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Review Article

Agricultural Mechanization, a Key Input to Food Security that Botswana should Consider

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Abstract

Botswana is a semi-arid, dry land with almost two thirds of the land being the Kalahari desert. Drylands have been hit the hardest by climate change. These regions currently struggle to provide sufficient food for their growing populations and face a series of daunting physical and demographic challenges: high poverty levels and unemployment, rapid urbanization, severe water scarcity, and land degradation. Unfortunately, many of these problems and constraints are expected to worsen because of climate change [1]. According to World Economic forum, 40% of the worlds landmass is arid and with the climatic changes and rising temperatures more of it will soon turn into desert. Countries like Botswana find themselves with a daunting task of contending with such biophysical and socioeconomic stresses to ensure food security and livelihoods. “Making the Kalahari green” looks more like a fleeting illusion. This article through the help of literature highlights a few key challenges faced by Botswana’s agricultural industry. In the analysis of these main constraints that the country faces in achieving improved food security, a few mitigation measures and possible solutions are suggested also through literature review. I strongly believe that tis article would be of paramount help to relevant stakeholders in the Botswana agricultural sector, be it policy makers or farmers. Botswana is not only faced with the mammoth task of improving food security under semi-arid and marginal environments, but also to improve youth, rural and women employment and incomes (UNFPA Botswana, 2011). Botswana has a population of 2 415 920 with a median age of 24.4 years, a youthful nation of which 60.7% is unemployed. The role of the agricultural sector in household and national food security, employment creation, reduction of poverty, and other opportunities therefore remain of critical importance. If Botswana is to tackle all these challenges simultaneously, then it needs to consider Agricultural mechanization as an option to explore.

Keywords: Input; Food Security; Botswana

Introduction

Botswana; an overview

Botswana is a landlocked country in the center of southern Africa, with a total land area of 600,370 square kilometers (sq.km). Topographically Botswana is flat, with a mean altitude of 1000 meters. Due to its geographic (located roughly between tropics at latitude 23.5^0) and climatic zones (short rain seasons, warm to hot summers, cool to mild winters with infrequent frost), Botswana’s climate is hot semi-arid or sometimes referred to as subtropical, only 0.65% of land area is suitable for arable agriculture. According to World Bank, Botswana has low soil fertility, and highly variable and unreliable rainfall, not only in its amount but also in intensity thus very low agricultural potential. Consequently, the agricultural sector contributes only about 3.0% of the GDP. According to the (World Bank, 2014) Botswana has 25861000 hectare (ha) of agricultural land, 399000 ha of which is arable. According to FAO, agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. Arable land includes land defined by the FAO as land under temporary crops, temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned because of shifting cultivation is excluded.

Mechanization defined

FAO defines mechanization as “the application of tools, implements and machinery in order to achieve agricultural production” [2]. These can all be operated by manual, animal or engine (fossil fuel or electric) power. Essentially, agricultural mechanization represents technological change through the adoption of non-human sources of power to undertake agricultural operations. Mechanized agricultural operations can be grouped into power and control intensive functions. Mechanization of power intensive agricultural operations, such as land preparation, threshing, grinding and milling. It is characterized by non-human sources of energy input to replace human and animal ones required in the operations. On the other hand, mechanized control intensive operations, such as planting, weeding, winnowing, fruit harvesting, require greater human judgment and mental input in addition to energy (Pingali *et al* 2007). Grain harvesting can be thought of as both a power and control intensive operation (Binswanger 1986; Pingali 2007). Engine-powered irrigation and food processing are also included in mechanization. Mechanization has had a major impact on the demand and supply for farm labor, the profitability of farming, and the change in the rural landscape, including rural communities.

FAO (2014b) summarizes the main reasons for changing the power source for crop production from muscles (human or animal) to tractors:

1. Potential to expand the area under cultivation.
2. Ability to perform operations at the right time to maximize production potential.
3. Multifunctional – tractors can be used, not only for crop production, but also for transportation, stationary power applications and infrastructure improvement (drainage and irrigation canals and road works).
4. Compensation for seasonal labor shortages (or, indeed, release of labor for more productive work.
5. Reduction of the drudgery associated with the use of human muscle power for tasks, such as hand hoeing for primary tillage – especially important in tropical areas where high temperatures and humidity (sometimes associated with inadequate nutrition) make manual work extremely arduous.

