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Research Notes on Current Issues in Cameroon Agriculture

Nambangia Justin Okolle

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Corresponding Author
Dr. Nambangia Justin Okolle (okollejustin@yahoo.com)

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F**orum for Agricultural Research in Africa (FARA)**
12 Anmeda Street, Roman Ridge PMB CT 173, Accra, Ghana Tel: +233 302 772823 / 302 779421 Fax: +233 302 773676 Email: info@faraafrica.org Website: www.faraafrica.org

Editorial
Dr. Fatunbi A.O (ofatunbi@faraafrica.org) and Mr. Benjamin Abugri(babugri@faraafrica.org)

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FARA serves as the technical arm of the African Union Commission (AUC) on matters concerning agricultural science, technology and innovation. FARA has provided a continental forum for stakeholders in AR4D to shape the vision and agenda for the sub-sector and to mobilise themselves to respond to key continent-wide development frameworks, notably the Comprehensive Africa Agriculture Development Programme (CAADP).
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Summary

The Programme of Accompanying Research for Agricultural Innovation (PARI) is supported by the German Government through GIZ and implemented in Africa by the Forum for Agricultural Research in Africa (FARA). The project is aimed at conducting research that generate knowledge that informs the direction of investment for innovations. This report compiles about 15 thematic research that generated series of information towards the delivery of innovation in crops, livestock and fisheries in Cameroon. The research subjects include, 1. The effect of different storage materials against the bean weevil (Acanthoscelides obtectus) damage on beans grains in North-West Cameroon (Agroecological Zone III); 2. The assessment of the use and acceptability of biochar in Fako and Meme Divisions of the South West Region – Cameroon; 3. A Socioeconomic Evaluation of Cocoa Processing and Commercialization Innovation Value Chain In The Centre And South Regions Of Cameroon (Agroecological Zone V); 4. Needs assessment for innovations in the processing of Cassava into gari in the South West Region of Cameroon; 5. The effect of different storage materials against *Sitophilus zeamais* (weevil) damage on maize grains in South-West Cameroon (Agroecological Zone IV); 6. Comparing the Performance of a Locally-Made Seed Crushing/Extraction Machine with Manual Method of Seed Crushing/Extraction; 7. Chemical properties of components of "Njorku" (a biofertilizer with insecticidal properties); 8. Conservation of Onions in the Extreme North Region Of Cameroon; 9. Needs Assessment For Proliferation In Fragments (PIF) Of Plantain In Agro-Ecological Zone IV; 10. Current Research and Training Needs in The Processing And Packaging Of Potato In The Western Highlands Of Cameroon; 11. Assessment on the use of small machines by smallholder farmers in Agroecological Zone IV of Cameroon; 12. Intensification of pelleted feed from local Feed resources/ Agro-industrial by products for efficient and sustainable poultry production in major production zones (West, Center, & Northwest Regions) of Cameroon, and 13. An assessment of poultry processing in local markets in the South West and Centre Regions of Cameroon.

Study 1:

The Effect Of Different Storage Materials Against The Bean Weevil (*Acanthoscelides obtectus*) Damage On Bean Grains In North-West Cameroon (Agroecological Zone III)

Ntam Fidelis & Caroline Nain

Introduction

Beans is a widespread leguminous plant throughout the world occupying a cultivation area of approximately 12.5 million hectares (FAO, 2006). This legume is widely consumed and appreciated by Cameroonians. IRAD has developed and introduced many improved bean varieties in Cameroon which led to an increase in production from 198000 tons in 2005 to 265000 tonnes in 2010 (IRAD, 2013). Although there has been a marked increase in production, much is left to be done to ensure that the beans harvested is properly stored and thus available to consumers at affordable prices throughout the year. Therefore, the need to evaluate, improve on and introduce inexpensive storage technologies.

Hermetic storage is one of the most important alternatives to conventional storage of agricultural products. This storage is a type of modified atmosphere (MA) that has now been applied for the protection of stored agricultural commodities including cocoa beans as well as coffee, rice, maize, pulses and seeds (Navarro et al., 1993; Navarro, 2006). In this storage system, the conversion of oxygen to carbon dioxide results from respiration of the components of the storage ecosystem (the product, insects, microorganisms) and material quality is thus ensured by modification of the atmosphere. This storage system also called "sealed storage" or "air-tight storage" or "sacrificial sealed storage" or "hermetic silo storage" have been reported as a successful storage method for the protection of commodities, replacement of fumigants for insect control and for quality preservation of stored products. Recycled or reused plastic bottles have been used by small producers, as a safe storage during the off season with the advantage of allowing the farmer to store the product in separate units, preventing contaminated units from affecting the rest of the product (Quezada et al., 2006). Other hermetic storage systems in use include double and triple plastic bags which are being used to store cowpeas in West Africa (Baoua et al., 2013; Murdock et al., 2012). This study is aimed at evaluating hermetic technology for beans storage in the Western highlands of Cameroon with two main specific objectives:

- Identification of storage methods used for beans in the Western Highlands
- Evaluation of quality of beans stored under different hermetic conditions

Materials and Methods

Identification of storage methods used for beans

A questionnaire consisting of two main sections was elaborated. The first part focussing on general information concerning the respondents and the second part on storage methods (Annex 1). 20 bean farmers/sellers were interviewed in Bamenda town and Fundong using the structured questionnaire.

Evaluation of quality of beans stored under different hermetic conditions

The experiment was carried out at the Food Technology and Post-Harvest Laboratory of IRAD Bambui from October to November 2016. A completely randomized split-plot design

with two repetitions was used. The plots (treatments) represented by the conditions of storage (storage containers) and the subplots by storage periods in days (0, 15, 30 ….)

Beans variety used

GLP 190 (Mark-mark) beans variety was used in this study which is one of the improved bean variety introduced by research in the study area. The beans was purchased from the Bamenda main market, stored for sell in a propylene bag without any chemicals applied to it. The beans as obtained from the market, already showed presence of some weevils.

Storage containers

1 kg of grains were placed in:

- Transparent **plastic containers** with a tight fitted lid (PC)
- Reused **metallic containers** with well-fitting lids (MC)
- Waterproof **plastic bags** made with polyethylene based material and appropriately sealed (PB)
- Commonly used woven **polypropylene bags** (Control)

Figure 1: Beans in the different storage containers

Measurements

During storage, the beans sample were analyzed every 15days for:

Moisture content: the oven method was used to determine the moisture content of the beans at a temperature of 103 ± 1 ºC, for 24 hours. Drying was done in duplicate for each storage method using 50g of beans and the results were expressed as percentage moisture content.

Figure 2: Drying of beans in an oven (Gallenkamp Vacuum oven) for moisture content evaluation.

Weights: the weights of the samples were determined using a clock-face type balance.

Figure 3: weighing of beans

Moulding: the grains from each container were observed for signs of moulds, that is, development of whitish to greenish moulds on the beans and the results were recorded as moulding or not moulding

Weevils count: the content of each storage container was placed on a tray and the dead and alive weevils were counted and recorded.

Results and Discussion

Storage methods for beans in the western Highlands of Cameroon (result of survey)

Storage of beans

All the respondents were affirmative that they stored beans for later use but emphasised that the beans is well dried before storage and from time to time during the storage period to avoid spoilage.

Storage Methods

Table 1 gives the various storage methods used by respondents in the study area and the number of respondent that indicated use of these methods

Table 1: Storage methods for beans

Storage Method	**Usage (%)**

Polypropylene bags	65
Plastic containers or drums	25
Calabash	5

Number of respondent = 20

Reasons for choice of storage method

- ❖ The following reasons justified the choice of polypropylene bags for storage of beans
  - Easy transportation
  - Allows beans to be aerated and thus enhance longer storage
  - Availability of the bags
  - Safe storage since beans are not eaten by rodents
- ❖ The main reason given for the use of plastic containers/drums and the calabash was to prevent the beans from weevil infestation.

Use of chemicals

50% of respondents basically those using polypropylene bags for storage, also indicated application of chemicals for weevil control and to enable storage of beans for a longer period.

Storage duration & Losses during storage

The storage duration ranged from 5 months to 1 year for properly dried beans, with most of the respondents sunning the beans from time to time during the storage period.
Weevils were designated as the main cause of losses sustained during storage and 90% of respondent throw away the beans completely attacked by weevils whereas 10% of respondent boiled these beans for feeding of pigs.

Quality of beans stored under different hermetic conditions

The following results were obtained from the laboratory experiment

Moisture content of beans

The moisture content of the beans stored under hermetic conditions varied just slightly during the storage period with a generally observed slight increase in moisture from the day 0 to day 30. This slight increase can be explained by the respiratory activity of the beans and insects there present. The moisture content of the control however dropped from 16.4% to 11% after 30 days of storage. The drop in moisture in the control is perhaps due to the beans establishing equilibrium with the atmospheric moisture given that it is in contact with the atmosphere.

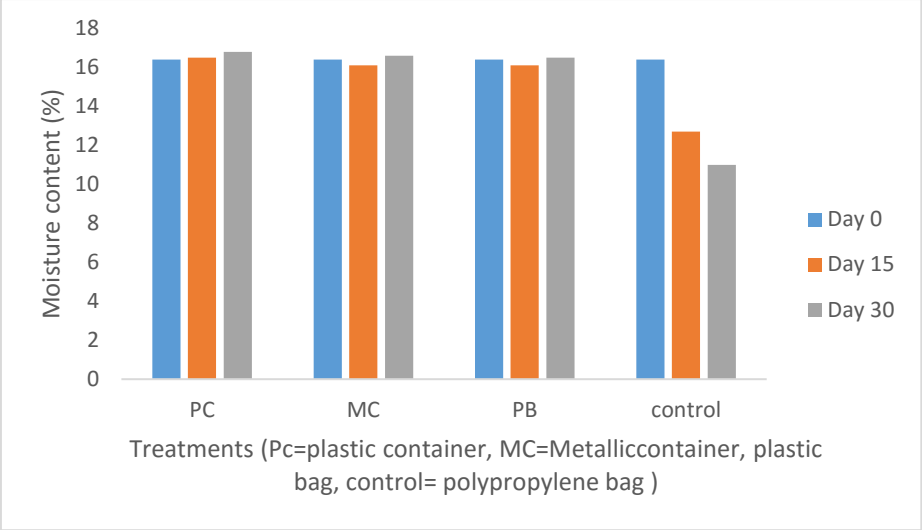

Figure 4: Mean moisture content of beans at different treatments and time periods

Test Weight

The weight of the control sample decreased during storage from 1000g to 925g during the 30 days storage period whereas those of the beans samples under the other storage conditions remained the same (figure 5). This drop in weight can be explained by the loss in moisture observed in this sample during this period of storage.

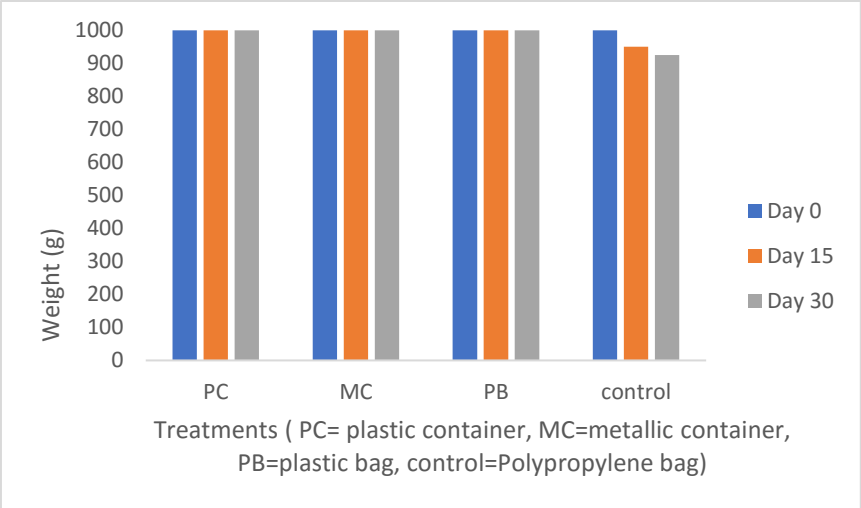

Figure 5: Mean test Weight at different treatment and time periods

Moulding

Mould growth was observed on beans under the hermetic storage conditions after 30 days of storage as shown on table 2 below. This is apparently due to the higher moisture content of the beans which encourages moulding as explained by Villers *et al.,* 2006.

Table 2: moulding of beans during storage

Days of storage		PC	MC	PB	Control

0		-	-	-	-
15		-	-	-	-
30		+	+	+	-

- No Moulding, + Moulding

Figure 6: Mould growth on beans during storage

Weevil counts during storage

As shown on Table 3, after 30 days of storage fewer live as well as more dead weevils were observed for storage of beans in plastic containers compared to the control. The evolution of weevil count could not however be established in this study considering the fact that the beans already showed the presence of weevils at purchase. Therefore the number of weevils in each treatment would not have been the same at the start of the experiment given that weevils found in the perforations in the beans could not be counted.

Table 3: Mean weevil count of weevils in beans with respect to storage container

	Plastic Container		**Metallic Container**		**Plastic Bag**		**Control (polypropylene bag)**	
Days	**LW**	**DW**	**LW**	**DW**	**LW**	**DW**	**LW**	**DW**
15	0	10	2	1	2	2	5	3
30	2	10	7	5	8	6	12	4

LW= live weevils, DW= dead weevils

Conclusion

Polypropylene bags with the addition of chemicals against weevils is the most used method of storage for beans in the North West Region of Cameroon. Hermetic containers for storage of beans enhanced weevil mortality but to avoid moulding under hermetic storage conditions, there is need for proper drying of beans before storage. The introduction of better storage techniques for beans will go a long way to improve on bean quality during storage and to ensure availability during off seasons.

References

Baoua, I.B., Amadou, L., Lowenberg-DeBoer, J.D., Murdock, L.L., 2013. Side by side comparison of GrainPro and PICS bags for postharvest preservation of cowpea grain in Niger. J. Stored Prod. Res. 54, 13–16. doi:10.1016/j.jspr.2013.03.003

IRAD, 2013. 50ans de recherché agricole au Cameroun: principaux résultats et acquis. P. 30-31

Murdock, L.L., Margam, V., Baoua, I., Balfe, S., Shade, R.E., 2012. Death by desiccation: Effects of hermetic storage on cowpea bruchids. J. Stored Prod. Res. 49, 166–170. doi:10.1016/j.jspr.2012.01.002

Navarro, S., 2006. Modified Atmospheres for the control of stored-product insects and mites. In: Heaps, J. W. (Ed) Insect Management for Food Storage and Processing, Second Edition, AACC International, St. Paul, MN,USA, pp. 105-146.

Navarro, S., Varnava, A, Donahaye., E., 1993. Preservation of grain in hermetically sealed plastic liners with particular reference to storage of barley in Cyprus, In: Navarro, S., Donahaye, E. (Eds). Proceedings International Conference on Controlled Atmosphere and Fumigation in Grain Storages, Winnipeg, Canada, June 1992, Caspit Press Ltd., Jerusalem, pp. 223-234.

Quezada, M.Y., Moreno, J., Vázquez, M.E., Mendoza, M., Méndez-Albores, A., Moreno-Martíinez, E., 2006. Hermetic storage system preventing the proliferation of *Prostephanus truncatus* Horn and storage fungi in maize with different moisture contents. *Postharvest Biology and Technology*, Amsterdam, v.39, n.3, p.321-326

Villers, P., De Bruin, T. and Navarro, S. 2006. Development and Applications of the Hermetic Storage Technology. In: Lorini, I. et al.(Eds.), pp. 719-729 proceeding of the 9th International Working Conference on Stored Products Protections Campinas, Sao Paulo,Brazil, ABRAPOS.

Study 2
Assessment of Use And Acceptability Of Biochar In Fako and Meme Divisions of the South West Region of Cameroon

Njukeng Jetro Nkengafac

Introduction

Biochar is a co-product, derived from processes of thermo-chemical transformation of biomass. The end products of this transformation are gases, biochar and energy. The biochar has several applications such as; carbon sequestration, the improvement of soil fertility, plant growth, and decontamination of pollutants such as pesticides, heavy metals, and hydrocarbons (Beesley et al., 2011; Cabrera et al., 2011, Fellet et al., 2011). The diverse range of biochar applications depends on its physicochemical properties, which are governed by the pyrolysis conditions (heating temperature and duration) and the original feedstock (Enders et al., 2012).

Up to date, biochar research has been mainly carried out in Europe and in the Americas, while few studies have been performed in Africa (Lehmann and Rondon, 2006). Therefore, investment in Africa needs to increase to understand the various conditions where biochar application could increase soil quality and yield productivity. In fact, even though the implementation of biochar systems in Africa can provide several benefits and positive impacts to local socio-economic development, the implementation strategy must be accurately defined in advance, by identifying the main sectors of the biochar systems (research, industries, and agricultural systems) to be encouraged, that could drive the adoption and the establishment of a biochar system in a certain area.

In Cameroon in particular some farmers have been trained on biochar production and usage in the frame work of different projects (Njukeng, 2016). The present study thus had as objective to assess the use and acceptability of biochar by the trained farmers.

METHODOLOGY

The study site:

This study was carried out in Owe and Malende villages of the Muyuka Sub Division and Kake II village of the Meme Division all of the South West Region of Cameroon. The major economic activity for inhabitants of these areas is farming.

Questionnaire administration:

Data for this study was collected based on a structured questionnaire. This questionnaire was divided into three different parts namely: study site and demographic information, biochar use and biochar acceptability.

The questions on site and demographic information were used to access the sex and social information for the respondents. The section on biochar used to find out how the biochar is being used. The last section on acceptability of biochar was used to assess the willingness of the respondents to use biochar and/or encourage others to use biochar as well as biochar parameters to be improved on.

At the beginning of the exercise, all the questions were read through and explained by the enumerators to make sure that the questions were understood by the respondents. The

respondents who could read and write filled the questionnaires themselves while enumerators assisted those who could not read or write.
Collected information was analysed using Excel software for graphical presentations.

RESULTS AND DISCUSSION

Tthe respondents in this study were located in Fako and Meme Divisions of the South West Region of Cameroon. This could be attributed to the fact that farmers in Fako Division were trained under the sponsorship of the USAID (PEER Grant) and those in Meme Division were trained by a local NGO called Key Farmers under the sponsorship of the Canadian government.

Study Site and Demographic Information

A total of 22 and 23 respondents were located in Fako and Meme Divisions respectively. As presented in Figure 1, 73% of the respondents were female and 27 % were male. This ratio could be attributed to the fact that the main crop in the study area is cocoa and more men are involved in cocoa farming than women. The women on the other hand are mostly involve in food crop production and are using the produced biochar to improve yields for these crops. Sixty percent of these respondents were married with less than 5 % being single or separated. Widows and widowers formed 27 % of the respondent population. The respondents (67 %) were mostly of age greater than 44 years. This is an indication that youths are not really involved in biochar production and usage.

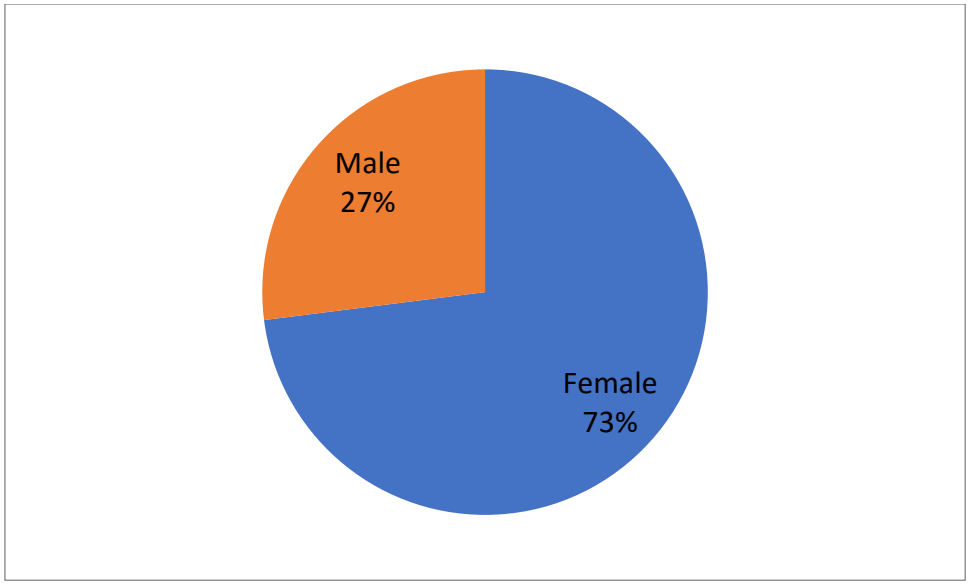

Figure 1. Gender distribution of respondents (%)

All the respondents are members of organisations such as non-governmental organization (NGO), common initiative groups (CIG), Credit unions and cooperatives. The main aim of them belonging to groups was to share ideas and benefit from financial support and training. These groups ranged between 12 and 400 membership strength.

Biochar use

Almost all the respondents knew about biochar (95.6%) with the few persons who did not know being those who still had to take the training. Most of the respondents (80 %) were familiar with plant-based biochar for, in most of their trainings cassava sticks, palm branches and cocoa pod husk were used. For household waste and animal manure based biochar, only 6.6% and 8.8% respectively of the respondents knew about them. Up to 88.9% of the respondents have once used biochar and 91.1% of this population use the biochar for crop production. None of them had used it for water purification or soil remediation. In fact these were new applications for them. However, a very limited number used it to cook.

Almost all the farmers (82.2%) used the biochar they produced as they are confident that it will improve their crop yields as well as the quality of their produce. 77.8 % of the respondents affirmed that biochar usage will reduce environmental pollution. However, about 2 % of the respondents were not sure of what will happen to the environment when biochar is used. According to Sohi et al., (2009), an environmental risk assessment that includes the impacts of biochar on terrestrial or aquatic ecosystems is necessary. More to this, given the stability of biochar, safe rates of applications need to be determined for individual soil types to avoid possible detrimental effects due to over-application (e.g. reduction in soil productivity).

According to the results of this study, 62 % of the respondent population agreed that sensitization and training are the most important issues (Figure 2) to be addressed inorder to make more people use biochar. Either training or sensitization alone would not be good enough to make more people use biochar.

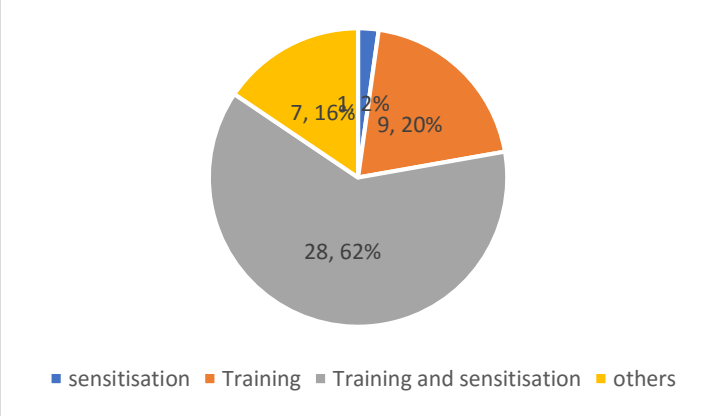

Figure 2. What can be done to make more people use biochar

Biochar acceptability:

All the respondents considered biochar to be a safe product for heat has destroyed all pathogens. In order to use biochar more effectively, 80 % of the respondents attested that better accessibility and easier handling are parameters to be improved while 40 % of the respondents said in addition to these two parameters, the product should be proofed and documented as well as have a competitive price. 90% of the respondents agreed that using biochar will reduce the usage of inorganic fertilizers.

Eighty nine percent of the respondents replied that biochar product safety is the most important biochar quality parameter. An analysis of a limited number of biochar samples has indicated concentrations of toxic combustion products such as polycyclic aromatic

hydrocarbons that are not at environmental risk level. However, a more systematic evaluation for a more complete range of other potentially harmful chemical contaminants associated with combustion, as well as toxic substances within feedstocks is necessary (Sohi et al., 2009).

Seventy three percent of the respondent population agreed that in addition to biochar product safety, the macro nutrient composition (nitrogen, phosphorus and potassium contents) are the most important quality parameters. Considering the micro element, pH, bulk density and organic matter of biochar, 70% of the respondents did not know much about them. This is obvious as most farmers have only been taught how to prepare the biochar with very little information on its chemical composition. Bulk density and pH are parameters that can be easily measured with very simple equipment. It is therefore suggested that simple tests be included in training sessions to make the farmers more familiar with their products.

From an economic point of view, 82 % of the respondent population said they will not buy biochar but produce theirs and if they have to produce and sell a 50 kg bag will be sold at 10. 000 FRS CFA. A majority (84 %) of the respondents will like to continue using biochar because it is cheap to produce and reduce their farming cost and besides, it is very safe when compared to inorganic fertilizer. In effect biochar enhances soils by converting agricultural waste into a powerful soil enhancer that holds carbon and makes soils more fertile, thus boosting food security, discouraging deforestation and preserving cropland diversity. Research results have confirmed some benefits of biochar that include: reduced leaching of nitrogen into ground water, possible reduced emissions of nitrous oxide, increased cation-exchange capacity resulting in improved soil fertility, moderating of soil acidity, increased water retention and increased number of beneficial soil microbes (IBI, 2016).

With regards to encouraging others to use biochar, 80 % of the respondents said they will encourage others to produce and use biochar because they will like to let other use a safe and very useful product.

Conclusion

Famers who have been trained on biochar production have used it and have attested that it is a relatively very safe product that improves their yields. However, there are certain parameters that they will like to be improved on such as: easier handling and better accessibility among others. Economically, money can be generated from the sale of biochar or farm cost reduced with the usage of biochar. Continuous sensitization and training are important tools to drive biochar usage forward. In fact the farmers have accepted biochar and will like to continue using it and encourage others to use it.

WAY forward.

- Design adequate biochar production systems that will give the advantage of recovering gases, biochar and energy.
- Sensitize and train many more people on biochar production
- Use different raw materials for biochar production
- Experiment biochar on different crops

DIFFICULTIES

Farmers not ready to respond to questionnaire. They complain that their time is not been properly compensated for.

REFERENCES

Beesley, L., Moreno-Jiménez, E., Gomez-Eyles, J. L., Harris, E., Robinson, B., and Sizmur, T.:(2011). A review of biochars' potential role in the remediation, re vegetation and restoration of contaminated soils, Environ. Pollut., 159, 3269–3282,

Cabrera, A., Cox, L., Spokas, K. A., Celis, R., Hermosín, M. C., Cornejo, J., and Koskinen, W. C. (2011). Comparative sorption and leaching study of the herbicides fluometuron and 4chloro-2 methylphenoxyacetic acid (MCPA) in a soil amended with biochars and other sorbents, J. Agri. Food Chem., 14, 12550–12560.

Enders, A., Hanley, K., Whitman, T., Joseph, S., and Lehmann, J. (2012). Characterization of biochars to evaluate recalcitrance and agronomic performance, Bioresource. Technol., 114, 644–653.

Fellet, G., Marchiol, L., Delle Vedove, G., and, Peressotti, A. (2011). Application of biochar on mine tailings: Effects and perspectives for land reclamation, Chemosphere, 83, 1262–1267.

IBI 2016. International Biochar Initiative

Lehmann, Johannes and Rondon, Marco (2006). Biochar Soil Management on Highly Weathered Soils in the Humid Tropics in Biological Approaches to Sustainable Soil Systems. Taylor & Francis Group, pp. 517-526.

Njukeng J. Nkengafac (2016). Final report on Compost and biochar from cocoa pod husk, opportunities for disease suppression and soil fertility Submitted to NSF for the PEER Grant.

Sohi Saran, Elisa Lopez-Capel, Evelyn Krull and Roland Bol (2009). Biochar, climate change and soil: A review to guide future research. CSIRO Land and Water Science Report 05/09.

Some respondents in Malende - Muyuka

Some respondents in Owe -

Some respondents in Kake II -

Some respondents in Kake II-

APPENDICES: Photo Gallery

Study 3

Socioeconomic Evaluation of Cocoa Processing and Commercialization in the Central and Southern Regions of Cameroon (Agroecological Zone V)

Nyambi Gwendoline, Eric Nossi, & Sidonie Nzukou

Introduction

Developmental efforts geared towards poverty reduction can be achieved through economic growth and/or the distribution of income (Kakwani et al., 2004). In the African context where agriculture is the backbone of every economy, such development process can be accelerated even further by bringing about change in agriculture through the engagement of actors in the agricultural innovation systems. It is in this light that FARA is overseeing the African Union Commission's Science, Technology and Innovation Strategy for Africa 2024 that seeks to review the social, economic, and technological progress Africa has made over the last decade and thereafter, initiate possible international scientific and research collaboration that would foster science and technology policies for the continent. The PARI Cameroon project is one of the several initiatives funded and overseen by FARA. A socioeconomic evaluation of cocoa processing and commercialization innovation value chain in the center and south regions of Cameroon was studied by researchers of IRAD, NKolbisson in agro ecological zone V.

Cocoa is a major contributor to Cameroon's gross domestic product (GDP) and foreign exchange earnings. The great majority of Cameroon's cocoa farmers are small-holders, generally obtaining low yields from small plots of land that are often less than 3 ha. Value addition through cocoa processing is an alternative for small farm holders to increase agricultural income and create employment in cocoa producing communities and small business enterprises.

Processing wet cocoa beans into dry cocoa beans and other products can add value to the cocoa and increase the farmers' income by substantial amounts. Econometric analysis by Adabe & Ngo-Samnick (2014) reveals that processed 5 kg of dry cocoa beans yields approximately 1 litre of cocoa butter that can be sold for 10.000 FCFA which brings about 200% net gains as compared to selling the dried beans. Despite the gross benefit of value addition, Segun (2014) suggests that cocoa processing in African nations is still below potential mainly due to lack of investment in cocoa processing technologies and infrastructure. Nevertheless, more quantities of cocoa are processed in the major West African cocoa producing countries than Cameroon. Nigeria, Ivory Coast, and Ghana process about 17%. 34%, and 46% respectively of its annual productions locally (Cocoa Barometer, 2009 in Segun, 2014). While Ghana for example aims to boosts its processed cocoa quantities to about 50% (Essegbey & Ofori-Gyamfi, 2012) Cameroon still lags behind and currently processes just about 15% of its cocoa, the bulk of which is processed by three major agro industries active in the cocoa processing and commercialization value chain. These agro industries are; Chocolaterie Confiserie du Cameroun (CHOCOCAM), Societe de Development du Cacao (SODECAO), and Cameroon Cocoa Service (SIC CACAO).

In view of promoting economic growth through agricultural development as stipulated by the country's strategic plan, Cameroon plans to increase processing levels to 30% in the near future by establishing more processing centers in major cocoa growing areas (Reuters. 2016; New Agriculturist. 2001). Actualizing such investment initiatives in cocoa processing technology in rural communities is not only necessary for income equity and the empowerment small farm holders and women, but would also boost economic growth in Cameroon. A plethora of research portrays that more women than men are active actors in the cocoa processing value chain in this male dominated cash crop sector. The implication of women in cocoa processing would reduce the income gap from gains of cocoa and also empower them.

According to Mounjouenpou et al. (2014) women involved in cocoa processing generate additional income that contributes to household management and improved livelihood. In addition to generating income, cocoa processed products provide supplementary nourishment, therapeutic and cosmetology benefits to families and the local communities. Cocoa processing is still at the rudimentary level in rural communities in Cameroon. Some processors have benefitted from institutional support while most of have them have engaged in peer support for processing procedures and activities. An understanding of the functioning of the cocoa processing value chain is important to channel resources in the required direction to encourage growth and the sustainability of activities in this sector. More so, an understanding of innovative actions in this value chain would guide to marshal the country's strategic plan for agricultural development of poverty alleviation and emergence to attain the Millennium Development Goals (MDGs) target.

A socioeconomic evaluation of innovations in the cocoa processing value chain in the South and Center regions was chosen for the singular reason that cocoa is not only a major source of revenue for small farm holders in these regions but is an engine of economic growth and development given that Cameroon is the fourth largest producer of cocoa beans globally. It is also critical to build a sustainable and thriving cocoa sector that would improve food security and livelihood geared towards attaining the country's development strategic plan and future emergence of the country.
The study aimed at carrying out a socioeconomic need assessment analysis of the cocoa processing value chain among small holder farmers in the Center and South regions of Cameroon.

The specific objectives are to:

- Identify the organizational and institutional linkages involved in cocoa processing value chain
- Examine the situation and trends in the production of cocoa processed products
- Identify constraints for growth and expansion of the cocoa processing value chain and propose mitigating strategies to such constraints.
- Discuss and identify pertinent issues/opportunities relating to further development and growth of the cocoa processing value chain.

METHODOLOGY

Description of the study sites

The study was conducted in agro ecological zone V comprising the Center and South regions of Cameroon. The zone is characterized by a bimodal rainfall pattern. The major activity of the population in these communities is agriculture and cocoa is the major cash crop of these regions. A purposeful selection of heavy cocoa production localities where cocoa processing was taking place was effected. Three cocoa processing communities (Ebolowa center, Afanete, and Nseleng) located in the Mvila and Vallee de Ntem divisions in the South region and five others (Memiam, Akomyada, Mbalmayo center, Goura, and Bialanguena) from Nyong et So'o and Mbam et Kim divisions of the Center region were selected for this study. Additional criteria for selection of study sites was the selection of communities where processed cocoa products were prevalent in the local markets, and finally, communities where farmers had received some form of training on cocoa processing by the Institute of Agricultural Research for Development (IRAD).

Data collection techniques

Data collection was done in three phases involving literature review, discussions with regional authorities of the Ministry of Scientific Research and Innovation, and the Ministry of Agriculture and Rural Development (MINADER). Finally questionnaires were administered to cocoa processors coupled and complemented with field visit to processing units.

We reviewed the literature on the status of cocoa processing by smallholders in Cameroon and other cocoa producing nations. Visit to the regional delegation of the Ministry of Scientific Research and Innovation served for an update and briefing on the status of cocoa processing by smallholder groups or individuals and the acquisition of contact information of processors. Most of the contacts information of individual processors was obtained through snowballing from other processors.

Structured questionnaires were administered to obtain information from cocoa processors. Complimentary information was obtained through oral interviews of officials of the regional delegations of the Ministry of Scientific Research and Innovation (MINRESI) and the Ministry of Agriculture and Rural Development (MINADER). Oral focus group discussions with the respondent also provided supplementary data for the study. The focal persons for processing groups or individuals were telephoned and appointed dates for interviews were set with them. For every community, the focal person's task was to assemble group members or individuals involved in the processing of cocoa on the appointed date for the interview and questionnaire administration.

