi-purpose Agro- Processing Centre was established to reduce postharvest losses using two approaches to market the Gambian mangoes namely (1) exporting as fresh mangoes by sea or air to Europe and (2) process mango fruits into mango pulp, juice, jam, dried flakes, etc. Lessons learnt from these Projects are that Donor assistance and Private Sector investments can greatly contribute to the development and rapid expansion of the Agricultural Sector, increasing foreign exchange earnings, creating employment opportunities particularly for women and youths, food and nutrition security, market outlet, generating rural incomes and higher living standards for small growers. Thus it is recommended that the Private Sector are encouraged to invest in Agriculture and given incentives for sustainability and socio-economic development.

Keywords:

Mango, value addition



O1-11. Effect of Processing on Quality Characteristics of Pearl Millet (*Pennisetum Glaucum*) Based Value Added Products

Eyoel Legesse^{1*} and Shimelis Admassu²

¹Food, Beverage and Pharmaceutical Industry Development Institute (FBPIDI), Ethiopia,

²Addis Ababa Institute of Technology (AAiT), Ethiopia

Corresponding author: email address: eyoel2007.el@gmail.com

Abstract

Pearl millet (*Pennisetum glaucum*) can be considered an "orphan" crop despite its significant potential. This research investigated the effect of processing on characteristics of pearl millet (*Pennisetum glaucum*) products. The proximate and mineral compositions, physicochemical and functional properties and reduction of antinutrients concentration were determined. In addition, the sensory quality of pearl millet value added products of bread and thin porridge were studied. Micronutrient concentration of the seeds showed large variation. Phosphorus was the most abundant (290.04 mg/100g) mineral whereas Calcium was low (2.66mg/100g). The ranges for tannins and phytate were 0.80 to 3.66mg/100g and 167 to 294mg/100g, respectively. Significant difference ($p < 0.05$) was observed between treated pearl millet flours in their proximate and anti-nutritional composition. The sensory evaluation of thin porridge and bread products was generally acceptable by panelists. The thin porridge prepared from 75% of unfermented and 25% of fermented pearl millet flour was more preferred in sensory attribute investigation. The bread prepared from 5% fermented pearl millet flour and 95% wheat flour was highly acceptable by the panelists. As a recommendation, increasing production and productivity of pearl millet is vital and competitiveness can be improved through promotion of value-added products.

Keywords:

Anti-nutritional factors, Staple food, Pearl millet flour



P1-2. Development and Quality Assessment of Nutrient-Rich Cereal-Based Porridge Flour in The Northern Region of Ghana

¹Agyiri M., ¹Appiah, F*, ¹Kumah, P. and ²Larbi, A.

¹Department of Horticulture, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

²International Institute of Tropical Agriculture (IITA), Tamale, Ghana

*Corresponding Author: fappiah.sp@gmail.com

Abstract

This study was carried out with the objective of enhancing the protein content of cereal-based porridge-types consumed in the northern regions of Ghana. The study comprised of a field survey and a laboratory study. The field survey and sensory trial were done in the purposely selected communities in the Northern region of Ghana (Duko and Tingoli) of the Suvelugu and Torlong districts respectively, while the nutritional analysis was carried out at the laboratory of the Department of Horticulture, KNUST. In all, 120 care givers and farmers were purposively selected to respond to structured questionnaires made of open and close-ended questions meant to evaluate the bio-data and eating patterns of respondents and to evaluate the sensory acceptability porridge formulations made. Ten treatments in the form of composite flour from two cereals (maize and millet) and a legume (soybean) at different levels of substitution of the conventional flour for legume flour were formed. The treatments were 90% maize:10% soybean, 80% maize:20% soybean, 70% maize:30% soybean, 60% maize:40% soybean, 50% maize:50% soybean, 90% millet:10% soybean, 80% millet:20% soybean, 70% millet:30% soybean, 60% millet:40% soybean and 50% millet:50% soybean. Sensory evaluation was done on the treatments in both communities and 90% maize:10% soybean and 90% millet:10% soybean were selected as the most preferred in terms of aroma, taste and colour with overall score of 1.71 and 1.39 respectively. The results indicated that 90% maize:10% soybean was nutritionally better with higher levels of protein (15%), iron (0.11%) and manganese (0.05%). Since the formulation fortified with 10% soybean was preferred, its consumption would help meet the protein and mineral needs of its consumers and its promotion for consumption is recommended. Improved consumption of both crops would help minimize their associated postharvest losses.

Keywords:

Porridge, breakfast meal, nutritional enhancement, nutritional composition, sensory evaluation



P1-3. Value Chain Assessment and Nutritional Composition of Two Indigenous Leafy Vegetables (Amaranthus and Corchorus Species) in Kumasi Metropolis

¹Baidoo, J. K., ¹Appiah, F*, ¹Kumah, P., ²Ngoni, N., and ²Afari-Sefa V.

¹Department of Horticulture, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

²World Vegetable Center, Arusha, Tanzania

*Corresponding author: fappiah.sp@gmail.com

Abstract

Indigenous leafy vegetables provide essential nutrients and their consumption is on the increase especially in urban communities where they are produced under urban horticulture systems. For sustained production, there is the need for information on appropriate handling, quality, profitability and wealth distribution along the value chains in Ghana. A study focused on *Amaranthus* and *Corchorus* spp. value chains within Kumasi Metropolis of Ghana was conducted to assess important value chain issues including quality, handling, wealth distribution and their implication on postharvest losses. A survey was carried out within the metropolis among the identifiable value chain actors. Nutritional analyses were based on standard procedures. The study showed that 56.0% and 28.0% of producers mostly transported their produce by means of Kia truck and mini-vans (trotro), respectively, whereas 41.0% of the retailers used mini-vans (trotro), 38.0% did head portage with 21.0% using taxi cabs. Sorting and grading was also done to ensure quality produce was sold to consumers. Existing storage facilities were not suitable as they resulted in high temperature build up and consequently high losses during transportation and sales. The *Amaranthus* spp. had crude protein content of 33.0% and crude fibre of 16.75% with potassium, calcium, iron and zinc being 2.27%, 39.2%, 163.052 mg/kg and 26.8 mg/kg, respectively. Leaves of *Corchorus* spp. contained crude protein content of 33.0% and crude fibre, potassium, calcium, iron and zinc content of 10.85%, 1.44%, 43.80%, 164.96 mg/kg and 17.28 mg/kg, respectively. Total yields of 7,759.44 kg/acre for *Amaranthus* spp. and 14,896.44 kg/acre for *Corchorus* spp. were recorded. With respect to wealth distribution, for each acre of crop produced and sold, farmers had profits of GH¢49.76/day compared to the trader who made GH¢510.00/day. Generally, production of *Amaranthus* and *Corchorus* spp. is very lucrative and a major source of income especially for traders. Improved wealth distribution would improve supply as farmers would produce more in response to monetary gains. *Amaranthus* and *Corchorus* spp. were rich in both macro and micronutrients and therefore good for nutrition. Improving their handling and quality would result in increased consumption and reduced losses.

Keywords:

Indigenous vegetables, nutritional composition, nutrition value chain, wealth distribution



P1-4. Extraction of Casein from High Acid Milk for Utilization in Yoghurt Development

Faith Ngundi Ndungi^{1*}, Patrick Muliro¹, Abdul Faraj¹ and Joseph Matofari¹

¹Department of Dairy, Food Science and Technology, Egerton University, Kenya.

*Corresponding author. Email address: faith.ndungi@gmail.com +254722287712

Abstract

One of the steps of yoghurt production involves supplementation with skim milk powders in order to improve on the total solids. Casein, a dried protein-rich product manufactured on the basis of milk coagulation may be used to replace costly skim milk powders. High acid milk (coagulated milk) is a major proportion of post-harvest losses in smallholder delivered milk at collection centers. This milk is considered of low quality and rejected based on failed alcohol test. This study aimed at extracting casein from high acid milk and utilizing it for enrichment as well as improvement of texture in yoghurt. Extraction of casein from the high acid milk involved inoculation of the milk with starter culture and incubating it. The casein was then introduced in yoghurt in three proportions; 1%, 1.5% and 2%. Other yoghurt samples included one with skim milk powder and another with neither casein nor skim milk powder. Viscosity and syneresis were measured by a cup-type viscometer and centrifugation at 3000 rpm for 5 minutes respectively. The syneresis of yoghurts after centrifugation ranged from 0.0 to 59.1%. Samples containing 2% casein and skim milk powder showed the lowest syneresis values. The same samples showed the highest viscosity values. High acid milk is considered of low quality and rejected but this does not reduce the milk to a non-utilization state. The addition of casein from high acid milk had a significant effect on viscosity and occurrence of syneresis in yoghurt.

Keywords:

High acid milk, Casein, yoghurt



P1-5. Innovative Technologies for Cassava Processing: Viable Option for SMEs Growth in Nigeria

Lateef Ayodele Sanni¹, Michael Oladimeji²

¹Department of Agricultural and Environmental Engineering; Obafemi Awolowo University, Ile-Ife, Nigeria;

²MAKSTECH Industries and Engineering Services Limited
Plots 1 & 2, Block VII, Imola Development Scheme, Ilesa, Osun State

Corresponding author: L.A. Sanni, +234 (0) 8062756778; ldsanni@yahoo.com

Abstract

The development of Nigeria's agro-industrial sector is generally accepted to be a viable option for diversifying the country's oil-dependent economy. With the dwindling revenue from oil, there is an urgent need for the agro-industrial development of Nigeria's economy. Cassava (*Manihot esculenta*, Crantz.) is a versatile crop widely grown in Nigeria. Handling and processing of the crop are still dominated by the cottage-level processors scattered all over the rural and semi-urban areas and who depend largely on manual processing methods. As a result, material wastage and poor quality of products such as gari and cassava flour are major challenges. This paper focuses on the recent research works carried out to completely mechanize cassava processing for gari and high quality cassava flour (HQCF) production. New and innovative cassava processing machines are designed, fabricated and tested based on a proper study of the knowledge, attitude and practices (KAP) of small scale cassava processors. Existing technologies hitherto available to the cassava processors are carefully studied and their inadequacies are used as design considerations in the development of the new technologies, namely, horizontal press, rotary sifter, rotary fryer and rotary grader. The target end users of the cassava processing machines are the small and medium scale enterprises (SMEs) in Nigeria. Quantitative and qualitative data show that the machines are efficient, cost-effective and capable of increasing the quality and quantity of gari or cassava flour that is produced. The new technologies are now being disseminated to some SMEs in Nigeria. The design principles, functions and specifications of the machines are provided. Full adoption and optimal utilization of the machines by SMEs will contribute significantly to the rapid growth of SMEs and indigenous technological capability will be enhanced.

Keywords:

innovative technologies, cassava processing, agro-industrial growth



P1-6. Effect of Different Peeling Methods on The Quality Characteristic of Livingstone Potato Flours

Ofoeze M.A.^{1,2}, Ukeyima, M.T.^{2,3} and Girgih, A.T.^{2,3*}

¹National Root Crop Research Institute Umudike P.M.B 7006 Umuahia, Abia State, Nigeria;

²Centre for Food Technology and Research, Benue State University, Makurdi, Benue State;

³Department of Food Science and technology, University of Agriculture, Makurdi, Benue State

*Corresponding author: girgihusa@yahoo.com; Phone: 07039886210

Abstract

Peeling of livingstone potato prior to utilizing it for food purposes is quite challenging. In this study, we evaluated the quality characteristics of Livingstone flours produced using different peeling methods: Lye peeling (LP) that involves the use of strong alkaline solution (NaOH); Knife peeling (KP) which involves gradual slicing off the peels and Abrasion peeling (AP) associated with scrapping or wearing away the peels. The percentage peel loss and flour yield were determined using standard methods. The proximate composition, phytochemical content and functional properties (oil absorption capacity and solubility) were also evaluated. The results showed that KP had the highest peel loss (37.47%), while AP (23.36%) and LP (23.23%) had lower peel loss values. In terms of flour yield, LP exhibited the highest value (31.71%), followed by AP (31.34%) and KP the least (23.75%). The Livingstone flours showed no significant ($P>0.05$) differences in their fat (0.01-0.02%) and protein (0.34-0.35%) contents. The crude fibre, moisture, ash and carbohydrate contents of the flours ranged from 4.66 to 5.03%, 16.01 to 14.95%, 4.62 to 4.82% and 74.14 to 76.26% respectively. The LP treated flour had the lowest oil absorption capacity (1.60) and solubility (11.60) however, the LP treated flour exhibited the highest tannin content (0.90%) when compared to the KP and AP treated samples. This result showed that LP exhibited the least peel losses and highest flour yield, hence would possess higher nutrient density when compared to the AP and KP treated flours which may help in reducing postharvest losses of nutrient quality.

Keyword:

Livingstone potato, peeling, flour, physico-chemical properties



P1-7. Effect of Drying on Degradation of Bioactive Compounds in African Eggplant

Naomi N. Mbondo¹, Jane Ambuko², Daniel N. Sila¹ and Willis O. Owino^{1*}

¹Department of Food Science and Technology, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya

²Department of Plant Science and Crop Protection, University of Nairobi, Nairobi, Kenya

*Corresponding author: willis@agr.jkuat.ac.ke

Abstract

African eggplants are highly nutritious and rich in phytochemicals. Losses during the peak season are mainly due to their perishability. Drying technology is effective for food preservation but can damage phytochemicals depending on drying method and temperature conditions. We evaluated the effect of four drying methods (solar, oven, vacuum and freeze) on the degradation of total phenolics, beta carotene, antioxidant capacity and lycopene in five accessions at two maturity stages. Fruits were dried up to <15% moisture content. Oven and vacuum drying was done at 50, 60 and 70°C. The results showed that response variables were significantly ($p < 0.05$) affected by drying method and drying temperature with freeze drying, vacuum drying, solar drying and oven drying presenting an increasing degradation order respectively. Among the fresh samples, spectrophotometric determination of beta carotene, total phenolic content analysis by the Folin-Ciocalteu assay and free radical scavenging activity by 2,2-diphenyl-1-picrylhydrazyl (DPPH) presented ranges of (11.67-29.50mg/100gdb), (609.64-1691.70mg/100g GAEdb) and (79.55-502.23mg/ml dbIC50 value) respectively. There was increase in beta carotene content and decrease in total phenolics from mature green to mature red stage. Lycopene analysis using high pressure liquid chromatography was detected in manyire green (0.16mg/100gdb) only at mature red stage. These results demonstrate that solar drying, a simple and least costly technique can be practiced by farmers to combat postharvest losses. Dried eggplants would be a significant source of food and income during the off peak and drought periods.

Keywords:

Beta carotene, total phenolics, antioxidant capacity, lycopene.



P1-8. Effects of Pre-treatment During Drying on The Antioxidant, Color and Rehydration Ratio of Selected Tomato Varieties.

Rosemary Mwende¹, Samuel Imathiu¹ and Willis Owino¹

¹Department of food science and technology, Jomo Kenyatta University of Agriculture and Technology, P.O Box 62000-02000, Nairobi Kenya.

*Corresponding Author: willis@agr.jkuat.ac.ke

Abstract

Drying technology has been practiced in an attempt to lower the water activity and increase the shelf stability of the dried product. There are many different drying techniques that have been employed in food processing applications. As a result, there is need to study the most optimum drying conditions to achieve maximum antioxidant retention and consequently reduce postharvest losses. The objective of this study was to determine the effect of pretreatment in enhancing drying and retention of the antioxidant properties of dried tomatoes products. Selected tomato varieties (Anna f1, Kilele, prostar f1 and Riogrande) were obtained from a greenhouse in JKUAT. Tomato quarters of each variety were prepared. Quarters were treated by spraying with (a) 0.5% sodium metabisulphate (S.M), (b) 0.5% calcium chloride (C.C) and (C) distilled water (control) and oven dried at 50°C, 60°C, 70°C to 13% moisture content. Lycopene, B-carotene, total phenolics, color, rehydration ratio and water content were determined in both the fresh and dried tomato samples. Results showed that the initial moisture content among the four varieties did not differ significantly ($p>0.05$) and ranged between 94.2-94.6%. A significant difference was observed in degradation of lycopene ($p<0.05$), B-carotene ($p<0.05$) and total phenolic compounds ($p<0.05$) on all drying temperatures. A higher level of lightness (L^*) ranging 37.74 ± 0.25 to 30.11 ± 0.26 in the pretreated samples was observed compared to the control ranging 26.13 ± 0.47 to 28.58 ± 0.29 . Better rehydration ratio ranging 3.63 ± 0.17 to 4.46 ± 0.07 was observed in 0.5% N.M samples than in 0.5% C. Cranging 3.15 ± 0.11 to 3.64 ± 0.07 and the control (2.99 ± 0.03 to 4.11 ± 0.12). Findings demonstrate that pretreatment of tomatoes during drying may enhance high overall quality.

Key words:

Lycopene, b-carotene, pre-treatment.



Work Stream 2

**Postharvest handling and
technologies for perishable
commodities**



O2-1. Postharvest Warm Water Treatment to Control Thrips in Export French Beans

Speckhahn C^{1, 2}, Subramanian S.¹, Meyhöfer R²

¹Plant Health Division, International Centre of Insect Physiology and Ecology, P O Box 30772 – 00100 Nairobi, Kenya;

²Section Phytomedicine, Institute of Horticultural Production Systems, Leibniz Universität Hannover, Germany; Herrenhäuser Strasse 2, 30419 Hannover, Germany

Abstract

Indigenous and invasive pests are major constraints to vegetable production and marketing in East Africa. Especially pest thrips such as Western Flower Thrips (*Frankliniella occidentalis*) severely hampers trade of export vegetables such as French beans. Effective postharvest treatment methods need to be evaluated and standardized to avoid quarantine risks. Normal postharvest processing of French beans results in removal of adult and larval developmental stages of the pest insect. But the egg stage, which is placed by the female into the plant tissue, makes killing or removal difficult. Therefore this study aimed to evaluate the effects of postharvest warm water treatment on the egg stage of some key invasive and indigenous thrips that infest French beans in Eastern Africa to ensure quarantine security. The effects of warm water treatment and different post treatment storage conditions were investigated regarding the emergence of larvae and the survival of eggs. Our results showed that exposure of French bean pods with eggs of *Frankliniella occidentalis*, *Frankliniella schultzei*, *Megalurothrips sjostedti* and *Ceratothripoides brunneus* to warm water at 50°C for 5 min resulted in 100% mortality of the eggs. Count of unhatched eggs was implemented after a 6 to 7 days observation period regarding larval emergence. The treatment of French beans at 50°C for 10 min and 5 min did also not affect the quality of bean pods related to their extent of surface yellowing. Treated and untreated beans kept under refrigeration (5°C for a period of 5 days) did not show larval emergence. However once the beans were removed from refrigeration, larval emergence was observed from the untreated beans, indicating that cold storage alone cannot ensure quarantine security. Hence warm water treatment at 50°C for 5 - 15 min could be a potential option for both, large and small scale farmers to ensure quarantine security against invasive and indigenous thrips infesting French bean in Africa.

Keywords:

Postharvest warm water treatment, French beans, *Frankliniella occidentalis*, *Frankliniella schultzei*, *Megalurothrips sjostedti*, *Ceratothripoides brunneus*, Quarantine security



O2-2. Ethylene Removal from Horticultural Produce Held Without Refrigeration by a Potassium Permanganate Ethylene Absorbent

M. Sabater¹, R.B.H. Wills² and Y. Li²

¹Bioconservacion SA, Barcelona, Spain; ²University of Newcastle, Australia.

Abstract

The postharvest handling of green banana and green vegetables at temperatures well above the current recommendations by means of an effective management of the exogenous ethylene levels has been shown. These papers generated regression equations to allow calculation of the temperature and ethylene levels required for any nominated postharvest life of several products. The practical application of such technology would reduce energy consumption with the resultant economic and environmental benefits. Furthermore, it could also be an effective strategy to retain quality and reduce wastage of horticultural produce in developing countries where cold chain technology is not available or is too expensive. This paper assessed the ability of an available technology (ethylene absorbent sachets of potassium permanganate -Bi-On®, Bioconservation SA, Spain-) to remove effectively the ethylene evolved from banana, strawberry, green bean and cucumber held under commercial packaging at 20°C and extend market life. The experimental design was based on obtaining an ethylene concentration in control packages of 0.1 to 1 $\mu\text{L L}^{-1}$, which is a relatively common concentration under commercial situations. The addition of the ethylene absorbing sachets reduced the ethylene concentration up to 0.002 $\mu\text{L L}^{-1}$ in green banana (1/23rd of the level of the control), up to 0.01 $\mu\text{L L}^{-1}$ in strawberry and cucumber (1/6th and 1/10th of the level of the control, respectively), and up to 0.05 $\mu\text{L L}^{-1}$ in green bean (1/6th of the level of the control). These levels of reduction have been shown to effectively contribute to increase the postharvest life of fresh produce at ambient temperature. Hence, this system is a valid technology to remove ethylene and thereby extend market life from horticultural produce held without refrigeration.

Key words:

ethylene, potassium permanganate, refrigeration, banana, strawberry, cucumber.



O2-3. Effect of Essential Oils Treatment on Anthracnose Disease Development, Quality and Shelf Life of Mango Fruits

Gerefa Sefu Bahir¹ and Neela Satheesh²

¹Jimma Dar University Institute of Technology; ²University College of Agriculture and Veterinary Medicine

Corresponding email: sefgare@gmail.com

Abstract

Anthracnose (*Colletotrichum gloeosporioides*) is one of the major constraints to production and productivity of mango worldwide including in Ethiopia. Toxicity to non-target organisms, pathogens resistance development, environmental contamination, are among the limitations to use of synthetic chemicals as control options. Although essential oils treatments are reported to be safe and effective in controlling anthracnose's fungal development they have not yet been evaluated specifically on mango. The present study was conducted to investigate the effect of ginger and cinnamon essential oils treatments on mango anthracnose disease management, the quality and shelf life extension of mango fruit. This study was done with the application of three different concentration levels of each type of essential oils, (0.025, 0.050, 0.075) % cinnamons and (0.15, 0.30, and 0.45) %ginger and the control (distilled water). All levels of essential oils concentration were applied by fully spraying on the fruits those formerly inoculated withsporesuspensionconcentrations (106spores ml⁻¹) of *Colletotrichum gloeosporioides*. Completely randomized design (CRD) with three replications was used in this experiment. Disease incidence was assessed by number of infested fruits showing any single symptoms out of total numbers of mango fruits stored and the severity of mango anthracnose was assessed based on visual rating scale 1-5. The study revealed that the tested concentrations did not affect some quality parameters of mango fruits by the 5thday after application but showed positive significant influence after 10th day of storage. Disease incidence and severity were effectively controlled with 0.45% ginger essential oils and cinnamon essential oil at 0.075%. The maximum disease incidence (100%) and severity (65.56%) were recorded in the control treatment on the 25th day after storage, while the minimum mean incidence (38.1%) and severity (26.67%) were recorded in ginger (0.45%) and cinnamon (0.075%) treated fruit 25 days after treatment, respectively. Disease incidence and severity directly affected some quality parameters like weight loss, Total Soluble Solids, Titratable Acidity, pH, Firmness, and Total soluble solids to Titratable Acidity ratio. Hence, the study clearly demonstrated that essential oils treatment could have significant application in anthracnose disease management, quality and shelf life extension of mango fruit in real practice.

Keywords:

Ginger, Cinnamon, Disease incidence, mango, shelf life



O2-4. Combinatorial Effects of Hydrocooling, Sanitizer Application and Cold Storage in Maintaining Quality of Vegetables

¹Chepngeno Joyce, ¹Kinyuru John, ²Ngoni Nenguwo and ^{1*}Owino Willis

¹Jomo Kenyatta University of Agriculture and Technology, Department of Food Science and Technology

P.O Box 62000-00200 Nairobi, Kenya

²AVRDC - The World Vegetable Center Eastern and Southern Africa P.O. Box 10, Dhuluti, Arusha, Tanzania

*Corresponding Author: Email willis@agr.jkuat.ac.ke Phone: +254 723 006 204

Abstract

Fresh produce quality is influenced by post harvest handling techniques and conditions. In developing countries maintaining low temperatures of produce after harvest throughout the supply chain is often challenging due to the prohibitive high initial capital costs. This study was undertaken to determine the effects of hydrocooling, low temperature storage and sanitizer application on postharvest shelf life of carrots, courgettes, African eggplants and tomatoes. Mature good quality produce was harvested and hydrocooled with water (2 ± 1 °C) containing calcium chloride (CaCl_2) at four concentrations, 0%, 0.5%, 1.0% and 1.5%, followed by low temperature storage at 10°C. Two controls were set up with produce hydrocooled and another not hydrocooled, both kept at ambient temperature (25 ± 5 °C). Produce quality assessment was done every two days on Vitamin C, decay incidence or chilling injury, microbial load, colour and specific sugars. Vitamin C declined for all the produce over the storage time of 9 days, with highest loss in produce stored at room temperature without hydrocooling for tomatoes, carrots and courgettes, from 21.6 mg/100g to 12.7mg/100m, 5.6 mg/100g to 3.0 mg/100g, 17.8mg/100g to 10.6 mg/100g respectively. African eggplants for the same treatment, showed highest vitamin C retention. Similar results were obtained on colour and specific sugars. With addition of CaCl_2 , the optimal concentrations for extended shelf life and nutrient retention varied according to produce. This was 0%, 1% and 1.5% for carrots, tomatoes and courgettes, with lower decay incidences and microbial loads. CaCl_2 used in hydrocooling African eggplants delayed the onset of chilling injury at 1.5% by two days, once chilling injury set in, CaCl_2 had no significant effect on the progression of chilling injury of the fruit. In conclusion, precooling tomatoes, courgettes and carrots with sanitizer extended shelf life by between 2 and 5 days.

Key words:

Hydrocooling, Low temperature storage, Postharvest Quality.



O2-5. Efficacy of Hexanal Application on the Postharvest shelf life and Quality of Banana Fruits (*Musa* spp)

Yumbya, P.M*¹, Hutchinson, M.J¹, Ambuko, J¹, Owino, W² and Subramanian, J³

¹University of Nairobi, Department of Plant Science and Crop Protection
P.O Box 29053-00625, Nairobi

²Jomo Kenyatta University of Agriculture and Technology, Department of Food Science and Postharvest Technology P.O Box 62000-00100, Nairobi

³University of Guelph, Department of plant agriculture, Vineland station, 4890 Victoria Avenue North, Vineland, Ontario LOR 2E0, Canada

*Corresponding email; muenipenny8756@gmail.com

Abstract

Banana is among the major fruits in Kenya produced by smallholder farmers as one of their source of livelihoods in almost all the agro-ecological zones. Profitability of banana production is however curtailed by huge postharvest losses ($\geq 50\%$) attributed to high perishability of the fruit. This scenario calls for research in commercially viable postharvest technologies for use by smallholder farmers especially none synthetic compounds. Hexanal is a naturally-occurring aldehyde compound that has been shown to slow down softening in temperate fruits thereby extending shelf life. The objective of this study was to evaluate the efficacy of hexanal applied as dip in enhancing the shelf life of Grand Nain and sweet banana varieties harvested from Meru and Machakos Counties. Fruits harvested at 104 days after anthesis were dipped in two hexanal concentrations (2%, 3%) and water for 2.5 and 5 minutes and allowed to ripen under ambient room conditions. Hexanal treatment for 5 minutes enhanced the postharvest shelf life by 9 and 3 days in Grand Nain and sweet banana varieties respectively. Dipping banana fruits in hexanal for 5 minutes significantly ($p < 0.05$) delayed peel and pulp softening compared to those dipped for 2.5 minutes. A 5 minutes hexanal dip treatment significantly slowed ethylene evolution rate and delayed the climacteric peaks by 6 and 3 days in Grand Nain and sweet banana varieties respectively. Progression of ripening and related changes including increase in titratable acidity, brix and soluble sugars was slower in hexanal treated fruits compared to the controls. These findings indicate that treatment with hexanal at 2% and 3% for 5 minutes can be used to prolong the shelf life of banana fruits for at least 9 days in Grand Nain variety. It should therefore be promoted for commercial applications among Grand Nain banana growers, retailers and wholesalers to enhance shelf life and extend marketing period

Key words:

Hexanal, banana, shelf life, postharvest, quality



O2-6. Comparison of Drying Rates of Chilli Peppers Using Solar House and Sun Drying Methods

Flora C. Amagloh¹ and Blessilla N. Kandoh¹

¹Council for Scientific and Industrial Research – Savanna Agricultural Research Institute, P O Box TL 52, Tamale, Ghana

Corresponding Email: flora.amagloh@gmail.com

Abstract

Drying of chilli pepper is suitable for reducing postharvest losses during glut. The objective of the study was to investigate which one of two drying methods; solar house and sun drying was more appropriate and efficient for drying chilli pepper and also to determine the effect of each drying method on the visual appeal of the chilli pepper. Weighed amounts of chilli pepper (60g per sample tray) were loaded into the solar house and sun drying platform with labelled sample trays and monitored at 2-hour intervals for the first three days and then 5-hour intervals from Day 4-11. The solar house and ambient temperatures were monitored during the drying period and pictures taken at each recording to study the visual appeal. The solar house temperatures ranged from a low of 36.3C to a high of 55.8C, while ambient temperatures ranged from 29.2C to 43.5C during the drying period. By the end of the first day, the weight loss of chilli peppers for each treatment was about 3.3%. By the third day, the highest weight losses recorded were 56.7% for solar house and 50% for sun drying. By Day 5, chilli peppers in the solar house had lost as much as 80% of their initial weight with sun-dried chilli peppers recording 70% weight loss. On Day 7, some trays recorded as low as 4g in the solar house (representing 93.3% weight loss) while 12g (representing 80% weight loss) was the lowest weight recorded for sun drying. On the last day of drying (Day 11), the chillis in the solar house recorded an average of 89.2% weight loss, while those in the sun recorded an average of 83.6% weight loss. Solar house drying was quicker than sun drying method and also protected the produce from both human and animal/insect intruders. Also, produce in Solar House can be left inside the dryer throughout the drying process, unlike sun drying during which produce have to be transported to and from the sun to the shade every day. Visual appeal was about the same in both methods.

Key words:

chilli pepper, postharvest loss, solar house dryer, sun drying, visual appeal



O2-7.Evaporative Pre-Cooling Technologies and Practices for Preserving Perishable Crops in Dire Dawa, Ethiopia

Melese Temesgen

Assistant Professor in Food Science Technology & Nutrition

E-mail: melese2b@gmail.com

Phone: 0912097802,

Haramaya University, Ethiopia

Abstract

In Ethiopia high postharvest losses (PHL) result in reduced food availability, lower quality foods, and lower nutritional value and/or food safety dangers. To address some of these PHL challenges, The World Food Logistics Organization, in collaboration with the Postharvest Education Foundation (PEF), has identified four simple postharvest practices and six improved technologies that, if adopted in Ethiopia, could have an enormous impact on farmers' earnings, nutrition and health. The use of such technologies and practices expected to be to assist local farmers, marketers, governmental extension workers and postharvest consultants in the private sector in Ethiopia to access the technical and extension information they need to be able to implement postharvest technology options that would reduce food waste, increase incomes from farming and keep more profits in their communities, improve nutrition and food safety. Among the technologies, evaporative forced air pre-cooling was implemented for storage of perishable crops at Dire Dawa region and improved the shelf life and quality of the commodities. In this project we use forced air evaporating pre-cooling to remove field heat and reduce the temperature of fresh produce before it is shipped or placed into storage. The pre-cooling storage was tested for all types of fruits and vegetable to optimize the temperature and humidity at safe level. However, in other parts of the country it is unusual to find cold storages facilities and there are huge losses in agricultural crops. From the findings of this work, evaporative pre-cooling is found to be appropriate technology for handling perishable fruits, vegetables, root and tubers in dire dawa region. This best storage practices need to be promoted in other parts of the country and training package targeting such key postharvest practices and technologies need to be developed and implemented in the country.

Key words:

pre-cooling, technologies and practices



O2-8. Postharvest Handling Practices and Losses of Some Major Fruits Sold in Abeokuta, South-Western Nigeria.

Odeyemi, O.M*,¹, Ogunkoya, and Onifade, O.T²

¹Department of Horticulture, Federal University of Agriculture, Abeokuta.
PMB 2240 Nigeria. 110001

²Agricultural Media Resources and Extension Centre (AMREC),
Federal University of Agriculture, PMB. 2240. Abeokuta, Nigeria.110001

*E-mail of corresponding author: bukief09@yahoo.com

Abstract

Postharvest handling activities have significant effect on postharvest losses and market value of fruits. This study investigated the postharvest handling practices and causes of losses in major fruits sold in four major markets in Abeokuta, South-western Nigeria. Simple structured questionnaire was administered to 120 respondents (fruit handlers), randomly selected from Osiele, Kuto, Iberekodo, and Lafenwa markets. Descriptive statistics was used to analyse data collected. 85% of the respondents were female while 15% were male, both with average age of 35 years which showed that most of them were in their active and productive age. Only 45% of the respondents had one form of education or the other. Nine major fruits were sold in the four markets namely; orange (23%), watermelon (10%), plantain (20%), banana (17%), pineapple (8%), pawpaw (3%), golden melon (7%), mango (3%) and apple (9%). 13% of the respondents were wholesalers while 87% were retailers. 37% of the respondents displayed their fruits under shade while 63% had their fruit displayed under direct sunshine (not shaded). 65% of the respondents who are majorly retailers sort their produce before selling while 43% wash the fruit before selling. Packaging materials identified included traditional woven basket (60%), jute sacks (35%), returnable plastic crates (2%) and other forms of packaging (3%). All fruits were stored under ambient condition. Fruit loss occur from mechanical damage (37%) especially during transportation and rough handling, physiological deterioration (25%), lack of sales (18%), poor/inadequate storage condition (7%) and insects and pest attacks (13%). Fruits are delivered to handlers on market-days by cars 35%, motorcycle 5%, open-trucks 12% and bus 48%. Conclusively, fruit handlers are not adequately informed on the importance of proper handling of fruits to prevent losses and deterioration. It is important that awareness, education and training should be extended to fruit handlers by relevant agencies.

Keywords:

Abeokuta, fruits, losses, markets, postharvest, quality



O2-9. Postharvest Losses and Management Strategies in Fruit and Vegetable Sector of Pakistan

Aman Ullah Malik^{1*}, Iqrar A. Khan¹, Raheel Anwar¹, Ahmad S. Khan¹, Faisal Shahzad¹, Abdul Ghafoor², Tahir Zahoor³, Muhammad Ashfaq⁴

¹Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan

²Institute of Business Management Sciences, University of Agriculture, Faisalabad, Pakistan

³National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pak

⁴Institute of Agricultural and Resource Economics, University of Agriculture, Faisalabad, Pak

*Corresponding author's email: malikaman1@gmail.com

Abstract

Currently, Pakistan's rich land resource of 1.5 million hectares is being used to produce 16 million tonnes of fruits and vegetables, worth US\$ 4.8 billion. Existing postharvest supply chain system leads to heavy postharvest losses estimated 35-40% (6.4 million tonnes) worth US\$ 1.9 billion, and wasting 613 thousand hectares of fertile land resources and inputs worth millions of dollars. With such high losses, no amount of resource and technology alone in production can ensure food security until postharvest losses are substantially reduced. Major reasons of postharvest losses are poor production and harvest practices, lack of on-farm infrastructure and cool chain facilities, poor packaging, inadequate market infrastructure, poor market conditions and energy issues. To reduce postharvest losses, there is need to improve on-farm and market infrastructure, optimize production and postharvest techniques, establish collection centers, cold stores, processing units at fruit and vegetable hubs under public-private partnership mode or loan with zero/low interest/tax exemptions etc, developing collaboration among stakeholders, modernizing packaging industry, capacity building of technical staff, farmers, workers, promote/implement food quality standards, improving marketing information system and market conditions, promote value addition and ensure energy supply to industry at affordable tariff. While developing new agriculture policy for Punjab province, target of reducing overall postharvest losses is going to be fixed. During past 10 years, various initiatives have been taken to reduce postharvest losses. These included citrus and mango value chain improvement project (Australia-Pakistan Agriculture Sector Linkages Program), development of code of practices (COP) for citrus and mango industry, with cluster approach (EU/UNIDO funded project), Fruit and Vegetable Development Project (Government of Punjab, Pakistan) and on-farm infrastructure development (USAID funded project) in which 15 on-farm pack houses have been developed; developing mango sea freight technology for commercial sea shipments to EU, have enabled growers to reduce losses, improve quality and enter high end export markets. This presentation will include learnings from these interventions and ongoing efforts to reduce postharvest losses at national level.

Key words:

Fruits, vegetables, Pakistan, postharvest loss, strategies

Production data source: Agriculture statistics of Pakistan, Ministry of National Food Security and Research, 2015.

Postharvest losses and values are estimated, value of fresh produce US\$ 300/tonne.



O2-10. Effect of Storage Temperature on Vitamin C, Total Phenolics, Phenolic Acids Profile and Antioxidant Capacity of Eleven Potato (*Solanum Tuberosum* L.) Varieties

Galani Y. Joseph Hubert,^{1,*} Pooja H. Gupta,² Nilesh J. Patel,² Avadh K. Shah,² Rajeshkumar R. Acharya³ and Jayantkumar G. Talati²

¹ Department of Agriculture and Veterinary Medicine, Université des Montagnes, P.O. Box 208, Bangangté, Cameroon. Email: josephgalani@gmail.com

² Department of Biochemistry, B.A. College of Agriculture, Anand Agricultural University, Anand-388110, Gujarat, India

³ Main Vegetable Research Station, Anand Agricultural University, Anand-388110, Gujarat, India

Abstract

There is a need to elucidate the changes in antioxidant activity, antioxidant compounds and antioxidant enzymes during low temperature storage of potato tubers, which affects metabolism and may alter various properties of the stored tubers. Eleven Indian potato varieties were evaluated for antioxidant parameters after 0, 30, 60 and 90 days of storage at room temperature, 15°C and 4°C. Total phenolics (7.86 to 15.46 GAE/100 g fw) and vitamin C content (8.28 to 24.16 mg/100 g fw) were different among the varieties and were affected by storage temperature; their levels fluctuated during storage but remained above the initial level until the last day of observation. Phenolic acids profiling by UPLC identified 12 compounds among which the most abundant was chlorogenic acid followed by gallic acid, sinapic acid and ellagic acid. Except para-coumaric acid which decreased at 4°C, all the phenolic acids increased with storage. Caffeic acid, chlorogenic acid, protocatechuic acid and gallic acid, mostly positively correlated to total phenolic content ($R^2= 0.456, 0.482, 0.588$ and 0.620 , respectively). Evaluation of antioxidant activity showed a close relationship between DPPH and ABTS methods ($R^2=0.801$), it increased during the initial days of storage and then dropped to a level comparable or lower than the original value, irrespective of the storage temperature. Correlations performed revealed that chlorogenic acid, gallic acid and ferulic acid mostly contributed to antioxidant activity. Activity of the antioxidant enzymes superoxide dismutase and ascorbate peroxidase both increased initially but then decreased to values lower than the initial level and were not influenced by storage temperature. Correlation with antioxidant activity indicated that the enhancement of reactive oxygen scavenging species in cold stored tubers is associated mainly with ascorbate peroxidase activity. Our results demonstrate that storage temperature adversely influences the metabolism and the content of phytonutrients in potato tubers, with subsequent increase in their antioxidant capacity.

Keywords:

Antioxidant, cold storage, phenolics, potato, UPLC, vitamin C



O2-11. Pre-Harvest Curing: Effects on Skin Adhesion, Chemical Composition and Shelf Life of Sweet Potato Roots in Tropical Conditions

Aditya Parmara*, Sascha M. Kirchnera, Barbara Sturma, ^b, Oliver Hensela

^aUniversity of Kassel, Department of Agricultural and Biosystems Engineering, Nordbahnhofstrasse ^{1a}, Witzenhausen, 37213, Germany.

^bNewcastle University, School of Agriculture, Food and Rural Development, Newcastle upon Tyne, NE1 7RU, UK.

*Corresponding author Email: aditya.parmar@daad-alumni.de

Abstract

Excoriation (skinning injury) is a serious post-harvest problem of sweet potato roots. In industrialized countries, sweet potatoes are exposed to post-harvest curing to facilitate skin toughening and wound healing. However, in developing regions, such a practice is hardly undertaken. Pre-harvest curing (PHC), where sweet potato are subjected to defoliation before harvest, may be a potential alternative to post-harvest curing. A field trial was conducted in southern Ethiopia. Roots underwent PHC treatment for 3, 7, 10, and 14 days, with 0 days as a control sample. Skin adhesion, chemical composition (ash, crude fiber, crude protein, dry matter and starch) of the parenchyma and the periderm were evaluated. A storage test at ambient conditions for 30 days was conducted. Skin adhesion among all the treatments was significantly increased. The maximum skin adhesion was observed for 14 days (358.92mN-m); however, after 7 days of PHC, no significant ($p\text{-value} \geq 0.128$) change occurred. Root dry matter and ash content remained unaffected by the treatments. An increase in periderm crude fiber was observed for treatment samples, indicating lignification. Parenchyma crude protein concentration demonstrated a sudden drop in value from control to 3 days of PHC (5.19 to 2.32%). For the successive durations, it started to increase from the level of 3 days demonstrating an active protein metabolism. Starch, being the most important constituent affecting palatability and processing of sweet potato, was not affected by the PHC. Roots subjected to PHC for 10 and 14 days presented a potential for enhancing shelf life by having a significantly lower weight loss after 30 days of storage.

Keywords:

Pre-harvest curing, skin-adhesion, sweet potato, weight loss



O2-12. Some Determinants of Postharvest Loss in Strawberry Fruit in Kenya

Maina Mwangi

Department of Agricultural Science and Technology, Kenyatta University, P.O. Box 43844-00100 Nairobi, Kenya

Email maina.mwangi@ku.ac.ke

Abstract

Strawberry is a high value crop with substantial demand especially in urban areas where it is consumed fresh or used in yoghurt, juices and dessert. Although local strawberry production has been increasing, Kenya is not self-sufficient and relies on importation. Despite this gap in production and demand, a significant proportion of locally produced fruits goes to waste and local growers have reported challenges in market access. A study in 2012 investigated downstream market activities to assess consumer behavior and determinants of loss. Information was obtained using a questionnaire and direct on-farm observations in Kiambu County (Kisberry growers association at Ndumberi) and individual growers at Ngecha (Limuru), and at points of sale from identified long term growers, established berry marketers including ten supermarkets outlets (Uchumi, Tuskys and Nakumatt outlets in Nairobi), and vendors in five open air markets (City market, Wakulima market, Ruiru, Kiambu and Githurai), and 150 consumers. Results showed the key consumer considerations are fruit freshness (100% respondents), color (sign of freshness and maturity, 91%), fruit size and uniformity (85%), the method and material used to package (85%) and portion on sale (punnet size and weight). To make a decision, majority of consumers would prefer to taste berries before purchase, but few (less than 10%) of vendors had this provision. Vendors with taste option sold more and had substantially less fruit going to waste on the shelf. Most buyers (77%) preferred uniformly large fruits of at least 2 inch at the widest rim but sellers (especially vendors in open air markets) often had fruits of varying sizes mixed in a single punnet. Small to medium fruit packages (0.5 kg) sold faster while punnets exceeding 1 kg remained on the shelf for significantly longer, with proportionately higher risk of deterioration. Although some vendors used pesticide and disinfectant dips (sodium hypochlorite Jik® and hydrogen peroxide) to slow fruit deterioration, the risk of pesticide contamination was important to less than 20% consumers. Vendors with cooled fruit display and storage area (mostly supermarkets) had significantly less fruit loss ($P < 0.05$) than vendors in open air markets. These findings provide a pointer to some of the factors to address to minimize waste and loss of strawberry fruit in Kenya's markets.

