IMPROVING OIL PALM PRODUCTION IN UGANDA THROUGH RESEARCH

NATIONAL OIL PALM PROJECT (NOPP)

RESEARCH REPORT AS OF JULY 2023

NATIONAL CROPS RESOURCES RESEARCH INSTITUTE (NaCRRI)/
NATIONAL AGRICULTURAL RESEARCH ORGANIZATION (NARO)

AUGUST 2023

Table 1: A summary of achievements and challenges faced during implementation of oil palm research as of July 2023

Output	Indicator	Annual target	Achieved	Remarks	Challenges
Existing Oil palm adaptive trials are maintained	Number of acres maintained	16	16	All trial sites maintained	Some sites foregone as a result of budget limitations
New oil palm adaptive trials established in Mid North and West Nile region	Number of oil palm adaptive trials established	23	23	Oil palm adaptive trials established in Apac, Dokolo, Nwoya, Zombo, Arua, Moyo, Adjumani	
Oil palm yield data collected from adaptive trials	Number of oil palm yield data sets	8	7	6 datasets collected by July 2023 and 1 data set collected since July 2023. 2 Off-station datasets not collected as of July 2023	It was not possible to collect data from some sites as a result of budget limitations
Best Management Practices (BMPs)demonstrated in Kalangala	Number of BMP plots maintained	5	4	4 BMPs demonstrated on smallholders farmers in Kalangala	Some sites and activities such as fertilizer application foregone as a result of budget limitations
Determine pollination weevil diversity & its relation to climate in Kalangala	Number of trials established	3	2	1 trial conducted as of July 2023, 2nd trial established as of September 2023	Lack of funds delayed establishment

Determination of maturity rates from anthesis to bunch ripening	Datasets collected	3	3	All trials established as of September 2023	Establishment was delayed by shortage of funds
Fusarium wilt and Ganoderma surveillance to prevent further spread conducted	Number of Surveillance reports	4	1		1 of 4 surveillances conducted due to budget limitations
Develop Ganoderma pathogen isolation protocol developed	Number of isolation protocols	1	0		Activity put on hold due to delayed release of research funds from NOPP
Oil palm pest surveillance and control methods designed	Number of surveillance conducted	4	1	Only one on-station pest control trial established as of July 2023 5 trial established in Kalangala as of Sept 2023	Limited funds available to buy enough pheromone traps delayed the trial establishment
	Number of datasets collected	4	1	Only one data set collected as of July 2023 and 6 datasets as of 1st September	Shortage of funds limited data collection

Executive summary

The National Oil Palm Project (NOPP) is mandated to identify and expand commercial oil palm production in Uganda. The suitability of areas for oil palm production is best determined by evaluating the performance of oil palm in these areas. The NARO research team has identified and planted oil palm adaptive trials in West Nile, in the districts of Arua, Zombo, Moyo and Adjumani and in the districts of Dokolo, Apac and Nwoya of Mid Northern Uganda. With the aim of evaluating yield performance, 5 varieties from CIRAD-Benin, supposedly exhibiting Fusarium wilt of oil palm resistance, Ganoderma trunk rot tolerance, short stature and drought tolerance traits are under evaluation under different agro ecologies.

The research team continues to evaluate oil palm growth and yields on-station and on-farm in different agro-ecologies. Data collection is yet to begin in the newly established trials. On station trials exist at NaCORI Kituza and at NaCRRI – Namulonge. The trials provide data for benchmarking Uganda's oil palm industry with the rest of the oil palm producing countries. The old trial at NaCORI yielded 14.01 ton of fresh fruit bunches per hectare while the young trial at NaCRRI yielded 1,489 bunches and 10.8 ton/ha. The growth parameters have increased with age to a canopy of 8.1 m, height of 2.14m, girth 2.7m.

Arachis pintoi has been earmarked as a potential cover crop for oil palm. Its short stature, ability to cover the ground and potential to fix nitrogen make it an appropriate cover crop. Seedlings have been prepared and circulated to increase its distribution and enhance adoption among farmers. Studies are underway to determine the appropriate propagation methods for easy multiplication of the cover crop for large scale planting.

Findings from trial on maturity indicated that oil palm in Kalangala takes an average of 6.3 months to mature from the time of flowering. This information will be important in developing the harvesting index for Kalangala hub.

Rhynchophorousphoenicis (African oil palm weevil) remains an important pest affecting oil palm fields. A study on pheromone traps has been initiated to assess their effectiveness in controlling the pest. Surveillances also focus on any other pests that may exist in the fields and trial sites.

Training was conducted with the extension officers in Buvuma hub. The training was aimed at skilling the oil palm extension officers in site selection, establishment, and management of young oil palm fields.

Three 3 acres of land have been earmarked for research to establish a research plot in Buvuma. The research plot wills serve as a testing area of research materials and also as a demonstration field.