The interview was carried out consecutively for seven days. In total, 105 cocoa processing actors were interviewed for about one hour per individual to understand the following: Sources of cocoa bean used in processing, types of products transformed, packaging and storage of processed products, quality control, commercialization of products, sources of finance and or credits, clientele types and degree of satisfaction with products, type of training received, labor cost, and constraints faced in the transformation and commercialization process. Field visits were paid to the processing units for observations.

Data analysis techniques

Data was analyzed using Microsoft Excel and Statistical Package for Social Sciences (SPSS) for descriptive and inferential analysis (means, frequency, percentages, cross tabulation relations).

Results

Organizational and institutional linkages involved in cocoa processing value chain

The main actors and their roles in cocoa processing and commercialization in Cameroon include:

1. Cocoa farmers whose functions are to carry out on-farm production, postharvest management for industrial processing and local level processing at the community level.
2. Cameroon Cocoa Service (SIC CACAO) and Cameroon Cocoa Development Society (SODECAO) are responsible for implementing government policies and programs on cocoa.
3. License buying companies who buy cocoa from the farmers and sell to exporting bodies e.g. SODECAO.
4. Cocoa processing companies like CHOCOCAM process cocoa for local market and regional market.
5. Civil society organizations (cooperatives. unions etc.) that promote rights and corporate responsibility.
6. Research institutions that conduct research on cocoa production and cocoa products and trains TOT processors.
7. Ministry of Agriculture and Rural Development is responsible for diffusing research results to farmers. They diffuse processing technologies from research to farmers and provide support for small holder farmers.
8. Ministry of Commerce is responsible for setting and standardizing market prices based on world cocoa market prices
9. Ministry of small and medium enterprise provides aid and support to small entrepreneurs involved in cocoa processing and commercialization.
10. Civil society; local and international development organizations support growth cocoa sector.
11. Ministry of Finance and budgeting oversees the country's economic policies and programs, national budget and resource allocation for every sector.

Situation and Trends in Processed Products Production

Demographic statistics of respondents

The majority of respondents were female (87.5%) compared to 12. 4% male respondents and 65.7% of the respondents were from the Center region. Figure 1 represents a breakdown and representation of numbers and percentages of respondents per region. Agriculture was the main source of income for 70% of the respondents.

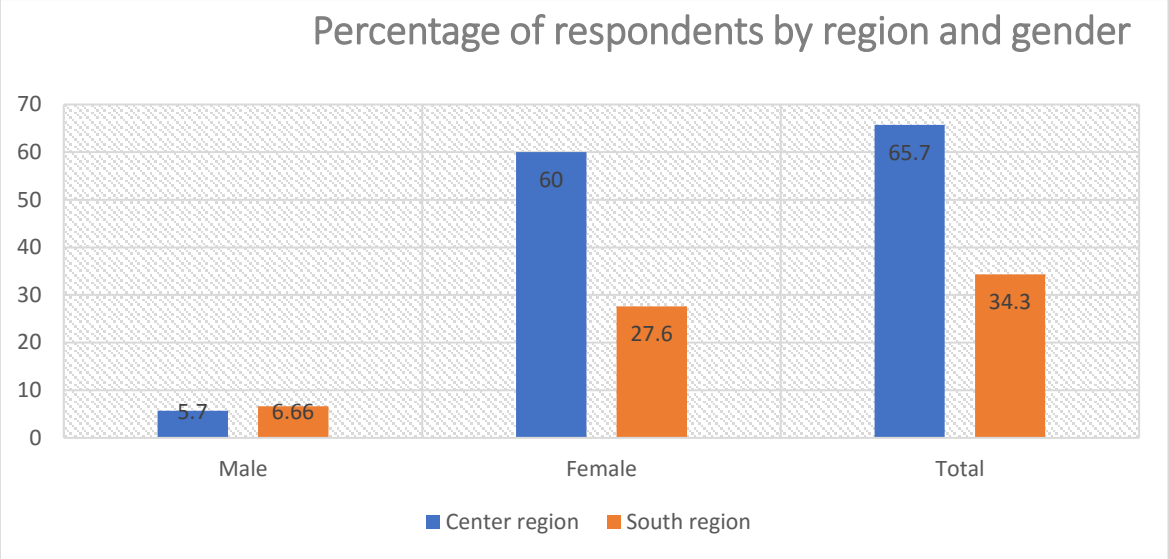

Figure 1: Representation of respondents by gender and region

About 14% of the respondents indicated that cocoa processing and commercialization was a primary source of income for them. The rest of the respondents' main source of income was salary and petit trading (Table 1). With regards to the marital status of respondents, 81% were married while 12% and 11% were single and widowed respectively. No respondent was below 20 years of age (Table 2). However, 62% of the respondents were between the age group of 40 – 59 years while 11%. 13% and 16% of respondents were in the 30 – 39, 60 – 69, and equal to or above 70 years age group respectively. Only 3% of respondents below 30 years in the Center region were engaged in cocoa processing. Slightly more than half of the respondents (53.3%) had attained secondary education while 36.2% and 6.7% had primary and University education. Four respondents (3.8%) had never attended school (Table 3).

Table 1. Primary source of revenue of respondents by level of education and gender

Principal source of income			Level of education				Total
		Gender	Never schooled	Primary	Secondary	University	
Agriculture		Male	0	0	6	0	6
		Female	4	31	27	2	64
	Total		4	31	33	2	70
Petty trading		Male	0	0	0	0	0
		Female	0	1	5	0	6
	Total		0	1	5	0	6
Salary earners		Male		1	2	0	3
		Female		0	7	2	9
	Total			1	9	2	12
Cocoa proccesing & commercialisation		Male	0	1	2	0	3
		Female	0	3	5	3	11
	Total			4	7	3	14
House maid		Male	0	0	1	0	1

		Female		1	1	0	2
	Total			1	1	0	2
		Male	0	2	11	0	13
		Female	4	36	45	7	92
	Total		4	38	56	7	105

Table 2. Age group of respondents by region and gender

REGION	Gender	Age group					Total
		20-29	30-39	40-59	60-69	≥ 70	
Center	Male	0	1	2	1	2	6
	Female	3	5	33	11	11	63
South	Male	0	0	6	0	1	7
	Female	0	5	21	1	2	29
Total		3	11	62	13	16	105

Social organization

The South Region is more organized than the Center region in terms of processing procedures and commercialization. In the South region, three organizational types are present:

1. All-in Cooperative processors

Group labor is collectively used to process the various products which are labelled with the group's logo and sold in the group's center. The proceeds are divided equally between the group members.

2. Partial Cooperative processors

In this organization type, individuals come together as a group to provide joint labor for the processing of their various products. Individuals label their products differently. The labelled products can be sold by any member of the group at 20% rate of the sale price.

3. Individual processors.

Some individuals single handedly process cocoa beans to desired products and sell them on individual bases. The smallest quantities are processed by such individuals.

In contrast to the South region, even though interviewed processors from the Center region were members to farmer groups and cooperatives, processing was most often an individual venture in terms of processing procedures and commercialization.

Membership to farmer organization or association is beneficial to farmers. It facilitates technology transfer and adoption process. It is also a venue to facilitate the acquisition of agricultural aid and incentives. A significant portion of the respondents (80.4%) reported belonging to farmers' organizations while 19.6% did not belong to any farmer organization. The following reasons were given by respondents as reasons for belonging to farmer

organizations; prospect for assistance, group labor, emulating others, village development, community belonging, cocoa processing, social savings, and group sales (Table 3).

Table 3. Reasons for farmer group membership

Reason for belonging to a farmer organization	Frequency	Percentage
Non member	25	24.76
Prospect for assistance	17	16.19
To emulate others in the community	6	5.71
Group labor	15	14.29
Village development	4	3.81
Community and social belonging	8	7.62
Cocoa processing	18	17.14
Social savings	3	2.86
Group sales	8	7.62
Total	105	100.00

Processed products and acquired trainings

Cocoa transformation is still timidly exploited in the Center and South Regions. However, even though the farmers from the South Region had not obtained any training from IRAD as compared to their Center Region counterparts, they were better organized and produced a larger array and quantities of processed products than their Center region counterparts.

Eleven different products are processed from cocoa beans in the two regions of study. These include: cocoa nibs, sweetened cocoa nibs, cocoa butter, cocoa powder, chocolate spread, chocolate drinks, cosmetics and therapeutic products, candy, win, and whisky. Cosmetic and therapeutic products include lipsticks, facial masks, nail vanish, pain tablets, and ovules. A similarity was observed in the Center and South region regions in the most frequently processed products. In both regions, respondents most frequently processed cocoa butter than the rest of the products followed by cocoa powder. In the Center region for example 67 of the 69 respondents from the region processed cocoa butter while 57 processed cocoa powder. This trend was observed in the South Region where 34 of the 36 respondents processed cocoa butter while 27 of them processed cocoa powder. There is a difference however in the innovative processing potential between the center and South regions as per different products processed. More array or brand of products were processed in the South Region than the Center Region. Cosmetic and therapeutic products (lipsticks. facial masks. nail vanish. pain tablets. and ovules), jam, and whisky are among the products processed in the SouthRegion that are not processed in the Center region. This innovative tendency was particularly observed in processors who were members of cooperatives and common initiative groups. As observed in figure 2, trainings for processing products was positively correlated with the practice. Further, higher number of processors for certain products (e. g. cocoa powder) were observed than the number that had been trained to process it indicating that, a number of processors/respondent had adopted some processing technologies from their peers. This was the case with processors from the South region while their Center region counterparts had been trained by IRAD. A total of 31 respondent (86.1%) had received training in the South region while 67 (97.1 %) had done so in in the Center region. Even though many more respondents in the Center region had

received training, the Center Region processors produced many more brands of processed products than their Center Region counterparts (Figure 2).

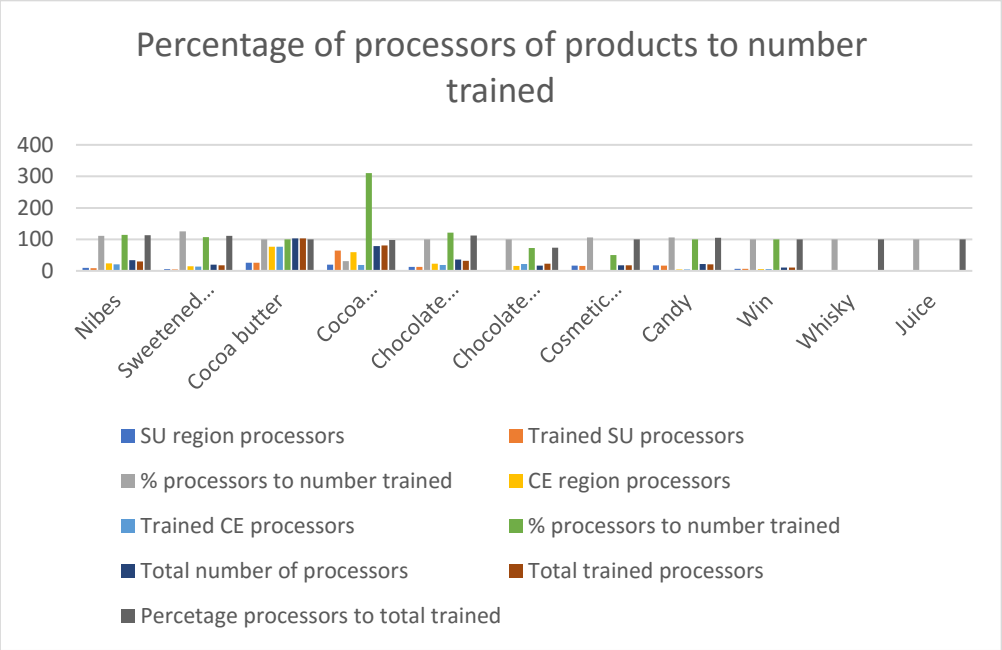

Figure 2. Processed cocoa products by percentage of trained processors

Many more respondents had received training on cocoa bean processing than in the other domains in the processing and commercialization value chain (Table 4)

Table 4. Domains of trainings received by respondents per region

	Domain of training						
Region	**Cocoa bean fermentation**	**Cocoa bean processing**	**Storage and conservation techniques**	**Cocoa cultivation**	**Commer-cialization**	**Finance manage-ment**	**Total**
Center	9	56	2	0	0	0	67
South	3	26	0	1	0	0	31
Total							

Membership to a farmer group influenced the quantities of cocoa processed positively (Table 5). On the other hand, the majority (85.7%) of the respondents sourced for cocoa beans about 1 – 5 times/annum while 10.5% of respondents sourced cocoa beans between 6 – 10 times/annum

Table 5. Quantity processed per annum by group membership status

Quantity in Kg	**Membership to a farmer group/organization**		**Total**
	Yes	**No**	
	Frequency (percentage)	Frequency (percentage)	Frequency (percentage)

< 20 kg	24 (30)	17 (68)	41(39)
20 - 99kg	20 (25)	4 (16)	28 (26.6)
100 - 200 kg	16 (20)	3 (12)	19 (18.1)
201 - 500 kg	2 (2.5)	0 (0)	2 (1.9)
501 - 1000 kg	10 (12.5)	1(4)	11 (10.5)
1001 - 2000 kg	3 (3.75)	0 (0)	3 (2.8)
Do not measure	1(1.25)	0 (0)	1(0.9)
Total	80 (100)	25 (100)	105 (100)

The mode of processing of product in both the CE and SU regions was mechanical, meaning that at least 75% of the processing tasks were performed manually. Only a third of processors in both regions were satisfied with the mode of processing of their products. The rest of the processor thought that mechanic processing was very laborious and tedious. A greater part of the labor for processing activities was provided by the family which was subsidized by seasonal paid labor. The South region's larger portion of labor was from the family but the farmer group labor was critical in the South region. Less than 30% of the respondents used paid labor for processing activities. Cocoa butter was the most solicited products in both regions of study (94.2%. and 52.8% in the Center and South regions respectively). The different brands of product in the South region were also highly solicited reason why the processors in that region are more proactive and innovative.

Consumption of processed products (Socioeconomic analysis)

Even though there's a commercial incentive to process, processors also consumed some of the products because of the health benefits of these products. Table 6 presents portions of auto consumption quantities in the two regions.

Table 6. Auto consumed quantities of processed cocoa product by processors.

Quantities in percentage	Centre		South	
	Frequency	Percentage	Frequency	Percentage
< 20	15	21.7	13	36.1
20- 40	16	23.2	22	61.1
41- 60	11	15.9	1	2.8
61- 80	11	15.9	0	0.0
81- 90	16	23.2	0	0.0
Total	69	100.0	36	100.0

Even though cocoa butter is the most difficult product to process as indicated by respondents, it is also the most expensive and most consumed and solicited products in the market because of its numerous benefits. In the Center region. 89% of respondents suggested that cocoa butter was the most beneficial products in terms of financial gains and uses while 72.2% of their South region counterparts attested to same properties (Table 7). Similarly, 84.5 and 77.8% of respondents from the Center and South regions respectively, indicated that cocoa butter was the most tedious/difficult product to process. Cocoa butter is most solicited because of its health, therapeutic and cosmetic benefits. It is used to treat stomach pains, rheumatism, nerve problems, skin care, and hair care. Cocoa butter is

described as a savior in the local communities for this numerous function. Local communities have relied on it as a prophylaxis treatment especially because it can be bought in small packaged quantities to as low as 1000frs/small bottle of 100ml. Difficulty in processing is mostly because processing is done on a very small scale manually using local equipment. Many of the respondents complained of the great heat and the risk of burns they are exposed to in the extraction of cocoa butter.

Table 7. Indication of the most benefitting and solicited processed cocoa products by respondents

Product that procure the most benefits	Center		South	
	Frequency	Percentage	Frequency	Percentage
Cocoa butter	62	89.9	26	72.2
Cocoa powder	2	2.9	1	2.8
Sweetened cocoa nibs	2	2.9	3	8.3
Soap	2	2.9	4	11.1
Chocolate	1	1.4	1	2.8
Glycerin oil	0	0.0	1	2.8
Total	69	100.0	36	100.0
Most solicited products				
Cocoa butter	62	89.8	31	49.2
Chocolate	1	1.4	2	5.6
Chocolate drink	2	2.9	0	0.0
Chocolate powder	4	5.8	0	0.0
Tablet	0	0.0	2	5.6
Nail polish	0	0.0	1	2.8
Glycerin oil	4	5.8	3	8.3
Total	69	100.0	36	100.0

As a source of income cocoa processing contributed between 25 – 50 % to the majority of processors income in both the Center and South regions (Figure 3).

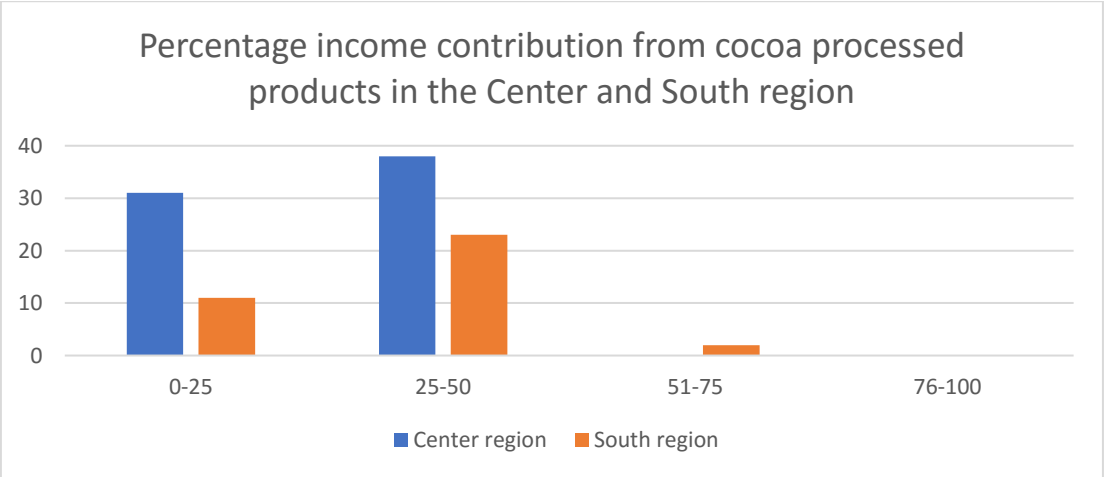

Figure 3. Portion of processed cocoa product contribution of annual contribution of respondents in the Center and South Regions

However, as is usually the case with most data collection involving monetary values, the majority of respondent; 87% and 94.4% from the Center and South Regions respectively would not tell how much they generated from the sale of cocoa processed products per annum (Table 8). One reason for this phenomenon could be explained partly by the fact that 85.5% and 56% of respondents did not keep a record of their activities and sales.

Even though, processing was viewed as an income generating activity, it was observed that it was not managed in a business proper manner by the majority of processors. However the sale amount/annum generated by respondents generally ranged from 2000 – 235000 FRS CFA for the Center region and 72000 – 150000 FRS CFA for the South region (Table 8). The mean income earning for the Center and South regions were 102,466 FRS CFA and 111000 FRS CFA as obtained from the annual income earnings of 11 processors. The following reasons were given for not keeping records of activities; ignorance of the importance to keep records, slow sales, the activities were still at the beginning, non-utility of records.

Table 8. Sales amount per annum for processed cocoa products registered by respondents

Sale amounts/annum	Center		South	
	Frequency	Percentage	Frequency	Percentage
2000	1	1.4	0	0.0
6000	1	1.4	0	0.0
7200	1	1.4	0	0.0
20000	1	1.4	0	0.0
37500	2	2.9	0	0.0
72000	0	0.0	1	2.8
120000	1	1.4	0	0.0
150000	0	0.0	1	2.8
235000	2	2.9	0	0.0
Amount unknown	60	87.0	34	94.4
Total	69	100.0	36	100.0

Commercialization of processed products

Two client categories suggested by respondents for cocoa processed products are consumers, and retailers. Consumers were by far the biggest client purchasing 84% and 80% of the processed products in general. The processors had verbal sale contracts with their clients. Even though the products were not certified, clients of the Center region were generally more satisfied with the products they bought than clients of the South region. Clients complains were mostly on price, the quantities sold with regard to the price, unavailability of product in times of need, and the validity of the conservation period. At the marketing level, processors faced the most competition from fellow local processors than from the industries. Only 3 persons in both the Center and South regions sold all their processed products without keeping some for auto consumption. The following venues are used for sale; home, store, local trade fairs, small stands, stores and mobile ambulant sale.

Constraints and solutions for growth and expansion of the cocoa processing value chain.

Cocoa bean sourcing constraints and proposed solutions

In general, the majority of respondents (61.9%) processed less that 50kg of cocoa beans/ annum which explains why most of the processed products are auto consumed. About 18.1% processed about 100 – 200kg of cocoa beans/annum while 10.5% processed about 500 – 1000kg/annum. Just 2.9 person processed up to 2000kg cocoa beans from annum. Respondents from the center regions generally processed more quantities of cocoa beans than those from the center region. The majority of processors from the Center region (85.5%) obtained cocoa beans from their farms. These were mostly married women who had cocoa beans given to them by their husbands. On the contrary, the majority of respondents who bought cocoa beans in retail and whole sale (52.8% and 33.3% respectively) were from the South region compared to their center region counterparts where only 14.5% bought cocoa beans in retail and non in whole sale. (Table 9).

Table 9. Sources of cocoa beans by region

Source	Centre		South	
	Frequency	Percentage	Frequency	Percentage
Auto production	59	85,5	5	13,9
Whole sale buy	0	0,0	12	33,3
Retail	10	14,5	19	52,8
Total	69	100,0	36	100,0

The following difficulties were described by respondents as major difficulties linked to the sourcing for cocoa beans in the Center and South regions; high prices of cocoa beans, scarcity of cocoa beans during off season, poor quality of beans, lack of capital, long distance from point of cocoa beans sale, and poor road infrastructure.

Possible solutions suggested to the above problems by respondents include; maintenance of road infrastructure, establishment of a single point of cocoa beans storage or sale, creating of own cocoa farms with support from the government, accessibility to credit to buy cocoa beans in large quantities during peak production season, training of farmers on fermentation techniques of cocoa beans and stabilization of cocoa bean prices.

Processing constraints faced by processors and proposed solutions

Table 10 represents the different channels and organization through which the respondents/processors were trained on cocoa beans processing technologies. IRAD was observed to be the major trainer and had trained 60.9% of the processors in the Center region while 18.8% and 5.8% processors had received training from friends and SODECAO respectively. In contrast to the Center Region, the South Region processors had not been trained by IRAD. The majority of processors (38.9%) in the in the South Region had received training through a female common initiative group (GIC Mamerne) and the diffusion of the technology trickled through friends (22.2%), National Employment Fund (11.1%) and CIG representatives (11.2%).

Table 10. Trainers of cocoa processing technology in the Center and South regions.

Trainer	Center		South	
	Frequency	Percentage	Frequency	percentage
GIC Mamerne	0	0,0	14	38,9
AFIBA (Women's group)	2	2,9	0	0,0
Friends	13	18,8	8	22,2
COFES	0	0,0	3	8,3
CIG representatives	4	5,8	4	11,1
National Employment Fund (FNE)	0	0,0	4	11,1
IRAD	42	60,9	0	0,0
SODECAO	4	5,8	0	0,0
SOS	1	1,4	0	0,0
Maison de la femme	0	0,0	2	5,6
UGICAGB	1	1,4	0	0,0
UGICAKO	2	2,9	0	0,0
SONA	0	0,0	1	2,8
	69	100,0	36	100,0

Respondents faced several major difficulties in the processing of cocoa products. Table 11 highlights some of the difficulty's respondents faced in processing activities. The major difficulties suggested are the use of local equipment for extraction, long extraction process, lack of adequate processing equipment, and non-mastery of the extraction process (Table 11). Respondents used manual hand machines, grinding stones, pots and spatula for processing activities which made the extraction process especially for cocoa butter extremely laborious. Processors lacked modern equipment for extraction such as electrical grinding machines, pressers and adequate molds which could ease the extraction and packaging process of cocoa butter most especially. This challenge was especially challenging for village communities that had no access to electricity.

Table 11. Difficulties encountered in the cocoa processing activities

	Center Region		South Region	
Expressed difficulty	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Managing the bitterness of beans	5	7.2	0	0
Local means of extraction makes the process tedious	31	44.9	16	44.4
Long process of extraction	9	13.0	5	13.9
Lack of adequate processing equipment	12	17.4	12	33.4
Long exposure to fire is hazardous to health	1	1.4	2	5.6

Non mastery of the extraction process	11	15.9	1	2.8
Total	69	100	36	100

Solutions to processing: Accessibility to electrical machines for shelling and grinding cocoa beans, and pressing cocoa paste to powder was requested by 80% and 58% of processors from the Center and South regions respectively (Table 12). Lack of electric energy was a constraint to ensure large scale processing in the Center region where 29% requested the need for electricity installations. In the South and Center regions, 5.8% and 8.7% respectively suggested the need for training on processing technologies.

Table 12. Proposed solution to processing constraints

Suggested solution	Center Region		South Region	
	Frequency	Percentage	Frequency	Percentage
Government should subsidize purchase of electrical millers and shellers	43	63	30	83.4
Government support to construct grilling ovens	0	0	2	5.6
Build capacity on processing technologies	6	8	2	5.6
Provide electric energy infrastructure in the village	20	29	1	2.8
Provide credit facilities	0	0	1	2.8
Total	69	100	36	100

Constraints to conservation and storage of cocoa products

Conservation and storage was not expressed as a major difficulty by 60.9% of the respondents.

This can be explained by the fact that the majority of the respondents process just small quantities of products. However, 21.5% of the respondents concerns were mostly linked to prevailing climate conditions of humidity, mold and insect attack. Respondents who produced larger quantities of products expressed the lack of adequate conserving equipment, lack of storage facilities and lack of knowledge on conservation and storage techniques as difficulties they encountered.

Proposed solutions

Table 13 represents solutions to conservation and storage problems suggested by respondents from the Center and South regions, with provision of modern storage facilities and capacity building on conservation and packaging techniques as major solutions.

Table 13. Proposed solutions to conservation and storage difficulties by respondents in the Center and South region

Proposed solutions	Center Region		South Region	
	Frequency	Percentage	Frequency	Percentage

Training of processors on conservation and packaging techniques	11	15.9	1	2.8
Develop appropriate/modern packaging for products	3	4.3	9	25
Provide modern facilities for storage	53	76.8	25	69.4
Only process products on demand	0	0	1	2.8
Use preservatives to increase shelf life.	2	2.9	1	0
Total	69	100	36	100

Commercialization constraints

Local processed products were sold on spot at home, village market, stores in town, through media, trade fairs, bio pharmacies, and hair and beauty salons. (Figure 4).

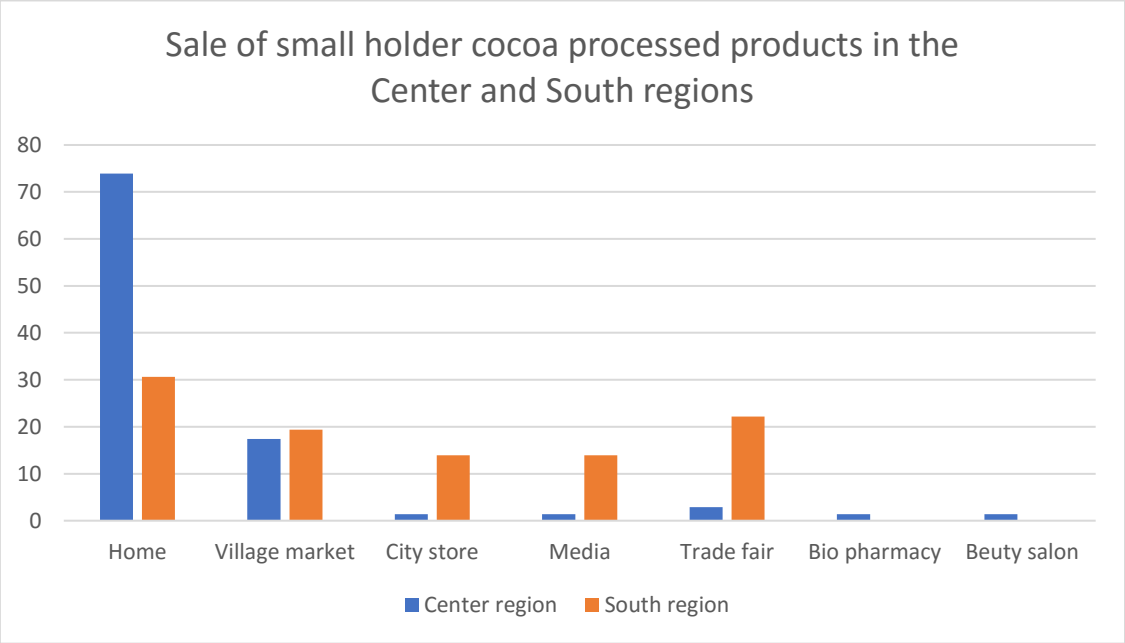

Figure 4. Sale venue of local smallholder cocoa processed products in the Center and South Regions

Industrial cocoa processed products generally did not have a market in the local communities because they were expensive for the local population. Respondents indicated that they generally did not face any competition from industrial processed cocoa products, but faced competition among their peers in the same village and those from neighboring villages. Older processors also face competition from younger processors. (Table 14). About 50.7 respondents from the Center region and 36.1% respondents from the South region reported facing competition from peers and youths.

Table 14. Commercialization constraints encountered by local processors/respondents in the Center and South regions

Constraints	Center region		South region	
	Frequency	Percentage	Frequency	Percentage
Non	14	20.3	3	8.3

Management of sale contracts	4	5.8	3	8.3
Competition from youths and neighboring village processors	35	50.7	13	36.1
Diverse inadequate packaging of similar product	3	4.3	3	8.4
Varied prices for similar products	2	2.9	14	38.9
Lack of enough clientele in the village	4	5.8	0	0
Production in small quantities	5	7.2	0	0
Poor quality of product due to non-certification of products	2	2.9	0	0
Total	69	100	36	100

Varied prices, diverse inadequate packaging for similar products, small processed quantities were other concerns reported by respondents.

Proposed solutions to commercialization constraints include the creation of a certification board to manage product quality and standards, and a marketing board that would oversee group sale points and standardize sale prices of products.

DISCUSION AND CONCLUSION

Issues and opportunities relating to further development and growth of the cocoa processing value chain

Processing technology adoption and investment

Investment in processing value chain and transfer of cocoa processing technology to small holders is critical. Processed products are an important source of food, income, employment, cosmetic and medication for the rural communities and Cameroon population at large. The results show a significant home consumption of processed products. The population can be treated with cocoa processed natural products at low cost compared to conventional medicine that are expensive and difficult to afford by rural community members.

More women and youth involvement in processing technologies is an opportunity for the government to leverage on youths' employment and income gaps of women as regards to cocoa revenues. Doing so would contribute to the development of the cocoa processing and commercialization value chain. However, as gathered from the study, poor road infrastructure and lack of appropriate equipment and finances is a hindrance to the development of this sector. Without adequate investment, it would be difficult to increase the processing capacity of cocoa beans to any substantial scale that would reap meaningful benefits to keep the value chain sustainable.

Investment in appropriate equipment and infrastructure would reduce the laborious and tedious procedure of processing and would attract more actors to the sector.

Processors knowledge base and capacity

The study confirmed that smallholders had been trained by IRAD, SODECOA, FNE and other civil organization on processing technologies which were adopted. The technology was further diffused by friends and group leaders. As with most implemented technologies, not

all regions benefit equally. The South region portrayed greater implications in the processing activities than the center region even though they had not benefited on capacity building activities from IRAD and SODECAO. More outreach on processing, conservation, fermentation, and commercialization is needed to scale out the technologies especially in the South region and the rest of cocoa producing communities of Cameroon.

5.1.3. Establishment of small holder processing platforms

Technology transfer and outreach programs work best with farmers as a group. Processing activities were more enhanced by groups than individual effort. The GIC Mamerne in the South region is a typical success story of a coordinated group effort to manage labor, processing and sales of processed products. Apart from having a wide range of products, they also had better sale arrangements and contracts with buyers. Such platform could be replicated in other communities.

Commercialization and quality assurance

Certification of product might not be necessary for family consumption is critical for larger scale processing especially because certification of the products was raised as an important concern to ensure customer satisfaction. A certification board would be necessary to ascertain the quality and standards of the processed goods that would be sold not only in local markets but city supermarkets where the entire population and other non-cocoa producing communities can access. In the South region for example, the fermentation was not a procedure practiced by producers and processors. Most processors bought fresh cocoa beans which were dried directly without fermentation and used for processing. Lack of fermentation can affect processed product quality in terms of flavor and taste. Fermentation reduces the bitter taste of cocoa beans and according to Mohammed et al. (2011) flavor is primarily a genetic trait but it can be accentuated with proper fermentation for better flavored products.

A general observation was the tendency for the local population leanings towards the use of natural products. There is a market to be exploited for processed products if processors adequately organize themselves and have efficient functional platforms. Government investment through provision of credit enterprises to small and medium business venture in cocoa processing would promote the sustainability of the processing value chain.

Conclusion

The importance of processed cocoa products to the smallholder and local population cannot be overemphasized. High prices of conventional industrial products and medication render them unaffordable to rural communities. Smallholder cocoa processed products are an alternative for rural communities to increase income, alleviate poverty and improve livelihood.

There is no gainsaying that through synergistic policy actions there are opportunities for driving innovations in the cocoa processing sector. However integrated effort is needed to forge forward with these innovations. There are motivated actors like youths and women, available market, and available raw materials for possible exploitation. Complementary policy actions and investment from the government/private sector are necessary for the success and sustainability of these innovations.

Recommendation

The following recommendations would ensure a productive and sustainable cocoa processing value chain among small holders in the Center and South regions:

- Capacity building of more youths and women on processing technologies. Transfer of fermentation technologies is particularly relevant to the South region processors. Given the high rate of technology adoption, training of trainers would facilitate the technology transfer process.
- Establishment of organized cocoa processing and commercialization platforms. A successful prototype is found in the South region which could be modified and scaled out to the Center region and other cocoa producing communities.
- Establishing a certification board, sale points and appropriate contracts between processors and retailers is important.
- Establish a marketing union to standardize sale price for processed products based on measured scale to ensure processors reap the true value of sold products.
- Processors in the Center and most especially those in the South Regions did not possess good knowledge base on fermentation procedure but had evolved in packaging practices. Further research on knowledge base and perception of fermentation on cocoa bean quality on processed products is relevant.

Finally, research on cost benefit analysis of cocoa processed products is also relevant to ascertain profitability levels of processed products.