Key words:

Consumers, loss, postharvest quality, strawberry



O2-13. Low Cost Evaporative Coolers as an Alternative Storage to Mechanical Refrigerators for Tomato Storage

Esa Abiso*, Neela Sateesh And Addisalem Hailu
Samara University, Department of Horticulture, Samara, Ethiopia
*Corresponding author: esaabiso@gmail.com

Abstract

Tomato is recognized as one of the most important commercial and dietary vegetable crop on the world. However its highly perishable nature limits the postharvest life of the fruit. Evaporative coolers have a significant effect on altering storage temperature and RH which are the two major factors that affect shelf life of the perishables. Hence, this study was undertaken with the objective of determining the effect of different low cost evaporative cooler storages and ripening stages on shelf life and postharvest quality parameters of tomato fruits. The experiment was laid out in completely randomized design laid out with two factors being the four storage methods (Zero Energy Cooling Chambers/ZECC, pot in pot storage, desert cooler and control); and two ripening stages (breaker and light red stages) each with three replications. Different response factors were studied: Average daily temperature, relative humidity, shelf life, deterioration and weight loss percentage, pH, titratable acidity/TTA/, total soluble solid/TSS/, fruit firmness, Lycopene, B-carotene, Chlorophyll A and B. Maximum retention (24 days) were obtained inside ZECC while minimum retention days were at room temperature (14 days) for tomatoes harvested at breaker ripening stage. Decay was observed early on the 6th day for fruits stored at ambient temperature but was started late after 11th day for fruits stored inside the evaporative coolers. Generally, weight loss and deterioration percentage, TSS, Lycopene and B-carotene content significantly increased with increment of storage time, but were early and fastest on tomatoes stored at room temperature. TTA, fruit firmness, Chlorophyll A and B content significantly decreased with the increment of storage times which were also fastest on tomatoes stored at room temperature. It can be concluded that evaporative coolers give an alternative approach to mechanical refrigerator for prolonging postharvest shelf life and maintain quality of tomato fruits. ZECC need a bigger space and it is appropriate to use as on-farm storage. Pots require small place and could be easily broken if designed for on farm-storage so it is recommended to use as individual HH storage. The passive cooler is appropriate for retailers at market place; where it can with stand breakage in busy market places.

Key words:

Tomatoes, Evaporative Coolers, Shelf Life, Quality



O2-14. Characterization of Ripening and Associated Gene Expression in Two Kiwifruit Cultivars at Different Storage Temperatures

O.W. Mitalo^{*1}, Y. Tosa¹, Y. Kasahara¹, S. Tokiwa¹, W.O. Asiche¹, E. G. Mworio³, W. O. Owino⁴, K. Ushijima^{1,2}, R. Nakano^{1,2} and Y. Kubo^{1,2}

¹Graduate School of Environmental and Life Science, Okayama University, Okayama, Japan

²Faculty of Agriculture, Okayama University, Okayama, Japan

³Meru University of Science and Technology, Meru, Kenya

⁴Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya

*Corresponding Author: omitalo89@gmail.com

Abstract

Physiological understanding of fruit ripening is essential to reduce postharvest losses in horticultural crops. Kiwifruit is classified as climacteric since ethylene induces rapid ripening. However, we previously reported that low temperature modulated kiwifruit ripening independent of ethylene. The purpose of this study was to determine the effect of storage temperature on ripening and associated gene expression in 'Sanuki Gold' and 'Hayward' kiwifruit cultivars. Ethylene production patterns of grouped or individually separated fruit at commercial maturity were monitored using a gas chromatograph during storage at 22°C. Fruit were also subjected to storage at either 5°C, 10°C, 15°C or 22°C using the individual separation technique. Here, fruit producing ethylene $\geq 0.02 \text{ nLg}^{-1} \text{h}^{-1}$ were eliminated from the storage rooms. Changes in fruit firmness (by a penetrometer), SSC (by a digital refractometer) and TA (by titration against 0.1N NaOH) were monitored at 0, 28 and 56 days. Gene expression analysis was conducted using Real-Time PCR on fruit samples at 0 and 28 days. Batched fruit depicted a synchronized climacteric ethylene production pattern. Individually separated fruit produced ethylene after a varying number of days while many fruit did not produce any detectable ethylene after 56 days. The highest proportion of ethylene-producing fruit was at 22°C. 'Sanuki Gold' fruit ripened faster at 5°C, 10°C and 15°C with increased expression of XET2, PG, EXP1, PMEi, B-AMY2, GA2ox1, MADS2, NAC5 and bZIP2 while minimal changes were observed in fruit at 22°C. On the other hand, 'Hayward' fruit ripened faster at 5°C and 10°C with increased expression of the ripening-associated genes while insignificant changes were observed in fruit at 15°C and 22°C. These results suggest that 'Sanuki Gold' kiwifruit were more sensitive to low temperature as they ripened even at 15°C while 'Hayward' kiwifruit could not. This difference in low temperature sensitivity could account for the discrepancy in maturity dates as well as postharvest storability between kiwifruit cultivars. Therefore, cultivar-tailored storage protocols are essential to effectively extend storage life.

Key words:

Ethylene, Storability, 'Sanuki Gold', 'Hayward', Low temperature



O2-15. Effects of Using Insulated Punnets and Conventional Packaging Films on The Storage of Fresh Robusta Banana Fruits

Abdul-Rahaman Adams, Leori Inusah, Pasenaa Peter
Wa Polytechnic. Department of Agricultural Engineering.
P. O. Box 553. Wa UWR Ghana, West Africa nupayala@yahoo.com, nupayala@gmail.com

Abstract

The application of poor consumer packaging technology to Banana fruits can increase fruit susceptibility to diseases which affect quality and shelf-life. Understanding the use of appropriate consumer acceptable packages is crucial in developing packaging for the fresh produce sector. In this study, four different consumer packages namely Perforated Insulated Punnet (PP), Non-perforated Punnet (NP), Perforated Films (PF) and Non-perforated Films (NF) and control samples (CT) were tested. Fruits in these packages were stored at 27°C for 7 days where rate of ripening, weight loss, total soluble solids, taste, pulp texture and consumer acceptance were assessed. The results demonstrated that the use of perforated punnets was better in reducing the rate of ripening. The changes in TSS was progressive in all the treatments but the control sample produced the highest Brix at 16% compared with Brix 15% for fruits in PP, NP, PF and NF. Weight loss was more pronounced in the control sample (11.7%) compared with the least weight loss of 0.7% for fruits in NF. Except for Sweetness and TSS without dilution, all the parameters assessed were statistically different at $P \leq 0.05$ among the treatments. Based on the results obtained, it can be shown that the use of insulation and perforations of punnets can be adopted for consumer use in the fresh produce sector.

Key words:

Robusta Banana, Insulation, Punnets, Weight loss, TSS, Acceptance



O2-16. Threats to Agro-Industrial Development in Nigeria: A Case for Post Harvest Losses in Cashew Nuts Production

Ogunsina, B.S.

Department of Agricultural & Environmental Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria.

bsogunsina@yahoo.com; babsina@oauife.edu.ng

Abstract

Cashew nut is an important agricultural commodity in global trade which has suffered great post harvest losses in Nigeria. Among major cashew producing countries in the world, it has been documented that Nigeria has comparative advantage in organic cashew production. Hitherto, there is rarely an integrated documentation of cashew nut production and processing in Nigeria. This work is an integrated overview of the Nigerian cashew nut industry based on author's field experience. It sensitizes all stake holders in the cashew industry and highlight unexplored investment opportunities to stimulate policy debates on the need for pre-export value addition to Nigerian cashew against sales of raw nuts and importation as processed kernels. Significant constraints to cashew nuts production and processing were identified and indices that may influence policy decisions and stimulate agro-industrial development were highlighted.

Keywords:

Cashew nut processing, Industry, Agro-industrial development, Nigeria.



O2-17. Postharvest Loss and Waste Prevention Strategies in Ghana: A Meta-Analysis

John Nelson Ekumah¹, Agnes Budu² and Angela Parry-Hanson Kunadu⁴.
Department of Nutrition and food science, University of Ghana
jnekamah@st.ug.edu.gh / +233-(0)-247091747

Abstract

Food insecurity is a major concern in Sub-Saharan Africa (SSA). Agricultural improvement has proven positive in remediating the situation. Postharvest loss and waste has however been a challenge. Ghana loses 20-50% of her annual agricultural produce while it struggles to eradicate hunger, malnutrition and poverty especially around the northern belt. Ghana however, in the quest to meet the Millennium Development Goals and the world food summit hunger reduction target has implemented working postharvest loss and waste prevention interventions and strategies. The study was therefore to reveal the impact of the adopted and implemented strategies on food security in Ghana. Meta-analysis of postharvest research and development in Ghana, government statistical data and Ministry of Agriculture (MoA) annual reports was employed. A broad-based multi-disciplinary literature search was also adopted to build a comprehensive study ensuring coverage of available data from the wide pool of postharvest research in SSA and Ghana. Appropriate productive technology, mechanization of postharvest handling systems and conflict prevention has contributed significantly to loss reduction at the northern belts. Nationwide education has improved domestic and catering facilities food waste. National Food Buffer Stock Company (NAFCO) and storage infrastructural development has contributed to an all year supply of food. Benchmarking these Ghanaian adopted strategies by other Sub-Sahara Africa countries will create a food secured SSA for a better nutrition and a healthy life in Africa.

Keywords:

Postharvest, Losses, Strategies, Ghana, Meta-analysis



O2-18. Postharvest Quality Requirements for Producers and Traders of Vegetables in Ethiopia

Ngoni Nenguwo¹, Bezabih Emanu² and Victor Afari-Sefa³

¹World Vegetable Center, Eastern and Southern Africa, Box 10 Duluti, Arusha, Tanzania,

²HEBDEZ Consulting, P.O. Box 15805, Addis Ababa, Ethiopia

³World Vegetable Center, West and Central Africa, BP 320, Bamako, Mali

Correspondence: ngoni.nenguwo@worldveg.org

Abstract

The marketing of vegetable crops is an important economic activity in many developing countries; it generates income for smallholders in both urban and rural production systems while providing employment for other value chain actors. To ensure a proposed marketing strategy will be efficient and cost effective, it is important to understand the postharvest constraints along the supply chain. A field survey was conducted to investigate the postharvest quality requirements demanded by tomato, onion and kale buyers and the response of farmers to market quality demands in Ethiopia. One hundred and fifty-five farm households were surveyed in the Bora and Dugda districts in Oromia region of Ethiopia. The survey collected and assessed samples of fresh produce at the farm gate as well as at various markets in the two districts. Producers indicated that colour (99.45% of respondents) and size (90.85% of respondents) were the most important attributes for marketing tomatoes and onions. However, traders ranked food safety (98.70% of respondents) as more important than colour (94.55% of respondents) for tomatoes and onions. Both groups had similar quality rankings for kale, with freshness being the most important attribute. Postharvest practices to improve quality and value addition were also assessed, with sorting being the most common marketing activity practiced by producers (74.27% of respondents), followed by cleaning (54.43% of respondents). For retailers, sorting (37.93 % of respondents) as well as cleaning (26.43% of respondents) were the most widely practiced postharvest actions. The results indicate limited awareness among various actors regarding quality requirements along the supply chain. Quality is also affected by less-than-optimum conditions for vegetable handling, storage and transportation. Activities to promote practices to reduce postharvest deterioration of vegetables should be encouraged, as well as platforms to share information on quality requirements.

Key words:

vegetable handling, postharvest survey, markets, tomatoes, onions, kale



O2-19. Post-Harvest loss Examining the challenges and Solutions in sub Saharan Africa

Adebola Adedugbe
University of Calabar, Nigeria.
Email: bolaadedugbe@gmail.com

Abstract:

Agriculture and its associated value chains are expected to contribute to local food security, to provide work opportunities in rural areas, and to have a catalysis effect on the development of related economic sectors. Post-harvest losses significantly endanger the livelihoods of stakeholders across the value chain by reducing valuable incomes and profitability. Post-harvest losses are a major contributor to food insecurity in Africa and there is an urgent need to mitigate the negative impacts across the agricultural value chain. At the Consultative Group on International Agricultural Research (CGIAR), vigorous efforts are under way to provide concrete solutions to the problem of food waste for farmers in poor countries. According to CGIAR, in Sub-Saharan Africa alone, up to 150kgs of food produced is lost per person every year. Cassava is a staple crop in Africa, but has a short shelf life after harvesting. C:AVA (Cassava Adding Value for Africa), an initiative supported by the Bill and Melinda Gates Foundation, has developed value chains for high-quality cassava flour (HQCF) in Ghana, Malawi, Nigeria, Tanzania, and Uganda. One way of reducing cassava losses is to process it quickly into HQCF. One solution producing tangible results is also CGIAR Research Program (CRP) MAIZE and CIMMYT's Effective Grain Storage Project (EGSP), which is helping African maize farmers to protect their source of food and income. This paper provides a short description of ways to preserve food and improve food security in sub Saharan Africa.

Keywords:

Agriculture, food insecurity, Postharvest loss, Sub Saharan Africa.



O2-20. Reducing Postharvest Losses in Rwanda

Gurbinder Singh Gill, Director, Agribusiness Associates and PI of Reducing Postharvest Losses in Rwanda

Mailing address: 2827 Spafford Street, Davis, California, USA – 95618

Tel: + 1 530 601 6876

Email: gsgill@agribusinessassociates.com

Abstract

Reducing Postharvest Losses in Rwanda is a new project started in August 2016, aimed at increasing food security by identifying the most efficient ways to reduce postharvest losses in selected horticultural crops. The first phase of the project is to measure postharvest losses, constraints and opportunities using Commodity Systems Assessment Methodology, Value Chain Analysis, and Environmental Lifecycle Assessment, in tomatoes, green chilies, orange fleshed sweet potatoes and bananas/plantains. We will be sharing the results and learnings of the assessments during the conference. In addition, we will also share our project's approach. The project will work to test and scale up several postharvest solutions through its three Postharvest Training & Services Centers. The Centers will be placed in the three partner organizations – Rwanda Agriculture Bank, National Agriculture Export Board and University of Rwanda. Our approach includes building local entrepreneurial capacity to support widespread adoption of appropriate technology. Overall, our work in Postharvest innovations and interventions will help farmers and agribusiness enterprises gain better return on investments by adopting appropriate technology and reducing postharvest losses. The project is initiated by the Horticulture Innovation Lab, funded by the U.S. Agency for International Development as part of the US Government's global hunger and food security initiative called Feed the Future initiative and led by the University of California, Davis.

Key words:

postharvest research, postharvest loss assessment, business development, capacity building, sustainability



P2-1. Physico-Chemical Properties of Extruded Fish Pellets Containing Black Soldier Fly (*Hermetia Illucens*) Larvae and Adult Cricket (*Acheta Domesticus*) Meals

F. Gichuho^{a*}, C. Mutungia,^c A. Faraja, H. Affognon^b, C. Tangac, S. Ekesic, K.K.M. Fiaboec .

^aEgerton University, Kenya. P.O. Box 536-20115, Egerton, Kenya.

^b International Crops Research Institute for the Semi-Arid Tropics, BP 320, Bamako, Mali

^cInternational Centre of Insect Physiology and Ecology, P.O. Box 30772-00100, Nairobi, Kenya.

*Corresponding author: Email: gichuhofrancis@gmail.com

Abstract

Sustainable mitigation of postharvest losses consists in the integration of value chains. One such integration approach is to put to alternative use components that become discarded because of damage or postharvest deterioration. We investigated the suitability of edible insects, reared on food discards, as substitutes for fish meal, the main protein source in fish feed. The physico-chemical properties of extruded fish feed pellets containing the edible insects were determined. Black-soldier fly larvae and adult cricket were harvested, blanched, sun-dried, and pulverised into a meal. The separate meals were each then incorporated into a 30% protein formulation substituting the fishmeal protein at levels of 0%, 25%, 50% and 75% to produce iso-proteinous formulations. Moisture contents of the formulations were adjusted to 10%, 20% or 30% (w/w), and then processed by hot-extrusion using a single screw extruder. Floatability, expansion rate, surface area, volume, bulk density, durability index, water absorption index, water solubility index, water stability, sinking velocity and leaching activity of the dried extruded pellets were determined. Type of insect did not significantly affect the physico-chemical properties of extrudates. However, the level of substitution significantly influenced floatability ($P < 0.05$), bulk density ($P < 0.05$) and water stability ($P > 0.05$). Moisture content had significant effect ($P < 0.05$) for most parameters apart from pellet durability index ($P > 0.05$) and water absorption index ($P > 0.05$). Floatability and water stability decreased with increasing level of insect substitution while expansion rate, durability index, bulk density, surface area and volume increased with increasing level of insect substitution. Most desirable extrudates were obtained with 75% substitution when moisture content of formulation was raised to 30%. The findings demonstrate that edible insects, reared on food discards can create value thus alleviate economic losses associated with postharvest loss.

Keywords:

Discarded food, Edible insects, Fish feed, physico-chemical properties.



P2-2. Effect of Pre-Harvest Calcium Supplements on Strawberry (*Fragaria Ananassa*) Yield, Quality and Shelf Life.

Tatenda Nyamwena^{1,2} and Arnold Bray Mashingaidze²

¹Horticulture Research Institute, P.O Box 810 Marondera, Zimbabwe.

²Chinhoyi University of Technology, P Bag 7724, Chinhoyi, Zimbabwe

tatendachapman@gmail.com, abmashingaidze@yahoo.com, +2363775055816,

Abstract

Strawberries are highly perishable owing to their high respiration rate and the soft fruit that is susceptible to bruising injury. Physical injury not only increases respiration and weight loss but trigger ethylene production which speeds up ripening and spoilage. Calcium fertilizers increases calcium concentration in the fruit thereby upsurge fruit firmness, shelf life and reduce respiratory dry matter losses. The effect of pre -harvest calcium fertilizer top-dressing supplements $\text{Ca}(\text{NO}_3)_2$, CaSO_4 and Calmax) on strawberry yield, fruit quality parameters and shelf life were investigated. Supplements were added from the onset of flowering at weekly intervals for four weeks with $\text{Ca}(\text{NO}_3)_2$ applied as a foliar application spray and as a side dressing to the soil, Calmax as a foliar spray and CaSO_4 broadcast to the leaves. Pre-harvest calcium supplement fertilizers significantly affected ($P < 0.001$) total soluble solids (TSS), fruit firmness, titratable acid (TA), pH, fruit diameter and weight in fruits harvested from the greenhouse but only significantly affected fruit firmness ($P < 0.001$), yield ha^{-1} ($P < 0.005$) and percent spoilage ($P < 0.001$) in fruits harvested from the field. In the field there was no significant difference in strawberry fruit yield between $\text{Ca}(\text{NO}_3)_2$ (soil applied), Calmax (foliar sprayed) and $\text{Ca}(\text{NO}_3)_2$ (foliar applied). Yield was lowest in the control and did not significantly differ with CaSO_4 (broadcast on leaves). In conclusion Calmax (foliar applied) and $\text{Ca}(\text{NO}_3)_2$ (foliar applied) are recommended because they increased marketable yield and shelf life of strawberries.



P2-3. Insect Pest Management of Post harvest Shea Fruits in Storage

*Aneni, T.I. ; Aisagbonhi, C.I. and Aidaigbe, V.C.

*Entomology Division, Nigerian Institute for Oil Palm Research (NIFOR), P.M.B. 1030, Benin-City, Nigeria

*Corresponding author

Email: tomaneni1@yahoo.com

Abstract

Insect pests can damage and affect the quality of the shea fruit in storage and this could threaten food security, self sufficiency and incomes. This paper describes approaches to assuring safety throughout the post-harvest storage value chain of the shea fruit. The study area, Niger State, Nigeria, was divided into zones (A - C) for effective coverage of storage warehouses. Selected warehouses were visited, observations conducted, shea fruits collected for laboratory analysis and the owners interviewed on processing and storage methods. The method used emphasized a participatory approach, facilitating greater local involvement in the collection of data that serves the purpose of gaining an insider's perspective. Direct observation of infrastructural facilities also assisted in validating information gained from respondents. Laboratory analysis were conducted on shea fruits for identification and quantification of storage insect pests from October 2014 to September 2015 at Nigerian Institute for Oil Palm Research (NIFOR), with temperatures fluctuating between 26°C – 34°C and relative humidity from 52% - 92%. As storage time increased, mites, chalcid ants, and weevils (Curculionidae) were observed. The shea fruits were observed to be mainly attacked by mites and beetles. October (25) and November (21) 2014 had the highest number of mites with fruits severely attacked, and with subsequent decrease observed. Shea fruits should be picked immediately as it matures, as fruits left in the fields for long periods become infested. During collection, it should be ensured that the fruits are not exposed to insect pests before they are properly bagged and removed. All infested shea fruits should be removed and separated immediately. Particular attention should be paid to cracks and gaps where insects may hide on the fruits. The fruits should be properly dried before storage to prevent germination and fungi attack. This study proffers improvement on indigenous storage systems to guarantee long term storage. Information provided will add value to improving insect pest management practices of the shea fruit, thereby leading to improved shea fruit quality.

Key words:

Shea fruit, storage insect pests, mites, management practices



P2-4. Postharvest Drying and Storage of Amaranth Seed Using Zeolite Beads and Effect on Seed Quality

C. Ndinya,¹ S. Weller,² D. Karanja,³ D. Chacha,³ and M. Mudeheri¹

¹KALRO Kakamega, P. O. Box 169, 50100, Kakamega. Email:christinendinya@gmail.com

²Purdue University. Email: weller@purdue.edu

³CABI Africa: Email: d.karanja@cabi.org

Abstract

P1-1. Seed is the foundation of any crop. Postharvest management of seed is important because it determines the eventual quality of seed and ultimately crop production. Seed drying and storage are important factors in postharvest management of seed business because they influence germination rates. Seed storage in tropical climates is a challenge because of the high humidity. Amaranth is a popular vegetable in Kenya and most of seeds produced currently are farmer saved. Seed drying and storage are some of the challenges farmers face. Zeolites (drying beads) is a newly developed technology that can dry and maintain low moisture content in seed when stored in hermetic containers. This study was conducted to determine the effect of zeolite beads on germination quality of amaranth seed when used for postharvest drying and storage. Amaranth seeds were harvested and sun dried to remove surface moisture. Seed samples from this seed lot were randomly scooped and mixed to create a sample for investigation. Zeolite beads were reactivated and initial moisture content of amaranth seed estimated using T/RH metre. The bead quantity required for a specified amount of amaranth was calculated. Zeolite beads and the amaranth seeds were mixed and placed in three hermetic containers. A second set of amaranth seed placed in three small cloth bags but without zeolite beads was the control. The seeds were all placed in a storage location under room temperature. The design of the experiment was a randomized complete design with three replicates. Seed samples were removed from the bags periodically at six months intervals and tested for germination for a total period of 24 months. Results indicated that the germination percentage of ALV seeds under zeolite storage were superior to those under the control. At 18 months onward germination of seeds stored without drying beads were significantly lower than those stored with drying beads. Germination ability of amaranth seed stored with zeolite storage beads did not significantly change over time. It remained at above 54 % during the storage period. Whereas for seeds stored in jute bags, the germination reduced by 50 % after two years. The longer the seeds were in storage the better the zeolite storage to the control.

Key words:

Zeolite drying beads, Amaranth seed, germination, storage



P2-5. Low-Cost Cold Storage Technology (Coolbot™): An Alternative for Small-Holder Horticultural Farmers

¹Esther Karithi, ¹Jane Ambuko, ¹Margaret Hutchinson, ²Willis.O.Owino, ³Lusike Wasilwa and ⁴Britta Hansen

¹Department of Plant Science & Crop Protection, University of Nairobi,
P.O Box 29053-00625, Nairobi

²Jomo Kenyatta University of Agriculture and Technology, P.O Box 62000-00100, Nairobi

³Kenya Agricultural and Livestock Research Organization, P.O BOX 57811-00200, Nairobi

⁴Horticulture Innovation Lab, UC Davis, One Shields Avenue, Davis, CA 95616

Corresponding Author: ekarithi3@gmail.com

Abstract

Poor temperature management is one of the key environmental factors that contribute to high postharvest losses in perishables commodities. The high cost of conventional cold rooms required for cold storage makes them inaccessible for majority of smallholder farmers in developing countries hence the need for cheaper alternatives. One such alternative is the Coolbot™ technology which has been previously tested and adopted in several countries. In this paper, the local adaptation of the Coolbot technology and testing its application in mango fruits will be demonstrated. The study was conducted in a participatory approach with smallholder mango farmers in Makueni County of Kenya between 2014 and 2015. An insulated room (3.7 X 3.7 X 4.0 M) was built from 200 mm thick structural insulated panels made from polystyrene. The room was then fitted with an air conditioner (LG brand of 24,000 BTU) and Coolbot which was sourced from Store It Cold LLC (USA). The system was then optimized according to the manufacturer's instructions. Mango fruits sourced from small-holder commercial farmers were separated into two batches. One of the batches was stored in the Coolbot™ cold room and the other store at ambient room conditions. In each case, the fruits were either packed in modified atmosphere packages (Activebag®) or left unpacked. The temperature on the Coolbot was set at 10°C and monitored regularly using Xsense® data loggers. A random sample of 5 fruits was taken from each storage condition after every three days to evaluate ripening-related changes including color, firmness, total soluble solids, respiration and ethylene evolution. Additionally changes in quality attributes including sugars and vitamins were determined. The Coolbot was effective to attain and maintain the set storage temperature 10 ± 2 °C over a 40-day storage period. At 10 ± 2 °C, shelf life of mango fruits was extended by 18-26 days compared to those stored at ambient room conditions. Combination of cold storage and MAP further extended shelf life by 8-10 days. Mangoes in the ambient room reached climacteric peak (53.9 ml/Kg/Hr) earlier on day 12 compared to the delayed one observed on day 35 for cold-stored fruits. There was synergistic effect of cold storage and MAP in preservation of quality and extension of the mangoes' shelf life. Findings confirm the efficacy of the Coolbot™ technology as an alternative cold storage option. The findings also confirm efficacy of the Coolbot cold room to preserve quality and extend the shelf life of mango fruits. Further studies under different environmental conditions and commodities are recommended.

Key words:

Coolbot™, cold chain, cold storage, post-harvest, quality



P2-6. Determination of Maturity Indices of three Mango Varieties produced in Embu County of Kenya

Jacinta Muiruri¹, Jane Ambuko¹, Richard Nyankanga¹ and Willis O. Owino²

¹ Department of Plant Science and Crop Protection, University of Nairobi, P. O. Box 29053-00625, Kangemi, Nairobi, Kenya

²Department of Food Science and Technology, Jomo Kenyatta University of Agriculture & Technology, P.O Box 62000 –00200, NAIROBI

Corresponding author cintawm@yahoo.com

Abstract

Harvest maturity significantly affects the overall quality and the shelf life of fruits such as mango. Failure to harvest the fruit at the right stage for the target market/use results in considerable postharvest losses. The main objective was to evaluate maturity indices of three commercial mango varieties namely 'Van dyke', 'Kent' and 'Tommy atkins' in Embu County of Kenya. The number of days from onset of flowering to the earliest maturity stage was established for each variety as stage 1. Subsequent stages (2, 3 and 4) were determined at regular intervals until the tree-ripe stage. The number of days from flowering to each maturity stage was computed. For each variety and maturity stage, five fruits were randomly sampled and analysed for physical (size, density, firmness, color), physiological (ethylene evolution and respiration rate) and biochemical (obrix, total titratable acidity and their ratio) maturity indices. The results showed that the 3 varieties attained a comparative physiological maturity (stage 1) at 97, 100 and 114 days after flowering for 'Tommy Atkins', 'Van dyke' and 'Kent' respectively. Although size increased as the fruits developed, it was not a reliable index of maturity since some small-sized fruits attained advanced maturity (stage 4) earlier than others that were large-sized. The fruits' flesh firmness decreased gradually with maturity while ethylene production increased with maturity. The TSS: TTA ratio increased from a mean value of 25.57 (stage 1) to 105.5 (stage 4). The results reveal significant differences in maturity indices of the three mango varieties despite similar physical indices. This confirms the unreliability of maturity indices such as size and shape in establishing the right harvest stage of mango fruits. Therefore a combination of flesh color, peel and flesh firmness as well as computational maturity indices to ascertain harvest maturity for mango fruits can be effectively used to reduce post harvest losses in mangoes.

Key words:

postharvest, harvest maturity, maturity index



P2-7. The Effect of Harvest Maturity on The Quality Attributes of Solar-Dried Mango Products of Selected Mango Varieties

Jacinta Muiruri¹, Jane Ambuko¹, Richard Nyankanga¹ and Willis O. Owino²

¹Department of Plant Science and Crop Protection, University of Nairobi,
P. O. Box 29053-00625, Kangemi, Nairobi, Kenya

²Department of Food Science and Technology, Jomo Kenyatta University of Agriculture & Technology, P.O Box 62000 –00200, Nairobi
Corresponding author cintawm@yahoo.com

Abstract

Processing of perishable fruit such as mango into shelf-stable products is considered as one effective strategy towards reduction of the high postharvest losses ($\geq 50\%$). The quality of processed mango products is affected by many factors including variety, stage of maturity and processing practices. The objective of this study was to determine the effect of harvest maturity on the quality attributes of dried products of three commercial mango varieties; 'Van dyke', 'Kent' and 'Tommy Atkins'. The fruits were harvested at three different maturity stages (3, 4 and tree ripe) based on the flesh color as the index of maturity. A random sample of ten fruits from each batch was peeled and cut into 2-3 mm thick chips. The chips were laid out on trays and loaded into a small scale green house solar drier whose conditions were; average temperature of 45°C, relative humidity between 21.8% to 63.5 % and the average air speed of 4m/s. The trays were removed once the sampled mango slices had achieved at least 10% moisture content. The dried and fresh mango slices were analyzed for Vitamin C, B-carotene, major sugars (fructose, glucose and sucrose), minerals (potassium, calcium, iron, magnesium and sodium), moisture content and firmness. Vitamin C was determined using visual titration method while major sugars and the minerals using AOAC method. The results showed that dried products had lower levels of ascorbic acid content and higher sugar levels compared to fresh products. Kent variety had the highest vitamin C level of 29.56 mg/100g of the dried slices at tree ripe stage. The results showed that harvest maturity is a major determinant of the quality of processed fruits such as mango. Quality of the processed products determines consumer acceptance and consequently feasibility of processing as a strategy to reduce postharvest losses in fruits such as mango.

Key words:

mango, maturity stage, nutritional qualities, solar drying



P2-8. Ergonomic Evaluation of Grain Extraction from Smallholder Farmer Grain Storage Structures in Zimbabwe

*Musundire, R., Mwanza, E.R., and Mashingaidze, A.B.

Department of Crop Science & Postharvest Technology, Chinhoyi University of Technology, P. Bag 7724, Chinhoyi

*Corresponding author: rmusundire@cut.ac.zw; rmusundire@yahoo.co.uk

Abstract

The rate of adoption of improved grain storage structures in Zimbabwean smallholder farming sectors has remained low due to factors such as inadequacy of structures to prevent grain theft and pest damage as well as difficulties in extracting stored grain. Rapid rural to urban migration has caused the demographic composition of smallholder farmers to be skewed towards the juveniles and elderly age categories. This study explored the challenges in manual grain extraction from the traditional granary, improved brick granary and metal silo. A randomized complete block experiment with two genders, three age groups (>50, 20-50, 8-15 years) and granary types (2x3x3) was used to test the ergonomics of manual grain extraction from these storage structures in Makonde District, Mashonaland West Province of Zimbabwe. Changes in heartbeat rate of 18 participants for each age category before and after extraction of 20 kg of grain from each storage structure were measured using a sphygmomanometer. The resting state of each participant before the experiment was used as baseline for change in heart rate. Grain extraction time for each participant was also measured. Gender x age group interaction had significant ($P < 0.05$) effect on heart rate change. Males exhibited a lower heart rate than female participants in all age groups except the age group > 50 years when extracting grain from the traditional and improved granary. Heart rate change was not significantly different when participants worked on the metal silo. The gender x age group x granary type interaction had significant ($P < 0.05$) effects on the change in heart rate for grain extraction from storage structures. The metal silo had least change in heart rate and extraction time compared to other grain storage structures signifying that less work is done in extracting grain from it. More time was required to extract grain from the improved brick granary, thus this structure requires alteration such as changing the position of the loading/off loading bay to facilitate entry and exit of grain extractor using minimal effort and without injury. In general, the results of this study suggest that the metal silo should be widely promoted as it requires the least time and effort for grain extraction regardless of age and gender participants.

Keywords:

Efficiency, grain extraction, storage structure



P2-9. Curbing Postharvest Losses in Okra Production in Nigeria: Thin Layer Drying Studies

Owolarafe, O.K., Aregbesola, O.A., *Ogunsina, B.S. and Odumosu, A.K.

Department of Agricultural and Environmental Engineering,
Obafemi Awolowo University, Ile-Ife, Nigeria.

Presenting Author/Correspondence: bsogunsina@yahoo.com; babsina@oauife.edu.ng;
+2348160601621

Abstract

Okro/Okra is a major vegetable in the Nigeria plagued by rapid perishability after harvest. The crop has limited year round availability due to inappropriate technologies for its postharvest handling. The large amount of pods which get wasted during peak harvest periods constitute serious economic losses to rural farmers. Slicing and drying are widely used traditionally as processing methods for ensuring okra supplies between production seasons in Nigeria. In this study, the effect of drying temperatures and slice thickness on the quality and nutritional characteristics of okro were studied. Drying curves were obtained for both temperature and thickness. Four different mathematical drying models were compared based on the coefficient of determination and standard error of estimate between the experimental and predicted moisture ratios. The results show that optimal drying was achieved at 80°C and 5 mm thickness. The logarithmic model was used to described the drying characteristics of okro where effective moisture diffusivity (D_{eff}) increased as temperature increased. The activation energy for 5 and 10 mm thickness were 45.7kJ/mol and 34.2 kJ/mol, respectively. Drying temperature and slice thickness indicate significantly effect on the quality and nutritional characteristics of okro; however, the best result was obtained at 50°C and 5 mm thickness. This work provides valuable data for standardizing a proven indigenous practice with the view to curbing the enormous losses associated with okra production in Nigeria.

Keywords:

Okro, Okra Post harvest losses, Slicing, Drying



P2-10. Evaporative cooling technologies: simple but effective short-term cold storage alternatives for smallholder horticultural farmers

Jane Ambuko^{1*}, G. N. Chemining'wa¹, Eliakim Mwachoni¹, Florence Wanjiru¹, W.O. Owino² and N. Nenguwo³

¹Department of Plant Science & Crop Protection, University of Nairobi, P.O Box 29053, Nairobi

²Department of Food Science & Technology, Jomo Kenyatta University of Agric. & Technology

³World Vegetable Center (AVRDC), P.O Box 10 Duluti, Arusha, Tanzania
Corresponding author : ambuko@yahoo.com

Abstract

Poor cold chain management is one of the factors that contributes to high postharvest losses ($\geq 50\%$) in fruits and vegetable value chains. Adoption of conventional mechanical refrigeration among smallholder farmers is limited due to the high cost and lack of/unreliable connection to the national grid in most rural areas. There is therefore need to explore alternatives to the conventional cooling options. This paper will present findings of on-station studies on two evaporative cooling technologies namely evaporative charcoal cooler (ECC) and a modified zero energy brick cooler (ZEBC) which is an adaptation of the original zero energy cool chamber (ZECC) developed in India. The efficacy of the two technologies (ECC and ZEBC) was evaluated at the University of Nairobi's Upper Kabete Campus Field station on selected vegetables. Freshly harvested vegetables were stored under three storage conditions including ECC, ZEC and ambient room. The room/chambers were fitted with data loggers to monitor temperature and relative humidity (RH) real time. Random sampling of vegetables was done to establish the rate of deterioration and loss of quality. The results revealed that temperature differences ranging between 20C and 100C in comparison to ambient room conditions could be attained with the ECC and ZEBC depending on the time of day and season. In addition, significantly higher RH (80-99%) was achieved with evaporative cooling. Under ECC and ZEBC storage, the vegetables' shelf life was extended by up to 5 days compared to those stored at ambient room conditions. There was a slower rate of deterioration and loss of quality in the vegetables as reflected in physiological weight loss, wilting, yellowing and loss of vitamin C. The results show that evaporative cooling technologies can be used for temporary storage of the highly perishable vegetables to prevent the rapid loss of quality otherwise observed in vegetables stored under ambient room conditions. The evaporative cooling technologies can be promoted for adoption by smallholder farmers in rural areas where connection to the national grid is still limited.

Key Words:

Postharvest losses, Cold storage, Cold Chain, Evaporative Cooling, ZEBC, ZECC



P2-11. Improving Postharvest Quality of Greenhouse Tomatoes using Plant Biomass Soil Amendments

Otieno P.C^{1*} and E.O Gogo¹,

¹Egerton University, Department of Crops, Horticulture and Soils,
P.O. Box 536-20115, Egerton, Kenya.

*Corresponding author: petercaleb68@gmail.com

Abstract

Many studies with soil organic amendments have focused on potential to manage soil pests and diseases and improving soil fertility. On the other hand, pre-harvest cultures like application of fresh derived plant material may improve postharvest quality of crops because of their soil fertility, hence plant nutrition importance. However, little has been documented on the ability of fresh organic amendments to boost post-harvest quality of greenhouse produced tomato. The present study was a potted greenhouse experiment conducted at Egerton University, Njoro, to study the impact of fresh soil amendments from *Lippia kituensis* Vatke (LK) and *Ocimum gratissimum* L. (OG) on postharvest quality of tomato. The tomato were grown in the greenhouse in a randomized complete block design with four levels of treatment applied (0% (Control), 2% (200g), 4% (400g) and 8% (800g) of plant biomass (LK and OG), replicated three times. Each amendment rates were in a 10 kg potted soil mixes. After harvesting, tomato fruits were stored under ambient conditions for 10 days and data on titratable acidity (TA), total soluble solids (TSS), sugar acid ratio, fruits firmness, lycopene content and weight loss on two days interval. Results indicated that pre-harvest application of soil organic amendments significantly enhanced postharvest quality of greenhouse produced tomato compared with control. TA, TSS, sugar acid ratio, firmness and lycopene content was improved by 10-40%, 22-35%, 15-25%, 10-18% and 23-60% during storage, respectively, depending on organic amendment used, compared with the control. However, organic amendment did not have significant influence on weight loss. The findings of this study may contribute to enhancement of postharvest quality of greenhouse produced tomato.

Keywords:

Organic amendments, *Lippia kituensis*, *Ocimum gratissimum*, tomato postharvest quality



P2-12. Postharvest Losses in Fruits: Dissecting Possible Role and Implications of Pre-Harvest NPK Nutritional Status of Fruits

Rosepiah Munene*, Joseph P Gweyi-Onyango
Department of Agricultural science and Technology,
Kenyatta University- P O Box 43844-00100 Nairobi
*corresponding author: rozymunene@gmail.com

Abstract

Though largely unnoticed, postharvest losses (PHL) and food waste are major causes of food and nutrition security problems, especially in developing countries. Knowledge on the magnitude of PHL is to mainly limited to the various operations at harvest and after harvest stages. The overall quality and condition of farm produce is rarely maintained during harvest and storage processes. Mineral nutrition is an important pre-harvest aspect that not only affects the post harvest quality but also the behaviour and losses of crop produce at and after harvest. Fruits and vegetables are excellent hosts of a large number of vitamins and mineral elements that are important in the alleviation of hidden hunger. However; their quality and quantity is greatly influenced by mineral plant nutrition such as nitrogen (N), Phosphorous (P) and potassium (K) which affect the quality of horticultural crops in many ways, particularly in physiological disorders. The main aim of this paper was to present a review on the influence of NPK mineral status on postharvest quality in various fruits and vegetables. A review of different journal papers and books was done to identify the effect of mineral plant nutrition in relation to postharvest quality development and maintenance. Excess N may result in reduced firmness and enhanced susceptibility to mechanical damage and postharvest decay hence reduced shelf life in tomatoes. Different N forms influence calcium (Ca) uptake availability, a deficiency which may induce a range of postharvest disorders in many fruits and vegetables such as blossom end rot (BER), soft nose, tip burn and reduced firmness. It also affects rate of respiration, ethylene production and fruits shelf-life. Insufficient levels of K may increase the possibility of yellow shoulder and internal whitening while in harvested tomato. Deficiencies in N and/or P supply have been found to increase acidity and ascorbic acid in citrus fruits. Mineral nutrition especially N form affect the postharvest nutritional value of harvested farm produce. Quality status of fruits and vegetables at and after harvest to some extent depend some pre-harvest plant mineral management and practices carried out during production. Therefore there is need to understand how pre-harvest NPK mineral fertilization and management enhance post harvest fruit quality and shelf life.

Key words:

fruits, nitrogen, phosphorous, potassium, postharvest



P2-13. Application of off-season flower induction chemicals to address seasonality in mango fruiting and the associated postharvest losses

Stephen Maloba¹, Jane Ambuko¹, Margaret Hutchinson¹, Willis O. Owino²

¹Department of Plant Science and Crop Protection, University of Nairobi,
P. O. Box 29053-00625, Kangemi, Nairobi, Kenya

²Department of Food Science and Technology, Jomo Kenyatta University of Agriculture & Technology, P.O Box 62000 –00200, NAIROBI

Corresponding Author: ambuko@yahoo.com

Abstract

Seasonality in Mango (*Mangifera indica*) fruiting resulting in peak and off seasons is one of the factors that contribute to the high postharvest losses (40 – 50%) reported in the mango value chain. Off-season flower induction is a strategy that can be used to address mango seasonality. Manipulation of mango trees to produce an off-season crop can be achieved through application of flower induction chemicals. This paper will demonstrate the application of two flower induction chemicals, potassium nitrate (KNO₃) and ethephon to induce off-season flowering in two mango varieties: 'Apple' and 'Ngowe'. The study was conducted in two agro-ecological zones (AEZs) of Kenya namely, Embu County (a high potential AEZ) and Makueni County (a low potential AEZ). Potassium nitrate was applied at two concentrations (2 and 4%), while ethephon was applied at three concentrations (300, 600 and 1000ppm) and compared to a control (water). Prior to spraying, 100 terminal shoots were marked randomly on each tree for percentage flowering determination. After inflorescence development, 20 panicles per tree were marked randomly on each tree to monitor fruit set. The experiment was laid out in a randomized complete block design with three replicates and three trees per treatment. Effect of the treatments was established from reproductive growth parameters including days to flowering and fruit set, number of panicles per tree and average fruit set per 20 panicles. Potassium (4%) increased percentage flowering (% of tagged shoots) in both 'Ngowe' and 'Apple' in both AEZs. In Embu, 4% KNO₃ resulted in 46% flowering in 'Ngowe' compared to 4% in 'Apple'. On the contrary, in Makueni, the response was greater in 'Apple' (60%) compared to 'Ngowe' (27%). Response to ethephon increased with concentration with the 1000 ppm giving the best response; 22 and 28% flowering (% of tagged shoots) for Embu and Makueni, respectively, in 'Ngowe'. In both AEZs and varieties, flowering was $\leq 3\%$ in untreated controls. Time to flowering was significantly shortened by both KNO₃ and ethephon treatments with 'Ngowe' being more responsive than 'Apple'. Significant treatment effect ($p \leq 0.05$) was observed on fruit set with 4% KNO₃ and 1000 ppm ethephon resulting in the highest fruit set in both AEZs and varieties. The findings reveal the potential of KNO₃ and ethephon to induce off-season flowering in 'Apple' and 'Ngowe'. Application of the chemicals can be explored as one strategy to address seasonality in mango and the associated postharvest losses.

