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Mechanizing Postharvest Processing Operations: A Panacea For Food Security And Sustainable Rural Development

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ABSTRACT

Food security and sustainable rural development are indispensible ingredients in attaining the Millennium Development goal (MDG) of eradicating extreme poverty and hunger. The reduced time for food preparation and the increasing demand for processed food heighten the need for developing healthy, affordable food products, and appropriate processing systems to provide food to the rapidly growing population in developing countries. Mechanizing postharvest activities has not attracted much attention from international research organizations, while research on the improvement of agricultural production has received considerable attention and funding. However, there is an emerging consensus on the critical role that postharvest systems can play in meeting the overall goals of food security, poverty alleviation and sustainable agriculture particularly in developing countries. This study focuses on the trends in mechanizing various postharvest processing operations, and its impact in attaining food security and sustainable rural development. It also highlights the set-backs to mechanization of postharvest systems.

Keywords: Mechanizing, Postharvest, Food Security, Rural Development, Processing Systems

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Introduction

The world population is growing faster than food supply making food insecurity the greatest challenge facing humanity today. John and Stephen (2013) stated that rapid population growth and increasing competition for available resources are putting leaders all over the world under intense pressure to satisfy human needs for food and clean water through sustainable rural economic development.

United States Department of Agriculture (USDA) defines food security as access by all people at all times to enough food for an active, healthy life (USDA, 2013). Similarly, Dogondaji (2013) stated that food security exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for active and healthy life. This definition implies that food security is a broad concept that is more than food production and accessibility. The Millennium Development Goal (MDG) One seeks to improve food security and to reduce extreme poverty and hunger in the world by half by the year 2015.

Rural development is the key tool for encouraging diversification and innovation in rural areas. It aims to reverse depopulation processes, stimulate employment and equality of opportunities, respond to growing requests for better quality, health, safety, personal development and leisure.

Development can be considered as sustainable if it meets the needs of the present generation without compromising the ability of future generations to meet theirs. Africa generally and sub-saharan Africa in particular has the highest hunger and malnutrition rates in the developing world (Ofoh, 2013). In Africa over 70% of the food insecure population lives in the rural areas more than half being smallholder farmers, who produce over 90% of the continent's food supply (Margaret, 2013).

Improving agricultural production is essential to achieve a sustainable development process that will contribute to reducing poverty and enhancing food security and income growth. High yielding varieties and new production technology have vastly increased the world's agricultural potential and provided rural income sources and affordable food for large parts of the population. But the production of food and other agricultural products does not end when the crop is harvested. Increasingly, agricultural products are not consumed in their raw form, and postharvest processing and storage account for a growing part of their final value. It has also been pointed out that to achieve self-sufficiency in food; there is an urgent need to match all efforts at increasing crop production with equal if not greater efforts of postharvest technology to save the crops that are produced from deterioration and wastages (Olayemi et al., 2010).

John (2013) noted that presently, Nigeria's food import has moved from less than $10million in the early 1970s to $4billion per annum. This monumental increase in food import is a clear indication that domestic agricultural output is not keeping pace with our domestic needs for essential food items and raw materials for agro-industries.

Yearly, farmers produce a lot to boost the economy but most are lost at post harvest stage. The postharvest technological scenario in cereals, grain legumes, oilseeds, vegetables, fruits, tubers, etc. of Nigerians presents a dismal picture and are mostly comprised of traditional techniques practiced by growers, traders and the processors resulting to considerable deterioration of physical and nutritional qualities of harvested crops (Oni and Obiakor, 2003).

The aim of this study is to x-ray the effects of mechanizing postharvest processing operations in attaining food security and sustainable rural development, which is pivotal in realizing MDGs especially goal one.

Trends in Postharvest Processing Operations of Some Staple Foods

Most foods, including starchy staples such as grains and tubers, are not consumed in their primary form but require some processing (Goletti and Wolff, 1999). According to Ndirika (2012), the processing and storage techniques for agricultural produce are predominantly by traditional methods which are unproductive, laborious, time wasting, poor quality, unhealthy and often result in losses of crops. This practice is prevalent in developing countries.

Postharvest processing may be defined as an activity which is performed to maintain or improve the quality or to change the form or characteristics of the agricultural product (Ndirika, 2012). Processing operations are undertaken to add value to agricultural materials after their production. The main purpose of agricultural processing is to minimize the qualitative and quantitative deterioration of the material after harvest. The operations connected with this include unit operations like cleaning, grading, drying, decortications, soaking, steaming, milling, concentration, threshing etc. Postharvest processing operations can be carried out using traditional method or improved (mechanized) method.