In devising sustainable measures for the management of Fusarium wilt of oil palm, 250 oil palm seedlings imported from CIRAD-Benin were planted in fields infested with Fusarium wilt of oil palm and Ganoderma trunk rot in Kalangala. These seedlings will be evaluated for performance against the major disease over a period of not less than 5 years.

In the BMPs, measures for management of Fusarium wilt of oil palm in Kagulube block and management of Ganoderma trunk rot in Kayunga block are demonstrated.

To furthermore improve on the achieved results, a number of activities have been planned.

1. Maintain the established new oil adaptive trials in mid north and West Nile region.
2. Evaluate Fusarium wilt under field condition for resistant oil palm varieties
3. Manage BMPs in Kalangala and established BMPs in Buvuma
4. Finalize evaluation of diversity of pollinators in Kalangala during wet and dry season.
5. Continue surveillance, identification and management of both major and currently minor diseases of oil palm in Uganda.
6. Continue with surveillance of oil palm pests in Kalangala and develop integrated oil palm weevil management strategies through use of different traps and suitable cultural practices.
7. Demonstrate appropriate oil palm technologies and products to the public through field demonstration plots and agricultural exhibitions.

Challenges in conducting the research activities

1. Limited human resource capacity. Despite which, research knowledge base is significantly growing in research and farmer experience.
2. Research lacks a reliable vehicle. This has made it difficult for the research team to effectively conduct surveillances, monitoring, management and data collection in trials, etc.
3. Delay of funds has severely affect coordination of research activities, their timely implementation and expected output vis-a vis planned annual targets.

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INTRODUCTION

In Uganda, edible oil demands of over 120,000 metric tons immensely exceed the production capacity of about 40,000 metric tons annually. Increased vegetable oil production capacity per unit areas is one of the measures identified by the government to bridge this gap in Uganda. Oil palm is the most productive vegetable oil crop in the world yielding up to 9 tons of oil per hectare yearly. In Uganda, the government is supporting oil palm production in order to reduce dependency on vegetable oil imports from south East Asia.

Indeed, oil palm has spurred the socio-economic transformation of the poor communities after two decades of its introduction in Kalangala islands in Uganda. The government is expanding oil palm production to other suitable areas across the country. With the success registered in Kalangala, oil palm has proved to be a potential crop that can improve livelihoods of the farming communities involved in production.

Despite the success in Kalangala, expansion to other areas is preceded by trials to determine the suitability of such areas for oil palm production. New areas have been identified and trials established in Mid North (Dokolo, Apac, Nwoya districts), North (Gulu, Amuru, Omoro districts) and West Nile (Adjumani, Moyo, Arua and Zombo districts) to assess the performance of oil palm and also test the new materials with characteristics of Fusarium resistance, drought tolerance, drought tolerance, short stature (slow growth) and high yields.

In the active production areas and trials, various devastating challenges threatening oil palm production in the country have been identified. These include but are not limited to; poor agronomic practices, physiological disorders, diseases outbreaks, pest infestations, farmer ignorance, and uncertain climatic conditions. Currently, majority of challenges are tethered to non-adherence of recommended practices such as weed management, proper pruning and fertilizer application routines.

Physiological disorders and disease out breaks are a major threat to oil palm production in Uganda. Preliminary surveys indicated the presence of bunch rot, bunch failure, uneven ripening, Fusarium wilt (*Fusarium oxysporum* f. sp. elaeidis), and *Ganoderma* stem rot (*Ganoderma* spp.).

In order to devise appropriate management strategies for the current outbreak of Fusarium wilt of oil palm, novel oil palm materials are being evaluated for resistance to Fusarium wilt of oil palm.

Similarly, pests especially *Rhynchophorous phoenicis* (African palm or red strip weevil) and giant beetles have devastated oil palms in Kalangala. These bore into the crown or root bulb of a young palm causing frond chlorosis. Currently, the African palm weevil is the most significant oil palm pest in Kalangala district. A study on pheromone traps has been initiated to assess effectiveness in controlling the pest in Uganda.

Despite these interventions, oil palm research is facing challenges that can potentially impact oil palm production in Uganda. These challenges range from infrastructure limitations, limited knowledge regarding the crop among various stakeholders and novelty of the crop in Uganda. In this regard, considering the production constraints at hand, the following objectives guide the research:

Objectives

1. Develop agronomic practices aimed at increasing oil palm yields of small-holder farmers.
2. Conduct physiological studies on oil palm growth, yield and maturity to inform optimum harvesting conditions.
3. Conduct oil palm disease surveillance and design sustainable integrated control measures.
4. Conduct oil palm pest surveillance and design integrated control measures.
5. Capacity building and dissemination of developed technologies through appropriate pathways.
6. Coordinate Research.

