Chapter

Challenges and Opportunities of Oil Palm Production in Uganda

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Abstract

Oil palm, a lucrative vegetable oil crop in the world, showed promising adaptability to some agroecologies in Uganda from studies carried out in the 1970s resulting in first commercial establishment in 2005 in Bugala Island, Kalangala district. Further, adaptability studies continue to reveal suitable areas for commercial oil palm production in the country. The infant industry faces an array of challenges, both biotic and abiotic especially in regard to smallholder farmer field management and build-up of pests and disease in the face of climate change both in the nuclear estate and smallholder farmers' fields. The rapid build-up of devastating diseases such as *Fusarium wilt* of oil palm and Ganoderma trunk rot in Uganda is an interesting scenario since they are often expected from second-phase plantings in other areas in the world. However, it may be attributed to the all-year-round weather suitability to pests and disease build-up on native or alternative hosts in most agroecologies in Uganda. This difference from other oil palm producing regions in the world has resulted in recently initiated oil palm Research in Uganda to focus on developing local solutions to challenges facing oil palm farmers in the country.

Keywords: oil palm, Uganda, history, opportunities, challenges, prospects

1. Introduction

The Oil palm (*Elaeis guineensis* Jacq), most suited to areas between 10°N and 10°S of the equator, is a monocotyledonous perennial tree belonging to the family Palmae, Subfamily *Cocoideae*, and genus *Elaeis* [1]. The genus has two main species containing 32 chromosomes; *E. guineensis* the West African oil palm which is the commercial type and *Elaeis oleifera* the South American oil palm used mainly for breeding purposes because it contains more liquid oil and has high resistance to diseases [2–4]. Oil palm originates from West Africa, in the Niger delta, particularly in the belt between Guinea and North Angola in West and Central Africa [5]. It spread widely in the Palm belt of Africa through Sierra Leone, Liberia, the Ivory Coast, Ghana, Togo, Benin, Nigeria, Cameroon, and the Democratic Republic of Congo (formerly Zaire). Through large-scale commercial and small-scale household plantings, oil palm has now been introduced to countries like Burundi, Equatorial Guinea, Ethiopia, Gabon, Gambia, Liberia, Madagascar, Mozambique, Sao tome and Principe, Tanzania, and

Uganda where environment and climatic conditions are suitable. Globally, oil palm production has spread to South-East Asia, particularly Malaysia and Indonesia, which are now the world's leading producers of palm oil and palm kernel oil [6].

Oil palm is the leading source of vegetable oil in the world compared to other oil seeds with an annual production of over 50 million tons accounting for 39% of global annual vegetable oil production [7, 8]. Asia is the highest producer with 86.8% followed by Africa with 6.5%, Americas with 5.5%, and Oceania with 1.2% [7, 9]. In Africa, oil palm is/has been identified to be grown in over 25 countries and is mainly supported by corporate investors [10]. The area under oil palm varies from naturally existing stands in traditional plantations to large commercial plantations in most parts of Africa. Nigeria has the highest area under natural oil palm stands/traditional plantations with 2,500,000 hectares followed by the Democratic Republic of Congo with 1,000,000, Guinea with 2,000,000 hectares, and Togo with 600,000 hectares [3, 10]. In Uganda, one of the countries without traditional oil palm stands, commercial oil palm cultivation was introduced in 1998 through a Vegetable Oil Development Project spearheaded by the government in an innovative public-private-producer-partnership (4P) involving an integrated processor/nucleus estate/smallholder model in the district of Kalangala [9, 11]. Currently, oil palm production in Kalangala exceeds 11,000 hectares and the production has been expanded to the districts of Buvuma and Mayuge. Adaptability studies have revealed that production is suitable in Masaka, Kibaale, Bugiri, and Kagadi [11, 12]. In Kalangala, over 6500 hectares belong to the private sector partner, Oil Palm Uganda Limited (OPUL) while over 5000 hectares belong to medium and small-scale farmers. With oil palm offering four times higher yields of oil per hectare compared to other oil crops, yields of 6–12 tons/ha realized in Kalangala have helped reduce the oil deficit in the country. Furthermore, it has helped to reduce the high poverty rates that existed before the introduction of commercial oil palm production in the then fishing district [13]. Currently, over 5000 people in Kalangala receive regular and reliable monthly payments from fresh fruit bunch sales resulting in reduced fishing activity on Lake Victoria and effectively reduced Uganda's dependency on oil imports [13]. However, average yields of 8 tons/ha are relatively low especially in smallholder farmer fields due to poor agronomic practices, biotic and abiotic stresses directly affecting production. These challenges have been majorly unabated by the low knowledge base on the novel crop and the use of oil palm varieties from Asia, which are poorly adapted to local conditions in the first round of plantings in Kalangala. For example, globally, *Fusarium wilt* of oil palm and Ganoderma trunk rot are expected to appear from second set plantings where they have been reported [14] as opposed to the outbreak of the two diseases in less than 12 years of the first plantings in Uganda [15].