References

Adabe, K. E. & Ngo-Samnick. E. L. (2014). Cocoa Production and Processing. CTA & ISF: Wageningen. 43pp.

Cargill (2016). Cameroonian cocoa sector makes good strides in sustainable production. Retrieved from: http://www.cargill.com/news/releases/2016/NA31970261.jsp

Essegbey, G. O. & Ofori-Gyamfi, G. (2012). Ghana Cocoa Industry: An Analysis from the Innovation System Perspective. *Technology and Investment*, *3,* 276 – 286. Doi:10.4236/ti.2012.34038

Farayola, C. O., Akintaro, O. S., Yahaya, A. A., & Oni, O. O. (2013). Determinants of Marketing Efficiency among Small-Holder. *International Journal of Management and Social Sciences Research (IJMSSR)*. *2 (11)*, 38 – 43.

Kakwani, N., Klandker, S., & Son, H. H. (2004). Pro-poor growth: Concepts and measurement with country case studies. International Poverty Center. UNDP: Brasilia.

Levai, L. D., Meriki, H. D., Adiobo, A., Awa-Mengi, S., Akoachere, J. T. K. & Titanji, V. P. K. (2015). Postharvest practices and farmers' perception of cocoa bean quality in Cameroon. *Agriculture and Food Security. 4(28),* 1 – 8. DOI 10.1186/s40066-015-0047-z

Mohammed, D., Asamoah, D., & Asiedu-Appiah, F. (2011). Cocoa Value Chain-Implication for the Smallholder Farmer in Ghana. *Department of Information Systems and Decision Sciences, KNUST School of Business, Kwame Nkrumah University of Science & Technology, Ghana*.

Mounjouenpou, P., Amang A. Mbang, J., Nossi, E. J., Bassanaga, S., Tetmoun, M. S. A., Achukwi, D. & Woin. N. (2014). Cocoa Value Chain and Capacity Building of Women

Cocoa-farmers for Sustainable Improvement of Their Livelihoods: The Case of Mbangassina and Mbalmayo, Cameroon. *Advances in Life Sciences*, *4(4),* 185 – 195. DOI: 10.5923/j.als.20140404.01

New agriculturist (2001). Country profile – Cameroon. Retrieved from: http://www.new-ag.info/en/country/profile.php?a=871

Reuters (2016). Cameroon plans to double cocoa processing to 30 percent of its total output: http://www.reuters.com/article/cameroon-cocoa-idUSL6N0WI2VF20150316

Segun. O. P. (2014). An Assessment of Investment in Technology in Cocoa Processing Industry in Nigeria. *Journal of Economics and Sustainable Development*, *5 (10),* 182 – 188.

7. APPENDIX

Legend: Figure 1 – 8: Photos of processing activities and products from the South region.
Figure 9 – 10: Photos of products from the Center region.

Figure 1. Electric cocoa bean miller

Figure 2. Sun drying of cocoa beans

Figure 3. Hand peeled roasted cocoa beans

Figure 4. Cocoa butter preparation

Figure 5. Cocoa butter and sweetened nibs

Figure 6. Cocoa candy

Figure 7. Sweetened cocoa nibs

Figure 8. Cocoa based cosmetic products

Figure 9. Progressive GIC Mamerne

Figure 9. Cocoa butter and roasted nibs

Figure 10. Group of processors in Goura

Study 4

Needs Assessment for Innovations in the Processing of Cassava into Gari in the South West Region of Cameroon

Levai Dopgima , Musongong Sirri Bella, & Majory Meliko

Introduction

Rapid urbanization throughout sub-Saharan Africa is currently being accompanied by a growth in demand for convenience foods. Cassava (*Manihot esculenta* Crantz) roots provide an ideal raw material for many of these types of food products. However, fresh cassava roots are bulky and costly to carry and, in addition, are likely to rot within a few days of harvesting. Most cassava varieties contain cyanide, which is not safe for consumption and require that they be processed to reduce its content to a safe level. Varieties that contain high amounts of cyanide normally taste bitter and should not be eaten raw, while the roots of 'sweet' varieties contain low levels of cyanide and can be eaten raw.

Cassava is an annual crop planted in Cameroon all year round in 8 of the 10 regions, except for the North and Far North Regions. Though the majority plant cassava for its edible roots, the leaves are also consumed as a vegetable in many parts of Africa (Makanjuola *et al*., 2012) and in the Centre, East and South Regions of Cameroon as well.

There exists both local and improved varieties for farmers to choose from when establishing their farms. Local varieties are obtained from neighbours, family or friends at usually no cost with the advantage that they keep the traits that are preferred. Some of these good traits include the fact that they can be boiled and eaten just like tubers and they can stay long in the soil after maturity and is harvested gradually. These local varieties are equally high in dry matter content hence a small quantity processed has a comparative high yield of gari or water fufu as the case may be.

The improved varieties released in the 80s and 90s mostly targeted the industry. These high yielding and disease tolerant varieties did not take into consideration these indigenous qualities, making adoption rate very slow. With the advent of a bigger market, farmers are now accepting these varieties that produce as high as 40 tons per hectare for production of gari.

Cameroon produced about 4.6 million tons of cassava in 2013 and this placed her 16th on the world ranking with its contribution of about 1.7% of the world production (FAO, 2014). Several recipes are used to process cassava into close to 40 different products with gari being the most consumed and traded of all food products made from cassava roots in Africa (Oluwole *et al*., 2004; Sanni *et al*., 2009; Adebayo *et al*., 2012). Gari competes well with rice in convenience and price in urban and rural markets (Sanni *et al*., 2009). The products are varied and even within a particular recipe there are variations. This variation makes it difficult to obtain a particular product all the time. The production of gari suffers from this recipe variation and in 2016, Levai *et al.* proposed a standard for gari production in Cameroon.

Cassava for gari production is harvested, peeled, washed and grated the same day. For good quality gari, Fermentation should be carried out for 2 days, the first being a 24 hour semi-solid state fermentation in bags inclined at 45^{o} and then a dry state fermentation on the press for another 24 hours. During the first stage, yeast and amylases breakdown the starch to simple sugars that are then consumed by lactic acid bacteria to produce lactic acid that produces the desired sour flavour of gari.

The duration of fermentation is very important in cassava processing. In as much as the other processing steps reduce the amount of cyanide present in gari, fermentation is the step that reduces it considerably below the recommended levels. It is therefore recommended to ferment cassava destined for consumption in varieties where cyanide content has not been performed and in those with known high content of cyanide.

Traditional methods of processing cassava roots can result in poor quality products that contain unacceptable levels of cyanide, as well as being contaminated by foreign matter and disease-causing agents. Consuming products from such processing methods can lead to acute cyanide poisoning, goiter, and a nerve-damaging disorder that makes individuals unsteady and unable to walk properly. Proper processing converts fresh cassava roots into safer and more marketable products by:

- Reducing cyanide levels in the processed products
- Prolonging shelf life
- Reducing post-harvest losses of fresh cassava roots
- Avoiding contamination of the products and the environment

Gari is the most widely consumed cassava product in Cameroon and serves as a major staple food in West and Central Africa. It is a fine to coarse granular flour produced from fermented, gelled and dehydrated cassava fresh roots. Gari is a dry product (8-10% moisture content), acidic (pH 4.5-5.0), and high in energy (~ 335 kcal/100 g). To produce gari, cassava roots are harvested, peeled, washed, grated, pressed to squeeze water and some starch, left to ferment in a semi solid and then solid state fermentation and then fried with or without the addition of a bit palm oil. When palm oil is added, the gari produced has a characteristic yellow colour otherwise it is white.

Production of gari varies from one region to the other and sometimes even within localities, leading to diverse types of gari which are identifiable based on their origin (Levai *et al.*, 2016)

In this study, we have assessed present innovations in the technology for processing cassava into gari, with a view of identifying gaps that can be complemented to boost gari production in Cameroon.

Methodology

This study was carried out in Fako, Manyu and Ndian Divisions of the South West Region of Cameron. These Divisions are the leading in gari production and in a previous study (Levai et al. 2016) are the origin of 2 of the best gari prototypes (Muyuka and Mamfe) produced in Cameroon. A semi-structured questionnaire was administered in the language the respondents understood best (Pidgin or English).

Results and Discussions

The demographic distribution of the data collect is as shown on table 1 below.

Table 1: Demographic distribution of data collected during survey

Category	Frequency	percentage
Sex		
Male	7	31.82
Female	15	68.18
Age		
<30	1	4.545
30-40	8	36.36
>40	13	59.09
Marital Status		
Married	20	90.91
Single	2	9.091
Household Size		
2	1	4.545
3	1	4.545
4	3	13.64
5	4	18.18
6	7	31.82
7	4	18.18
8	1	4.545
9	1	4.545
Level of Education		
No formal Education	3	13.64
Primary	12	54.55
Secondary	5	22.73
Advanced	1	4.545
university	1	4.545

Gari production is predominantly an activity by women with men mostly coming in as hired labour. Results show that 68.18% of production is con ducted by women. These women are mostly married (90.91%) aged above 40 (59.09%) and have barely gone beyond primary education.

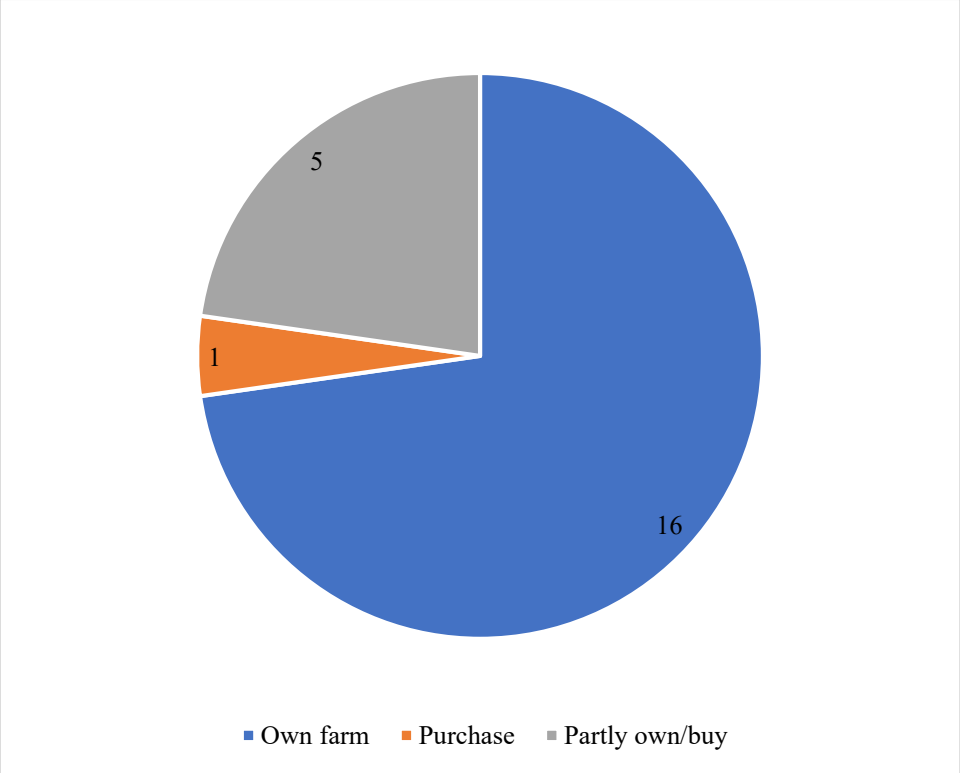

Figure 1: Distribution of sources of cassava roots for gari production

Most of the respondents are principally farmers and obtain the cassava for production from their farms 16(72.7%) as shown on fig. 1. Only 1 (4.5%) respondent entirely purchase the cassava she uses for gari production. This is a trader in Muyuka who is venturing into gari production and has a farm which has not yet attain maturity.

In the production of gari, labour is hired at every step. Being laborious and time consuming, labour is hired to harvest, transport out of the field, transport to the site of production, peel (sometimes done in the field as harvesting is going on), wash, grate, press and fry. For all these steps, machinery is presently adopted at 100% only for grating.

The machines for grating (Pic. 2) though workable, need to be produced with standard specifications for food processing machines. All parts that come in contact with the roots and the grated mash have to be made of stainless steel but is no yet the case. The metal used gets rusted and the paint also gives way and gets into the mash. Farmers however attribute this to the high cost of the machines made with parts of stainless steel and say that they will throw away the first mash that comes through which is coloured.

Picture 1: Gari production unit at Besingi showing cassava peeling machine, a gari fryer and hydraulic press

Picture 2: Cassava grating machine powered by electricity (left) and a hydraulic press with bags ready for frying (right)

There is a simulation of a peeling machine (Pic. 1) at Besingi, on the way to Mundemba. This technology has plenty of shortcomings. The first is that it chops of the roots and mixes with the waste peeling and the efficiency at which it peels is not up to 50%. The producers of the machine are still fine-tuning it and if properly developed, it will go a long way to reduce the labour involved in peeling cassava roots.

Standards for fermentation of gari (Levai et al., 2016) advice that mash be fermented for 2 days with a first day semi-solid state fermentation and a second day solid-state fermentation. Results show that fermentation is usually carried overnight (fig. 2). Their reason usually is that the roots are harvested in the morning and by the time they finish grating, it is late to bag. The mash is left in the plastic covered overnight and bagged the next morning. This allows for some fermentation to take place.

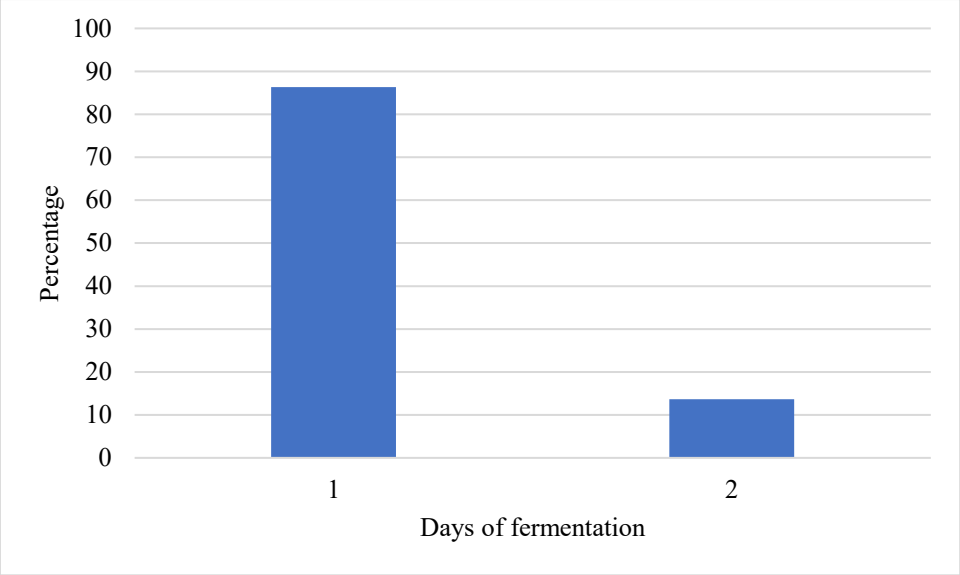

Figure 2: Distribution of days during which fermentation of mash is carried out before pressing

The consequence of such fermentation is that for varieties with high cyanide content, we might still consume gari with levels higher than the recommended thresholds. This is the reason some people consume gari as snack and get drunk. Other authors have reported that frequent consumption of gari as a snack is a precursor of blindness. All these are attributed to the fact that such gari was produced from cassava roots with high cyanide content.
Just after a two day fermentation, gari is pressed (Pic 3 and 4). This step is important for two reasons; the first is to remove moisture and allow a solid-state fermentation by Lactic Acid Bacteria (LAB), and subsequently remove the moisture considerably so that it can easily be fried. During the LAB fermentation, the characteristic sour taste of gari is developed. One day is ok to attain the sour taste recommended by most consumers. There are however some consumers who prefer gari to be fermented at this stage for as long as 3 days.

Picture 3: Fermented mash in bags ready to be pressed on hydraulic press

Picture 4: Different methods of pressing mash. Pressing with sticks (left), hydraulic press (middle) and manual press with rotatory arms (right)

Pressing is traditionally done by placing fermented mash in bags between sticks (pic. 4). There is also the presence of a hydraulic press and a manual metal press. These presses are easy to use and within a short time gets mash to near dryness. These innovations are presently used by farmers who produce more than 30 basins of gari a week. The smaller producers complain of the cost to acquire such machines.

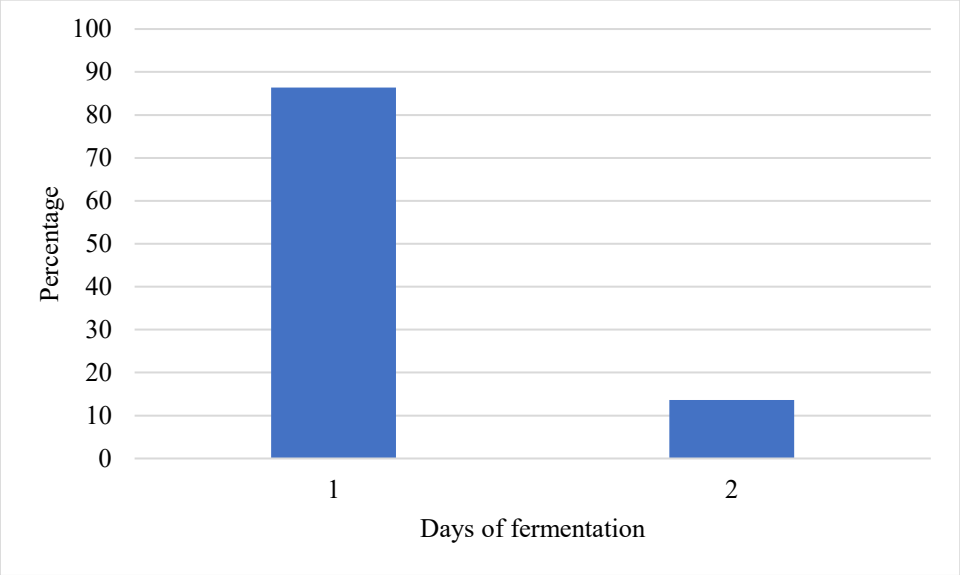

Figure 3: Number of days during which fermentation is carried out

Cake breaking and sieving is done manually using a traditional sieve made out of rattans. This permits the cake to be loose for easy stirring when frying. Frying is itself done for the most part on built fire places that provides for prevention of direct heat from the flames getting to the operator. The fire is usually made with wood. Frying requires a lot of heat and constant stirring. Framers who have understood this will only use particular types of wood for this process. The heat must be high enough to initiate the gelling process, bake and dry the gari to about <13% moisture content. This usually takes 20-30 mins per batch. The operator knows that it is ready when a clump held between the palms easily scatters when released.

Picture 3: Sieve made out of rattans used for cake breaking (left) and woman frying gari in a closed fire place (right)

Frying is the stage that guarantees the keeping quality of gari. If not properly done, gari gets mouldy within a few weeks. When frying is properly carried out, gari can have a shelf life of more than six months. Presently, gari is still fried in the traditional fashion. Improved gari fryers have been developed in Nigeria and China but are still relatively expensive for producers in Cameroon because they have not yet constituted in cooperatives.

There exists the white and yellow gari in the market. The main difference is that in the yellow gari, palm oil is added either in the mash before fermentation or during frying. The yellow however is more produced and solicited than the white. Producers equally attest that it is easier for them to produce the yellow that the white.

With the technology of gari production in place, farmers still face enormous difficulties. These difficulties have been ranked as follows.

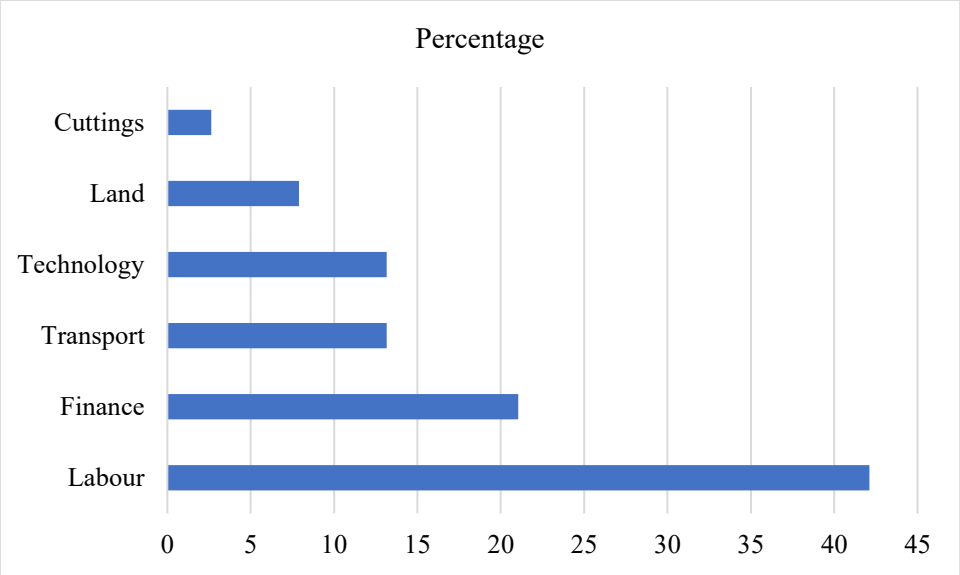

Figure 4: Constraints faced by farmers in completely applying innovations to improve gari production

Based on the results, the major constrain in gari production is the availability and high cost of labour. Most of the steps (peeling, washing, pressing and frying) in production are still done manually. They are very laborious and time demanding. The next is availability of funds for the hired labour and to get developed innovations and since land is equally getting scare, farmers have to get further into the bush to get farming land. This then possess transportation problems as the terrain leading to farmlands sometimes are practically difficult to access even on bikes. Though minimal, availability of improved quality planting material is becoming a problem especially as farmers are moving from subsistence agriculture towards industrialisation.

In order to mitigate these problems, farmers were asked to propose what they think can be solutions to these problems raised.

Table 2: Recommendations by farmers to mitigate their production constraints

Constraints	Proposed solution
High cost and non-availability of labour	Improve on mechanization of laborious steps (Peeling, washing, pressing, frying)
Lack of funding	- Formation of a cooperative of producers, and - subsidies given to agro-process machine producers to reduce cost - Improve access to credits

Technology	- Organise workshops to demonstrate complete technology package, and - Install an innovation centre with all machines
Transportation	Open and dis-enclave farm lands to improve accessibility
Availability of farm land	Put in place laws to protect and make available land for agriculture
Availability of cuttings	Funding made available for Research and seed multipliers to make cuttings available

4. Conclusion

Though there exist innovations in the processing of cassava into gari, there are still gaps in the full adoption of these innovations. This makes gari production still laborious and time consuming consequently influencing the price of gari that gets to the table of consumers. Continuing production of gari the way it stands now, there is a threshold that cannot be exceeded because of the constraints as shown on fig. 4. Therefore with the increasing demands, the recommendations made by farmers as shown on table 2 should be looked at to fill the gaps of the innovations.

5. References

Makanjuola, O.M., Ogunmodede, A.S., Makanjuola, J.O. and Awonorin, S.O. (2012). Comparative Study on Quality Attributes of Gari Obtained from Some Processing Centres in South West, Nigeria. *Advance Journal of Food Science and Technology.* 4(3): 135-140

Adebayo B.A., Nanam T.D., Bamidele E.A., and Braima D.J. (2012). Quality management manual for the production of *gari.* IITA, Ibadan, Nigeria.

Oluwole, O.B., O.O. Olatunji and S.A. Odunfa, 2004. A process technology for conversion of dried cassava chips into garri. *Nigeria Food Journal*. **22**: 65-73.

Sanni, L.O, O.O. Onadipe, Ilona P., Mussagy M.D., A. Abass, and Dixon, A.G.O. (2009). Successes and challenges of cassava enterprises in West Africa: a case study of Nigeria, Bénin, and Sierra Leone. IITA, Ibadan, Nigeria. 19 pp.

Levai L.D., Nsimi M.A., Nana G., Ngone A.M., Amayana A., Sama A.M.L. and Ngome F.A. (2016). Consumer perception of gari prototypes and prospects for improvement and marketing In the South West Region of Cameroon. *International Journal of Agriculture and Environmental Research* 02:05:p1304-1318

Study 5

The Effect of Different Storage Materials Against *Sitophilus Zeamais* (Weevil) Damage on Maize Grains in SouthWest Cameroon

Henry Andukwa , Ojong Ntane Agbor, Missi Valentine, Forchibe Ethelene, & Nambangia Justin Okolle

Introduction

Zea mays commonly known as corn is one of the most important cereal crops cultivated in developing countries. Over 100million hectres of land in developing countries is used for production of maize with 70% of the produce coming from low and middle income countries (FAOSTAT, 2010). Nutritionally it is rich in carbohydrate, dietary fibres and minerals.

In Cameroon, this staple crop is cultivated in all the regions. In 2014 Cameroon was ranked 49 positions in the world in terms of maize production with 1,600.000tons within a harvested area of 820,000 hectres (www.factfish.com). It is produced for local consumption and export. Locally it is usually consumed as roasted corn when freshly harvested from the farm, dry fermented dough and as corn porridge. It helps in providing an economic safety net as much of the maize is sold directly to industries for the production of animal feeds and commercial starch or converted to local alcoholic drinks such as “sha”, corn beer etc. which is an important contribution to the economy of the rural communities.

However not all the maize produced is utilized. Some are lost during threshing and storage. Report from FAO and African Development Bank (ADB) in 2010 on Continental and Reduction Program, Post-harvest losses states that 15% of maize produced in Cameroon is lost as post-harvest losses. Post-harvest losses are mostly caused by insects such as the maize weevil *sitophilus zeamais.* This weevil damage grains especially during storage hence to prevent damage caused by this weevil there is a need for a better storage facilities. The aim of this work is to test the effect of different storage materials on maize weevil during maize storage and the ability of the grains to germinate after a certain period of storage.

Materials And Method

Baseline survey

A survey was carried out to determine all the different types of storage materials used by maize farmers to store their maize and also the different methods used in preserving the maize after harvesting so that, such storage materials would be used for the experiment proper to test their effect on maize weevil during storage of maize grains. This survey was carried out in two subdivisions in Fako Division namely; Muyuka and Buea subdivision. Two localities were chosen from each of these subdivisions. Ikata village and yoke were chosen for Muyuka while Muea and Bolifamba for Buea subdivision. A questionnaire was produced, and these questionnaires were given to enumerators who went door to door in these localities asking the questions only to maize farmers irrespective of their sex and while filling the questionnaires.

Experiment on different storage materials

Preparation of weevil stock

20kg of weevil- damaged maize grains containing some of the weevils were placed in a fertilizer bag and allowed for two weeks for the weevils to multiply so as to have enough weevil stock for inoculation.

Experimental set up

90kg of maize grains free from weevils were bought from the local market at Ekona. The grains were placed in a fertilizer bag and then carried to the Entomology-Nematology unit at the Institute of Agricultural Research for Development (IRAD)-Ekona. Six different storage containers were selected. 5kg of maize grains were weighed and placed in each of the 6 different storage containers. The storage containers were labeled T1 – T6 where T1 = use of fertilizer bag only which served as the control, T2 = polyethene bag only, T3 = plastic bucket with lid, T4 = metal container with lid, T5 = polyethene bag inserted into a fertilizer bag and T6 = plastic jug with lid (10L supermont® container). Each container was inoculated with 50 weevils from the weevil stock. The storage container T1, T2 and T5 were tied using a chord at the opening while the containers T3, T4 and T6 were sealed at the opening using a scotch to prevent air from getting into the containers. Each treatment was replicated 3 times. The containers containing the weevils and maize grains were stored in a cupboard that was only opened during data collection.

Polyethene bag only (T2) **polyethene bag inserted in a fertilizer bag (T5)**

Metal container with lid (T4)

Plastic bucket with lid (T3)

10L supermont® container with lid (T6)

Estimation of the number of grains per subsample

A small plastic cup of diameter 4cm and height 6.4cm was used as a standard for measuring subsamples taken from the different treatments. The number of grains per subsample was estimated by taken 5subsamples using the plastic cup. The grains of each subsample were counted by hand picking. The number of grains per subsample was then estimated by averaging the number of grains of the 5subsamples.

Data collection

Each replicate of each treatment was agitated then subsamples were taken from different corners of the storage container using the standard measuring plastic cup. 4 cups full of maize was taken from each storage container and poured unto separate trail. The number of maize grains with holes caused by the weevils, number of undamaged grains, number of dead weevils, and number of live weevils were counted and recorded. The counting was done after every 7days and this lasted for 8weeks.

Counting of damaged grains and weevils

Germination test

Ten grains of maize without holes were selected from each storage materials after two weeks of setting-up the experiment and placed in separate petri dishes lined with moist filter paper. The petri dishes were labeled T1 – T6 depending on the storage material as mention in section 2.1.2 above. Each petri dish containing maize grain representing a storage material was replicated three times. The grains were allowed for three days then the number of grains germinated were counted and recorded. The germination test was carried out after every 14days within a period of two months.

Petri dishes containing maize grains for germination test

Results

Dead and live weevils count

The population of dead weevils was different from that of the live weevils throughout the four weeks in the different treatments. There was a higher increase in the weevils numbers in T3 (plastic buckets with lids) and T4 (Tight fitting metals containers with lids) in week 1. There has been also a slight difference in the numbers of weevils for the first week in T1 (Fertilizers bags only) and T2(wrappen bags only). Meanwhile there were no live weevils recorded in the first week in T6 (Supermont plastic containers with seal taped lids). Fig 1.

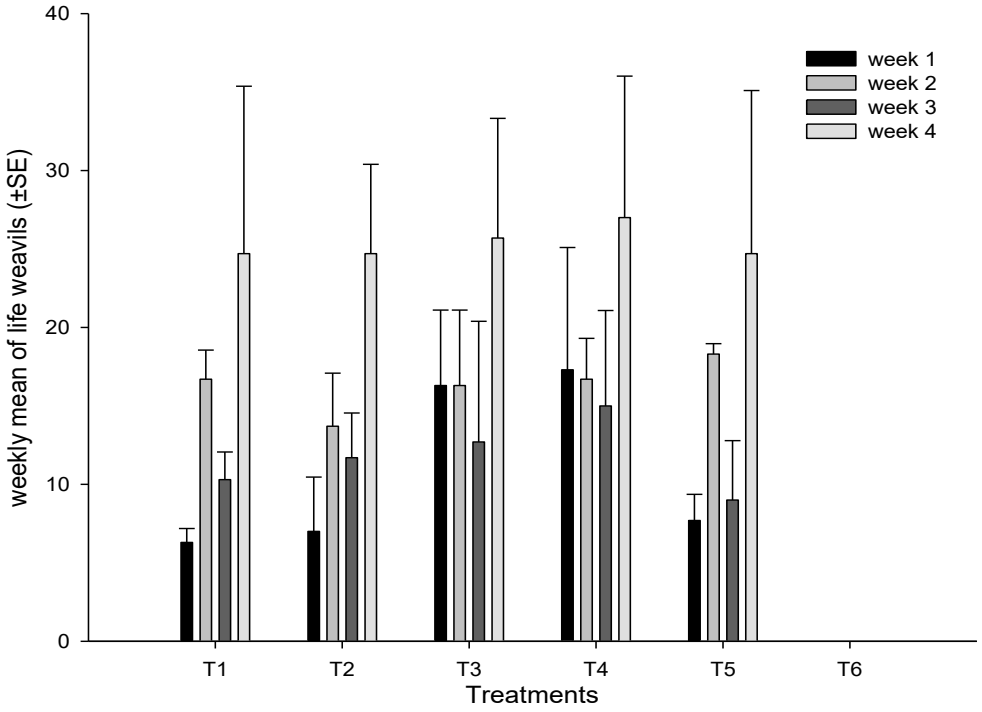

Fig 1. Weekly mean of live weevils in different storage containers

On the other hand, the population of dead weevils were very high for T4(metal containers) followed by T6(supermont plastic containers with seal tape lids),then T5(wrappen +fertilizer bags),T3(plastic buckets with lids),T2(wrappen only) and finally T1(fertilizer bags only) in that decreasing order, see Fig 2.

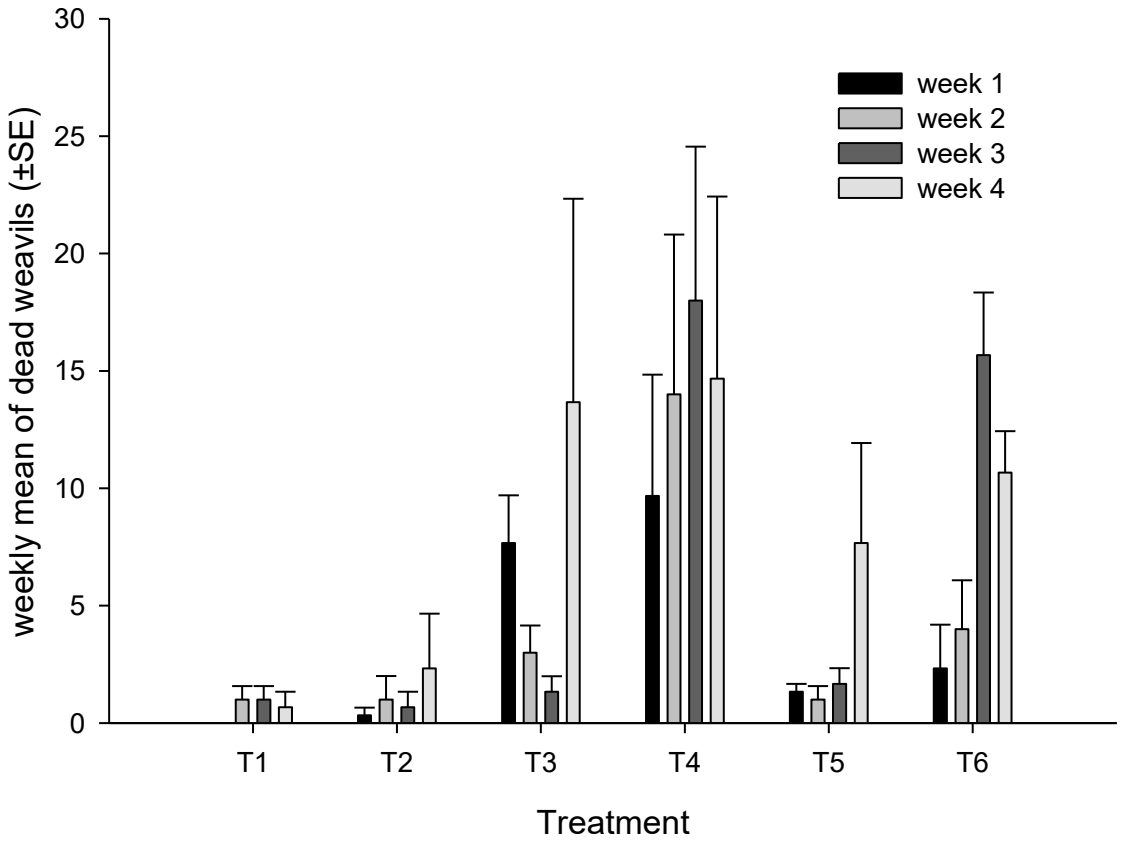

Fig 2. Weekly mean of dead weevils in the different storage containers

Numbers of infested and un infested weevils counts

For the mean weekly infestation and un infestations of the maize by weevils, it was found that all the storage containers had at least some numbers of maize which were infested, but the rate of infestation was different for all the treatments.