Key words:

Flowering, flower induction, mango, seasonality



Work Stream 3

**Postharvest handling technologies
and storage solutions for grains**



O3-1. Field Testing of a Multipurpose Solar Dryer for Smallholders Farm

Klein E. Ileleji¹, Ravindra Shrestha¹, Ibrahima Sarr², Papa Diop², Patrick Ketiemi³ and Hugo De Groote⁴

¹Agricultural & Biological Engineering Dept., Purdue University, West Lafayette, Indiana USA; ²Institut Senegalais de Recherches Agricoles (ISRA/CNRA), Bambey, Senegal;

³Kenya Agricultural and Livestock Research Organization, Njoro, Kenya; ⁴International Maize and Wheat Research Center (CIMMYT), Nairobi, Kenya

Abstract

Drying crops is one of the most feasible low-cost means of reducing post-harvest losses and aflatoxin contamination. Open sun-drying on the bare ground, concrete, tarred road or on a tarp is still the most common means of drying crops for small-holder and medium farmers. However, this method is not efficient and results in poor product quality & phytosanitary condition, and handling losses. A multipurpose solar dryer was developed as part of a project through Purdue's USAID funded Post-harvest Handling and Food Processing Innovation Lab. The multipurpose crop dryer is applicable to drying cereal grains, oilseeds, tubers, vegetables and cash crops like cocoa and coffee. It was tested for drying shelled maize (corn) on the field in the fall of 2016 in West Lafayette, Indiana, USA, in Velingara, Senegal and in Kakamega, Kenya. The field tests involved configuring the solar dryer fans to be turned on or off for certain periods of time during drying. For comparison, shelled corn was also dried on drying trays and a tarp side-by-side under the same environment conditions. We will present the findings of these field tests in three different locations (West Lafayette-USA, Kakamega-Kenya and Velingara-Senegal) around the globe.

Keywords:

solar dryer, post-harvest technology, smallholder, shelled maize



O3-2. On-Farm Comparison of Maize Postharvest Storage Technologies in Central Tanzania

Adebayo Abass¹, Shamim Daudi², Audifas Gasper¹, Janine Rüst², Daniel Madulu¹, Esther Kabula¹, Martin Fischler², Kurt Schneider³

¹International Institute of Tropical Agriculture (IITA), Regional Hub for Eastern Africa, 25 Light Industrial Area, Mikocheni B, Dar es Salaam, Tanzania.

²HELVETAS Swiss Intercooperation, Grain Postharvest Loss Prevention Project (GPLP), P. O. Box 2978, Nyerere Road, NBC Building, Dodoma, Tanzania.

³Independant consultant, Guatemala City, Guatemala.

Corresponding author: martin.fischler@helvetas.org

Abstract

The effectiveness of different storage technologies for maize under conditions of smallholder farmers were tested in Dodoma and Manyara regions of central Tanzania. Seven storage methods including the use of different hermetic storage containers (metal silos and plastic barrels with and without fumigation with phostoxin, PICS bags) and non-hermetic polypropylene (PP) bags combined with insecticide treatment (ZeroFly® bags with yarn treated with Deltamethrin, and maize grain treated with Actellic Super) were tested and compared with traditional storage of untreated maize in PP bags. The study was conducted in 2 villages per region involving 5 farmers per village (total 20 farmers). The dominant insect pests identified in the stored grains were the Maize weevil (*Sitophilus zeamais*) and the Red flour beetle (*Tribolium castaneum*). The hermetic storage and use of insecticides were effective in controlling insect population during storage. However, the insecticide-treatment of polypropylene yarn (ZeroFly®) did not reduce insect population. Grain damage and weight loss of maize stored in ZeroFly® bags and untreated maize stored in PP bags were significantly higher ($p < 0.05$) at 30 week storage than grains in other storage treatments. Insect damage accounted for the largest portion (52-86%) of grain damage observed in all the storage treatments and grain damage was more strongly correlated with *S. zeamais* population ($r = 0.63$; $p < 0.0001$) than *T. castaneum* population ($r = 0.53$; $p < 0.0001$). It was concluded that all the hermetic storage techniques tested were effective in preventing maize damage by insects for a storage period of 30 weeks (about 7 months) and can be recommended. Since there was no significant difference between hermetic treatments (with or without phostoxin fumigation) hermetic storage alone can be recommended to farmers provided high quality in design of technologies is ensured, that is metal silo and plastic barrel are hermetic, and sound handling and management of the technologies by farmers including proper placement and hermetic sealing of lids and ensuring no perforation of PICS bags.

Keywords:

grain postharvest losses, maize, hermetic storage, on-farm validation, comparative analysis.



O3-3. Effect of Seed Conditioning Methods in the Control of Cowpea Weevil (*Callosobruchus maculatus*) in the Northern Region of Ghana

Dari, L. and Tindan, I. P.

Department of Food Science and Technology. Faculty of Agriculture, University for Development Studies, Tamale-Ghana.

Contact: linddari@yahoo.co.uk, +233244959690

Abstract

Cowpea (*Vigna unguiculata*) and its subspecies from the genus *Vigna* and family Fabaceae is one of the most important food legume crops in the semi-arid tropics covering Asia, Africa, Southern Europe, and Central and South America. Cowpea is known for its nutritional composition especially protein content and it is often recommended as foodstuff to help balance the nutritional status of consumers. Weevil infestation however, has been one of the challenges associated with the storage of cowpea in an attempt to ensure prolonged shelf-life and crop quality. The study was conducted between December and May on "beng pella", a cultivar of cowpea commonly grown in Nyankpala in the Tolon District of Northern Region, Ghana. The objective of the study was to assess the effectiveness of three seed conditioning methods in the control of cowpea weevils. Two indigenous treatment methods (wood ash from mahogany (*Khaya senegalensis*) and powdered orange peels) commonly used in Northern Ghana for the storage of cowpeas and the triple bagging method were adopted. Samples were analyzed based on physical characterization using number of holes count, germination test, live and dead weevils count. From the results, all treatments provided varying levels of effectively controlling *Callosobruchus maculatus* with the triple bagging and wood ash being the best. The controls were in a state that is not acceptable economically and agronomically.

Keywords:

Cowpea, *Callosobruchus maculatus*, triple bagging, orange peels, wood ash



O3-4. Evaluation of Maize Drying Systems to Aid Smallholder Farmers Mitigate Post-Harvest Losses in Sub-Saharan Africa

Dirk Maier^{1,*}, Sam Cook¹, Grant DeVries¹, Laura Greig¹, Trevor Stevenson¹, Ben Plumier^{1,2}, Chukiat Chotikasatian^{1,3}, Kizito Nishimwe^{1,4}, Francis Aboagye-Nuamah^{1,5}

¹ Iowa State University, Iowa, USA

² Kansas State University, Kansas, USA

³ Kasetsart University, Thailand

⁴ University of Rwanda, Kigali, Rwanda

⁵ Kwame Nkrumah University of Science and Technology, Ghana

*Corresponding author: e-mail: dmaier@iastate.edu

Abstract

Reducing post-harvest loss is critically important to improve food security for smallholder farmers and populations in Sub-Saharan Africa. Approximately a third of the world's food production is lost at post-harvest stage. Reduction of moisture content to safe storage levels after harvest is critical for staple crops (cereal grains, pulses, oil seeds) to prevent spoilage from molds, mycotoxins and insects. Numerous drying systems have been developed and introduced for use by smallholder farmers who typically harvest grains by hand from two hectares of land or less. In many cases, drying systems have not been properly evaluated before deployment, and thus technology transfer and adoption have failed. Recently, two drying systems have been developed and evaluated that consider critical engineering parameters related to design and operation in the local context, the Vietnamese-designed STR small batch circular column dryer and the AflaStop shallow bed dryer developed in Kenya. Characteristic of both systems is that they can be built using local materials, operated with locally available energy sources, and achieve reasonable drying rates (i.e., hours instead of days). With a focus on Ghana, this project evaluated the sourcing of local materials, construction of the two drying systems, combination of the AflaStop biomass-fueled heat exchanger and STR circular column drying bed, and efficiency and overall success of achieving target maize drying rates at design airflow rates. Using the combination of the AflaStop biomass burner/heat exchanger and STR circular column drying bed, drying rates ranged from 1.5-2.2 points of moisture removed per hour for approximately 280 kg of shelled maize. The maize had a final moisture content of approximately 13% with no substantial loss in test weight or damaged grain after drying.

Key words:

Biomass burner, drying systems, drying rates, post harvest loss



O3-5. Ghana Maize Marketers' Utilization of Advanced Drying Methods in Post-harvest Loss Reduction.

Nkoyo Etim Bassey*, Arnim Kuhn, Thomas Heckelei
Institute for Food and Resource Economics, University of Bonn,
Nussallee 21, 53115 Bonn, Germany
Corresponding author's e-mail address: nkoyo.bassey@ilr.uni-bonn.de (N. E. Bassey)

Abstract

Proper drying of maize grains is crucial to prevent the growth of fungal species and deterioration in storage. However, it is important that while fulfilling its preventive role, methods used should also avert further contamination during drying and ensure food safety. This study assesses Ghana maize marketers' utilization of drying methods to reduce losses of maize grains and also enhance food safety. First the study identifies available drying methods and technologies in the area from interviews with technology providers and disseminators, and focal group discussions (FGDs) with economic agents. The awareness and utilization of methods identified was assessed in an interview with 288 maize marketers in Techiman and Nkoranza districts in Ghana. Contingent on the drying method currently used, their willingness to pay (WTP) for drying technologies was also assessed. Methods were classified and analysed based on the likelihood of averting contamination; the different classes of methods are advanced, intermediate and conventional. Results show that conventional methods, which allow for contamination, are the most utilized methods and utilization costs incurred are mostly non-recurring. Very few marketers (less than 4%) have been trained on drying methods for PHL reduction; trainings were on conventional methods for those trained. Contrariwise, although advanced drying methods which avert contamination are available in the study area, marketers' awareness and utilization of these methods are extremely low and negligible. On average, a sub-sample of 214 marketers is WTP GH¢5 per bag of maize ($\approx 100\text{kg}$) to utilize advanced drying methods. This is an important reflection of marketers' value of advanced methods and a basis for making decisions about post-harvest interventions. Some possible strategies for future technology utilization and WTP include: educating marketers on proper grain handling, improving technology diffusion process, and ensuring that interventions are feasible.

Keywords:

Advanced drying methods, Awareness, Enhanced food safety, Ghana, Utilization



O3-6. Insect Infestation in Stored Grain: The Resident Versus the Visitor, Who Inflicts Greater Food Loss?

Honest Machekano¹ and Brighton M. Mvumi^{2*}

¹Biological Sciences Department, Faculty of Science, University of Zimbabwe,
P.O. Box MP 167, Mt. Pleasant, Harare, Zimbabwe.

²Department of Soil Science and Agricultural Engineering,
Faculty of Agriculture, University of Zimbabwe, P.O. Box MP 167, Mt. Pleasant, Harare,
Zimbabwe.

*Corresponding author: Email: mvumibm@agric.uz.ac.zw Tel: +263-4 303211 ext 15530

Abstract

Many studies in stored-product entomology focus on controlling pests already inside storage facilities, without the ecological knowledge on the dynamics leading to product re-infestation. An important component of postharvest integrated pest management (IPM) is the distinction between source and sink grain patches to develop infestation prevention techniques. The current study examined the role of resident versus incoming insect infestation in closed and open stored-shelled-maize grain compartments and determined spatial distribution of the insects by grain depth. Phosphine-fumigated grain in closed and open compartments was used, and the same was repeated using unfumigated grain. Whether open or closed, fumigated grain had significantly lower ($P=0.001$) grain damage and weight loss than the unfumigated grain. Fumigated open compartments had significantly higher ($P=0.004$) grain damage and weight loss than closed ones, showing the effectiveness of exclusion of incoming infestation. Unfumigated grain showed no significant differences in grain damage and weight loss between closed or open compartments which shows that resident infestation inflicts higher food loss than incoming infestation. In vertical spatial insect distribution within bulk grain, *Prostephanus truncatus* had significantly higher populations at bottom levels of unfumigated grain. In fumigated grain, *Tribolium castaneum* at the bottom, was significantly higher ($P=0.001$) in open than closed compartments, while the opposite was true for the unfumigated grain. *Sitotroga cerealella* and *Sitophilus zeamais* populations were significantly higher ($P=0.011$ and $P=0.001$ respectively) at the top of both open and closed unfumigated compartments, with the closed having higher populations than open. *Cryptolestes ferrugineus* population was significantly higher ($P=0.018$) at the bottom of unfumigated than fumigated compartments. We showed that grain suffers less loss when it acts as a sink patch to incoming insects than when it acts as a source patch. Population build-up and 'settling' to inflict significant grain damage takes time for 'visitors' than for 'residents'. These results have ecological impact in postharvest IPM and farmer training.

Key words:

Grain damage, grain weight loss, infestation, sink patches, source patches, storage insect ecology



O3-7. Stored Grain Protection and Management Capacity Building In Nigeria – Review of 7 Years Of Experience

Klein E. Ileleji¹, George Opit², Samuel G. McNeill³, Mobolaji Omobowale⁴, Adeola Ala⁵, Grace O. Otitodun⁶, Samuel I. Nwaubani⁶, Harold V. Tarver⁷ and Elise Solorio⁷

¹ Agricultural & Biological Engineering Dept., Purdue University, West Lafayette, Indiana USA;

² Entomology & Plant Pathology, Oklahoma State University, Stillwater, Oklahoma, USA;

³ Biosystems & Agricultural Engineering, University of Kentucky, Princeton, Kentucky, USA;

⁴ Agricultural & Environmental Engineering, University of Ibadan, Ibadan, Nigeria;

⁵ Zoology Department, University of Ibadan, Ibadan, Nigeria;

⁶ Nigerian Stored Products Research Institute, Ilorin, Nigeria;

⁷ Office of Capacity Building and Development, Foreign Agricultural Service, USDA, DC, USA

Abstract

The state of know-how and personnel capacity to manage grain stocks through the grain value-chain is one of the understated aspects of capacity building in Africa. Most of the time, emphasis is placed on the provision of technologies that aid in improving quality and reducing losses during grain handling and storage, with little emphasis on training of personnel. This presentation discusses seven (7) years of training in stored grain protection and management provided to the industry in Nigeria as part of a USAID funded project through a cooperative agreement with USDA-Foreign Agricultural Service and three Land-grant universities (Purdue University, University of Kentucky and Oklahoma State University) in the USA. About 500 personnel that include agricultural extension agents, operation managers of grain storage complexes/warehouses, millers, university faculty, research institution scientists, farmers, equipment fabricators and university students have been trained in Nigeria on grain post-harvest handling, stored grain protection and management using two curricula. The curricula were designed to target storage and handling on-farm in local storage barns and small warehouses, and storage in bulk in large silos and in bags in large warehouses. We present some of the impact on loss reduction, quality improvement and personnel safety that we have documented through the years, and methods developed that have generated retained knowledge acquisition. Most importantly, we discuss our strategy to sustain this program by developing partnerships among Nigerian institutions who would eventually be responsible to carry on the work of empowering the industry with the knowledge it needs to reduce losses and ensure food security. As we move into the delicate phase of expanding local partnership and handing over leadership to local institutions, we also explore how this model can be replicated elsewhere in the continent.

Keywords:

capacity building, stored grain protection and management, post-harvest technology, training



03-8. Efficacy of Silica Gel and Hot Bulbs in Convective Maize Drying with Encased Air

Isaiah E. Muchilwa^{1*} and Oliver Hensel²

¹ School of Engineering, Moi University, 3900-30100, Eldoret, Kenya;

² Department of Agricultural Engineering, University of Kassel, Nordbahnhofstr. 1a, 37213, Witzenhausen Germany

*Corresponding author, email: imuchilwa@yahoo.co.uk

Abstract

Open-air sun drying is common in Sub-Saharan Africa, a practice that exposes food to foreign matter, soil and airborne contaminants which enhance the risk of biodeterioration during storage. Rapid dehydration of foods in enclosed (semi-hermetic) spaces limits this unnecessary exposure, but requires strategies to prevent humidity accumulation within the voids and hence the need for dehumidifiers. This study sought to compare the dehumidification / desiccation potentials of silica gel and hot-bulbs (or surface heaters) as applied to convective cobed maize drying in enclosed spaces. Sensor psychrometric approaches were employed to estimate the rate at which water from convective dehydration is withdrawn from the air when silica gel or a combination of space heating and vents are applied. A total of 25 samples, including unhusked, husked and shelled maize, with moisture contents of 25 – 49% wb, were dehydrated independently using 3 – 9 litres of encased air at 30 – 53°C, the range of transition from low to high temperature drying. Drying times of 3 – 212 hours were observed with space heating in the range 3 – 26 Watts. Drying took the longest at 30°C, but with no significant biodeterioration observed. The convective air relative humidity at this low temperature setting exceeded 70% for no longer than 48 hours, on account of falling rate of drying kinetics which created sub-optimal surface-dry conditions in time, impeding the growth of moulds. Relative humidity was limited to just 11 - 20% during the first five hours of desiccation with silica gel at peak drying rates of 0.0164 – 0.0455g per min. Granular desiccants could prove useful for in-store dehydration of maize as their hygroscopicity can be restored quickly and efficiently, even in crude ovens, without the risks associated with high-temperature or open-air food drying. In the absence of silica gel, vented space heating was shown to dehumidify encased air just as well and could provide a cost-effective approach to energising maize drying on small farms in the tropics.

Key words:

Cobed maize; water activity; encased air; headspace; desiccant assisted drying



O3-9. Reducing Grain Postharvest Losses in Tanzania: Lessons from Business Model of the Grain Postharvest Loss Prevention Project

Rakesh Munankami, Project Advisor, Grain Postharvest Loss Prevention (GPLP) Project, HELVETAS Swiss Intercooperation, P O Box 2978, Dodoma, TANZANIA
rakesh.munankami@helvetas.org

Abstract

Smallholder farmers living in rural areas constitute the majority (85%) of Tanzanian population. Postharvest losses are in a range of 15–40% for different crops, but are of particular concern for grains (30%) which form the base for food and income for majority of rural population. The Grain Postharvest Loss Prevention (GPLP) project aims to reduce postharvest losses in food grains and thereby improve the food security and income in the central corridor of Tanzania. The project uses Market Systems Development (MSD) approach playing a catalyst role to develop and sustain supply chains for improved postharvest loss reduction technologies (PHT) by facilitating linkages between suppliers (market actors - agro dealers, local agents and artisans) and users (smallholder farmers) of PHT. The project has supported establishment of National and District level multi-stakeholder platforms to share experiences and address policy issues. Ninety-two percentage of trained (15,000) farmers have adopted improved postharvest loss reduction and management practices and more than 500 metal silos and 7,000 PICS bags have been adopted, safely storing more than 950 MT of grains. The project has learned that a motivated and capable partner with shared vision of the market system is a key to the success and sustainability of market development interventions. Although the business model highlights the central role of agro-dealers, all the market actors including local agents, agro-dealers and artisans are in direct contact with the farmers. The project initiatives are successful where there is good coordination among key actors at community level. Sustainability of PHT business for market players is highly dependent on the level of demand being continually created. Adoption of new technology (e.g. metal silo) is however slow and only market actors with a longer-term vision are interested to engage in such business.

Keywords:

agro-dealers, artisans, business model, market system development, postharvest



O3-10. Effect of Sealing Methods on Metal Silos for Control of *Prostephanus truncatus* in Stored Maize Grain

Kimani Anne ^{a*}, Tadele Teferab, Olubayo Florencea, Kilalo Doraa

^aDepartment of Plant Science and Crop Protection, Faculty of Agriculture, University of Nairobi, P.O. Box 30197 00100, Nairobi, Kenya.

^bInternational Maize and Wheat Improvement Center (CIMMYT), ICRAF House, UN Avenue, Gigiri, P.O. Box 1041- 00621, Nairobi, Kenya.

*Corresponding author: wangoanne@gmail.com; Tel: +254 720452066

Abstract

Larger grain borer, *Prostephanus truncatus* (Horn) is the most destructive storage pest causing over 30% dry weight loss of stored maize grain. Pesticides are available for management of *P. truncatus*, but have negative effects on human beings and the environment. Metal silos are promoted globally as cheap, effective and environmentally friendly strategy in the management of storage pests. An on-station experiment was conducted to determine the effect of sealing metal silos with different materials available locally for control of *P. truncatus* in stored maize. Metal silos with 100 kilogram holding capacity were loaded with 90 kilogram of grain, lighted candle placed on top of the grain and metal silo outlet and in-let lids sealed using either: rubber band, grease, rubber band combined with grease, and lid without sealing (control). Thirty five days after storage, metal silo sealed using rubber band combined with grease had significantly ($P < 0.05$) least weight loss (0.6%) and grain damage (4.5%) compared to the control with highest weight loss (1.9%) and grain damage (6.6%). Metal silo sealed using rubber band combined with grease had significantly ($p < 0.05$) higher CO₂ (2.1% v/v) than control (0.5% v/v) which had the least. Insect mortality was significantly higher (100%) in metal silo sealed using rubber band, grease and rubber band combined with grease compared to control which had the least (80%). Therefore, metal silos effectively controlled *P. truncatus* in stored maize grain for up to 35 days with 100% insect mortality when properly sealed using rubber band, grease and rubber band combined with grease.

Key words:

Carbon dioxide, Maize, Metal silo, Oxygen, *Prostephanus truncatus*.



O3-11. Postharvest Losses and Management Strategies in Cereal Sector of Pakistan

Irfan Afzal¹, AmanUllah Malik^{2*}, Iqrar Ahmad Khan², Shahzad M. Ahmed Basra¹, Raheel Anwar², Abdul Ghafoor³, Tahir Zahoor⁴, Muhammad Ashfaq⁵

All authors are in University of Agriculture, Faisalabad, Pakistan:

¹Department of Crop Physiology/Agronomy;

²Institute of Horticultural Sciences;

³Institute of Business Management Sciences;

⁴National Institute of Food Science and Technology;

⁵Institute of Agricultural and Resource Economics.

*Corresponding author's email: malikaman1@gmail.com

Abstract

Cereal crops hold major share in agronomic crops of Pakistan, with an annual production of 37 million tonnes worth US\$ 11.3 billion, over an area of 14 million hectares. Wheat is the leading cereal crop (67%) followed by rice (19%), maize (13%) and other cereals. Despite developments in cereals production technology, the postharvest losses remain high estimated in the range of 10-15% which translates into 5.6 million tonnes in volume, worth US\$ 1.7 billion, along with wastage of 2.1 million hectares of land and inputs. The major issues are technical inefficiency, improper harvesting and drying methods, inadequate technology, poor storage infrastructure, inappropriate transport system, poor enforcement of grading standards, and inefficient market structure. There is need to improve postharvest management of cereals which includes harvesting at proper maturity stage, use of modern machinery and practices, proper screening/cleaning, drying, packaging and toxic-free fumigation of grains prior to storage or marketing, proper storage conditions and pest control, employment of skilled personnel in seed processing sector, and compliance with fair average quality limits during procurement. There is need to fix targets for reducing overall postharvest losses in cereals to 8-10% over the next five years. A viable approach is the drying of cereals through natural or artificial means after harvest followed by hermetic packaging to keep the product dry until use. In order to improve existing storage infrastructure, silo bags for temporary storage and concrete and steel silos for permanent bulk storage are recommended. This presentation will provide the current status as well as lessons from previous interventions and ongoing efforts to reduce postharvest losses of cereals in the country.

Key words:

Cereal, Pakistan, postharvest loss, management strategies



03-12. Controlling Weevils in Maize by Means of Physical Disturbance

C. J. Bern,^a D. Bbosa, T. J. Brumm, K. A. Rosentrater, D. R. Raman
Department of Agricultural and Biosystems Engineering, Iowa State University, Ames, Iowa 50011, USA
Corresponding author: cjbern@iastate.edu

Abstract

Maize weevils (*Sitophilus zeamais*) can cause large losses in maize stored by smallholder farmers. Physical disturbance (tumbling) has been shown to be effective in controlling bean weevils in common beans, no reports were found describing this approach for control of maize weevils. The objective of this research was to determine effectiveness of storage container physical disturbance in maize weevil control. An analysis of variance between laboratory experiment with two treatments: control (undisturbed) containers and disturbed containers, with three replications of each, and four storage times (40, 80, 120 and 160 days) was conducted. Recycled cylindrical 2.6-L capacity unsealed plastic coffee containers were each loaded with 1 kg of maize and 25 live adult weevils/kg were introduced. Every 12 h, disturbed treatment containers were manually rolled through one circumference of their 15.6-cm diameter. At 40 d, live weevil numbers were significantly lower (ca. 46% lower) in the disturbed containers, and after 160 d, live weevil numbers had been reduced by 93% compared to control containers. Maize moisture did not vary significantly between treatments. Disturbed containers had significantly lower mechanical damage, and broken corn and foreign material (fines produced by weevils) along with significantly higher test weights. This work suggests that physical disturbance, which probably disturbs females as they lay eggs, may be effective for control of maize weevils in maize stored on smallholder farms.

Keywords:

Maize, physical disturbance, post-harvest losses, maize weevil, test weight



O3-13. Applying the Most Appropriate PH Solution by Making the Correct Distinction Between Symptoms and The Actual Causes of Losses.

Cephas Taruvinga
Technical Office Food Losses
FAO Rome Italy
Cephas.taruvinga@fao.org

Abstracts

The main purpose of this article is to highlight the importance of distinguishing between causes of post-harvest losses and their symptoms. The article will go further and categorize causes of food losses as either micro, meso, and macro or as direct and indirect causes. Clearly making a distinction between symptoms and causes and categorizing the causes provides a framework for identifying causes of food losses and applying sustainable solutions. Results of food loss assessments recently carried out across the continent have demonstrated that a failure to distinguish a symptom from the cause results in a wrong solution being applied or the applied solution is not sustainable. According to the analysis of the loss assessment reports from various countries, a failure to distinguish between symptoms and causes, a wrong diagnosis of the cause can be made resulting in a wrong solution, which does not directly address the problem being applied. The article will describe symptoms and causes of food losses and provide examples of symptoms and causes for different scenarios. The article will also highlight the fact that although symptoms are similar for various critical loss points, this does not imply that the causes are also similar. Because of this apparent similarity in symptoms, it is crucial to isolate the actual causes so that a sustainable solution is applied. The article is based on a desk study of food recent loss assessment reports for various countries.

Key words:

food loss causes, food loss symptoms, loss assessment, post-harvest, micro, meso and macro causes, supply chain, sustainable solutions



O3-14. Effective Strategies for Stored Maize Post-Harvest Loss Prevention at Rural Primary Schools in Uganda

Thomas Brumm^{1,*}, Rachael Barnes², Mike Sserunjogi³, Samuel Kiprotich³, Dorothy Waynama-Masinde⁴, Moureen Mbeiza⁵, Dennis Lutwama⁵ and Dirk Maier¹

¹ Faculty, Agricultural and Biosystems Engineering, Iowa State University, 605 Bissel Road, Ames, Iowa, 50011 USA

² Student, Department of Agricultural and Biosystems Engineering, Iowa State University, Ames, Iowa, USA

³ Student, Makerere University, Uganda

⁴ Faculty, Global Resource Systems, Iowa State University, Ames, Iowa, USA

⁵ Staff, Iowa State University Uganda Program, Kamuli, Uganda

*Corresponding author: e-mail: tbrumm@iastate.edu

Abstract

Maize is an important component of school feeding programs at rural primary schools in the Kamuli District of Uganda. The primary source of maize is from families who pay a portion of their school fees with maize. Pupils bring up to 5 kg of maize at various times throughout a three-month term, with varying levels of moisture content and quality. The maize is weighed and stored in bags and containers until needed by the school feeding program. Monitoring of stored maize at four primary schools in the district revealed significant losses of maize quantity and quality in storage due to insect infestation, rodent depredation, mold spoilage and theft. Over 50% loss of maize quantity has been documented due to insects which in one school's storage silo represented the equivalent of an entire month's school porridge. Strategies for maintaining maize quality and reducing post-harvest storage losses is being implemented at these four schools with the help of staff from the Iowa State University Uganda Program (<https://www.globe.iastate.edu/global-experience/extension-projects-uganda/>). These strategies include: secure and clean storage facilities; test moisture and quality; dry and screen maize; store 10 kg or smaller lots in hermetic containers for disinfestation; monitor for moisture, molds, mycotoxins and insects; manage storage inventory as first-in, first-out; keep accurate records; and train school personnel and pupils to assume maize storage management responsibilities. Initial observations show an increase in maize quality and a reduction in losses due to insects. The costs for implementing these strategies are expected to be recouped by the increase in the amount of quality maize available for the school feeding programs.

Keywords not in the title:

insects, rodents, hermetic storage, moisture, mold, mycotoxins, inventory, school feeding



O3-15. Hermetic technology for control of insect pests in stored maize

Paddy Likhayo^{b,d} *, Anani Y. Bruce^a, Kimondo Mutambuki^b, Tadele Tefera^c, Jones Mueke^d

^aInternational Maize and Wheat Improvement Centre (CIMMYT), PO Box 1041 - 00621, Nairobi, Kenya.

^bKenya Agricultural and Livestock Research Organisation (KALRO), PO Box 14733 - 00800, Nairobi, Kenya.

^cInternational Centre of Insect Physiology and Ecology (ICIPE), ILRI Campus, PO Box 5689, Addis Ababa, Ethiopia.

^dKenyatta University (KU), Department of Zoological Sciences, PO Box 43844 - 00100, Nairobi, Kenya.

* Corresponding author. Tel.: +254722228311;

E-mail: paddy.likhayo@kalro.org; paddy.likhayo@gmail.com

Abstract

On-farm trial with a total of 32 farmers in eight villages of Naivasha and Nakuru regions of Kenya was carried out to evaluate hermetic grain storage technologies under farmers' management conditions. The hermetic technologies tested were metal silo and SuperGrain IV-R™ bag alongside the standard woven polypropylene bag with or without Actellic super dust. Moisture content, insect population, grain discolouration and weight loss were analysed 90, 180 and 270 days after storage. Grain moisture content remained stable over the storage period. Both metal silo and SuperGrain IV-R™ bag suppressed insect population, prevented grain loss and cross-infestation of insects from the surrounding environment. On the contrary, polypropylene bags allowed rapid insect population build up and re-infestation from the surrounding environment. Grain weight losses were 1.5% in the metal silo and 1.8% in the SuperGrain IV-R™ bags compared to 32% in the polypropylene bags without Actellic Super dust, 270 days after storage. The present study, therefore, demonstrated that storing grains either in metal silo or SuperGrain IV-R™ bags would benefit farmers in reducing grain losses and improving quality. The study was of great interest to the farmers and grain storage scientists.

Key words:

Maize, Metal silo, On-farm storage, *Prostephanus truncatus*, *Sitophilus zeamais*, SuperGrain IV-R™ bag



O3-16. Effectiveness of Integrated Pest Management for Preservation of Stored Maize in Nigerian Markets

Otitodun, G. O^{1*}, Ala, A. A.², Omobowale, M. O.³, Nwaubani, S. I.¹, Opit, G. P.⁴, McNeill, S. G.⁵Ileleji, K. E.⁶, Ogundare M. O.¹, Braimah, J. A.², Igbele G. I.¹, Ajao, S. K.², Busari, G. S.², Akhere O. E.³, Ogwumike J.³, Kolayemi O. R.³

* Corresponding author's email address: funkeotis@yahoo.com

¹Department of Entomology, Nigerian Stored Products Research Institute, Ilorin, Nigeria

²Department of Zoology, University of Ibadan, Ibadan, Nigeria

³Department of Agricultural and Environmental Engineering, University of Ibadan, Ibadan, Nigeria

⁴Department of Entomology and Plant Pathology, Oklahoma State University, Stillwater, Oklahoma, USA

⁵Biosystems and Agricultural Engineering Department, University of Kentucky, Lexington, Kentucky, USA

⁶Agricultural and Biological Engineering Department, Purdue University, West Lafayette, Indiana, USA

Abstract

Nigerian local farmers and grain merchants store harvested produce on-farm and in small storehouses (SHs) in markets where infestation by stored-product insects cause significant losses especially in quality and quantity thus resulting in lower economic returns. Infestation by insect pests in these SHs is usually controlled by the unilateral use of chemical insecticides, causing pesticide resistance in insects and harm to human health and the environment. In this study, the effectiveness of integrated pest management practice and D.I.C.E (IPMD) – which includes sanitation, drying, and regular inspection of grains for the control of stored-product insect pests was compared with traditional storage practice (TRN) where there was little sanitation and monitoring of insect pests. This study is on-going in three markets located in Ibadan, Oyo and Ilorin towns in Southwest Nigeria. There are two storehouses (SHs) in each market and TRN or IPMD was randomly assigned to each SH as a treatment. Each SH has twenty-five 100-kg polypropylene bags of maize which are sampled monthly to assess numbers of stored product insects. Percent insect damaged kernels and aflatoxin accumulation levels are used as indicators for grain quality. The experiment was started in February 2016 and data presented here is for the 10-month period through November 2016. Mean numbers of insect-damaged kernels in the TRN treatment increased progressively from 0.01 in February to 0.12 in November becoming significantly higher in October and November with 0.08 and 0.12 mean numbers when compared to the IPMD treatment which had 0.06 and 0.07 respectively. Similarly, numbers of live insects in TRN increased with storage period, 0.05 in March to 4.45 in November and was significantly higher than in the IPMD treatment, 1.13 in November. Aflatoxin levels were below 5ppb. Based on data from this study, IPMD was effective in preserving grain quality during storage.

Keywords:

Zea mays, Insect Damaged Kernels, Integrated Pest Management, Traditional Storage Practice



O3-17. Rodents' Postharvest Losses in On-farm Maize Storage in the Lowland Tropical Zone of Kenya

Kukom Edoh-Ognakossan^{1,2*}, Christopher M. Mutungi^{1,4}, Hippolyte D. Affognon³, Tobias O. Otieno^{5,6}, Daniel N. Sila², Willis O. Owino²

¹International Centre of Insect Physiology and Ecology, P.O. Box 30772-00100, Nairobi, Kenya

²Department of Food Science and Technology, Jomo Kenyatta University of Agriculture and Technology, P.O. Box 62000-00200, Nairobi, Kenya.

³International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), BP 320, Bamako, Mali.

⁴Department of Dairy and Food Science and Technology, Egerton University, P.O. Box 536-20115, Egerton, Kenya.

⁵Mammalogy Section, National Museums of Kenya, P.O. Box 40658-00100 Nairobi, Kenya

⁶Ewaso Lions Project, P.O. Box 14996-00800, Nairobi, Kenya.

*Corresponding author: eognakossan@icipe.org; kukom.edoh@gmail.com

Abstract

Rodents are the second most important storage problems after insects in on-farm maize storage in Kenya and the greatest storage problem in the lowland tropical agro-ecological zone. Rodent infestation impacts on the availability and safety of maize stored by small-holder farmers. However, there is limited information on the actual magnitudes of maize losses due to rodent infestation and food safety issues associated with rodent damaged-grains. Such information would help to improve maize postharvest management. Stores of 20 farmers from which 10 stored shelled maize grain and 10 dehusked cobs, were monitored over 3 months under natural infestation conditions to quantify actual weight losses due to rodents. Ten other farmers allocated their room and granary for rodent trapping over 4 months to determine rodent species associated with the losses and their population estimate. Additionally, rodent-damaged grains and non-damaged grain samples were compared for total mould count (CFU/g), mould incidence, and total aflatoxin contamination to evaluate the effect of rodent infestation. Cumulative weight losses ranged from 2.2 to 6.9% in shelled maize grain and from 5.2 to 18.3% in dehusked cobs over 3 months of storage. *Rattus rattus* was the only rodent species captured over the whole trapping period with a trap success rate of 0.62 - 10%. Microbiological analysis showed that total mould count and *Fusarium* spp. incidence were significantly higher in rodent-damaged grains than in the non-damaged ones ($P = 0.001$ (total mould count), $P = 0.011$ (*Fusarium* spp. incidence)), whereas no significant differences were obtained for *Aspergillus* spp. incidence ($P=0.239$) and total aflatoxin contamination ($P = 0.077$). The findings of this study demonstrate that rodents are a significant cause of postharvest losses in on-farm maize storage, thus postharvest losses mitigation strategies in the Kenyan lowland tropical zone should include rodent control mechanisms. The results also suggest that sorting to remove any rodent-damaged grains before use can improve farmers' food safety.

Keywords:

Rodents, postharvest losses, quantity loss, quality loss, lowland tropical, Kenya.



O3-18. Qualitative Discussion about Reducing Grain Postharvest loss with Logistical Platforms in Ghana

Lanier, W., Salifu, W., NeverIdle Farms Consulting (Ghana). Contact: NeverIdleFarms@gmail.com

Abstract

The discussion objectives were to understand why the spread of “sms information, mechanization, seed, fertilizer, and pest management” (inputs), “commodity exchanges and stationary storage” (platform) for surplus grain have failed to reduce “Postharvest and related input loss” (PHL) that otherwise would have net benefits for African growers, ecosystems, and foreign reserves. Three methods were used: 1) Evaluate the scientific rigor used to assess platforms by organizing, reviewing, and comparing literature; 2) Ground proof “mobile logistical platform” (MLP) by observing adaptive learning at 4 locations; and 3) Identify any potential roadblocks to reducing PHL by adopting MLP. The qualitative comparison suggested assessments lack scientific rigor, ignore MLP and roadblocks like: i) primitive platforms built from local materials to stop condensation caused by day and night temperatures that allow fungi and insects to flourish, are unable to store sealed, plastic as the bags wear quickly and rats and insects chew in. Primitive does not accommodate airtight metal as large cans built by local artisans, are hard to manage; ii) typical institutions that create platforms for average local production, forget averages are rare and that capacity will be empty or overflow and impact quality. If institutional platforms are distant or limit pest monitoring, they are soon rusting monuments to inappropriate technology transfer; and iii) agribusinesses that profit from PHL until the degradation of rural ecosystems limits production. However, science has proven MLP breathe to mitigate condensation so fungi and insects die, rise above rats or ground water, and let gravity reduce drudgery. Observation suggests MLP can democratize decisions so the net benefits of inputs and nutrition accrue to growers, farming sustains ecosystems and food imports decrease while surplus grain is exported for net foreign exchange reserves. The discussion recommended that policies should cause progress to MLP so institutions and agribusiness are more accountable to growers.

Key words:

grain, postharvest loss, aflatoxin, storage.



O3-19. Food Loss Assessment Study on Maize and Sunflower Value Chains in Uganda – Causes and Recommended Solutions and Strategies

¹Harriet Muyinza, PhD, ²Michael Hilary Otim, PhD, ³William Ntege Nanyeenya, ⁴Myriam Annette

¹Senior Researcher, Crop Science/Entomologist Food Biosciences Program National Agricultural Research Laboratories (NARL), Kawanda, Uganda, Corresponding author :
Email: hmuyinza14@gmail.com

²Senior Research Scientist/Crop Entomologist, National Cereals and Legumes Research Programs, National Crops Resources Research Institute (NACCRI), P.O. Box 7084, Kampala, Uganda, Email: motim9405@gmail.com

³Agricultural economist, National Livestock Resources Research Institute (NaLIRRI), Uganda, Email: willinany@gmail.com

⁴UN FAO consultant, Email : Myriam.Annette@fao.org

Abstract

This food loss assessment (FLA) on maize and sunflower in Uganda has been undertaken in the framework of a UN Rome-based agencies FAO, IFAD and WFP joint project titled “Mainstreaming food loss reduction initiatives for smallholders in food deficit areas” funded by the Swiss Development and Cooperation agency, in Lira and Apac districts in northern Uganda. The project aims to improve food security and income generation opportunities through reduction of food losses in supported food grains and pulses value chains. The FAO field case study methodology for FLA used combines approaches (observations, interviews and group discussions, actual measurements and analyses) to identify major causes of losses, critical loss points (CLP). For maize, losses at harvest were 4.7% due to spillage, 17% at drying and shelling due to spillage, grain breakage and discoloration; 26% at storage due to pest damage and aflatoxin contamination, and 5% due to spillage at milling. Harvest needs to be at the right time, and drying in improved cribs or tarpaulins. Pre-treatment of grain including sorting and conditioning of grain to the right moisture content is necessary prior to milling, and improved mills promoted to reduce spillage and ensure food safety. For sunflower, losses at harvest were 5%, 3% at bulkers’ storage, and 34 % at millers’ storage levels caused by spillage and aflatoxin contamination. Farmers sell grain when moist to get higher revenue, which causes molding at millers’ level and aflatoxins contamination. Indicative mean levels of aflatoxin contamination was 3 out of 4 samples. Reduction of losses requires capacity building, sensitization on proper harvesting, post-harvest practices, the value and effect of losses, and supervision of workers. Acquisition of threshers and winnowers for proper handling and cleaning is recommended. Millers need to purchase grains that are properly dried and not moldy to avoid losses and aflatoxins contamination.

Key words:

case study, food loss assessment, maize, producers, qualitative and quantitative losses, storage, sunflower, Uganda



P3-1. Effect of Improved Practices on Food Grain Losses and Income of Vulnerable Household in Kebbi, Sokoto and Federal Capital Territory in Nigeria

Abiola M.O. and I.C. Osamudiamen
Federal University Oye, CRS, Abuja, Nigeria

Abstract

The study examined the effect of improved practices on post harvest losses and income of vulnerable households in Kebbi, Sokoto and Federal Capital territory, Nigeria without considering all the other part ways along the food chain. At first, two communities were chosen from Bwari Local Government area in Federal Capital Territory, two communities from two LGA of Kebbi state, eight communities from four Local government areas of Sokoto State given a total of seventy (70) villages in all. Five respondents were chosen randomly from each village giving a total sample size of 350 respondents. Primary data were collected through the use of detail questionnaire administered to respondents. Data generated were subjected to inferential and descriptive statistics. Results indicate improved practices has an increasing effect on mean income of respondent by shifting the intercept upward but a decreasing effect on post harvest food grain losses was observed by shifting the intercept inward indicating a negative association food grain losses of vulnerable household in the study areas. Respondents derived their income from sales of food grains such as maize, rice, millet, cowpea and sorghum. Improved practices identified among respondents were the use of PIC bags, adopting of improved varieties of planting materials (such as TZSRY and TZRW variety of millet, Maize and sorghum which matures in 60-75 days and 100 days compared to unimproved variety which matures in 90-120days) and fertilizer. The challenges observed were, peeling machine, mixers grounding machine, bagging and labeling machine, platform for drying, sealing machine, filters, basins, pestles and mortars, insecticides and pesticides for storage and PIC bags. Nine causes were identified as causes of food grain losses while eight stock management practices were used to prevent losses, the stock management practices adopted were traditional

Keywords:

Income, Food loss, Nigeria



P3-2. Moisture Adsorption of Semi-Processed Adult Cricket (*Acheta domesticus*) and Black Soldier Fly Larvae (*Hermetia illucens*) Flours

E. Kamau^a, C. Mutungi^{b,d*}, J. Kinyuru^a, S. Imathiu^a, H.D. Affognon^c, S. Ekesi^d, K.K.M. Fiaboe^d

^aJomo Kenyatta University of Agriculture and Technology,

P.O. Box 62000-00200, Nairobi, Kenya.