It is important to note that mechanization requires a hefty capital investment as well as skilled labor, thus there has to be a sufficient demand as a precondition for successful mechanization. In other words, farmers (and relevant stakeholders) should see mechanization as the most cost effective option among other available alternatives for them to consider its adoption. Therefore, it is of paramount importance that the levels and types of advanced mechanical technologies be suitable and compatible with local agro-ecological, industrial, socio-economic, and agronomic conditions for it to be successful.

Agriculture, according to the World Bank contributes 32% to Africa's gross domestic product (GDP) and provides employment to 65% of the labor force on the continent. In many countries in Africa, up to 85% of the workforce is employed in the agricultural sector. The International Food Policy Research Institute (IFPRI, 2016a), argues that Agricultural Mechanization is more likely to increase labor demand when it enables more land to be cultivated (and when it is profitably applied along the value chain).Historically agriculture was the main economic activity for the majority of Batswana, both rural and urban dwellers. At independence in 1966, agriculture accounted for 40% of gross domestic product (GDP) and 15% of formal employment. To date its contribution to the GDP and formal sector has significantly declined to 2.5% and 1.8%, respectively (Gob. Revised 2004 Agricultural Census Report 2008). The low contribution of the agricultural sector to the country's GDP is mainly due to use of outdated technologies and farming techniques, which subsequently result in low productivity. A 2008 FAO UN report titled "Agricultural mechanization in Africa" cited low level of engineering technology inputs in agriculture as one of the main constraints hindering the modernization of agriculture and food production systems in Africa. It continues to state that Africa is the only region in the world where agricultural productivity is largely stagnant. Yields of maize and other staple cereals typically remain at about 1 tonne per hectare (1000 kg/ha), which is about a third of the average achieved in Asia and Latin America.

Key challenges in Botswana

Water scarcity

Water is a scarce resource in Botswana that undoubtedly need good planning which should take into consideration both the short and long-term effects of its use. Of the total land area of the country, only 2.5% (15,000 square kilometers) is covered by water [FAO, 1995b]. Botswana like its neighboring countries Namibia, Zimbabwe and South Africa is experiencing 'water stress', that is to say the countries have freshwater resources between 1000 and 1700 cubic meters (m^3) per person per year (UNEP,1999). One of the factors leading to scarcity of water is the rapidly increasing population subsequently leading to an increase in demand for freshwater. According to a report published by the UN Department of Economic and Social Affairs on 21 June 2017, titled "The World Population Prospects: The 2017 Revision", the total population of Botswana currently stands at about 2 038 228. Botswana experiences population growth of 38 089 persons per year (UNFPA Botswana, 2011). This may lead to water resource depletion if the rate of replenishment is exceeded by the rate of use.

The mean annual rainfall for Botswana is 400 mm, ranging from 250 mm in the southwest to a maximum of 650 mm per annum in the northeast (Pallett, 1997). Pallet continues to state that there are low rates of surface runoff and groundwater recharge. Even during the wet season, stream flow is not continuous, with internal rivers only flowing for 10-75 days a year. The Okavango Delta in the northwest is a large inland delta including about 6 000 km^2 of permanent swamp and between 7 000 and 12 000 km^2 of seasonally inundated swampland. Together with the Chobe and Linyati rivers, it accounts for 95 percent of all surface water in the country. An estimated 11 km^3 of water flows every year into the delta, but most of it is lost through evapotranspiration. At the current rates of abstraction, the lifetime of surface and groundwater resources is limited to decades [3].