The major challenges threatening production of oil palm range from outbreaks of Blast in the nurseries, Oil Palm Weevil (*Rhynchophorus ferrugineus* Olivier), Fusarium wilt of oil palm and Ganoderma trunk rot, uneven ripening among others in the main fields.

Despite these challenges, the government through its National Oil Palm Project, NOPP has supported the oil palm industry through expansion to newly suitable areas and research for the identification of locally applicable technologies. This has ensured steady growth of the oil palm industry in Uganda over the past 2 decades.

2. Importance of oil palm in diets and income

Oil palm is an economically and nutritionally important crop in all countries where it is cultivated and/or its products imported. It is the most consumed vegetable oil in many countries in Asia, Africa, Central, and South America accounting for 39% of the total global output of oilseeds, overtaking soybean oil as the leading vegetable oil [16, 17]. Oil Palm is grown for its fruits from which the major products are derived including palm and kernel oil, and palm-kernel cake as the by-product [18]. Economically, palm oil products serve as a source of foreign exchange and as a raw material for industrial use. These oils are processed into a wide range of products for industrial and home or food uses where, refined, bleached, and deodorized (RBD) olein is used mainly for making cooking and frying oils, while RBD palm oil (unfractionated palm oil) is used for producing margarine, shortening, vegetable ghee, frying fats, and in the production of ice cream where milk fats are replaced by a combination of palm oil and palm kernel oil. Other than food uses, palm and kernel oils are used in industries to make soap, detergents, and cosmetics; in the chemical industry for plasticizers and coatings. The crude palm oil and its by-products including palm kernel cake, fruit chaff, mesocarp fiber, palm kernel shells, empty fruit bunches are burnt to provide electric energy and fuel (for biodiesel production). On the other hand, empty fruit bunches and palm oil mill effluents are used as farm plant nutrients and as feeds for livestock [18].

In Uganda, Oil palm is mainly grown for industrial use, domestically, it has reduced the country's dependency on imported oils and has provided a readily available source of vegetable oil for improving health standards and food intake. Financially, the production of palm oil has also improved the social standards of smallholder farmers and big population of people working in oil palm plantations for the nucleus estate. The others are employed by those with private oil palm farms and many others along the value chain get monthly remunerations from sale of ripe bunches [13]. Investments in oil palm production have led to improved infrastructure and service delivery in production and surrounding areas which have directly stimulated local economies and opened many areas to tourism around Lake Victoria. Nutritionally, palm oil is the richest source of dietary pro-vitamin A, vitamin E (30% tocopherols, 70% tocotrienols), vitamin K, carotenoids, and dietary magnesium.