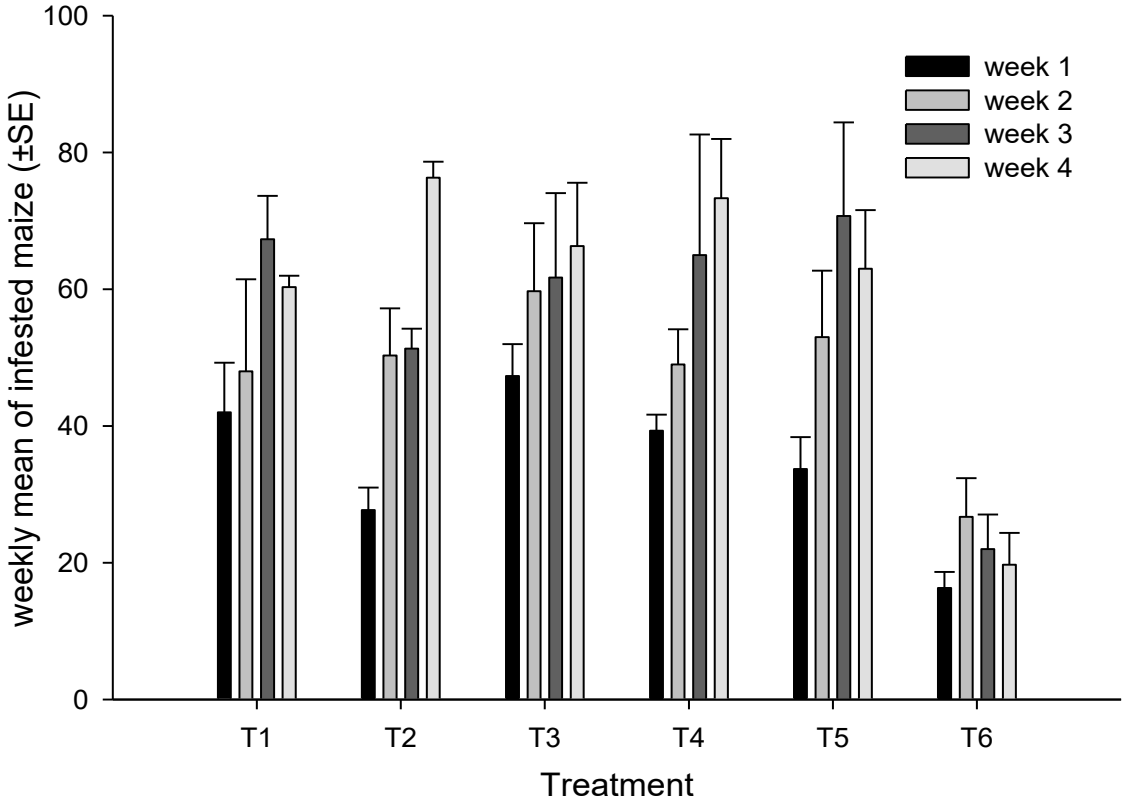

Fig 3.weekly mean of infested maize grains for the different treatments

We could deduce that in all the 4 weeks of the experiment, T1(fertilizers bags only) had the highest numbers of infested maize, followed by T3(plastic buckets with lids),then T4(metal containers with lids),T5(wrappen +fertilizer bags),T2(Wrappen bags only) and finally T6(supermont plastic containers with seal tape lids) in that order. There was gradually an increase in the numbers of infested maize as the experiment progresses, but at one point in treatment T6(supermont plastic containers), the numbers of infested maize were just constant.

Finally, the numbers of un infested maize out numbers the infested maize for all the different treatments. Fig 4.

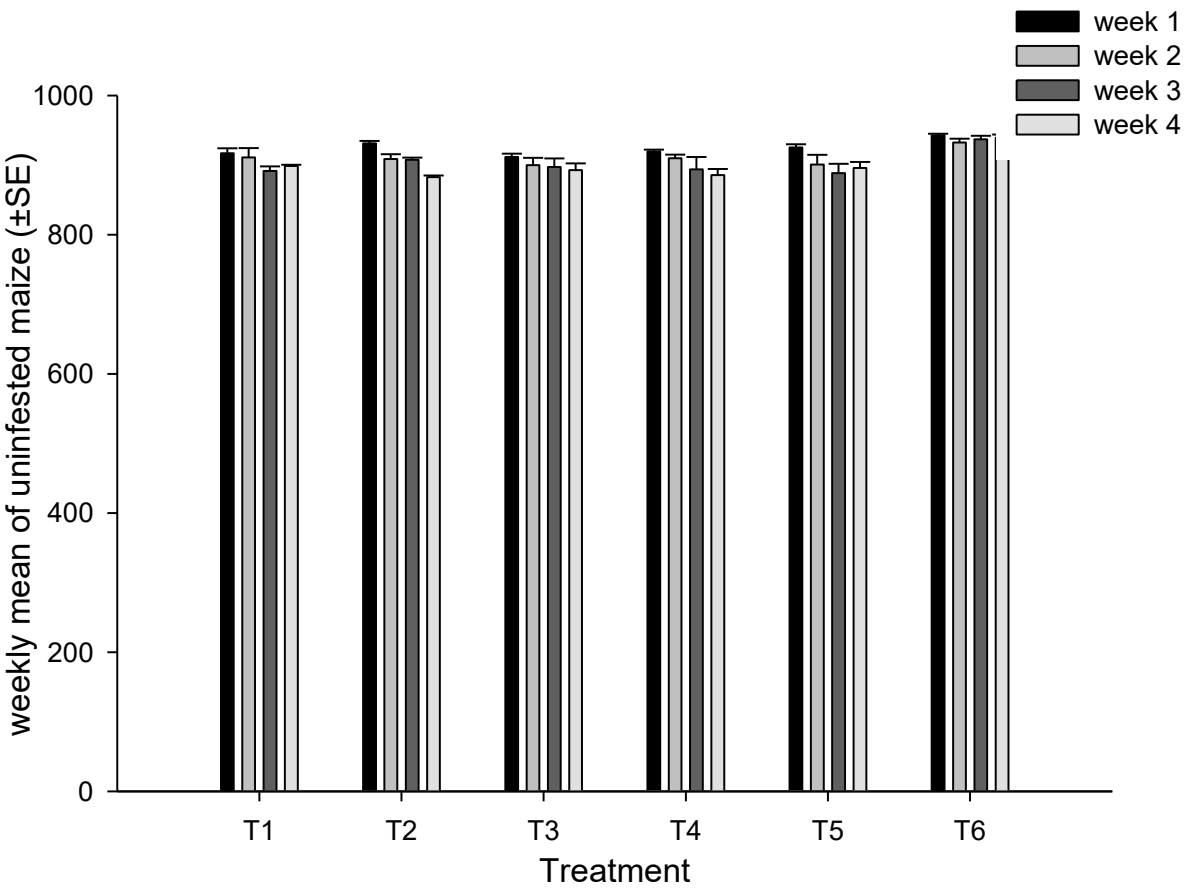

Fig 4.Weekly mean of un infested maize for the different storage containers

Conclusion

For the fact that the T6(supper plastic containers with seal tape lids) treatments could cause a very high rate of mortality of the weevil within the first week could be related to the very tight fitting opening with seal tape and also for their small openings to reduce oxygen supply to weevils. T1(fertilizer bags only) and T3(plastic buckets with lids) have increase numbers of weevils and even an increase numbers of infested maize because oxygen could penetrate into these containers and thus enhance the survival of these weevils and hence their rate of feeding on the maize grains. The same explanation is also applicable to T4 (metal containers) and T5(wrappen +fertilizer bags).

References

Komen, J.J., Mutoko C.M., Wanyama J.M., Rono S.C. and Mose L.O. (2006). sEconomics of Post Harvest Maize Grain Losses in TransNzoia and UasinGishu Districts of NorthWest Kenya. Kenya Agricultural Institute, Kitale

Study 6

Comparing the Performance of a Locally Made Seed Crushing/Extraction Machine with Manual Method of Seed Crushing/Extraction

Ojong Agbor Ntane, Missi Valentine, Forchibe Ethelene, and Nambangia Justin Okolle

Introduction

Vegetables are important commodity for growth and development as they serve as a source of micronutrients and a quick source of income to farmers. As a result they are very essential in life. They are the edible parts of plants cultivated for human consumption (Agudo.,2005). They could be indigenous (native to a region) or exotic (imported and domesticated) (Weinberger and Msuya, 2004). In the South West region of Cameroon, they are mostly propagated through seeds. A seed is an embryonic plant enclosed in a protective outer covering. It carries the genetic and physiological basis for crop development. As such it forms the basis for agricultural production and the nutrition of mankind. Despite the medicinal and economic importance of vegetables, it has still remained under subsistence cultivation by farmers, producing what can just be consumed. Great production has been limited by lack of available quality seeds in this region. Seed extraction is very possible, but it demands a lot of attention and carefulness because the method of extraction will determine the seeds viability, vigour and physical appearance. At present, the manual method is being used to extract the seeds from the fruits. This method is highly labour intensive, time consuming and low yielding. The present study evaluates the performance of a locally manufactured electronic seed extractor machine to crush these fruits.

Materials and methods

The study was conducted at the Entomology-Nematology/ Seed processing unit of IRAD Ekona. Mature seeds of standard sizes of African egg plant (*Solanum melongena*), pepper, (*Capsicum sp*), tomatoes (*Lycoperscicon esculentum*), obtained from the local markets were used. Mature seeds of standard sizes were used. The fruits were crushed using two different methods but the seeds are extracted using the same method (wet method).

Determination of crushing efficiency due to methods of fruit crushing

Method 1: Manual

The fruits are tied in a bag and trample upon using the feet until all the fruits are properly crushed. The crushed fruits are poured in a plastic basin and allowed to ferment for 48hours. Water is being added to hasten the fermentation process.

Method 2: Electronic Machine

The electronic machine was locally fabricated at a machine store in mile 16 Buea. It consists of one main component, ***the fruit crushing chamber*** which is made up of the following parts, A) Feed hopper used to feed the fruits to the crushing chamber by gravity

B) Crushing unit with a shaft to crush the fruits

C) Bolted Screw connected with the shaft in the crushing unit used to dismantle or change length of component

D) Power transmission system used to generate power for the machine to function appropriately
E) An electronic motor which carries the sensors/engine of the machine
F) A collector which collects the crushed fruits into a basin for fermentation

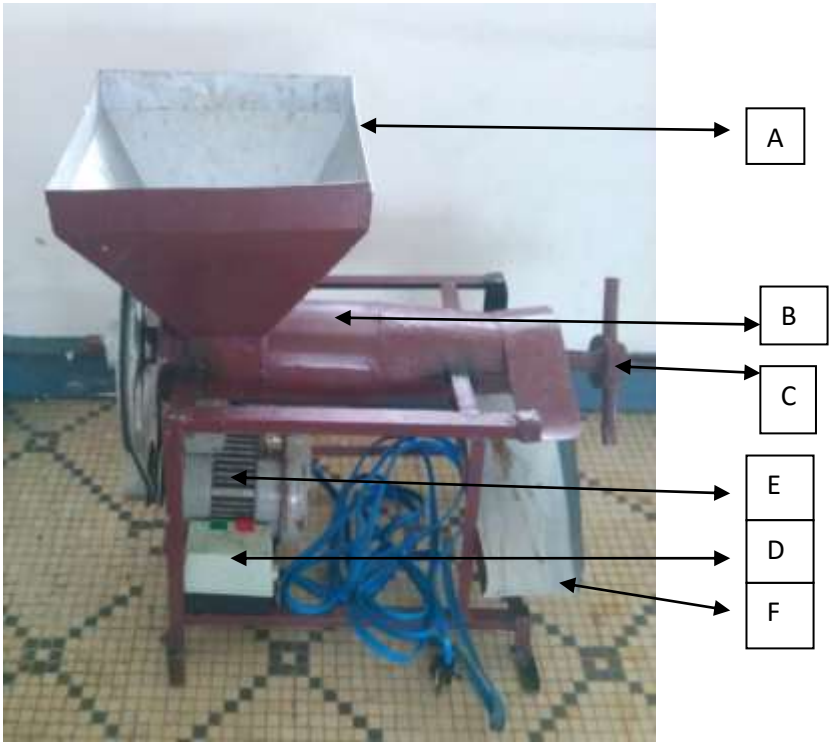

Fig 1: A locally fabricated seed extraction machine

In this method, the fruits are poured into the feed hopper, then the machine is connected to a power source where by power is supplied to the motor to carry out the crushing process. Water is added to facilitate the crushing. While crushing, the screw auger is adjusted to give the required crushing diameter. The crushed seeds are collected into a non metallic basin .Water is again added to wash out any remaining seeds through the seed outlet in to the fermentation basin. The seeds are allowed to ferment for 48hours for complete separation from the pulp. They are then washed with clean water using a 0.3cm and 0.2cm sieve for African eggplant, pepper and tomatoes respectively, until all the floating seeds which are not viable are poured out. The clean and viable seeds sink to the bottom and its then put in a sieve to drain water for about 20mins. It is then spread on a batch under shade to avoid direct sunrays which is known to damage the seeds for 5-7 days dried to the appropriate moisture level (8%). After drying, laboratory test were done for seed germination percentage.

Schematic presentation of the processes involved in seed processing (crushing, fermentation, washing, drying, germination test and storage)

Data analysis

All data were analysed using GENSTAT 12th edition. Percentage data were acsin transformed before subjecting to Analysis of variance (P=0.05). All graphs were plotted in SIGMA PLOT 10.0 edition.

Results andDiscussion

Weight of seeds

The seed weights were influenced significantly by extraction methods. Tomatoes and Eggplant extracted manually had a higher weight when dried compared to mechanical extraction. This could be due to the fact that some seeds were damaged by the machine during crushing,(Fig 1.) On the other hand, the seeds of pepper extracted manually had a lower weight compared with seeds that were extracted mechanically. This could be due to the improper crushing of the pepper fruits manually, there by leaving so many seeds still attached to the fruits (Fig 2).

Fig 1. Broken seeds of eggplant by machine

Fig 2. Pepper seeds not well crushed

Pepper seeds well crushed with machine

Table 1: Weight of seeds before (fresh weight) and after (dry weight) extraction and duration of extraction

Extraction methods	Vegetable	Fresh weight/kg	Dry weight/kg	Duration of seed extraction/mins
Manual extraction	Tomato	16	0.034	5
	Eggplant	12	0.453	15
	Pepper	10.5	0.089	10
Machine extraction	Tomato	16	0.03	3
	Eggplant	12	0.353	6
	Pepper	10.5	0.126	4

As seen in Table 1 above, the length of time for the machine extraction was far less than the length of time used manually

Seed germination test

1. **Tomato seeds**

Germination for tomato seeds commenced three days after the setup. Total Percentage seed germination was recorded after seven days. There was a significant difference of seed germination, between the different seed extraction methods (manual extraction and machine extraction) ($F_{(1,5)} = 12.840, p=0.023$). Highest percentage of seed germination was recorded for seeds that were manually extracted (96.7%) (Fig 3). This could be as a result of damages caused by the machines on the reproductive parts of the seeds.

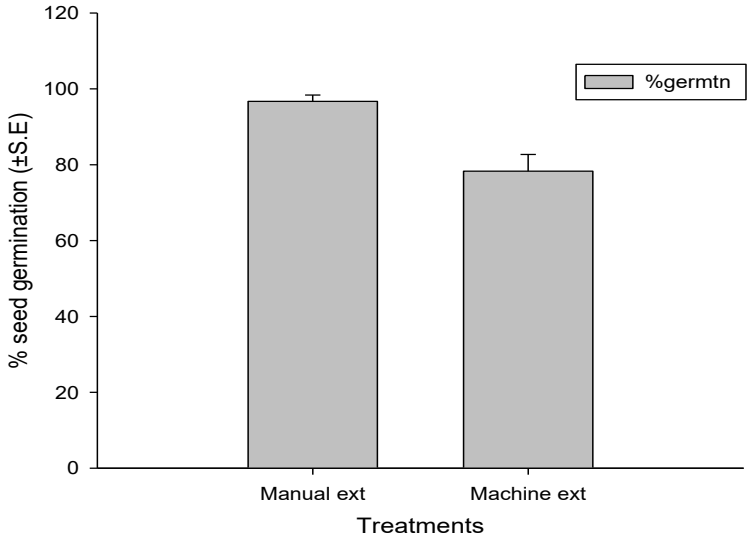

Figure 3: Percentage seed germination for tomato seeds extracted manually and using a machine

2. Pepper seeds

Germination for seeds extracted mechanically commenced germination after seven days while seeds extracted manually commenced germination after ten days. After fourteen days, total percentage seed germination was recorded. Analysis showed that there was a significant difference of seed germination between the two extraction methods ($F_{(1,5)}$ = 29.14, $p = 0.006$). Highest percentage of seed germination was recorded for mechanically extracted seeds (53.3 %) compared to seeds extracted manually (Fig. 4). Pepper is amongst the common crops known to still exhibit dormancy ,Jeffrey., 2004. The machine could be an artificial method to scarify the coats and break dormancy, reason for the aforementioned trend.

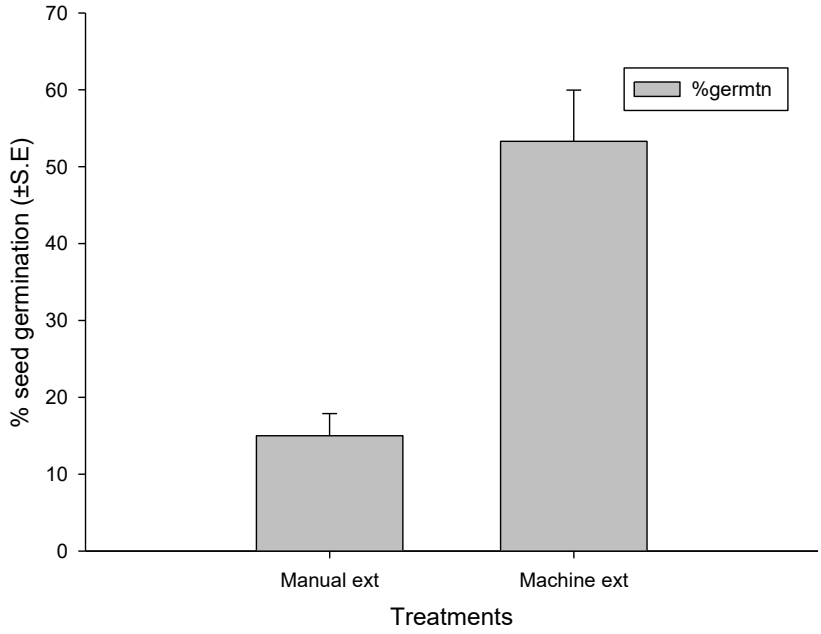

Figure 4: Percentage seed germination for pepper seeds extracted manually and using a machine

3. Eggplant seeds

Germination of seeds extracted mechanically, commenced germination seven days after setup. After fourteen days, percentage seed germination was recorded. Only seeds extracted mechanically had some percentage of seed germination (23.3 %) while no germination was observed for seeds extracted manually (Fig. 5). Analysis showed a significant difference for percentage seed germination between the two extraction methods ($F_{(1,5)}$ = 86.49, $p < 0.001$). This may be attributed to the fact that eggplant exhibit some level of dormancy . The machine crushing of the fruits has been used as a means of scarification in other to break through the seed coats and cause it to be permeable, thereby, facilitating germination.

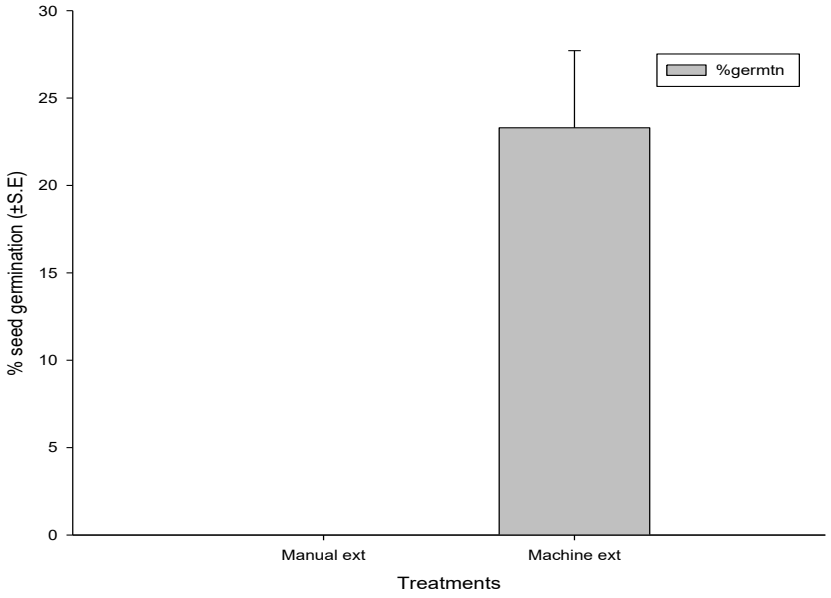

Figure 5: Percentage seed germination for eggplant seeds extracted manually and using a machine

Morphological characteristics of seeds

The seeds that were manually extracted had brighter colour compared to the seeds that were machine extracted which had a dull colour, especially tomatoes (Fig 6). This may be attributed to the material from which the machine was fabricated. This may have a negative influence on the market demand of the seeds.

A) Seeds of tomatoes machine washed
B) Seeds of tomatoes hand washed

Fig 6. Morphological characteristics of the seeds

Operation cost

Cost of machine.....350000frs = 700$

Cost of operation.....labour +electricity +repairs and maintenance

The labour cost ($/h) was calculated based on the fact that at least two workers were needed to properly operate the machine. This was estimated at 4$/day (8hrs/day). Hence the labour cost was calculated at **0.5$/h.**

The electricity cost($/h) was calculated to be 0.625 units /h/ 0.15$, and it was estimated at 0.22hrs to be **0.021.**

Repairs and maintenance ($/h) was estimated at 2% of machine cost/100hrs of operation

2% * 700/100 = 0.14

Operation cost ($/h) was calculated based on the sum of labour, electricity and repairs and maintenance. Hence 0.5 +0.14 +0.021 =0.661

Total machine cost ($/h) was calculated based on operation cost and cost of machine

0.661 +700 =700.661

Extraction time(h) = 1/productivity

=1/0.385

=2.6

Extraction cost ($/h) = total machine cost *extraction time

= 700.661 *2.6

= 18217.21

The cost of extraction was also estimated and calculated manually ($/h) . In this case instead of two labourers, five labourers were needed. Their output was determined based on the total productiveity as follows;

4*5/ 0.385 **= 51.94**

Conclusions

A locally manufactured machine was evaluated based on cost effectiveness, efficiency, and the germination ability of TAV seeds. The following results were achieved.

- In terms of time and labor, the machine extraction method is cost effective as it uses less time.
- For germination, the machine extraction proved beneficial as it is seen to break dormancy especially for seeds such as eggplant and pepper which has a serious problem of dormancy.
- Although the machine method has been proven efficient in breaking dormancy, it equally destroys the seeds. Actual care needs to be taken during the process.
- The machine was proven to be cost ineffective as compared to manual extraction of seeds in terms of extraction cost. The machine cost was 18217.21$/t as compared to 51.94$/t for manual. Therefore, for small scale production, machine extraction is not recommended due to the above mentioned findings.
- The manual extraction method in this study has been proven cost effective for small scale production but labour intensive for larger scale production.

Recommendations

- The material that is being used to fabricate the machine should be the original, hard, durable and meant for that purpose, as this may cause electrical problems as seen in Fig 8.
- Further studies should be carried out on how to break dormancy for pepper and eggplant.

Study 7

Chemical properties of components of "Njorku" (a biofertilizer with insecticidal properties)

Lawrence Tatanah Nanganoa & Nambangia Justin Okolle

Introduction

In Cameroon like in many developing countries, there is increase in land pressure resulting from rapid population growth and other uses, it is no longer possible in many areas to maintain the long fallow periods crucial for soil fertility regeneration. This has resulted in the breakdown of the natural soil fertility replenishment system, to the point where large tracts of land are becoming degraded and left out of cultivation. This has led to the practice of continuous cultivation on low fertile soils resulting in inadequate food production or decline in crop yield [1]. Research results obtained at International Institute of Tropical Agriculture (IITA) (1992) Ibadan, Nigeria, Cameroon and elsewhere indicate that soil degradation can be halted or retarded by maintaining a crop cover or continuous incorporation of organic residue on the soil surface [2].

Soil fertility depletion is the single most important constraint to food security in sub Saharan Africa. Though the use of organic resources such as farmyard manure and compost have been in use for several years for improving soil fertility, these methods of soil fertility improvement has been inadequate to meet the challenges of soil fertility depletion in the region. One of the reasons is that the nutrient proportions in the organic residues are neither adequately balanced for plant nutrition, nor is the efficiency known. The characteristics of plant residues vary depending on the plant species, plant tissues, and soil chemical and physical properties. Thus the imbalance of nutrients as regards to plant demand and the variability in nutrient contents [3] as well as other properties, of chemical and physical nature, may limit the agricultural use of organic residues. However, to correct these factors, the residues must be analyzed, in order to exploit their agricultural potential.

The objectives of this study were to characterize the chemical and physical properties of *tithonia diversifolia* leaves and soft stem, ash of oil palm nut and fiber waste and bush pepper, to evaluate the agronomic potential of these materials and to determine the quantities required in crop fertilization programs.

Justification

Tithonia diversifolia has recently gained tremendous research interest in the tropics. In Cameroon, *T. diversifolia* is seen growing as a pure stand or among vegetation along roadsides and on smallholder farms. It accumulates a large amount of nitrogen and phosphorous from the soil and therefore makes a very good organic fertilizer. The stems and leaves are soft and rot easily. When it is cut and buried into the soil it rots quickly and releases nearly all the nitrogen into the soil in about two weeks, making it available for crops. In the south-West region of Cameroon where there is intensive cultivation of oil palm, waste ash of processed oil palm fruits is one of the major waste products resulting from the processing of oil palm fruits in an oil mill. This waste made of fiber and nuts is use as fuel to the local oil mill. The ash generated (OPB) can be used as a fertilizer supplement, for crop production [4]. Bush pepper is a known botanical pesticides.

Materials and methods

Tithonia biomass was harvested along roadsides in Buea (Cameroon) by cutting the soft stems (ST) and leaves before (NF) and after (F) flowering. These parts were separately carried in plastic bags to the laboratory. Waste ash of processed oil palm nuts (OPB) was obtained from a local oil mill (Banga Bakundu, Cameroon) and the bush pepper (BP) was bought from a local market.

Laboratory analysis

Tithonia samples were cleaned and oven dried at 65 °C for 72 hours. The dried samples of *tithonia* and bush pepper were milled in preparation for analysis. The OPB was analyzed as obtained from the oil mill. Sample analysis was done according to standard methods. The total N was determined by semi-microkjeldahl digestion and distillation techniques, P was determined by colorimetry and k determined by flame photometry. Organic carbon was determined by using the Walkley and Black method.

Data Analysis

The analysis of variance (Anova) was used to compare the means of the different organic residues. Significant means were further compared using the Least Significant Difference (LSD) ($p<0.05$). The JMP 5 software was used to analyze the gathered data for interpretation.

Results and Discussion

The total concentrations of nitrogen (%), Phosphorus (%), Potassium (%) and Organic Carbon Org. C (%) of the different organic residues on dry matter basis are as follows:

- *Tithonia* leaves from non-flowered plants (NF): **N** (6.47± 0.15), **P** (0.33±0.01), **K** (3.46±0.16), **Org C** (46.98±0.14)
- *Tithonia* leaves from flowered plants (F): **N** (5.46 ± 0.12), **P** (0.29±0.01), **K** (2.63±0.18), **Org. C** (50.55±0.82)
- soft stems of *Tithonia* (ST): **N** (3.03 ±0.12), **P** (0.35±0.01), K (3.87±0.27), **Org C** (47.57±2.03)
- waste ash of processed oil palm nuts (OPB): **N** (0.35 ±0.02), **P** (1.07±.12), **K** (3.68±0.21), **Org. C** (6.74±1.64)
- Bush pepper (BP): **N** (2.67 ±0.64), **P** (0.23±0.01), **K** (2.10±0.24), **Org. C** (54.64±2.13)

The highest concentration for Nitrogen was obtained with NF, Phosphorus with OPB and potassium with ST (however there was no significant different with that of OPB). From the results, it was also observed that *Tithonia* leaves from plants that have not flowered has higher **N,P,K** values as compared to *Tithonia* leaves from flowered plants (Figure 1).

From literature, *Tithonia* has nutrients averaging 3.5%, nitrogen (N), 0.37%, phosphorus (P) and 4.1% potassium (K) on dry matter basis [5]. The high nitrogen content of *Tithonia* in this study might be due to the rich volcanic soil of this area. The results have also shown that a mixture of these organic residues; *Tithonia* leaves, stems, bush pepper and the ash of oil mill waste (Njorku) can serve as a low cost organic fertilizer.

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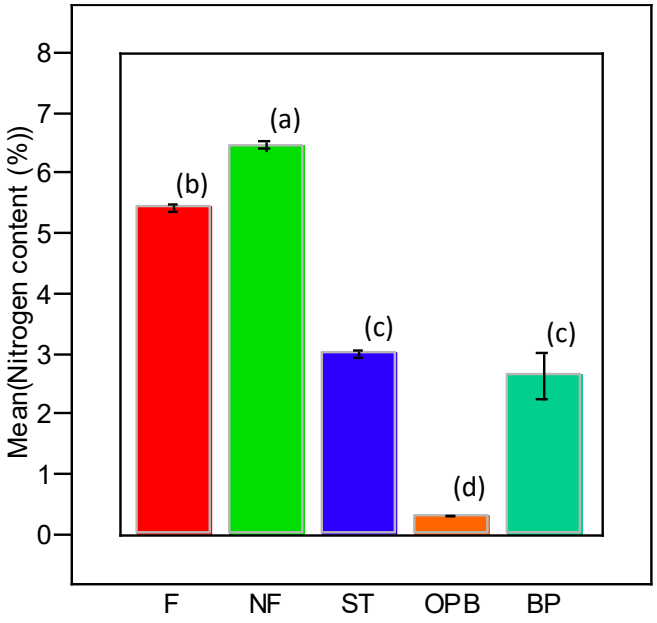
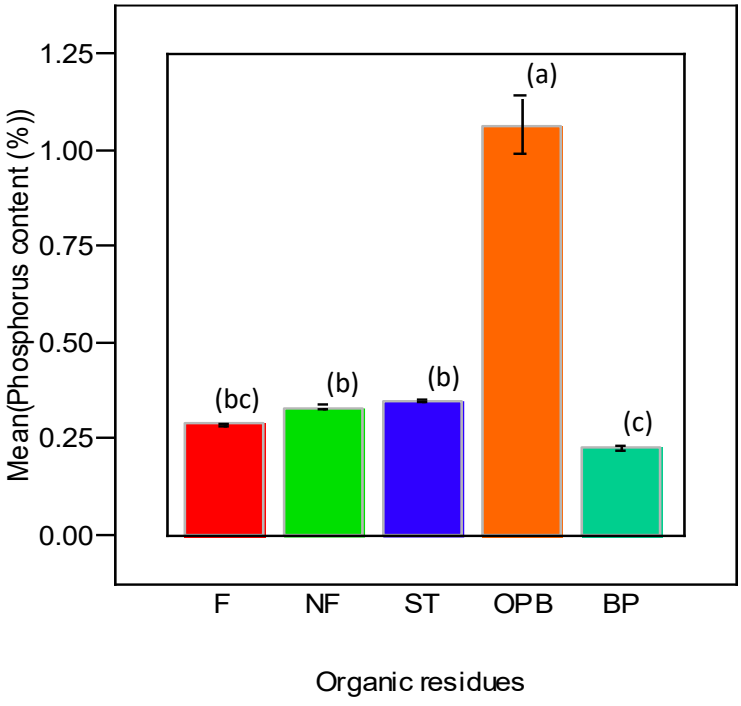

Mean(Nitrogen content (%))
8
7
6
5
4
3
2
1
0
(b)
(a)
(c)
(d)
(c)
F
NF
ST
OPB
BP
Organic residues


Mean(Phosphorus content (%))
1.25
1.00
0.75
0.50
0.25
0.00
(bc)
(b)
(b)
(a)
(c)
F
NF
ST
OPB
BP
Organic residues

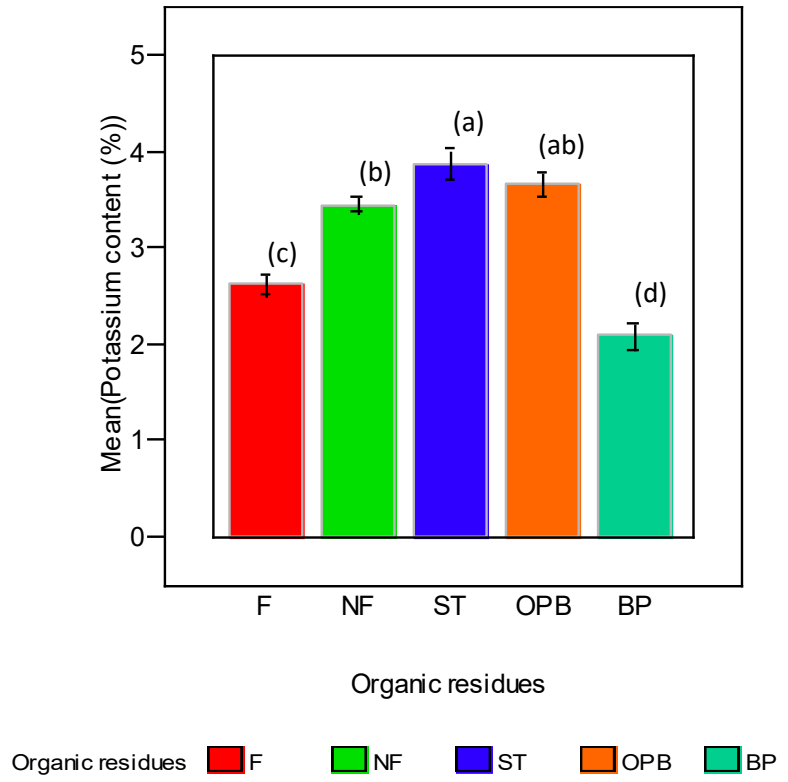


Figure 5: Total NPK in organic residues. F: *tithonia* leaves from plants that have flowered; NF: *Tithonia* leaves from plants that have not flowered; ST: soft stem of *tithonia* plants that have not flowered; OPB: ash of processed oil palm nuts. Means having the same letter do not differ significantly by the LSD test ($p < 0.05$).