Local farmers continue to rely heavily on rainfall, which of late has become erratic and below average. Only 0.00962% of total agricultural land is irrigated [4]. Apart from the perennial rivers and wetlands in the north and the over-utilized Limpopo and its tributaries in the east, Botswana suffers from a lack of surface water and therefore development relies heavily on groundwater. Approximately 35% of the total water supply is from surface water, whereas the remainder (65%) is from groundwater [5]. Groundwater resources can be found almost everywhere in the region and is the main source for most of Botswana's towns and smaller settlements, the livestock industry, its power stations and many mining developments. Rural and remote towns are often entirely dependent upon groundwater except in cases such as Kasane on the lower Chobe-Zambezi River and Mohembo and Shakawe on the Okavango River (Ashton pers. comm., 2000). The climate and geography of the country also play part in water scarcity, according to UNDP Botswana has reached her peak of dam development owing to the flat topography of the country. (Pallett, 1997) also argues that the availability of water in the environment is influenced by the climate; he continues to states that in southern African savannas the climate (and therefore, the water availability) sets the limit for growth and development that can take place in the region. Kgathi [5] also argues that high temperatures lead to very high evaporation rates that deplete the already low rainfall In Botswana. The year 2018/19 has already been declared a drought year by the government of Botswana. Prior to that, the year 2015/16 was also declared a drought year. With this recurrence of drought, irrigation is no longer an option but a necessity.

Figure a

Lack of access to sources of financial credit

Agriculture in Botswana as it is in most of Africa, allows little room for improvement though it has so much potential. According to (World Bank, 2010; Deininger, 2011), African countries are currently achieving less than 30 percent of their potential yield. The industry is dominated by small-scale farming, most agricultural production and staple foods come from small-scale low-income farmers, who face a bewildering set of obstacles while trying to make out a decent livelihood on less than five hectares. These subsistence farmers, otherwise known as smallholder farmers or traditional farmers are predominantly women. Although it varies from region to region, the majority of women are involved in crop production than men because they own more arable land than men do (57.6 percent against 41.6 percent. This demographic group however remains the most unemployed (21.4 percent against 14.5 percent). Moreover, 18.4 percent of Batswana live below the poverty line and 33 percent of that population being female-headed households whilst 27 percent is male-headed households. This means that the majority of smallholder farmers who happens to be women have no credit worth, and thus have little access to sources of financial credit. Generally almost all smallholder farmers are resource poor and thus have difficulty investing in agricultural machinery and production enhancing inputs.

Most commercial financial institutions are reluctant to extend credit to poor farmers with little or no collateral. Perhaps the "high-risk" business nature of agricultural production also plays a part. Therefore, small holders find themselves with restricted purchasing power, and subsequently resulting in low yields, as they cannot invest in fertilizer use and irrigation. A 2014 KPMG Africa report titled "Agriculture in Africa" states Botswana like most of African uses far less fertilizers than other parts of the world, it continues to say that Sub-Saharan region uses 8 kilograms per hectare (kg/ha) compared to 107 kg/ha of Latin American and Asia. Botswana on average uses 58.5kilograms per hectare (kg/ha), which is extremely worrying because annual rate of nutrient rich top soil depletion is 60kg/ha, 25 billion tons of rich top soil are lost globally.

Land tenure

Most smallholder farmers have less than 5 hectares of agricultural land; some who do not own land but have interest in farming cannot afford to purchase or even lease profitable sizes of cultivable land. Lack of security of tenure severely hinders investment in the agricultural sector, it hinders continuous and consistent production and therefore consistent supply of produce to the market, and as a result, most local retails prefer to import agricultural produce from large-scale producers from the neighboring countries. For a successful transition from semi-subsistence farming to commercial farming, land tenure must be secure and guaranteed, this offer the farmers the assurance and confidence to invest in mechanization and other production enhancing inputs. Small amounts of land can also be a hindrance to adaptation of mechanization by farmers. (Chancellor, 1971) argues that cases from Asia show that mechanization is often driven by large farm sizes. It is not economically sensible for a Motswana farmer who owns two hectares of land to invest in mechanization and other production enhancing inputs, let alone own a tractor. (Binswanger 1986) argues farmers who own tractors in most developing countries are typically medium and large-scale farmers, who also provide hiring services to non-owners when it helps them maximize their tractors' utilization. Such trends have been observed locally too, tractor owners hire them out to the ministry of agriculture through the ISPAAD programme (Integrated support programme for arable agriculture development) a support scheme by the government to assist arable farmers to acquire requisite inputs and draught power to undertake tillage operations. One may argue that farm size and mechanization go hand in hand, though large farm sizes is not a prerequisite for mechanization to be profitable; nonetheless it is a factor in terms of mechanization adoption.