Several studies have documented the special characteristics of palm oil. A comparative study with soya bean oil, peanut oil, and lard/fat reported that palm oil had an effect of reducing total blood cholesterol and "bad" low-density lipoprotein (HDL)-cholesterol and increases the amount of "good" high-density lipoprotein-cholesterol. Soya bean oil and peanut oil had no effect on the blood cholesterol but lard/fat increased the cholesterol levels [19, 20]. Other separate studies have also showed the benefits associated with consumption of palm oil in increasing "good" HDL-cholesterol in humans [21, 22]. According to USDA, a tablespoonful of palm oil contains 114 g of Calories, 14 g fat, 7 g saturated fat, 5 g monosaturated fat, 1.5 g polyunsaturated fat, and 11% Vitamin E. The wide range of natural palm oil fractions, have important nutritional and health properties, including antioxidant activities, cholesterol lowering, anti-cancer effects, and protection against atherosclerosis attributed largely to its tocotrienol content. Pro-vitamin E is vital for good vision, a healthy immune system, and cell growth, The major component of its glycerides is the saturated fatty acid palmitic; It has a balanced fatty acid composition of saturated and unsaturated fatty acids where the amount of the unhealthy trans-fatty acids is low in palm oil and it does not require partial hydrogenation ("hardening") to obtain solid fat unlike in some other oils and fats. Palm oil is the only oil with such good culinary characteristics that is cheap and readily available in sufficient amounts. Palm oil is the best alternative oil to use in order to avoid the trans-fatty acids in human diets [16].

As the World Health Organization (WHO) moves to ban trans-fats from peoples' diets, oil palm is gaining increased popularity and demand as a preferred safer oil.

3. Demand for oil palm and its bi-products

Corley [23] predicted that the global demand for palm oil would double and exceed 93 million metric tons by 2050. The increase in demand is attributed to general increase in global population, the relatively lower and stable prices of palm oil and the suitability of oil palm as a crop for vegetable oil production. Demand for palm oil is driven majorly by the food industry accounting for over 80% and the industrial uses including oleo chemical industry accounting for 20% [24]. Palm vegetable oil, a product of either oil palm fruit mesocarp or kennel, is widely gaining acceptance in the food industry due to the decreasing demand in genetically modified organisms (GMO) based oils among consumers and its associated health benefits. Oil palm can also be used in the paper and plywood industry, compressed wood industry, and the renewable energy/biodiesel industry [25–29]. Crude palm oil from the mesocarp fruit has been traditionally used for food in Africa for millennia and remains a main component of food, especially in the west and central Africa. In Uganda, the current entire oil-seed production meets half of the demand and the other half is mainly from crude palm oil imports from South East Asia. Both the locally produced and imported crude palm oil in Uganda are refined into vegetable oil or used in the manufacture of soaps and detergents. The wide gap in demand for palm oil for use in the food, energy, and manufacturing industries is an opportunity for Uganda to exploit through the expansion of oil palm production. This opportunity is being spearheaded by the government of Uganda and its partners through the expansion of oil palm production from Lake Victoria islands to other suitable areas across the country.

4. High income derived from increased demand for oil palm

In Uganda, palm oil and its products are mainly used as cooking oil and as a raw material for soap and detergents. Fresh fruit bunches from the nucleus estate, OPUL, and smallholder farmers are currently produced, gathered, and processed into crude palm oil at OPUL mills in Kalangala before being shipped for final product processing by BIDCO in Jinja. The production of oil palm and processing of palm oil is labor intensive and therefore generates opportunities along the value chain which contributes to an increase in different local income streams [30]. As noted earlier, Uganda imports vegetable oil yet there is an opportunity for increased production. The deficit provides an opportunity for local farmers to involve in oil palm production and alleviate rural poverty given the assured market for their farm produce through currently existing contract farming arrangements with large manufacturing companies. Direct investments in the oil palm-producing Islands have also led to the development of infrastructure and improved service delivery in these tourist hot spot areas generally boosting both the domestic and international tourism industry in the country. These developments as a result of oil palm production have thus provided wider avenues for tax collection by the government of Uganda from not only the different stages of the oil palm value chain but also other growing sectors of the local economy. Generally, Kalangala is performing positively on most development indicators, like roads, local income, farm roads, schools, health centers, and financial institutions contributing to the national gross domestic product (GDP).