Table III: C/N ratio of the different organic residue

organic residue	Org. C (%)	N (%)	C/N
F	50.55	5.47	9.24
NF	46.98	6.47	7.26
ST	47.57	3.03	15.70
OPB	6.74	0.35	19.26
BP	54.65	2.67	20.47

All plant materials had C: N ratios lower than 32:1 beyond which soil N immobilization can be expected [6]. Carbon to nitrogen ratios varied from 7.26 in *T. diversifolia* leaves from plants that have not flowered to 20.47 in bush pepper.

Conclusion

Tithonia diversifolia grown along the road sides of Buea, Cameroon have high NPK values. The ashes of processed oil palm fruits have high PK values. Bush pepper which is used as organic pesticides also had high nitrogen content. A combination of these organic materials (NJorku) could substitute for inorganic fertilizers because it is cheap and readily available.

Perspectives

- Analysis of calcium and magnesium of the organic residues is on-going.

- With the interesting properties of the above organic residues, a field trial on the influence of Njorku (*Tithonia diversifolia*, ash of processed oil palm fruits and bush pepper) on soil fertility improvement, growth and yield of sweet potato would be carried out.

References

1. Ruthenberg, H. Farming systems in the tropics. Oxford University Press, London U.K., 1971.
2. International Institute of Tropical Agriculture. Sustainable Food Production in Sub-Saharan Africa. Ibadan, Nigeria, 1992.
3. Westerman, P.W. & Bicudo, J.R. Management considerations for organic waste use in agriculture. Biores. Technol., 96:215-221, 2005.
4. Adjei-Nsiah S. and Boahen Obeng C., Effect of Palm Bunch Ash Application on Soil and Plant Nutrient Composition and Growth and Yield of Garden Eggs, Pepper and Okra, International Journal of Plant & Soil Science 2(1): 1-15, 2013.
5. Jamal B, Palm CA, Buresh R J, Niang A, Gachengo C, Nziguheha G and B Amadalo Tithonia diversifolia as a green manure for soil fertility improvement in Western Kenya. *Agrofor. Syst.*; Vol. 49. N0. 2: 201-101, 2000.
6. Troeh, FR and Thompson LM, Soils and Soil Fertility, Sixth Edition. Blackwell Publishing Professional, USA. 489pp, 2005.

Appendix - Photos

Appendix 1: Landfill of oil palm bunch waste. Appendix 2: Sun-dried Tithonia leaves

Appendix 6: Tithonia diversifolia fresh leaves. Appendix 4: Ground mixture (Njorku)

Study 8

Conservation of Onions in the Extreme North Region of Cameroon

Maurice Gandebe & Oumarou Palou

Introduction

Onion, (*Allium cepa*) belonging to the scientific family Liliaceae is produced mainly for human consumption. It is used as spices or ingredients in sauces. The rapid urbanization in the Extreme North Region of Cameroon comprising various ethnic groups has brought to the fore a multiplicity of culinary arts in the region. This urbanization combined with the opening of urban markets flows in the Southern region of the country, CAR, and Nigeria has led to unprecedented development of market gardening in the region. Market gardening in the Extreme North region is dominated by the cultivation of onions. There is the imperative to have a good mastery of mechanization, irrigation, and conservation. The cultivation of onions is practiced in almost all the administrative headquarters of the Extreme North. Large production households are situated in the Diamaré Division, notably at Ngoyang, Meskine and Congola.

Goal

Given the importance of onions, this study aimed to explore the sector in order to identify the bottlenecks in the onion value chain towards the food security endeavour.

Methodology

The study was conducted in three localities (Ngoyang, Meskine and Congola) of the Diamaré Division in the Extreme North region. A questionnaire was administered to 39 onion producers. The sample population was selected using a purposive sampling technique.

Results

Socio-economic aspects

The study found that onion production is essentially practiced by men (household heads). 35,89% of producers ranged between the age of 31 and 40, 33,33% were aged between 41 and 50 while 20,51% and 10,25% of producers were more than 50 years and less than 30 years respectively. The majority of producers (79,48%) have attained primary level of education and have an average of eight (8) dependents with three (03) who are actively engaged in agricultural activities. Agriculture is their principal activity but (5,12%) of producers are civil servants and (2,56%) comprise of teachers who are involved in cultivation of onions.

Production and Technical Training

The majority of producers access land for cultivation of onions through rentals. 87% of producers get access to land through lease of parcels, whilst 2,56% work in family farms and 5,12% work on parcels inherited from family relatives. Onion producers have not been trained in agricultural professional institutions. In fact, 92,30% have no basic training in this field. They receive information on cultivation techniques and conservation of onions from the neighbouring farmers, an average from extension workers (agricultural technical agents) in the zone.

Production and Procurement

Onions seeds are bought from the local market and the variety used by producers is the Goudami. They believe that the seeds are of good quality and less expensive. They obtain fertilizers from the market but face difficulties with the high cost and the distance between the sales point and parcels. The sowing of onion is usually carried out in the month of September. The tools used *par excellence* for land preparation is the plough in that it is easy to manipulate and less costly. The technique for land preparation entails the formation of compartments. This technique helps to maintain moisture and strengthens the retention of water.

Although this technique of land preparation helps in water retention, producers' still water their crops at least twice per week using a motor pump. Given the delicacy of this activity, onion producers seek recourse to hired labour notably in conducting activities such as ploughing, transplanting, maintenance and harvesting. After harvesting, they transport their products with difficulty thus impacting negatively on the quality. To limit this loss which varies from 1 to 25%, they conduct the art of sorting.

Production and Fertilisation

Fertilisation is usually done 02 times before harvest, notably in the months of December and February. It is done using NPK (20.10.10) at the rate of four (04) bags average for quarter (¼)

hectares. They carry out phytosanitary controls using products such as: optimal, landrine and Gago. These phytosanitory controls are carried out on average 2 to 3 times.

Production and Conservation

Harvest is usually done in the month of March and producers harvest an average of 55 bags (jute bags), per quarter hectare. The harvested quantity is of great importance as the incomes enable them to satisfy most of the household needs. To maximise profit, all the producers conserve their harvest on stalls in a ventilated warehouse. Most often, they do sorting and treatment during conservation. To carry out treatment, they use products such as termitox, Marshall and tioral.

Production and Commercialisation

Producers spend an average of 300 000 FCFA in production and their harvest is estimated at 550 000 FCFA. Onions are used in several forms (sauces, seasoning, and medical properties). The month of March is the period of abundance for onions on the market and the month of August is the period of scarcity. During these periods, there is a significant variations in the market prices, a bag of onions is sold for 10 000 FCFA during the month of March and 50 000 FCFA during the month of August.

Other constraints faced by producers include transportation linked to lack of vehicles and poor road infrastructure. Coupled with these constraints, there is lack of training concerning most producers, who envisage technical, material, financial and infrastructural support to improve their economic activity.

Conclusion

From the field study and direct observations, the production and producers of onion face enormous difficulties in the sector and improvement should commence with technical training, followed by supervision in conjunction with technical training in mechanisation and conservation and financial support.

6.Annexes

PHOTOS

Study 9

Needs Assessment For Proliferation In Fragments (PIF) Of Plantain In Agro-Ecological Zone IV

Levai Dopgima, Musongong Sirri Bella, & Majory Meliko

Context

With the continuous involvement of individuals in farming, the demand for planting material has been on the rise. There are extensions of farmlands to plant cash crops like cocoa, oil palm and rubber. All these cash crops take and average of three years to start producing actively. During this time, the farmer needs money to carry out maintenance of the planted plots. Most farmers have resorted to the planting of annual crops like maize, egusi and most recently, plantain is the plant of choice.

The demand for plantain suckers is currently about 25 million annually. This cannot be met by growing in the field. With a production of an average of 12 suckers per annum, it will require about 2.5 million stands (about 1,000 Ha planted at 2mX2m). In order to circumvent this shortcoming, CARBAP introduced the PIF method for rapid multiplication of plantain. This method from acquisition of the sucker used to plant care in the nursery uses 12 steps and if followed leads to the production of 20-100 suckers per plant within three months. Compared to 12 suckers a year in the field, this is the technology that should be used by small and medium scale farmers to reduce the pressure of planting material availability.

This notwithstanding, best practices so far situate farmers only at an average of 10 suckers per plant. There is therefore a need to study the process undertaken by farmers with a view to accessing and filing gaps in the transfer of the technology that limits productivity. This survey was conducted in agro-ecological Zone IV from October to December 2016.

Major steps in PIF

The steps here are based on the recommendation of study by Ngo-Samnick et al. (2011)

Making a propagator

Propagators, or seedbeds, are made from wood, plastic or cement, constructed at ground level or above ground. Their size can vary and depends on the production objectives. They can be built with planks of wood, cement blocks, etc. The recommended dimensions is One metre wide, with variable length. A propagator of 1 m x 10 m is a good size

The base is sealed in order to prevent direct contact between the substrate and the ground below. A 10 cm layer of fine sand or gravel can be added to the bottom, or a sheet of polythene, perforated in order to allow drainage from watering.

The seedbed is filled with a layer of light-coloured sawdust approximately 20 cm deep. Sawdust from coloured wood (dark, red or yellow) sometime contain substances that potentially reduce plantlet development.

Greenhouse: The greenhouse is a framework built around the propagator about 80 cm to 120 cm above the seed flat. It is best to make two slopes in order to facilitate runoff in case of rain. The propagator should be hermetically sealed with strong, transparent polythene.

Shade house: This is built 1.5 – 2m above the greenhouse and is used to allow about 50 percent of sunlight through. The material used will depend on availability and resources (palm fronds, straw, netting, etc.).

Selecting Suckers: This is a major step to the whole operation. The sucker used should have narrow, sword-shaped leaves, with a pseudo stem of 5 to 40 cm in height (sword sucker), and the bulb should be free from traces of disease (no fringing or traces of nematodes). Usually this can be achieved only if the farmer has a seed farm.

Figure 8: Brick propagators, greenhouse and sword suckers for PIF pr

Figure 7: Cleaning and trimming of sword sucker

Cleaning and trimming

This involves cleaning the bulb with a sharp knife or machete. The top of the bulb should be removed, as well as all the roots, up to 3 to 5 mm. Once trimming is completed, the bulb should be totally white.

Peeling: The success of the procedure depends on this stage. Peeling involves removing the leaf sheaths one by one. At the level of the bulb, there is a light-coloured band (the colour depends on the variety) that attaches each leaf sheath to the bulb; this is called the knot. Each leaf sheath has a knot. Peel up to 2 mm above the knot. Remove the sheaths one by one, generally 3 to 5 layers. The pseudostem should be cut back to 1 to 2 cm above the stem's last visible knot. Make a right-angled crosscut on the bud at the starting point of each leaf sheath.

Phytosanitary treatments before incubation
In order to eliminate fungus, insects and nematodes, the peeled stem is then soaked in a solution of fungicide and insecticide, then dried in the open air, in a dry, shady place for between 48 and 72 hours. There are a number of different products, with different instructions for use. The precise amounts of pesticides should be added to the water while stirring.

Incubation/Propagation
This stage involves placing the explants in the propagator. Once the drying period is completed, use a sharp knife to trim the surface of the explant until only 2-3 mm of the pseudostem remains. Sort the explants and place same sizes together. Place the explants side by side in the propagator with the crosscut facing up. The number of explants per square metre will depend on the size of the explants used. Cover with a 2 to 3 cm layer of light-coloured sawdust. It is recommended not to water the explants on the day they are placed in the propagator, but to water thoroughly 24 to 30 hours later.

Reactivation
Two weeks later, the explants will have multiple shoots. In some cases, plantlets stemming from side buds develop more quickly and have greater strength. When the shoots reach thumb size, reactivation can begin. Remove the plantlets from the explant 2 mm above the node, and make a new right-angled crosscut in the pseudostem of the plantlet. Reactivation is not necessary and will depend on production objectives. It is not recommended for beginners as it requires a lot of experience, but is a means of increasing the number of plantlets per explant.

Harvesting plantlets
Taking cuttings occurs 30 to 40 days after propagation. Young plants with 3 to 5 leaves are carefully removed with a scalpel, razor blade or very sharp knife. Depending on the variety (Horn or French), in three months 20 to 100 plants can be produced per explant.

Replanting in bags and acclimatisation
The plantlet is replanted, with all its roots, in a black, perforated polyethylene bag, whose size will vary according to the production schedule. In contrast, separated plantlets without roots should be replanted in the propagator sawdust for ten days before being transferred to bags. Bags of 17 cm x 24 cm are highly recommended. Make sure that the bags are filled with rich compost and that water can easily drain through. In certain conditions, the compost can be mixed with sand or coffee husks.
Once filled, the bags are placed on a plank and watered the evening before replanting. It is recommended that the bags be thoroughly soaked when beginning the replanting. To replant, make a hole in the centre of the bag, deep enough so that the roots will not be bent. Place the plantlet in the hole and gently fill it with soil, without pressing down. Only the bulb should be in the soil; if the plantlet is pushed too far in, it may take longer to begin growing. Once replanting is completed, water the plantlets thoroughly. Place them in the shade, in a temperature of 25-27°C, in order to facilitate acclimatization. The plantlets should be watered four times a week.

Plant care

Weed the nursery regularly. The plantlets will suffer from competition with weeds. In addition to treating the plantlets, insecticide can also be applied directly in the bags or in the propagator in order to control parasites. In case of need, apply foliar fertilization. Between six to ten weeks after taking cuttings, the young plants are ready to be planted and can be transferred to the field.

Gap analysis of PIF in plantain production

Following the above steps elaborated by Ngo-Samnick et al. (2011) in PIF gives an average of 20 – 100 plantlets per sucker. Best results we obtained in the field were achieved by *Groupement Initiative Commun (GIC) Production Agricole du Cameroun* (PRODCAM) at Bonepoupa, GIC – WED (Women Education and Development) in Njombe and GIC – Bioexotica in Nkonsamba, each producing and average of 10 plantlets per sucker. Based on the administered questionnaire (Appendix I), we studied each step as conducted by the various farmers and realised the following gaps.

a) Propagators were mostly constructed following specifications. Most farmers opted for wooden propagators as they were cheap to construct. The main reason however being that farmers practiced this activity on rented lands and so could not build permanent structures. However, GIC PROTAB at Bessombe working on their acquired land have constructed befitting propagators with cement blocks.
b) Greenhouses were constructed following specifications. Most farmers use wood for construction and maintain a height of 1.25 – 1.5m, a width of 1.25m and a variable length of between 6 – 20m depending on the type of plank used and the piece of land. The cages are covered with a transparent plastic that has a width of 2m and variable length.
c) For most of the farmers visited shade houses were constructed with palm fronds except for GIC PROTAB that constructed with pillars and angle-bars and durable nets as roof.
d) Except for GIC PRODCAM with 4Ha of multiplication plot with 98% purity of Batard, all farmers buy suckers. This is the first major problem that farmers encounter. The can neither control the variety received nor attest to the treatment that these suckers have had. Being a critical stage in PIF, it is necessary to have a seed farm to control production.

   The reasons farmers advance is the lack of finances to establish and maintain a collection plot, and the fact that the market for PIF is not very stable.
e) Cleaning and trimming of suckers is not followed as prescribed by Ngo-Samnick et al. 2011. This is an area where training is required for farmers to understand. Most farmers will clean away the side buds and depend only on meristematic tissues and the apical bud. This greatly reduces the potential of the sucker.
f) Peeling to reduce leaves is another critical stage in the PIF process. Cutting the leaves at the collar region where the leaves attach to the stem or pulling the leaves out would destroy the buds. If the knife used is equally not sharp enough, the incised buds will rot and die. Most of the farmers however attest that they have acquired training form CARBAP, PACA and C2D Plantain Project. This step has to be looked into again with great consideration. Since this work was conducted when farmers where not in activity, it was difficult to access this step.
g) Phytosanitary treatments were properly applied by most of the farmers who all acknowledge that it was a key factor in maintaining the suckers healthy. They all

agreed that without these treatments, suckers will get rot in less than 2 weeks and will greatly impact the results negatively.

Some of the products used include the following: Savanel, Bastion, morcap, counter, bencozeb, mancozep, carbofuran, harvestmore, Digro-vert and a 30:10:10 (NPK) fertilizer.

h) Incubation in the propagators is well followed. A variant was noticed in Tongo conducted by SUFEM. Here the substrate (sawdust) is completely soaked before suckers are placed on. This probably explains why most of their suckers (about 30%) get rot during incubation.

i) Reactivation requires great skill to perform. Most farmers reactivate only once. It is required that it is done twice to increase that number of plantlets produced. We could equally not evaluate this practical step but recommend training to improve the way farmers carry out this step.

j) This is a step that is easy to perform and farmers have mastered it

k) Most farmers sell plantlets so they don't have to worry with potting. Those that sign conventions with MINADER however, have to pot the plantlets. They use mainly a mixture of river-sand and coffee husk in a mixture of 50 – 50. This gives has given them satisfactory results.

l) Plant care has been easy for these set of farmers as they use minute doses of fertilizer and nematicide for plant growth and they explain that there is little or no diseases that affect nursery plants. The major problem here is that the plants are usually produced in the dry season when water is scarce.

Needs for the improvement of PIF Innovation

In order to circumvent the problems raised by farmers involved in plantain seed production using PIF, the following must be looked into;

No	Problem	Proposed solution	Impact
1.	Selection of Suckers	Establish collection plot with selected varieties	- Suckers can be harvested at the sword stage - Fertilizer application will be controlled so as not to affect PIF
2.	Cleaning and Trimming	Training to maximise use of auxillary buds	Improve number produced per sucker
3.	Peeling	Training to peel above collar region and incise buds	Improve number produced per sucker
4.	Incubation	Training on choice of substrate and preparation	Reduce sucker rot and improve production
5.	Reactivation	Training on how to carry it out	Improve number produced per sucker
6.	Acclimatisation	Train on other sources of material to use	Reduce cost of procurement of substrate
7.	Plant care	Provide bore-holes for proper irrigation	Reduce risk of plant death after production

Conclusion

The demand for plantain plantlets is currently high so much do that supply is very minimal. With the technology of PIF developed, it can curb this demand gap especially to satisfy small and medium sized farms of up to 20Ha. Notwithstanding, the transfer of this technology has noticed some shortcomings that can be addressed as cited above. If this is done and the right persons trained, PIF can go a long way to reducing this need for plantain planting material.

Recommendation

- Organise farmers and real demand communicated to these farmers. This will make the market stable and farmers can better plan.
- Equip farmers with Bore-holes for them to irrigate plants in the dry season
- Build capacity of farmers in the key steps so that process can be properly conducted.

Reference

Ngo-Samnick L, Nanga NS, Nondjock P, Dunn D, Mengaptche E and Leroy S (2011). Improved plantain production. The Pro-Agro Collection. Joint publication by Engineers without Borders, Cameroon (ISF Cameroun) and The Technical Centre for Agricultural and Rural Co-operation (CTA). www.cta.int and www.isf-cameroun.org ISBN (CTA): 978-92-9081-476-4

Study 10

Current Research and Training Needs in The Processing And Packaging Of Potato In The Western Highlands Of Cameroon

Ntam Fidelis & Caroline Nain

Introduction

Potato (*Solanum tuberusum*.) is an important food crop currently grown at a significant scale in more than 130 countries including Cameroon, covering about 18 million hectares (Struik et al. 1999). The average world farm yield for potato was 17.4 tons per hectare, in 2010 (FAOSTAT, 2010). The yearly production of potato amounts to 295 million tons accounting for about half the yearly world production of roots and tubers, one third of which is from developing countries. It is a short season, high-value crop. Its production in Africa nearly tripled over the past 35 years, from 1.3 million tons in the early 1960s to 3.7 million tons in 1996 (CIP, 1999; Harold et al, 1997). Potato has a high nutritive value and the ratio of protein to carbohydrates is higher than that of most other food crops (Schippers, 1998). It is used for human consumption, animal feed, and as a source of starch and alcohol (Horton 1997).

Its role in the market economy in Cameroon has increased, due to demand for root and tuber food crops from neighboring countries like Gabon and Central African Republic, Equatorial Guinea etc. (Aquah et al 1994). The crop has now assumed a cash crop status with an annual tonnage of over 250,000 tones, grown on about 70000 ha in Cameroon (FAOSAT 2014). It plays an important role in the national food and nutritional security, poverty alleviation, and income generation and provides employment in production to consumption areas especially for farmers of the western highlands of Cameroon.

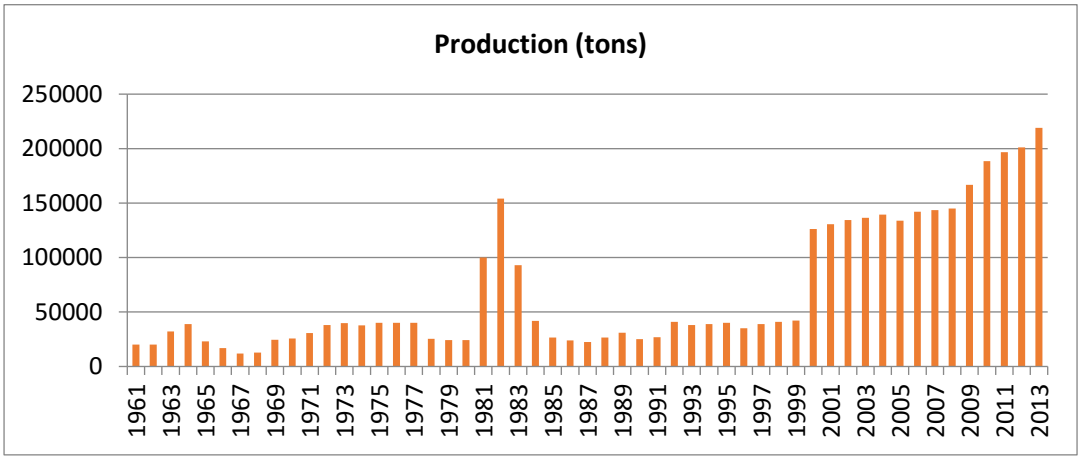


Figure 1: Potato Production in Cameroon
Source: FAOSTAT (2014)

Potato is grown in six regions with highland zones between 1000 and 3000metres above sea level. The Western Highlands (North West and West regions) are the highest producing areas in the country, accounting for 80% of the national production. More than 70% of the women in the Western Highlands of Cameroon are involved in potato cultivation (Foncho, 1989).

Though not a traditional staple food in Cameroon, potato is becoming an important agricultural commodity. In the country's highlands areas (North West, West, Adamawa, and Far North), potatoes can be produced all year-round. They are grown primarily on small farms, most of which are less than 2 ha, using labor- and input-intensive production methods, and sold as a cash crop. Understanding potato processing and marketing may lead to proper targeting of production and marketing, which may in turn, lead to increased consumption.

Agricultural research and extension efforts in Cameroon have resulted in development of potato varieties with higher yields and resistance to pests and diseases. IRAD Bambui Regional centre for example is well known for their research results in the production of clean Solanum potato seeds which has gone a long way to improve on the yield of this crop.

However, inadequate attention to appropriate postharvest handling, storage and processing to make potatoes available throughout the year at a price consumers can afford is a major drawback to further development of the crop. With an increase in production there is need for processing, packaging and marketing strategies to be put in place to ensure that the products obtained do not end up wasting due to post-harvest spoilage and an absence of varied ways for their consumption. Processing will add value to this agricultural produce therefore improving on household income and livelihood of farmers.

Development and support for commercial-level potato processing is one approach through which marketing constraints can be alleviated. Processing has the potential for enabling potato achieve an industrial level status similar to that of maize and wheat. This would help to create more employment, improve nutrition and enhance incomes for potato farmers.

This study will evaluate current research/training needs in the processing and packaging of potato (*Solanum tuberosum*) in the western highlands of Cameroon

Objectives

1. Assess processing and packaging of potato in the western highlands of Cameroon

2. Develop training needs for processing and packaging of potato in the western highlands of Cameroon

Methodology

Study Area

The study was carried out in the Western highlands of Cameroon which is made up of the North West and Western regions of Cameroon. The cities of Bamenda, Santa, Dschang and Kumbo were the main sites for the study.

Data collection

The survey method was used for data collection. Both qualitative and quantitative data was collected during the survey. Secondary and primary data were collected. Literature review on potato production, processing and packaging was carried out. An inventory of processing and packaging technologies available in the study area as well as innovations in the potato value chain was documented. A market survey of selected producers, consumers, restaurants, supermarkets, shops permitted us collect primary data for the study.

A training needs assessment constituted the second part of the study and the development of training needs for the processing and packaging of potato in the western highlands of Cameroon.

Results and Discussion

Potato production in the Western Highlands of Cameroon

Potato producers in study area are educated with at least 43.9% having completed primary education and over 31 % of them having completed secondary education (Figure 2). Potato being a crop susceptible to pest and diseases and needing specialized techniques in production, the producers will be willing to adopt appropriate agronomic practices to increase the productivity of the crop. Potato producers across the study area owned an average of 1.7 ha of land.

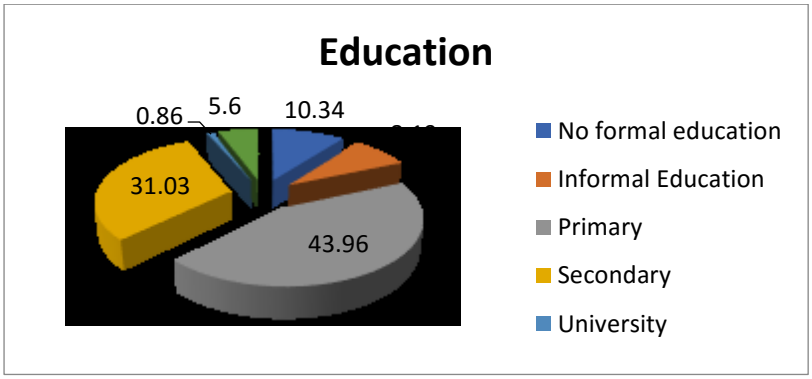


Fig. 2: Level of education of potato producers

We realized that just like other producers/processors in the country, potato processors across the regions are involved in several other activities for income generation. These include crop farming, animal rearing, petit trading etc. This diversification of income generation as reported by the producers/processors permit them to obtain additional income for their livelihood.

Potato Value Chain

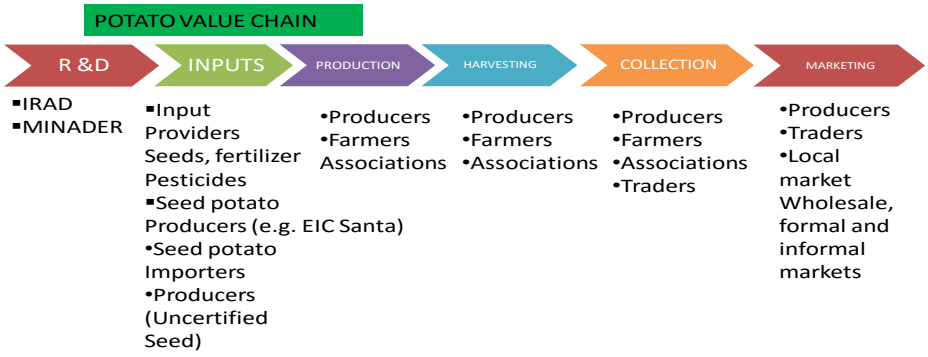


Figure 3: Potato value chain

Figure 3 gives the various actors along the potato value chain as inventoried during the study. At the level of research and development the two main actors are IRAD and MINADER. In terms of input dealers we found several actors including input providers and seed producers involve in this activity. Seed and ware potato producers as well as producers associations filled the remaining parts of the chain which include production, harvesting, collection and marketing.

We observed that processing of potato is only done traditionally by road side vendors and some restaurants and therefore not strong on the value chain. Industrial processing is not yet developed in the study site despite the fact that 80% of the country's production comes from these regions.

Varieties grown

Several varieties of potato are grown. Figure 4 shows the different varieties cultivated with CIPIRA being the most cultivated and Dosa (an imported variety) the least cultivated. The farmer-based approach to varietal evaluation has contributed to increased yields in the major production zones, especially the Western Highlands (Demo *et. al*. 2000). Cipira and Tubira are the most frequently cultivated varieties, followed by imported varieties such as Cardinal, Desiree, Mondial, Dosa and Spunta.

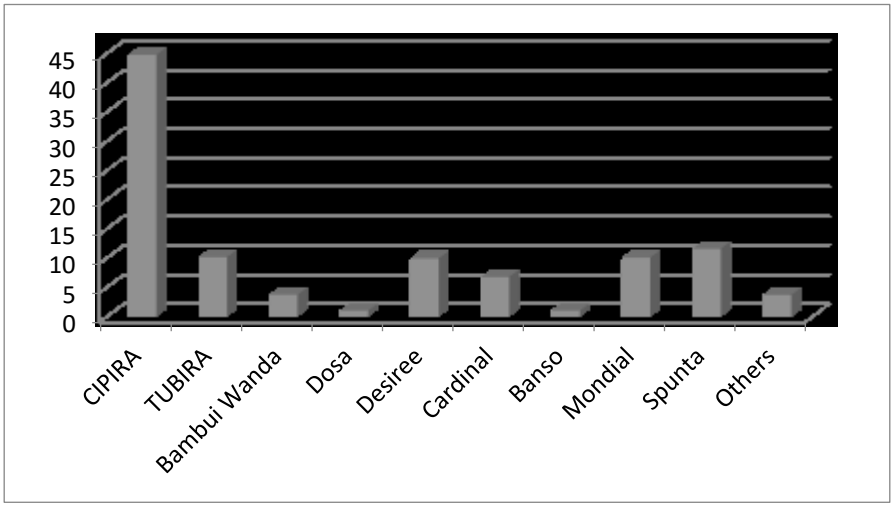


Figure 4: Varieties of potato grown
Source: *Ntam et al., 2016*

23

Some imported potato varieties

Storage

Long-term storage of potatoes (intended for consumption) is not a common practice in the Western Highlands of Cameroon. Potatoes are harvested several times through the year, hence are consistently available, and storage is difficult under the warm and humid conditions where most potatoes are grown. Over half the processors indicated that storage losses due to pests, diseases, and physiological disorders are major constraints. Figure 5 shows the methods of potato storage in the study site.

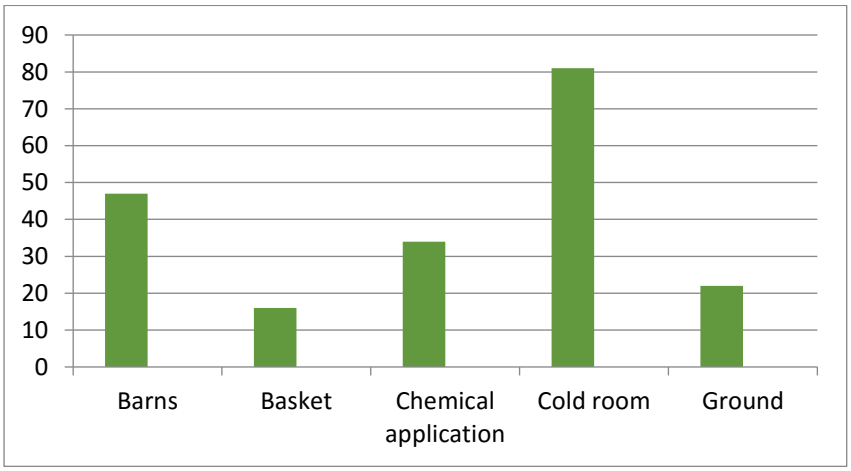


Figure 5: Method of potato storage

Marketing

Although most potatoes are consumed locally, over three quarter of the crop harvested is marketed in fresh form. This average, however, is based on a very high disparity between subsistence farmers who sell very little of their crop, and commercial farms that sell nearly all of their harvest. Commercial farmers are found in Santa and Oku in the North West region and Dschang and Mbouda in the West region.

Marketing chains are well established, often under the direction of women, and provide a strong source of employment for people in rural and urban areas. Wholesalers sometimes travel to rural areas to meet farmers directly, or at markets or supply and assembly sites in towns, where bulk buying takes place. Retailers in main marketing centers typically sell potatoes in containers of ten to fifteen kilograms. Exports to neighboring countries such as Gabon and Equatorial Guinea are now common in Santa, Oku, Kumbo and Dschang. Industrial processing of potatoes has not yet been developed in the study site.

Bags of potato ready for the market in Santa, North West Cameroon

Processing and packaging of potato in the Western Highlands of Cameroon

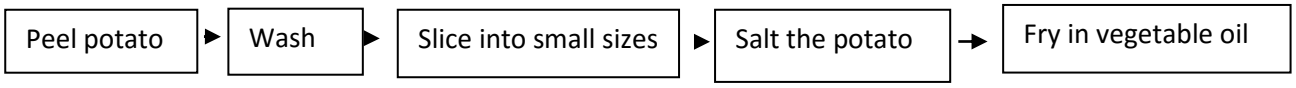
Results from the survey show that potato processing and packaging in the Western highlands of Cameroon are carried out mostly by some restaurants and road side vendors using traditional methods. Four main potato food products are prepared by these individuals. We did not come across any industry or small-scale enterprise involved in the processing and packaging of potato in the study site. These food products include potato French fries, potato flour, potato hotpot, boiled potato and bounded potato and beans.

Most of the respondents interviewed reported that the potato used in processing is purchased from nearby markets. 90% of those involved in this activity are women. Results show that the technology used in the processing/preparation of the potato was traditional with the use of kitchen equipments/utensils. The sources of energy used by the vendors are saw dust, fuel wood and gas cookers. The source of water for preparation was mostly tap water. No packaging is used for these food products because it is served just after preparation. Apart from hot pot that is preserved in food flasks after preparation and served as the need arise, the other food products (French fries, boiled potato and bounded potato and beans are not preserved. However, potato flour is preserved in plastic bags. These food items are also prepared in most households of the Western Highlands of Cameroon.