Most cereals are staple crops in developing countries. Processing of cereals involves the following operations: Shelling, Threshing, Drying, Storage and Milling.

Shelling and Threshing

The processes of separating food grain from the pod (shelling) or from the stock (threshing) can be a great loss if performed incorrectly. The most widespread methods of shelling grains are such traditional methods as pressing the grain off the cob with thumbs, or rubbing two cobs together, holding one in each hand, or beating the cobs in a sack with a stick or rubbing the cobs across a rock.

Simple shelling devices have been invented which can be easily made locally. One of these is a hand held wooden Sheller. A number of grain shellers for manual operation, suitable for small-scale producers are manufactured commercially and industrial – scale producers make use of a wide range of engine operated machines. Traditional methods, generally employed in cereal producing countries, involve beating the heads with sticks on the ground or in sacks, or using pestle and mortar.

Trampling by animals, tractor wheels or foot during shelling or threshing operations has been reported to cause heavy losses, since a percentage of the grain is crushed. When threshing is done on an earth floor, earth and other impurities can be mixed with the grain (FAO, 1989).

Drying and Storage

In the traditional drying of cereals, the harvested heads are generally left in the sun on a hard, clean piece of ground or rock slab, they are dried to a moisture content of 10-12%. When the crop is harvested during the dry season (as in Nigeria), drying is not a problem. When sun drying is not possible, the heads are often hung or placed above the fire to dry on special rigs. After drying, the heads are stored either threshed or unthreshed. In many countries the grain is stored in the head and is threshed only as required. Storage methods vary with region and are related to socio-cultural background and climate.

Threshed grains are stored in bags and small quantities of immediate consumption or for seed are stored in clay pots, tins or calabashes. On large farms in many areas, grains are stored in warehouses ventilated by small windows, in sacks on platforms covered with canvas, or in large silos. In Ethiopia and Sudan, square or round underground pits are traditionally used for storing grain, in dry areas where the groundwater table is sufficiently low. Reduction of the moisture content of grains to 12-15 %, protection from insects, rodents and proper storage are major problems in many cereal producing areas. The main constraint of most traditional structures for storing maize is that they do not allow for optimal free ventilation and therefore a long pre-harvest field drying as well as a further post-harvest drying is required before grain can be stored safely.

Artificial drying techniques have had some success in West Africa, several forced air dryers like the continuous flow dryers, storage dryers and batch dryers had been introduced for drying grains.

Improved shelled-grain storage structures for small producers have been developed and introduced in dry climates. They use metal and cement which are durable, improved storage structures have also been developed for humid climates. For example high moisture (over 30%) maize can be harvested when ripe and safely stored in narrow cribs. Large-scale farmers and traders store shelled grain in bags, mainly because it is easier to load the shelled and bagged grain onto a lorry. Grains in bags should have a moisture content not exceeding 12-13%. The bags are stored in brick or stoned walled buildings with corrugated iron roofs (FAO, 1989).

Milling

Traditionally, grains are usually ground to produce a meal. Pounding with a pestle and mortar is a widely traditional method, another is grinding the grain slowly between two stones. Dry milling is more common with maize than wet, although flint-type maize is sometimes milled wet. Similar method is also employed in sorghum milling.

Small-scale mechanical dry-maize milling is widespread in Africa at village level. Various hand operated or engine powered grain mills are available for maize grinding. There are both African and imported machines. In Cameroon, mechanical hand grinding is done by corn-mill societies in which women purchase and use double-handled, large-wheel, plate-type mills for grinding dry maize. In many villages' engine- powered hullers and hammer mills feature prominently. The range and capabilities of these milling machines vary considerably. Examples of hammer mills used for maize milling in Tanzania and Kenya are the Arusha, manufactured in Tanzania and marketed under various names (i.e.) the MGM models and the Ndume, manufactured in Kenya).

Hammer mills powered by petrol or diesel engines have been installed in many trading centers. In some areas, for example in Botswana and Nigeria, Sorghum hulling equipment has been installed in rural areas to supplement the hammer mills, mainly operated as custom mills where farmers bring their clean grain for polishing and grinding for a fee.

A small number of commercial sorghum processing mills are active in Sudan. Unfortunately, economic difficulties limit the increase in Sorghum industrialization. Industrial technologies for milling Sorghum are not well developed yet. Not all sorghum varieties can be used successfully in industrial processing (FAO, 1989).

