

TASK 3 - GLOBAL FOOD SECURITY - THREE KEY CONSTRAINTS TO THE PLANT HEALTH OF MAIZE (CORN) IN NIGERIA AND DIRECTIONS FOR FUTURE RESEARCH

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TITLE

Research into three key constraints to plant health of maize (corn) in Nigeria and directions for future research.

BACKGROUND INFORMATION

Nigeria is a developing country having the highest population in Africa with over 200 million people in a land area of 923,768 km² and therefore, population density of 217 people per km² (World Data Atlas, 2020). Nigeria is also known as the Poverty Capital of the World (Kazeem, 2020).

Maize is the most important staple food which can provide a balanced diet and is widely cultivated in Nigeria. Nigeria is currently the 12th largest corn producer in the world producing 11 million metric tonnes (MT) of corn per annum (Statista, 2020).

ABSTRACT

Three key constraints to plant health of maize in Nigeria include:

- 1) **Low soil fertility** mainly due to soil erosion, soil salinity, flooding, bush burning and other unsustainable human activities.
- 2) **Pests and diseases** of maize which include insects (armyworms, stem borers, aphids, grasshoppers), fungi (*Aspergillus flavus*, downy mildew), bacteria (bacterial stalk rot), viruses (maize mild mottle virus), parasitic nematodes in soil, vertebrates (rodents, birds, monkeys) and weeds (parasitic weed *Striga*).
- 3) **Water scarcity** due to drought and improper irrigation (Bandyopadhyay, R. 2020).

A review of available data indicates that future agricultural science research should be directed towards more sustainable methods of agriculture including crop rotation and intercropping with nitrogen fixing legumes to enrich soil naturally, as well as diversification of crops in Nigeria into a variety of more drought tolerant crops (for example cassava). These practices will also help suppress crop diseases and pests and reduce over reliance on certain crops (for example maize).

It is also important to educate Nigerian farmers on the best sustainable farming practices (for example cultivating nitrogen fixing legumes) to improve soil fertility and maintain healthy soils with biodiversity.

Effective COVID-19 virus control through strict social restrictions is also essential to safeguard food security in Nigeria being a highly populated developing country.



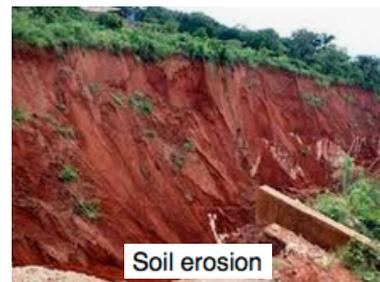
Maize cultivation in Nigeria

Nigerian hybrid maize



Location of Nigeria in Africa

Corn Production by Country in 1000 MT		2019
1	United States	347,782
2	China	260,770
3	Brazil	101,000
4	Argentina	50,000
5	Ukraine	35,800
6	India	29,000
7	Mexico	25,000
8	South Africa	14,500
9	Russia	14,500
10	Canada	13,400
11	Indonesia	12,700
12	Nigeria	11,000
13	Ethiopia	8,400



Soil erosion



Flooding



Armyworms in corn ear



Drought

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THE THREE KEY CONSTRAINTS

The three key constraints to plant health of maize in Nigeria are :

- 1) **Low soil fertility** due to :
 - a) **soil erosion** mainly caused by human activities, climate change and intense rain causing loss of agricultural soil.
 - b) **soil salinity** causing land degradation, dehydration of crops and decrease in crop yields.
 - c) **flooding** which destroys crops and depletes healthy soil of essential nutrients and organic matter.
 - d) **bush burning** resulting in destruction of beneficial soil organisms and soil nutrients leading to low soil fertility, lack of healthy soil biodiversity and soil erosion.
 - e) **desertification** caused by human activities and climate change.
 - f) **drought** from extreme weather conditions mainly due to climate change.
 - g) **ignorance of farmers** on best farming practices in cultivating and maintaining healthy soils for plant health.

- 2) **Pests and diseases** of maize which include :
 - a) **insects** (armyworms, stem borers, aphids, grasshoppers)
 - b) **fungi** (*Aspergillus flavus* that produces carcinogenic aflatoxins in corn ears, downy mildew)
 - c) **bacteria** (bacterial stalk rot)
 - d) **viruses** (maize mild mottle virus)
 - e) **parasitic nematodes** in soil
 - f) **vertebrates** (rodents, birds, monkeys)
 - g) **weeds** (parasitic weed *Striga*)

- 3) **Lack of water** due to :
 - a) **drought** caused by climate change resulting in absence or weakness in the atmospheric rain-generating systems during the rainfall seasons
 - b) **improper irrigation practices** and drainage management by farmers due to lack of education on more efficient and effective irrigation methods.