^bEgerton University, P.O. Box 536-20115, Egerton, Kenya.

^cInternational Crops Research Institute for the Semi-Arid Tropics, BP 320, Bamako, Mali.

^dInternational Centre of Insect Physiology and Ecology, P.O. Box 30772-00100, Nairobi, Kenya.

*Corresponding author E-mail: cmutungi@icipe.org

Abstract

Edible insects are a dietary source of protein for a significant part of rural populations in Africa. The insects are processed in various ways and stored until they are sold in the market or consumed. Moisture sorption isotherms help to identify critical moisture contents of storage, that can help optimize the shelf-life of stored products. Adsorption isotherms of semi-processed adult house cricket (*Acheta domesticus*) and black soldier fly larvae (*Hermetia illucens*) flours were determined gravimetrically at 25, 30 and 35 °C, over a water activity (aW) range of 0.11 – 0.97. There was a significant effect ($p < 0.05$) of temperature on moisture adsorption behaviors. Sorption isotherms were of type II, with the sorption capacity decreasing with increase in temperature at a constant water activity. Experimental sorption data were fitted to various models including Guggenheim-Anderson-de Boer (GAB), Brunauer-Emmett-Teller (BET), Caurie, Oswin, Smith and Khun models. The Caurie model best represented the experimental data of both insect flours over the full aW range. Oswin and Smith models provided the second best fits to experimental data of both samples in the aW range of 0.11-0.84. GAB model fit was also adequate. GAB monolayer moisture content decreased with increase in temperature for cricket and black soldier fly larvae in the order of $3.163 > 2.981 > 2.162$ and $2.790 > 2.450 > 2.162$ respectively. Net Isosteric heat and entropy of sorption were determined from the equilibrium data using the Clausius-Clapeyron equation. Both parameters decreased with increase in moisture content. At ambient temperature (25-35°C), the insect flours should be dried to moisture contents below 8% (cricket) and 5% (black soldier fly), and stored in environments where relative humidity does not exceed 60% to minimize chemical and microbial spoilage.

Keywords:

Black soldier fly, cricket, edible insects, moisture adsorption, shelf-life



P3-3 Experiences and Challenges in Transfer of Milk Postharvest Technologies in Pastoral Communities of Kenya

Francis O. Wayua,^{1*} Amos O. Adongo² and Josphat I. Sagala²

¹Kenya Agricultural and Livestock Research Organisation, Non-Ruminant Research Institute, P. O. Box 169-50100, Kakamega, Kenya. Tel. +254-710-629683; +254-738-986220. Email: fwayua@yahoo.co.uk; Francis.Obuoro@kalro.org (*Corresponding author)

² Kenya Agricultural and Livestock Research Organisation, Sheep, Goat and Camel Research Institute, P. O. Box 147-60500, Marsabit, Kenya.

Abstract

Postharvest technologies are essential in reducing food losses and wastage. Several milk postharvest technologies were introduced in pastoral communities in Kenya, with the objective of reducing postharvest losses and enhancing commercialisation. This paper describes the experiences and challenges in the technology transfer process. The paper is based on field experience and synthesis of literature on milk processing in pastoral areas, including journal articles, case studies and project reports. Cultured fermented milk, ghee, cheese and milk sweets were developed using appropriate technology. Cream separator enabled ghee making from camel milk which was impossible using traditional methods. Other technologies included hygienic milk handling, evaporative cooling and solar milk pasteurisation. Technology transfer was through participatory demonstrations with groups, study tours, exchange visits, and product exhibitions in field days, shows and trade fairs. During exhibitions, farmers participating in research activities demonstrated various technologies reaching, for example, over 10,000 clients in Marsabit, Garissa and Turkana counties. Beneficiary groups transferred the technologies to the wider community by explaining the various technologies. Technology transfer was catalysed through adult literacy classes and competitive farmer grants. Up-scaling was done using stakeholders, extension pamphlets and video documentaries. Adoption of hygienic milk handling and cultured fermented milk was over 50%. This pioneering work on milk processing in pastoral areas significantly contributed to food security and influenced policy, leading to development of Kenya Standards for camel milk. Challenges in technology transfer included high illiteracy and poverty, unavailability of milk processing equipment and ingredients locally, lack of electricity, marketing, and weak regulatory system. It is concluded that for these marginalised groups, application of appropriate milk postharvest technologies will lead to higher degree of food self-sufficiency and less dependency on food aid. The challenges to technology transfer should be addressed for maximum contribution of the technologies to food security and income generation.

Keywords:

Milk, pastoralist, food security, Kenya



P3-4 Efficacy of Filter Cake Against *Sitophilus granarius* and *Rhyzopertha dominica* in Stored Wheat

Karta Kaske Kalsa^{1,2}, Bhadriraju Subramanyam^{1,3}, Girma Demissie⁴, Rizana Mahroof⁵

¹Bahir Dar Institute of Technology, Bahir Dar University, Bahir Dar, Ethiopia

²Ethiopian Institute of Agricultural Research, Kulumsa Research Center, Asella, Ethiopia;

³Department of Grain Science and Industries, Kansas State University, Manhattan, USA;

⁴Ethiopian Institute of Agricultural Research, Bako National Maize Research Center, Bako, Ethiopia;

⁵Department of Biological Sciences, South Carolina State University, USA

Correspondence: kartakaske@gmail.com

Abstract

Silica based inert dusts are becoming eco-friendly alternatives to control stored grain insect pests due to environmental and health concerns associated with chemical use. A study was conducted to determine the efficacy of filter cake (silica based inert dust) on combined populations of *Sitophilus granarius* and *Rhyzopertha dominica* in stored wheat. Filter cake dust at ≤ 0.4 mm particle size was administered on 500 g wheat seed at rates of 10 000, 7 500, 5 000, and 2 500 ppm while a control was maintained at nil amount of filter cake dust. The bioassay was carried out using liter sized plastic jars in completely randomized design with three replications. Experiments were maintained at $23.1 \pm 1.7^\circ\text{C}$ and $61.0 \pm 4.3\%$ relative humidity. Mortality data was collected at three, seven, and fourteen days after treatment. Results indicated that mean mortality rate at three days after treatment ranged from 38.0 to 74.0% in *S. granarius* and 73.3 to 93.3% in *R. dominica*. Average mortality rate of *S. granarius* at 14 days after treatment was 84.0 to 98.7% while that of *R. dominica* was about 98.3 to 100%, while filter cake dust caused 100% on *R. dominica* at concentrations of 5 000 to 10 000 ppm after 14 days of treatment, the highest rate of mortality (98.7%) of *S. granarius* was observed at rates of 7 500 to 10 000 ppm. In summary, the present results have shown that filter cake dusts are effective against the species under study. It is, therefore, recommended that filter cake dust can be used to control *S. granarius* and *R. dominica* in stored wheat at application rates of 7 500 ppm and 5 000 ppm, respectively.

Keywords:

Filter cake, inert dust, *Rhyzopertha dominica*, *Sitophilus granarius*, wheat



P3-5 Effectiveness of Hermetic Bags in Protecting Maize Grains from *Sitophilus zeamais* Motschulsky (Maize Weevil)

Karta Kaske Kalsa^{1,2}, Bhadiraju Subramanyam^{2,3}, Girma Demissie⁴, Rizana Mahroof⁵

¹Bahir Dar Institute of Technology, Bahir Dar University, Bahir Dar, Ethiopia

²Ethiopian Institute of Agricultural Research, Kulumsa Research Center, Asella, Ethiopia;

³Department of Grain Science and Industries, Kansas State University, Manhattan, USA;

⁴Ethiopian Institute of Agricultural Research, Bako National Maize Research Center, Bako, Ethiopia;

⁵Department of Biological Sciences, South Carolina State University, USA

Correspondence : kartakaske@gmail.com

Abstract

In Ethiopia postharvest losses of maize due to storage insect pests such as maize weevil are an increasingly important constraint to smallholder farmers in achieving food security. Hermetic storage bags such as Purdue Improved Crop Storage (PICS) bags and super grain bags (high-density polyethylene bags reducing gas exchange) can be used to reduce postharvest losses. To test the effectiveness of different bags against maize weevil (*S. zeamais*), on-farm trials were conducted in Mecha district, North Western Ethiopia. The experiment consisted of three treatments: two hermetic bags and one traditional storage structure (gota), replicated in nine smallholder farms. Measurements of gas composition (CO₂ and O₂ levels), insect mortality, adult insect density, grain damage, weight loss, grain moisture content, grain bulk density, and thousand kernel weights were determined after four months of storage. Perceptions of farmers regarding utility of hermetic bags were collected through checklists and open discussions. Results indicated that there were statistically significant improvements in most of the measured parameters. Average adult insect mortality rate in hermetic bags was about 79.6% to 84.6% while in 'gota' it was only 34.4%. Mean grain damage in 'gota' was about 13.6% whereas in hermetic bags it was about 3.6 to 5.6%. Grain bulk density and thousand kernel weight were significantly higher in hermetic bags than in 'gota'. Farmers had positive perception on effectiveness of the improved maize storage bags for protection of their grains from weevil damage, but 46.7% out of 30 farmers had perceived that bag prices were costly. In summary, the hermetic bags were effective in protecting maize grains from *S. zeamais* damage under on-farm conditions and their performance was applauded by farmers in the study area. Thus, use of PICS and SuperGrain™ should be encouraged and adequate information should be delivered to farmers on economic benefits of using hermetic bags in order to prevent maize storage losses and enhance food security in Ethiopia.

Keywords:

Hermetic bags, maize grain, *Sitophilus* spp., storage, Ethiopia,



P3-6 Stored Maize Pests, Their Damage and Economic Losses in South-Eastern Kenya

Muo Kasina¹ and John Huria Nderitu²

¹The National Sericulture Research Centre of the Kenya Agricultural and Livestock Research Organization, P.O. Box 7816-01000 Thika.

²Faculty of Agriculture, Department of Crop Science and Crop Protection, University of Nairobi

Correspondence: Muo.Kasina@kalro.org; Tel. +254-738 199 323

Abstract

Frequent and long droughts resulting in famine is a common occurrence in south-eastern Kenya. Maize is one of the most important staple crops in this region. However, post harvest pest infestation reduces storage time for the grains and quantity and quality available to the households. This study was carried out to determine farmer knowledge and management of larger grain borer (LGB, *Prostephanus truncatus* (Horn)) and other stored maize pests in Emali, Makueni county. LGB is known to have infested this area as it entered Kenya from Tanzania, and Kyuso, Kitui county, which is off the LGB pathway but both areas have similar agroecologies. Farmers were randomly selected using local administrator data. Grain samples were collected from all respondents for lab incubation and analysis to confirm farmer assertions about the pests. A sample was collected using Nobbe trier from farmer-stored maize, where random scoops were done from available maize to get 250g per farmer. All samples were put in kilner rearing jars and incubated in the lab under room temperature. They were not sieved or screened in any way for purpose of maintaining farmer treatment. Data was entered in excel and analysed to compare mean values using SPSS software. Significance was tested at 95% level of confidence limits. The results show that maize is the most important commodity in both areas for food (88%) and income (48%) as ranked by respondents. There was significant ($P < 0.001$) difference in the reporting of key maize pests. Most respondents (82%) in Kyuso ranked maize weevil first while those at Emali (88%) ranked LGB. Samples from Kyuso had no LGB emergence in the lab four months post sampling. In contrast, Emali samples had high LGB emergence, confirming the reports by farmers that this pest is the most important. There was significant ($P < 0.001$) difference in the use of pesticides by farmers across the two sites. Kyuso (60%) farmers do not dust their maize before storing compared with the few from Emali (18%) who don't. The overall findings indicate that farmers may not be effectively managing LGB and other stored maize pests as a result of wrong identification, which would lead to the use of wrong control measure. The LGB presence poses a serious food insecurity concern for the residents of the study area and efforts should be implemented to reduce infestation particularly in areas not yet infested. This pest's effects on cassava further exacerbates its impact on availability of staple food. Simple pest identification and management guides should be developed to enhance knowledge and control of these pests.

Key words:

Larger grain borer, maize weevil, farmer knowledge



P3-7 Reducing Post-Harvest Loss in Cowpea (*Vigna Unguiculata* L.) By Use of Botanicals to Control The Cowpea Weevil

¹Mwandikwa J.M, ²Kamotho G.N, ³Gitonga W.

¹School of Agriculture and Biotechnology, Karatina University, P.O. Box 1957-10101, Karatina, Kenya.

²Ministry of Agriculture, Kitui County, P.O. Box 33 - 90200, Kitui, Kenya

³Mwea Tebere Irrigation Scheme, P.O.Box 80-00103, Wang'uru, Kenya

Corresponding author: gracekamotho@yahoo.com

Abstract

Cowpea (*Vigna unguiculata* L.) is one of the pulses that suffer postharvest losses most. The major insect causing losses to stored cowpea seeds in Kenya is the cowpea weevil, *Callosobruchus maculatus*. Although insecticides are widely available, they are expensive, potentially dangerous to users and pollute the environment. In drier areas of Kenya where the pest is common, small-scale farmers use botanicals with varying levels of success. The objective of this study was to assess the effectiveness of a locally available botanical, wild basil (*Ocimum americanum* L.), in the management of the cowpea weevil. Varying levels of *O. americanum* at 0.5, 1.0, 2.0, 4.0 and 8.0 g of dried leaf, flower and whole plant were compared for their effectiveness against the weevil in stored cowpea seed. For each treatment, 10 g of cowpea seeds were placed in plastic vials containing 10 cowpea adult weevils. Experiments were laid out in a completely randomized design at Kenya Agricultural and Livestock Research Organization, Nairobi, Entomology Laboratory. Data was analysed by Genstat software and means separation was done by Fischer's protected least significant difference at $p < 0.05$. Lowest post-harvest weight loss of cowpea seed and highest mortality of cowpea weevil was recorded when 8 g of leaf powder to 10 g seed were used. Since wild basil is a common weed in Mbeere, Kitui, Makueni and Mwingi, it can be utilized in these areas as a cheap control measure for cowpea weevil.

Key words:

Botanicals, cowpea, cowpea weevil, postharvest loss



P3-8 Population Dynamics of Stored Maize Insect Pests in Warehouses in Two Agro-Ecological Zones in Ghana

N. Manu¹, E. A. Osekre¹, G. P. Opit⁴, G. Mbata³, F. H. Arthur², J. Campbell², P. Armstrong², J. K. Danso¹, E. P. Nsiah⁵

¹Dept. of Crop and Soil Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

²United States Department of Agriculture, Agricultural Research Service, Center for Grain and Animal Health Research, 1515, College Ave. Manhattan, KS 66502, USA

³Dept. of Biology, Fort Valley State University, 1005 State University Drive, Fort Valley, GA 31030, USA

⁴Dept. of Entomology and Plant Pathology, Oklahoma State University, 127 Noble Research Center, Stillwater, Oklahoma 74078-3033, USA

⁵PENS Food Bank, P.O. Box 143, Ejura-Ashanti, Ghana

Corresponding author: george.opit@okstate.edu

Abstract

Understanding insect population dynamics in the storage environment is vital to implementing successful integrated pest management strategies. Populations of insect pests of maize in and outside three warehouses located within two agro-ecological zones in Ghana were monitored from October 2015–July 2016 with a view to understanding their dynamics in order to formulate management strategies. Two of the warehouses (Wienco and Gundaa) are located in the Guinea Savanna zone while one (MiDA) warehouse is located in the Transitional zone. Storguard pheromone traps and dome traps were used to monitor bi-weekly the population of flying and crawling insects respectively. Data showed that peak mean numbers of 61.4/trap, 9.67/trap and 2.33/trap, respectively, of *Plodia interpunctella* (Hübner), *Tribolium castaneum* (Herbst) and *Rhyzopertha dominica* (Fabricus) were recorded in the warehouses. *P. interpunctella* was found in the receiving, cleaning and stacking rooms of the warehouses. *Sitotroga cerealella* (Oliver) with mean captures of 3.5/trap was found in the receiving and cleaning rooms of Gundaa and 10.4/trap in the stacking room while 0.2/trap of *Prostephanustruncatus* (Horn) was recorded in the stacking room only. Wienco which had good sanitation, fogged with deltamethrin before maize storage and treated maize with Phostoxin® after storage had the least numbers of insect pests. MiDA (57.20/trap) and Gundaa (46.65/trap) had the highest numbers of insect pest species among the three warehouses due to poor management practices. MiDA warehouse had lower insect pest numbers in the Storguard traps but higher captures in the dome traps initially but insect captures increased in both traps with time. This study has shown the importance of maintenance of good sanitation in the stored product environment and the need to use both trap types for effective insect monitoring in warehouses.

Key words:

Insect pests, stored maize, pheromone traps, warehouse



P3-9 Insect Population Dynamics in Maize Stored Using Four Storage Treatments

*Nwaubani, S. I.¹, Omobowale, M. O.², Otitodun, G. O.¹, Ala, A. A.³, Opit, G. P.⁴, Ileleji, K. E.⁵, McNeill, S. G.⁶, Ogundare, M. O.¹, Igbele, G. I.¹, Ajao, S. K.², Braimah, J. A.³, Olenloa A. E.², Kolayemi O. R.², Ogwumike J. C.²

*Corresponding author's email address: ihueze2004@yahoo.com

¹Department of Entomology, Nigerian Stored Products Research Institute, Ilorin, Nigeria

²Department of Agricultural and Environmental Engineering, University of Ibadan, Ibadan, Nigeria

³Department of Zoology, University of Ibadan, Ibadan, Nigeria

⁴Department of Entomology and Plant Pathology, Oklahoma State University, Stillwater, Oklahoma, USA

⁵Agricultural and Biological Engineering Department, Purdue University, West Lafayette, Indiana, USA

⁶Biosystems and Agricultural Engineering Department, University of Kentucky, Lexington, Kentucky, USA

Abstract

Various technologies are being tried globally to find cost-effective, reduced-risk and sustainable alternatives to conventional insecticides. Primary insect pests of grains are the ones capable of initiating infestation. Losses caused by this group have been estimated at 20 – 90 % for untreated maize in sub-Saharan Africa. Presence of live insects beyond specified levels leads to price penalties or rejection of entire commodity by buyers. Consequently, we assessed four low-cost treatments to determine their persistent deterrence of insect pests. These include; maize in PICS bags, maize in ZeroFly® bags, Bularafa- diatomaceous earth (DE) treated maize in polypropylene (PP) bags, and Piper guineense seed dust-treated maize in PP bags. These were compared with prevailing practices in the markets, comprising of positive and negative controls – maize treated with Permethrin in PP bags and untreated maize in PP bags, respectively. The study that was conducted in four market storehouses (SH) in Ibadan, Oyo and Ilorin, Nigeria, was initiated in February 2016, lasting over 11 months. Each SH had the 6 treatments and each treatment had six 100 kg bags assigned to it. The experimental design was a randomized complete block design (RCBD). By October and November, *Sitophilus zeamais* population was 0.13 – 1.50 in all treatments compared to the negative control, 6.96 – 11.29 respectively. *Psocid* population increased significantly in all treatments and more so in Zerofly (14.71) and DE (13.71; 13.42) treatments during the rains – July to November. Total number of insects increased significantly with storage especially in the negative control (0.79 – 26.54) while treatments had 0.00 – 16.63 respectively. The PICS bag was most effective, harbouring least number of insects, 0.54 insect per kg of maize. These experimental technologies showed bright prospects for integration with other components of IPM in small-scale storage systems in Nigeria.

Keywords:

Low cost and safe treatments, PICS bag, Zerofly bag, DE dust, Piper guineense seed dust, insect pests.



P3-10 Maize Grain Stored in Hermetic Bags: Effect on Grain Quality of Pest Infestation and Moisture

Paddy Likhayo^{c,d,*}, Tadele Tefera^b, Anani Y. Bruce^a, Jones Mueke^d

^a International Maize and Wheat Improvement Centre (CIMMYT), PO Box 1041 - 00621, Nairobi,

Kenya. E-mail: A.Bruce@cgiar.org

^b International Centre of Insect Physiology and Ecology (ICIPE), ILRI Campus, PO Box 5689, Addis Ababa, Ethiopia. E-mail: ttefera@icipe.org

^c Kenya Agricultural and Livestock Research Organisation (KALRO), Food Crops Research Institute, PO Box 14733 - 00800, Nairobi, Kenya.

E-mail: paddy.likhayo@kalro.org Kenya.

^d Kenyatta University (KU), Department of Zoological Sciences, PO Box 43844 - 00100, Nairobi, Kenya. E-mail: mueke.jones@ku.ac.ke

* Corresponding author. Tel.: +254 722228311;

E-mail: paddy.likhayo@kalro.org; p.likhayo@yahoo.com

Abstract

Maize grain was stored for 180 days in hermetic bags or open-weave polypropylene bags to compare quality preservation when subject to infestation by *Sitophilus zeamais* and initial grain moisture contents of 12, 14, 16 and 18%. The moisture content of grain in hermetic bags remained unchanged while in polypropylene bags it fell. Grain in hermetic bags at 12% initial moisture content stored well and suffered only 1.2% weight loss while in polypropylene bags the weight loss was 35.8%. There were fewer insects in hermetic than polypropylene bags. Some insect development did occur in the hermetic bags. This was possibly due to damage of the hermetic seal by entry holes made in the bags by *Prostephanus truncatus*. The study was on only one site which was hot and dry and further investigation under cool, hot and humid conditions is required.

Keywords:

Hermetic grain bag, moisture content, maize storage, *Prostephanus truncatus*, *Sitophilus zeamais*



Work Stream 4

**Aflatoxin management, food safety
and Nutrition**



O4-1. Influence of Moisture Content on, Insect Pests and Mycotoxin Levels of Maize in Farms in Northern Region of Ghana

N. Manu¹, E. A. Osekre¹, G. P. Opit², F. H. Arthur³, J. Campbell³, G. Mbata⁴, P. Armstrong³, J. K. Danso¹, E. P. Nsiah⁵

¹Dept. of Crop and Soil Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

²Dept. of Entomology and Plant Pathology, Oklahoma State University, 127 Noble Research Center, Stillwater, Oklahoma 74078-3033, USA

³United States Department of Agriculture, Agricultural Research Service, Center for Grain and Animal Health Research, 1515, College Ave. Manhattan, KS 66502, USA

⁴Dept. of Biology, Fort Valley State University, 1005 State University Drive, Fort Valley, GA 31030, USA

⁵PENS Food Bank, P.O. Box 143, Ejura-Ashanti, Ghana

Corresponding author: george.opit@okstate.edu

Abstract

Maize production in Ghana has been increasing steadily due to improvement in production technology but the benefits of improvement in yields are not being fully realized due to improper storage resulting in high losses. Very little information is available on post-harvest losses of maize in the Northern Region of Ghana, necessitating this study which determined post-harvest losses of the commodity in selected farms. The study spanned October to December, 2015 in six communities in the Northern Region of Ghana, where there is only one maize growing season, from August to December. Samples were collected from different farming communities, namely, Aduyili, Toroyili, Zamnayili, Diari, Pong-Tamale and Savelugu. Different storage systems (granary, polypropylene storage bags and warehouse) used by smallholder farmers were assessed. Weight loss (%), total number of kernels, insect damaged kernels (IDK), weight of IDK, types and numbers of insects in samples, % IDK per 250 g of maize sampled and mycotoxin (aflatoxin and fumonisin) levels were determined. Results showed that moisture content of maize from the communities were below 14% for both pre-harvest and piled maize. No insect pests were found in the pre-harvested maize, however a mean number of 1.67/250-g maize, mainly larvae of different insect species, were found in piled maize. Insect numbers increased at the post-drying stage, with the granary storage system recording significantly ($P < 0.05$) higher (15.4/250-g) numbers than the other two storage systems. The polypropylene bags also had significantly more insects (9.0/250-g) than the warehouse storage system (3.5/250-g). Aflatoxin levels were lower at the pre-harvest stage with a mean of 13.13 ppb but increased significantly ($P < 0.05$) to 25.09 ppb at the piled stage. Fumonisin levels were 1.16 ppm at pre-harvested stage and 1.1 ppm at piled stage and these were below the recommended threshold of 4.0 ppm in Ghana. Results suggest that heaping of maize on-farm should be avoided and discouraged to reduce insect damage and keep aflatoxin levels low (below 15 ppb threshold in Ghana).

Key words:

Maize, mycotoxin, post-harvest loss, storage system



O4-2. Effect of Harvesting Time and Drying Methods on Aflatoxin Contamination in Groundnut in Mozambique

Emmanuel Zuza Jnr^{1*}, Manuel I.V. Amane², Amade Muitia³ and Ana Maria Mondjana¹

¹Eduardo Mondlane University, Faculty of Agriculture and Forestry Engineering, Department of Crop Protection, P.O. Box 257, Maputo, Mozambique.

²Institute of Agriculture Investigation in Mozambique, P.O. Box 3658, Maputo, Mozambique.

³Nampula Research Station, Av. FPLM km 7, Via Corrane, Nampula, Mozambique

*Corresponding author: manzyzuzajnr@gmail.com

Abstract

Groundnut is one of the most important legume crops in Mozambique grown as food and as a cash crop. However, the presence of mycotoxins, especially aflatoxins has the potential to limit its use both in the human and livestock diet. Furthermore, aflatoxin contamination of agricultural crops, such as; groundnut leads to annual losses of more than US \$750 million in Mozambique and Africa. Poor management practices by farmers and adverse climatic conditions at harvest and post-harvest are some of the prompting factors for post-harvest aflatoxin contamination. In this study, the effect of harvesting time and drying methods on groundnut post-harvest aflatoxin contamination were examined at Nampula Research Station and Mapupulo Agricultural Research Center in Northern Mozambique. A randomized complete block design in a split-split plot arrangement with four replications was used with three groundnut varieties; (ICGV-SM-99568, ICGV-SM-01514 and JL-24) as the main plot and three harvesting dates (10 days before, at physiological maturity and 10 days after physiological maturity) and two drying methods; platform drying (A-frame) and mat drying (tarpaulins) as sub-plots. A total of 96 groundnut samples were analyzed for aflatoxin contamination using immuno-chromatographic assay strips by the M-reader. In both locations, field observations indicated that on average aflatoxin contamination levels were lower at physiological maturity (≤ 10 ppb) compared to harvesting 10 days before (≤ 15 ppb) and 10 days after physiological maturity (≥ 20 ppb). It was also observed that the two drying methods were effective in prevention of aflatoxin contamination on groundnut kernels to levels lower than 20 ppb. However, aflatoxin contamination levels were significantly lower (≤ 12 ppb) as a result of the A-frame than the tarpaulin method. The results of this study therefore, have indicated that proper post-harvest management of groundnuts such as harvesting at physiological maturity and improved drying gave lowest aflatoxin contamination levels lower than the FDA/WHO regulatory levels of 20 ppb.

Keywords:

Groundnut, harvesting time, aflatoxin contamination, drying methods.



O4-3. Isolation and Identification of Compounds from Piper Guineense Seed Extract for The Control of Sitophilus Zeamais

Mobolade Dele Akinbuluma^{1,2}, Francis Kolawole Ewete¹, Baldwyn Torto²

¹Department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria.

²International Centre of Insect Physiology and Ecology (icipe), Nairobi, Kenya

Corresponding author's e-mail: mobolade.james@yahoo.com

Abstract

The maize weevil, *Sitophilus zeamais* Motschulsky causes severe postharvest losses on maize grain thereby threatening food security throughout the developing world. Synthetic insecticides that effectively control this insect pest have undesirable effects on the environment. This study proposes an alternative method for the control of the maize weevil due to the problems caused by the use of synthetic chemicals. Isolation and identification of compounds from the seed extract of the African Black Pepper, *Piper guineense* Schum and Thonn were carried out at icipe, Nairobi. The study also evaluated the biological activities of the compounds obtained on the adult maize weevil in the Department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria, under laboratory conditions of $27 \pm 2^\circ\text{C}$ ambient temperature and $65 \pm 5\%$ relative humidity. Experiments were arranged in a Completely Randomised Design with four replications. Identified compounds were tested singly and in blend and parameters including mortality, oviposition and repellent effects were assessed. Chromatographic separations yielded five pure compounds namely; dihydrowisanine, guineensine, piperine, piperlonguminine and trichostachine when subjected to Liquid Chromatography-Quadrupole-Time of Flight (LC-Q-TOF). Piperine and guineensine performed better ($P < 0.05$) than other compounds causing high mortality, ovicidal and repellent effect on *S. zeamias*. Germination of maize seeds treated with the compounds was not affected. The results of the study also showed that piperine and guineensine may have a synergistic effect when combined as an insecticide. In conclusion, *Piper guineense* offers a unique and useful source of biopesticide material for controlling *Sitophilus zeamais* in stored maize.

Keywords:

Piper guineense, Isolation, Biological activities, Piperine, Guineensine



O4-4. Use of Hermetic Storage to Control Aflatoxin in Maize

Sophie Walker, COP of AflaSTOP, swalker@acdivoca.org

Abstract

In 2004, an outbreak of acute human aflatoxin-poisoning (aflatoxicosis) in the Eastern Province of Kenya attracted worldwide attention. Consumption of highly contaminated maize was found responsible for the high number of human fatalities. The continuing Kenyan aflatoxin crisis claiming human lives each year, demands ongoing attention until realistic management strategies, pre- and post-harvest, are put in place. In recent years, hermetic storage has been increasingly promoted in Asia and Africa, as low oxygen levels result in 100% insect mortality. AflaSTOP sought to determine if any hermetic storage devices currently in, or about to be, introduced to the Kenyan market are able to: 1) impede post-harvest aflatoxin contamination 2) withstand frequent opening, and therefore an interruption of the hermetic principle, without loss of their effectiveness; 3) reduce insect damage. Furthermore, storage experiments were conducted with grain at recommended (<13%) and farmer achieved (14-15%) moisture content to assess if these conditions influence the performance of the devices. AflaSTOP established that hermetic storage will impede the growth of aflatoxin at different moisture levels. However, to effectively store grains hermetically for longer periods of time (over 3 months), maize needs to be below 13.5% moisture content. In On-Farm trials, AflaSTOP established that ~70% farmers were able to set up and use hermetic devices effectively, whether they received training or not. AgResults demonstrates that sales of hermetic bags are rapidly increasing as many farmers adopt hermetic storage, due to concerns about consuming insecticides currently applied to preserve grains. However, non-adopters are still concerned about the devices failing and the loss of an asset if it is damaged. AflaSTOP also introduced a mechanical dryer on a pay for service model which is being adopted by farmers in wet harvest areas.

Key words:

maize, aflatoxin, hermetic storage, moisture levels



O4-5. Packaging Atmosphere Influences Quality, Occurrence of Mycobiota and Aflatoxin B1 in Peanut (*Arachis hypogaea* L.) Kernels cv. 'Khon Kaen 84-8'

Peter Opio ^{a,c} and Songsin Photchanachai ^{a,b}

^a Postharvest Technology Program, School of Bioresources and Technology, King Mongkut's University of Technology Thonburi, Bangkok 10140, Thailand

^b Postharvest Technology Innovation Center, Commission of Higher Education, Bangkok 10400, Thailand

^c Busitema University Faculty of Agriculture and Animal Sciences, Arapai campus, P.O Box, 203, Soroti Uganda.

Abstract

Peanut is one of the most important oilseed and food security crop widely cultivated and consumed in most developing countries in the world. During storage its high oil content predisposes it to oxidative and fungal deterioration. This study desiderated the efficacy of packaging atmosphere on occurrence of mycobiota, AFB₁ and peanut kernel quality during storage. During a fifteen week storage period, peanut kernels inoculated with or without *Aspergillus flavus* were stored under 100% CO₂, 100% N₂, vacuum and normal air. Mycobiota occurrence, AFB₁ contamination level, moisture content, lipase activity, free fatty acids and rancidity (Thiobarbituric acid; TBA value) were investigated. Storage of peanuts (*Arachis hypogaea* L.) under different packaging atmospheres had effect on quality, fungal occurrence and aflatoxin B1 (AFB₁) contamination. A total of five major fungi were identified with four storage fungi and one field fungus; *Rhizopus stolonifer*, *Aspergillus niger*, *A. flavus*, *Penicillium* spp., and *Fusarium* spp., respectively. Packaging in 100% CO₂ significantly repressed the fungal occurrence especially *A. niger* while all other packaging atmospheres with or without peanuts kernels inoculated with Aflatoxin producing fungus *A. flavus* suppressed proliferation of both *R. stolonifer* and *Penicillium* spp. The peanut kept in a vacuum package revealed AFB₁ contamination level below detection limit (0.4µg/kg). Peanut kernels in 100% CO₂ packaging atmosphere maintained an acceptable color appearance indicated by, a* and b* value, chroma as well as the color change compared to other treatments. Different packaging atmospheres showed variable results in relation to the free fatty acids levels and lipase enzyme activity with packaging under 100% N₂ revealing the lowest level of both. Subsequently, 100% N₂ packaging atmosphere effectively inhibited rancidity occurrence in peanut kernels during storage. The results in our study portray that 100% CO₂, 100% N₂ and vacuum packaging atmosphere could have a potential to suppress occurrence of Mycobiota, maintain peanut kernel quality in relation to color and lipid oxidation, and as well curtail AFB₁ contamination respectively. O101.

Key words:

AFB₁; Mycobiota; Packaging atmosphere; Peanuts; Quality



O4-6. Good Crop Management Practices Help Reduce Aflatoxin Contamination in Groundnut Before Storage in Mali

Konaté D., Affognon H.*, Ogunbayo A., Desmae H. and Tabo R.

All authors:

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), BP 320, Bamako, Mali.

*Corresponding author: Hippolyte Affognon (h.affognon@cgiar.org)

Abstract

Groundnut is the main grain legume in Mali as it plays an important role as food and cash crop. However, its productivity is low because of low adoption of improved technologies of production. In addition, inappropriate postharvest and storage practices further predispose harvests to quantitative and qualitative losses, especially contamination by aflatoxin. The objective of the present study was to investigate the effect of good crop management practices in reducing aflatoxin contamination in groundnut before storage in Mali. Participatory demonstration plots consisting of improved technology and farmers' local practices were established in three regions (Sikasso, Koulikoro and Mopti). Diammonium Phosphate (18-46-0) fertilizer was used as basal application at the rate of 100kg/ha during land preparation. Gypsum was applied at the rate of 400kg/ha at 35-40 days after sowing. The improved technology included mainly the use of tolerant varieties, appropriate fertilizer, harvesting at 70-80% maturity and drying pods at 8% moisture content. A total of 224 groundnut samples, 112 each from improved technology and farmers' practices plots were collected and analyzed. The Aflatoxin concentration in seeds was measured using the enzyme linked immunosorbent assay (ELISA). The overall analysis showed that samples from improved technology plots had an average of 3.94 ± 5.23 ppb of aflatoxin which is significantly less ($p < 0.01$) than the samples from the farmers' practices with an average of 12.71 ± 15.10 ppb. Furthermore, considering data from each region, significant differences were also observed between improved technology and farmer' practices, though the difference was only significant at 10% in Mopti which is drier than the other two regions. This study revealed that improved variety with good crop management practices can help reduce aflatoxin contamination in groundnut before storage. We recommend a holistic approach combining tolerant varieties, crop management practices, capacity development and public awareness for the reduction of Aflatoxin contamination in groundnut.

Keywords:

Groundnut, aflatoxin, crop management practices, Mali



O4-6. Good Crop Management Practices Help Reduce Aflatoxin Contamination in Groundnut Before Storage in Mali

Konaté D., Affognon H.*, Ogunbayo A., Desmae H. and Tabo R.

All authors:

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), BP 320, Bamako, Mali.

*Corresponding author: Hippolyte Affognon (h.affognon@cgiar.org)

Abstract

Groundnut is the main grain legume in Mali as it plays an important role as food and cash crop. However, its productivity is low because of low adoption of improved technologies of production. In addition, inappropriate postharvest and storage practices further predispose harvests to quantitative and qualitative losses, especially contamination by aflatoxin. The objective of the present study was to investigate the effect of good crop management practices in reducing aflatoxin contamination in groundnut before storage in Mali. Participatory demonstration plots consisting of improved technology and farmers' local practices were established in three regions (Sikasso, Koulikoro and Mopti). Diammonium Phosphate (18-46-0) fertilizer was used as basal application at the rate of 100kg/ha during land preparation. Gypsum was applied at the rate of 400kg/ha at 35-40 days after sowing. The improved technology included mainly the use of tolerant varieties, appropriate fertilizer, harvesting at 70-80% maturity and drying pods at 8% moisture content. A total of 224 groundnut samples, 112 each from improved technology and farmers' practices plots were collected and analyzed. The Aflatoxin concentration in seeds was measured using the enzyme linked immunosorbent assay (ELISA). The overall analysis showed that samples from improved technology plots had an average of 3.94 ± 5.23 ppb of aflatoxin which is significantly less ($p < 0.01$) than the samples from the farmers' practices with an average of 12.71 ± 15.10 ppb. Furthermore, considering data from each region, significant differences were also observed between improved technology and farmer' practices, though the difference was only significant at 10% in Mopti which is drier than the other two regions. This study revealed that improved variety with good crop management practices can help reduce aflatoxin contamination in groundnut before storage. We recommend a holistic approach combining tolerant varieties, crop management practices, capacity development and public awareness for the reduction of Aflatoxin contamination in groundnut.

Keywords:

Groundnut, aflatoxin, crop management practices, Mali



O4-7. Effect of Temperature, Relative Humidity and Moisture on Aflatoxin Contamination of Stored Maize

F.C. Muga^{1*}, T.S. Workneh¹, M.O. Marenya^{2,3}

¹School of Engineering, Bioresources Engineering, University of KwaZulu-Natal, Pietermaritzburg, South Africa.

²Department of Agricultural and Rural Engineering, School of Agriculture, University of Venda, Thohoyandou, South Africa.

³Institute for Agricultural Engineering, Agricultural Research Council, Silverton, Pretoria, South Africa

*Corresponding author E-mail address: mugafc@gmail.com

Abstract

Maize grain is vulnerable to attack by *Aspergillus flavus* (*A. flavus*) both in the field and during storage, producing aflatoxins. High temperature (T), relative humidity (RH) and grain moisture content (MC) promote *A.flavus* growth and aflatoxin contamination of maize during storage. In this paper, aflatoxin contamination of maize grain was studied under selected T, RH and MC levels. Maize grain sample at MC levels of 14, 15, 16, 18, and 20 % (w.b) was inoculated with *A. flavus* spores and incubated in a climatic test chamber for ten days at 20°C and 30°C, and RH of 60% and 90%. The results indicated that T and RH significantly influenced aflatoxin contamination while MC had no significant effect on aflatoxin levels. Aflatoxin contamination occurred at both 20 °C and 30 °C. Aflatoxin production was pronounced at 30°C, ranging between 0.3 µg.kg⁻¹ – 11179.7 µg.kg⁻¹, compared to 20°C which ranged between 0.8 µg.kg⁻¹ – 733.7 µg.kg⁻¹. 90 % RH had higher levels of aflatoxin of between 3.9 µg.kg⁻¹ – 11179.7 µg.kg⁻¹, while the highest level of aflatoxin detected at 60% RH was 2.4 µg.kg⁻¹. Interaction between factors had no significant effect on the level of aflatoxin except for T and RH interaction. The results indicated that aflatoxin levels are significantly lower at 60% RH than at 90% RH for the selected levels of temperature and moisture content. Therefore, contamination of maize grain by aflatoxin can be minimised and/or controlled by maintaining the levels of RH in storage structures below 60 %.

Keywords:

A. flavus, aflatoxin, maize, storage.



O4-8. Incidence of Fusarium Mycotoxins in Major Traditional Weaning Foods (Ogi and Soybean Powder) From Nigeria

CA. Chilaka^{1,2}, M. De Boevre¹, O. Atanda³ and S. De Saeger¹

¹Laboratory of Food Analysis, Department of Bioanalysis, Faculty of Pharmaceutical Sciences, Ghent University, Ghent, Belgium

²Department of Food Science and Technology, College of Applied Food Science & Tourism, Michael Okpara University of Agriculture Umudike, Abia State, Nigeria

³Department of Biological Sciences, McPherson University, Seriki Sotayo, Ogun State, Nigeria

Corresponding author: Cynthia.Chilaka@UGent.be

Abstract

Fumonisin, zearalenone, and trichothecenes are the most common Fusarium mycotoxins contaminating a wide range of crops and food products worldwide. They have been implicated in several toxic health effects on humans and animals which may be acute or chronic. Of great concern is the co-occurrence of Fusarium mycotoxins and their modified forms in foods which may result in synergistic and/or additive effects on the host. To date, studies have paid little attention on the occurrence of Fusarium mycotoxins in Nigeria's food system. The present study reports the incidence and co-occurrence of Fusarium mycotoxins in traditional fermented cereal-based products (ogi) and soybean powder used as weaning foods in Nigeria. A total of 60 samples of ogi (n=30) and soybean powder (n=30) were randomly sampled from selected markets in the Derived Savanna zone in Nigeria between September and October, 2015. The samples were analysed and quantified for Fusarium mycotoxins with a multi-mycotoxin liquid chromatography-tandem mass spectrometric (LC-MS/MS) method. The data obtained revealed the occurrence of 13 and 10 Fusarium mycotoxins in ogi and soybean powder, respectively, with dominant mycotoxins for ogi being fumonisin B1 (93%, range: 67-1,903 µg/kg) and zearalenone (80%, range: 28-388 µg/kg) for soybean powder. Co-occurrence of at least 2 Fusarium mycotoxins was observed in 93% and 87% of ogi and soybean powder, respectively. The high levels of contamination and co-occurrence of Fusarium mycotoxins in the samples may predispose infant consumers to toxic health effects of mycotoxins. This study reveals the need for frequent monitoring of these toxins in food products, and the establishment of a food safety action plan along the process chain as an intervention strategy.

Key words:

Fusarium mycotoxin, LC-MS/MS, ogi, soybean powder, Nigeria



O4-9. Development of International Mycotoxin Alliance

Y. Martin Lo¹, Sarah De Saeger², and Charles Wilson³

¹Biointellipro LLC, Ashton, Maryland, USA and College of Biological Science and Engineering, Fuzhou University, Fujian, China

²Ghent University, Laboratory of Food Analysis, Ottergemsesteenweg 460, B-9000 Ghent, Belgium

³World Food Preservation Center, Shepherdstown, West Virginia, USA

Abstract

The International Mycotoxin Alliance (IMA) aims to coordinate expertise around the globe to integrate actions tackling mycotoxin, the most critical problem damaging the health of many people in developing countries. Aflatoxins for instance cause liver cancer while aflatoxins and fumonisins are related to stunting in African children. Co-occurrence of multiple mycotoxins in one crop as well as effects of climate change make this research complex. The mycotoxin problem needs to be tackled in a multi-disciplinary way primarily focusing on prevention measures, but mycotoxin analysis for monitoring and control purposes is definitely needed. The developing countries suffer from several problems related to mycotoxin analysis. First, analytical tests are expensive and there is a lack of expertise. Only a limited number of laboratories perform the tests. Most pronounced is the lack of training in analytical methods as well as in use and trouble-shooting of the analytical equipment. This makes it difficult for developing countries to be engaged in mycotoxin monitoring activities as their developed counterparts do. The gap in capacity needs to be addressed. This project has three distinct stages centering on a core question—“Do the technical competencies suffice?” Not only does it serve as a deciding criterion that evaluates the progress of each stage before advancing, but it also serves as a feedback loop that connects the latter stage back to the former when needed. Each of the stage has its own specific objectives and will be carefully assessed to establish solid foundation for the next. We aim to equip developing countries with proper equipment and instrumentation to understand their environmental baseline, then by bringing in biological control adequate for the region to alleviate the problem, and collectively establish a database to provide guidelines to farmers on their control strategies.