ANNUAL PROJECT ACHIEVEMENTS

OUTPUT 1: Develop agronomic practices aimed at increasing oil palm yields of small-holder farmers

Establishment and Maintenance of New oil palm trials

The National Oil Palm Project (NOPP) is responsible for expanding commercial oil palm production to suitable agro-ecologies across Uganda. The National Agricultural Research Organisation (NARO) is tasked with identifying suitable areas and varieties for commercial oil palm growing in Uganda's agro-ecologies. NARO established 23 acres of oil palm adaptability trials with 5 Tenera hybrids under evaluation for yield, drought and disease tolerance. The trials are in Apac, Dokolo, Nwoya, Adjumani, Moyo, Arua and Zombo districts.

The established trials will be under maintenance and proper agronomic management to facilitate good growth and eventual yields of the varieties under test. Maintenance activities commenced in December 2022. Slashing, ring weeding and creation of the fire bands were carried out in the 23 acres of the oil palm trials. The fields were prepared ready for the next round of fertilizer application.

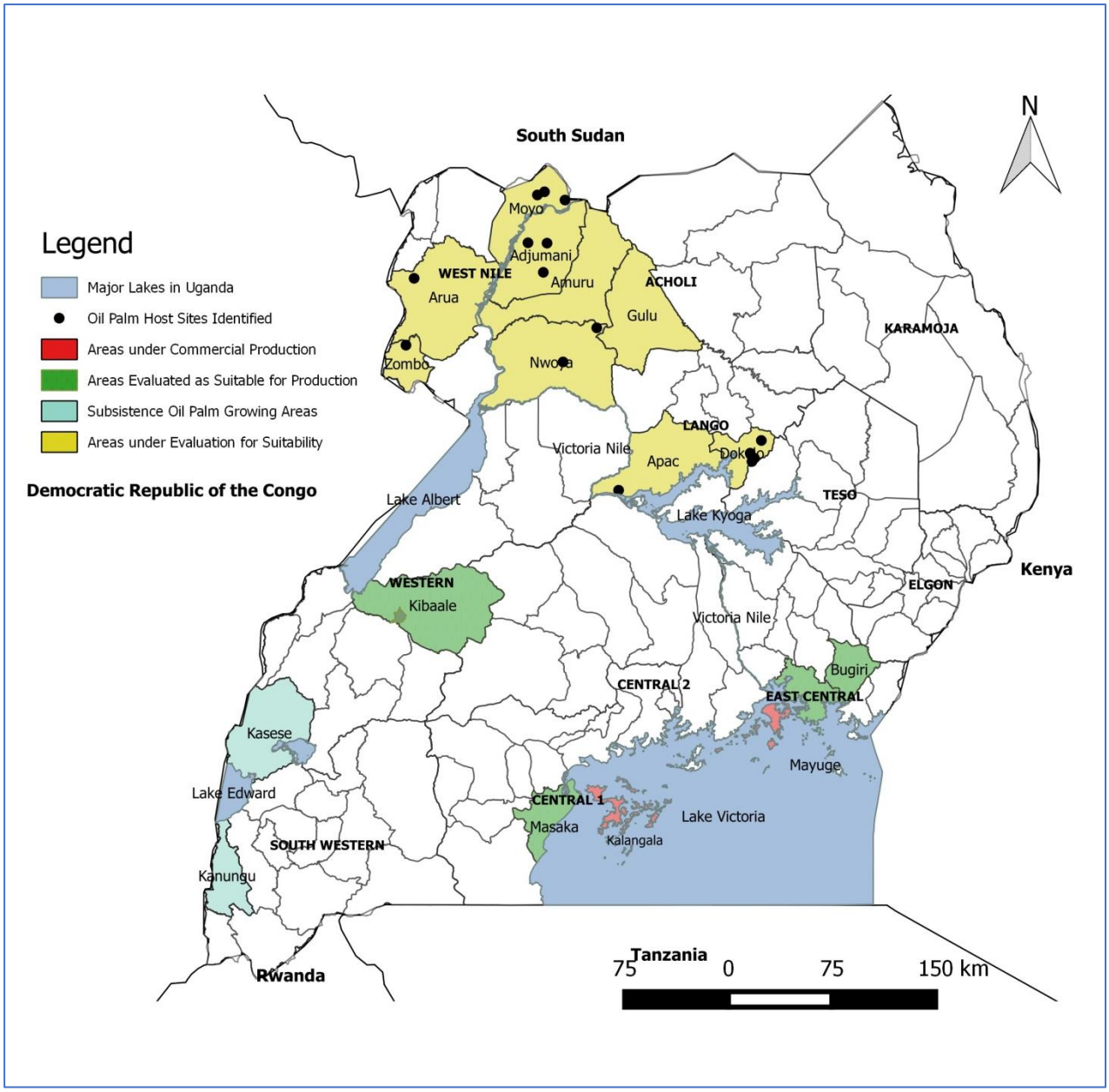

Figure 1: Map of Uganda showing oil palm production and study sites.