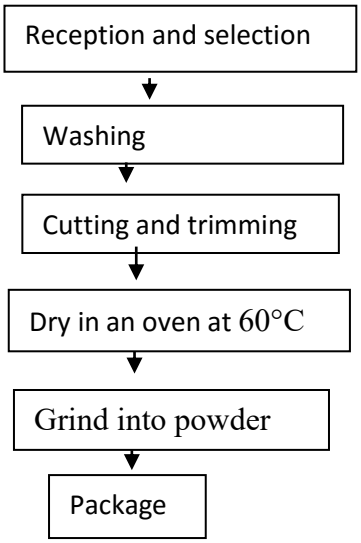
Description of processing techniques

It should be noted that all these products are processed locally.

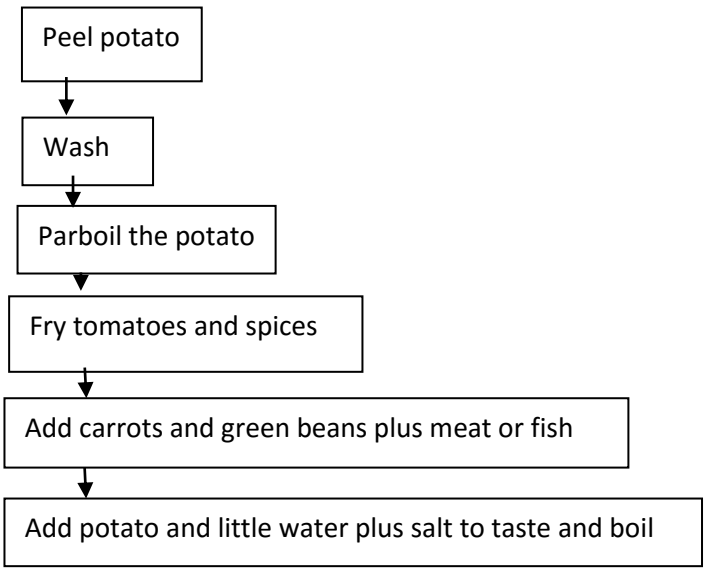
(a) Potato French fries: The potato is peel with knifes and washed with clean water. It is then sliced into small pieces and salted to taste and then fried with vegetable oil.



(b) Potato flour: Peel potato, wash and slice. Dry the potato in an oven at 60°C or in lyophiliser. Grind into powder and package.



(c) Potato Hot pot: Peel the potato, wash with clean water, slice into small sizes or keep them whole if the sizes are small and parboil the potato. Fry tomatoes and add spices of choice and add some carrots and green beans plus potato, add little water, salt and magi to taste.



(d) Bounded potato and beans ("tukuni"): Boil beans to be ready. Peel the potato and wash. Add potato to beans and add spices and palm oil and cook. Bound the potato and beans after cooking.

(e) Imported potato products

Some potato products are imported from Europe and sold in supermarkets in the study site such as potato chips, potato crisps etc. which are well packaged. These products are being consumed and appreciated by the population.However, there are some processing constraints: reported that

(i) Peeling is a major constraint. The respondents peeling takes time especially small sized varieties.
(ii) Low dry matter content for some varieties. These varieties get soft when prepared.
(iii) Potato are Expensive during off season and scares
(iv) Storability is difficult. Potato gets rotten in the store after few weeks.
(v) When exposed to light potato turns greenish and does not cook well. Becomes bitter due to enzyme activity.

Training Needs for Potato Processing and Packaging

Development and support for commercial-level potato processing is one approach through which marketing constraints can be alleviated. Processing has the potential for enabling potato achieve an industrial level status similar to that of maize and wheat. This would help to create more employment, improve nutrition and enhance incomes for potato producers and processors. In addition to using fresh potatoes for home consumption, the crop can be processed into a range of value-added products such as chips, crisps, various snack food items, French fries, dried products such as flakes, and convenience products such as pre-peeled potatoes and frozen French fries.

Aspects to be included in the training of potato processors

Determining potato quality for processing: Quality means different things according to the purpose for which potatoes are used. Quality should be an important aspect for farmers, traders and processors regarding which criteria to use during production, marketing or processing. A quality aspect such as appearance (colour, size and defects) determines the visual attractiveness of the finished products. Colour of finish-fried potatoes and that of the partly fried products is also important. Organoleptic aspects such as texture ('mouth feel') and flavour of finished products are also relevant for no consumer would like to purchase oily or soggy French fries. On the other hand, consumers would not like to eat products that are bitter as a result of excessive levels of toxic compounds inherent in some varieties. There may also be need to incorporate nutritional data such as the levels of amino acids, vitamins and minerals in the product.

Tuber quality aspects: There are two important parameters that are used to determine tuber quality for processing, external and internal aspects. The quality of processed French fries and crisps depends on raw materials used (potato tubers, fat, salt and packaging) and methods of processing including the unit operations and their control.

Selection of processing potato varieties: Some varieties are not suitable for the manufacture of processed products. It is important for processors to only use those varieties that make good quality products both at harvest and after storage for various periods of time. Some varieties are unsuitable for processing directly from the field due to a number of reasons.

Harvesting and postharvest handling: Potatoes reach full maturity when the tops of plants become withered. Although tubers of acceptable size may be harvested for immediate use, only fully mature potatoes should be stored. Mature tubers have optimum levels of dry matter content necessary for high yields, good consumer appeal and result in good texture and low oil content in processed products. Fully mature tubers also suffer less from harvest and transport damage and are easier to handle during processing. Trainees will be educated on the appropriate time to harvest and the rules to follow in storage.

Storage methods: Immediate need for cash drives many farmers to harvest early and sell their potatoes at low prices. Market prices improve after 2-3 months, implying that there is need to improve storage to bridge the supply gap between harvests, steady prices and ensure food security. This could also encourage investments by the private sector and individual farmers. Storage should be low-cost using normal ambient (outside) air circulation. Low-cost potato stores in highland areas can be constructed using locally available materials for holding processing potatoes for a longer period.

Training in Potato Processing: In the laboratory we determine the specific gravity of tubers and carry out a laboratory examination for quality of French fries and crisps. A laboratory assessment of processing quality in storage would show whether the varieties are good for processing or not. A test can be conducted on partly fried (or blanched) French fries or on cooked tubers to check on after-cooking blackening not appreciated by consumers. Potato tubers can be peeled by hand or mechanically, and then sliced on manual or mechanical slicers before being fried in wire baskets immersed in open kettles of hot oil or in electric fryers. These operations have a high demand of manual labour, which could be suitable for small-scale processing of both French fries and crisps. For production of large volumes, however, automatic and semi-automatic equipment is necessary. Waste from peeling, slicing and washing contain starch which has commercial value. This, together with small potatoes may be used as animal feed. Training the processors to ensure that finished products meet standard microbiological standards for the health of consumers is very important. Food Processors in the Western Highland can be trained to produce the following products:

i. Potato chips
ii. Frozen Potato French fries
iii. Potato flakes
iv. Potato flour

Conclusion

With an increase in potato production there is need for processing, packaging and marketing strategies to be put in place to ensure that potato produced in the Western Highlands of Cameroon do not end up wasted due to post-harvest spoilage. There is need for varied ways of consumption of potato in the region and beyond. Processing will add value to the potato and therefore improve on household income and livelihood of the producers.

References

Acquah E., Lyonga S. 1994. Internal Review of the Tropical Root and Tubers Research Project. 78 p.

CIP (Centre International de la Pomme de Terre). 1999. Program report: 1993-1994. Lima, Peru.

FAOSTAT: 2014. Food and Agriculture Organization of the United Nations.

FAOSTAT: Production-Crops, 2010 data". Food and Agriculture Organization of the United Nations.

Foncho P.A.F. 1989. Future plans and strategies for potato research in Cameroon.

Harold J., Judith A., Pavis J. 1997. *Annotated bibliography of nematode pest of potato.* Lima, Peru. 315p

Horton D. 1992. La papa: Produccion, commercialization y programas. In: Potato viruses and their control L. F. Salazar, (ed). CIP, Lima, Peru. 214 p.

Ntam F.T., Mveng P. and Meka S. 2016. Factors Affecting the Supply and Demand for quality seed potato in Cameroon: Farmers'/institutions' perspectives and policy options. In press

Schippers R. 1998. Cash Cropping Study in Enugu Nigeria. Preliminary overview of field studies. 78 p.

Struik P.C., Wiersema S.G. 1999. *Seed Potato Technology*. Wageningen Pers, wageningen, The Netherlands

Study 11

Assessment on the use of small machines by smallholder farmers in Agroecological Zone IV of Cameroon

Ngane Benjamin Kome

Introduction

From time immemorial "Early Man" discovered the use of tools in facilitating his farming, hunting and gathering activities. Since then there have been a dare need to use machines in agricultural activities such land preparation (clearing and ploughing), planting, weeding, pruning, harvesting, processing, preservation and marketing.

Agricultural technology is among the most revolutionary and impactful areas of modern technology, driven by the fundamental need for food and for feeding an ever-growing population. According to Field and Johns (2007), agricultural machines have been designed for practically every stage of the agricultural process- tilling, planting, irrigating, protecting from pests and weeds, harvesting threshing, livestock feeding, sorting and packaging. These machines have massively increased output and drastically changed the way people are employed and produce food worldwide.

Many farmers are upset by their inability to fix new types of high technology farm equipment. This is due partly to their inability to get financial support to meet the challenges of innovation. Another concern of many is how an inventor turns his new invention ideas into money. This is probably the single most often asked question. Upfront it is important to know that only a minority of ideas eventually make money. Some people have no clue as to how to proceed. Innovative technologies are only useful when they are put at the disposal of users, are socially accepted and provide benefits to stakeholders. STI (2013) mentioned that true modernization can only be attained if stakeholders such as the government and other policy makers whole-heartedly embrace the concept of funding technological innovations and provide enabling environment for it. It is also time too for researchers to have a paradigm shift from existing research for development models to the present day widely promoted and applied Integrated Agricultural Research for Development (IAR4D) model. With this model, researchers within a platform focus mainly on solving problems that arise from the value chain within the platform.

Research and innovation can be seen as a promoter of economic and social development. This means that research should be reinforced towards innovation in order to realize set objectives. According to the Growth and Development Strategy paper of Cameroon (GESP 2009), for Cameroon to become an emerging country and a newly industrialized country by 2035, there must be an increase in crop, animal and forest products. A 30% increase in output of agriculture compared to the level at 2005 is expected. The much-talked second generation agriculture requires the use of machines in all the value chains (production, disease control, harvesting, processing/preservation and marketing).

In spite of the potential role of technology development to the practice of second generation agriculture, there is a dearth of information on the machines produced and used by small farmers in Cameroon. Also Little emphasis is laid on technological training that is likely to support industrial development. Policies to promote technological innovation are

not in place in Cameroon. The target set for the continent namely to spend 1% of GDP on research and development remains elusive as the latest statistics indicate that average expenditure on research and development in Sub Saharan Africa is 0.30-0.40% (Johann et *al*. 2014).

Most of the machines produced and used today are still in their incipient stage of development. Some need sponsors to fine-tune their production and functioning while others need social acceptability, valorization and vulgarization. There is need for scaling up. Even when technologies are developed, they are not available for consumption. For technological innovations to be effective in contributing to sustainable development they must be available for use in order to have any meaningful impact on the development of the agricultural sector. Adoption and usefulness of these technological innovations can be used as criteria for selection for development, testing and funding support.

This study will be very useful in identifying machines produced and used by small farmers in Cameroon. It will also bring out partners and innovation platforms which are important in promoting innovative technologies. This will go a long way in guiding policy makers on the support and development of prioritized technologies. Based on this rationale, the study has as objective to improve the use of machines by small farmers, more specifically.

- To know the machines made and used by small farmers
- To know the adoption rates, performance of the different innovations (achievements and difficulties).
- To identify those technological innovations that will contribute to the development of stakeholders (prioritizing them).
- To recommend some of the technological innovations for long-term and short-term sustainable development (promotion and sponsor).

Methodology/Approach

Study Site Agro ecological Zone V.

The Agro ecological Zone V is the Monomodal Rainfall Pattern agro ecological Zone of Cameroon. It spans the South West, Littoral and Part of the South Regions (Ocean Division) of Cameroon. This area has two distinct seasons, a dry season lasting from November to February and a rainy season between March and October (Njukeng et *al.* 2011).

The vegetation of this area is typical of the equatorial forest. However, there exists areas of swamp forest at the coast of the Atlantic ocean and along river beds. Patches of the Biafran forest can also be found around the Littoral and South Regions of Cameroon. The soil types consist of old volcanic soils around the Muanenguba and Kupe mountain areas and young volcanic soils around the Mount Cameroon area (Fako Division). Sedimentary and alluvial soils are also present along the coast of the Atlantic Ocean and river banks such as River Wouri, River Mungo and River Sanaga.

Agriculture is the mainstay of the rural population of the study site. About 70 % of the population is involved in agricultural activities. The main crops grown are cocoa, oil palm, rubber, cocoyams, yams, cassava, melon, maize, vegetables and fruits. Animals mostly farmed are poultry, goats, sheep, pigs, cattle and horses. Non-conventional livestock

production includes snail farming, rabbit farming and bee keeping. Non timber forest products (NTFPs) such as bush mango *(Irvingia* spp.), bitter cola (*Garcinia cola*), plums (*Dacyodes edulis*) Kola nuts (*Cola* spp.) are also gathered from forests and planted in farms.

The major farming method practiced by small farmers is the slash and burn method. Sustainable agriculture is being promoted by the Ministry of Agriculture and Rural Development (MINADER), the Ministry of Scientific Research and Innovation (MINRESSI) and civil society organizations in the study area. Through these organizations farmers are encouraged to practice agroforestry technologies and organic farming. Plantation agriculture is mainly carried out by the Cameroon Development Corporation (CDC), Pamol Plantations Ltd Cameroon, SOCAPALM and and Plantations Haut du Penja. The crops grown by these agro-industries are hevea (rubber tree), oil palm and banana.

Technical education is still undeveloped in this area with only two state tertiary technical institutions in the agro-ecological zone- ENSEC Douala and the Higher Teachers Technical College (HTTTC) Kumba. Vocational training institutions include the Vocational Training Centre in Moliwe-Limbe, Government Technical High School Ombe, Government Technical High School Kumba and several rural artisan centres (SARs).

This study was conducted within the Humid Forest Monomodal Rainfall Pattern (Zone IV). Three administrative Divisions were purposefully selected from the agro ecological zone and three towns in each administrative division also chosen for the study. Fako Division, Kupe Muanenguba Division and Ocean Divisions were selected for this study. However famous innovators in other Divisions such as in Meme Division and Wouri Division were contacted and interviewed.

Semi structured questionnaire were the main instrument of the survey. Participatory rural appraisal tools and techniques were also employed. The questionnaires were hand administered at homes, shops and market places. The interviewer asked the questions and recorded the responses of all interviewees Telephone calls and the internet were used to contact some respondents. Information on technological innovations in small farmers machines, the level of adoption/use, achievements and difficulties and potential for development were elicited. Respondents included farmers, innovators, researchers, university lecturers, research and development organisations, civil society organisations, government ministries such as MINADER, MINFOF, Ministry of Small and medium size enterprises, small scale agricultural/forest-based processing enterprises, traders, policy makers, lecturers in tertiary institutions and professional schools in the domain of agriculture and engineering. Qualitative information on the manufacture, development and use of machines used by small farmers was collected.

Information from flip charts obtained during focus group meetings, notes from interviews with key informants, photos and relevant literature were collated, analysed and interpreted. Descriptive statistics were used. Percentages were calculated and histograms and pie charts produced. The sphinx software was used for the data analysis.

Key Results

Results of this survey show a check list of inventors and machines made and used by small farmers, actors of innovation, domain for which the machines were made and are being used (value chain type), value chain function and perceptions of policy makers.

Inventory of small farmers' machines.

A total of 30 machines was recorded in the mechanization of small farmers in the study site. These included machines used for land clearing, land, harvesting, crop protection, packaging, preserving food crops and fertilizers. Mechanization for fisheries products was also inventoried.

Characterisation of stakeholders

Types of stakeholders of mechanization for small farmers included individuals, organizations, the state, tertiary/ professional schools and innovation plat forms. Production of machine is carried out in decreasing order of importance as follows- individuals, the state, organizations and schools. It is worthy to note here that most of the innovations in small farmers' machanisation by the state have been promoted by the Institute of Agricultural Research for Development (IRAD) of the Ministry of Scientific Research and innovation (MINRESI) and her partners such as CARBAP and MINADER.

Value chain function

The survey also showed that these machines were made and used for some value chain functions in decreasing order of importance as follows- agro processing, production and storage/warehouse; and not for others (marketing and consumption).

Drivers for mechanization

The reasons and advantages for using machines were identified in decreasing order of importance as more work done per unit time, less cost on labour and reduced boredom in operations.

Consumption

Adoption rates and sustainability of mechanization were obtained. Generally machines produced by individuals and organizations were not used by many others. However, the adoption of processing and preservation mechanization were highest and marketing the least in the entire zone.

Policy makers

The perception of policy makers such as the delegations of Small and Medium Sized Enterprises, Social Economy and Handicraft and Ministries of Agriculture and Rural Development and Technical and Vocational Training were recorded through the questionnaire and PRA interviews as follows:

- Technological development is a corner stone for long term economic and social development.
- There was need to promote mechanization in small farms in order to meet the challenges of second generation agriculture.
- Funding of science, research and technology will be given much more attention in the years ahead.
- A clear investment policy will soon be available to bolster technological development.
- Farmers need other resources such as adequate farm sizes in order to make use of machines efficiently.

10 machines were considered very important based on their potentials and are recommended for development (Tab. 2)

Table 2: Top ten Important machines.

S/N	Name of Machine	Inventor	Locality
1	Selector of cocoa waste	Ntui David	Muyuka
2	Retractable harvester	Njoh Justin	Kumba
3	Moringa leaf drier	Eku &Kids	Tombel
4	Palm nut separator	Ngannu Thomas	Mile 16-Buea
5	Plastic Recycler	Wam Elvis	Kumba
6	Poultry incubator	IRAD Tabot Julius	Ekona
7	Fish pellet drier	Eyabi George IRAD	Batoke –Limbe
8	Electric and solar fish drier	IRAD	Batoke –Limbe
9	Melon cracking machine	Ngannu Thomas	Mile 16-Buea
10	Maize tillage planter	Ndika Bright	Buea

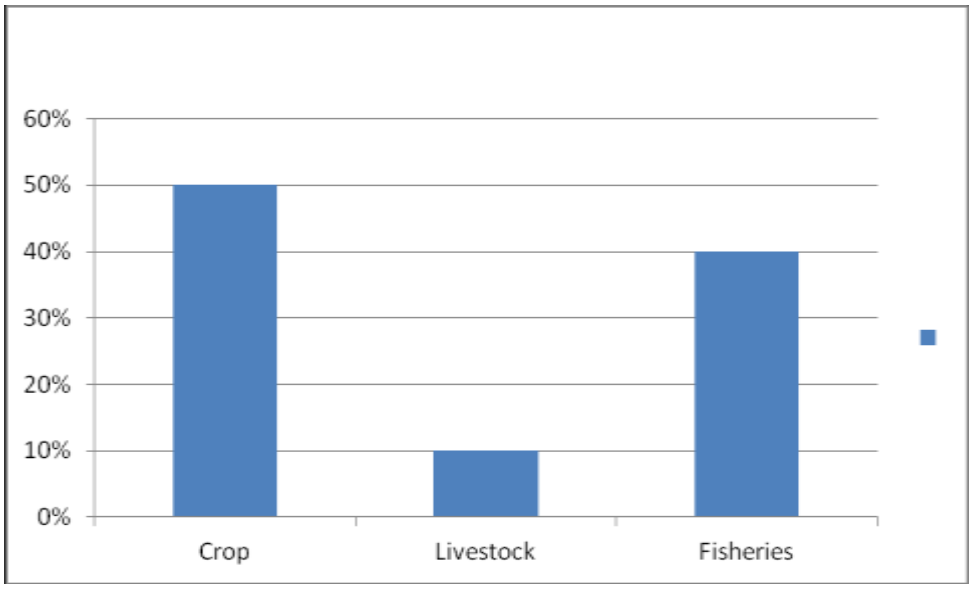


Fig. 1: Percentages of machines in the different value chain types.

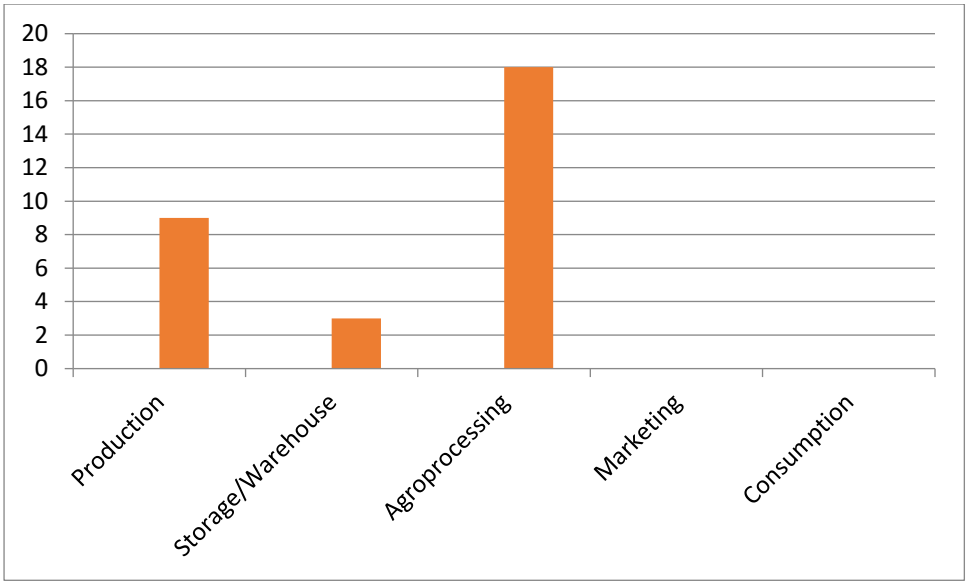


Figure 2: Number of machines in the different value chain functions

4. Conclusions & Recommendations

This study has given an insight on machines used by small farmers. A total of thirty machines were identified. Most of the machines (72%) were designed, sponsored, constructed or used by single organizations such as the Institute of Agricultural Research for development (IRAD). The adoption rate is low for most of the machines produced because these machines have a lot of shortcomings. These machines need to be developed in order to be useful to many stakeholders. Machines in certain value chain types and value chain functions have been more developed than others due to longevity in usage and the importance of the required products (e.g. cassava processing).

Machines produced by stakeholders in the sector are still rudimentary because of inadequate technical knowhow necessary to develop them. Inadequate education and commitment of policy makers has gravely militated against the growth of the agricultural mechanisation sub-sector. Funding for developing machines and investment on science and technological training are therefore prerequisites for the advancement in agricultural machinery.

From this study, it can also be inferred that funding of science, technology and innovation for making machines is still the responsibility of small holders and private investors.

Based on the above premises, to enable the agricultural mechanization for small farmers to develop, the following framework for action as well as practical steps can be taken:

- All stakeholders should come together to develop machines which will be useful to many actors.
- An innovation system should be created favouring networking of organizations within the small farmer mechanization sub-sector.
- It is strongly recommended that the state should not only formulate good policies for technological development but should also put in place the necessary implementing mechanisms.
- The state should invest in vocational education and funding of science, technology and innovation.

5. References

Field H.L., Johns (2007). *Introduction to Agricultural Engineering Technology. A Problem Solving Approach.* New York, NY Springer, ISBN 0387369139.

GESP (2009). Growth and Employment Strategy Paper. Reference Framework for Government Action Over the Period 2010-2020.

Johann M., G. Jaques, V.L. Milandré (2014). Functions of Science Granting Councils in Sub-Saharan Africa.

Njukeng J.N. P.M. Muenyi, B.K. Ngane, E.E Ehabe (2011). Ethephone Stimulation and Yield Response of Some Hevea Clones in the Humid Forest of South West Cameroon. International Journal of Agronomy Vol. 2011 art. I.D 257340 (eds) M. Tajada, 5p.

STI Act (2013). Science Technology and Innovation Act, Science, Technolgy and Innovation Systems in Sub-Saharan Africa, 2013, CESTII Report 2013.

6. Appendices

Appendix 6.1. Summary Inventory Small Farmer's Machines, actors involved, value chain, effects and drivers

S/N	*Innovator/ user*	*Name of Innovation*	*Actors*	*Role of actors*	*Value chain*	*Effect/ Difficulties*	*Drivers*	*Scale*
1	IRAD/ CARBAP, Njombe & Ekona	Propagator for the plantain pith multiplication technique.	IRAD/CARBAP,	Inventors of the technique and machine	Production	Positive effect. Much more planting materials, more food	Insufficient planting materials & availability of varieties limited	50 plantlets from one sucker. Cost 100000/100
			MINADER,	Facilitation, organizing farmers and extension				
			farming groups	Beneficiary end-users				
2	Mr. Njoh Justin	Retractable harvester	Njoh Justin	Designer and sponsor	Harvesting	Positive but requires better quality metals	Many people have died while climbing tall trees.	3000 trees monthly
3	Eku & Kids	Moringa leaf dryer	Eku and Kids	Initiator	Processing and preservation	Positive. Leaves can be dried in the rainy season.	Difficulties in drying leaves during the rainy season.	300 kg-500kg monthly
			BLACIG	Designer				
4	Eku &Kids	Moringa blender	BLACIG	Designer	blending leaves,	Positive.	Difficulty in	500 kg -700

					fruits and roots	Plant parts can be powdered	producing plant powder	kg monthly
5	*Wam Elvis*	*Wam's Plastic Recycling Plant*	*Self*		*Packaging and preservation*	*Positive*	*A lot of plastic waste that pollute the environment*	*100 kg recycled monthly*
6	*Ngannu Thomas*	*Egussi (melon) cracking Machine*	*Traders of melon, restaurants and individuals*	*Designer*	*Food processing*	*Positive*	*Cracking with the hands is difficult and takes much time*	*1000 cigarette cups monthly*
7	*Ngonde Blasius*	*Cocoa drying oven*	*Cocoa farmers*	*Designer and sponsor*	*Processing*	*Positive but consumes wood and produces smoke*	*Cocoa is harvested in the rainy season and cannot be dried in the sun.*	*Used by 10 farmers. Dry 30 -50 (100kg) bags yearly*
			Welder					
			Mat weaver					
			Carpenter					
8	*Ngonde blacius*	*Palm oil mill*	*Ngonde*	*Designer and sponsor*	*Processing*	*Positive but manual and small in size*	*Palm oil was produced by hands and legs*	*100 L monthly*
9	*Ngannu Thomas*	*Palm nut separator*	*Nganyu*	*Designer and sponsor*	*Processing*	*Positive but small in size*	*Separation was done with hands*	*250 kg monthly*
10	*Ntui David*	*Cocoa waste*	*Chocolate and*	*Designer and*	*Processing*	*Positive but*	*A lot of useful*	*50 bags of*

		converter	*manure producers*	*sponsor*		*there is loss of material in air.*	*product is abandoned in ovens and farms*	*manure and 5 bags of chocolate monthly*
11	*IRAD Ekona*	*Poultry incubator*	*IRAD*	*User*	*Hatching of eggs*	*positive*	*Many eggs can be hatched at same time*	*30000 eggs monthly*
12	*IRAD Ekona*	*Poultry incubator*	*Electrician Carpenter*	*Designer and user*	*Egg production*	*Positive*	*Able to hatch several egg without the layer*	*Used by researchers and students*
			IRAD	*Sponsor*				
			Dr. Etchu	*Designer/Researcher*				
13	*IRAD Batoke*	*Electric and solar energy drier*	*IRAD*	*Sponsor*	*Fish drying*	*Positive*	*Useful even when hydro or thermal electricity are absent*	
14	*IRAD Batoke*	*Aquarium*	*IRAD*	*Designer and sponsor*	*Fish production and esthetics*	*Positive*	*To increase fish production and beatification*	*150 fishes in a year*
			Electrical engineer	*Power supply*				
			carpenter	*Builder*				
			Mr. Eyabi	*Researcher*				
15	*IRAD Batoke*	*Local fish drier*	*IRAD*	*Designer and sponsor*	*Fish processing*	*Positive but needs a*	*Post harvest loses were*	*2 tons monthly*

						thermostat	*much*	
16	*IRAD Batoke*	*Local pellet dryer*	*IRAD*	*Designer and sponsor*	*Fish preservation*	*Positive but no thermostat*	*Post harvest losses*	*500 kg monthly*
17	*Fisher men*	*Fishing nets*	*Fisher men and boat owners*	*Setting of the nets*	*Fish production (catch)*	*Positive but setting is slow*	*Fish catching is faster*	*2 tons a month*
18	*Ekona CDC*	*Cassava grating*	*Ekona yard population*	*User*	*Transforms cassava*	*Positive but not wheeled*	*Produces cassava derivative foods*	*1ton monthly*
19	*Ntungwe Romanus*	*Cassava grating machine*	*Welder*		*Transforms cassava*	*positive*	*Fast in making cassava derivatives*	*13-50 persons daily*
			Electrician					
20	*Est. Djenizli/ Etone Martin*	*Multipurpose food processing*	*Est Djenizli*	*Inventor*	*Processes several food material- cassava, cocoyam, maize*	*positive*	*Fast in processing food stuffs*	*Used by 173 households*
			Etone martin	*Donor*				
			CIGs	*Users*				
21	*IRAD Ekona*	*Stalk pelleting mill*	*IRAD*	*User*	*Pelleting rabbit feed*	*positive*	*Produces feed in pellets*	*IRAD*
22	*IRAD Ekona*	*Pellet dryer*	*IRAD*	*User*	*Drying of pellet feed*	*Positive*	*Dries feed fast*	*IRAD*
23	*IRAD Ekona*	*Animal feed mixer*	*IRAD and local population*	*User*	*Mixes and blends fee*	*Positive*	*Compounds feed*	*1 ton monthly*
24	*MATABI*	*Sprayer*	*All crop producers*	*users*	*Herbicide and pesticide*	*Positive*	*Weeding and pesticide*	*As required by farmers*

					application		*application labour intensive*	
25	*IRAD Ekona*	*Kenyan top bar bee hive*	*All honey producers in Ekona*	*Builder and user*	*Production of honey*	*Positive*	*Monitoring of hives was not possible with the traditional hive.*	*5 litres in 4 months*
			Mr. Lenchi	*Builder*				
26	*IRAD Ekona*	*Bee harvesting smoker, suit and gloves*	*All honey producers*	*Users*	*Easy harvesting of honey*	*Positive*	*Bee stinging was common during harvesting*	
27	*IRAD*	*Corn thresher*	*IRAD*	*User*	*Removes seeds from the cob*	*Positive*	*Threshing is difficult by hand*	*2 tons monthly*
28	*IRAD Ekona*	*Vegetable seed producer*	*IRAD*	*Designer, sponsor and user*	*Removes seeds from seeds*	*Positive*	*Manual seed production takes much time*	*Used only by IRAD as required*
29	*IRA*	*Cassava grater*	*IRA*	*Designer*	*Processes cassava into foods*	*Positive*	*Fast food processing*	*20 constructed within the zone*
30	*Ndika Bright*	*Maize tillage planter*	*Gov't Technical High School*	*Designer& sponsor*	*Tills and plants maize*	*Needs to be developed*	*Tilling and planting tedious*	*Under constructio n*

6.2: Appendix 2: Photos of some machines

A stalk pellet mill. It is used for producing pellets of animal feed. It has a reservoir with an engine powered by electricity.

Pellet dryer. Used for drying pellets of animal feed. It is a wooden cupboard heated by electricity.

Feed mixer. Mixes different components of animal feed. It consists of a large cylindrical container, a collecting container and an engine and outlets.

An incubator. For hatching eggs of birds. It has trays containing eggs inserted in for hatching

A locally made bird egg incubator. It is a wooden box with an electrically heating component having a thermostat.

A Fish dryer. For drying fish. It is a wooden cupboard with two chambers- one heated by solar energy and the other by hydro electricity.

A melon cracker. It cracks melon seeds. It is a motorized metal box with a resevoire attached to it. The cracking component is found in a closed metal box.

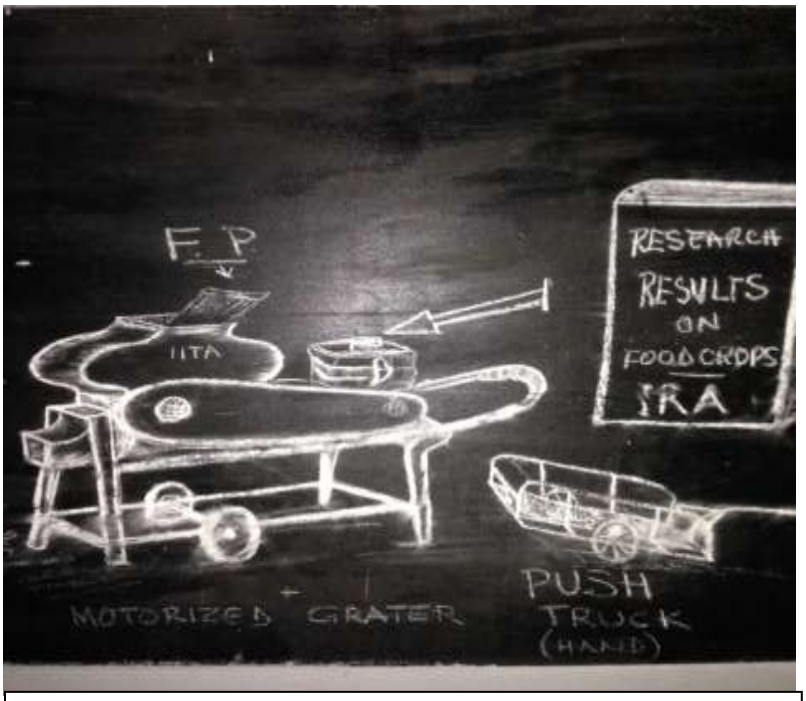
A low-cost non-mist propagator*. The base and lid are made of polythene sheets. This creates a greenhouse condition within the propagator. The base is underlain with a rooting medium made up of six-month old rotted sawdust to a depth of 15cm*. It is used for rooting cutting of plants including vines, e.g. *Gnetum* spp. It can be adapted for producing plantain plantlets..

A maize Tillage Planter.