5. Increase in demand can be met through research and development

Much as oil palm is still new in Uganda, some considerable amount of knowledge on the crop has been gained. This is courtesy of research with the research team based at the National Agricultural Research Organization (NARO). The research has from the time of inception focused on pests and diseases surveillance and integrated pest management system as a key control method, development of best agronomic management practices for optimal fertilizer uses, and enhancing the capacity of smallholders in agronomic practices to increase the yields [31]. Determination of optimal conditions for harvesting by determination of the time from pollination to ripeness maturity and maturity to fruit rotting. It should be noted that oil palm planting materials currently in use are being purchased from West Africa and South-East therefore, multi-locational trials, should be set up to identify the materials which are better adapted to the Ugandan conditions. Furthermore, training of researchers, in regional and international oil palm research centers both in Africa and South-East Asia like in oil palm breeding for training and acquisition of planting material for breeding trials are vital. Accurate and reliable data capture including weather data from potable automated weather stations and frequent monitoring is important in determining whether these plants can successfully grow under such environment [31]. Further, due to global warming, water retention techniques and some other cultural practices which lead to increased water retention and harvesting are important in oil palm production. There is need to develop an environmentally friendly method of breeding for superior oil palm planting materials suited for Uganda with good characteristics like disease resistance, oils with a higher level of unsaturated fats and drought tolerance with the help of molecular methods since the oil palm genome has been sequenced [32].

6. Challenges in oil palm productivity in Uganda

Despite only being in the second decade of production, the oil palm industry in Uganda faces several biotic and abiotic challenges which have limited production, productivity, and profitability. Production of oil palm started a few years basing on early basic agronomic research on adaptability and potential yields levels. Other production constraints such as fertilizer requirements, pests, diseases, and physiological factors were not prioritized at that time. Thus, the research information gap in Uganda is one of the main production constraints given the difference in environments. Some of the constraints observed in oil palm fields/plantations in Uganda are peculiar and do not tally with observed situations in other countries both in the nursery and in the field. In Bugala island, seedling take 18 months to mature and become ready for planting in the main fields and the time to fruiting has been found to be longer (we need to state the period here) than in other countries. Materials (varieties) grown in other countries have been found to respond differently in Uganda. These varieties have shown different yield attributes for size, number of bunches, un-even ripening, bunch rot all of which affect the production and productivity of oil palm [12].

Agronomic practices: Replenishing the soil with nutrients is vital for increased oil palm production just like any other crop. Oil palm is a heavy feeder and several tones of bunches are harvested and carried out of the field each year and hence mineral nutrients are removed from the soil. Therefore, fertilizers are an inevitable requirement and the major nutrient source in oil palm production. However, farmers do not regularly apply fertilizers in their fields and yet surveys show that oil palm plants have deficiencies characteristic of lack of mineral nutrients. Cover crops that would contribute to soil nutrients have not appealed to farmers and there is minimal adoption of both strategies probably because the fertilizers come at a cost and failure to maintain cover crops. Similarly, no nutrient studies have been carried out to determine the critical fertilizer requirements and the ideal application rates. The information gap and poor soil fertility management options hinder improved production and profitability.

Limited access to oil palm planting materials for evaluation: The oil palm industry in Uganda relies on materials from other countries which have breeding programs and are into seed production. The imported materials are intended for production without prior evaluation. Limited access to materials restrains evaluation and selection of the best materials for particular environments. There is a need to carry out a countrywide prospectus of the available oil palm germplasm and genotype and their characterization so that they can be a source of important genes when a breeding program is established since the oil palm genome has been sequenced [31]. This will also ease the selection of high-yielding varieties.

Physiological disorders: A number of physiological disorders such as non-uniform ripening, bunch rot, and bunch failure have been identified in Uganda [12]. Non-uniform ripening leads to poor fresh fruit bunch quality and high free fatty acid levels which affects oil palm profitability due to the rejection of pour quality fruits at the factory [33]. Bunch failure, the abortion of a bunch before it is fully ripe occurs between 2 and 4 months after anthesis [34]. It is caused by poor pollination and sometimes acute and severe shortage of assimilates caused by lack of water or radiation [14, 35].