Figure 2: A maintained oil palm trial in Dufile Sub-county, Moyo district

Figure 3: An oil palm trial field planted in Kango sub-county, Zombo district

Existing oil palm adaptive trial growth and yield performance:

The old trial at NaCORI Kituza yielded 13.6 ton of fresh fruit bunches per hectare while the young trial at NaCRRI yielded 11.8 ton/ha and 1,590 bunches. The bunch weight has increased from the previous 6.3kg to the current 7.4kg. The growth parameters have increased with age to a canopy of 8.1 m, height of 2.14m, girth 2.7m.

Yields obtained from the old trial in Kituza reduced compared to the normal steady trend. The difference could have been caused by the lapse in fertilizer application. The yields of the trial in Namulonge are showing steady increase overtime. This is expected and the trial is growing towards the peak period of production in the oil palm production cycle.

Table 1: Growth parameters for oil palm trees at Namulonge for March 2023

Location	Canopy size (M)	Plant Height (M)	Girth (M)	Number of fronds	Number of spears	Frond length	Frond width
Namulonge A	8.1	2.14	2.7	39.8	4.1	3.4	1.4
Namulonge B	7.7	2.02	2.4	35.6	4.8	3.07	1.25

Table 2: Yield data for the new oil palm research trial at NaCRRI for the year ending in June 2023

Bunch number	**Bunch weight (Tons)**	**Average bunch weight (kg)**
1,489	10.8	7.2

Table 3: Oil palm Yields parameters for Kituza for the year ending in June 2023

Bunch number	**Bunch weight (Tons)**	**Average bunch weight (kg)**
694	14.01	20.2

Cover crop management trials:

Arachis pintoi has been earmarked as a potential cover crop for oil palm. Its short stature, ability to cover the ground and potential to fix nitrogen into the soil make it an appropriate cover crop in oil palm.

Multiplication of the cover crop and distribution to farmers has been approved by the oil palm consultant. However, preparation of planting materials from sods leaves the source bare and requires a large area of established cover crop. Using the research plot at Namulonge as

the source of material, studies are underway to determine the appropriate propagation methods for easy multiplication of the cover crop for large scale planting of the cover crop.

Meanwhile, seedlings have been prepared and circulated to some oil palm farmers to increase the distribution of the cover crop and enhance adoption among farmers.

Figure 4: Pinto nut (*Arachis pintoi*) growing in the oil palm farmer's field

Cover crops fix nitrogen in the soil, control soil erosion and control weeds among other functions. *Arachis pintoi* can fix about 146kg N ha^{-1} $year^{-1}$(Rose *et al*., 2019) relieving the farmers of costs of fertilizers, minimizing the risks of pollution of water bodies with fertilizers and also by control erosion. It also reduces the costs of weed management by controlling weeds and the frequency of weed control. *Mucuna bracteata* is the only cover crop available for oil palm farmers in Kalangala but farmers have not adopted it citing its vigorous growth and regular management and very thick ground cover among others. Arachis pintoi which is low growing and not vigorous is presented as an alternative.

OUTPUT 2: Physiological studies on oil palm growth yield and maturity to inform optimum harvesting conditions conducted

Determination of variation in oil palm pollinator weevils in Uganda

Survey experiments have been initiated in mature oil palm plantations that are at least five years old in out-grower fields in Kalangala, and adaptive trials in Bugiri, Mayuge, Buvuma, Masaka, Kibaale, Kagadi, and Bundibugyo to determine abundance and sexual variation of pollinator weevils on blooming male inflorescence. The male inflorescence is safely removed from the plant. Three spikelets are taken out of the male inflorescence's lower section on each side of the flower, then three more are taken out of the middle section on each side of the flower, and three more are taken out of the top section on each side of the flower. The three spikelets from the various portions are safely packed in three distinct sealable packs and delivered to the NaCRRI entomology lab, where counting is done.

Physiological challenges including bunch failure and bunch rot in some locations were reported Masika. Poor pollination is one of the reasons for challenges including bunch failure and uneven ripening. The pollinator weevil population in Kalangala and other oil palm growing regions of Uganda is to be determined in order to assess how they affect oil palm bunch development, bunch rot so that assisted pollination can be implemented in areas of need. Preliminary results show that most of the study areas have sufficient number of oil palm weevils. A final report is being, drafted while further studies to determine weevil population needs to be carried out to determine the causes of parthenocarpy

Determination of maturity rates from anthesis to bunch ripening

The time span from flowering and pollination to fruit ripening in Ugandan conditions must be carefully examined in order to ascertain the oil palm maturity period. By using this knowledge, the proper harvesting standards that are appropriate for the environmental circumstances in Uganda may be developed, minimizing any losses caused by the present harvesting standards that might not be suitable for the local conditions.