Lack of skilled labour

Generally, local farmers are well acquainted with conventional farming techniques acquired over generations of farming, but they lack the knowledge of contemporary farming techniques and technologies. The level of farmer training is relatively low and opportunities for further training are limited and expensive. Academic institutions like Botswana University of Agriculture and Natural resources (BUAN) through its Centre for In-service and Continuing Education (CICE) offers short course and training farmers, but most farmers cannot afford to pay for such or even afford to come from remote areas to the city. Furthermore, extension and training services do not easily reach rural and remote areas, Farmers lack the knowledge and skills to operate mechanized equipment (FAO, 2011c), and when machines are used, this lack of proficiency leads to misuse and mismanagement of machinery – especially of more sophisticated machines. This hinders the improvement of agricultural production and productivity and of the general level of farm management (FAO, 2009c).

Lack of skilled labour has also led poor agricultural practices, there is inadequate management and use of natural resources (land and water use). This has led to land degradation such as soil erosion, deforestation and soil compaction as well as contamination underground water resource due to wrong application of pesticides and fertilizers. (Ali and Byerlee, 2001) state that water scarcity could turn into a major problem if deforestation rates are not controlled or if irrigation systems are not efficient, (i.e. water logging and salinity resulting from excessive water use). In Botswana, farmers have reported an increase in water run-off from their ploughing field, perhaps one can attribute this to soil compaction due to use of heavy farm machinery like ballasted tractors and combine harvesters. (Raper, 2005) states that soil compaction causes an increase in soil mechanical resistance and as a result, increases drafting force, fuel consumption, time of farming operations and implements abrasion. In addition, compaction has an adverse impact on agricultural progress, several studies have been made and results show that it adversely affect crop production as well as properties of soils and their ability to sustain crop/plant development.

Harvest and post-harvest losses

According to FAO UN, more than one third of agricultural produce in developing countries is lost due to poor harvesting techniques, post-harvest handling, storage and processing methods. Lack of appropriate grain storage technologies leads up to 20-30% losses, particularly due to postharvest pests. This means that more than one third of energy embedded in that production is consequently wasted. (Tefera and Abass, 2012) argue that food waste and loss is a large and increasingly urgent problem and is particularly acute in developing countries where food loss reduces income by at least 15% for 470 million smallholder farmers and downstream value chain actors, most of whom are a part of the 1.2 billion people who are food insecure. They further point out that globally, food waste and loss consumes a quarter of global freshwater and a fifth of farmland on unconsumed food. The world population will reach 9 billion by 2050, and with 2 billion more mouths to feed. (Tefera and Abass, 2012) caution that If food loss is not reduced, food production in developing countries will need to increase by an estimated 70% and this requires an investment of $83 billion per year.

Post-harvest loses can be categorized as qualitative losses (such as loss of caloric and nutritive value, loss of acceptability by consumers, and loss of edibility) and quantitative losses (which is loss of produce due to poor handling during packaging, processing and transportation.)

Locally post-harvest loses are generally due to limited knowledge of the issue and of ways to prevent and reduce it, limited technical know-how of smallholder farmers, limited access to credit and financing. Local farmers lack proper storage facilities and infrastructures. Those who have storage facilities lack the expertise of neither management of storage facilities and prevention of pest infestation during storage. Apart from causing quantitative losses, pests are also linked to aflatoxin contamination and poisoning of produce especially grain during storage.