Temperature: Temperature is an important factor in oil palm production. It can inhibit growth in seedlings by up to seven times at temperatures equal or lower than 17.5°C in seedlings less than 1 year [33]. Generally, there is undefined strong yield reduction at a minimum monthly average temperature of less than 18–19°C. Therefore, for good oil palm production, the minimum temperatures should be between 22 and 24°C and maximum temperatures between 29 and 33°C. However, there have been records of night temperatures going below 18°C on Kalangala islands which could be one of the key factors affecting optimum oil palm yield.

Pests: The major pest that constrains oil palm production in Uganda is the oil palm weevil, *Rhynchophorus phoenicis* [36]. At the nursery stage, chewing Lepidopteran larvae including the armyworm have been identified. In the field, the oil palm weevil has been recorded in areas where oil palm trials are established and across all the oil palm-producing blocks in Kalangala islands. The irreversible damage caused affects the optimum yield per unit area. The pest life cycle takes place in the oil palm host plant or other alternative hosts and during development, the larvae can excavate over 1 meter in length into the oil palm plant which dies within 3–4 months after infestation [37]. It is not always easy to detect weevil infestation before the damage caused by the larvae is seen. Measures taken to control the weevil have majorly been application of diluted insecticide directly on the affected and surrounding tissues. The efficacy of using pheromone traps and sugarcane as a lure are being evaluated by our research team but are yet to be adopted by the farmers. However, management of the weevil has been complicated by the fact that oil palm weevil larvae are a delicacy in some parts of the country like the Kalangala islands where some people rear them for consumption and sale.

Diseases: *Fusarium wilt* of oil palm (**Figure 1**) and Ganoderma trunk rot (**Figure 2**) are the major diseases affecting oil palm production in Uganda [15]. In other oil palm growing areas in the world, *Fusarium wilt* of oil palm and Ganoderma trunk rot often occur from the second phase of planting or following replacement of coconut plantations [14] as opposed to Uganda where they have been identified in the first plantings in less than two decades.

Other diseases observed in Uganda include; Blast disease in nurseries in Kalangala, and Leaf spot, Leaf rust, and Anthracnose in nurseries in Namulonge. Research in

Figure 1.
A Fusarium wilt *of oil palm-infested field in Kalangala district.*

Figure 2.
Standing (A) and fallen (B) Ganoderma trunk rot diseased palms observed at Kituza, Mukono district.

Uganda has adopted measures that include evaluating imported seedlings for resistance/tolerance to local disease strains such as *Fusarium wilt* of oil palm before being recommended to the private sector. Adoption of good cultural practices and selective use of tested chemicals are also being strongly recommended for use in the management of oil palm diseases in Uganda.

Rainfall: Generally, Uganda's weather is characterized by two rainfall seasons separated by short spells of drought around the Lake Victoria crescent where oil palm is most suitable and longer periods of drought in the North and Eastern parts of the country. Oil palm requires sufficient amounts of rainfall for efficient growth throughout the year. When all conditions are favorable, an oil palm plant transpires approximately 6 mm of water per day and this requires that there is a sufficient amount of water in the soil. However, the average transpiration rate in the dry season is 1.0–2.5 mm per day while in the wet season, average transpiration is 4.0–6.5 mm per day [38]. When the amount of rainfall is low leading to moderate or severe water stress, oil palm growth, and hence yield are strongly suppressed leading to delayed emergence of new leaves although old leaves do not wilt [39, 40]. Increased water stress, results in decreased photosynthetic rate and this is worsened by increased vapor pressure deficit even when the soil water is sufficient [41]. During the dry spell, oil palm production is limited however, research in Malaysia has shown that irrigation application during such periods produces a linear relationship between that water volume and oil palm yield [41]. It is therefore important to explore different options like irrigation as well other water retention methods.

Limited collaboration with other oil palm research institutes: limited research collaborations with other institutes or organizations involved in oil palm research especially internationally led to slow information and knowledge exchange. Similarly, technical backstopping is important for Uganda to establish a successful oil palm production value chain and research program. Poor information flow within the stakeholders hinders quick responses to production challenges in the nascent oil palm sector in the country.