Innovator, Mr. Ndika Bright interviewed by the Cameroon Radio and Television. It a machine to place the seeds on the seed bed without prior tillage. It is a Catarpillar planting tractor. Beneficiary of the 1st prize award during the Ministry of Scientific Research and Innovation open day in Buea in April 2016.

Knap-sack sprayer. It is designed to spray. It is composed of a liquid tank, a pressure pump, cap, mouth, a pressure valve, belt, hose, trigger and nozzle. It is carried on the back and is mostly used to apply pesticides, fertilizers and herbicides.

A vegetable seed extractor. Designed and produced by IRAD Ekona (Traditional African vegetable project). It consists of a reservoir a motor mounted on a metal frame. It is used for extracting seeds



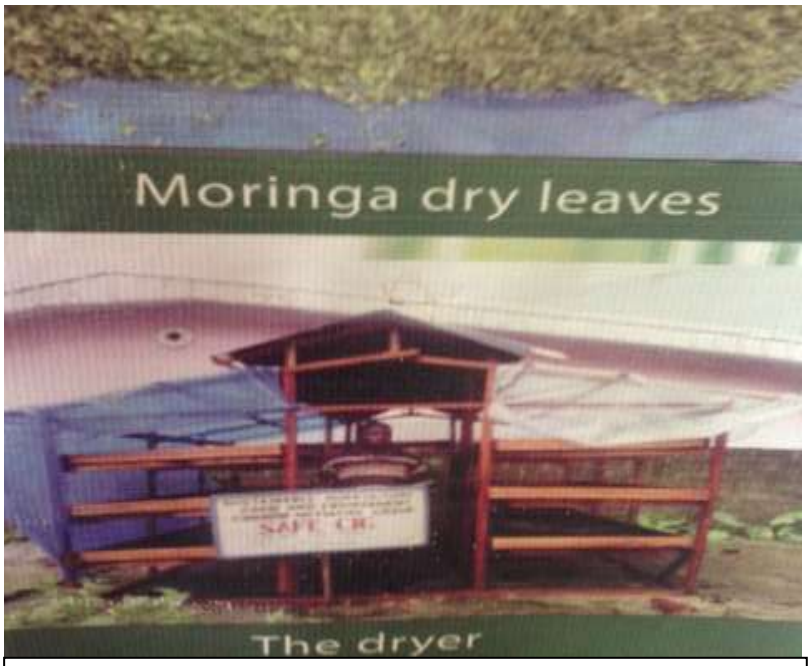
A motorized grater. Designed by (now IRAD) Ekona in 1985. It is designed to grate cassava for different variants of cassava foods ("water fufu, bobolo, garri, nkumkum and miondo")

Research results put into use. Grater in use in Tombel Town. It is wheeled and has an engine driven by petrol.

A multipurpose food processing machine. *It processes several foods stuff using different properties and parts. It has 3 components ,dry grinder, wet grinder and a grinder for spices. It is powered by thermal energy.*

A multipurpose grater without wheels

Cocoa oven. It is used for drying cocoa. It consists of concrete walls and a floor of metal rails supporting bamboo bars. It is heated by fuel wood charged in a fire place. The disadvantage is that it wastes wood and therefore not



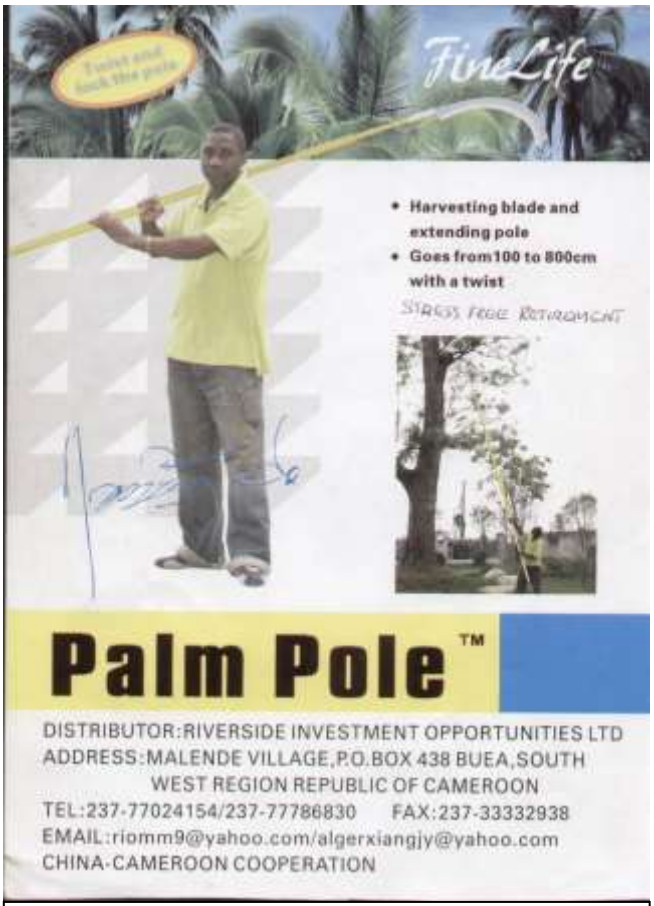
Moringa leaf dryer. Designed by Eku and Kids. Used for drying moringa leaves. It is a hut with a leather roof and polythene sheeting on the sides and floor. It has a wooden frame.

Moringa blender. Used for blending the leaves, roots and seeds of moringa. It has blades in a metal frame and is driven by electricity.

A plastic recycler. It has 5 major parts: an electric panel, a blower, an oven, a reactor and a manual thermometer.

A fish dryer. It consists of concrete walls and a fire place. The top has strong metal rods on which the fish is placed.

Preparing fishing nets. A big needle is used for weaving the edges of the net.



Harvesting pole. Mr. NJOH Justin carrying his

An aquarium. Used for growing some exotic species of fish for esthetics. It is a glass box, with rocklike substratum and an air pump.

Fish meal Pelleting machine . Used for pelleting fish feed. It has a reservoir, a grinder and a molder.

Cocoa "waste" converter: It converts residue from ovens into pure cocoa and separates it from the dirt which is converted into manure (organic fertilizer. It has blower that separates the dirt from the particles of

An oil palm hand mill. For processing palm oil. It consists of a pipe and a spiral press in a reservoir mounted on a metal stand. The press is activated by a wooden handle attached at the top of the spring.

A fish feed mixer. It mixes fish feed for pelleting. It has an engine driven by electricity

Fish pellet dryer. It is a wooden cupboard with filament bulbs for heating the different compartments.

A corn thresher: It is a wheeled hand truck with a rotating arm that removes the seeds.

Some bee farming equipment. Gloves, a knife and a smoker. These are protective against bee stinging.

***Kenyan Top bar beehive*:** It is used for bee farming. It is a wooden box on a stand of about 1m high. The cover is made up of small wooden bars covered with plastic sheeting.

Study 12

Impact of new method of extending semen for artificial insemination in cattle for small holder dairy cattle in Cameroon

Bayemi Henry

Introduction

Population growth and income growth in developing countries are fuelling a global increase in demand for food of animal origin. The resulting demand comes from changes in diets of billions of people and provides income growth opportunities for many of the rural poor. This demand cannot be satisfied by indigenous cattle breeds alone because of their long calving intervals, low productivity in beef and milk, standing only at 500 litres of milk/cow/lactation (Ebangi et al, 2004) which is relatively low when compared to crossbreds of Holstein and Jersey which under the same conditions produce 12 litres/cow/day. In order to benefit from the demand, farmers in developing countries should adapt to the new environment, which demands dissemination of technologies and changes of production systems to eliminate low productivity. The efficiency of a livestock value chain is largely dependent on reproduction (Bayemi, 2012). Artificial insemination (AI) was the first major biotechnology technique to be applied to improve reproduction and genetics of farm animals.

The success of artificial insemination largely depends on the quality of the semen and proper AI practices (Bayemi *et al*, 2010). However, this AI has been up to recently, dependent on the use of frozen semen in Cameroon, imported from developed countries, which has limited the extension of this technique to small scale farmers because of the very high cost of frozen semen (about $US 20 per litre). There is therefore the need to look for locally available, low cost technology that can be used to extend chilled semen for a longer duration. The main objective of this study was to evaluate the substitution of standard extender egg yolk with fruits in citrate extenders of bull semen.

Material and methods

Description of study site

The study was carried out at IRAD Regional Centre, Bambui found in the Western Highlands, another dairy producing region, is located in the mid and high altitude zone of the country which lies between latitudes 5°20' and 7° North and longitude 9°40' and 11°10' East of the Equator. The surface area of the North West Region is 17,910 km^2 covering 1/6 of the country's land area. Altitudes range from 300 to 3000 m above sea level. The climate is marked by a dry season from November to mid-March and a rainy season from mid-March to October. Rainfall ranges between 1300-3000 mm with a mean of 2000 mm. Minimum and maximum temperatures have means of 15.50°C and 24.5°C, respectively; although temperatures can go above 30°C. There are three types of soils: volcanic, hydromorphic and ferralitic. The human population is estimated at 1.82 million inhabitants, being one of the highest population densities in the country, with at least 79 inhabitants per km^2 and a population growth rate of 3.1% (Winrock International, 1992). The agricultural population is estimated at 72% with 160,025 farm families. Agricultural products from low to medium altitude include: oil palm, cocoa, Robusta coffee, fruit trees, cocoyam, maize, small livestock, rice, and groundnuts. The high altitude (above 1400m) products include: solanum potato, Arabica coffee, vegetable and

small and large ruminants (PNVRA, 2002).The province is the third major cattle producing area (500,000 cattle) after the North and the East. The main vegetation is Savannah. Pastures are dominant with *Sporobolus africanus*. But the following species can be encountered: *Pennisetum clandestinum* and *Pennisetum purpureum*, *Loudetia*, *Hyparrhenia*, *Urelytrum fasciculatun*, *Panicum phramitoides*, *Paspalum arbiculare*. Some improved species have also been introduced such as *Brachiaria* spp, *Trypsacum laxum*, *Stylosanthes* spp and tree legumes (Merlin et al 1986; Njoya et al 1999).

Animals and management

The bull was housed in the IRAD Bambui fattening shed and managed under a zero grazing system. The bull was cleaned once a week with soap and water and fed 4kg of a protein based concentrate and forage daily in its stall. Water was given ad libitum. It had all necessary vaccinations and was regularly dewormed and treated for ectoparasites.

Preparation of extenders

Sodium citrate salt was used as a buffer for the experimental extenders. In order to prepare the various extenders with different percentages of olive oil, 0.147g citrate salt (Sigma Aldrich), 0.00375g penicillin (Sigma Aldrich), and 0.00625g streptomycin (Sigma Aldrich) were weighed on an electronic precision balance and dissolved in 5ml distilled water. To each experimental buffer solution 1.25ml of an olive oil egg yolk ratio were added as follows; (0% olive oil/100% egg yolk, 25% olive oil/75% egg yolk, 50% olive oil/50% egg yolk, 75% olive oil/25% egg yolk and 100% olive oil/0% egg yolk). Extenders were prepared just before collection (Table 1). After the extenders had been thoroughly homogenized, an electronic pH meter (HANNA instruments; pH probes and HI 98150 GLP pH / ORP METER) was used to adjust the pH of each extender to 7.4 as recommended for citrate egg yolk buffer solutions. The solutions were then put in a water bath at 34.5°C pending semen collection.

a. Banana

The banana (*Musa sapientum)* was crushed and centrifuged two times 3500 rpm for 30 minutes. It resulting product was mixed with distilled water at 25/75% proportions (25% banana and 75% distilled water).

b. Soursop

Using a sterilized knife, the soursop *(Annona muricata* L*.)* was dissected and seeded using a clean sterile spoon, the flesh was removed, cut and mashed with the spoon in a dish and the juice was extracted. The extracted juice was collected into centrifuge tubes and centrifuged at 3000 rpm for 15 minutes. The supernatant from the first centrifugation was centrifuged again at 3000 rpm for 15 minutes.

c. Water melon

Water melon (*Citrullus lanatus) was* crushed and centrifuged two times 3500 rpm for 30 minutes, then diluted at 10% water melon and 90% distilled water.

d. Coconut milk

Coconut tree is a plant affiliated to the botanical family *Palmaceae*. Coconut milk was obtained from green premature Coconut fruits (*Cocos nucifera l.)* fruit. The water (termed milk) was extracted and stored in the freezer.

e. Fresh Raffia Palm sap

The raffia palm sap is the fluid obtained by tapping the inflorescence or succulent part of stem of raffia palm (*Raffia hookeri*). The centrifuged fresh palm wine was then boiled for 10 minutes, cooled to room temperature (18-22°C) and distributed into test tubes containing egg yolk and the buffer solution.

f. Tomato Juice

Two ripped and healthy tomato fruits of the *Solanaceae* family were washed with running tap water, sterilized with alcohol, cut, mashed with a spoon in a dish and the juice was extracted. The juice was collected into centrifuged tubes and centrifuged at 3000 rpm for 15 minutes. The supernatant from the first centrifugation was centrifuged again at 3000 rpm for 15 minutes.

g. Pawpaw Juice

Pawpaw (*Caricaceaes* family) juice was obtained from mature ripped fruits. A clean sterile spoon was used to gently grate the soft tissue of the pawpaw fruit into a clean dish. The fluid was then transferred into test tubes and centrifuged at 3000 rpm for 15 minutes. The supernatant from the first centrifugation was centrifuged again at 3000 rpm for 15 minutes. The supernatant resulting from the second centrifugation was collected into a clean 15 ml tube.

h. Soursop (*Annona muricata L.*) juice

A ripe and healthy soursop *(Annona muricata)* fruit was washed with running tape water and sterilized with alcohol. Using a sterilized knife, the soursop was dissected and seeded using a clean sterile spoon, the flesh was removed, cut and mashed with the spoon in a dish and the juice was extracted. The extracted juice was collected into centrifuge tubes and centrifuged at 3000 rpm for 15 minutes. The supernatant from the first centrifugation was centrifuged again at 3000 rpm for 15 minutes. The supernatant from the second centrifugation was collected into test tubes. The volume and the pH of the soursop *(Annona muricata)* juice (SJ) were measured and recorded and kept in a refrigerator at 4^0c until used for the experiment.

i. The control treatment

The control was the standard extender used at IRAD Bambui (Bayemi et al, 2010).

Semen collection, analysis and dilution

Semen was collected as stated by Bayemii et al (2010). The target of cell concentration of $30x10^6$ spermatozoa/ml of diluted semen was set. Here, it was considered that 30% of the spermatozoa are morphologically abnormal or dead and that one dose of diluted semen equals 1ml and contains 30 million spermatozoa. Sperm concentration was evaluated using a hemacytometer to be 'A' and that the total volume of semen collected to be 'Y'. Then the total volume of viable cells equals (0.7A) Y. The number of doses in the semen therefore equals (0.7A) Y/30 million. The volume of extender required therefore is [(0.7A)Y /30 million]-Y=B.

From this volume of extender required to dilute the entire volume of semen (B), we proceeded to obtain the volume of semen required for the 5ml and the 35 ml extenders as follows;

If the volume B is required for Y, then, for 5ml, (Y/B)5 ml of semen will be required for 35ml, (Y/B) 35 ml of semen will be needed.

The above calculation was being done to end up with a concentration of 30 million live cells/ ml of diluted sample because the pH of different dilutions will change at different rates as the cells produce lactic acid which changes this pH. The volume of semen required in each case was then pipetted and the semen extended with it.

Motility

Immediately after dilution, the individual and progressive motility of the spermatozoa were obtained by placing a drop of each diluted sample on a clean warmed slide covered with a cover slip and observed under light microscopy. These motility values were scored as percentages of the overall counted cells in the representative fields of view by identifying and counting 20 successive cells in this field. For the individual motility, the number of cells among these 20 counted that are in motion are noted and expressed as a percentage of the overall

counted while for the progressive motility, it was obtained by counting the number of cells that are in real progressive motion in any direction among the overall 20 counted then expressed as a percentage. A 20-fold dilution of this semen was then prepared with tap water, properly mixed, mounted on the hemacytometer then the live cells (light in color) were counted and noted. This water also served as a spermicidal solution because it disrupts the osmotic pressure stability of the sperm cells thereby killing or attenuating them (Ghalsasi, 2004). This facilitates fixation on the hemacytometer.

The samples in the 5 tubes were then corked, put in plastic cups containing warm water from the water bath into the refrigerator at 5ºC. On a daily basis, 75µl of each sample was being pipetted into 5 other empty tubes in the water bath from which the post-thaw individual and progressive motility and Live cell concentration readings were being gotten as earlier discussed after thawing for about 3 minutes. This procedure of monitoring was carried out until all the cells in each sample die (point of zero motility).

Statistical analyses

The effects of treatments, level of replacement of egg yolk, replicate and time (days) were evaluated using the general linear model (GLM) procedure of Statistical Analysis Systems (SAS 2002). The data was first adjusted using an angular transformation into arcsine (Ibrahim, 1998; Yadolah, 2008). Untransformed data have been reported in the results for clarity of interpretation. The Duncan Multiple Range test was used to separate means and level of significance was considered significant at $P < 0.05$.

Results and discussions

Coconut milk (43.4%) and pawpaw juice (41.25%) led to the highest number of progressively motile sperms ($P< 0.05$) without evidence of difference between them ($P > 0.05$). They were followed by tomato Juice (40.35%), fresh raffia palm sap (40.40). Substitution of egg yolk at 75% had highest individual motility while total substitution (100%) had the lowest ($P<0.0001$). Meanwhile 50% and 75% substitution led to similar sperm progressive motility ($P>0.05$). Sperms retained 70% motility up to 15 days with coconut milk, 14 days with pawpaw juice, 14 days with fresh raffia sap and 13 days with tomato juice. In the egg yolk treatment control, the drop below 70% was after the 4th day. Room temperature semen could be used only within one day in all treatments. Fruits extenders performed better than egg yolk extenders, thus showing the beneficial effects of fruits in improving sperm motility.

On the other hand there was a statistical significant increase ($p<0.0001$) in Soursop juice in the progressive motility (PM) and plasma membrane integrity (PMI) of the treatment with 50% SJ although no statistical difference was noticed in the pH of extenders. PM and the percentage of sperm cells with intact plasma membrane decreased steadily from the first day of the experiment to the end when the evaluated semen parameters died down to zero. Also, sperm cells showed motility of 50.78% 9days after extension in 50% SJ while on the day 9 sperm cells of other extenders had their progressive motility under 50%. Similar results were obtained for PMI with 50.78% of sperm cells having intact plasma membrane 9days after extension in 50% SJ while PMI of cells in the other extenders were below 50%. All the extenders seemingly maintained a similar pH trend throughout the period of storage. However the pH in the 50% SJ extender had the best pH closest to 7 during the experimental period.

Egg yolk extender containing 50% of soursop juice gave the best result for both progressive motility, plasma membrane integrity. Just like in other works done by Ekaluo et *al.,* (2013), soursop fruit extract mitigated the caffeine-induced toxicity on weightof testes and epididymes,

sperm motility, sperm count andsperm head abnormality. Ekaluo et *al.,* (2013) suggested that the mitigating effect of soursop fruit extractcould be attributed to its rich vitamin C content. Pamplona-Roger, 2005; El-Sokkaiy and Awadalla, 2011;and Al-Amoudi, 2012 equally reported results which agree with those of Ekaluo et al 2013 on the protective role of vitamin C. Enzymes like, catalase, and peroxidase have been detected in soursop pulp (Neela and Alexender, 2009). The presence of catalase and peroxidase in the soursop fruit which like vitamin C are powerful antioxidants could be responsible for the increase in the progressive motility and the plasma membrane integrity observed with the egg yolk extender substituted with 25% and 50% of soursop juice.

Conclusion

Results from these experiments suggest that the substitution of 50% of egg yolk by soursop juice could be adopted in chilled semen extender due to its beneficial properties on chilled bull semen parameters. In Cameroon where eggs are relatively more expensive, extenders may adequately be made with tropical fruits. However more studies need to be carried out on avoiding the sharp fall in motility 2 weeks after extension, on chemical concentrations and used fruits and in fertility of sperms kept for 15-21 days in these conditions.

References

Bayemi P.H., 2012. Science and technology for livestock value chain development: a focus on artificial insemination. CTA feature article. Kowledge for development. http://knowledge.cta.int/en/Dossiers/CTA-and-S-T/Selected-publications/Science-and-Technology-for-Livestock-Value-Chain-Development-A-Focus-on-Artificial-Insemination

Bayemi P.H., Leinyuy I., Nsongka V.M., Webb E.,C., Ebangi A.L., 2010. Viability of cattle sperm under different storage conditions in Cameroon. *Tropical Animal Health and production.* DOI 10.1007/S11250-010-9637-8.

Ebangi, A.L.,Tawah, C.L., Mbah, D.A., Tanya, V.N.,Ndi, C., Ekue,F.N., Messine, O., Ottou, J.B.B., Enoh., M.B., 2004. Mortalities amongst different genotypes of crossbred dairy calves in a tropical environment. Journal of the Cameroon Academy of Science vol. 1, No. 2: 117–124.

Ekaluo U.B., E.V. Ikpeme, Y.B. Ibiang and F.O. Omordia, 2013. Effect of Soursop *(Annona muricata* L.) Fruit Extract on Sperm Toxicity Induced by Caffeine in Albino RatsJournal of Medical Science, 13 (1): 67-71.

Ekaluo U.B., E.V. Ikpeme, Y.B. Ibiang and F.O. Omordia, 2013. Effect of Soursop *(Annona muricata* L.) Fruit Extract on Sperm Toxicity Induced by Caffeine in Albino RatsJournal of Medical Science, 13 (1): 67-71.

Ibrahim H. 1998. Small Ruminant Production Techniques. ILRI Manual 3. ILRI (International Livestock Research Institute), Nairobi, Kenya. 207 pp.

Merlin P, Tsangueu P and Rousvoal D ,1987 Seasonal dynamics of the infestation of cattle by ticks (Ixodoidea) on the Western high plateaus of Cameroon. II. Traditional extensive stockfarms. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, Volume 40, Numéro 2, pp133-140

Neela Badrie, Alexander G. Schauss, 2009. Soursop (Annona muricata L.): Composition, Nutritional Value, Medicinal Uses, and Toxicology. In: Ronald Ross Watson and Victor

R. Preedy, editors, Bioactive Foods in Promoting Health. Oxford: Academic Press, pp. 621-643.

Njoya A, Mbanya N J, Nguemdjom A, Kamga P, Ndi C, Kameni A and Nfi A ,1999 Cattle productivity on smallholder farms in the western highlands of Cameroon. In Development of feed supplementation strategies for improving the productivity of dairy cattle on small holder farms in Africa. Proceedings of Research Coordination of a Coordinated Research Project organized by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture held in Vienna, Austria, 7-11 September1998

PNVRA (National Agricultural Extension and Research Programme), 2002 Preparation of the farming season 2002 PNVRA in a flash, PNVRA/NAERP/NWP, Bamenda, Cameroon

SAS/STAT, 2002, Statistical Analyses System (8th ed., Volume 2). Cary NC: SAS Institute Inc.

Winrock International, 1992. Animal Agriculture in the Sub Saharan Africa. University of California, Davis, CA: Institute of Agricultural Development. 162 pp.

Yadolah Dodge, 2008. The Concise Encyclopedia of Statistics. University of Neuchâtel, Switzerland. Springer reference, 612pp.

Study 13

Intensification of pelleted feed from local Feed resources/ Agro-industrial by products for efficient and sustainable poultry production in major production zones (West, Center, & Northwest) of Cameroon

Etchu Kingsely Agbor

Introduction

Processing of manioc produces large quantities of waste and is generally considered to contribute significantly to environmental pollution (FAO, 2001). A cassava starch production unit processing 100 tons of tubers per day has a production of 47 tons of fresh by-products, which can cause environmental problems when left in the vicinity of plant treatment or negligently disposed of (Aro et al., 2010). In Nigeria, for example, cassava waste is generally left to rot or burned to create space for the accumulation of even more heaps. The clusters emit carbon dioxide and produce a strong offen sive odor (Aro et al., 2010; Adebayo 2008). Cassava peels (large quantities of cyanogenic glucosides) and corks (large amounts of biodegradable organic matter) can cause surface water pollution, especially if stored in the rain or simply thrown into surface waters (Pandey et al. (2000), Cereda et al., 1996, Barana et al., 2000).
The variability of rice bran, and in particular its fiber content, has a very high effect on its nutritional value for poultry (Widyobroto 1989. High-lysine rice bran and the content of methionine (Tsvetanov et al ., 1990 and good availability Mn (65%) () Fialho et al., 1993).
Cameroon, like many African countries, is experiencing significant population growth. Ensuring food security depends on intensifying livestock production in general and poultry production in particular (Teguia et al., 2004). However, this sector faces several constraints, as is the high cost of the ingredients used in the rations. These ingredients account for approximately 60-70% of the cost of poultry production.
Hence the study of the effect of cassava peels and rice bran on the growth performance of finely brown chickens.

Literature Review

Cassava peels

Cassava peels can be used for feeding poultry after sun drying, so processed peels contain HCN levels that are acceptable for poultry (Osei et al., 1989; Nwokoro et al., 2005b). The method of fermentation of cassava peels has been tested by several authors, whether to lower HCN or fiber content (Osei et al., 1988) or to increase the crude protein content (Buitrago 1990), but the results do not Are inconclusive.
In some experiments, growth performance was maintained with flesh diets containing up to 15% meal cassava peels (Osei et al., 1988, Osei 1992, Nwokoro et al., 2005b). Food intake is generally not very affected, but depends on the formulation of foods (isoenergetic diets or not). However, in some performance experiments decreased by 5% of peel manioc flour in diets (Egbunike et al., 2009, Osei et al., 1989). This may be due in part to problems in food formulation as it is proven that performance degrades with insufficient inclusion of proteins (Egbunike et al., 2009). There may be an advantage in feeding fresh cassava peels to slow-

growing chickens (Ogbonna et al., 2000). The recommendation of broiler chickens is to limit the incorporation of cassava meal peels to 5-10% depending on its quality, with a suitable feed formulation. Higher levels of cassava meal peels might be required to slow down the growing chicken, or in situations where depression in growth performance is counterbalanced by a lower feed cost

Rice bran

In broiler chickens, rice bran can become rancid and reduce the growth and stability of meat lipids (Chae et al., 2002). It is suggested that it be included at relatively low levels (up to 15% only) in broiler chickens diets (Vieira et al., 2007, Shin et al., 2004, Gallinger et al., 2004;). Higher levels may result in poor calcification (Aruna Tomar et al., 1999). Decreased food consumption and increased mortality can occur with more than 80% inclusion (Carrion et al., 1989). In order to mitigate the adverse effects of phytate, enzyme inhibitor and oxidative rancidity as well as high fiber content, enzymes such as phytase, xylanase or lipase can be added to the rice bran, allowing To include higher levels of rice bran in the broiler chicken diet and resulting in better performance of the animal.

Technological treatments can alter the nutritional value of rice bran for broiler chickens. Heating decreased nutritional value (Vali et al., 1989), but cooking by extrusion of rice makes its possible inclusion at 20% (Mujahid et al., 2003). Combinations of rice bran with other fillers may be beneficial for broiler chickens: 10% rice bran + 5% palm oil yielded results comparable to those of commercial concentrates (Ibiyo et al. 2005). Rice bran and meal peanut blends gave higher gross margins than corn soy meal diets (Khalil et al., 1997). Rumen liqueur can also be added to the rice bran to solubilize P content in phytates (Pujaningsih, 2004), which makes P supplementation decreased possible. Although rice bran does not compare favorably with maize (Gupta et al., 1988), it can replace up to 25% of maize in food and be economically efficient (El-Full et al., 2000).).

PROBLEM

In poultry farming, the cost of food accounts for about 70% of the cost of production.
Lower production costs would mean finding new sources of low-cost, abundant, local and available food.

HYPOTHESIS

The use of cassava bark and rice bran as an alternative source of energy would improve the growth performance of finely brown chickens

This activity has the under listed as general and specific objectives.

General objective: Intensify the use of rice bran and cassava peels for efficient and sustainable broiler production.

Specific objective

- To increase the use of agro-industrial by-products (rice bran and cassava peels) for good quality broiler production.
- Reduce environmental pollution through careless dumping of the rice bran and cassava peels following rice and cassava processing.
- To improve on the income of the rural farmer and strengthen the capacity of poultry farmers.

Material and Methods

Collection of the feed samples (ingredients) :

Rice Bran and Dried Cassava Peels were collected from Ndop and Mbalmayo respectively. The rice bran is a major by-product of the rice factory managed by UNDVA program. It produces over 15.000 tons of rice bran per anum. The Dried cassava peels were collected from an Innovation Platform group whose one activity is cassava processing. The rice bran and dried cassava peels were futher dried to minimum moisture less than 4% and analysed for their proximate nutritive content.

Study Site

The study was carried out at the experimental farm of the Agricultural Research Institute for Development (IRAD) in Nkolbisson, in the western suburbs of Yaoundé, a forest region in central Cameroon. This center is located at 3 ° 86 of Longitude North and 11 ° 5 of Latitude East. This agro-ecological zone is characterized by an average temperature varying between 23 and 25 ° C, a bimodal rainfall of 1500 to 2500 mm / year and a relative humidity ranging between 70 and 90%. The climate is of the subequatorial type marked by four seasons (2 dry seasons and 2 seasons of rain) (Ekalle et al., 2015).

Animals, experimental rations and experimental design

A total of 258 chickens of arbor acre stature aged 30 days and weighing an average of 639 g were distributed in 3 treatments of 28 chickens each. The chickens were housed in groups of 3 in boxes, which made 3 experimental units per treatment. They were reared on deep litter at a density of 10 chickens / m2. Each of the experimental rations T0 (free from rice bran and cassava bark), T1 (containing 5% rice bran) and T2 (containing 4% cassava bark) were assigned to these experimental units Completely randomized (Table I). The test was completed when the chickens were 46 days old. Food and water were served ad libitum.

Data collection on the performance of the performance of the animals

Data was collected on performance indicators such as feed intake, growth rate, from which feed efficiency and feed conversion ratrion will be collected ; mortality and cost efficiency.

based Ration

Table 1. Proximate composition of Dried cassava peel and Rice bran (% dry weight).

Sample	Ash	Moisture	Protein	Fat	Crude fibre	Carbohydrate

Cassava peels	$9.82^{b} \pm 0.4$	$90.01^{c} \pm 0.3$	$18.49^{c} \pm 0.1$	$3.43^{a} \pm 0.4$	$6.5^{a} \pm 0.2$	3160.3
Rice bran	7.76 ± 04	90.33 ± 02	18.95 ± 03	4.42 ± 02	6.84 ± 04	3268.1

Values with the same alphabet along the same column are not significantly different (P > 0.05).
Values are mean ± S.E (n = 3).

1. Formulation of rations

Table 2: Formulated Rations for the study using rice bran and dried cassava peels as energy substitute for maize

Feed formulation for the trial			
Ingredient/ Level of inclusion	To	T1- PRB	T2 - PDCP
Maïs	55.68	51,68	52,68
Rice Bran (9% Maize)	**0**	**5**	**0**
Dried Cassava peels (7.2% Maize)	**0**	**0**	**4**
Tourteau de soja	22	23	23
Tourteaud'arachide	7	7	7
Farine de poisson	5	5	5
Coquillage	2	2	2
Os	1	1	1
Méthionine	0,15	0,15	0,15
Lysine	0,15	0,15	0,15
CMAV 5%[1]	5	5	5
Sulfate de fer	0,02	0,02	0,02
TOTALS	98	100	100
CP - %	21.45	21.82	21.84
Energy – K.Cal/g	2834	2808	2772
Number of birds/ Replicates	60 (20x3)	60 (20x3)	60 (20x3)

Data collection and analysis

-Feed consumption

The previously weighed feed was distributed to the birds and at the end of each week, the remains were weighed. Weekly food consumption was assessed by distinguishing between the quantities served and the rejections collected in each experimental unit.

-

Live weight and weight gain

At the beginning of the test and every 7 days thereafter, the chicks from each experimental unit were weighed. The weekly weight gain was obtained by making the difference between 2 consecutive weekly weights.

-

Consumption index (I.C.)

The consumption index was obtained by comparing the amount of food consumed and the

weight gain during the same week:

$$\text{I.C.} = \frac{\text{Amount of feed consumed per animal (g)}}{\text{Average weekly gain. (G).}}$$

Results and discussion

Food consumption:

In general, food consumption has been affected significantly by the different treatments, but it appears to be higher in T2. Animals fed T2 food consumed more food than those subjected to T0 and T1 treatment. This high consumption could be due to the fact that the 4% level of skin incorporation was far from the incorporation limits obtained by Nwokoro et al. , 2005b; Which was 15%. More interesting results have been obtained with the feeding of fresh cassava peels to slow-growing chickens (Ogbonna et al., 2000).

Live weight:

The final weight of chickens fed by the control treatment is higher than the chicks fed by the T1 and T2 test treatments. This would mean that cassava peels and rice bran would lead to a decrease in weight gain during growth with respect to the control.

Weight gain: weight gain is higher ($P > 0.05$) for animals that consumed the food T0 control

Consumption Index

CI is higher in animals fed T1 and T2. This higher consumption index is due to the high feed consumption of T1 and T2 treatments and the low weight gain of the animals fed with the granulated feed. These results corroborate those of Egbunike et al. , 2009 which observed a decrease in growth performance has for a diet 5% rate of incorporation of manioc peel flour. In broiler chickens, rice bran can become rancid and reduce the growth and stability of meat lipids (Chae et al., 2002). However, in contrast to authors such as El-Full et al., 2000, which states that rice bran can replace up to 25% of maize in the diet and be economically effective in broiler chickens.

Recommendation

Though the cassava peels used were not too friendly on the performance of the animals due to poor processing me thod. However, for subsequent and effective usage, the cassava peels should come from good and edible variety of cassava, which upon peeling should be washed and dried to minimum moisture (less than 4%) and included up to 15 – 25% in the finisher diet.

Conclusion

At the end of this study, which evaluated the effect of cassava peels and rice bran on the performance of finished broiler chickens, it was found that: The cassava and rice husk peels can substitute maize as energy source for sustainable broiler production. Their energy levels are comparable to that of maize. However, higher levels above 15% except fermented, would lead to a decrease in the performance of Broiler growths in the respective finishes.