Preliminary trials have been running continuously in Kituza, Mukono District, Bugiri and now Kalangala since February 2019 to determine these time frames. Before anthesis, the fields are inspected to identify female inflorescences. Selected palms were tagged and their flowers were then isolated before being treated with a 40% formalin solution to destroy any foreign pollen and broad-spectrum insecticides to prevent insect pollination. Preliminary

results have shown that oil palm in Uganda take a period of six months to six and half months to mature the final data is to be collected at the beginning of October and a final report will be written. This will give a clear indication of the true time from anthesis to maturity that will help to set standards for harvesting hence increasing quality of the harvested fresh fruit bunches and maximize profits.

OUTPUT 3: Major diseases of oil palm identified and their management options developed

Disease outbreaks are part of the biggest challenges facing the oil palm industry in Uganda. Identification and development of sustainable management measures to oil palm diseases is one of the tasks assigned to oil palm research. As a result, both major and minor nursery and main field disease of oil palm have been identified in the country, including; Leaf spots of oil palm, anthracnose, rust, blast, Fusarium wilt of oil palm and Ganoderma trunk rot. The occurrence of these diseases, especially Fusarium wilt of oil palm is threatening the development of the oil palm industry in Uganda.

Management of Oil Palm Disease

Fusarium wilts of oil palm

Surveillance in Kalangala

Trend studies were initiated in Kalangala to monitor periodic disease incidence and severity in infested fields. Data is collected quarterly from these areas with the aim of understanding spread of Fusarium wilt in the district and devising sustainable management strategies. This is part of an early warning strategy to cub infection and improves farmer awareness on identification and management of Fusarium wilt of oil palm.

Methods

At least 14 oil palm plots in 5 blocks have been identified and marked for data collection. Fusarium wilt occurrence, average severity and percentage incidence data are collected quarterly. Average severity is assessed using a 1–5 scale on at least 20 oil palms in a marked 100x100m area. The scale is represented by; 1= no visible symptoms, 2= symptoms on less than 25% of the leaf area, 3= symptoms cover 50% leaf area, 4= symptoms on entire leaf

area, 5= stunting, deformation, and death of the plant. Incidence is calculated as a percentage of symptomatic palms observed in a given period.

Results

The incidence and severity of Fusarium wilt of oil palm is still relatively higher in localized fields in Kagulube block (Fig…..). However, palm nutrition and management is poor in the severely affected fields in the block'

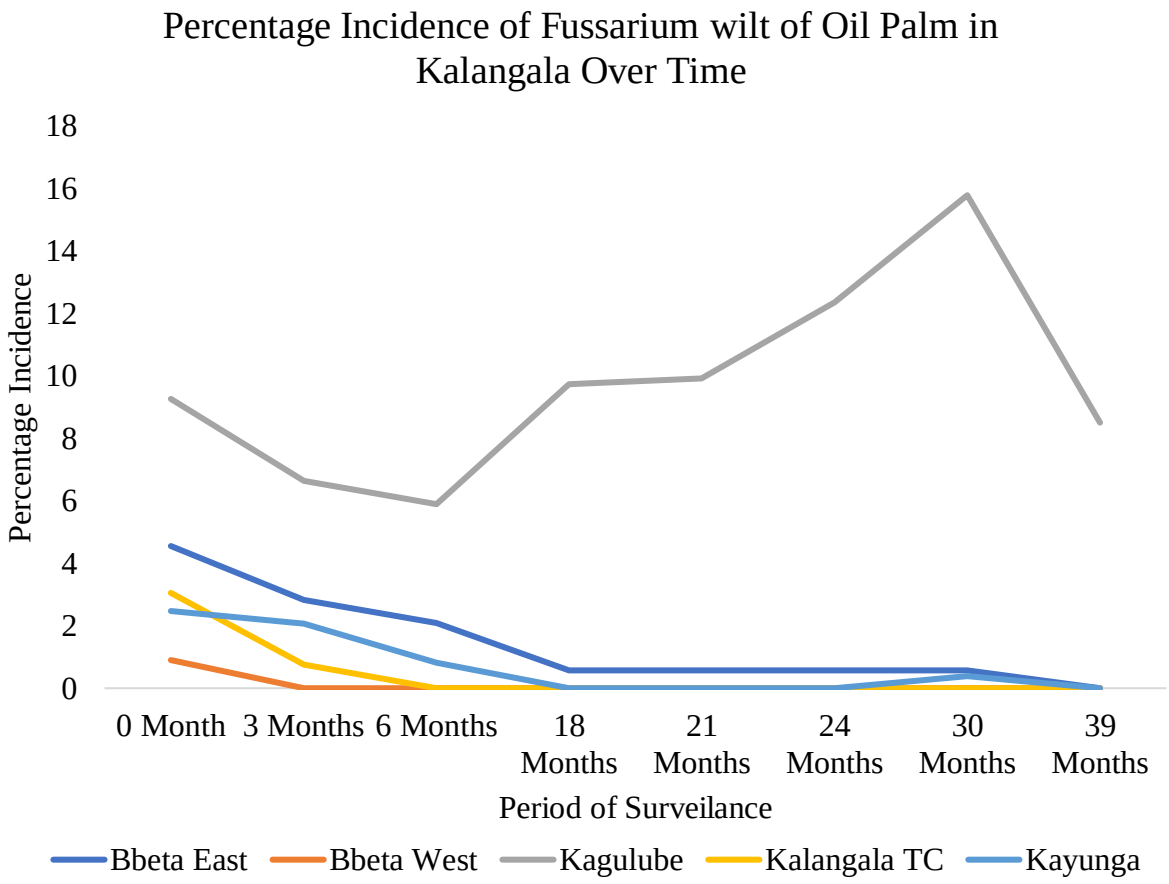

Figure 10: Percentage incidence of Fusarium of oil palm at 0, 3, 6, 18, 21, 24, 30 and 39 months.