Local millers pay more for grain that is at safe moisture content (around 12-13%) to avoid quality deterioration during storage. Smallholder farmers without storage facilities end up selling their grain soon after harvest before it reaches the optimal state to avoid losses due to several environmental factors such floods. Consumer dissatisfaction with produce quality also plays a huge role in postharvest losses; most of the time local retailer opt to import agricultural produce due to this. In other instances, farmers can produce large quantities of good-quality produce but then lack a dependable, fast, and equitable means of getting such commodities to the consumer and end up losing produce due to spoilage. Moreover, most handlers involved directly in harvesting, storage, packaging, and transporting of produce have limited or no appreciation for quality maintenance or the need thereof. Therefore, there is no enough demand to justify the need for agro-dealers to import or manufacture harvesting and postharvest handling equipment.

Other challenges

It will be unfair not to credit the government of Botswana for trying to address these challenges that farmers face through the ISPAAD programme (mentioned earlier). The main objectives of this help scheme is to increase grain production, and promote food security at both household and national level as well as help commercialize agriculture through mechanization. Besides increase in cultivated land, the programme has not been a success. Botswana still import large amounts of agricultural produce especially grains and cereal. one of the reasons being that there is not enough technical expertise put into implementing this scheme, farmers are provided with generic fertilizers without soil testing and analysis or consideration of the agro-ecological zone. Soil fertility is still a major challenge for smallholder farmers in Botswana, the country has marginal soils; therefore generic fertilizers will not bring forth any desired results more especially that they are used alongside low yielding genotypes which are also rain fed. There has to be precision in addressing soil fertility, and such measures should be tailor made to suit specific soils needs.

Through this scheme, farmers are also provided with generic pesticides and herbicides. The use of generic pesticides and herbicides has led to pests' pesticide resistance and resurgence. Most of the times when field is sprayed with a pesticide, not all of the insects will die, and the ones that remain will produce offspring that will also be tolerant to the pesticide. This forces farmers to continue using pesticide in large quantities and adding more chemicals which eventually get carried away by run-off and eventually end up in a water sources.

Furthermore, land tilling operations are carried out with consideration to soil profile or any other physical conditions like moisture, stability or its pre-consolidation stress. This has led to heavy soil compaction (discussed earlier) and elevated soil moisture loss due to extreme soil inversion. For a country that is experiencing severe water scarcity, conservation farming (zero till) should be a priority. In addition, extension outreach and farmer training has been more demonstrative than practical, it is an inarguable fact that there is great inadequacy in learning just by observation.

Proposed solutions

Drip Irrigation

Figure b
Source; Getty Images

With Botswana, experiencing shortage in water, and fertilizer application deemed as a costly and energy intensive endeavor, perhaps the most economical solution would be practice of zero or reduced-till farming as well as drip irrigation where applicable. These farming systems conserve soil moisture and reduce energy and time consumed in the field. Drip irrigation or fertigation is a method of providing nutrients and water to crops that minimizes the waste of the nutrients and water. It can require little to no energy and can drastically increase the energy efficiency of growing food. Drip irrigation can increase yields by up to 50% while saving up to 40% in water consumption. It can also saves energy required to pump, filter, and transport water in areas with little or no rainfall. Over the years, there has been an increased use of drip irrigation in light of global drought conditions.

(Fishelson and Rymon, 1989) state Israel as a perfect example to support the aforementioned statement, they point out that most of the cotton in Israel, is grown under drip irrigation. Israel is a major exporter of fresh produce and a world-leader in agricultural technologies despite the fact that the geography of the country is not naturally conducive to agriculture. Its natural water supplies are below the UN definition of water poverty, but nonetheless farming in Israel is a highly advanced. The country has almost tripled land used for farming, and allocates 17 percent of its national budget to agriculture. Today, Israel manages to produce 95% of its own food. (www.factsaboutisrael.uk).

As the graph below shows, the highest yields that can be obtained from irrigation are more than double the highest yields that can be obtained from rain fed agriculture. Furthermore, the table shows that, even low-input irrigation is more productive than high-input rain fed agriculture.