O4-10. Development of International Mycotoxin Alliance

Y. Martin Lo¹, Sarah De Saeger², and Charles Wilson³

¹Biointellipro LLC, Ashton, Maryland, USA and College of Biological Science and Engineering, Fuzhou University, Fujian, China

²Ghent University, Laboratory of Food Analysis, Ottergemsesteenweg 460, B-9000 Ghent, Belgium

³World Food Preservation Center, Shepherdstown, West Virginia, USA

Abstract

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O4-11. Nutritional and Economic Postharvest Losses of African Leafy Vegetables Along the Supply Chain

Gogo E.O.^{1,2*}, Opiyo A², Ulrichs C¹ and Huyskens-Keil S¹

¹Humboldt-Universität zu Berlin, Faculty of Life Sciences, Division Urban Plant Ecophysiology, Lentzeallee 55-57, 14195 Berlin, Germany

²Egerton University, Department of Crops, Horticulture and Soils, P.O. Box 536, 20115 Egerton, Kenya

*Corresponding author: elishag6@gmail.com

Abstract

Over the last decade, African leafy vegetables (ALVs) such as African nightshade (*Solanum scabrum* Mill.) have featured increasingly in both formal and informal markets in the peri-urban and urban centers of Africa. They are rich in vitamins, minerals, proteins, and dietary fiber and antioxidant compounds. As such, they are recognized as high value crops that can help in meeting the problem of unemployment, poverty and malnutrition ("hidden hunger") in developing countries. The crop is however highly perishable with more than half of the harvested crop being lost before it reaches the consumer. There is lack of appropriate postharvest handling and treatment, storage or refrigeration facilities for ALVs in Kenya. This is compounded by scanty information on postharvest losses of the ALVs thus making the management of such losses along the supply chain very difficult. The objective of the present study was to determine the nutritional and economic postharvest losses of African nightshade plants along the ALV supply chain. The study was conducted in the three main commercial ALVs producing counties in Kenya, i.e. Nakuru, Kisii and Kakamega, where three farmers from each county were randomly selected. The farmers were allowed to do their normal routine ALVs handling procedure right from harvesting to marketing as samples were collected at each supply chain stage (at harvest, before transport, after transport and at the market). Dry matter, macro-nutrients (N, P, K, Ca and Mg), micro-nutrients (Fe and Zn), protein, carotenoids, chlorophyll content and cumulative and economic postharvest losses were evaluated. The results revealed that the dry matter along the supply chain (from harvest to marketing), reduced by 32.8-45.5%, depending on the county. The mineral elements and protein were reduced by 3.2-29.4% while chlorophyll and carotenoid contents declined by 70.9-90.9% and 70.4-91.9%, respectively. Cumulative quantitative losses increased by 71.8-292.4% while the economic losses ranged from 12.6-34.4%. The findings indicate the immense loss of nutritional, quantitative and economic attributes of African nightshade plants along the supply chain. Managing postharvest losses and maintenance of quality attributes of ALVs should be key actions to improve the food nutrition, health and security situation in developing countries.

Keywords:

African indigenous leafy vegetables, Food losses, Postharvest losses, Postharvest quality, Shelf life, Traditional leafy vegetables



O4-12. Biodegradability of Mycotoxins in Anaerobic Digestion: A New Solution to Valorize Highly Contaminated Mycotoxin Batches?

M. De Boevre¹, K. Audenaert², B. Willems³, L. De Gelder⁴, And S. De Saeger¹

¹Ghent University, Laboratory of Food Analysis, Ottergemsesteenweg 460, B-9000 Ghent, Belgium - marthe.deboevre@ugent.be

²Ghent University, Department of Applied Biosciences, Valentin Vaerwyckweg 1, B-9000 Ghent

³Innolab CVBA, Derbystraat 223, B-9000 Ghent

⁴Ghent University, Laboratory for Environmental Technology, Valentin Vaerwyckweg ¹, B-9000 Ghent

Abstracts

Mycotoxins are toxic, low-molecular-weight, secondary metabolites produced by fungi. They occur worldwide in a variety of food and feed commodities, and are of major public health concern because they are the most hazardous of all food and feed contaminants in terms of chronic toxicity. Anaerobic digestion, with the production of biogas, is widely employed to treat organic-biological waste (OBW). In Belgium, 40 biogas plants are in operation or under construction with a total processing capacity of 2.234 million tons per year, of which 9 thermophilic and 31 mesophilic installations. In Africa, the biogas industry is a growing field as biogas represents an opportunity to increase the African energy mix and the potential to increase electricity generation. Also, it is a sustainable and renewable option, helps eradicate poverty by promoting energy jobs, and can be generated all over the country. Biogas plants in Africa are existing, however, are still in different stages of development. Sixty percent of the input in anaerobic digesters is OBW, however there is still specific legislation concerning the presence of certain contaminants in the waste. Specifically, for mycotoxins, Public Waste Agencies reject the processing of OBW in digesters due to insufficient guarantees regarding the effect of the mycotoxins on the anaerobic digestion process itself, and the mycotoxin degradation which influences the subsequent marketing of end products, such as fertilizers or soil improvers in agriculture. This presentation gives an overview of the biodegradability of aflatoxins, deoxynivalenol, zearalenone, fumonisins, ochratoxin A, T-2 toxin and ergot alkaloids in thermophilic and mesophilic digestion installations. Digestates were analyzed with a newly-developed and validated liquid chromatography tandem mass spectrometry (LC-MS/MS) method for the simultaneous determination of the mentioned mycotoxins in aqueous matrices. In addition, the mycotoxin-background concentration of agricultural soils in Flanders was verified using LC-MS/MS, in order to verify whether digestates originating from contaminated batches would significantly contribute to the overall mycotoxin concentration in soil. The obtained knowledge gleans crucial information to valorize highly-mycotoxin-contaminated OBW-batches in biogas digestion installations, and opens doors to stop the food losses in export due to mycotoxin-rejected batches.



P4-1. Moisture Content, Insect Pests, Mycotoxin Levels in Maize In Three Districts In The Middle Belt Of Ghana

J. K. Danso¹, E. A. Osekre¹, N. Manu¹, F. H. Arthur², J. Campbell², G. Mbata³, G. P. Opit⁴

¹Dept. of Crop and Soil Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

²USDA-ARS Center for Grain and Animal Health Research, 1515 College Ave.², Manhattan, KS 66502, USA

³Dept. of Biology, Fort Valley State University, 1005 State University Drive, Fort Valley, GA 31030, USA

⁴Dept. of Entomology and Plant Pathology, Oklahoma State University, 127 Noble Research Center, Stillwater, Oklahoma 74078, USA.

Corresponding Author: george.opit@okstate.edu

Abstract

Insect pest infestation and mycotoxin contamination of maize threatens food safety and security and contribute to low farm income, especially in the tropics where maize is a staple. Thus knowledge of factors such as moisture content and environmental conditions that facilitate insect pest infestation and mycotoxin contamination is critical in implementing mitigating strategies. This study focused on post-harvest losses of maize by assessing grain moisture content, insect pests, and aflatoxin and fumonisin levels of maize on-farm and post-drying stages during the major and minor cropping seasons in the middle belt of Ghana. Data showed that maize moisture content decreased significantly from the field stage (17.2–19.0%) to the post-drying stage (12.4–14.2%). The mean grain moisture content was significantly higher in the major season (20.4%) than in minor season (12.5%). *Sitophilus zeamais* Motschulsky, *Sitotroga cerealella* Olivier, *Cathartus quadricollis* Guerin-Meneville and *Carpophilus dimidiatus* Fabricius were the dominant insect species that attacked maize on-farm in the middle belt of Ghana. Mean numbers of insects were significantly ($P < 0.05$) higher in the minor season (7.9 per 500 g) than in the major season (6.3 per 500 g), but in both seasons, higher numbers of insects were detected at the heaped stage (9.6 per 500 g) compared to the field and post-drying stage (≤ 6.8 per 500 g). Percentage insect damaged kernels (%IDK) was significantly ($P < 0.05$) lower at field stage (0.4%) than at both the heaped and post-drying stages where similar levels were observed ($\geq 0.6\%$). Mean aflatoxin (ppb) and fumonisin (ppm) levels were significantly higher in the major season (29.1 ppb, 1.6 ppm) compared to the minor season (3.5 ppb, 1.0 ppm). These data show that effort should be made to promptly harvest, dry, shell and store maize during the major cropping season to reduce mycotoxin contamination and insect infestation.

Keywords:

Aflatoxin, fumonisin, insect pests, maize post-harvest losses, food security



P4-2. Hermetic Storage for Controlling Postharvest Losses and Aflatoxin Contamination on Maize in Kenya

J. Ng'ang'a^{a, b}, C. Mutungi^{b, c*}, S. Imathiua, H. Affognon^d

^aDepartment of Food Science and Technology, Jomo Kenyatta University of Agriculture and Technology, P.O. Box 62000-00200, Nairobi, Kenya.

^bInternational Centre of Insect Physiology and Ecology, P.O. Box 30772-00100, Nairobi, Kenya.

^cDepartment of Dairy, Food Science and Technology, Egerton University, P.O. Box 536-20115, Egerton, Kenya.

^dInternational Crops Research Institute for the Semi-Arid Tropics, P.O. Box 320, Bamako, Mali.

*Corresponding author E-mail: cmutungi@icipe.org

Abstract

Hermetic technologies have been promoted in recent years for chemical-free storage of grains. We investigated the effectiveness of triple-layer hermetic bags for halting insect damage, and the effect on mould and aflatoxin contamination in rural on-farm maize stores in Eastern Kenya. Farmers were randomly selected, shelled maize purchased from them after harvest and filled in the hermetic, jute or woven polypropylene (PP) bags and kept in the farmers' own stores for 35 weeks. Grain moisture content (M.C.), insect population, grain damage and weight loss, and total mould were examined at the onset of the trial and after every 7 weeks, while aflatoxin contamination was examined at trial onset and after 14, 28 and 35 weeks. Temperature and relative humidity in the trial site and inside the bags, as well as oxygen and carbon dioxide levels in the hermetic bags were monitored. Moisture in the maize packed in hermetic bags remained significantly higher ($P < 0.05$) than in PP and jute bags in the last 14 weeks of storage. The maize stored in hermetic bags remained free from insect infestation, while PP and jute bags permitted profuse build-up of insect populations causing grain damage of up to 82.3% that corresponded to 48.5% weight loss. Total aflatoxin contamination of maize stored at an initial M.C. $< 13\%$ and $13 - 14\%$ increased significantly in PP and jute bags (5 - 8 folds) but not in the hermetic ones. Total aflatoxin contamination of maize stored at an initial M.C. $> 14\%$ increased in the three types of bags (hermetic, PP, jute). The findings of this demonstrate that hermetic bags are effective in controlling losses caused by storage pests and can prevent aflatoxin accumulation if grain moisture is below 14%. Pre-storage precautions should emphasize proper drying.

Keywords:

Maize, hermetic bags, on-farm storage, storage pests, aflatoxin.



P4-3. Evaluation of Maize Drying Systems to Aid Smallholder Farmers Mitigate Post-Harvest Losses in Sub-Sahara Africa

Dirk Maier^{1,*}, Sam Cook¹, Grant DeVries¹, Laura Greig¹, Trevor Stevenson¹, Ben Plumier^{1,2}, Chukiat Chotikasatian^{1,3}, Kizito Nishimwe^{1,4}, Francis Aboagye-Nuamah^{1,5}

¹Iowa State University, Iowa, USA

²Kansas State University, Kansas, USA

³Kasetsart University, Thailand

⁴University of Rwanda, Kigali, Rwanda

⁵Kwame Nkrumah University of Science and Technology, Ghana

*Corresponding author: e-mail: dmaier@iastate.edu

Abstract

Reducing post-harvest loss is critically important to improve food security for smallholder farmers and populations in Sub-Sahara Africa. Approximately a third of the world's food production is lost at post-harvest stage. Reduction of moisture content to safe storage levels after harvest is critical for staple crops (cereal grains, pulses, oil seeds) to prevent spoilage from molds, mycotoxins and insects. Numerous drying systems have been developed and introduced for use by smallholder farmers who typically harvest grains by hand from two hectares of land or less. In many cases, drying systems have not been properly evaluated before deployment, and thus technology transfer and adoption have failed. Recently, two drying systems have been developed and evaluated that consider critical engineering parameters related to design and operation in the local context, the Vietnamese-designed STR small batch circular column dryer and the AflaStop shallow bed dryer developed in Kenya. Characteristic of both systems is that they can be built using local materials, operated with locally available energy sources, and achieve reasonable drying rates (i.e., hours instead of days). With a focus on Ghana, this project evaluated the sourcing of local materials, construction of the two drying systems, combination of the AflaStop biomass-fueled heat exchanger and STR circular column drying bed, and efficiency and overall success of achieving target maize drying rates at design airflow rates. Using the combination of the AflaStop biomass burner/heat exchanger and STR circular column drying bed, drying rates ranged from 1.5-2.2 points of moisture removed per hour for approximately 280 kg of shelled maize. The maize had a final moisture content of approximately 13% with no substantial loss in test weight or damaged grain after drying.

Key words:

Biomass burner, drying systems, drying rates, post harvest loss



Work Stream 5

**Policy, practice, gender angles in
postharvest Management**



O5-1. Extension and Learning Platform for Postharvest and Agro-processing

LEONIDES HALOS-KIM (ENGR.)

Director, Postharvest and Agro-processing Extension

Sasakawa Africa Association (SAA), Addis Ababa, Ethiopia

E-mail: l.halos-kim@saa-safe.org | Telephone: +251 911229789

Abstract

The reduction of postharvest losses through the adoption of improved postharvest handling technologies had been the subject of many research and development programs. Many postharvest technologies resulted from these efforts, but there is insufficient evidence that they reach the intended users. Bringing knowledge and technologies to farmers and processors requires a concerted effort among the development agents in order to show impact. Sasakawa Africa Association (SAA) had developed an extension model to improve the adoption of postharvest handling and agro-processing technologies through the establishment of a Postharvest Extension and Learning Platform (PHELP). The PHELP is a venue to showcase improved postharvest handling and processing technologies, their operational requirements and their associated benefits. It is operated under actual circumstances which affects system efficiency, management and profitability of the different technological options demonstrated. The platform also serves as a venue for training extension staff and producers while providing more information on their utilization potentials and constraints which are useful in fine-tuning technologies, or developing and adopting technology dissemination strategies. Using the facilities in the PHELP, extension agents are trained as frontline postharvest extension staff. They in-turn train the producers (farmers and processors) in the proper use and management of the technologies. In the long-run, the PHELP, facilitated by the extension agents, is expected to develop into a profitable enterprise that can generate income to pay for its operating costs. The PHELPS in Mali and Ethiopia had resulted in increasing use of the technologies by farmers. Sustained operation of the PHELP however requires good group and enterprise management, access to new technologies and services, and linkage to market. Institutionalizing the PHELP under government programs will make it an effective extension and learning platform, to facilitate the adoption of postharvest technologies.

Key words:

Enterprise, Extension, Platform, Market Access, Postharvest, Strategy, Technological Options



O5-2. Scoping Study on Gender Mainstreaming in the Agriculture Sector in Kenya

Margaret Hutchinson¹ and Faith Kasiva² Wanjiku Kabera³

¹Department of Plant Science and Crop Protection, University of Nairobi, P.O. Box 30197-00100, Nairobi, Kenya.

²UN WOMEN Kenya Country Office, UN Complex, Gigiri, Block M, Ground Floor, P.O. Box 0218-00100, Nairobi, Kenya

³African Women Studies Center University of Nairobi P.O. Box 30197-00100, Nairobi, Kenya. Corresponding Author: hutchjesang@yahoo.com

Abstract

Agriculture is a key driver of Kenya's economy accounting for about 25% of the GDP. Kenya's women and youth make a significant, although frequently 'invisible', economic contribution, mainly in agriculture and the informal business sector, while men dominate the formal sector. The performance of the agricultural sector is seriously compounded by persistent gender inequalities in access to productive resources, assets, finance and services, which in turn limit productivity and agricultural outputs. Over 75% of women live in rural areas where they undertake farming. In addition, women make up nearly half of all small and medium enterprises but their businesses tend to be smaller and are less likely to grow. The objective of the study was to document ongoing gender mainstreaming initiatives at the policy level and community level in the agricultural sector in Kenya. The study used purposive sampling and a semi-structured questionnaire, desk study, personal interviews and validation of information was conducted between 2015 and 2016 in Nairobi. The key informants included development partners, UN Agencies, key national and county government ministries as well as farmer organizations working in Kenya. The main findings of the study indicated that while there are many gender focused programmes, the policy frameworks are either non-existent, weak or are in the process of being put in place. The study provides possible strategies to mainstream gender in the Agriculture sector in a sustainable manner.

Key Words:

Gender Mainstreaming in Agriculture, Policy, UN Women-Kenya



O5-3. Postharvest Training and Services Centers Can Reduce Postharvest Losses in Developing Countries.

Mohmad Arief Zargar

Department of Botany, University of Kashmir, Srinagar-190006, India. arifk11@yahoo.co.in

Abstract

The biggest cause of postharvest loss in developing countries is lack of know-how/knowledge regarding the causes of postharvest losses and its prevention. Since stakeholders (growers, traders, marketers, and retailers) do not know root cause of problem, how can they address it? In most cases, even simpler and cheaper solutions can make huge differences, but only when stakeholders know the cause and methods to control it. Improper harvesting and obsolete practices of post harvest handling, management and processing are responsible for huge post harvest losses of fresh fruits (apple and cherry) and vegetables (onion and potato) in Kashmir (India). Commodity System Assessment (CSA) (through well-structured questionnaires) revealed improper harvesting and temperature mismanagement of apple and cherry, while postharvest sprouting of onions and potatoes as the big causes of postharvest losses. These losses can be reduced drastically by simply following standard/proper procedures of harvesting and post harvest handling/processing. That too is possible at no or little additional cost, but certainly with high returns. However, stakeholders, especially growers, neither know the cause of problem nor the means of its remedy. Thus, first important step to reduce postharvest losses should be to sensitize and practically educate stakeholders about the causes of problem, and the need and ways to control it through simple and cheap techniques. Though technologies do exist in developed world to address various causes of postharvest loss, but stakeholders in developing world (like Kashmir) either do not have access/means to these technologies or do not have knowledge about them. So first and foremost step in addressing postharvest losses would be practical education/training of stakeholders at ground level and that is only possible through Postharvest Training and Services Centers (PHTSC). Governments or NGO's or other organizations should set up PHTSC's in their respective states in order to impart practical training to stakeholders.

Keywords:

Postharvest, Losses, Training, Education, Knowhow, Handling, Developing Countries



O5-4. Post-harvest losses in Jhapa: Technology prospects and its constraints

Sudarshan Ananta Nepal
Central Department of Economics, Tribhuvan University
Correspondence: sudarshannepal100@yahoo.com

Abstract

Nepal is the agrarian's economy with more than half of population dependent to it. Around 84 percent people are residing in the rural area with limited access to education, employment opportunity, health facilities and so on. Nepal food insecurity and hunger is alarming factor which not only prevails in few food deficit districts. Due to geographical diversity many people in Mid and Far West Region live in small and isolated communities resulting to difficult food assistance. However, more food grains can be made available by reducing the loss in various post-harvest operations. Around 60-70 percent of production remains with the farmers which result to large storage losses especially in Terai belt of Nepal. The objective of the paper is to highlight the major post-harvest techniques followed in district of Jhapa which lies on Terai region of Nepal and outlining the main hindrances for post-harvest losses. The study is based on a sample survey of 125 rice farmer from Jhapa district in Terai region of Nepal. Farmers are selected from the different villages of upper and lower parts of Jhapa. Agriculture processing will help to minimize the qualitative and quantitative deterioration of material after harvest. Home scale storage practices are most common practice in survey field resulting to high storage losses. Small household admitted that they lack connectivity to storage facilities nearby. Weekly market has supported farmers to reduce post-harvest on fruits and vegetable items. Firstly the household farmers should be given access to effective storage technologies to avoid post-harvest losses of vegetable and fruits in this region of Nepal. Although the poverty has reduced in recent year declined largely attributing to the circular migration and influx of remittance; the sustainability of poverty reduction is uncertain in the long run as contributing factor for poverty reduction are particularly exogenous and are subject to external vulnerability.



O5-5. Gender Roles, Relationships, and Social Equity in Post-harvest Management

Talentus Mthunzi, Elizabeth Mketiwa Mnyandu, Kouboura Alice A. Djinadou Igue, Pedro Tomo and Sithembile Ndema Mwamakamba
Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN)
141 Cresswell Street,
Weavind Park
Pretoria 0184
South Africa
E-mail: tmthunzi@fanrpan.org

Abstract

Research has shown that women and children play a major role in farming as they provide labour for all agricultural activities. Apart from on-the-farm activities, women are also heavily engaged in postharvest activities and preservation of food to ensure that it is available for the whole family in and out of season. Addressing gender issues within the postharvest management (PHM) field is therefore imperative. In efforts to understand the challenges faced by women in PHM, the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) under the Postharvest Management in Sub-Saharan Africa project, conducted a study to look at how gender roles, relationships, and social equity issues affect PHM in Benin and Mozambique. Two focus group discussions and literature review were done. In Mozambique, a review of national, regional, and global literature on PHM, gender and social equity and interviews with policy key informants were conducted. The studies were also validated by national stakeholders in the focus countries through validation workshops. The studies highlighted that despite the women empowerment awareness campaigns conducted, there is a gap still existing in policies, programmes and projects delaying the realisation of gender and social equity in PHM. Gender and PHM strategy and policy documents must align to local and regional policy documents so that PHM gender mainstreaming becomes a national and regional responsibility. Increased involvement of smallholder farmers in PHM research trials and measurement of postharvest losses in the countries will also improve PHM interventions acceptability. Tools and innovations developed to aid post-harvest handling must meet requirements according to gender needs, age, and socio-cultural relevance.

Key Words:

Agriculture, Gender, Innovations, Postharvest Management and Loss, Technologies.



O5-6. Policy Frameworks for Food Standards Related to Post-Harvest Management of Grains and Pulses

Talentus Mthunzi, Elizabeth Mketiwa Mnyandu , Victor B. Anihouvi , Dr Ivone Moucha and Sithembile Ndema Mwamakamba

Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN)

141 Cresswell Street,

Weavind Park

Pretoria 0184

South Africa

E-mail: tmthunzi@fanrpan.org

Abstract

Smallholder farmers experience huge post-harvest losses (PHL) due to physiological, physical and environmental causes. The conditions that induce high crop perishability include mechanical damage; excessive exposure to high ambient temperature, relative humidity and rain; contamination by spoilage fungal and bacteria; invasion by birds, rodents, insects and other pests; and inappropriate handling, storage and processing techniques. However, poor infrastructure and lack of enabling policy environment tend to exacerbate the effects of post-harvest losses. Effective post-harvest systems are needed to ensure that the harvested food reaches the consumer, while fulfilling food standards in terms of quality, volume and safety. The Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) under the Postharvest Management in Sub-Sahara Africa project, undertook country case studies to analyse existing policy frameworks for food standards and norms related to post-harvest management of grains and pulses in Benin and Mozambique. Evidence from the studies show that there are no post-harvest management (PHM) policies and standards that support and guide PHM at both national and community levels in both countries. The studies conclude by recommending the need for developing appropriate regulatory frameworks aimed at post-harvest losses in rural food supply chains. The rural food supply chains are necessary in the improvement of food security of communities in Sub-Saharan Africa. Policies and standards should be developed to facilitate adoption and implementation of good post-harvest handling practices options thereby reducing post-harvest losses at community level and contributing towards food and nutrition security.

Key words:

Benin, Postharvest Management, Mozambique, Regulatory frameworks, Standards and Norms



P5-1. Ramping up the Training, Equipping and Support of Postharvest Extension Specialists in Africa

Cathy Kitinoja and Lisa Kitinoja, The Postharvest Education Foundation
PO Box 38, La Pine, Oregon 97739, USA
Corresponding author email: kitinoja@postharvest.org

Abstract

Agricultural extension education includes the study of approaches for assessing training needs, designing informal outreach programs, using appropriate teaching methods, designing practical training aids, and monitoring/evaluation of the outcomes. The topic of focus for most extension education graduate studies are agricultural production or agricultural marketing. In Africa there are active graduate programs in postharvest technology, but these still tend to highlight research skill development, laboratory studies and formal classroom teaching. How are young extension professionals in North and Sub-Saharan Africa going to gain the expertise and confidence they need to work successfully with the users of appropriate technologies for improved postharvest handling, storage and/or processing practices? How will countries achieve the targets set by the 2014 Malabo Declaration in Africa (to halve current levels of Postharvest Losses by 2025) or Sustainable Development Goal 12.3 (reducing food loss/waste by 50% by 2030)? The Postharvest Education Foundation (PEF) has been training young professionals as Postharvest Specialists since 2012. To date 100 trainees in 18 African countries received a year of intensive e-learning based training, were equipped with practical tools and training aids, and receive on-going mentoring and technical support. Those trained in postharvest loss assessment, improved small-scale technologies and extension methods have developed postharvest outreach programs that reach approximately 30,000 smallholder clientele per year. While PEF has successfully trained 100 Postharvest Extension Specialists in SSA in the past 6 years, thousands more postharvest specialists are needed to reach the millions of Africa's smallholder farmers, traders, processors and marketers. PEF plans to ramp up the training to reach 500 young agricultural professionals per year, with a goal of training 2000 new Postharvest Extension Specialists by 2020. Training materials will be developed into a self-guided manual, and provided to users in open access format. Graduates are expected to work as postharvest researchers, professors, subject matter specialists, extension workers, NGO training staff, and/or in private sector as independent postharvest consultants.

Key words:

outreach, capacity building, postharvest extension



P5-2. Postharvest Loss Assessment Along the Tomato Value Chain in Lilongwe District, Malawi

Jacinta Andrew Nyaika¹, Pemphero Kashoni¹ and Sibongile Zimba Chimzinga¹

¹Lilongwe University of Agriculture and Natural Resources-Bunda Campus, Lilongwe Malawi.

Corresponding author: jnyaika@bunda.luanar.mw

Abstract

A study was conducted to assess the magnitude and factors that cause postharvest losses of tomato along its value chain. Tomato is one important vegetable crop in Malawi that is utilized by almost every household, but the crop is highly perishable. The study was conducted in Lilongwe district with 42 farmers from Thunga Association in Mkwinda Extension Planning Area (EPA), 35 middle men who buy from these farmers and 30 vendors who sell in Lilongwe urban markets. Two supermarkets were also consulted to provide information on the quality and quantity of tomato losses they experience. It was conducted in the main tomato growing season during March-May, 2016. A modified commodity systems assessment method was carried out to collect data by tracking the sampling units along the tomato value chain. Qualitative and quantitative data was collected for data analysis using Statistical Package for Social Scientists (SPSS) version 17. Results indicated that factors that contribute to postharvest losses are environmental, mechanical, biological, physiological and cultural practices. Farmers had limited knowledge in production and postharvest management of tomato. Notably, harvesting practices contributes 04.84% of the losses, storage 10.66%, transportation 15.06%, pathology 16.24% and market infrastructure 08.20%. The study also noted some conventional tomato postharvest technologies used by farmers in Lilongwe district. In conclusion, fresh tomato losses range from 05-50% along its value chain. It was recommended to put in place strategic plans for training farmers on tomato good agricultural practices and postharvest management practices, alternative ways of using and disposing of tomato waste and need for investing in product development for the crop to reduce losses. The government of Malawi needs to improve the market infrastructure to suit the needs for storage of the tomato crop and enhance its marketing for the export market.

Key words:

diseases, respiration, storage, transportation, temperature and humidity



Work Stream 6

**Food loss and waste assessment in
agricultural value chains
– the Metrics**



O6-1. Postharvest Losses along the Cooking Banana, Potato and Cassava Fresh Value Chains in Uganda

Diego Naziri^{1,2 *}, Sarah Mayanja¹, Sam Namanda¹, Asha Nalunga⁴, Adebayo Abass⁵, Kelly Wanda⁶, Alex Tatwangire⁷, Caroline Nabukeera⁷, Enoch Kikulwe³

¹ International Potato Center (CIP), Kampala, Uganda;

² Natural Resources Institute (NRI), Chatham Maritime, UK;

³ Bioversity International, Kampala, Uganda;

⁴ National Agricultural Research Laboratories of the National Agricultural Research Organization (NARO), Kampala, Uganda;

⁵ International Institute of Tropical Agriculture (IITA), Dar es Salaam, Tanzania;

⁶ International Institute of Tropical Agriculture (IITA), Kampala, Uganda;

⁷ Makerere University, Kampala, Uganda

* Corresponding author: d.naziri@cgiar.org

Abstract

Policy makers and development practitioners are challenged by the paucity of reliable data on the extent of postharvest losses (PHL) for devising suitable policies and strategies for their reduction. This study estimates PHL at different stages of the cooking banana, potato and cassava fresh value chains in Uganda by using cross-sectional data. A distinction was made between physical losses (product disappearing from the chain) and economic losses (partially deteriorated product sold at discounted price). Our findings indicate that the non-marketed output incurs very low physical losses (apart from potatoes, primarily during harvesting and storage) and, by definition, no economic losses. Conversely, substantial losses are found along the market chain. Physical losses affect about 30% of traded potatoes, followed by bananas (21%) and cassava (3%). However, the cassava value chain is characterized by much higher economic losses (about 47% of marketed roots sold at discount due to their rapid postharvest deterioration) than in the case of bananas and potatoes (10% and 8%, respectively). Overall, out of the total marketed output, 50% of cassava, 38% of potatoes and 30% of bananas incur either physical or economic losses. However, unlike banana and cassava that are mainly subsistence crops, potato in Uganda is primarily produced for the market. This results in a proportion of total potato production incurring PHL much higher (36%) than for banana and cassava (about 12%). Nevertheless, being its annual production enormous in the country, the quantity of bananas affected by PHL is about 7 and 25 times higher than the one of cassava and potato, respectively. Banana and cassava retailers - primarily women - are the value chain actors incurring the highest losses while, for potato, wholesalers are the most affected. Our findings contribute to policy prioritization and show that a diverse set of interventions is required to tackle PHL.

Key words:

cassava, cooking banana, postharvest losses, potato, Uganda value chains



O6-2. Systematic Review of The Measurement of Postharvest Losses in Perishables in Brazil

Gilmar P. Henz, Embrapa Headquarters, Brasilia-DF, Brazil. E-mail: gilmar.henz@embrapa.br

Abstract

Postharvest losses (PHL) of perishables emerged as a problem in Brazil since the 1960's, when the country underwent a fast urbanization process. Since then, many publications on PHL have been produced, nevertheless just a few are known and used as references in both national and international publications. Thus, the objective of this paper was to document Brazilian publications on measurement of PHL of perishables. Bibliographic searches on measurements of postharvest losses of perishables were conducted using available databases in Brazil, such as SciELO and Google Scholar, and the Embrapa's library system. More than 100 scientific papers, reports and technical documents on PHL were found and individually examined. Studies reporting losses caused by postharvest diseases, mechanical damage and/or resulting from the use of technologies were not included. Forty-one publications were selected by title, objective and scope and categorized according to their measurement method (surveys/interviews or quantitative) and measured losses (physical, qualitative, and/or economic). Brazilian publications on PHL can be categorized into three major groups as (1) estimates/interviews with questionnaires; (2) measurement/quantitative methodology; and (3) economics/logistic studies. Most of PHL evaluations carried out in Brazil applied surveys and/or interviews as measurement method and presented loss results as physical or percentage. Studies applying quantitative methods usually reported results as qualitative loss, such as diseases, physical damage and appearance changes, as well as physical or percentages. A significant number of studies are related to economic losses in marketing and transportation. Any of the Brazilian experiences in measuring PHL can potentially be replicated in Africa, depending on the context, budget and interest. The quantitative PHL methodology and the economic/logistics studies are more science-based and therefore recommended.

Keywords:

post harvest losses, estimations, surveys, qualitative



O6-3. Post-Harvest Losses in Ethiopian Food Production System: The Case of Perishable Food Crops

Melese Temesgen

Assistant Professor In Food Science Technology & Nutrition

E-Mail: Melese2b@Gmail.Com

Phone: 0912097802,

Haramaya University, Ethiopia

Abstract

In Africa, field studies have shown that 40 to 50% of the perishable horticultural crops are lost before they can be consumed, (25 to 30%), for grains and root crops mainly due to high rates of bruising, water loss and subsequent decay. Post-harvest food loss is one of the largest contributing factors to food insecurity and under-nutrition. Factors for food loss are constraints in harvesting methods, storage, transport, process, cold chain, road infrastructures, and package and market integration system. In Ethiopia postharvest loss rates are reported to range from 30 to 50% depending on the crop. According to USAID, reports the post harvest losses for fresh produce are 40-50 % which contributes for food insecurity, poverty and breaks the capacity of the poor farmers. High postharvest losses result in reduced food availability, lower quality foods, and lower nutritional value and/or food safety dangers. Most of the past efforts in Ethiopia focused on development and dissemination of better yielding, disease resistant varieties for farmers along with production technology packages. With intensive extension and promotion of micro-irrigation and small-scale water harvesting, surplus production has been achieved. But when production is boosted, prices will fall if there is no means to extend the shelf life via improved postharvest handling, cooling, cold storage or processing into more stable food products. There is also limited qualified manpower and participation by food science and technology professionals in the sector, including at the policy advisory level. This clearly shows that there must be technology and training transfer on post harvest reduction. Therefore, any action on reducing post harvest food losses and waste will highly support the country currently pursuing in the growth and transformation plan. With context, in this paper, the overview of post harvest losses in African and specifically in Ethiopian food production system will be presented in detail.

Key words:

perishable, post-harvest, losses and poverty



O6-4. Farmer Post-Production Practices, Grain Losses and Perceptions in Maize-Based Smallholder Farming Systems of Zimbabwe

Brighton M. Mvumi¹, Alex A. Chigoverah^{1*}, Tafireyi Chamboko², Shinga Mupindu³

¹Department of Soil Science and Agricultural Engineering, Faculty of Agriculture, University of Zimbabwe, P. O. Box MP167, Mt Pleasant, Harare, Zimbabwe

²Department of Agricultural Economics, Faculty of Agriculture, University of Zimbabwe, P. O. Box MP167, Mt Pleasant, Harare, Zimbabwe

³Gender & Rural Development Trust, Harare, Zimbabwe

Corresponding author email: mvumibm@agric.uz.ac.zw or mvumibm@hotmail.com

*Presenting author: achigoverah@gmail.com

Abstract

Maize is a strategically important crop in attaining household food and income security in most sub-Saharan African countries. Inefficiencies along the post-production chain result in food losses with negative impacts on farmers' livelihoods but studies on the existing situation are scarce. A household survey of 310 farmers was therefore conducted in 2015 covering five major maize-producing districts of Zimbabwe to analyse post-production farmer perceptions and practices in the smallholder farming sector. Critical loss points and associated quantitative losses were identified as field drying and harvesting (12.8%), storage (9.8%) and homestead drying (6.8%). Losses at these points were attributed to unfavourable weather conditions, rodents, storage insect pests, termites and spillage. Farmers store grain mainly for household consumption, marketing and seed retention. The majority (95.5%) store their grain in shelled form. Use of stand-alone granaries for bulk grain storage is low (16.2%) with most farmers (78.3%) preferring to store in polypropylene bags placed either in living rooms (28%) or bedrooms (36%). Synthetic pesticides are widely used (96.5%). Phosphine use by some farmers is alarming and has serious safety implications on household and surrounding residents, pesticide-handlers and the environment. High fumigant use was attributed to reduced efficacy of available synthetic insecticidal dust, especially in larger grain borer-prevalent areas. Most grain is sold on local markets (61.3%) which offer immediate cash payments. Agricultural extensionists are pivotal in providing technical advice on production, post-production and marketing aspects. Results suggest the need for continuous capacity building of extension staff on post-production management aspects. Training of farmers and setting-up learning centres are important to help bridge the knowledge and practice gap and increase farmer adoption of environmentally-benign alternatives to conventional synthetic pesticides. The study discusses the findings in the context of changes that occurred over the last two decades, the major change-drivers, and policy implications.

Keywords:

household food security, income security, farming livelihoods, food losses, synthetic pesticides, phosphine fumigation, *Prostephanus truncates*



O6-5. Food Loss Assessment Study on Maize and Rice Value Chains in The Democratic Republic of Congo - Recommended Solutions and Strategies

Sumbu Zola Eric, Professeur à la Faculté des Sciences agronomiques, Université de Kinshasa. Agrochimiste. Téléphone: +243998331694, E-mail: sumbu_zola@yahoo.fr
Muteba Kalala Damien-Joseph, Professeur à la Faculté des Sciences agronomiques, Université de Kinshasa, Agroéconomiste. Téléphone: +243998264460, E-mail: [mutedadam@yahoo.fr](mailto:mutebadam@yahoo.fr)

NgondeNsakala Robert, Ministère D'Agriculture Pêche et Elevage, Directeur des services Nationales des statistiques Agricoles (SNSA), Agroéconomiste. Téléphone: +243815101894, E-mail: ngonde_robert@yahoo.fr

Myriam Annette, UN FAO consultant, Email : Myriam.Annette@fao.org

Abstract

Food loss assessment (FLA) on maize and rice selected supply chains was undertaken in the Democratic Republic Congo in the framework of the UN FAO, IFAD, and WFP joint project titled "Mainstreaming food loss reduction initiatives for smallholders in food deficit areas" funded by the Swiss Development and Cooperation agency. The project aims to improve food security and income generation opportunities through reduction of food losses in supported value chains. The results of the study serve for the formulation of recommendations on feasible loss reduction solutions and policy development. The FAO field case study methodology for FLA was used, combining different approaches (observations, interviews and group discussions, actual measurements and quality analyses) to identify major causes of losses, the critical loss points (CLP), assess quantitative and qualitative losses, and the feasibility of solutions. For maize, long field drying exposing cobs to a humid and hot climate and pests causes 10-15% of losses due to mold, and 7-8% due to insects; traditional and precarious storage facilities not weatherproof and letting rodents, insects, and mold, and long storage cause 5-20% of losses; 6-13% quantitative losses of during transport are caused by spilling. For retailers, losses after sieving and sorting are 4-6%. For rice, drying on racks or on the ground, insects, long storage in precarious infrastructure cause losses around 4-5%. Recommendations include dissemination of good practices and training of extension agents, producers and actors on best post-harvest management (PHM) practices; improving storage facilities for farmers and bulking stages, and access to efficient, feasible, and available storage and PHM equipment; appropriate use and maintenance of hulling/milling equipment; reinforcement of public services in charge of training on PHM and control of storage facilities.

Key words:

Case study, drying, food loss assessment, maize, storage, post-harvest losses, post-harvest management, rice, storage



O6-6. Rice Postharvest Loss Assessment in Bunkure LGA, Nigeria Postharvest losses measurement of irrigated rice in Bunkure Local Government Area in Kano State Nigeria

Antoine A ¹, Esther A.I² and Leonides H.K ³

¹ Sasakawa Africa Association (SAA), Bamako, Mali. Antoine@saa-safe.org
+ 223 95 33 71 32

² Sasakawa Africa Association (SAA), Kano, Nigeria. eibrahim@saa-safe.org
+234 80 36 25 16 72

³ Sasakawa Africa Association (SAA), Addis Ababa, Ethiopia. L.halos-kim@saa-safe.org
+251 91 12 29 78 9

Abstract

Measurement of postharvest losses of irrigated rice, SIPI rice variety, from harvesting to winnowing/ Cleaning was carried out in Bunkure Local Government Area in Kano State of Nigeria to provide accurate data regarding the losses. The average quantitative cumulative loss is 6.34% with component losses from harvesting, threshing and winnowing/cleaning at 4.45%, 1.40% and 0.49%, respectively. Postharvest losses affecting rice production and food security in Nigeria. No simply and accurate method of measuring losses. The aim of this assessment is to make farmers understand the magnitude and causes of postharvest losses, and provide a reference information for policy-makers to design intervention program to reduce the losses. The activity was also conducted to develop a practical postharvest loss measurement aimed at improving data availability on postharvest losses which could be replicated for other crops. Actual field measurements were conducted involving extension staff and participating farmers. Five rice fields of 2,000sq.m each were randomly selected from area. Six sampling plots of 3sq.m each were randomly selected from farmer rice field where harvesting, threshing and cleaning of rice were conducted using traditional practice. In each process, the grain losses which are edible were collected, cleaned, measured (weight and moisture content) and calculated by using the respected formula. The average quantitative cumulative loss is 6.34% with component losses from harvesting, threshing and winnowing/cleaning at 4.45%, 1.40% and 0.49%, respectively. Harvesting losses were incurred from cutting of the straw, laying, collecting and transporting to stack until further processed and consists mostly of shattered grain and missed grains during cutting. The traditional method is mainly manual; the attitude of harvester (farmer) has a significant effect. The measurement of threshing and cleaning losses is more straightforward as they are done in designated area in the farmstead, and consist of un-threshed and spilled grains. The amount of grains lost due to poor handling cannot be ignored when addressing food security. Sasakawa Arica Association / Sasakawa Global 2000 had started to introduce improved methods of harvesting and threshing/ cleaning of rice, and other grains, to reduce losses and drudgery, and to improve the quality of the grains.

Key words:

Bunkure, Cleaning, Harvesting, Irrigated Rice, Nigeria postharvest loss measurement.



O6-7. How are Post-harvest Loss Estimates for Sub-Saharan Africa Obtained?

Nkoyo Etim Bassey^{1*}, Arnim Kuhn¹, Victor Okoruwa²

¹Institute for Food and Resource Economics, University of Bonn, Nussallee 21, 53115 Bonn, Germany

²Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria

Corresponding author's e-mail address: nkoyo.bassey@ilr.uni-bonn.de (N. E. Bassey)

Abstract

Reliable and consistent post-harvest loss (PHL) estimates are required to identify where interventions are needed. However, estimates differ considerably between studies and databases, especially region-wide estimates; making the extent of loss uncertain. This study reviews methodologies used to provide the magnitude of PHL in Sub-Saharan Africa with the aim of understanding how estimates are obtained. The focus was on region-wide studies, databases, and micro-level studies which have provided loss estimates in the last decade (2005 – 2015). The procedures of 2 databases, 2 region-wide studies and 45 micro-level studies were reviewed. Findings show that micro-level studies are the most crucial in providing region-wide loss estimates, as they form the basis for consolidations in region-wide studies and the development of conversion factors/ profiles used for databases. However, these micro-level studies are scarce due to both outright unavailability and a more crucial case of consequential unavailability, resulting from poorly documented procedures and inappropriate statistical analysis/ reporting. Consequently, consolidations and conversion factors/ profiles rely on some studies which are not recent, thereby overlooking the dynamic nature of PHL. Majority of the micro-level studies reviewed lacked thorough documentation of procedures, failed to report variability measures, or failed to indicate clearly which variability measure was reported. To provide reliable and updated estimates for the region will require avoiding consequential unavailability by improving documentation and reporting in micro-level studies.