7. Opportunities in oil palm production

The growing demand for palm oil is being driven by increasing population associated with increased demand for food with industrial palm oil products being central in the food industry and other associated industrial uses. Furthermore, in addition to the local market, the growing retinal and international market is pushing especially developing countries with suitable conditions for oil palm production including Uganda to adopt or expand production of the crop. In Uganda, this is being achieved through expansion of the area under oil palm cultivation through attraction of large commercial farmers and inclusion of local small-scale farmers in setting up new oil palm plantations across the country (**Figure 3**). Among other opportunities as discussed below, Uganda's equatorial climate characteristic of a mean annual rainfall of about 1180 mm and average temperature of 18–35°C with minimum regional variations in temperature and humidity favor growth of oil palm [42–44].

Breeding and biological technologies for oil palm improvement: Because Uganda imports most of its planting materials from other oil palm growing countries, there is little knowledge about the genetic quality of the planting materials available for farmers and research in Uganda. This has partly contributed to the poor physiological quality of the planted trials as farmers are unable to identify hybrids from

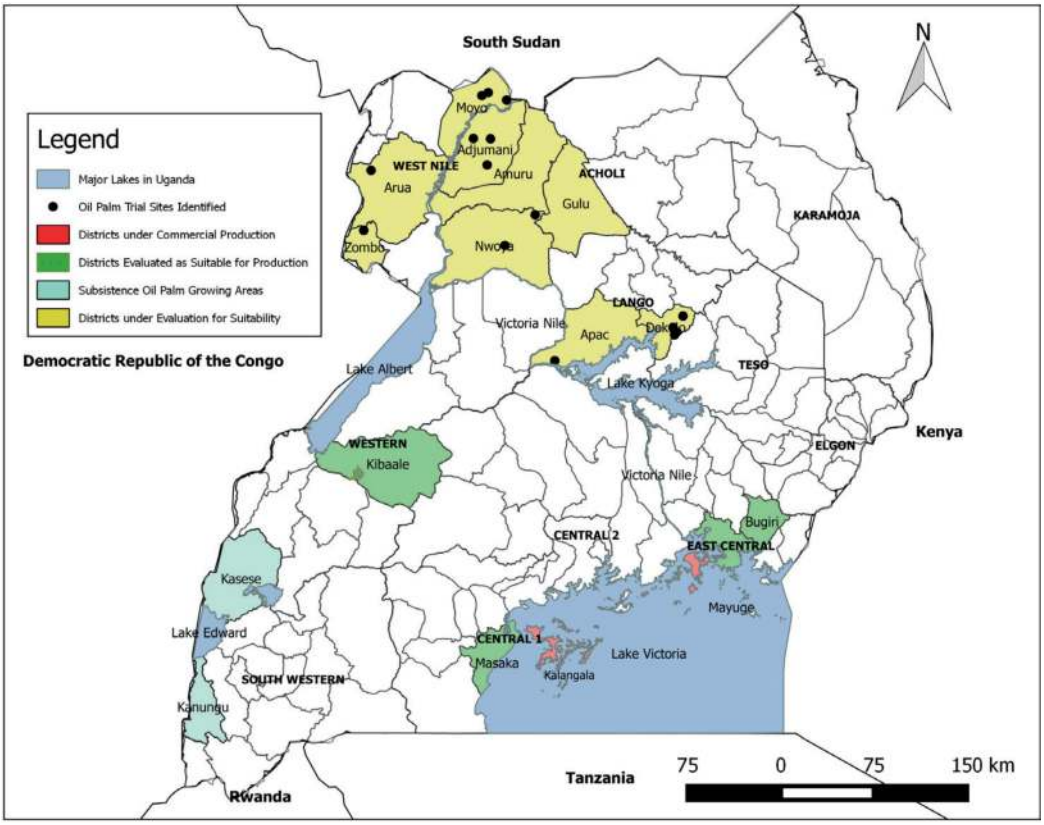

Figure 3.
Map of Uganda showing current oil palm commercial production districts and adaptability study areas.

non-hybrids. Therefore, in the long run, research in Uganda intends to identify and characterize the genetic quality of oil palm seedlings, using morphological and molecular tools. This will eventually lead to the identification of particular genes of interest to be incorporated in the breeding trials for the production of quality planting material that can benefit farmers while addressing local challenges.