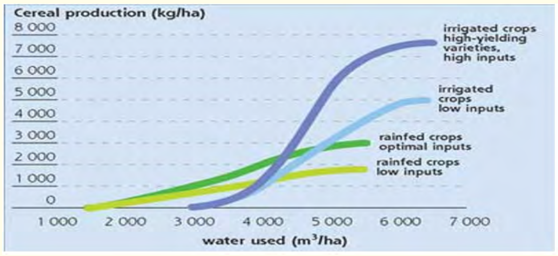

Figure c

Source: Crops and Drops-FAO.

Water resources management

According to (FAO 2016) for dryland like Botswana it is important that there is planning, designing and managing for multiple uses of water resources. (FAO, 2016) further states that multiple benefits can be derived from the synergetic use of water resources, resulting in greater water-use efficiency and more services for all. Water storage (e.g. reservoirs) and water-supply infrastructure (e.g. multipurpose dams, canals and green infrastructure) can be designed and managed in ways that more effectively serve the needs of water users for irrigation, livestock watering, homestead gardens, habitats for fish and other aquatic resources.

Reuse of treated wastewater for food and non-food production is another option to consider, if food safety is ensured. Wastewater has the advantage of being readily available, regardless of the weather. Food safety standards and guidelines will therefore be needed to ensure that crop, agroforestry and fish production using wastewater streams meet human health standards. (FAO 2016) also suggests another alternative, water desalination – though it can be an expensive source for developing countries like Botswana.

(Botswana Water Sector Policy Brief, 2012) states that the country has over 210,000m^3/day in wastewater, this means that Botswana has potential to raise irrigation output from the current 3,000ha to more than double it with a commensurate increase in food tonnage. A commensurate number of jobs would be created in the process also, having reached her peak of dam development owing to the flat topography and thus faced with a cap in terms of water storage capacity, Botswana can still be overcome this challenge by underground storage of surface run-off water. This technology will allow for harvesting of additional water thus improving water security.

Figure d

Conservation agriculture

Botswana farmers can adapt conservation agriculture (CA) systems such as minimal soil disturbance (reduced tillage or zero tillage), crop rotation and soil cover. The systems are highly recommended in favor of conventional tillage practices more so that they reduce production costs and improve the soil fertility status. There is less or no soil inversion, therefore soil moisture is preserved. Zero-tillage technology has since been developed, such as no-till air drills allow for cropping without turning over of the soil thus reducing soil erosion and retaining soil moisture. (Schmitz, 2014) states that benefits from zero tillage include increased carbon sequestration and reduced nitrous oxide emissions, soil erosion and salinity, fuel and labor use, and tractor hours amongst other things.

Other practices include greenhouse nursery technology, use of shade netting to protect crops from high radiation and plastic mulching; which is the use of plastic sheet as mulch or cover

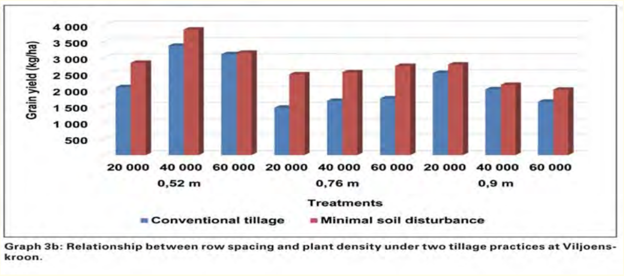

Figure e

Source: ARC-Grain Crops Institute.

Figure g

Source: Farmbiz Africa.

over the crop to reduce soil moisture content loss through water evaporation. Furthermore, plastic mulching can also act as a barrier for weed emergence, thus providing a chemical free and more economical way of managing weeds. (Balraj Singh, 2019) further states that argues that this practice is also suitable for large-scale cultivation of vegetables as well as for fruit orchards.