Keywords:

Assessment methods, Micro-level, Post-harvest loss, Region-wide, Sub-Saharan Africa.



O6-8. Post-Harvest Loss Assessment in Cowpea, Maize and Sorghum Selected Supply Chains in Burkina Faso and Recommended Solutions and Strategies

Doulaye Diancoumba, Food technologist, Consultant, Burkina Faso, Email: doulaye.diancoumba@gmail.com

Alain Tagnan, Agro-économiste, Directeur de l'Administration et du Patrimoine de la Société Nationale de Gestion du Stock de Sécurité Alimentaire (SONAGESS),

Email : alain.tagnan@yahoo.fr

Hado Sawadogo-Ouédraogo, sociologist, Consultant, Burkina Faso, Email: hswadogo0383@gmail.com

Myriam Annette, UN FAO consultant, Email : Myriam.Annette@fao.org

Abstract

Food loss assessments (FLA) on cowpea, maize and sorghum selected supply chains (SC) in Burkina Faso have been undertaken in the framework of an UN Food and Agriculture Organization (FAO), the International Fund for Agricultural Development (IFAD) and World Food Programme (WFP) joint project "Mainstreaming food loss reduction initiatives for smallholders in food deficit areas" funded by the Swiss Development and Cooperation agency. The project aims to improve food security and income generation opportunities through reduction of food losses in supported value chains. The results of the study are used for the formulation of recommendations on appropriate solutions to be promoted and policy development. The FAO field case study methodology for FLA was used, combining different approaches (observations, interviews and group discussions, actual measurements and analyses) to identify major causes of losses, the critical loss points (CLP), assess quantitative and qualitative losses, and the feasibility of solutions. Gender perspective was also considered. Indicative levels of losses include the following: 5.4% at harvest for sorghum; while for maize, losses at harvest is about 3.5%, at shelling around 5.6%, at storage 2.7%, and during milling 37.5%. For cowpea, losses at harvest can reach 8.7%, at threshing and winnowing 1.1%, and at storage 35% when hermetic techniques are not used. The causes of losses have been identified and the following areas of interventions have been identified as priorities based on the findings: i) dissemination of harvest and post-harvest good practices; ii) awareness and capacity building of extension agents, producers on post-harvest losses (causes and consequences including those related to gender, best practices), and lobbying; iii) support producers' acquisition of appropriate post-harvest equipment: tarpaulins or threshing floor and hermetic storage techniques (silos, bags, plastic containers, etc.), and warehouses; iv) improve the efficiency of threshing operations, including mechanization; v) advocacy for the quality control of polypropylene bags.

Keywords:

Burkina Faso, food loss assessment, case study, producers, storage, cowpea, maize, sorghum, qualitative and quantitative losses.



O6-9. An Assessment of the Magnitude of Postharvest Losses in off-farm Grain Storage Systems in Kenya

Joseph Kibaki Mwangi^{1, 2}, Christopher Mutungi^{1, 2*}, Soul-Kifouly G. Midingoyi¹, Abdul Faraj², Hippolyte D. Affognon³

¹ International Centre of Insect Physiology and Ecology (icipe), Nairobi, Kenya.

² Department of Dairy and Food Science and Technology, Egerton University, P.O. Box 536-20115, Egerton, Kenya

³ International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), BP 320, Bamako, Mali

*Author for correspondence: cmutungi@icipe.org

Abstract

Since liberalization of the Kenyan grain marketing system in the 1990s, private sector actors play a big role in grain handling and distribution. For this reason, off-farm storage has become an important undertaking of large traders, small- and medium-scale grain aggregators, wholesalers, retailers, and millers. In the past, almost all studies conducted to address grain postharvest losses focused on storage at farm level. As a result, postharvest losses experienced in off-farm stores are unknown. Making such information available would help to improve postharvest management. A study was conducted to assess the magnitude of off-farm postharvest losses and the factors associated with them. A cross-sectional survey of 39 public and 74 private stores was conducted in 2014/2015 across Kenya. Key personnel in charge of grain storage were interviewed using structured questionnaires. The data were analyzed using multivariate regression by fitting a fractional logit model. The total perceived losses amounted to $18.4 \pm 2.6\%$, and were contributed mainly by insects ($7.2 \pm 1.0\%$), moulds ($5.7 \pm 0.2.1\%$), moisture ($3.4 \pm 0.5\%$); and rodents ($2.0 \pm 0.5\%$). Total losses in public and private stores were not significantly different ($p = 0.426$), insects, rodents and moisture contributed equally to the losses. However, losses caused by molds were significantly higher ($P = 0.0247$) in private stores. Higher losses were associated with the use of residual insecticides, purchasing low quality maize, reuse of storage bags, use of low grain standards and untimely intervention in pest control. Lower loss magnitudes were associated with short-term storage periods (< 2 months), adherence to phytosanitary requirements, cleaning and drying grain before storage, and treating grains within the first month of purchase. Similarities were observed in storage problems and magnitude of losses in public and private grain stores and the total losses exceed the economic threshold. Postharvest loss mitigation strategies should therefore strongly target off-farm in addition to on-farm storage.

Key words:

Grains, Kenya, off-farm storage, postharvest losses



O6-10. Expanding the African Postharvest Losses Information System - APHLIS+

Tanya Stathers¹, Bruno Tran^{1,2}, Marc Bernard², Felix Rembold³, Brighton Mvumi⁴, Jan Priebe¹, Frank Sonntag⁵, Rudolf Bock⁵

¹Natural Resources Institute (NRI), University of Greenwich, UK;

²AfricaRice, Benin;

³Joint Research Committee, European Commission;

⁴University of Zimbabwe;

⁵Agricultural Knowledge Management, Germany

E-mail: T.E.Stathers@gre.ac.uk

Abstract

The 2008 food crisis led development agencies involved in improving food security across sub-Saharan Africa to realise they needed a more accurate understanding of the level of postharvest losses of staple food crops occurring. The African Postharvest Losses Information System (APHLIS) was launched in 2009, bringing a rigorous knowledge management approach to cereal postharvest losses (PHL). The relevant scientific literature was critiqued and used to build profiles of the PHLs occurring along the value chains of nine cereal crops, by country and province for 37 sub-Saharan African countries. APHLIS provides estimates of PHL figures where direct measurements are not available. A network of African experts, input data specific to the season and province on influential factors such as weather during crop harvesting and drying, crop production figures, proportion of grain kept for farm storage or marketed, number of harvests, scale of farming, and for maize the presence or absence of the larger grain borer. An algorithm combines the PHL profile with the seasonal data for the focal location, to calculate a modified estimate of PHLs along the value chain for the specific local circumstances. APHLIS produces outputs as losses tables and maps presenting PHL data by % weight loss, tonnes lost, or loss density. These science-based loss estimates are available at www.aphlis.net. The systems' transparency enables the quality of the estimates to be evaluated. A downloadable calculator enables users to input production figures and fine-tuned seasonal factors to produce loss estimates for their specific location. Work has begun on APHLIS+, which is expanding to include: loss estimates for key root and tuber, and legume crops; methods for estimating financial and nutritional value of PHLs; risk warning systems; and an improved user interface to make APHLIS more accessible and user-friendly.

Keywords:

postharvest loss estimates; financial, nutritional and weight losses; database



O6-11. The Rapid Loss Appraisal Tool (RLAT) for Agribusiness Value Chains

Heike Ostermann, Margret Will, Kerstin Hell
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ),
Sector Project Sustainable Agriculture
Contact: Karl Moosmann
Friedrich-Ebert-Allee 36
53113 Bonn, Germany
karl.moosmann@giz.de

Abstract

The purpose of the Rapid Loss Appraisal Tool (RLAT) is to provide a sufficiently accurate pre-screening result in identifying intervention points along agribusiness value chains. The RLAT aims to identify incentives for value chain operators and to propose activities to reduce pre- and post-harvest losses by taking a holistic view on food losses. The results can be relevant for both food security purposes and for checking the viability of strategies to upgrade value chains that form part of rural economic development. As well, RLAT considers aflatoxin risk assessments to be an essential part of a comprehensive loss appraisal on crops that are susceptible to aflatoxin contamination and integrates them accordingly. The methodology supports the design of concrete interventions that have the primary aim of improving food security at the subsistence level, either on farms or in communities, and the secondary aim of upgrading specific value chains. The supporting literature is divided into two publications, the RLAT User Guide and RLAT Toolbox. Together they provide information on the requirements and use of RLAT as well as ready-to-use instruments and materials. The Rapid Loss Appraisal Tool is particularly useful for value chain projects that have a focus on reducing food loss and food waste along the chain as well as for professionals and stake holders working in this domain. Given that these documents provide hands-on support materials, the use of RLAT does not require scientists; technicians can quite easily manage the appraisal exercise. RLAT was designed to serve the needs of local or regional practitioners and not those of macroeconomic policymakers.

Keywords:

food losses, value chains, aflatoxin



O6-12. Gender Perspective Taken into Consideration in Food Loss Assessment Studies Undertaken in Burkina Faso

H Sawadogo-Ouédraogo¹, D Diancoumba¹, A Tagnan¹, M Totobesola² and A Safa²

¹Consultants, Burkina Faso

²UN Food Agriculture Organization (FAO)

Correspondent: Email: hsawadogo0383@gmail.com

Abstract

Food loss assessments (FLA) on cowpea, maize and sorghum selected supply chains in Burkina Faso have been undertaken in the framework of FAO, IFAD and WFP, joint project “Mainstreaming food loss reduction initiatives for smallholders in food deficit areas” funded by the Swiss Development and Cooperation agency. The project aims to improve food security and income generation opportunities through reduction of food losses in supported value chains. The results are used to formulate recommendations, appropriate solutions, and policy design considering gender dimensions. The FAO field case study methodology for FLA used is a gender sensitive tool. It comprises an inclusive language, analyses the roles played by women and men, by collecting sex disaggregated data. The results allowed getting a global perspective of the situation. The mechanized threshing and winnowing of maize is undertaken by both sexes with a more important burden on women. The sorghum’s shelling, delegated to men is now done by tractors, while winnowing, women’s task remains manual whatever the quantity. Several factors such as, limited participation in decision making, limited access to the grains, have demotivated women’s involvement. The recommendations highlight the importance of awareness raising, capacity development, and take into consideration the specific needs of both sexes in the promotion of post-harvest equipment, mainstreaming gender in the development of food loss reduction’s policies.

Key words:

Burkina Faso, food loss assessment



P6-1. Evaluation and Consumer Acceptance of Five Tomato (*Lycopersicon Esculentum* Mill) Cultivars in Northern Region of Ghana

¹Dari L., ²Nenguwo, N. and ²Afari-Sefa, V.

¹Department of Food Science and Technology, Faculty of Agriculture, University for Development Studies, Tamale-Ghana.

²AVRDC – The World Vegetable Center, Arusha, Tanzania,

Corresponding author's E-mail address: linddari@yahoo.co.uk, +233244959690

Abstract

Tomato (*Lycopersicon esculentum* Mill) is one of the most widely consumed vegetables in the world. It is a major horticultural crop with a global production of 153 million metric tonnes. However, Ghana records a low productivity (7.5 Mt/ha), even though tomato accounts for the highest area of cultivation of 44,100 sq.km compared to 19,400 sq.km for other vegetables. Many landraces or local cultivars are used in the northern region of Ghana including "Burkina", "Techiman" and "Wosowoso" with "Wosowoso" being the most grown within and around the Tamale Municipality. Farmers use their own saved seeds or purchase seeds of local cultivars because they are relatively cheap compared with the foreign and well packaged seeds sold in agro-input shops. It is estimated that tomato yields for Northern and the Upper regions should be between 33,000 and 38000 kg/ha during the dry season with irrigation and good soil management, but farmers often achieve less than half of these yields. The aim of this study was to evaluate the quality and shelf-life performance of some selected tomato varieties in comparison with the local landraces commonly grown by farmers in the Northern region of Ghana. Seeds of "Wosowoso" (farmers' own seeds), Popvriend tomato seeds from Holland, Tanga, Tengeru 1997 and Tengeru 2010 developed and released by the World Vegetable Center AVRDC from Tanzania were nursed and transplanted onto a land area of 4 x 2 m² for each treatment using a complete randomized block design. Harvested fruits were stored in the Zero Energy Cooling Chamber and at room condition to evaluate the shelf-life. Farmers preferred Tengeru 2010 due to the fruit size and ease of extraction of seeds, while consumers preferred Tanya based on firmness and taste. Farmers indicated their willingness to purchase the seeds of these varieties when made commercially available. However, their ability to purchase high quality seeds of superior varieties is limited by high cost.

Keywords:

Cultivars, preference, sensory analysis, shelf-life, tomato



P6-2. How Much Has Been Published on Postharvest Losses of Perishables and Food Waste in Brazil?

Gilmar P. Henz, Embrapa

Headquarters, Brasilia-DF, Brazil. E-mail: gilmar.henz@embrapa.br

Abstract

Although discussions on postharvest losses of fresh perishables and food waste in Brazil have increased in recent years, there are relatively few scientific papers on both subjects. A bibliographic search was performed with Google Scholar, SciELO database (Scientific Electronic Library Online) and CAPES Portal of Periodicals using the terms postharvest losses (PHL) (“perdas pós-colheita”) and food waste (FW) (“desperdício de alimentos”) in Portuguese to know what has been published. In Google Scholar, 46,100 records were obtained for FW and 16,100 for PHL, and only 48 and 24 records, respectively, when the two terms are searched together in the title. At the SciELO database, the search in all indexes resulted in 22 scientific papers for PHL and 14 articles for FW. Most of the records of Google Scholar are grey literature, such as newspapers articles, editorials, academic papers (theses, dissertations), abstracts, reports and technical documents published only in Portuguese. Research on FW is dispersed in subareas, such as health, nutrition, consumer behavior, organic residues management. Research on PHL is basically carried out by professionals linked to Agriculture, Food Sciences and Rural Economics and aimed at reducing losses by applying specific technologies or studies on increased costs caused by losses. So far, FW and PHL tend to be considered as distinct subjects in Brazil, lacking more comprehensive publications considering both areas together, as currently regarded by the international scientific community.

Keywords:

losses, waste, food, fruits, vegetables, publications



P6-3. Efficacy of Lime and Vinegar powder as a disinfectant for tomato during storage

Jacinta Nyaika¹, Budhi Lamsal², Carl Bern³ and Ajay Nair⁴

¹Horticulture department, Lilongwe University of Agriculture and Natural Resources-Bunda Campus, Malawi

²Food and Nutrition Department, Iowa State University, USA

³Agricultural and Biological Engineering Department, Iowa State University, USA

⁴Horticulture Department, Iowa State University, USA

Corresponding author: jnyaika@bunda.luanar.mw

Abstract

A study was conducted to determine the efficacy of using lime and vinegar as food antimicrobial disinfectants during postharvest storage of tomato. Observations show that farmers in Malawi do not wash and sanitize their produce after harvest. Mature Green tomato variety Mountain Fresh from Iowa State University Horticulture Research Farm was used. Data was collected on surface microbes such as Yeasts, Molds, E-coli and coliforms, physiological weight loss (PWL), Total soluble solids (TSS) and color change, for four weeks in storage period. Data was analyzed using Genstat 18. PWL (%) was significantly different for the interaction between sanitizers and storage period. Unwashed tomato lost 10% in 4 weeks whilst tomatoes washed in water lost 6.1% and those treated to lime lost between 6.53 to 7.39% and those treated with vinegar powder lost between 7.06 to 9.82%. TSS was significantly different for sanitizer and storage period. Total colony units for e-coli was significantly different at $P < 0.05$. On average tomato treated with lime, vinegar and bleach ranged from 1.2 to 3 CFU-g in week 1 to 4-8 CFU-g in week 4. Tomato washed in water had 2.6CFU-g of e-coli in week 1 and 9.2 CFU-g in week 4. Unwashed tomato had 6.2 CFU-g in week 1 and 14.7 CFU-g in week 4. Total colony units for e-coli was also significantly different at $P < 0.05$. On average tomato treated with lime, vinegar and bleach ranged from 1 to 4 CFU-g in week 1 to 2-74 CFU-g in week 4. Tomato washed in water had 3CFU-g in week 1 and 6CFU-g in week 4. Unwashed tomato had 3.5 CFU-g in week 1 and 9 CFU-g in week 4. Development of moulds and yeasts was also significantly different at $P < 0.05$. Tomatoes stored for 4 weeks had more CFU for yeast and mold.

Key words:

Postharvest, storage, sanitizers, pathogens, weight



P6-4. Postharvest knowledge and skills gap in crop value chains: Can Universities bridge the gap?

Jane Ambuko

Department of Plant Science and Crop Protection, University of Nairobi,

P.O Box 29053-00625 Nairobi

Corresponding Author : ambuko@yahoo.com

Abstract

Postharvest losses in horticultural value chains are reported to range between 40 to 50%. The high losses in these value chains, which are dominated by smallholder farmers, are attributed to various factors. Key among these factors include poor postharvest handling practices and lack of knowledge on appropriate postharvest technologies. There is a general postharvest knowledge and skills gap among the practitioners in crop value chains. This is attributed to the training focus in agricultural training institutions including universities. Over the years, training and capacity development in most Universities has focused on the production side of the supply chain. This is reflected in the curricula and programs offered by most agricultural institutions. Generally the disciplines that are geared towards plant/crop breeding, pest management, agronomy have received greater emphasis at the different levels of training. Similarly the research and facilities in most institutions have focused more on the production side of the value chain. There has been very little focus (in training and research) on the postharvest side of the supply chain. As a result, most of the practitioners in agricultural value chains (including farmers, traders, transporters, extension agents) are poorly equipped to deal with postharvest challenges. In this paper, the need for postharvest training to equip practitioners in agricultural value chains with the requisite knowledge and skills for good postharvest management will be highlighted. The current status of postharvest training in some universities in Kenya will be discussed. The opportunities for Universities to address the skills and knowledge gap in agricultural value chains will be highlighted. Universities and other tertiary institutions are tasked with producing a skilled labor force for the agricultural sector. Universities should exploit their strategic advantage to build capacity at different levels through responsive curricula and outreach programs.

Key words:

food loss, food waste, training, curricula, smallholder



P6-5. Post-Harvest Loss Reduction in Fruits: Is Proper Identification Methods of Maturity Indices a Solution?

Kimani M. Maina* and Joseph P. Gweyi-Onyango.

Department of Agricultural Science and Technology, Kenyatta University

*Corresponding author: kimanimoses43@gmail.com

Abstract

A decrease in quantity or quality of food at whatever stage of food value chain is considered food waste. The African continent contributes the largest percentage to food waste especially to perishable products such as the fruits and vegetables. The timing and stage of maturity of a fruit at harvest is crucial in its storage and marketable life and quality. A proper timing to attain maximum nutrient composition without losing the other desired attributes is key. Fruit consumers rely on the visual appearance, texture/firmness and taste as the main maturity indices for assurance of nutritional and food safety. The common maturity indices such as skin colour, shape of fruit, aroma, size, firmness are easier to be established through physical assessment but others require use of specialized equipments. In Kenya, timing of fruit harvesting is determined purely through this physical assessment, leaving out other vital indices which are of essence such as sugars, acidity, oil content, dry matter content, juice content and concentration levels of other soluble solids. The protocols for maturity stage are destructive and non destructive (optical, vibrational, electrical, nuclear magnetic resonant and gas analysis techniques). Some of these protocols such as: brix hydrometer or refractometer test for sugars, diffuse reflectance for soluble solids, protein, fat and carbohydrate determination, Fourier analysis, the delayed light emission and the Electronic aroma detection (e-nose). Most of these methods are not available in Kenya, apart from a few in select institutions of higher learning and research centers. Unlike the developed countries where such protocols are in place, the reliance on physical assessment leads to high amount of nutrients loss as the fruit progresses from maturation to ripening due to improper timing of harvesting. The current document is compares and contrasts methods used in developing and developed countries and shows that extension of fruit shelf-life (particularly nutrient) by few days to even weeks based on proper identification or timing of harvest period is possible

Key words:

Maturity indices, nutrient losses, shelf life, harvest timing, fruit



P6-6. Assessment and Mitigation of Aflatoxin and Fumonisin Contamination in Animal Feeds in Rwanda

Kizito Nishimwe^{1,2*}, Erin Bowers¹, Jean de Dieu Ayabagabo², Richard Habimana², Samuel Mutiga³, Dirk Maier¹

¹Iowa State University, Iowa, USA

²University of Rwanda, Kigali, Rwanda

³Bioscience eastern and central Africa – International Livestock Research Institute (BecA-ILRI), Nairobi, Kenya

*Corresponding author: e-mail: nishimwe@iastae.edu

Abstract

Aflatoxins and fumonisins are fungal metabolites that contaminate crops and animal feeds under favorable growth conditions. They are of importance to public and animal health as they are associated with or are causative agents of certain cancers in humans. The Feed the Future Innovation Lab for Livestock Systems (LSIL) based at University of Florida launched several competitively-funded multi-disciplinary, integrated and applied research and capacity-building projects. Iowa State University secured a 1-year LSIL-funded research project with the aim of assessing and mitigating aflatoxin and fumonisin contamination in animal feeds in Rwanda. Specifically, this project focuses on: Quantify aflatoxin and fumonisin levels in animal feeds at different points in the animal feeds value chain, establishing a surveillance and early detection system for aflatoxin and fumonisin presence and mitigation in animal feeds, to raise awareness of aflatoxin and fumonisin contamination and prevention among stakeholders involved in the animal feeds value chain and provide input to the regulatory framework in regards to policies for the mitigation of aflatoxin and fumonisin contamination in animal feeds. Preliminary results to improve food and feed safety for a better livelihood in Rwanda will be shared in this presentation.



P6-7. Effectiveness of Hermetic Facilities as Alternatives to Synthetic Pesticides for Sorghum Storage Under Hot Smallholder Conditions

Macdonald Mubayiwa^{1*}, Brighton M. Mvumi^{1**}, Tanya Stathers², Shaw Mlambo¹ and Tinashe Nyabako¹

¹Department of Soil Science and Agricultural Engineering, Faculty of Agriculture, University of Zimbabwe, P.O. Box MP167, Mt Pleasant, Harare, Zimbabwe.

²Natural Resources Institute, University of Greenwich, Central Avenue, Chatham Maritime, Kent, ME4 4TB, United Kingdom.

**Corresponding author: mvumibm@agric.uz.ac.zw or mvumibm@hotmail.com

*Presenting author: mmubayiwa@gmail.com

Abstract

Sorghum is widely grown in marginalized, semi-arid and arid areas of sub-Saharan Africa (SSA) for food due to its tolerance to dry conditions. Despite production of better yields under these conditions, high postharvest losses of about 13.5 % are incurred. Synthetic pesticides, pesticidal plants and ashes are often used to reduce insect pest-induced postharvest losses, but high losses are still being recorded. Consequently, farmers have increased the pesticide application rates and frequencies. To find safe and sustainable grain storage technologies in sorghum storage, field trials were conducted in wards 8 and 15 of Mbire district in Zimbabwe, during the 2015/16 storage season to evaluate the efficacy of hermetic storage technologies and synthetic pesticides under hot (30 – 42 °C) smallholder storage conditions. The treatments evaluated were metal silos, Purdue Improved Crop Storage (PICS) bags, GrainPro Super Grainbags™, and two commercial synthetic pesticides (Shumba Super dust and Actellic Gold dust), and an untreated control. Grain samples were collected from each treatment replicate at 8-week intervals over a period of eight months, and analyzed for insect pest counts by species, percentage grain damage and grain weight loss. There were significant differences ($p < 0.001$) in grain damage, weight loss, and pest populations, with hermetic storage facilities showing superiority over chemical pesticides. There were no significant differences in grain weight loss between Shumba Super dust (11.7 %), Actellic Gold dust (11.5 %) and untreated grain (11.5 %). However, hermetic storage facilities kept grain weight loss below 5 % over the 8-month long storage period. Results show that hermetic storage facilities can be used as effective alternatives to available synthetic pesticides. The results are discussed in the context of wider scale applicability in similar environments and conditions in SSA.

Key words:

Smallholders, Hermetic grain storage, insect pests, Postharvest losses



P6-8. Farmers' Awareness and Adoption of Improved Grain Storage Technology in Western Kenya

Martins Odendo*¹ and Francis Muyekho²

¹The Kenya Agricultural and Livestock Research Organization (KALRO),
Kakamega Research Centre P.O. Box 169 – 50100, Kakamega, Kenya

²Masinde Muliro University of Science and Technology (MMUST), PO Box 190-50100,
Kakamega

*Corresponding author: Email: odendos@yahoo.com

Abstract

Maize (*Zea mays*) grain losses due to poor storage contribute to food and nutrition insecurity, hunger and low farm incomes in Kenya and other sub-Saharan African (SSA) countries. Efficient post-harvest handling, storage and marketing can tremendously contribute to socio-economic aspects of rural communities as stated in Kenya's development blue print, the Vision 2030. In view of high grain losses, many initiatives have been launched to promote improved grain storage technologies including metallic silos, hermetic bags and chemicals to replace ineffective traditional methods such as cribs, gunny bags and baskets. The adoption of these technologies and factors influencing the adoption are not clearly understood. The objectives of this study were to: evaluate farmer's sources of information on grain storage, assess the adoption of improved grain storage technology, and establish factors influencing the adoption of improved grain storage technologies. It was hypothesized that socio-economic factors and characteristics of the storage technologies did not significantly influence adoption of improved post-harvest technologies. A multi-stage sampling technique was used to select a sample of 613 households for the study from Siaya and Kakamega Counties in western Kenya during the 2015 long rain season. Data were analyzed by descriptive statistics and logit econometric modelling. Results show that the main sources of grain storage information were government extension agents (66%), followed by other farmers (20%) and radio (12%). Majority of the farmers (48%) still use gunny bags, whilst only 28% use the hermetic bags and 0.5% apply metallic silos. The key factors influencing the adoption varied by the storage technology. However, age, education level and sex of the household head, and amount of maize grain produced significantly influenced adoption ($p < 0.05$). Moreover, characteristics of the storage technology such as costs, ability to keep off rodents and other pests as well as awareness of the technologies influenced the adoption. We recommend that more effort be put in awareness creation on improved grain storage technologies and reduction of the cost of the technologies, especially of metallic silos, in order to enhance adoption.

Key words:

adoption, maize, postharvest losses, technology



P6-9. Are Improved Postharvest Management Technologies beyond the reach of smallholder farmers in Linthipe Extension Planning Area in Malawi?

Miriam Matita^{1*} and Haswell Dambolachepa²

¹Extension Department, Lilongwe University of Agriculture and Natural Resources, Lilongwe, Malawi

²Ministry of Agriculture and Food Security, Dedza District Agricultural Office, Dedza, Malawi

Abstract

An assessment was conducted in Linthipe EPA during the 2012/2013 storage season to determine factors influencing adoption of postharvest management of maize. A Questionnaire was administered to sixty farmers that were selected using simple random sampling. The study found out that adoption of recommended practices and storage structures for maize are affected by inadequate extension service delivery and farmers' low income levels. Improved storage structures have not been fully promoted and there is little institutional support to farmers from government and various NGOs with regard to postharvest management of maize. Over 90 percent of farmers rely on subsidized insecticides which are not timely available resulting in a gap of three months between time of harvesting and insecticides application exposing maize to pest infestation. The findings suggest the need to consider implementing post harvest management programmes for maize by Government and other stakeholders to reduce losses amidst heavy investments in the fertilizer subsidies for maize. Short to medium terms loans could be made available to promote adoption of improved post harvest management technologies and practices for maize.

Key words:

Postharvest, smallholder farmers, maize, extension service



P6-10. Postharvest Practices and Losses: A Case Study of Six Farm Settlements in Oyo State, Nigeria

*Omobowale, M.O.¹, Ala, A.A.², Otitodun, G.O.³, Nwaubani, S.I.³, Ileleji, K.E.⁴, McNeill, S.G.⁵, Opit, G.P.⁶, Olenloa A.E.¹, Yinusa B.¹, Kolayemi O.R.¹, Ogwumike J.C.¹, Braimah, J.A.², Ajao, S.K.², Busari, G.S.²

* Corresponding author's email address: mo.omobowale@ui.edu.ng

¹Department of Agricultural and Environmental Engineering, University of Ibadan, Ibadan, Nigeria

²Department of Zoology, University of Ibadan, Ibadan, Nigeria

³Entomology Unit, Nigerian Stored Products Research Institute, Ilorin, Nigeria

⁴Agricultural and Biological Engineering Department, Purdue University, West Lafayette, Indiana, USA

⁵Biosystems and Agricultural Engineering Department, University of Kentucky, Lexington, Kentucky, USA

⁶Department of Entomology and Plant Pathology, Oklahoma State University, Stillwater, Oklahoma, USA

Abstract

Postharvest losses remain a major problem in sub-Saharan Africa despite interventions by governmental and international bodies. There is a critical need for information update of postharvest practices most especially from small-holder farmers in order to assess current practices. A pilot study was designed to collect information from grain farmers in 10 farm settlements (FS) in Oyo State, Nigeria to evaluate post-harvest practices. Six FS (Ijaye, Ilorin, Eruwa, Iresaadu, Ipapo and Ogbomosho) were surveyed. Each FS comprises 80–100 lead-farmers who employ other farmers and labourers. A total of 240 respondents (40 from each location) who were identified as lead-farmers, were interviewed using structured questionnaires administered during a focused group discussion. Threshing, drying, storage practices and facilities used were considered. Maize threshers without blowers were found in all settlements. Threshing without blowing implies that maize taken into storage is not sufficiently clean thereby making it attractive to insects. Sun-drying of maize in open spaces expose grains to re-wetting by rain, defecation by birds and animals as well as dirt from the surroundings, leading to early deterioration. Dryers, graders and modern storage facilities which would ensure proper processing were not available. About 90% of farmers reported significant postharvest losses, up to a third of harvest. Moreover, the high risk of losses due to stored product insect pests compel about 90% of respondents to apply field pesticides on stored produce despite the threat to human health. Practices in harvesting, threshing, drying and storage were similar and technologically backward. Lack of adequate storage facilities compels farmers to use wrong and risky methods of keeping insects and rodents away from grains. Adequate information dissemination to farmers on proper practices was lacking and this lack of research-based knowledge transfer in hard-to-reach agrarian communities must be addressed if Africa would achieve food security.

Keywords:

Postharvest losses, Farm Settlements, Food Security, Mechanization, Threshers



P6-11. Assessment of Postharvest Losses in Pepper (*Capsicum Annuum* Cv. Legon 18) In The Kwahu North District, Ghana.

Osei-Kwarteng*, M., Mahunu, G. K., Abu, M., and Darko, G.

Department of Horticulture, Faculty of Agriculture, University for Development studies, P.O.Box TL 1882, Tamale, Ghana.

*Corresponding Author: misokwart@yahoo.com

Abstract

About 20-50 % of vegetables produced in Ghana are lost after harvest due to pre-production, production, harvest and postharvest management, and marketing decisions. This study systematically assessed the contribution of pre-production, production and postharvest handling activities on postharvest losses in an exportable chilli pepper variety (Legon 18) in the Kwahu North District of Ghana. The commodity system assessment methodology (CSAM) was used. Fifty farmers were purposively sampled from seven communities based on the acreage of pepper produced. A semi-structured questionnaire covering pre-production, production and postharvest components of the CSAM were administered. The data was descriptively analysed using Microsoft Excel (2007). The total postharvest loss for the 50 farmers was quantified as a percentage of the ratio of damaged produce to harvested produce. A high percentage (80%) of the farmers attributed lack of extension services as the main pre-production factor affecting postharvest losses of their produce. The major production factors significant to farmers produce loss were: poor weed control (22.6%), inappropriate irrigation (16.2%), high plant density & poor planting patterns (18.6% each) and, field sanitation (18.6%). As high as 80% of labour during harvest and postharvest are not trained to enhance proper harvesting and handling of produce. Although the farmers used postharvest practices (sorting, 84%; curing, 25%; packaging, 24%; boiling, 13%), they perceived lack of adequate technical knowledge of these practices as a major cause of their postharvest losses. Postharvest loss of 16.3% was estimated. The study suggests that the farmers have observed and could project the impact of their activities and management decisions on postharvest losses. We recommend that the major pre-production, production and postharvest factors affecting postharvest losses should be quantified and more technical knowledge (good agronomic and postharvest practices) should be given to the farmers and their labour force.

Keywords:

Commodity system assessment methodology, Farmers, Postharvest loss, Capsicum



P6-12. Post-Harvest Losses in Banana Production Value Chain in Meru and Kisii Counties Of Kenya: The Role Of Socio-Cultural Diversity

Winnie Ntinyari* and Joseph P Gweyi-Onyango
Department of Agricultural Science and Technology, Kenyatta University,
P O Box 43844-00100; Nairobi, Kenya
*Corresponding author: ntinyariwinnie55@gmail.com

Abstract

Banana (*Musa Spp*) is a crop of economic importance in Kenya. It is grown for both commercial and nutritional purposes in the main regions like Kisii and Meru counties. However, its production and use is faced with a great challenge of post-harvest losses (PHLs). Most of the losses are associated with social-cultural practices that are dominant in some of the rural areas. Thus, the focus of this review paper was to determine the magnitude of the losses experienced during post-harvest handling of bananas and the contribution of socio-cultural factors to the losses. The findings were obtained through use of existing reports, published papers and student's thesis. The results revealed that consumption of over-ripe fruits, essential nutrients such vitamins and micronutrients like zinc and iron in edible plant tissues are substantially reduced, leading to hidden hunger. Banana wastes can lead to accumulation of bio-solids in urban areas that lead to clogging of drainages and consequently environmental pollution. Meru county is estimated to lose between 15- 30 % of bananas due to inappropriate post-harvest handling practices. In Kisii greater losses results in transportation of bananas through use of motorbikes in rough roads that result to reduction of value by 30%. Losses due to poor storage was approximated to be 43% in both regions due to poor means and lack of storage of effective storage facilities. However, in Kisii it was extremely high due to high poverty levels in the rural populations. Importantly, social- demographic characteristics indicate that most farmers in the region have not attained tertiary school education and thus do not understand critical techniques of food production technologies with emphasis on post-harvest practices. In addition, approximately 60% of the farmers in two counties indicated to have less knowledge in production and handling of the farm produce. The diversity in consumption and cultural value placed on banana as a crop has an implication on wastes of banana. This is contrary in Meru where 75% of production focusses on economic and provides an avenue for more middlemen, leading to frustration during period of glut. But in Kisii the banana can be consumed in various forms, including production of alcohol. Importantly, in both counties 80% of majority farmers are women and thus experience difficulties during harvesting due to bulkiness of bananas. Therefore, there is potential of reducing food insecurities in the world through prevention of post-harvest losses in bananas. This implies that more research need to be done on production of the banana due to its potential to form backbone of the economy in the major producing regions. Infrastructure should also be improved to reduce storage and transportation loses.

Key words:

Post-harvest, food security, waste, cultural values, food diversity, eating habits



Work Stream 7

**Emerging Innovations, strategies,
practices in Postharvest Management**



O7-1 Polymer Membrane Technology for Shelf Life Extension of Fruits and Vegetables

Shubham Chandra¹

¹Chandra Associates, 20 Zain Circle, Milford, MA 01757 USA

Email : shubhamchandra@chandraassociates.com

Abstract

Roughly one-third of the fruits and vegetables produced for human consumption, gets lost or wasted globally. These losses, that vary between 33% to 57 % depending upon the region, are primarily, due to poor practices in storage and transport. These postharvest losses can be reduced using the proprietary Chandra Associates (CA) FILMS intelligent polymer membrane technology. CA FILMS use a membrane technology capable of providing different package permeabilities, in order to create specific oxygen and carbon dioxide levels in a package, even as the temperature is changing. The permeability of the polymer to oxygen/carbon dioxide molecule is defined as its permittivity to the transport of oxygen/carbon dioxide molecules of that type, expresses as the quantity of molecules going through the membrane given surface area and thickness during a fixed amount of time when there is a partial pressure built between the two surfaces of this membrane. These optimum atmospheres for various fresh fruits and vegetables have been established based upon extensive research conducted at UC Davis, Post-Harvest Technology, Research and Information Center. As the produce consumes oxygen and gives off carbon dioxide, a partial pressure is created, which is a function of the membrane permeability and its carbon dioxide to oxygen selectivity ratio, an equilibrium gas concentration is established in the package. The composition of the atmosphere within a package results from the interaction of a number of factors that include the permeability characteristics of the package, the respiratory behavior of the produce, and the environment. The ability of elevated CO₂ and reduced O₂ to retard the microbiological spoilage of fresh produce is one of the most compelling reasons for the use of this innovative packaging technology. Generally, reducing the oxygen levels, leads to reduction in metabolic activity, and hence lower ethylene levels. The creation of higher carbon dioxide levels leads to reduction in mold and fungal growth, and minimizes the effect of ethylene on ethylene sensitive produce commodities. Thus the created atmosphere of lower oxygen and higher carbon dioxide is able to extend shelf life, maintain high quality and preserve nutrients of fresh produce items by naturally regulating respiration of said items. The membrane technology also accommodates temperature switch, fluctuations provides the FF&V the capability to maintain its quality, are often encountered in the supply chain. No changes to current handling procedures for FF&V are required to take advantage of this technology. Insertion of CA FILMS technology has provided extensions of shelf life for a variety of fruits, vegetables (whole and cut), flowers, other perishables such as fish, meats, bread and sandwiches. Chandra Associates has also developed a proprietary model to predict the steady-state concentration of oxygen and carbon dioxide in the package headspace. Steady-state models incorporating temperature effects on respiration and permeability have been incorporated into the database. In addition, more complex dynamic models have been developed to account for temporal changes in package volume, product respiration, and the humidity and temperature of the environment.

Keywords:

Modified atmosphere; intelligent packaging; permeability; mathematical modelling; postharvest losses

O7-2. Energy Efficient Adsorption Cooling System for Perishables as Alternative to Mechanical Refrigeration in Rural Areas

Aaron Dzigbor^a, Annie Chimphango^{a*}

^aProcess Engineering Department, Stellenbosch University, 7600, South Africa

*Corresponding author: achimpha@sun.ac.za

Abstract

Effective cooling is mostly provided by mechanical refrigeration, which in most cases is run by electricity. Many communities in rural areas either do not have access to electricity or cannot afford electricity. Consequently, use of mechanical refrigeration is limited. This lack of refrigeration causes shortfall in fresh produce between the harvest and off harvest period. The objective of this study was to design a self-sustaining and energy efficient cooling system that could be used in rural agricultural areas without access to electricity. To achieve this objective, an adsorption cooling system was designed and constructed in-house. Activated carbon-sodium chloride composites were produced by introducing sodium chloride at varying dosage levels of 10, 15, 20, 25, 30 and 35.7% into the pores of pure activated carbon in order to improve its thermal conductivity. Pure activated carbon without sodium chloride introduced into the pores and activated carbon-sodium chloride composites produced were used as the adsorbents whilst ethanol was the refrigerant used during testing of the cooling system. Experimental results showed that the temperature drop in the storage compartment of the adsorption cooling system ranges from 8°C to 4°C for pure activated carbon and composite activated carbon with 35.7% sodium chloride, after one hour of testing. Furthermore, the cycle time and desorption energy of adsorption cooler using pure activated carbon as adsorbent reduced from 2780 seconds and 22 MJ, to 1607 seconds and 12 MJ, respectively, when activated carbon composite with 35.7% sodium chloride was used as an adsorbent. Specific cooling power also increased from about 134 W/kg for pure activated carbon to 162W/kg for the same composite. The results from this study showed that adsorption cooling could be a promising alternative to mechanical refrigeration. In addition, composites could be used to reduce energy supply to adsorption cooling system, especially in areas with limited energy supply.

Key words:

Refrigeration, adsorption cooling, fresh produce, energy efficient



O7-3. Development of a Low-Cost Moisture Meter for the Grain Trade

S. McNeill¹, P. Armstrong², M. Omobolaji³, G. Otitodun⁴, E. Osekre⁵, K. Ileleji⁶, and G. Opit⁷

¹Associate Extension Professor, Biosystems and Agricultural Engineering Department, University of Kentucky, Princeton, KY 42445 (smcneill@uky.edu)

²Research Engineer, USDA-ARS-CGAHR, Manhattan, KS 66502

³Lecturer, Department of Agricultural and Environmental Engineering, University of Ibadan, Ibadan, Nigeria

⁴Principal Research Officer, Entomology, Nigerian Stored Products Research Institute, Ilorin, Nigeria

⁵Entomologist, Department of Crop and Soil Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

⁶Associate Professor, Agricultural and Biological Engineering Department, Purdue University, West Lafayette, IN 47907

⁷Associate Professor, Department of Entomology and Plant Pathology, Oklahoma State University, Stillwater, Oklahoma 74078

Abstract

Agricultural scientists have worked in West Africa to assess grain drying and storage systems with the aim of reducing post-harvest losses (PHL), which are between 20 and 30%. Many grain PHLs can be attributed to poor drying and storage conditions and the lack of an affordable, reliable instrument to quickly and accurately measure grain moisture, a key factor in determining grain quality and storability. Maize that is not properly dried can lead to aflatoxin contamination and associated health concerns. Thus, a low-cost moisture meter would help farmers determine when grains were well dried and safe for consumption. Accurate moisture measurement can also help merchants select which grain lots to purchase and which lots to reject from farmers until they are dried further. A low cost meter was developed to reduce PHL of grains and is referred to as the PHL moisture meter. The meter was built and evaluated in laboratory studies in the U.S. and field tested in Ghana and Nigeria. The meter accuracy was compared to two commercial meters: (a) John Deere Chek Plus-SW08120 grain moisture tester and (b) bench top DICKEY-john GAC@2100 Agri meter. Field tests have shown the accuracy of the PHL moisture meter was comparable to that of the GAC2100 moisture meter for maize below 15% MCwb. Measurement differences showed a positive offset of 0.45% for the PHL meter relative to the GAC2100, whereas the John Deere SW08120 moisture meter offset was 2.37% MCwb. More field measurements from Ghana and Nigeria are being collected and will be summarized in this report. The PHL meter will be demonstrated during the conference to illustrate its operational features, electrical components, and mechanical assembly. Ideally, it could be manufactured in Africa to expedite the goal of reducing postharvest grain losses.

Keywords:

Grain moisture, storage, postharvest loss, aflatoxin mitigation, food security.