Agronomic practices: Well-researched and precise agronomic practices (Improved technologies) reduce the costs of production and improve yields and ultimately profits. Oil palm responds well to good agronomic practices if it is grown in a favorable environment. The agronomic practices in the field start right from planting of the seedling through the management until fruiting. Some of the important practices that must be followed include fertilizer application, proper pruning, soil, weed, water, and nutrient management. Fertilizers take a large portion of the production costs under oil palm and must be applied judiciously to maximize profits. For fertilizer application, precise rates are applied to avoid wastage. Fertilizer requirements for oil palm depend on the resident nutrients in the soil that are basically determined by the parent rock and stage of soil formation. In Uganda, rates of between 1.5 and 2 kg of NPK every 3 months per tree depending on the age of palms are applied. Nutrient deficiencies from Mg and Boron are often identified, and in such incidences, rates of 1–1.5 kg and 60 g of Dolomite and Borate are applied, respectively, per tree. To supplement on soil nutrient retention, larger areas have adopted the use velvet bean (*Mucuna pruriens*) as cover crop. Further, oil palm factory effluent and empty bunches are being applied in oil palm fields to improve soil nutrient levels and soil characteristics. The use of velvet bean has been resisted by small scall farmers due to the high labor requirement to manage its vigorous growth, climbing attributes and the reported high incidence of snakes in such fields. For the above reasons, research has embarked on the characterization, multiplication and promotion of *Arachis pintoi* (Pinto nut) as a cover crop in place of velvet bean. Pintoi requires less management due to its short growing thick cover attributes which can make it easily appealing to farmers in Uganda and it is effective in controlling weeds, fixing nitrogen, protecting the soil from erosion and providing organic matter [45]. Weed management is also important in oil palm production. Weeds depress the performance of oil palm by depriving the palm trees of resources and suffocating them leading to few bunches formed per tree [46]. Manual slashing, chemicals and use of cover crops are the common practices used in controlling weeds under oil palm production in Uganda. Chemical use should be limited to a few times in a year because of the potential for environmental pollution, chemical residual accumulation and deterioration of soil and water health since production in Uganda mostly occurs around lake Vitoria crescent. Manual slashing is a bit costly compared to cover crop and efforts are underway to help farmers understand the value of this technology to reduce costs.

Pruning: Pruning is important in oil palm production and affects bunch production particularly the number and size of bunches. The ideal number of fronds per tree is between 32 and 40 with few fronds on a tree and un-pruned trees producing low yields [47]. The impact of agronomic technologies on oil palm production and productivity is obvious. It however varies with environment and location citing the need for tailoring such practices to the specific oil palm producing environments. However, in Uganda, knowledge of these management aspects is majorly applied basing on what has been done in other oil palm producing regions.

Tolerance to pests and disease: Oil palm is a perennial tree with capacity to sustain profitable output for over 25 years. This relatively long-life productivity exposes oil palm to gradual and/or rapid build-up of pests and diseases both in the nursery and the main fields. Oil palm is prone to infestation by various pests and diseases at different stages of growth respective of the growth location. In Uganda, several diseases and pests have been reported. Fusarium wilt of oil palm and Basal stem rot [15] are the major challenges facing oil palm in Uganda. These diseases have posed a threat to the oil palm commercial production currently at its infant stage. *Fusarium wilt* is the most important disease of oil palm in Africa and is notable in replanted fields [48]. In Uganda however, *Fusarium wilt* manifested in the first planting of commercial plantations in both young (<5 years) and older palms (>5 years). *Fusarium wilt* in older palms in Uganda exists in two forms, that is, "acute" and "chronic" wilt. In chronic wilt, the oil palm older fronds wilt before desiccating and breaking near or at some distance from the petiole and hang downwards around the palm trunk. The young fronds remain erect but gradually get small and chlorotic in appearance. In the acute form, the fronds maintain their erect position but die rapidly within 2–6 month. Internally, brownish-gray or black discoloration develops in the vascular system across the trunk as a result of build-up of plant defenses such as gum, tylose, and gels against the growing pathogen [48–50].