Figure f

Precision farming

Mandel, Lawes and Robertson [6] argue that adoption of agricultural precision technology is another sensible option; they argue precision agriculture technology offers farmers opportunities to increase profit by simultaneously decreasing wasted resources and labor costs. Some examples include the addition of GPS auto-steer and guidance to reduce overlap during field operations, automatic yield monitors, and variable rate technologies (VRT) for applying liquid fertilizer. However, (Swinton and Lowenberg-deBoer, 2001) argue that the adoption of agricultural precision technology most often occurs in labor-scarce, land abundant countries. Therefore, they caution that in developing countries, precision technology can lead to farmer workers displacement.

Post-harvest management

For storage facilities and infrastructure, farmers can adopt metal silos. Metal silo has proved an effective hermetic storage for grains in countries like Uganda and Kenya. Hermetic storage ensures that there is no insect infestation in grains during storage, and furthermore it preserves seed viability at end of storage.

In Kenya, most farmers have resorted to using metal silos to store grains and insulate them from weevils (which are usually responsible for 10-20 percent of post-harvest losses) and other pest attacks. According to FarmBiz Africa 2018, traditional storage facilities like cribs and gunny bags cannot guarantee protection against the large grain borer that is usually responsible for 30 percent of post-harvest losses in Kenya, sometimes wiping out entire harvests during severe infestations.

In the study "Hermetic wheat storage for small holder farmers in India", Somavat., *et al*. [7] compared the effectiveness of hermetic bin bags, metallic bins and gunny bags for storage of wheat under ambient conditions in India. There was no insect infestation found in clean grains stored in hermetic bags after 9 months of storage. For the artificially infested grains, bored grain percentage remained stable at 0.33% for hermetic bags in contrast to 2% and 8% for metallic bins and gunny bags respectively. At end of storage, seed viability was found to be higher (88%) for hermetic bags compared to 82% and 73% in metallic bins and gunny bags respectively (Figure 1).

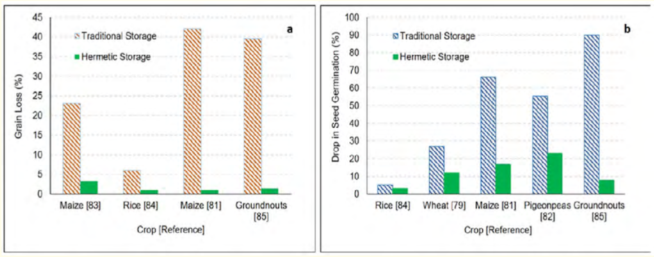

Figure 1

Source: Foods 2017, 6(1), 8; https://doi.org/10.3390/foods6010008.

Amount of losses (a) weight loss; (b) seed germination losses, for various grains due to natural or artificial insect infestation during storage in traditional storage vs. hermetic storage (in the case of a range of losses, an average of the losses was used).

Local manufacturing of farm tools and implement

Moreover, fabrication of metal silos can be done locally, an opportunity for local manufacturing industry to consider. It is evident that mechanization can open other doors of opportunities that can help diversify the country's economy. In countries such as India, China, Brazil, the rapid expansion in farm machinery demand has stimulated the growth of local machinery manufacture to the point where these countries are now major producers and world leaders in farm machinery exports. (Mrema et al 2008) argues that although a broad range of imported machinery is used in Africa, very little of it is specifically designed for the continent's conditions, as manufacturers do not perceive that there is sufficient demand in Africa. This bring an opportunity for local manufactures to pursue partnerships with foreign machinery manufacturers. (AGCO 2012) states that efforts have been made to pursue tractor manufacturing in Africa through joint venture schemes, such as the one between AGCO and Algeria Tractors Company to produce Massey Ferguson tractors. (Houmy et al 2013) gives example of the Nazareth Tractor Assembly Plant in Ethiopia, which assembles roughly 300 tractors per year, which accounted for 46% of tractors entering the Ethiopian market between 2005 and 2010 (World Bank 2012a).