Impacts of Mechanizing Postharvest Operations

It is widely accepted that post-harvest activities are an integral part of the whole food production system involving series of operations from the producer through to the consumer (Ndirika, 2012); this activity adds value to the community in which they are carried out. Mechanizing Postharvest processing operations plays enormous role in economic development. Some of them include:

Significant Reduction in Food Losses

The United Nations predicts that 1.3 billion tons of food is lost globally every year (Gustavsson et. al, 2011). Food losses in Europe and America range from 280-300 kgs/year, and are about 120-170 kgs/year in Sub-Saharan Africa and South/Southeast Asia (Gustavasson et. al.,2011).

With the current world population expected to reach 10.5 billion by 2050, this food loss, if managed and prevented, can feed future generations. Nigeria produces a wide range of agricultural produces which are lost at one level or the other at post harvest stage leading to wastage in human effort, farm inputs and investments (Olayemi et al., 2011). This loss is majorly, due to the use of primitive methods in agricultural processing. However, adoption of appropriate mechanized systems in agricultural processing has a significant reduction in food losses, thereby, fostering food security.

Poverty Eradication

Mechanized postharvest operations contribute to reducing poverty by enhancing income earning opportunities for poor people, and by providing time-saving processed foods to the urban poor. Mechanizing postharvest processing operations leads to the establishment and strengthening of small-scale rural agro-industries and complementary support services. This provides income opportunities for smallholders and for landless labourers, which tend to be among the poorest strata in developing countries. Participatory research methods for developing postharvest technology options and selecting appropriate organizational schemes for small rural enterprises are products that are non-location specific. Cross-case and cross-country analysis of experiences, lessons learned and best practices are in high demand by development practitioners at the local level.

Employment Generation

Ndirika (2012) state that postharvest activities create employment and income for many households in the rural communities. Postharvest Processing and Storage Technologies have the potentials to create rural industries, which will in turn, reduce rural to urban drift. The farmer whose role has been reduced to producer can be transformed into producer cum processor and thus getting more dividends for hard labour, input, kind of risk taken and generating resource for socio-economic advancement keeping pace with modern times.

Sustainable use of resources

Research on mechanizing Postharvest processing technologies contributes to sustainability by finding alternatives to chemicals which have polluting effects on the environment, and are hazardous for human health. Thus alternative pest control mechanisms for grain storage reduce the need for pesticides, which reduces pollution, minimizes accidents with pollutants, and also lowers pesticide residues in food consumed by humans.

The reduction of postharvest food losses in itself contributes to sustainability. Reducing waste of already produced food is more sustainable than increasing production to compensate for postharvest losses. Increasing production leads to more intensive farming or to an expansion of the area under cultivation, both of which may have negative effects on the environment especially when poor rural households tend to farm in fragile ecosystems or marginal land.

Need for Increasing Research on Postharvest Processing Technologies

The postharvest sector is still relatively under developed compared with the primary agriculture sector which has received considerable attention and funding in most developing countries. The technologies for postharvest handling including storage, and processing in developing countries are still fairly simple, labour intensive with substantial participation by low income groups particularly women. Also little research has been done to improve the performance of the sector compared with primary agricultural production (Goletti and Wolff, 1999).

Nowadays, postharvest quality and produce safety are considered the most important concerns of the rank and file (Hassan, 2010). Several factors/trends, however, continue to highlight the increasing importance of mechanizing postharvest processing operations, thus helping to emphasize the need for more research and development work in the area.

The first trend is urbanization, particularly in developing countries. As people live farther away from where food is prepared, they increasingly rely on smooth transport, storage, processing, and marketing systems to give them access to a secure food supply. The reduced time for food preparation and the increased demand for processed food increase the need of developing healthy, affordable food products, and appropriate processing systems to provide food to the rapidly growing urban population in developing countries.

The second trend is a contraction of the agricultural sector, measured both by a declining agricultural GDP as a share of total GDP and a declining labor force engaged in agriculture. Alternative rural income sources are essential to limit rural-urban migration. Mechanizing postharvest processing operations can provide much needed employment for those who exit the agricultural sector. Research on policies, institutions, and technologies to strengthen the development of rural agro-enterprises would directly contribute to the strengthening of the rural economy even within a contracting agricultural sector.

Finally, a trend toward improved infrastructure and communication network opens new market opportunities for the poor farmers in developing countries. However, to make such opportunity operational, more research on appropriate technologies to store, transport, process, and ensuring quality will be necessary.