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References

Adebayo, AO, 2008. L'utilisation des déchets de manioc pour élever des chèvres. Projet de 2008 à 4345. Marché du développement de la Banque mondiale

Aro, SO; Aletor, VA; Tewe, OO; Agbede, JO, 2010. potentiels nutritionnels de manioc déchets de tubercules: Une étude d'une usine de traitement de manioc amidon dans le sud-ouest du Nigeria cas. Livest. Res. Rural Dev., 22 (11

Aruna Tomar; Singh, KS, 1999. Fémur minéralisation osseuse chez les poulets nourris d'au son de riz. Indian J. Poult. Sci, 34 (3): 332-336

Barana, AC; Cereda, MP, 2000. Cassava eaux usées (manipueira) traitement à l'aide d'un anaérobie biodigestor deux phases. Ciencia e Tecnologia de Alimentos, 20 (2)

Buitrago, JA, 1990. L'utilisation du manioc dans l'alimentation des animaux. Centro Internacional de Agricultura Tropical (CIAT), Cali (Colombie), 446 p.

Carrion, JG; Lopez, J., 1989. Le total du son de riz comme un substitut pour le maïs dans l'alimentation des poulets de chair. 2. Carcass le rendement et la composition chimique. Rev. Soc. Bras. . Zootec, 18 (4): 327-333

Cereda, MP; Takahashi, M., 1996. Cassava déchets: leur caractérisation et l'utilisation et le traitement au Brésil. Dans: Dufour, D .; O'Brien, GM; Best, la farine et de l'amidon de manioc R.: progrès dans la recherche et le développement CIAT publication, n ° 271. CIAT

Chae, BJ; Lee, KH; Lee, SK, 2002. Les effets de l'alimentation rance son de riz sur les performances de croissance et de la qualité de la viande de poulet du poulet de chair. Asian-Aust. J. Anim. Sci, 15 (2):. 266-273

Egbunike, GN; Agiang, EA; Owosibo, AO; Fatufe, AA, 2009. Effet de la protéine sur la performance et l'hématologie des poulets nourris d'écorces de manioc. Cambre. Zootec, 58:. 655-662

Ekalle N. M., Mongo B.G.1, Ghomsi M.O.S., Tientcheu B.L., Tchakounte J., Hakoue F., Leinyuy I., Bayemi P.H. (2015) Substitution of Groundnut Cake with Palm Kernel Cake on the Growth Performance of Broilers, Jacobs Journal of Agriculture, Accepted: 09-13-2015

El-Full, EA; Asker, AEN; Ali, MMM; Abdel Wahed, HM; Omar, EM, 2000. L'utilisation de son de riz en chair et couche alimentation en référence à l'enzyme supplémentation. Poult égyptienne. Sci. J., 20 (3): 517-543

FAO, 2001. L'évaluation environnementale stratégique. Une évaluation de l'impact de la production et de la transformation du manioc sur l'environnement et la biodiversité. Actes du forum de validation sur la stratégie mondiale de développement du manioc, Volume 5. FAO, Rome, 26-28 Avril 2000

Fialho, FB; Lopez, J.; Bellaver, C., 1993. Effet des niveaux de son de riz et de manganèse sur les caractéristiques de performance et de l'os chez les poulets de chair. Rev. Soc. Bras. . Zootec, 22 (5): 830-838

Gallinger, CI; Suarez, DM; Irazusta, A., 2004. Les effets de son de riz inclusion sur la performance et la minéralisation osseuse chez les poulets de chair. J. Appl. Poult. Res, 13 (2):. 183-190

Gupta, JJ; Singh, KS, 1988. Effet de l'autoclavage alimentaire du son et des huiles de riz sur leur valeur alimentaire dans les régimes de poulets de chair. Indian J. Poult. Sci, 23 (1):. 29-34

Ibiyo, OVM; Atteh, JO, 2005. Réponse des poulets de chair de démarrage à des régimes alimentaires contenant des niveaux gradués de son de riz avec ou sans huile de palme. Nigerian J. Anim. . Prod, 32 (1-2): 39-45

Kratzer, FH; Earl, L.; Chiaravanont, C., 1974. Facteurs influençant la valeur alimentaire de son de riz pour les poulets. Poult. Sei., 53 (5): 1795-1800

Nwokoro, SO; Ekhosuehi, assurance-emploi, 2005. Effet de remplacement du maïs avec pelures de manioc dans l'alimentation des coquelets sur les caractéristiques de performance et de carcasse. Trop. Anim. . Santé Prod, 37 (6): 495-501

Ogbonna, JV; Dredein, AO, 2000. Effet de l'alimentation humide sur la performance des poussins d'un coq. Trop. Agric. (Trinidad), 77 (4): 262-264

Study 14

An Assessment Of Poultry Processing In Local Markets In The South West And Centre Regions Of Cameroon

Precilla Tatah Ijang, Tabot Julius Enow & Musongong Sirri Bella

Introduction

Poultry is one of the fastest growing sectors in agriculture in Cameroon. Interest in poultry farming has increased because of increasing urbanization, change in diets of urban dwellers and potentials as a source of income for many. This is particularly true for women, who have been empowered by many non-governmental organizations to start small businesses directed towards improving livelihoods. The increasing number of fast food centers in urban and peri-urban areas has made demand for chicken and eggs to be very high. However, current production rates are not able to meet demand.

Considering the important role of poultry in the economy of Cameroon, strategies have to be put in place to promote local production through research, training and outreach. Areas where intervention is required are production of high-quality and low-cost nutrition, housing, production of parent stock and day old chicks, production of new breeds that combine desirable characteristics of exotic and local breeds and capacity building of poultry famers.

Diseases, poor management, insufficient breeding, nutrition are seen as major components affecting rural poultry production. As the standard of living rises, the demand for eggs and poultry meat becomes substantial and most people cannot raise their own poultry (Etchu 2004). Therefore it becomes more necessary to pay more attention to the poultry industry through better management, the use of high producing breeds, good fencing, housing, protection from bad weather conditions and careful marketing. Increasing outbreak of diseases, high mortality, lack of capital, poor quality nutrition, lack of day old chicks and good parental stock have played negatively in the poultry industry, which was previously plagued by the bird flu virus.

There is awareness about good practices to reduce contact and spread of pathogens between birds. Never the less, biosecurity is still very weak and requires improvement at all levels.Many markets have processing points where birds are slaughtered. Theoretically, this facility is recommended to reduce contact between public and birds provided the processing is done under proper and hygienic conditions unfortunately, this is never the case. FAO (2008)

Birds processing involves several steps: pre-slaughtering management, slaughtering, hot water body temperature, de-feathering, evisceration and packaging of the final product.

Pre-slaughtering involves the withdrawal of feed 8-12hrs before slaughtering a practice which is never carried out. Slaughtering is usually carried out without any form of protective clothing. Other protective materials, such as overalls rubber aprons rubber hand gloves rubber boots are never used. Tools are only occasionally cleaned at the end of the day. The washing of hands after slaughtering is done irregularly; eventually at the end of the day. Hands are never disinfected.

It is for these reasons that this survey aims at gathering information on the processing of poultry in the local markets, their problems and their access to solutions to these problems to improve on the biosecurity at all levels in the local markets in South-West and Centre regions of Cameroon.

Materials and Methods

- A list of local markets and people to contact in the South-West and Centre regions of Cameroon were prepared.
  - South-West Region:
    Mamfe, kumba, Muyuka, Mutengene, Muea and Buea Central market.
  - Centre Region
    Mokolo, Nkolbisson, Mendong and Yaoundé central market
- Questionnaire and a check list for biosecurity in the local markets were administered, a total of 50 in each region.
- Photographs were taken and observations made in each local markets.

Photo 1: Poultry markets:

Buea

Mamfe

Kumba

Muyuka

Photo 2: Processing points in the local markets


Photo 3: Processing of birds in the local markets

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Photo 4: Storage of processed birds in the local markets

Data analysis

All data collected were computed into a data sheet analysed using descriptive statistics and the software SPSS version 17.0

Results and Discussion

Most of the poultry marketers in the local markets in the regions are males with a percentage of 51.1 % and 66.7% fall within the age range of 21-40 years.

Their source of income come from sales of poultry products 53.3%, slaughtering of birds 2.2%, and others (farming, loans and family support) 35.6%.

The average price per bird's ranges between 2500- 5000FCFA 55.6%, 5100-7000FCFA 13.3% and 7000 +FCFA 31.1% where 62.2% sales are done all year round and 37.8% seasonally. Most of the unsold birds 80% are usually taken home 2.2%, left in the markets, 6.7% slaughtered and freeze and 11.1% at giveaway price.

The offal, 73.3% are dumped at the site ,13.3% gathered and buried at home 4.4 % sold and 8.9% others (deposited at the streams and remained at the sales points).

The sanitary and health disposal put in place are; no slaughtering near the cages 8.9%, cleaning and washing after the market 60% ,wearing of mask 15.6% and others (dumping of waste into the refuse can and burning of death birds)

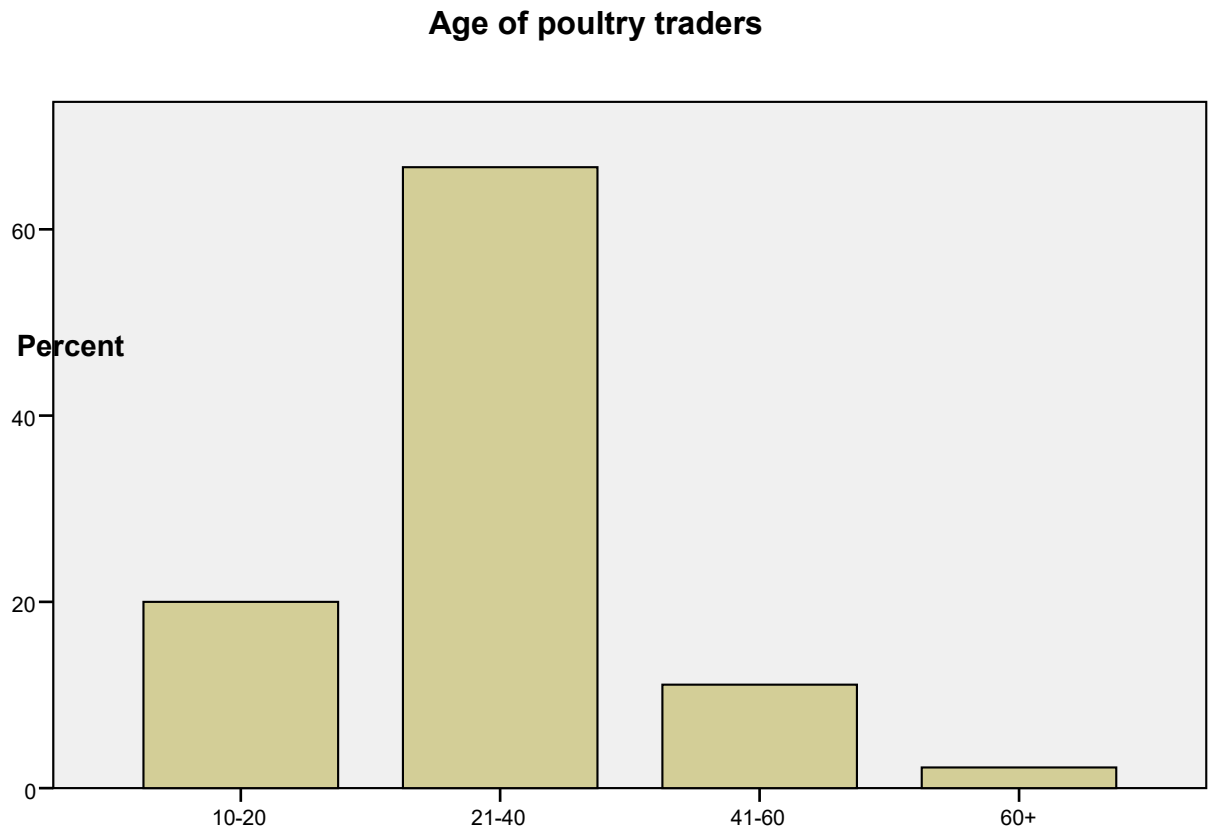


Figure 1. Age of poultry traders in the local markets

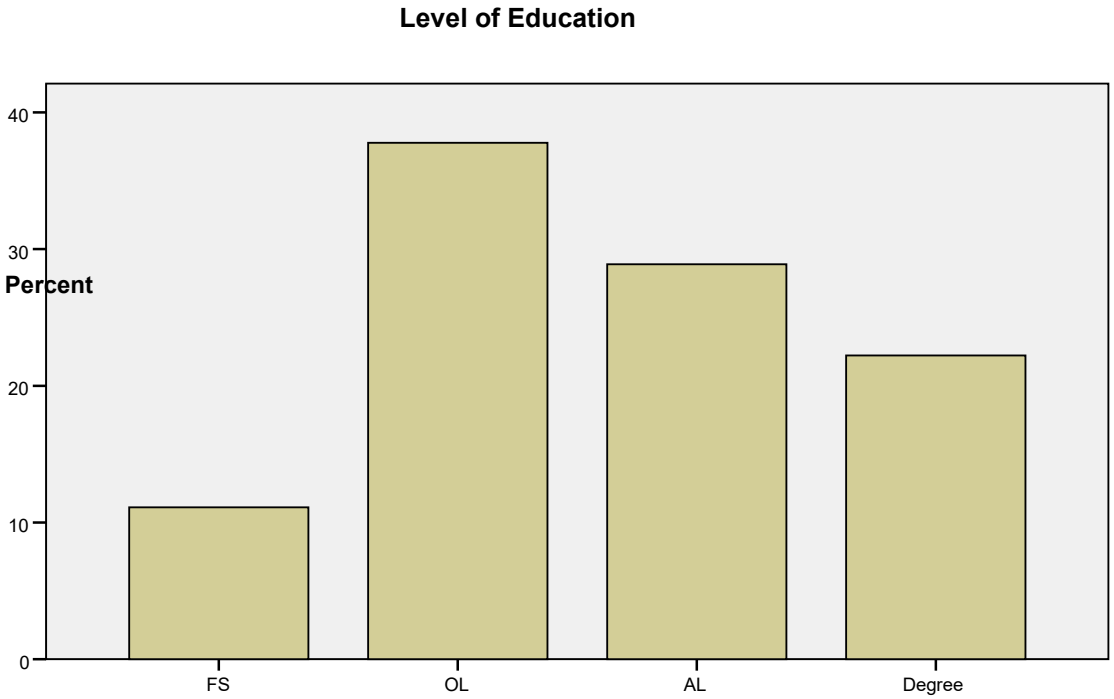


Figure 2. Level of Education of poultry traders

Figure 3. Major income sources of poultry traders

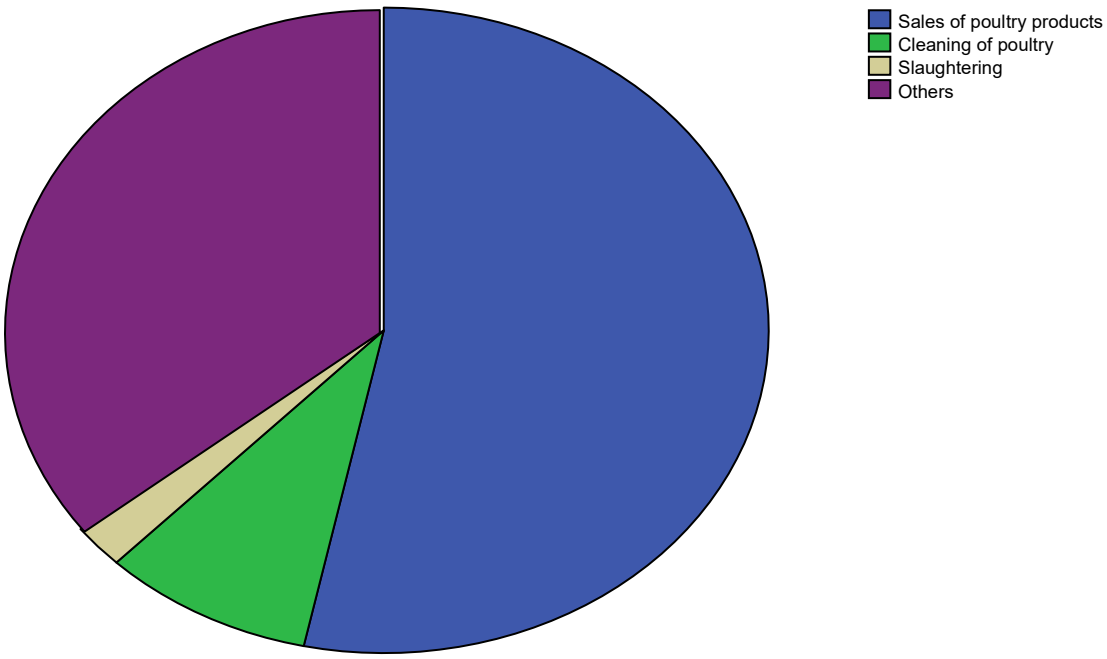


Figure 4. Segment poultry traders in the local markets serve

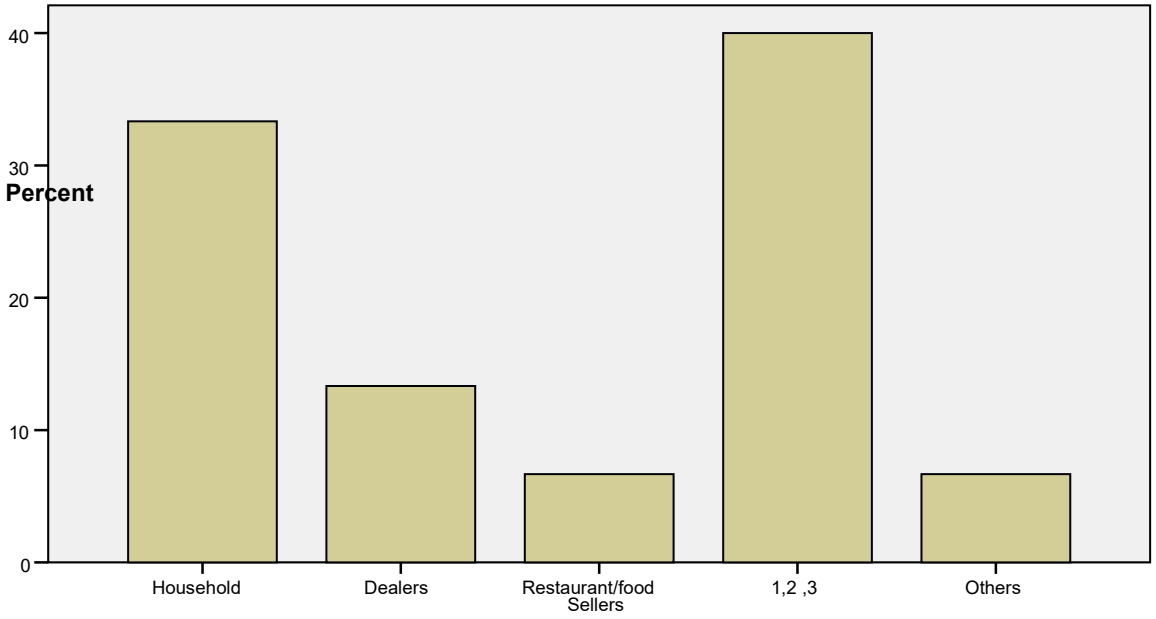
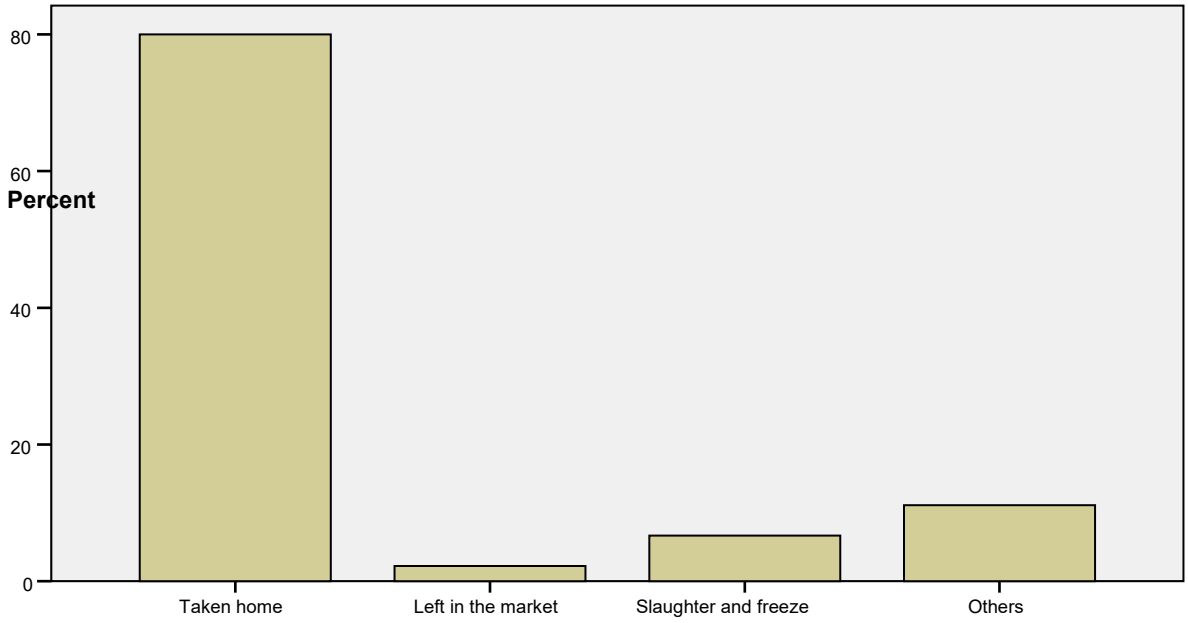


Figure 5. Destination of unsold birds in the local markets



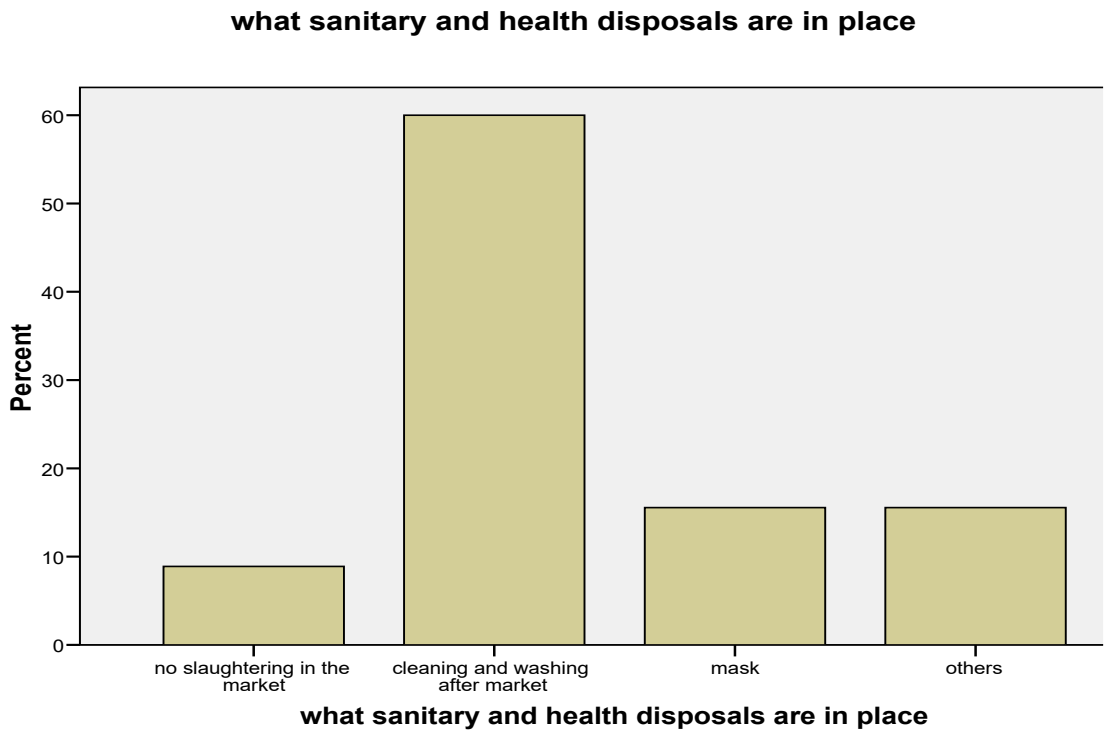


Figure 7. Disposal of offal in the local markets

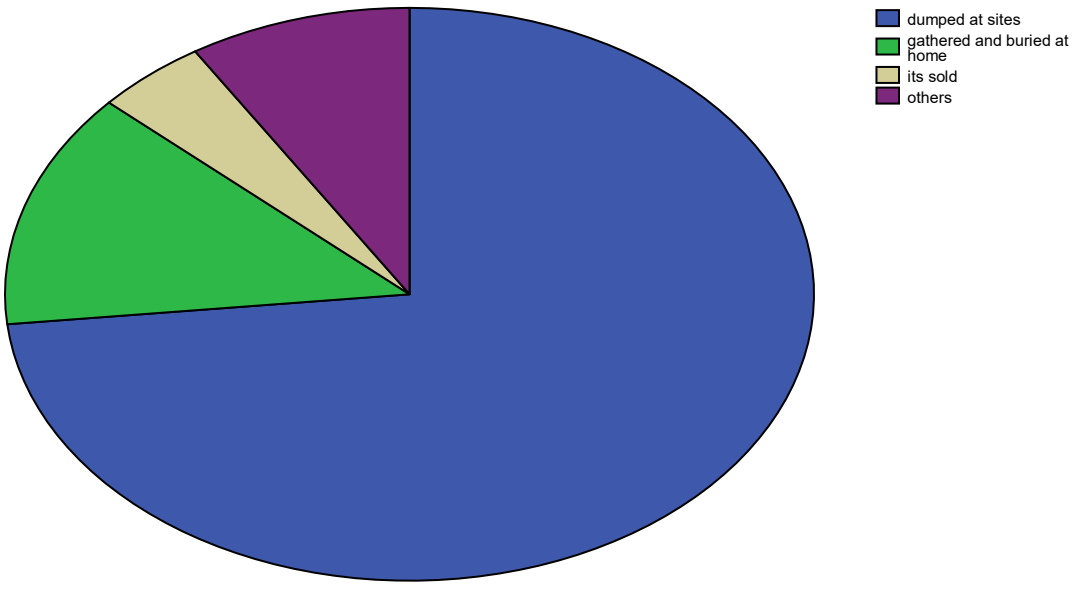


Table 1: Check list for the Assessment of Poultry Processing in Local Markets

Monitor activities on the market	Poor	Quarantine for sick birds	Poor
Availability of specifications for vehicles carrying birds	Very poor	Control movement of poultry to/from market	Poor
Location of the poultry market	Poor	Disinfections facilities for trucks	Poor
Poultry market separate from other stands	Poor	Reduce density of birds in cages	Good
Access to para- veterinary services	Poor	Separation of birds by species	Good
Ante and post- mortem inspection of birds	Very poor	Separation of birds by age class	Good
Access to veterinary inputs	Poor	Other animals traded in market	Poor
Garbage disposal services	Poor	All-in all-out policy on the market	Poor
Segregation of customers and birds	Poor	Keep new arrivals separated from old stock	Good
Mandatory routine disinfections of the market	Poor	Enclosure preventing escape	Good
Floor and walls easy to clean		Improved cages	Good
Presence of drains on the floor	Poor	Availability of clean water	Good
Availability of toilets	Good	Availability of hot water	
Cleaning of cages	Poor	Disinfection of cages	Poor
Prohibit sharing of cages / other equipment	Poor	Disinfection of shared equipment	Poor
Access to facility to wash, disinfect hands and shoes	Poor	Availability of processing facilities	Very poor
Good hygiene in storage facilities	poor	Good hygiene at slaughtering points	Very poor
Safe disposal of sick/dead birds	Poor	Safe disposal of waste	Good
Protective material for people slaughtering birds	Very poor	Disinfection of infrastructure and premises	Poor
Disinfection and Cleaning of equipment used for slaughtering	poor	Hands washing and disinfection after slaughter	Poor
Improved packaging of slaughtered bird	Very poor	Availability of storage facilities	Poor

Most of the local markets lack facilities for processing, storage and culling birds, an Incinerator, and disinfection facilities for trucks.

Many markets have processing points where birds are slaughtered with very poor hygienic conditions and premises nevered disinfected.

Processing is generally carried out without any form of protective materials such as mask, clothing (overall or aprons), head covers rubber hand gloves and rubber boots. Washing of hands and equipment only done at the end of the day.

Conclusion

There is awareness about good practices to reduce contact and spread of pathogens between birds. Never the less, biosecurity is still very weak and requires improvement at all levels.

Tools are only occasionally cleaned at the end of the day. The washing of hands after slaughtering is done irregularly; eventually at the end of the day. Hands are never disinfected. Constructions of good shades and a slaughter house in each local markets will help to improve biosecurity.

Recommendations

- Construction of good shades and poultry slaughter house with pipe borne water to improve biosecurity in the local markets.
- To create a permanent union in the local markets to handle the slaughtering of birds, disposal of offal and collaboration between veterinary service and the marketers.
- Periodic disinfection of the poultry market to eliminate pathogens.
- Marketers must be trained in aspect of:
  Destination of unsold birds.
  General hygienic conditions.
  Removal of sick/dead birds.
  Carcass and waste storage.
  Carcass and waste disposal.
  Pre-slaughter management.
  Cleaning and disinfection of slaughter tools.
  Use of alternate disinfectants.
  Clinical diagnosis of diseases.
- To create a veterinary post in the local markets to improve on the veterinary services in the poultry markets.

Research Team

S/N	NAME	SPECIALITY
1.	Mr. Enow Julius Tabot	Animal Production/Nutrition
2.	Dr. Ngome-Tata Precilia	Socio-Economics
3.	Mrs. Sirri Bella Musongo	Agricultural Sociologist

Questionnaire and check list for the Assessment of Poultry Processing in Local Markets

This questionnaire is a survey aims at gathering information on the various poultry processing in local markets, their problems and their access to solutions to these problems. The information gathered will be treated as confidential. We request your assistance to provide the necessary information solely for the intention of this survey. ***We will wish you provide and tick the right answer for each question.***

Administrative information

Region:……Division: …… Subdivision: ……..
Respondent:……..Contact address: ……
Market:……Date: ……...

Section 1: Socio-demographic profile of respondents

1. Sex: ☐Male ☐Female 2. Age: ----------

3. Level of education: …….. 4. Marital status: ……..

5. What is your major means of income? ……..

Section II: General information on Poultry Traders

6. Are you a member of any association? ☐Yes ☐No

7. For how long have you been in this business? ……..

9. How often do you sell? ☐Throughout the year ☐Seasonally ☐Others ……..

10. If seasonally, specify the periods ……

11. On average, how many days per week do you sell at the markets? …….. ……Days

12. Do you also sell at other markets? ☐Yes ☐No

13. Do you pay any fee to sell in the market? ☐Yes ☐No

14. If yes, how much? …….. FCFA

Section III: Poultry Buyers and Destination of Poultry Sold in the Market

15. From who do you buy poultry to sell? ☐Own produce ☐Buy from farmers ☐Buy from other traders ☐ Others specify……

16. Where do these birds come from? ☐Within the town ☐Out of the town ☐ Others specify ……

17. Which customer segment do you usually serve? ☐Household consumers ☐Dealers ☐Restaurant/food seller ☐Others specify……

18. What is the total number of poultry sold each day?

Type	Live birds	Slaughter birds	Both
No.			

19. What is the average price of birds sold to customers in the market?

Type	**Live birds**	**Slaughtered birds**
Amount.		

20. Do you have an arrangement with the poultry suppliers? ☐Yes ☐No

21. If yes, what kind of arrangement? ☐Verbal ☐Written

22. Do you depend on a particular supplier or are you flexible according to the demand? ☐Fixed suppliers ☐Different suppliers

Section IV: Handling and Biosecurity practices in local poultry markets

23. Do you slaughter birds yourself or do you employ a slaughtering service? ☐Myself ☐Slaughtering service ☐others ……..

24. Does the market have a slaughtering place? ☐Yes ☐No

25. What do you do with the birds that are not sold the same day? ☐Take them home ☐Keep them in the market ☐Slaughter and freeze them ☐others, specify ……

26. How and where do you dispose of offal? ☐Pack it and take to the waste disposal in the market ☐Pack it and bury it at home ☐Sell it ☐others, specify ……

27. What sanitary or health disposal are in place? ☐Prohibit slaughtering birds at the market ☐Clean and wash the place after each market day ☐Use a mask for protection ☐others, specify ……

28. Who is responsible for the control? ☐Sellers ☐Market ☐ Others specify……

29. In your opinion, what can be done to improve on this sub sector? ……
……
……

(Mark-very good-4; good-3; poor-2; very poor-1)

Market (daily or weekly) _____

Monitor activities on the market		Quarantine for sick birds	
Availability of specifications for vehicles carrying birds		Facilities for culling birds	
Control movement of poultry to/from market		Presence of an Incinerator	
Location of the market		Disinfections facilities for trucks	
Poultry market separate from other stands		Reduce density of birds in cages	
Access to para- veterinary services		Separation of birds by species	
Ante and post- mortem inspection of birds		Separation of birds by age class	
Access to veterinary inputs		Other animals traded in market	
Garbage disposal services		All-in all-out policy on the market	
Segregation of customers and birds		Keep new arrivals separated from old stock	
Mandatory routine disinfections of the market		Enclosure preventing escape	
Floor and walls easy to clean		Improved cages	
Presence of drains on the floor		Availability of clean water	
Availability of toilets		Availability of hot water	
Cleaning of cages		Disinfection of cages	
Prohibit sharing of cages / other equipment		Disinfection of shared equipment	
Access to facility to wash, disinfect hands and shoes		Availability of processing facilities	
Good hygiene in storage facilities		Good hygiene at slaughtering points	
Safe disposal of sick/dead birds		Safe disposal of waste	
Protective material for people slaughtering birds		Disinfection of infrastructure and premises	
Disinfection and Cleaning of equipment used for slaughtering		Hands washing and disinfection after slaughter	
Improved packaging of slaughtered bird		Availability of storage facilities	

Thank you for your time and patience

References

Food and Agriculture Organization of the United Nations –Nigeria (2008). Consultative Mission on the Nigerian poultry market chain to improve biosecurity.

FAO (2009.) Good practices in small scale poultry production: A manual for trainers and producersin East Africa. Pp. 99

Etchu K.A. (2004). Seasonal and processing effect of sweet potato diets fed to Broilers and Breed Cocks in the humid tropics. Ph.D Thesis. University of Ibadan.

PNUD (Programme des Nations Unies pour le Développement), 2006**.** Rapport sur la pauvreté rurale au Cameroun, Bureau de Yaoundé

Van Eekeren N., Maas A., Saatkamp H.W. and Verschuur M. (2006). Small-scale chicken production. Agrodok 4. Pp. 91