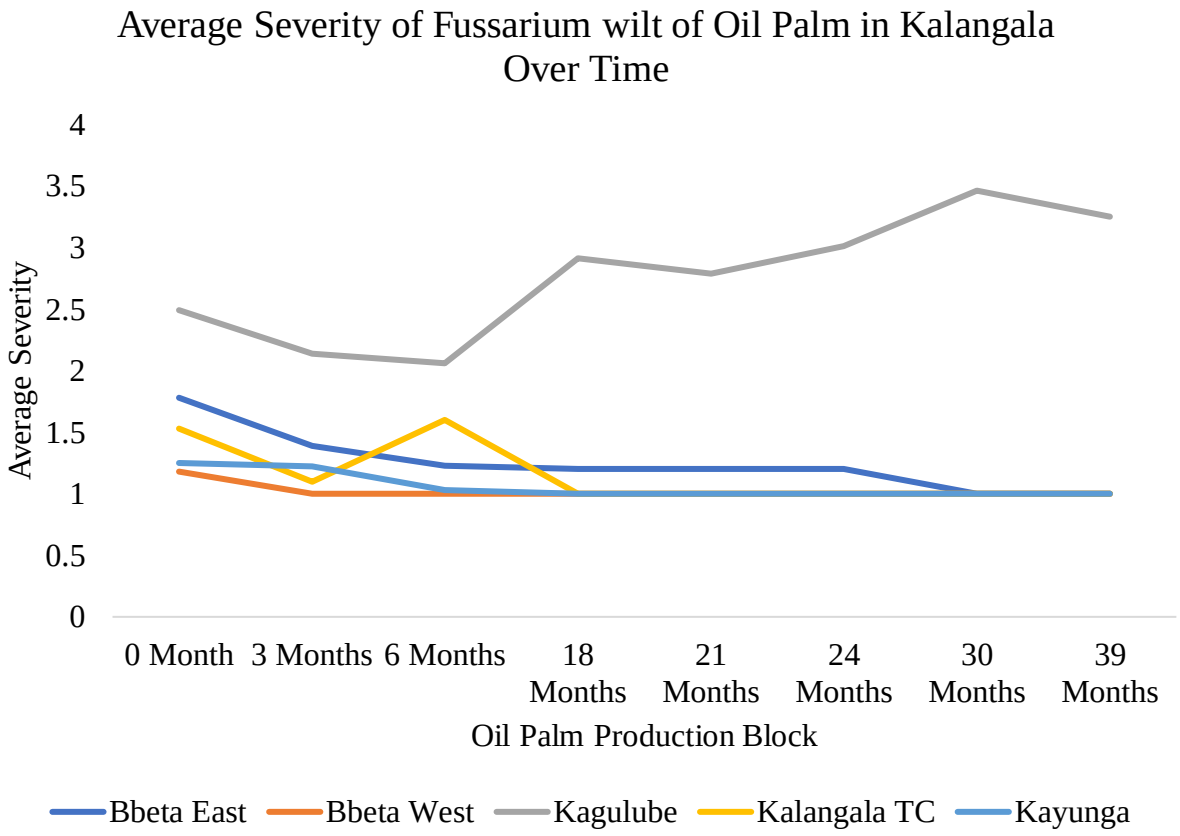

Figure 11: Average severity of Fusarium wilt of oil palm at 0, 3, 6, 18, 21, 24, 30 and 39 months.

Surveillance in Buvuma

Following reports of wilt symptoms in Buvuma, a team from research and PMU visited the affected areas. The symptoms observed included moderate foliar chlorosis and necrosis along the fronds. Older fronds were more affected. The areas visited included Tome, Bukabale and OPBL production blocks. Internal discoloration was not observed in sampled palms. The symptoms observed were not typical of Fusarium wilt of oil palm. However, samples were collected for further laboratory analysis.

In the laboratory, analysis of processed sample cultures for structure, colour and arrangement of hypha and spores showed that the necrosis and chlorosis was caused by fungal infection typical of anthracnose and leaf spots.

Figure 5: An affected palm with necrotic symptoms on the older fronds observed in Buvuma

Figure 6: Internally, no discoloration was observed in the affected fronds in Buvuma.