O7-4. Better Use of Cassava Waste to Improve the Life of Poor Farmers and Processors in Africa

C.M. Fauquet

Director GCP21, CIAT, Apdo. Aereo 6713, Cali, Colombia

Cell: 314-477-3973 Email: c.fauquet@cgiar.org

Abstract

Cassava is the fourth most important food crop in the World and with 56% of the global production in Africa; it is the most important crop in Sub-Saharan African countries. However, it has the lowest average yield in the world with 10t/Ha, compared to 21t/Ha in Asia. Nevertheless, for the last 18 years, cassava out-performed all the major crops in the world, in relative production. This huge increase in production is fueled by the high demand for starch in south-East Asia and the huge demand for food in Africa. Cassava world production in 2014 surpassed 270 million tons with more than 147 million tons in Africa. Cassava waste is enormous in Africa because all the food processing is done manually. Recent studies estimated cassava losses to amount to more than 30%, i.e. 45 million tons in 2013 in the African continent. Not only is it a huge loss of food and feed but it is also a health and environmental threat. The Global Cassava Partnership for the 21st Century – GCP21, is deploying all possible technologies to boost cassava production and its use for better products, in a safer environment. GCP21 organized a workshop in 2013, in Nigeria to address the specific question of the use of cassava peels in the feed industry. The Roots, Tubers and Bananas (RTB) program, funded a pilot project in Nigeria to use cassava peels to produce animal feed, which is now entering in a pre-industrial phase in collaboration with Nigerian feed millers. Other studies are being developed to investigate the use of more advanced technologies to use cassava waste to produce high quality fish feed for Africa. These different activities will be detailed at the congress in Nairobi. Furthermore, the African Development Bank – AfDB, is launching in 2017 the TAAT program (Technologies for African Agricultural Transformation) aiming at reducing food imports. Mechanization of production and processing is considered for cassava, and if the plan is successful, the industrialization of food processing will use all the waste for feed and energy. Details of the cassava component of the TAAT program will also be presented at the congress.

Key words:

cassava, waste, food, feed, Africa, industrialization



O7-5. Willingness to Adopt Plastic Crate by Actors in the Tomato Value Chain in Nigeria

Babarinsa Olumuyiwa^{1,2}, Babarinsa Folorunso¹, Ogundele Richard³

¹FADEB Consultancy, Ilorin, Nigeria;

²Federal University of Technology, Akure

³GEMS4, Coffey International Development Ltd, Nigeria;

Corresponding Author: kanmix1@yahoo.com

Abstract

Tomato is the most widely consumed fresh vegetable in Nigeria. The country is the second largest producer of tomato in Africa. Tomato presents distinct problems of both transportation and packaging because it is much more perishable than other vegetables. The objective of the study was to investigate the awareness and willingness of stakeholders in the tomato value chain to adopt a new packaging container (plastic crate), as against the conventional traditional woven basket. The study was carried out in KwanaGarfan in Kano State (the biggest tomato collection centre in Nigeria) and Mile 12 international Fruit and Vegetable market, Lagos state (delivery market). For the purpose of this study, plastic crate was introduced to the market in KwanaGarfan and transported to Mile 12 Lagos. A structured questionnaire was administered to obtain information from the stakeholders. The awareness level for crate was low with truck dealers being the lowest 20% and highest for truck drivers at 56.5%. Dealers (100%), retailers (100%), and brokers (64.3%), as well as drivers (80%), and loaders (78.3%) believed that the plastic crate was more appropriate for tomato handling. On willingness to adopt, all the dealers, retailers, truck drivers, 91.3% of loaders and only 42% brokers were willing, with different degree of willingness ranging from "willing" to "highly willing". Dealers were not ready to accept the responsibility for the cost of transfer, saying retailers should be responsible (66.7%) for tomatoes purchased with crate. On the other hand, 72% of the interviewed retailers accepted responsibility for transferring tomatoes into crates upon delivery. Alternative containers considered appropriate for subsequent sales transactions were raffia basket (62.5%), plastic bags (25%) and carton box (12.5%). With economic consideration, 85.7% and 15.4% of the dealers and retailers, respectively, believed that it would increase their income while 39.1% of loaders believed that it would increase cost of loading.

Key words:

Adoption, Awareness, Willingness, Raffia basket, Plastic crate



O7-6. Agricultural Service Delivery: Strengthening Private Crop Protection Service in Southern Ethiopia

Abebe Shiferaw¹, Bereket Dindamo², Tesfaye Lemma³, Dirk Hoekstra⁴

¹ Consultant at Environment and Coffee Forest Forum (ECFF) Corresponding Author
Tel : +251911482350, Addis Ababa, Ethiopia shiferaw.abebe@yahoo.com Formerly staff at Int. Livestock Research Institute(ILRI)

²Innovation specialist, CASCAPE Project (Ethiopia), formerly staff at ILRI.

³Associate Professor, Haramaya University, formerly Post Doc Scientist at ILRI (IPMS project)

⁴Senior Project Advisor, LIVES project, ILRI. Formerly IPMS project Manager, Addis Ababa.

Abstract

While there is a growing appreciation of the increased involvement of both private and public sectors in agricultural service delivery, there is less involvement of private sector in crop protection service in Ethiopia. This paper describes a new approach undertaken to strengthen agricultural service delivery in strengthened Private Crop Protection Service (PCPS) from 2006 to 2010 in Southern Ethiopia (Halaba Special district) through International Livestock Research Institute (ILRI) managed project and its' partners. PCPS involved farmers who provided community crop protection services after having adequate training, demonstration and input supply by ILRI managed project with close monitoring by district office of agriculture experts to ensure service standards. The study methods include questionnaires (key informants, focus group), service ranking, temporal service comparison, indicator based service assessment and SWOT analysis. The study shows that the PCPS in 2007/2008 crop seasons benefited 1104 households (HH) on 1707 ha of land in 19 Kebeles Associations (KAs). The estimated PCPS direct off-farm income is 194 USD/season/ service provider. The estimated average yield increase due to PCPS is 2.9 quintal/ha with an estimated indirect financial benefit of 197 USD/season/customer. Service assessments show higher demand, positive perception, and better attitude for the PCPS compared to the existing informal crop protection services (ICPS). The study recommends piloting to increase service coverage in other districts with more crops and scale out at national level as a new approach to improve service and reduce major bottlenecks in crop loss for increased crop productivity in Ethiopia.

Key words:

Halaba, Crop protection, Crop Loss, Ethiopia, Agricultural Service delivery



O7-7. Gender Dynamics in Postharvest Management - A Case Study from Ethiopia

ABERASH TSEHAY (MS.)¹, MISRAK ADMASU², MITIKE ABDISA², SENAYIT YETNABERK (PH. D.)

² LEONIDES HALOS-KIM (ENGR.)³

¹Theme Coordinator, Postharvest and Agro-processing (PHAP) Extension, Sasakawa Africa Association (SAA)/Sasakawa Global 2000 (SG 2000) Addis Ababa, Ethiopia. E-mail: aberasht@saa-safe.org Telephone: +251 911347704

²Program Officers, SAA/SG2000 – Ethiopia

³Director, Postharvest and Agro-processing Extension, Sasakawa Africa Association (SAA) Addis Ababa, Ethiopia

Abstract

Women in Ethiopia constitute proportionally a large group of the labor force in agriculture sector. They participate in all aspects of crop production: land preparation, planting, weeding, harvesting, threshing, transporting, processing, and marketing. SAA/SG 2000 had been working with women agro-processors to reduce losses, improve quality and quantity of products, and increase their income. The impact of the intervention had shown increasing awareness among women processors on their potential to produce more and better quality products that enabled them access market. Women also reported increased confidence in managing and decision-making in their agro-processing enterprise. Gender awareness training for both men and women had improved the support of men to their wives and encouraged them to actively pursue their activities. Introduction of postharvest technologies such as threshers, combine harvesters and hermetic storage reduces workload on women and men farmers, and improves grain quality and quantity. However, the technologies can have differential impacts on men and women and there is limited knowledge of gender dynamics in postharvest management in Ethiopia. Women have a significant role in postharvest management, however, this can be limited by the support of the male-members of the society. To understand this role, SG 2000, supported by the Swiss Development Agency (SDC) conducted a survey among the supported groups to analyze the gender dynamics of postharvest technology introduction. The study aimed to contribute to gender equity in postharvest management by generating information that would minimize the risk of creating, or maintaining gender gaps but also contribute to ensuring gender equity in project implementation. Data was collected through individual interviews and focus group discussions. The analysis focused on intra-household access and control over resources and intra-household decision making. The findings indicated that introduction of shellers, combine harvesters and hermetic storage reduces workload for both men and women. However, such introductions without paying attention to the household decision making, control and benefit, may not contribute to increasing food security of a household just because it reduces loss. In some cases, women experienced loss of access to grain with adoption of technologies by the family. It is recommended that introduction of postharvest technologies should also engage with norms, values, perceptions and assumptions; include capacity development processes; engage in access, control and benefit; and involve women in design of technology.

Keywords:

Gender, Postharvest Management, Agro-processing, Enterprise, Income Generation, Market Access, Postharvest, Strategy, Technological Options



O7-8. Participatory Community Solar Drying of African Indigenous Vegetables for Improved Quality

Darius O. Andika and John H. Nderitu
oandika@yahoo.co.uk

Abstract

Recent intensified campaign on production and consumption of African Indigenous vegetables (AIV) has resulted in increased marketable volumes by small holder farmers in rural area. This has created challenges of post-harvest handling since most of the excess produce is wasted through rapid deterioration. To address this challenge, several drying methods have been developed and introduced to rural communities including, sun drying and solar drying. The objective of the study was to enhance community participatory solar drying of AIV for improved quality and household incomes. Promotion focused on enclosed solar drying since it provides high air temperatures and consequential lower relative humidities leading to improved drying rates and a lower final moisture content of the dried crop. As a result, the risk of spoilage during the drying process and in subsequent storage is reduced. Drying in an enclosed structure has the additional benefit of providing protection against rain and contamination.

Key words:

Community participation, Solar drying, African Indigenous vegetables



O7-9. Yield and Quality Characteristics of Waste Potato Peel Starch as Influenced By Extraction Method

Kipkoech, R. and Abong', G*

Department of Food Science, Nutrition and Technology, University of Nairobi,
P.O. Box 29053-00625, Nairobi, Kenya

Corresponding author: georkoyo@yahoo.com/ooko.george@uonbi.ac.ke,
+254 735508558/700073386

Abstract

Potato peels represent a severe disposal problem to the potato industry. Utilization of peels into useful products such as starch may turn the peels into a competitive raw material for starch extraction since it contains considerable amount of starch. Starch was extracted from potato peels using water, pectinase and sodium hydroxide. The Yield, functional and pasting properties of extracted starch were measured. The starch content of the peels was found to be 50% on dry weight basis. The yield (44.6%) was significantly ($p<0.05$) enhanced by extraction using pectinase enzyme more than water (17.2%) and sodium hydroxide (17.6%). The effectiveness of pectinase to increase yield was attributed to disintegration of pectin network resulting in release of starch granules. Peak viscosity and gelatinization temperature significantly differed ($p<0.05$) with extraction method while peak temperature did not differ significantly ($p>0.05$). The swelling properties of starch differed significantly ($p<0.05$) with the extraction methods. The highest swelling power was in pectinase extracted starch (16.85%) and lowest in water (13.6%). However, solubility of starch extracted with pectinase was significantly ($p<0.05$) lower (10%) compared to water (13.08%) and sodium hydroxide (13.87%). Water binding index was significantly improved with pectinase (121.105%) and lower (113.25%) in sodium hydroxide. The clarity of paste was found to be significantly ($p<0.05$) more in pectinase extracted starch compared with water and sodium hydroxide. The current study show potential for utilization of potato peel waste for production of starch for industrial application.

Key words:

potato waste, pasting properties, functional properties, solubility



O7-10. Evaluation of High Humidity Chamber for Postharvest Storage of Green Peppers, Green Beans and African Eggplant

Arne Pauwels¹, Glory Swai³, Roseline Marealle², Roman Fortunatus², Ngoni Nenguwo²

¹ Wakati BVBA, Van Boendalestraat 7, 2000 Antwerpen, Belgium

² World Vegetable Center, Eastern and Southern Africa,
P.O. Box 10 Duluti, Arusha, Tanzania

³ P.O. Box 533, Korogwe, Tanga, Tanzania

Correspondence: ngoni.nenguwo@worldveg.org

Abstract

Vegetable crops are highly perishable and need to be kept in suitable conditions such as cold rooms after harvest in order to reduce postharvest losses. Many smallholder farmers do not have access to these types of facilities and so have greater losses and lower incomes. It is useful to identify alternative lower cost methods of storage. A novel method that is being tested is the "Wakati" which is a low cost storage chamber made from a tent with a water container connected to a fan to create a humid environment. The chamber also produces ozone for removing microbial spores and reducing levels of ethylene. An experiment was established to evaluate the effectiveness of this method of storage for extending the shelf-life of vegetable crops. The Wakati storage chamber was compared with storage under shade conditions for its effect on the storage life and quality of green peppers, green beans and African eggplant under ambient temperature conditions over a 5 day period. The results show the highest weight loss for green beans stored in shade at 11.58% compared to those in Wakati at 6.10%. The trend was the same for green pepper with 5.49% weight loss for shade stored fruit and 2.45% for those stored in the Wakati but for African eggplant fruit there was no difference in weight loss between the two treatments. The results indicate that the Wakati high humidity chamber has potential to store certain types of perishable produce over a short timeframe of 3-5 days.

Key Words:

Low cost storage, weight loss, crop quality, postharvest diseases



O7-11. Enhancing Global Harmonization Of Regulations For Reducing Food Losses And Waste In Sub-Saharan Africa

*^{ab}Benard Odhiambo Oloo, ^{ac}Ruth Oniang'o, ^{ab}Daisy Lanoi

^{ab}Global Harmonization Initiative and Egerton university

^{ac}Global Harmonization Initiative and Egerton University

*Corresponding author: Contacts: olooo.odhiambo@gmail.com

Abstract

Food losses all over the world are estimated to account for over a third of all the food produced, 1.3 billion tonnes lost. Several reasons are responsible for this magnitude of global food losses with general consensus being that the post-harvest losses (PHLs) is the major cause of food loss in the developing countries while food waste is a major food loss contributor for the developed world. For sub-Saharan Africa, curbing food loss due to PHL is most critical. Losses at this level does not just mean loss of food but also the loss of time, energy, water and labour hours spent in producing the products, a situation that leaves households more vulnerable and exhausted. One of the sources of food losses and safety across different regions within Africa is the loss of food based on different standards or their application and or interpretation across sub-Saharan Africa. Global harmonization of food standards and especially across Africa has the potential for reduction in the food losses all across this region. This paper through rigorous reviews available data, published data, government documents, disseminated information and several websites of important stakeholders evaluates the application of global harmonization across various countries within the sub-Saharan Africa with the aim to quantifying any benefits accruing from the implementation of harmonization of standards across different regional blocks within the sub-Saharan Africa.

Keywords:

Postharvest losses, global harmonization, food standards, sub-Saharan Africa



O7-12. Research & Development of Chinese Tradition Cereal Food Under Room Temperature Storage

Xinzhong Hu, Xiaoping Li, Liu Liu, Zhen Ma, Xiaolu Sheng, Ruzhen Zhu
College of Food Engineering and Nutritional Science, Shaanxi Normal University, 710062,
Xi'an, Shaanxi, China
Correspondence: hxinzhong@126.com

Abstract

Man-tou, Noodle, Mian-pi are Chinese tradition wheat products and the most popular staple foods in North Chinese diet. To solve the problem of short storage time, mold growth under room temperature storage, retrogradation of steamed cereal production, also to meet the requirement of convenience, safety consumption and industrialization. Recently, a novel, thermal-vacuum package technology has attracted attention due to its high processing efficiency and low cost. The results showed, the vacuum degree of thermal-vacuum package of Man-tou with increased the adding water amounts, but the man-tou making with lower water addition might increase the relative proportion of deep-bound water content during 90 days storage; the sensory evaluation score was acceptable after steam re-cooked. Fermentation can increase the mouth feel of final mian-pi products, combined the thermal on-line package technology, the shelf life can be prolonged 15days. By modifying the recipe of stretched noodle, combined the plastic packaging, the shelf life of noodle can be kept for 3 day. The technology can significantly increase the value and shelf life of Chinese tradition cereal products, avoided the secondary contamination by microbes during transportation and retail and giving good taste along with least starch retrogradation, is a low energy consumption technology.

Key words:

mantou, Mianpi, Noodle, Room temperature storage, microbes contamination.



O7-13. Promoting Business Models and Dissemination Techniques for Sustainable Postharvest Management Among Smallholder Farmers

Jerry Tingle Egessa, Max Olupot, Angela Deppeler, Raphael Dischl, Simplicie Davo Vodouhe and Licinia Cossa

African Forum for Agricultural Advisory Services

Plot 22A, Nakasero Road

Kampala

Uganda

E-mail: jegessa@afaas-africa.org

Abstract

In achieving wide access to information and technologies for effective postharvest management (PHM), a concerted effort of public, private and civil society actors is a precondition. The project "Postharvest Management in Sub-Saharan Africa" applies this approach in Benin and Mozambique. It aims to increase food security of smallholder farmers through reduced postharvest losses (PHL) of grains and pulses by a) improving pre-storage handling and storage technologies; b) documenting and disseminating the best PHM options tested, and c) using field evidence and PHM research to advocate for appropriate PHM policies and regulations. Cost-benefit and technical effectiveness analysis shows that the economic benefit of good PHM technologies largely depends on 1) additional benefits from selling safely stored grain later in the season (price fluctuations) and 2) the rate of PHL of particular foods in a given context. Hermetic systems such as metal silos and triple (PICS) bags show most promising results. In Mozambique, profits achieved from selling maize stored in 500 kg hermetic metal silos are sufficient to pay back the cost of the technology after two to three cropping seasons. However, initial investment costs of this technology compromise its demand. The project promotes business models with local agro-dealers as central market players: They procure input materials, contract artisans for silo production, sell or lease PHM technologies to farmers and market them through their client networks, with support from extension services. The success of PHM business models and adoption of PHM technologies largely depend on the access of farmers and agro-entrepreneurs to finance. The project thus validates different financing modalities including saving groups, warrantage and cooperation with local banks. Further, the project fosters innovative communication channels and tools for broad dissemination of information on good PHM options through extension services and media, including didactic videos, interactive radio programmes, theatre performances and online platforms.

Key Words:

Agriculture, Business Models, Postharvest Management, Good Practices, Technologies.



O7-14. A New Model of International Short Course Training: An African Postharvest Case Study

Walters, E¹, McConchie, R¹, and Olubayo, F²
fmmogi@gmail.com

¹School of Life and Environmental Sciences, Faculty of Science, University of Sydney, Sydney, Australia

²Department of Plant Science and Crop Protection, Faculty of Agriculture, University of Nairobi, Kenya

Abstract

Australian higher education scholarships for developing nations have typically been provided as formal Masters and PhD programs. While there is a long history of success with these programs, the length of training can deplete the local work force considerably for 2-4 years, impacting productivity. In addition, there is some question about how effectively the skills gained during the training translate back in the workplace. In the last 4 years the Department of Foreign Affairs and Trade (DFAT) have added short intensive training programs to their suite of scholarships, targeting mid-career personnel and focussing on development of a return-to-work plan to enhance impact. This paper presents a case study based on 3 years of short course postharvest training for African nations, outlining 4 key elements of success: 50% of the training is located in Africa to maximise context; adult learning methodologies to enhance personal learning; the program focussed on change management when they return home and progress is tracked; and sensitive pastoral care provision which took care of the settling and other non-academic needs of the trainees, to ensure a safe learning environment. Tracking of the trainee's post-course progress on the implementation of their work plans on return home has shown that this modular training with field experiences in Africa and the networking among the trainees, has a positive impact on the work ethics of the trainees and their performance at their work place.

Keywords;

Capacity building, postharvest management, Cereals and legumes



P7-1. Acoustic Detection of Postharvest Insect Pests of Maize *Zea Mays* L. and Common Beans *Phaseolus Vulgaris* L. (Fabaceae) in Kenyan Grain Stores

Anastasia Wanjiru Njoroge¹, Christopher Mutungi^{1,2*}, Hippolyte Affognon³, Uwe Richter⁴, Oliver Hensel⁴, Barukh Rohde⁵, R. W. Mankin⁶

¹ International Centre of Insect Physiology and Ecology, P.O. Box 30772-00100, Nairobi, Kenya;

² Egerton University, P.O. Box 536-20115, Egerton, Kenya;

³ International Crops Research Institute for the Semi-Arid Tropics, BP 320, Bamako, Mali;

⁴ University of Kassel, Faculty of Agricultural Engineering, Nordbahnhofstraße 1a, 37213, Witzenhausen, Germany

⁵ Department of Electrical and Computer Engineering, University of Florida, Gainesville, Florida 32611;

⁶ U S Department of Agriculture, Agricultural Research Service, Center for Medical, Agricultural, and Veterinary Entomology, Gainesville, Florida 32608

*Corresponding author; E-mail: cmutungi@icipe.org

Abstract

Postharvest losses caused by insects are extremely important in stored grains. Unprotected storage structures provide an abundant food source for the pests, whose population can increase markedly within a short time, leading to severe losses. Although technologies exist for storage pest control, taking early action is crucial. Typical methods like detection of increasing temperature inside the store or visual appearance of insects are often too late, when massive infestation and losses have already happened as a consequence of internally feeding larvae. We analyzed the utility of the sound signals emitted during feeding and movement of the larvae and adult forms of *Prostephanus truncatus* and *Sitophilus zeamais* on maize and *Acanthoscelides obtectus* on beans for the early detection of infestations by these species. Sound signals were recorded in the laboratory in a noise-shielded chamber (22-25°C). The signals were corrected for background noise, and further processed using fast Fourier transform and other algorithms on specialized software. The processed signals were then analyzed for frequency and time pattern differences of impulses following a specified spectral profile classification approach. The counts of broadband (multiple peaks from 1-8 kHz) and mid-frequency (band at 3 kHz) impulses and the rates of broadband and mid-frequency impulses were significantly different for larval and adult forms of *S. zeamais*, and *P. truncatus*. The larvae of *A. obtectus* displayed continuous low-amplitude sound impulses frequently occurring in trains of two or more impulses, while the adults displayed lower-amplitude impulses with shorter bursts. Larvae and adults of these pests display distinct acoustic fingerprints which make their early detection possible. The development automated acoustic devices for use in early pest detection in storage facilities will help reduce the food and economic losses by providing early warning for timely decisions.

Keywords:

Acoustic detection, Grain storage; insect pests



P7-2. Effect of Guar and Xanthan Gum Coatings on the Shelf Life and Quality of Cassava Roots

Loreto Atieno¹, Elija M. Ateka², Jane Ambuko³, Willis Owino¹

¹Department of Food Science and Technology, Jomo Kenyatta University of Agriculture and Technology, Nairobi; ²Department of Horticulture, Jomo Kenyatta University of Agriculture and Technology, Nairobi; ³Department of Plant Science and Crop Protection, University of Nairobi, Nairobi.

Corresponding author: willis@agr.jkuat.ac.ke

Abstract

Postharvest physiological deterioration (PPD) limits the shelf-life and utilization of a cassava root crop as it affects the nutritional, physical and physiological properties of the crop. The cassava root's response to PPD renders the root unpalatable and unmarketable and is a major contributor to postharvest losses. Edible coatings have been found to be effective in preserving the quality of various perishable produce. There are variations in the different coating solutions used on different products hence need for optimization of the concentrations. The objective of this study was to determine the optimum concentration of both guar gum and xanthan gum that can lead to maximum shelf life extension and quality preservation of the cassava. The cassava (KME 1) was harvested at uniform maturity and cleaned. The cassava was dipped in 1%, 1.5% and 2% of guar gum, 1.5%, 2%, 2.5% of xanthan gum, 1%, 1.5%, and 2.5% of a combination of the two gums and some roots were left as control and stored at room temperature for a period of 20 days. Sampling was done every two days for assessment. The coated cassava showed lower respiration rates and ethylene production rates than the control samples. In addition, the change in quality parameters of the cassava; phenols, colour, flesh firmness, weight loss and dry matter content was significantly ($P \leq 0.05$) delayed in the coated samples. The PPD occurrence was also significantly reduced by coating. The results suggest that by using the 1.5% xanthan gum, 1% xanthan-guar mixed gum and 2% xanthan guar gum as edible coatings, the shelf-life of the cassava root can be extended by up to 20 days at room temperature without any decline in its quality hence promoting its economic benefits.

Keywords:

Cassava, postharvest physiological deterioration, xanthan gum, guar gum, shelf life



P7-3. Improvement of Women's Livelihoods Through Provision Bio-Fertilizer For Vegetable Gardens in Two Villages at West Kordofan, Sudan

Mohammed A. A. Hamad¹, Muna Ahmed², Elshiekh Awadelkkarim Ibrahim³

¹University of Kordofan, Dept. of Rural Extension and Training, Sudan

²University of Khartoum, Institute of Environmental Studies, Sudan

³University of Kordofan, Dept. of crops science, Sudan

Corresponding Email: abugitaf2013@gmail.com

Abstract

Consequence sand encroachment in the area adversely affected soil fertility leading to crops failure in women gardens. The objective of the research is to improve the productivity of home gardens owned and managed by poor women in rural rain-fed semi-arid areas of Sudan adversely affected by climate change. 20 gardens were randomly selected from 46 gardens. Different concentrations of the bio-fertilizer (control, 0.5m³, 1m³, and 1.5m³ for each m²) were applied in 12 plots (2x6m) and 3 subplots within each plot as replicate. Two types of vegetables were randomly planted in each plot; one representing fruit vegetable (Okra) "*Abelmoschus esculentus* L. Moench" and the other leafy vegetable (Jews mallow) "*Corchorus solitorius* L.". The experiment was conducted for two successive seasons. Parameters measured were mainly fresh pod weights, number of pods per plant, plant height, leaf area etc. MSTATC and STATISTIX8 program were used for data analysis. Results showed significant increase in yields for both vegetables, except Jews mallow in the first season. Okra yield increased from 0.93 ton/ha fresh green pods to 1.4 ton/ha with 1.5 m³ fertilizer in season one. In season two, okra increased from 0.92 ton/ha to 1.38 ton/h with 1.5 m³ fertilizer application. In season two, Jews mallow yield increased from 13.15 ton/ha to 21.06 ton/ha with 1.5 m³ fertilizer application. Combined analysis of variance indicated that there were significant differences among treatments for all studied traits in Okra and Jews mallow. It could be concluded that bio-fertilizer adoption could contribute to women empowerment through using high dose from bio-fertilizer to insure optimum yield of Okra and Jews mallow during off-season and using dry vegetables losses (pods and leaves) for home consumptions and hence improve family socioeconomic life style.

Keywords:

bio-fertilizer, food security, vegetables garden, Sudan



P7-4. Smallholder Oriented Approach to Post-Harvest Management For Groundnuts In Kenya: A Review

Nelson Wafula^{1, 2*}, Moses Siambi², Joseph P Gweyi-Onyango¹

¹Department of Agricultural Science and Technology, Kenyatta University, P. O. Box 43844-00100 Nairobi, Kenya

²ICRISAT, ICRAF house, UN Avenue, Gigiri, P. O. Box 39063-00623, Nairobi, Kenya

*Corresponding author; nelwaf@gmail.com

Abstract

Smallholder farmers struggle to improve the post-harvest environment which includes poor infrastructure, challenging climate, rudimentary technologies and low capital. Groundnut (*Arachis hypogaea*) is an important oilseed and food crop rich in protein with high-energy value where developing countries account for nearly 95% of world production. Farmers in Kenya lose 20-30% of groundnut yield during and after harvesting mainly because they lack adequate information. Therefore this review was carried out to argumentatively analyze critical steps during harvesting and storage of groundnuts that can maximally reduce post-harvest losses from literature globally. Timely harvesting is key for maintaining good quality because early harvesting leads to drop in oil content, aflatoxin contamination and shrinkage of seeds while late harvesting leads to difficulty in uprooting pods. The drying stage is crucial because storing groundnuts with high moisture content (>8%) leads to mycotoxin formation. Building cocks, tray dryers, racks, A-frames, inverted windrows and mats are modern drying methods that have shown to reduce postharvest losses by more than 25% compared to the traditional methods around the world. The use of this methods independently or in combinations have shown to reduce moisture contents from above 21% to below 7% within seven days which guarantees reduction of post-harvest losses without significant loss in quality for more than 10 months. Farmers should grade the crop before storage by removing residues, broken, damaged, poor and fungal infected groundnuts. Storage materials should be made of materials that allow air to circulate and stored in a well-ventilated, dry and cool place. Due to the high cost of insecticides and the increasing amount of pest resistance to insecticides, a strong focus should be on these good storage practices. Through dissemination of this effective and appropriate practices and technologies, there will be reduced post-harvest losses and thus enhanced livelihoods and food security.

Key words:

Arachis hypogaea, contamination, aflatoxin, storage and harvesting.



P7-5. Influence of Different Edible Coatings and Storage Media on Quality and Shelf Life of Cucumber (*Cucumissativus L*) Fruits

Odeyemi, O.M* and Salau, O.R

Department of Horticulture, Federal University of Agriculture,
Abeokuta.P.M.B.2240. Nigeria. 110001

*E-mail of corresponding author: bukies09@yahoo.com

Abstract

Cucumber is a fruit crop that is highly perishable due to extremely high metabolic activity. An experiment was conducted at the Laboratory of the Department of Horticulture, Federal University of Agriculture, Abeokuta (FUNAAB) in Nigeria to determine the effects of different edible coatings and storage media on the quality and shelf life of cucumber fruits. The cucumber fruits 'Market more' variety were harvested at physiological dark green immature stage from the Organic Skill plot in FUNAAB and treated with different edible coatings; Shea butter, coconut oil and honey while those without edible coating served as control. Treated fruit samples were stored in Evaporative cooling structure-ECS (21-23°C and 89-90% RH) for 21 days and open shelf (27-29°C and 74-75% RH) for 10 days. Fruits were evaluated for physical and biochemical parameters which included weight loss, colour and firmness change, Vitamin C content, Potassium and Iron content, Total Soluble Solid, Titratable acidity and sensory evaluation. Results revealed that Shea butter coated fruits had significantly ($p \leq 0.05$) reduced weight loss, colour and firmness retention, higher amount of vitamin C content when compared with other fruits coated with coconut oil, honey and those without coating stored in the ECS or open shelf. Potassium and Iron contents of fruits at pre storage were similar with fruits coated with Shea butter at post storage in the ECS or open shelf. The ECS delayed colour change and retained firmness in fruit samples when compared with samples stored at open shelf. Shea butter coated fruits stored in both media had acceptable sensory quality parameters such as visual quality, external colour, taste and no incidence of moulds when compared with other treated fruits. Thus, the use of Shea butter as an edible coating and ECS as a storage medium for cucumber fruits extended shelf life and maintained quality.

Keyword:

Cucumber fruits, edible coatings, postharvest, quality, shelf life, storage



P7-6. Effects of Hexanal Formulations on Prolonging the Postharvest Life and Quality of Papaya Fruit

Ouko J.R*¹, Hutchinson M.J¹, Jane Ambuko¹, Willis Owino² and Jayasankar Subramanian³

¹Department of Crop Science and Plant Protection, College of Agriculture and Veterinary Sciences, University of Nairobi, Kenya

²Department of Food Sciences and Technology, Jomo Kenyatta University of Science and Technology, Kenya

³Department of Plant Agriculture, University of Guelph, Vineland Station, 4890 Victoria Avenue North, Vineland, Ontario L0R 2E0, Canada

Corresponding author: oukobora@gmail.com

Abstract

Huge postharvest losses, estimated at approximately 40%, is one of the major challenges on the production of thin-skinned fruits such as papaya. Papaya (*Caricapapaya* L) ripens and softens over a short time, usually in 3 days, predisposing the fruit to more physical damages and phyto-pathogens invasions even in careful handling further shortening the fruits' post-harvest shelf life. Hexanal, a naturally occurring compound has been tested in other parts of the world and reported to enhance the postharvest life of other fruits. However, no study has been conducted in Kenya or in any other part of Africa. The objective of the study was to evaluate the efficacy of Hexanal formulations (Enhanced Freshness Formulation, EFF) in prolonging the shelf life of papaya in two agro-ecological zones, Machakos (AEZ IV) and Meru (AEZ II) in Kenya. Two concentrations, 1%, 2% and a control at two timings, 2.5 and 5 minutes were applied as a dip treatment in solo sunrise and mountain papaya varieties in a randomized complete block design. Fruits treated at 2% for 5 minutes lost up to 19% of their cumulative physiological weight unlike the controls which lost up to 35%. Treated fruits were 374% more firm than control fruits. All the EFF treated fruits significantly showed reduction on skin damages, reduced pathogen invasion and extension of fruit shelf life by 6 days. EFF treatment delayed ethylene and respiratory peaks by three days. Total titratable acidity decreased during the ripening period with no significant difference between the treatments. Total soluble solids increased as the fruit ripened then declined after sometime. The results of the study indicate that EFF could be a viable and novel option for reduction of postharvest losses for the delicate tropical and sub-tropical fruits in Africa even among small scale farmers and traders.

Key word:

Postharvest losses, Kenya, Papaya, Enhanced Freshness Formulation (EFF)



P7-7. Use of Hermetic Storage to Control Aflatoxin in Maize

Sophie Walker, COP of AflaSTOP, swalker@acdivoca.org

Abstract

In 2004, an outbreak of acute human aflatoxin-poisoning (aflatoxicosis) in the Eastern Province of Kenya attracted worldwide attention. Consumption of highly contaminated maize was found responsible for the high number of human fatalities. The continuing Kenyan aflatoxin crisis claiming human lives each year, demands ongoing attention until realistic management strategies, pre- and post-harvest, are put in place. In recent years, hermetic storage has been increasingly promoted in Asia and Africa, as low oxygen levels result in 100% insect mortality. AflaSTOP sought to determine if any hermetic storage devices currently in, or about to be, introduced to the Kenyan market are able to: 1) impede post-harvest aflatoxin contamination 2) withstand frequent opening, and therefore an interruption of the hermetic principle, without loss of their effectiveness; 3) reduce insect damage. Furthermore, storage experiments were conducted with grain at recommended (<13%) and farmer achieved (14-15%) moisture content to assess if these conditions influence the performance of the devices. AflaSTOP established that hermetic storage will impede the growth of aflatoxin at different moisture levels. However, to effectively store grains hermetically for longer periods of time (over 3 months), maize needs to be below 13.5% moisture content. In On-Farm trials, AflaSTOP established that ~70% farmers were able to set up and use hermetic devices effectively, whether they received training or not. AgResults demonstrates that sales of hermetic bags are rapidly increasing as many farmers adopt hermetic storage, due to concerns about consuming insecticides currently applied to preserve grains. However, non-adopters are still concerned about the devices failing and the loss of an asset if it is damaged. AflaSTOP also introduced a mechanical dryer on a pay for service model which is being adopted by farmers in wet harvest areas.

Key words:

maize, aflatoxin, hermetic storage, moisture levels



Work Stream 8

**Postharvest handling and
technologies for livestock products**

O8-1 An Assessment of Milk Production Efficiency of Smallholder Dairy Households and Post-Harvest Losses In Meru County, Kenya

*D.K. Mugambi¹, M. Maina M²

¹Directorate of Livestock Development, County Government of Meru, Kenya

²Directorate of Grant Support, Kenyatta University, Kenya

*Corresponding author: daudimwaambi@yahoo.com

Abstract

Dairy farming is a major economic activity in Kenya, contributing about 4% of the National gross domestic product. It is a main source of income, food and employment in the country. The amount of Kenyan milk in the local market, however, is inadequate and not affordable to a majority of citizens, despite the fact that the country is the home to the largest dairy herd in Africa. The objective of this study was to assess the efficiency of milk production at the household level and the incurred post-harvest losses. Data were collected from 140 randomly sampled dairy farming households in Meru County, and analyzed using both Frontier 4.1c and SPSS. Results indicated an average household technical efficiency of 85.5%. The coefficient for the fitted milk production model was 2.20. It was revealed that households kept an average of 5.19 (SD= 6.10) mature dairy cows and their crosses, milking an average of 46.98 (SD=58.36) litres daily. An individual cow produced an average of 9.0 litres a day. It was revealed that the number of lactating cows and the amounts of roughages, concentrates, and mineral supplements were the major factors influencing household milk production. Farms lost about 3% of their milk during deworming and about 1.7%, while using antibiotics to treat diseases, mainly mastitis. Farmers indicated that most of their evening milk was sold to brokers and village hotels, with some being involuntarily consumed at home when local demand is low. About 42% of the farmers immersed their evening milk in cold water or put it in aluminum buckets or in charcoal containing units to preserve their evening milk. Milk bar owners and brokers reported a loss of about 6% of their milk, which they associated with poor general hygiene. High dairy labour turnover had a positive correlation with poor hygiene. Households were largely efficient, but operated under resource-constrained; low input-low output production systems. An opportunity exists for households to benefit from economies of scale. They require minimizing labour turnover to address hygiene challenges, recurrent disease incidences and frequent new staff trainings. Improved household-level milk cooling facilities require being designed and availed to dairy farming households at affordable costs. Both the county and national governments require providing infrastructure for milk cooling at strategic points.

Keywords:

Milk, Technical Efficiency, Post-harvest Losses



O8-2. Extraction of Casein from High Acid Milk for Utilization in Yoghurt Development

Faith Ngundi Ndungi^{1*}, Patrick Muliro¹, Abdul Faraj¹ and Joseph Matofari¹

¹Department of Dairy, Food Science and Technology, Egerton University, Kenya.

*Corresponding author. Email address: faith.ndungi@gmail.com +254722287712

Abstract

One of the steps of yoghurt production involves supplementation with skim milk powders in order to improve on the total solids. Casein, a dried protein-rich product manufactured on the basis of milk coagulation may be used to replace costly skim milk powders. High acid milk (coagulated milk) is a major proportion of post-harvest losses in smallholder delivered milk at collection centers. This milk is considered of low quality and rejected based on failed alcohol test. This study aimed at extracting casein from high acid milk and utilizing it for enrichment as well as improvement of texture in yoghurt. Extraction of casein from the high acid milk involved inoculation of the milk with starter culture and incubating it. The casein was then introduced in yoghurt in three proportions; 1%, 1.5% and 2%. Other yoghurt samples included one with skim milk powder and another with neither casein nor skim milk powder. Viscosity and syneresis were measured by a cup-type viscometer and centrifugation at 3000 rpm for 5 minutes respectively. The syneresis of yoghurts after centrifugation ranged from 0.0 to 59.1%. Samples containing 2% casein and skim milk powder showed the lowest syneresis values. The same samples showed the highest viscosity values. High acid milk is considered of low quality and rejected but this does not reduce the milk to a non-utilization state. The addition of casein from high acid milk had a significant effect on viscosity and occurrence of syneresis in yoghurt.

Keywords:

High acid milk, Casein, yoghurt



O8-3. Inclusiveness and Efficiency in Post-Harvest Loss Reduction; A Glance at the FAO-Thiaroye Fish Processing Technology

Yvette Diei Ouadi¹, Aina Randrianantoandro¹, and Oumoukhairy Ndiaye²

¹United Nations Food and Agriculture Organization

²Centre for Training of Fisheries Officers, Senegal

Abstract

Fish smoking in the tropics is predominantly a hot-smoking process, with the use of inefficient equipment contributing to huge post-harvest losses. The need to address the inefficiencies led in 1967 to development of the Chorkor kiln by the UN Food and Agriculture Organization (FAO) in partnership with the Ghana Food Research Institute/FRI. It has been strongly promoted worldwide, but with advances in science it was necessary to further improve it. Indeed, the presence in food of chemical contaminants, the polycyclic aromatic hydrocarbons (PAHs) at abnormal levels is known to make food unfit for consumption, therefore to be removed physically from the supply chain, hence losses with impact on incomes of the producers. Compliance issues at border inspection posts of the European Union (EU), have prompted the development of an alternative process that meets the regulatory requirements of these lucrative markets. The design of FAO-THIAROYE fish processing technique, now known as the FTT or FTT-Thiaroye fits within that framework. The FTT is more efficient than the Chorkor kiln. It generates safer products, portrayed by the PAHs levels that meet the regulatory limits, substantiated by reference laboratories and the return of previously banned medium-scale processing units on the national competent authority list of EU approved establishments. This was a clear sign of restored confidence with the adoption of this new system. In Cote d'Ivoire, one of the 2 countries to have first experienced the FTT, the economic losses of 1.6 million between 2006 and 2010 due to the self-ban from export and post-harvest losses documented as 16.64 tonnes (about 4,000 USD) annually per smoker have been reduced; and the ratio of fuelwood used dramatically decreased from 5 to 0,8 kg wood/kg fish. A 2016 FAO-commissioned study concluded that the initial investment (1,600\$ for a full equipment) may be a challenge for these fishers, but FTT kilns are financially and economically profitable, technically, socially and environmentally sound. This supports the trends of its expansion from 2 countries before 2014 to more than 10 now in Africa, with a foreseen dissemination in 2017 to Asia.

Keywords:

Fish safety, FTT, kilns, market, smoking, women



O8-4. Harnessing Lessons in Sustainable Dairy Farming to Kenyan Dairy Sector from The Dutch Dairy Sector for Reduction of Post-Harvest Milk Losses.

*^aOloo Benard Odhiambo, ^aDaisy Lanoi.

*Corresponding Author: olooo.odhiambo@gmail.com

^aDairy and Food Science and Technology Department Egerton University.

Abstract

Dutch dairy sector is a premier player in the global arena. The Dutch have also been associated with the world's most productive dairy cattle in Friesian-Holstein. There are many important breakthroughs on sustainable intensification and successful running of a dairy farm from the Dutch. Kenya on the other hand is just entering the transitional phase in dairy development. It is already an important player in dairy farming in Africa whose production is second only after South Africa. One of the major challenges of the Kenyan dairy sector results from post-harvest losses of milk due to poor handling, transportation, and preservation facilities. There are several lessons that the dairy industry in Kenya may be able to learn in order to raise to its optimal potential. This paper, through an intensive interrogation of the Dutch dairy sector through; field excursions, group discussions, expert presentations, and lectures makes important situational analysis of the Dutch dairy sector and compares it to the Kenyan dairy industry situation. The Kenyan dairy industry situation was studied through a thorough desktop review of major government, Non-government organizations, discussions with experts and other major players in Kenyan dairy landscapes' publications. This study makes cognizant the fact that in designing any interventions in the Kenyan dairy industry it is vital to understand the trends and the drivers that shape the dairy industry in Kenya. Based on these prevailing circumstances it has discussed the vital lessons: sustainable intensification, use of technology in dairy farm management and practice, and strong collaboration among stakeholders that the Kenyan dairy sector may learn from the Dutch dairy industry to ensure that any gains from the improvement in the Kenyan dairy sector remains sustainable. In deed by so doing, the Kenyan dairy sector will be better placed to deal with challenges resulting in post-harvest losses of dairy products.