Considering an additional constraint due to COVID-19 virus -

As long as Nigerian maize farmers practice social distancing to avoid spread of the COVID-19 virus and are permitted to continue farming, this should not adversely affect maize cultivation in Nigeria, however, the maize marketing and distribution transport chains could be affected by any COVID-19 travel restrictions.



Soil erosion



Soil salinity



Flooding



Bush burning

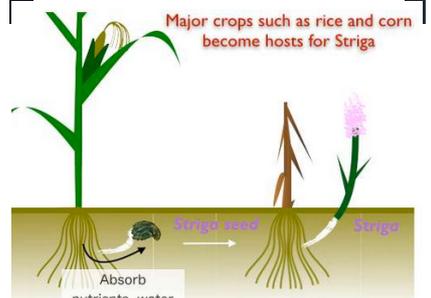


Armyworms in corn ear and armyworm moth



Maize ear infected with *Aspergillus flavus* fungi (Photo: Maize Pathology Laboratory / CIMMYT)

Major crops such as rice and corn become hosts for *Striga*



Striga, a parasitic weed absorbing nutrients and water from roots of corn (Credit: ITbM, Nagoya University)



Drought



Irrigation practices



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DIRECTIONS FOR FUTURE RESEARCH (CONTINUED)

Directions for future research to address these 3 key constraints include (continued) :

2) Pests and Diseases Research

Although successes have been recorded in controlling maize pests and diseases using synthetic pesticides, the following negative impacts must also be considered and taken into account :

- i) the toxic effects and health hazards of pesticides on non-target organisms such as humans, livestock and wildlife,
- ii) the development of pest resistance to pesticides, and
- iii) the pollution of water resources and aquatic life.

It is also necessary to weigh the cost of chemical pesticides versus cheaper and healthier pest prevention options that the farmers can undertake themselves. Future research should therefore investigate the following more environmentally friendly natural alternatives in repelling pests and diseases (Aktar, Sengupta & Chowdhury, 2020):

- a) Research into optimising use of **natural green pesticides from plant extracts** to protect agricultural crops and stored produce from attack by insects and non-insect pests. An example is neem oil, a natural pesticide from neem tree (*Azadirachta indica*) seeds and fruit, containing Azadirachtin, an active component for repelling and killing pests (Chaudhary, 2020).
- b) Research into **effective cover crops after maize** such as *Mucuna Pruriens*, or Velvet Beans to suppress weeds, break disease cycles and reduce populations of bacterial and fungal diseases.
- c) Research into **effective intercropping** with different variety of different crops as natural barriers to break pest invasion and reduce the spread of plant diseases.
- d) Research into modern agricultural biotechnology to create approved genetically modified safe and edible **pest resistant varieties of maize** plants without any negative health effects.
- e) Early **pest detection technology** to effectively monitor crops and detect pests and diseases early so that immediate action can be taken before severe damage to crops. For example, utilisation of satellite imagery and the development of a data base to monitor and immediately provide maize crop protection against armyworm infestations of maize crops.
- f) Research and provision of **effective natural pest control solutions and training for farmers** disseminated via projects such as ICS-Nigeria (Information and Communication Support for Agricultural Growth in Nigeria) recommending steps to deal maize pests and diseases, avoiding use of chemical pesticides as far as possible.

Note : Information and Communication Support for Agricultural Growth in Nigeria (ICS-Nigeria) is a project which aims to increase the quantity and quality of information available for increased agricultural production, processing, and marketing.



Neem leaves, fruit, tree and seeds



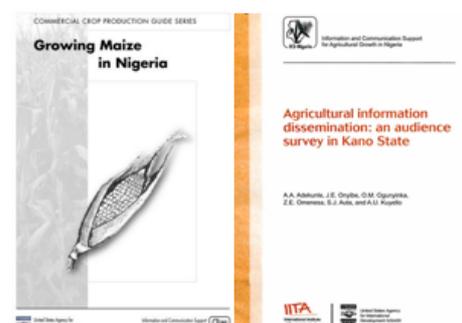
Mucuna pruriens or velvet beans cover crops after maize crops



Cultivating pest resistant varieties of maize



Satellite imagery of corn fields to detect armyworm infestation of maize crops



Increasing quantity and quality of information to farmers for improved maize productivity

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DIRECTIONS FOR FUTURE RESEARCH (CONTINUED)

Directions for future research to address these 3 key constraints include (continued) :

3) Water Scarcity Research

Nigeria has 11 out of 36 states, falling within dessert prone zones. Persistent drought, delay in onset of rains, early cessation of rains, short rainy seasons and pronounced dry spells have caused low agricultural productivity due to over reliance on rainfall for agriculture. Directions for future research should therefore, include the following (Ezeabasili, Okoro & Ezeabasili, 2020):