Evaluation of Oil Palm Materials for resistance to Fusarium wilt of oil palm and Ganoderma Trunk rot

Five oil palm varieties, imported from CIRAD-Benin, were evaluated under screen house conditions for resistance to local strains of Fusarium wilt of oil palm over a period of 6 months.

Phenotypically, all varieties showed resistance to the local strain of Fusarium wilt of oil palm. Mild Fusarium wilt symptoms were observed externally (Figure 5) and internally (Figure 6) after 6 months of the experiment. However, for conclusive results, the experiment needs to be repeated with susceptible varieties.

(a) (b)

Figure 7: An inoculated seedling with dry older leaves after 6 months (a) and an experimental seedling after dissection to reveal internal discoloration

To evaluate for resistance under fields conditions, similarly, 150 seedlings were planted in a Fusarium wilt of oil palm hotspot field in Kagulube production block (Fig. 3). The seedlings were planted as a replacement of suspected Fusarium wilt diseased palms in a severely infested and poorly nourished fields in Kagulube. Baseline data collection and observations do not show any Fusarium wilt of oil palm related symptoms in the young palms. Data (occurrence, average severity and percentage incidence) will be collected bi-annually over a period of 5 years (short term) and over 10 years (long term).

Figure 8: A seedling being planted in a Fusarium wilt of oil palm hot spot field in Kagulube

Best Management Plots for Fusarium wilt of oil palm and Ganoderma trunk rot:

To demonstrate best management practices to farmers in the management of Fusarium wilt of oil palm and Ganoderma trunk rot, *Arachis pintoi* (pinto nut) was planted in the best management practice, BMPs plots in Kayunga for Ganoderma trunk rot and Fusarium wilt of oil palm in Kagulube block as a cover crop. Pinto nut is intended to replace the more vigorous and harder to manage Mucuna that had been ignored by small scale farmers in Kalangala.

The pinto nut is expected to minimise soil erosion, improve soil biomass and thus the soil structure and nutrient content while effective reducing spread of both Fusarium wilt and Ganoderma trunk rot in the affected field through improved palm nourishment and reduced soil movement.

Figure 9: Soil mounting and uprooting of fallen trunks in a Ganoderma trunk rot BMP site at Kayunga block.

OUTPUT 6: Conduct oil palm pest surveillance and design their control methods

Oil palm weevil, *Rhynchophorus phoenicis* (Coleoptera: *Curculionidae*) is a key pest of palms in Kalangala. The research team at NaCRRI does surveillance of oil palm pests, including oil palm weevils. Environmentally sustainable management options have been designed to control oil palm weevil, including use of sex pheromone traps, bio-insecticides and improved agronomic practices.

Oil Palm weevil infected trees per acre:

A higher number of fields assessed in Bbeta West and Bbeta East showed 8.2% and 6.8% infected trees per acre compared to Bubembe and Bbeta East. The growers whose fields were assessed noted that oil palm weevil infected trees range from 1-14 trees per acre (Fig. 10). It was also noted that a higher number of oil palm weevil infested trees were in lowland oil palm plantations when compared to infected trees in the upland plantations (Fig. 11)

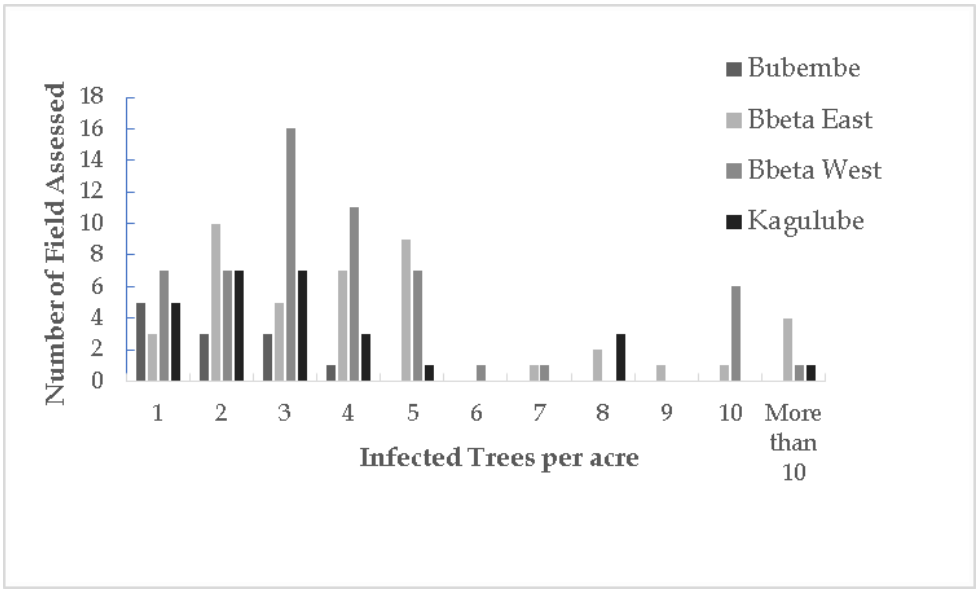

Figure 10: Estimated trees infested trees/acre by the oil palm weevils of the four blocks