Key words:

Dutch dairy sector, sustainability, dilemmas, Kenyan dairy sector



O8-5. Evaluation of Commercial Feasibility of The Deep-Frying Processing Technology in The Reduction of Post-Slaughter Losses in Kenya

Catherine Kunyanga^a, Josphat Gichure^a, Pius Mathi^a and Jasper Imungi^a

^a Department of Food Science, Nutrition and Technology, University of Nairobi, Kenya

Corresponding author: Dr. Catherine Kunyanga; ckunyanga@uonbi.ac.ke

Abstract

The livestock sector in Kenya contributes over 12% to Kenyan gross domestic product (GDP) although the sector is dominated by small-scale producers in the pastoral regions. In addition, the livestock sector is the fastest growing sector at 48% due to increased meat consumption among Kenyan consumers. In the Arid and Semi-Arid regions (ASALs), the livestock sector accounts for 90% of employment and 95% of family incomes for pastoral communities. Post-slaughter losses (50%) in the pastoral regions are caused by poor livestock production systems, poor pre-slaughter handling, poor slaughter techniques/operations, and inadequate processing technologies among other challenges. Most of the traditional technologies used are not standardized and no attempts have been made to mainstream them into the formal markets. Therefore, this project was designed with the objective of reducing post-slaughter losses through development of commercially feasible meat products using innovative processing technologies. The paper will discuss how data was collected by a multi-method research approach using structured questionnaires in exploratory surveys, interviews, Focus Group Discussions among the pastoralist communities in Turkana, Garissa, Kajiado and Isiolo. The findings of the study showed that among the current pastoral indigenous products and processing techniques (including sun-drying, solar drying, smoking, use of herbs and spices, and salting), the deep frying technology of beef produced a high quality, shelf stable and culturally acceptable commercial beef products. The potential for commercial improvement was shown to range from 60% - 72.06%. The cost analysis and commercial feasibility studies showed that a KES 150 deep-fried packaged beef product can easily sell in the formal markets in Nairobi and even at lower prices in the pastoral regions. It was concluded that the deep-frying technology is commercially viable in the formal meat value chain and can be used to reduce post-slaughter losses as well as generate income for the pastoral communities in Kenya. In addition, utilization of non-meat products and by-products has economic incentives hence reduces the cost of compliance.

Key words:

Commercial Feasibility, Post-slaughter Losses, Deep-frying Technology, Meat Value Chain



O8-6. Reduction of Post-Slaughter Losses in the Meat Value Chain through Value Addition and Innovative Processing Technologies

Catherine Kunyanga^a, Josphat Gichure^a, Pius Mathi^a and Jasper Imungi^a

^a Department of Food Science, Nutrition and Technology, University of Nairobi, Kenya

Corresponding author: Dr. Catherine Kunyanga; ckunyanga@uonbi.ac.ke

Abstract

Post-slaughter losses in the meat value chain in most developing countries have been attributed to inappropriate post-slaughter handling, under-utilization of edible by-products and lack of appropriate processing technologies. Post-slaughter losses contribute up-to a third of total losses along meat value chains. Post-slaughter losses include weight loss or even stress during loading, transportation and marketing or quality deterioration during handling, slaughter and storage. Pre-slaughter handling techniques such as trekking for long distances, usually more than 100 kms, also lower the meat quality hence more losses. This is despite the fact that Kenya has an estimated livestock resource of 14.1 million indigenous cattle and 3.4 million exotic cattle. This paper presents scientific evidence on how value addition and innovative processing technology can be leveraged to address these challenges and opportunities for commercial exploitation to reduce post-slaughter losses along the beef value chain. The developed deep fried and solar dried beef products are based on indigenous knowledge and techniques used by pastoral communities to produce traditional meat product. A multi-method research approach was used to collect data using structured questionnaires in exploratory surveys, interviews, Focus Group Discussions. Lab simulations for the new products and process development were done in the pilot plant. Models for upgrading and modification of processes for commercialization were applied and the process analysis documented. Standard analytical methods were used to assess the microbial, chemical and sensory quality as well as stability tests and acceptability studies. Results showed that there is a technological base for production of high quality, shelf stable and low-cost commercial meat products and based on innovative processing technologies. The developed beef products have high proteins (52.10% to 66.48%), energy (329.69 Kcal/100g to 404.20 Kcal/100g); fats (10.78% to 15.40%) and moisture (14.05% to 19.35%) content were considerably low. No pathogenic microorganisms were present. The products had high shelf stability, low-cost (KES 200-250/kg) and were culturally acceptable. Therefore, post-slaughter losses can be reduced by increasing efficiency along the chains, value addition and by-products utilization.

Keywords:

Meat Value chain, Post-slaughter losses, Processing technology, Value addition



O8-7. Ten-Years FAO Support to Assessment Methodology and Informed Fish Loss Reduction Policies and Strategies

Dr. Yvette Diei Ouadi

Fisheries and Aquaculture Policy and Resources Division (FIA)

FAO Fisheries & Aquaculture Department

Tel. +39.0657053251 - Fax. +39.0657053020 www.fao.org

Correspondence: ainajedia@yahoo.fr

Abstract

With more than 60 % of Africa's fisheries production and ten million actors, small-scale fisheries is the backbone of the sector, a key contributor to food and nutritional security, income generation and economic welfare. However its actual potential is not fully utilized owing to several shortcomings, one of the salient being the high level of post-harvest losses. Addressing this challenge requires a better understanding of the patterns of these losses, hence a systematic assessment methodology that identifies their significance, whether they can be reduced and what benefits this is likely to bring sustainably. In 2006, the fisheries and aquaculture department of the UN Food and agriculture Organization (FAO) engaged in a collaborative undertaking with 12-Sub-Saharan African countries that led to the establishment of a methodology to assess post-harvest losses in small-scale fisheries (<http://www.fao.org/docrep/014/i2241e/i2241e.pdf>). The methodology known to be the first of its kind to be piloted, validated and adopted, has framed a systematic approach to reduction of losses in smallholders. It consists of three methods, the exploratory qualitative method (IFLAM- Informal Fish Loss Assessment Method), Load Tracking (LT) and Questionnaire Loss Assessment Method (QLAM). It has been proven in overcoming the challenges in data and information collection on small-scale fisheries, can be tailored to the geographical context and value chain needs. Indeed further improved in 2013 in mainstreaming the multifaceted aspects of losses along the supply chain, it evolved since 2015 into a methodology for a holistic understanding of the fish losses in the use of critical tropical fishing gears in Africa, Asia and Latin America. It has generated data, snapshot cases with subsequent baseline indicators and milestones setting, strategy development (ex: <http://www.fao.org/3/a-i5935e.pdf>), documenting best practices and promoting technology innovations (ex: <http://www.fao.org/3/a-i5141e.pdf>). Lessons from the process of assessment and subsequent fish losses control measures portray its contribution to countries' efforts towards the realization of the Malabo Declaration of halving the current levels of post-harvest losses by 2025.

Keywords:

Fish loss, interventions, methodology, policy, post-harvest, strategy, technology



O8-8. Tackling milk wastage in Uganda by increasing its shelf life

Tibimanywa Geoffre, Regional coordinator food security and Livelihood at Brac Uganda
Mbarara Regional office, kamukuzi division
Email: gtibimanywa@gmail.com
Mobile: +256 753747771/ 775508556

Abstract

Agriculture is the back bone of Uganda and over 80 per cent of Uganda's population are engaged in the sector yet 69 per cent of them are small holder farmers. Livestock sector alone contributes 290 million US DOLLARS to the national GDP and is a source of livelihood for over 4.5 million Ugandans. The objective of this study was to enhance capacity of local milk processors (for UHT milk, pasteurized milk, ghee and yoghurt) and improve market linkages between milk producers and dealers for faster marketing through improved milk handling and transportation cold chain maintenance at the milk chilling centres. The implementation will rely on the leverage of Dairy cooperative societies, will utilise their existing structures and engage them at all stages to deliver the results. This is steadily progressing with time, for instance, the cattle population has grown from 13.6 million in year 2014/15 to 14 million in 2015/2016 which has seen increase in production of animal products, for example, Beef production increased from 170,000 to 220,000 metric tonnes, while milk production increased from 1.9 billion litres to 2.4 trillion litres between 2013 and 2016 (MAAIF). Most of the milk is produced in remote areas of western Uganda which have poor road network and not connected to electricity supply leading to increased occurrences of milk spoilage and wastage. This will result in over 18000 dairy farmers accessing meaningful and reliable market and 128 primary societies using modern milk handling and transportation techniques. The 8 Local milk processors will be able to produce in large processed milk in large quantity. Survey could be carried out to establish which areas need particular attention than others and dairy cooperative societies could be supported with smart phones with an installed app, to enable them access market information at any time. Other stake holders like Dairy development authority, Uganda Crane creameries could be engaged to gain much deep understanding of the sector.

Key words:

Powdered milk, Ultra heat treated milk, Pasteurized milk, Stainless still milk cans, Cold chain, Farmer organisations, Cooperative societies, Cooperative unions, Dairy Development authority
Ministry of agriculture animal industry and fisheries



O8-9. Effects of Smoking Techniques and Ambient Storage on The Concentration of Polycyclic Aromatic Hydrocarbons (Pahs) Of Smoked Catfish (*Clarias Gariepinus*)

^{*ab} Salaudeen, Mutiat Motolani and ^b Osibona, Adesola Olayinka

^a Nigerian Institute for Oceanography and Marine Research, Victoria Island, Lagos, Nigeria

^b University of Lagos, Department of Marine Sciences, Akoka, Lagos, Nigeria

*Correspondence author salaudeen06@yahoo.com, salaudeenmm@niomr.gov.ng

Abstract

Smoked fish are usually stored for certain period of time prior to marketing and consumption. The effects of smoking techniques and storage on the concentration of polycyclic aromatic hydrocarbons (PAHs) of smoked catfish were determined. Smoked dried catfish were produced using traditional smoking kiln (44-gallon drum) and an improved smoking kiln by Nigerian Institute for Oceanography and Marine Research (NIOMR). The smoked dried catfish were packed in polythene bags and stored at ambient (30 ± 3) °C, temperature for 12 weeks. During storage, the concentration of PAHs in traditionally smoked catfish ranged between 81.48 and 99.86 µg/kg while that of improved kiln smoked catfish ranged between 48.56 and 63.16 µg/kg. There were significant ($P < 0.05$) reduction in the concentration of PAHs of the smoked catfish from the two smoking techniques during the 12 weeks storage period. Benzo (a) Pyrene was identified in the traditionally smoked catfish up the 8th week storage but absent at the 12th week storage period. The sum total of the new EU PAH markers, PAH4 were within the maximum limit of 12 µg/kg. The reduction in the levels of PAHs during storage might be as a result of the PAHs being converted to other compounds which need further study.

Key words:

Catfish, smoking techniques, storage, PAHs, PAH4.



O8-10. Reducing Fish Postharvest Losses by Use of Solar Tent Dryers

Joseph Nagoli¹, Levison Chiwaula², Geoffrey Kanyerere³ and James Banda³

¹WorldFish – Malawi Office, P.O Box 229, Zomba, Malawi

²University of Malawi, Chancellor College, P.O Box 280, Zomba

³Department of Fisheries, P.O. Box 593, Lilongwe

Abstract

In Malawi over 30% of fisheries production is estimated to be lost through poor post-harvest handling especially for small species. Current open-sun drying processing methods do not offer immediate solutions to fish losses especially during peak catch periods of these species occurring between January and April which is associated with rains and high humidity. A solar tent dryer was therefore designed and tested for drying small fish species namely: Usipa (*Engraulicypris sardella*), Utaka (*Copadichromis* spp.) and Ndunduma (*Diplotaxodon limnothrissa*) in Lake Malawi for drying efficiency, profitability, and fish quality and develop the value chain for the small fish products. The Solar tent dryer was made up of a UV treated polythene 200 µm sheet worn over a wooden frame. The solar dryers achieved up to 10% moisture content thereby increasing shelf-life of fish products to seven weeks. Spoilage indicators TVB-N g/100mg and pH (-log [H+]) for fish dried in solar dryers versus open sun drying ranged from 15.45-17.31, 6.26-6.62 and 15.70-20.56, 6.32-6.31 respectively. The Total bacteria viable counts, TVB-N (g/100mg) and pH (-log [H+]) at the period of sensory rejection were 5.5×10^6 cfu/g/cm², 17.20 and 6.36 for open sun drying and 3.1×10^3 cfu/g/cm², 17.14 and 6.30 for solar dryer, respectively. Evaluation of economic viability of the dryer indicated that it is highly likely that fish processors will pay to own and use solar dryers. The average amount male fish processors were willing to pay was estimated at MK17, 732 (~US\$25) and female fish processors - MK13, 765 (~US\$19). Solar tent drying was therefore, economically and socially sound as it reduced labour demand from women who are the main processors for small fish species. The solar dryer can therefore reduce postharvest losses without increasing fishing effort and result in increased fish consumption and utilization through improved organoleptic preference.

Key words:

Fish, losses, postharvest, processing, solar tent-dryer



O8-11. An Evaluation of the impact of Vertical Integration on Post-Harvest Milk Losses mitigation among Smallholder Dairy Farmers in Lower Central Kenya.

J.K. Mutura ¹, M. Maina M², D. K. Mugambi ³

¹Stima Sacco Society Ltd, Kenya

²Directorate of Research Support, Kenyatta University, Kenya

Corresponding author: kuriamutura@gmail.com

Abstract

Dairy farming is an important economic activity among the developing countries as it fills the income gaps created by the inadequacies of the financial markets. Vertically integrated small holder dairy farmers maximize return on investments through value addition, complimenting own produce from other sources and offering diversified products from the same material inputs. Value addition and product diversification facilitates increased market participation leading to reduced post-harvest milk losses. About 80% of the dairy output in Kenya emanates from small holders, many of whom are in the highlands. Approximately thirty five percent of total milk produced is consumed on farm by the calves and the farmer's family while the balance is available for sale. This paper reports on a study conducted to evaluate the impact of vertical integration on post-harvest milk losses mitigation among small holder dairy farmers in Lower Central Kenya (Kiambu County). Multistage sampling technique was used in collecting data from 288 small holder farmers. Data management was carried out using SPSS version 20 while econometric analysis were carried out using STATA version 12. Logit regression model was used to determine the likelihood of a household to integrate vertically. Results showed that fixed investment cost, storage type, milk cost share, percentage of milk sold and dairy enterprise turnover explain a household likelihood to vertically integrate in its dairy sector. Vertical integration leads to optimum utilization of dairy farmers fixed assets, diverse forms of milk storage hence reducing post-harvest losses. High turnover encourages smallholder dairy farmers to integrate vertically with resultant value addition and reduced post-harvest losses.

Key Words:

Smallholder dairy farmers, Vertical Integration, logit regression, market participation.



O8-12. Post-Harvest Milk Loss Reduction in Kenya: The Case of Smallholder Dairy Commercialization Programme

Kembe Moses Ageya¹ and Kibiego Michael¹

¹Smallholder Dairy Commercialization Programme: email: pcu.sdcp@gmail.com

¹Smallholder Dairy Commercialization Programme: email: kibiegomb@gmail.com

Abstract

Kenya has one of the largest and most developed dairy sub-sectors in Sub-Saharan Africa, accounting for about 4% of GDP and with a growth rate of 4% per annum compared to 1.2% for agriculture as a whole. There are presently over 1,000,000 smallholder farmers who depend on dairying for their livelihood. Of the total farm milk production, on-farm consumption (consumed by families or calves) accounts for about 45% of production while the remaining 55% is marketed through various channels. About 42% of marketed milk is sold directly from farmer to consumers; another 32% is sold to milk shops, kiosks, and traders. About 80% of traded milk is sold through the informal sector. The informal sector dominance is mainly due to an inefficient processing sector and consumer preference for raw milk, which is cheaper. The informal traders pay higher farm-gate average prices to producers than the dairy farmer cooperatives and deliver milk to consumers at prices that are up to 40% lower than those of processed packaged milk. While informal milk trade has created substantial employment opportunities for the rural and urban poor, there are concerns about the public health risks from informally marketed milk due to potential for adulteration and poor hygiene in milk handling. In addition, the dairy sector is faced with post harvest milk losses. There are milk losses in the dairy value chain due to inaccessibility of the market and the constraints to production due to inadequacy of business development services. Milk losses also occur due to inaccessibility of the market as a result of poor infrastructure, leading to inaccessibility of farm inputs and time spent and costs incurred to obtain household supplies from far away market centres. Analysis of the losses due to poor infrastructure has three aspects to it: first, the actual loss of milk which cannot be delivered due to poor roads; second the loss of milk due to poor hygiene and rejection once it is delivered to the collection centre; and finally the loss of the farmer's productive time while searching for water, firewood, feeds, veterinary services and other essentials that are required for production and home use but are not readily available. The Smallholder Dairy Commercialization Programme (SDCP) has responded to the challenge of milk losses. The overall goal of SDPC is to increase the income of the poor rural households that depend substantially on production and trade of dairy products for their livelihoods. This development goal is pursued through two specific objectives: (i) improving financial returns of market-oriented production and trade activities by small operators through improved information on market opportunities, increased productivity, cost reduction, value adding, and more reliable trade relations; and (ii) enabling more rural households to create employment through, and benefit from, expanded opportunities for market-oriented dairy activities, in particular as a result of strengthened farmer organisations. There are three components that enables the achievement of the objectives. Component 1 - Organization and Enterprise Skills aiming at providing Programme beneficiaries - smallholder dairy producers, small scale processors and small scale milk traders - with the appropriate organizational, managerial and enterprise skills to fully benefit from market-driven commercialisation of milk production, processing and trading. Component 2 - Technical Support to Smallholder Dairy Products designed to provide Programme beneficiaries with the technical skills required to participate in and benefit fully from market-driven commercialisation of milk production, processing and trading. Component 3 - Development of the Milk Marketing Chain to improve linkages for small-scale milk producers, traders and processors to local milk markets and increase their access to the processing sector. The objective of SDPC to reduce milk losses include reduction in economic losses, increase in milk quality and increase in smallholder farmer's incomes. More specifically the programme has provided substantial capacity building on hygiene milk production, loss reduction and value addition. Supply, installation, testing and commissioning of bulk milk coolers has reduced the milk losses through chilling.



O8-13. Network Governance, Value Addition, Gender and Traceability in The Aquaculture Sector in Kenya

Josphat N. Gichure^{1*}, Joyce G. Maina²

¹Department of Food Science, Nutrition and Technology, University of Nairobi, P.O. Box 29053-00625 Kangemi, Nairobi, Kenya

²Department of Animal Production, University of Nairobi, P.O. Box 29053-00625 Kangemi, Nairobi, Kenya

E-mail of the corresponding author: josphatnjengag@gmail.com

Abstract

After the lapse of the Economic Stimulus Program in 2012, the farmed fish sector has faced great challenges, namely inadequate information flow, low uptake of modern processing and preservation technologies, underutilization of by-products and unorganized market structure. These challenges are responsible for material and economic postharvest losses which accounts for almost 26 % of the harvested produce. As a means of appraising innovations and coordination to address postharvest losses, this study was conducted to generate empirical information on network organization and governance structure, postharvest handling, product development and gender dimensions. Data collected from 321 farmers, 66 traders and 82 consumers using semi-structured questionnaire was triangulated with focus group discussion, key informant interviews and review of policy documents in Kirinyaga, Busia, Kakamega and Migori counties. From the results, fish volumes harvested were low with a mean of 528 pieces from each pond. Uptake of modern processing and preservation technologies was limited with rudimentary techniques being the main forms of value addition: gutting and descaling by 78% of the farmers while deep-frying by 89% of the traders. Unlike tilapia which was mostly sold whole, catfish was presented as live fish, filleted or chunked. Smoking and sun-drying were done by less than 5% of the respondents. Commercial freezing was not common with the exception of 18% of farmers and traders who put unsold fish overnight in home freezers. Unequal power dynamics with regards to gender was evident. Long supply chains were evident and when coupled with limited knowledge on information sharing amongst supply chain actors meant that traceability was almost inexistent. The study concludes that limited adoption of modern preservation techniques, inappropriate network and governance structure and lack of gender equitable systems and structures were the main causes of postharvest losses.

Key word:

network governance, gender, postharvest losses, traceability, fish farming



P8-1. Microorganisms of smoked fish from Iseyin local government, Oyo state Nigeria Akinyemi, A. A.

Department of Aquaculture and Fisheries Management ,
Federal University of Agriculture, Abeokuta, PMB 2240, Abeokuta, Ogun State, Nigeria.
adeoluakinyemi@yahoo.com

Abstract

This study evaluated the microflora associated to fish samples. Smoked fish samples were bought from open local markets. The smoked fish samples were *Tilapia* spp. (*Oreochromis niloticus*), *Clarias gariepinus* (Catfish), *Chrysichthys nigrodigitatus* ("Bagrid catfish"). The total bacteria count ranged from 0.0 to 0.7×10^6 CFU/g. The highest microbial load of 0.7×10^6 CFU/g was obtained from the intestine of *Clarias gariepinus*. None of the bacterial load of analysed samples obtained was higher than the recommended value but fell within range. The fungal of the fish samples in most cases revealed no growth of fungi and in few cases recorded 0.1 to 0.3×10^6 cfu/g. Bacteria isolates in the fish samples were: *Escherichia coli*, *Staphylococcus saprophyticus*, *Pseudomonas fluorescens*, *Proteus mirabilis*, *Staphylococcus aureus*, *Bacillus subtilis*. *Escherichia coli* was the most abundant found in the fish samples while *Proteus mirabilis* and *Staphylococcus aureus* was the least occurring bacteria. *Penicillium notatum* was found to be the most abundant of the fungi isolated from the fish gills, skin and intestine. All bacteria isolates were significantly susceptible to Ofloxacin and Pefloxacin while Streptomycin was the least effective in all the commercial synthetic antibiotics used.



P8-2. Assessment of Potential Microbiological Hazards Associated with Farmed Fish in Kenya

Anne Chepkoech*¹, Edward Karuri¹, Joyce Maina² and Nicanor Odongo¹

¹Department of Food Science, Nutrition and Technology, University of Nairobi, P. O. Box 29053-00625, Nairobi, Kenya.

²Department of Animal Production, University of Nairobi, P. O. Box 29053-00625, Nairobi, Kenya.

*Corresponding author E-mail: annechep76@gmail.com. Tel: +254721384915.

Abstract

Since EU banned fish imports from Kenya due to food safety concerns, the fish sector has continued to experience stricter hygiene controls. However, there is still limited upgrade in terms of food hygiene and food safety management systems. Fish traders still experience fish spoilage related to poor handling and storage. The objective of this study was to determine the potential microbiological hazards associated with farmed fish in Kisumu County, Kenya. The study was done in four sub-counties in Kisumu County, namely: Kisumu East, Kisumu West, Nyando and Seme. Sampling was done along the value chain which included pond water, pond fish, retail fish and retailer's hand swab. The samples were analyzed for coliforms, *Staphylococcus aureus*, *E. coli*, *Vibrio* spp. and *Salmonella* spp. Seme sub-county had significantly the highest *Staphylococcus aureus* count of 6.35 logcfu; *Vibrio* spp. was present in all the value chain points and in all the sub-counties. The study established potential microbial hazard to the final consumers due to poor hygiene handling along the value chain. There is need to develop and implement effective hygiene and food safety management practices along the fish value chain in the study region.

Keywords:

Farmed fish, hygiene, microbial hazards, pathogens



P8-3. Postharvest Microbial Quality of Edible Insects During Handling and Processing

D. Nyangena^{a*}, C. Mutungib,^d, S. Imathiua, J. Kinyuru^a, H. Affognonc, C. Tangad, S. Ekesid, K.K.M. Fiaboed

^a Jomo Kenyatta University of Agriculture and Technology, P.O. Box 62000-00200, Nairobi, Kenya.

^b Egerton University, P.O. Box 536-20115, Egerton, Kenya.

^c International Crops Research Institute for the Semi-Arid Tropics, BP 320, Bamako, Mali.

^d International Centre of Insect Physiology and Ecology, P.O. Box 30772-00100, Nairobi, Kenya.

*Corresponding author E-mail: dorothyngyana@gmail.com; cmutungi@icipe.org

Abstract

Edible insects are a dietary source of protein for a significant part of rural populations and their livestock in Africa. In recent years, edible insects have been promoted as a means of achieving food security among such communities. Micro-organisms naturally thrive on and in insects due to their rich nutritional profiles. In addition, microbial contamination of edible insects begins at harvest through soil, handling techniques and packaging materials. The effect of post-harvest processing on the initial microbial load of *Acheta domesticus*, *Ruspolia differens*, *Hermetia illucens* and *Spodoptera littoralis* were investigated in an attempt to increase their safety upon consumption. *A. domesticus* and *H. illucens* were reared on brewery waste whereas *S. littoralis* was reared on black night shade leaves, and *R. differens* was collected from the wild. Samples were processed by boiling (96°C) or toasting (150°C) for 5 minutes, or by solar-drying (45-50°C) or oven-drying (60°C) to constant moisture content. The unprocessed materials and processed products were analyzed for total viable count (TVC), *Escherichia coli*, *Salmonella typhi*, *Staphylococcus aureus*, and moulds and yeasts using standard methods. TVC of the unprocessed materials ranged from 7.5 to 9.21 log CFU/g, and was higher than the acceptable limit (7 log CFU/g). Boiling and toasting reduced TVC by 4 to 6 logs cycles, and completely reduced *E. coli*, *S. typhi* and yeasts/moulds. Oven-drying reduced the TVC number by 0.07 to 2.4 log cycles, while solar drying resulted in an increase in TVC in some insects. All the other micro-organisms studied were partially eliminated, though not to a safe limit. *Staphylococcus aureus* was only partially eliminated in all the processes. These findings demonstrate that heat processing methods are effective in ensuring microbial safety of edible insects. The drying methods could be useful for increasing shelf stability but a cooking step should precede drying to ensure safety.

Keywords:

Edible insects, microbial contamination, post-harvest processing



P8-4. Influence of Milk Handling Containers on Raw Milk Shelf Life

Faith Ngundi Ndungi^{1*}, Patrick Muliro¹, Abdul Faraj¹, Joseph Matofari¹ and Ruth Momanyi¹

¹Department of Dairy, Food Science and Technology, Egerton University, Kenya.

*Corresponding author. Email address: faith.ndungi@gmail.com +254722287712

Abstract

Milk quality deterioration contributes to post-harvest losses. One of the factors that leads to this milk quality deterioration is the type of containers used to store and transport milk from farm gate to collection center after milking. The common milk handling containers are plastic containers, mazzi (recommended food grade container), aluminium and stainless steel cans. The utilization of the recommended food grade container may be hindered by some factors including: transporters preference, where the plastic containers are most preferred because they are lighter to carry than the stainless steel and aluminum cans. The terrain (bad road network) also contributes to plastic containers preference since they can be closed tight compared to the aluminium and stainless steel cans that are loosely covered therefore leading to milk spillage. The mazzi can on the other hand comes in small carrying capacity of a maximum of 10 liters, a great disadvantage to the transporters who preferred to carry a large volume of milk using the 20 liters plastic containers in one trip. The utilization of plastic containers has been reported to increase deterioration of milk quality compared to the other containers. This issue has been reported by farmers, milk collection centers operators and extension officers.

Key words:

Shelf life, Raw milk, Mazzi can, Plastic can



P8-5. Experiences and Challenges in Transfer of Milk Postharvest Technologies in Pastoral Communities of Kenya

Francis O. Wayua,^{1*} Amos O. Adongo² and Josphat I. Sagala²

¹ Kenya Agricultural and Livestock Research Organisation, Non-Ruminant Research Institute, P. O. Box 169-50100, Kakamega, Kenya. Tel. +254-710-629683; +254-738-986220. Email: fwayua@yahoo.co.uk; Francis.Obuoro@kalro.org (*Corresponding author)

² Kenya Agricultural and Livestock Research Organisation, Sheep, Goat and Camel Research Institute, P. O. Box 147-60500, Marsabit, Kenya.

Abstract

Postharvest technologies are essential in reducing food losses and wastage. Several milk postharvest technologies were introduced in pastoral communities in Kenya, with the objective of reducing postharvest losses and enhancing commercialisation. This paper describes the experiences and challenges in the technology transfer process. The paper is based on field experience and synthesis of literature on milk processing in pastoral areas, including journal articles, case studies and project reports. Cultured fermented milk, ghee, cheese and milk sweets were developed using appropriate technology. Cream separator enabled ghee making from camel milk which was impossible using traditional methods. Other technologies included hygienic milk handling, evaporative cooling and solar milk pasteurisation. Technology transfer was through participatory demonstrations with groups, study tours, exchange visits, and product exhibitions in field days, shows and trade fairs. During exhibitions, farmers participating in research activities demonstrated various technologies reaching, for example, over 10,000 clients in Marsabit, Garissa and Turkana counties. Beneficiary groups transferred the technologies to the wider community by explaining the various technologies. Technology transfer was catalysed through adult literacy classes and competitive farmer grants. Up-scaling was done using stakeholders, extension pamphlets and video documentaries. Adoption of hygienic milk handling and cultured fermented milk was over 50%. This pioneering work on milk processing in pastoral areas significantly contributed to food security and influenced policy, leading to development of Kenya Standards for camel milk. Challenges in technology transfer included high illiteracy and poverty, unavailability of milk processing equipment and ingredients locally, lack of electricity, marketing, and weak regulatory system. It is concluded that for these marginalised groups, application of appropriate milk postharvest technologies will lead to higher degree of food self-sufficiency and less dependency on food aid. The challenges to technology transfer should be addressed for maximum contribution of the technologies to food security and income generation.

Keywords:

Milk, pastoralist, food security, Kenya



P8-6. Information Sharing Strategies on Milk Postharvest Loss Reduction Among Smallholder Dairy Farmers of Olenguruone Division, Kenya

¹Rop K. Willy, ²Prof. Joseph Matofari, Ph.D, ³Prof. Isaiah Tabu, Ph.D

¹Department of Crops, Horticulture and Soils Egerton University, P.O. Box 536-20115, Egerton, Kenya

²Department of Dairy and Food Science and Technology, Egerton University, P.O. Box 536-20115, Egerton, Kenya

³Department of Crops, Horticulture and Soils, Egerton University, P.O. Box 536-20115, Egerton, Kenya

Corresponding Author: kwillyrop16@gmail.com, Egerton University, P.O. Box 536-20115, Egerton, Kenya

Abstract

The dairy industry in Kenya is one of the largest agricultural subsector contributing about 14% of agricultural Gross Domestic Product (GDP) and 3.5% of total GDP, respectively. The sector has been experiencing losses of about 67 million litres of milk through spoilage, spillage and 'forced home consumption' annually. If these postharvest losses were reduced, the dairy industry could contribute more to the economy of the country and provide sustainable solutions for Africa. This paper sought to identify and quantify access and use of dairy postharvest information and how it is contributing to reduction of milk postharvest losses. Purposive and proportionate random sampling techniques were used to select respondents from Olenguruone Division. Data collected was analyzed using descriptive statistics with aid of Statistical Package for Social Sciences. Results showed that a majority (57.60%) of the dairy farmers get information from Milk Cooperative Society, followed by Government extension services (14.70%) while, from Local government leaders and internet source were least with 0.40% respectively. The last two sources of information are attributed to socioeconomic challenges, attitude and low perception to ICTs amongst rural smallholder dairy farmers. Therefore, this paper recommends creation and support of dairy cooperative societies to motivate smallholder farmers to access and use information on modern dairy postharvest technologies that will contribute to reduction of milk losses in the milk value chain.

Key words:

Postharvest losses, dairy technology, information, access



Special Symposia Abstracts



Horticulture Innovation Lab – USAID



USAID-1. Importance and feasibility of cold chain technology in the developing world

Elizabeth Mitcham, Director, Horticulture Innovation Lab, University of California, Davis, CA, ejmitcham@ucdavis.edu

Angelos Deltsidis, International Postharvest Specialist, Horticulture Innovation Lab, University of California, Davis, CA adeltsidis@ucdavis.edu

Amrita Mukherjee, Specialist, Horticulture Innovation Lab, University of California, Davis, CA amukherjee@ucdavis.edu

Mohd. Rezaul Islam, Associate Researcher, WorldFish and Horticulture Innovation Lab, ranaramon@gmail.com

Abstract

The nearly complete absence of any segment of the cold chain in the produce sector in many developing countries, including cooling after harvest, cold storage (when stored), cold transport and refrigerated display at retail, contributes significantly to high produce losses and poor availability of nutritious foods in the off-season. While the cold chain is considered by some to be out of reach for small-scale farmers, it is imperative that innovative approaches be implemented to increase access to cooling and cold storage and transport technology. Low temperatures have many benefits for maintaining quality of harvested horticultural crops, including lower respiration rates, lower ethylene production, reduced water loss, reduced growth of decay organisms and human pathogens, and slower ripening and senescence. Evaporative cooling has been proposed in many areas. In hot, dry climates it can be useful approach for short term collection and holding of produce; however, under humid conditions it does not perform well. Under ideal conditions, the air temperature can be reduced 10°C maximum. Alternatively, a relatively inexpensive small cold room can be constructed with an insulated room, a window air conditioner unit and a CoolBot™ controller. For approximately \$10,000, a small room can cool produce to approximately 2°C. However, there are challenges with management of the facility and a comprehensive economic assessment of the feasibility of this technology is underway in Bangladesh. We have observed that small-scale farms in Bangladesh are frequently able to sell their produce at higher prices after short term cold storage. For example, in one case, the farmer was able to double his income by storing chili peppers for one or two weeks and then selling them when the price was higher.

Keywords:

Cold storage, cooling, temperature, CoolBot™



USAID-2. Evaluation of interventions to improve packaging methods for tomatoes produced by smallholder farmers

N. Nenguwo*, R. Fortunatus and R. Marealle, World Vegetable Center, Eastern and Southern Africa, P.O. Box 10 Duluti, Arusha, Tanzania

* Corresponding author: contact – ngoni.nenguwo@worldveg.org

Abstract

Current methods of packing tomatoes for transport include poor quality wood crates, baskets and plastic basins. These types of containers provide inadequate protection for the contents and can result in damage to fruit due to rough interior surfaces. Trials were conducted to evaluate various methods of packaging that can be used to reduce damage to tomatoes. Improved packaging methods identified for reducing damage include using smaller size wood crates and improved quality plastic crates. In our first experiment, wood crates that had a depth of 10 and 20 cm were compared with standard wood crates that were 30 cm deep. A second trial compared plastic crates with standard wood crates. The experiments were conducted by packing the containers with tomatoes, loading the filled containers into trucks, transporting them to local markets, and then measuring the percentage of damaged fruit. The lowest percentage of damage occurred in the standard crates (29.73%), followed by 37.50% for crates 20 cm in depth and 40.83% for the 10 cm crates. In the second trial, 21.08% of fruit was damaged in wood crates, and 14.27% in plastic crates. The higher damage to tomatoes in shallow wood crates was unexpected; it could have occurred due to the absence of a cover on the wood crates. The results of the second trial indicate plastic crates should be recommended to reduce damage to tomatoes.

Key words:

Postharvest losses, handling, transportation, damage, containers



USAID-3. Securing the Harvest: adapting local and global technologies to reduce post-harvest loss in strategic African crops

Jagger Harvey, PhD; Director, Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss, Kansas State University, 103B Waters Hall ,1603 Old Claflin Pl, Kansas State University Manhattan, KS 66502 , +1 785-532-3588, jjharvey@k-state.edu

Abstract:

The Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss (PHLIL) is a strategic, applied research and education program aimed at improving food security by reducing post-harvest loss and food waste of seeds and durable staple crops, e.g., grains, oilseeds, and legumes. The Lab's efforts are focused in four Feed the Future countries: Bangladesh, Ethiopia, Ghana, and Guatemala. Through collaborations between U.S. universities and local universities, research institutions and other partner organizations, PHLIL is conducting research, testing and outreach to contextualize and address current post-harvest loss factors and task division in rural communities and households. Validated and piloted post-harvest loss technologies, including grain dryers, storage bags and silos, moisture meters, and mycotoxin testing procedures, with low acquisition costs and limited operational footprints are providing accessible solutions to resource-poor farmers and small and medium enterprises in our programs in Ghana and Ethiopia. PHLIL is reaching an inflexion point in the research for development pathway. The program has formed strategic partnerships and enhanced human and institutional capacity in Ghana and Ethiopia, as well as other program countries. PHLIL has now successfully characterized and gleaned insights into various post-harvest losses in chickpea, dried fruits, maize, nuts, rice, sesame seeds and wheat. Further, a more advanced understanding of the socioeconomic, gender and nutrition context is emerging through surveys, trainings, workshops and focus group discussions. Overall, this has produced a matrix of successfully adapted postharvest interventions, which are effectively being moved from research into piloting and technology transfer in close association with key local actors. This ensures that the ultimate intervention packages bear the mark of their buy-in, input and innovation; these actors form the long-standing front line defense against post-harvest losses, and hold the key to improved nutrition and reduced poverty.

Key words:

post-harvest, Ghana, Ethiopia, Feed the Future



USAID-4. Taking it to Scale – Options for Hermetic Storage

Brett Rierson, Head World Food Programme, Global Post-Harvest Knowledge & Operations Centre, brett.rierson@wfp.org

Abstract

There have been pilots in over 40 countries to reduce post-harvest losses, by a variety of international agencies. With the exception of Post-Cosecha in Latin America, most have shown that hermetic storage reduces losses, yet almost all fail at the most crucial stage: taking a technology beyond an academic conversation, and taking it to scale. Looking at the challenge from a supply chain perspective, and leveraging its deep field presence, the World Food Programme (WFP) in Uganda has successfully scaled to over 110,000 farmers who have chosen to participate and purchase hermetic storage, with private sector manufacturers and distributors a central element of the success. Farmer incomes have tripled, farming families have their own stored food during the lean season, and aflatoxin levels have plummeted. Yet, this is just the first step. The Uganda government has asked WFP to closely collaborate with its Ministry of Agriculture to lead a nation-wide effort to reach 2.5 million farmers before 2025. Brett Rierson, the Head of WFP's Global Post-harvest Knowledge & Operations Centre, based in Kampala, will provide insights on the successes and challenges in Uganda, as well as provide an overview of the additional six African countries where WFP has begun the initial rollout of its successful model.

Keywords:

Supply chain, private sector, aflatoxin



USAID-5. Designing Affordable Grain Dryers for On-Farm Use in Africa

J. Lowenberg-DeBoer, Purdue University

Abstract

The growing availability and use of hermetic grain storage in Africa is reducing storage losses for dry grain, but grain drying is still a major constraint for many smallholder farmers in humid areas. The engineering principles for grain drying are well known, but that expertise has not been applied to development of mass produced technologies for on-farm use by smallholder farmers. The focus on-farm is justified by the fact that: a) centralized grain drying facilities are not widely available, b) quick drying after harvest is key to preventing aflatoxin accumulation, but poor roads and lack of vehicles make it difficult to transport the grain in a timely way even if centralized drying exists, c) centralized drying makes the most sense when grain is sold at harvest, but that may not be the most profitable option for many smallholders. Profitable technology for grain drying is commonly available to large scale farmers worldwide, but drying technology that fits the scale and the budget of smallholder farmers is not. This presentation will focus on the process of designing grain dryers for smallholder on-farm use in Africa, with specific attention to the development of design criteria that reflect the needs of the ultimate user (i.e. smallholder farmers) and supply chain concerns from manufacturers, distributors and retailers.

The design criteria proposed include:

- 1) Drying heat provided by solar or biomass
- 2) Initial investment less than US\$100,
- 3) Capacity to dry 100 kg/day,
- 4) Easily transported to isolated farmsteads and fields on the back of a donkey or motorbike, and
- 5) Manufactured in Africa.

The presentation will be based on the experience of the Food Processing Innovation Lab (FPL) and draw on lessons learned through the Purdue Improved Crop Storage (PICS) project. The presentation will be of interest to agricultural researchers, development specialists, and donor organizations.



USAID-6. Implementation of the Dry Chain through Drying Beads Technology

Johan Van Asbrouck & Patcharin Taridno
Rhino Research Group, Bangkok, Thailand
johan.rhino@gmail.com

Abstract

In warm and humid climates, food and seed deterioration can proceed very quickly. As a consequence, one-third of all food produced in these regions is lost before reaching the consumer. This indicates that producing more food alone will not fully address malnutrition, food security and agricultural sustainability. The "cold chain" is globally accepted and used for preserving the postharvest quality of fresh produce, but what about dry commodities such as grain, beans, nuts, that provide 70% of the global calories? Together with Dr. Kent Bradford (UC Davis), we developed the "Dry Chain" concept, simply expressed as "Make It Dry -- Keep It Dry". Dry commodities at harvest to safe moisture contents, package them in water-proof containers, and maintain the integrity of the containers through storage, transport and distribution. Implementing the Dry Chain promises to have an impact comparable to the cold chain, and does it with lower energy inputs as no ongoing refrigeration is required. The key is availability of a system that enables farmers to dry their commodities to a sufficiently low moisture level and that is simple, fast, affordable, efficient, and mobile with low investment and running costs. Our system is based on desiccant Drying Beads, produced from non-toxic zeolite clay, that can fulfill these requirements. The Drying Beads technology directly removes water from air for use in drying systems and subsequently efficiently reactivates the Beads for reuse. Such drying systems would enable farmers to use the Dry Chain concept to preserve their harvests for their own consumption or marketing. Rapid postharvest drying and packaging preserves nutritional value and prevents accumulation of mycotoxins during storage. This presentation describes the Drying Bead technology and its use in implementing the Dry Chain concept in postharvest handling of dry commodities. Key words: Drying, Seed, Grain, Storage, Nutritional value, Drying Beads.



USAID-8. A Technology-based Incubation Centre for Developing Affordable Nutritious Foods

Violet Mugalavai¹, Mario G. Ferruzzi², Hawi Debelo³, Cheikh Ndiaye^{3,4}, Augustino Onkware¹, Djibril Traore⁴, Hugo de Groote⁵, John R.N. Taylor⁶, Gyebi Duodu⁶, Betty Bugusu³ and Bruce R. Hamaker³

¹University of Eldoret, Eldoret, Kenya

²North Carolina State University, West Lafayette, USA

³Purdue University, West Lafayette, USA

⁴Institut the Technologie Alimentaire, Dakar, Senegal

⁵International Maize and Wheat Improvement Centre (CIMMYT), Nairobi, Kenya

⁶University of Pretoria, Pretoria, South Africa

Abstract

Food fortification is a well-recognized approach for addressing micronutrient deficiency worldwide. However, its impact is dependent on factors including identification of affordable and bioavailable micronutrient forms, their incorporation into consumer products for target markets, consumer acceptability, and product viability. The Feed the Future Food Processing Innovation Lab (FPL) seeks to leverage food processing through establishment of technology-based food processing Incubation Centres as a means to drive the value chain and deliver products with improved nutritional quality with emphasis on vitamin A (VA), iron (Fe) and zinc (Zn). In Kenya, the project partners with University of Eldoret where an Incubation Centre was launched in 2016. This includes an integrated research and product development strategy with the goal to address market demand for affordable, convenient, and nutritious products which leverage indigenous micronutrient-rich plant materials. The program has focused on 1) creating an Incubation Centre with cereal processing equipment, including an extruder for processing instant thick and thin porridge flours with fortification, and training and staffing the Centre, 2) screening native African fruits and vegetables for their potential to deliver bioaccessible forms of proVA, Fe and Zn, 3) assessing the impact of processing on quality attributes of conventional and instantized fruit/vegetable-cereal blends, and 4) determining consumer interest in fortified cereal products based on these concepts. The studies have identified baobab (*Adansonia digitata*), moringa (*Moringa oleifera*), and hibiscus (*Hibiscus sabdariffa*) as priority sources for Fe and Zn, and dried carrot and mango for ProVA sources. Blended cereal products containing baobab increased bioaccessibility of total ProVA carotenoids from mango and carrot by 2-3 fold. The studies indicate that consumers, even of lower socioeconomic status, were willing to pay a modest premium for instant products with added nutritional value, and that production of desirable cereal blends which deliver bioaccessible micronutrients from native plant materials is possible.