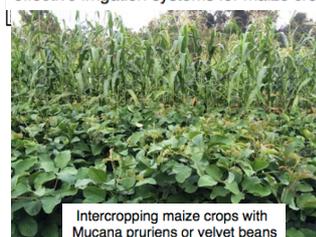
- Research into **effective irrigation systems** that can maximise effective plant water absorption, minimise precious water loss due to evaporation, prevent soil salinity due to improper irrigation, low rainfall and high evaporation, as well as avoid capillary movement of dissolved ground-water salts to top-soils.
- Managing water supply** for maize cultivation via crop water requirement estimations for the following **4 aridity zones** in Nigeria. This will help determine the best agricultural zones to cultivate maize for water usage efficiency (Akande, Costa, Mateu & Henriques, 2020).
 - Humid
 - Moist Sub-Humid,
 - Semi-Arid, and
 - Dry Sub-Humid.
- Research into **monitoring systems** to determine whether effective rainfall is sufficient at the humid and moist sub-humid zones. Then, investigating availability and cost effectiveness of setting up supporting irrigation systems for semi-arid and dry sub-humid zones to meet reduced rainfall expectations.
- Research into **effective intercropping with cover crops** like Mucuna Pruriens or Velvet Beans which can provide pathways for water to steadily trickle down into the soil. This will reduce the quantity and rate of water draining off maize crop fields as surface flow, therefore, contributing to increased soil water storage potential and the recharging of aquifers.
- Research into cultivation of **more drought tolerant maize varieties**.
- In semi-arid zones, where water is scarce and irrigation systems not cost effective, research should be directed towards **replacing maize cultivation with more drought tolerant crops such as cassava**, which produces edible leaves and roots that are a source of carbohydrates (Adeniji, Ega, Akoroda, Ugwu & de Balogun, 2020). Cassava however, contains linamarin (93%) and lotaustralin (7%) which are cyanogenic glycosides and natural plant defence toxins. When the cells of cassava roots are ruptured :
 - an enzyme, linamarase is released, which
 - converts linamarin and lotaustralin to toxic hydrocyanic acid (HCN), also known as prussic acid (Kвете, 2020).



Effective irrigation systems



Research into aridity zones of Nigeria to balance dependence on rainfall with effective irrigation systems for maize crops



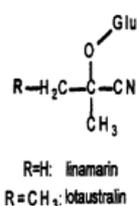
Intercropping maize crops with Mucuna pruriens or velvet beans



More drought tolerant maize varieties

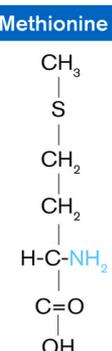


Drought tolerant cassava crops

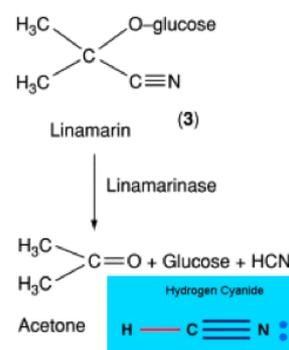


- an enzyme, linamarase is released, which
- converts linamarin and lotaustralin to toxic hydrocyanic acid (HCN), also known as prussic acid (Kвете, 2020).

- As HCN is hazardous to humans and animals who consume it, research should include education in **safe methods of cassava root preparation** (such as cutting into small pieces and boiling in water) to remove toxic HCN before consumption. Further investigations should also include whether **adding methionine** (an amino acid lacking in cassava leaves and roots) can be utilised to detoxify HCN released by cassava.



Cassava contains linamarin which converts to toxic prussic acid or hydrocyanic acid (HCN) when enzyme linamarase is released on rupture of root cells.



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CONCLUSION

Research and review of the three key constraints to the plant health of maize in Nigeria (which include low soil fertility, pests and diseases, and water scarcity) including its causes, indicates that the directions for future research should be directed towards more environmentally friendly farming practices and diversification of crops in Nigeria. This includes rotation cropping and intercropping maize with nitrogen fixing legumes, then digging it into soil as green manure, application of natural pesticides and diversification into more drought tolerant crops (like cassava). Reducing over reliance on certain crops (like maize) will also help suppress and break crop disease cycles. It is important as well, to educate Nigerian farmers on effective solutions to overcome these three constraints via sustainable farming practices, for healthy soil with bio-diversity.

COVID-19 virus control is also essential through strict social restrictions to safeguard food security in Nigeria being a highly populated developing country. It is also equally vital that a serious study into Nigerian population increase rates versus its maize and other food crops productivity should be conducted due to limited agricultural land in this highly populated country. Research should then be directed towards the necessity of introducing birth control measures to strike an achievable balance between sufficient crop cultivation and the food demands of this highly populated nation.



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Entrant details

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