Basal stem rot is a disease of both young and old palms that restricts water movement within the plant causing failure of newly and fully elongated formed leaves/spears to open, collapse of lower and older leaves from the petiole cloaking the palm trunk, drooping and yellowing of young leaves which later die back from the tip [51, 52]. Internally, both the roots and the stem are affected. The tissue in the lower stem characteristically turns yellowish from the inside and can easily break while outer tissue blackens accompanied with appearance of distinctive fructifications and often gum exudates. This is followed by collapse of the whole plant or falling off of the entire crown.

Bunch rot is increasingly causing rotting of fruits before maturity among oil palm farmers in Uganda. The cause of the diseases has yet to be identified in Uganda but the major causes globally include *Marasmius palmivora* and "over bearing" in palms [12, 53]. Other diseases of oil palm identified in Uganda include; Leaf spot, Leaf rust, Anthracnose and Blast.

Oil palm weevil (*Rhyncophorus phoenicis*) is the most important pest of oil palm in Uganda responsible for fall of productive palms in all the oil palm producing blocks in Kalangala district [36]. Other pests of importance in Uganda include; Elephant beetle (*Augusoma centaurus*), and the Rhinoceros beetles (*Oryctes monoceros*). However, the larvae of the oil palm weevil are a delicacy in Kalangala and a significant source of accessible cash further complicating the management of the pest in the Island.

Research: Oil palm is a novel commercial crop in Uganda and as such, research is paramount in regard to identifying and addressing challenges associated with production of the crop in the country. Never the less, research in Uganda is tasked to develop local solutions to identified challenges given the dependency on foreign partners not only for seed but also locally untested best management practices. Research has thus considered the establishment of authorized nurseries in the country to ensure timely access to quality planting materials especially by resource limited farmers. This has ensured access to planting materials during the planting season and at the same time availability of locally tested and approved physiologically healthy genetically superior planting materials that will eventually boosting oil palm production. Without an active breeding program in the country, Uganda has imported a diversity of oil palm seedlings with varied genetic potential. Therefore, there is a need for an improved understanding by researchers on what type of oil palm varieties are essential for improvement. This can be done by first maintaining and conserving the genetic quality of existing yield generating varieties. Additional steps for controlling genetic quality might include the regulation and enforcement of standards, mass sensitization, and further research to establish characteristics which might allow early differentiation between hybrid and non-hybrid material as abasis for a breeding program in the country.

8. Future prospects for oil palm research in Uganda

The prospects for oil palm research are high in a similar way as the economic importance of the crop. The increasing demand for the oil palm products in the country, the information gap and the subsequent need to provide research solutions to sustain the oil palm industry in the country altogether will propel oil palm research in Uganda. Some of the areas that require attention which will provide useful information for increasing production and productivity in the oil palm sector include: Conducting fertilizer studies to establish the critical nutrient levels and fertilizer application rates for oil palm, determine the suitability of the different areas in the country for oil palm production, evaluate new materials for adaptation to potential areas identified for oil palm production, adopting locally customized research to establish some of the standards locally suitable in our environment such as planting distance, soil conservation and nutrient management under oil palm production, oil palm disease and pest identification and integrated management, regular farmer trainings to disseminate knowledge on better management and increased productivity, and locally applicable best management practices.

To the future, the oil palm research system should focus on production of hybrid varieties as they are more yielding and resistant to diseases. But because this requires technical steps including the selection of parents, inflorescence isolation, checking the inflorescence at maturity and controlled pollination, there is need for training of more oil palm researchers to work to contribute to the development of sustainable production of oil palm in the country.

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Conflict of interest

We declare no conflict of interest.

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