Farmers training and improved extension outreach

Moreover, community sensitization and on-farm trainings should be more practical than demonstrative; the government can make use of unemployed agriculture graduate and hire them as extension officers to reach even the most remote area. A programme like ISPAAD for instance is in dire need of technical expertise and skill of agricultural mechanization graduates. According to (Statistics Botswana, 2014) Botswana, with an overall 97.85% of youth literacy rate still lacks skilled personnel in the agricultural industry. Youth are an asset to any society because of the need for continuity and sustainability of communities. They are a potential resource for sustainable development of any nation. (Oloruntoba, 2002) asserts that youths in all countries are both a major human resource for development and key agents for social change, economic development and technological innovations. Agriculture has over the years evolved from just rearing of animals and growing of crops, it now encompasses application of science and technology to agricultural production and processing. Therefore, the involvement of youth in the sector is of critical importance as they are the ones acquainted with the knowledge, skill and technical expertise to spear head a technology driven and commercially viable agriculture sector envisaged by Botswana.

Agricultural cooperatives

To improve marketing of their produce, farmers can establish agricultural cooperatives. Agricultural cooperatives also know as "farmers' co-op" can be categorized into supply, credit and marketing cooperatives. A farmer needs to buy "inputs" for his farm, things like seeds and fertilizers. After harvest time he wants to sell his produce. Many farmers believe that it would be better to buy their inputs together and to sell their total produce together, rather than each individual buying and selling as best he can. Marketing co-operatives finds ways of selling produce, and supply co-operatives, help to arrange for things that are needed for production, whilst credit cooperatives act as a source of financing for both working capital and investments (MATCOM, 1978).

Agricultural cooperative eliminate the intermediaries, helping smallholder farmers to gain more control in marketing their products, increase the price they receive for their products; reduce the costs of marketing their produce, simplify obtaining agricultural inputs such as seed and fertilizer; and making the market for their goods more secure.

In most cases, local smallholder farmers find themselves restricted to selling to a few individuals in terminal markets (bus ranks) because their volume is inadequate to penetrate more lucrative markets such as agro processing firms or well established retail shops. A marketing co-op, however, will mean sufficient product to supply larger and more lucrative markets where prices can be higher.

Improved plant varieties

Through science and research, improved crop varieties could be developed using traditional plant breeding methods and biotechnologies. Improved crop varieties have the potential to achieve higher yields, increased nutritional content, more tolerance to drought and pests, and/or more efficient use of water and soil nutrients in marginal ecological zones. High yield genotypes can improve crop production and increase its contribution to national food security [8-26].

Conclusion

Mechanizing agriculture can contribute to improved agricultural production and economic transformation, only if agricultural mechanization is made more accessible and effective. One cannot overemphasize the importance of capital investment and proper planning for a successful mechanization revolution. The roles of government in promoting mechanization is appreciated, nonetheless the country has to first overcome poorly planned programs for it to enjoy the full benefits of mechanization. Researchers, policy-makers and relevant expertise need to be involved in all stages of implementation.

Expansion of cultivable land is also important; results have shown that in situations where land is not a constraint, increased farm power can lead to direct increases in production. In cases where the expansion of agricultural land is limited, the application of advanced tools and machines only will not lead to increased yields. Therefore, good farming practices and farming techniques and use of advanced inputs such as improved genotype (seeds), fertilizer, and pesticides, as well as irrigation play a role in improving yield, however desired results cannot be realized without the use of proper tools and machines. L.J. Clarke [2] argues that the level, appropriate choice and subsequent proper use of mechanized inputs into agriculture has a direct and significant effect on achievable levels of land productivity, labor productivity, the profitability of farming, the environment and, finally yet importantly, on the quality of life of people engaged in agriculture. Inappropriate selection and use of farm machinery has in many cases, led to heavy financial loss and lowered agricultural production as well as contributed to environmental degradation.

Technical assistance is required at both farmer level and government level. Farmers require assistance in all aspects of their activities (i.e. agricultural, financial and business planning advice, marketing, stock control, bookkeeping etc.) The government too, might also require assistance to develop the above services that meet the demands of farmers, and this is where private sector comes in. The private sector is in the best position to judge what is best for a particular business and research better about the market as they have skills and expertise that is not usually found in the civil service. The linkage between farmers, private and public sector could be pivotal in "making Kalahari green".

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