Set-back to Mechanizing Postharvest Processing Operations

Although the biological and environmental factors that contribute to postharvest losses are well understood and many technologies have been developed to reduce these losses (Kadar, 2002; Gross et al., 2004), they have not been implemented. In many cases, due to one or more of the following socioeconomic factors:

- inadequate marketing systems;
- inadequate transportation modes
- unavailability of needed materials, tools, and/or equipment
- lack of information
- governmental regulations and legislations.

Mrema and Rolle (2002) reported that priorities within the postharvest sector of developing countries have evolved from a primarily technical focus geared towards the reduction of losses, to a more holistic approach designed to link on-farm activities to processing, marketing and distribution. Despite this evolution in trends, fundamental problems and concerns of the sector have remained relatively unchanged, with high postharvest losses, poor marketing systems, weak research and development capacity, and inadequacies in policies, infrastructure, extension services and information exchange cited as major constraints within the sector in developing regions of the world.

Rwelamira (1997) reported that inadequate access to improved technology has been one of the factors contributing to poverty and food insecurity in the rural areas. While researchers have identified many potentially useful postharvest technologies for use in developing countries, there is a lack of information regarding the costs and financial benefits of these postharvest technologies, since costs are rarely documented during research studies (Lisa et al., 2011). Generally the adaptive research step between gathering laboratory findings and extension of the results is missing or local costs are simply not considered when investigating the technology and its field applications. Technically useful practices therefore tend to be disregarded since there is no information on costs or their potential financial returns in different developing regions. Although extension services in developing countries are increasingly involved in providing educational programs and training activities on postharvest topics, often there is a lack of follow-through and support after the training (Lisa et al., 2011).

Conclusion

Increasing investments in postharvest processing technologies can have a major impact on reducing waste and increasing the food supply, leading to improved incomes without increasing production and wasting the expenditures on all the inputs required (land, water, seeds, fertilizers, pesticides, labor, etc.). This in addition, guarantees food security and fosters development in rural communities. Promoting research on Postharvest processing technologies is a vital tool in attaining Millennium Development Goals, particularly goal One.

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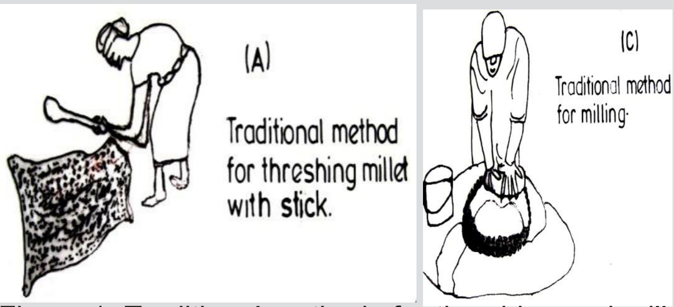

Figure 1: Traditional methods for threshing and milling (source: Ndirika, 2012)

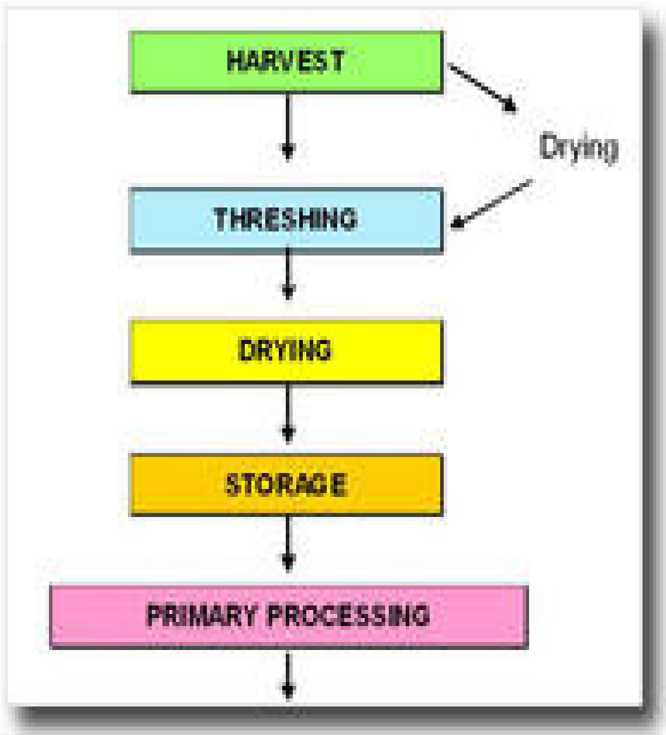

Figure 2: Postharvest System