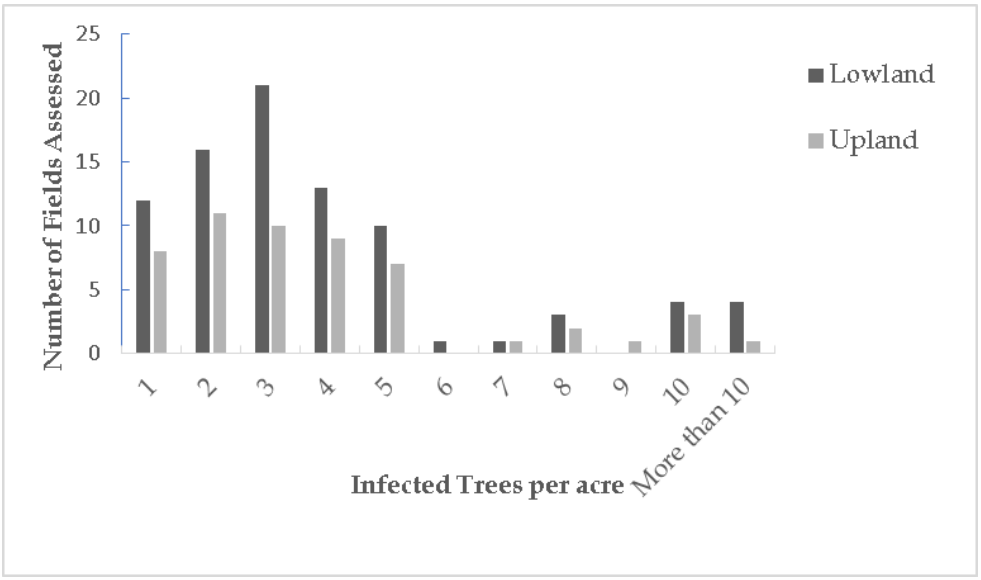

Figure 11: Estimated infested and damaged trees/acre in low land and upland plantations

(a)

(b)

Figure 12: Assessment of oil palm farms for oil palm weevil infestation and damage in the trunk (a) and in the canopies (b), Kalangala

OUTPUT 5: Capacity building and dissemination of developed technologies through appropriate pathways

Training of the Hub extension officers

The Oil Palm Research participated in a training organized by NOPP agronomist for Buvuma hub extension officers. The training was aimed at skilling the oil palm extension officers in

site selection, establishment, and management of young oil palm fields. The extension staff were given knowledge that would help them in field situations related to oil palm in the early stages of the plant establishment and care including ideal site selection, lining, holing, planting, nutrient deficiency identification, fertilizer application, pest and disease control.

Figure 13: Demonstration on management of a palm in a waterlogged area

Research Plot in Buvuma

The project aims at transferring oil palm production knowledge through practical participation and observation. Three 3 acres of land have been earmarked for research to establish best management plots in Buvuma. These will be planted with three oil palm varieties under testing in Uganda's conditions that have characteristics of Fusarium resistance, Ganoderma tolerance and drought tolerance. Establishment of these sites will take place in the first quarter of 2023/2024 financial year.

To furthermore improve on the achieved results, a number of activities have been planned.

PLANNED ACTIVITIES FOR FY2023/2024

1. Maintain the established new oil adaptive trials in mid north and West Nile region.
2. To fast-track importation of some leguminous plants for assessment and increase the options of cover crops.
3. Establish and manage fertilizer trials in Kalangala district.
4. Evaluate Fusarium wilt under field condition for resistant oil palm varieties
5. Efficiently manage BMPs at Kalangala and established BMPs in Buvuma
6. Finalize evaluation of diversity of pollinators in Kalangala during wet and dry season.
7. Continue surveillance, identification and management of both major and currently minor diseases of oil palm in Uganda.
8. Continue with surveillance of oil palm pests in Kalangala and develop integrated oil palm weevil management strategies through use of different traps and suitable cultural practices.

Challenges in conducting the research activities

1. Limited human resource capacity - the project lacks a fulltime entomologist and as the project spreads out the scope of work has increased
2. Research lacks a reliable vehicle. The two old vehicles often break down and are not fit for long distances.
3. Delay of funds delays implementation and limited funding of the oil palm research activities compared to the planned annual targets.

Conclusion

The research activities reported are additive and continuous and results will continuously be generated. Periodically, journal publications, and information materials are published to communicate the research achievements and best management practices. Adaptability trials will be continuously managed to generate data needed to design appropriate management practices for commercial oil palm production. All the research activities in pathology, physiology, entomology and agronomy go a long way to develop the appropriate production practices to improve production of oil palm based on the current trends.