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MATHEMATICAL SOLUTION TO FOOD INSECURITY IN NIGERIA (CASE STUDY OF DAMATURU)

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ABSTRACT

Improving food security depend on identifying the indicators of food insecurity that must be monitored and addressed. This paper was set to address food insecurity in Nigeria through utilization of mathematical skills. Thus it is being recommended that there should be effective and fundamental mathematics education at all levels so as to transform skills realized to solve nation's food insecurity. To achieve this, a case study was adopted which targeted Damaturu local government area of Yobe state. This can be done by introducing new improved varieties of maize which can tolerate soil acidity with the short raining season in the area and also to educate farmers of new strategies of maize farming. Many researchers/authors showed that lack of adequate rainfall in the area, nature of the soil, lack of capital, lack of education and awareness on modern farming system, government inability to subsidize prices of fertilizer were some of problems hindering people of the area from planting maize in Damaturu.

KEY WORDS: Improved Variety, Soil Acidity and Modern Farming System

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1.1 INTRODUCTION

Mathematics is an indispensable subject to humanity because of its versatile application in every aspect of human activity. It is necessary to note that mathematics is of significant importance in the field of engineering and by extension , to all sciences and beyond. It is a solid foundation for every successful Scientist. Studies have shown that many people's images of mathematics are negative and is perceived as difficult in many cultures and largely masculine.

Trombley and Weiss (1993) defined basic mathematics skills as those skills that the majority of high school graduates would be able to perform. They went further to remarked that mathematical skills is a multi-faceted construct that in general, reflects the ability to do quantitative thinking, or more specifically, be able to discover, manipulate and evaluate relationships. According to the National Council of Teachers of Mathematics NCTM(2011), basic skills of mathematics must not be limited to routine computation at the expense of understanding, application and problem solving. The council reiterated that the identification of basic skills in mathematics is a dynamic process and should be continually updated to reflect new and changing needs. According to Odili (1986) and National Council of Teachers of Mathematics, (2011), ten basic skills areas were developed by National Council of Mathematics Supervisors (NCMS).

Achieving global food security requires dramatic change in the current food production system. From better technologies to improved farming practices. There is much to be done to sustainably increase food production while minimizing environmental impact. International Fertilizer Development Centre (IFDC) believes the key to global food security starts with the soil and ends at the supermarket. We strive to develop better fertilizer and production technologies, transfer these improved technologies to smallholder farmers, and connect these farmers to efficient and profitable markets. By working with strategic partners, we build local capacity and ensure sustainable impact. This continuum is supported by our work to foster an enabling environment which includes conducive government policies, knowledge and data management, and smart fertilizer subsidies, among others.

Food security 'exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life' (World Food Summit, 1996). On the other hand, food insecurity 'exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life'. This might be occasioned by unavailability of food, insufficient purchasing power, inadequate use of food or inappropriate distribution channels at the household level. Food insecurity in a country or region may be chronic, seasonal or transitory. To face these challenges, IFDC has developed a new strategy that will guide our work for the next decade. By streamlining our legacy of expertise while also incorporating innovative thinking and expanded partnerships, IFDC remains ready to solve issues of hunger, malnutrition, poverty, and environmental sustainability.

We go beyond short-term answers to complex problems. By working with partners to bridge the traditional gap between research, smallholder farmers, and markets, we strive to solve the greatest food security issues facing the world today. Fundamental improvements in soil and plant nutrition will be required to meet the challenge of sustainably feeding 10

billion people by 2050. Global population growth will drive a substantial increase in food demand, while climate change is already accelerating the risks affecting food production, especially in poorer regions. Major changes in agricultural systems – especially improvements in nutrient use efficiency and soil health – will be required to meet our shared challenge of creating a more food-secure, environmentally sustainable world.

Achieving impact at scale requires research and technology adapted to smallholder needs but must go beyond technology development. IFDC experts and their partners work across the discovery-to-consumer system. This includes testing of advanced fertilizers and related nutrient management technologies; design of fertilizer manufacturing and quality control processes; market systems development; gender and youth empowerment; and applied policy and regulatory analysis. With an emphasis on working with strategic partners and strengthening local capacity, IFDC bridges the traditional gaps between research, technology dissemination, and market systems that often undermine efforts to innovate, achieve results, and sustain impact at scale.

Every year, December 5 is celebrated as World Soil Day. This is the day for all soil lovers, including scientists, policy makers, students and farmers, to talk about the importance of soils for agriculture in general and food security in particular. This day highlights the importance of soils on Earth. The soil provides habitats for many living creatures and supports the production of foods and feeds. In December 2013, the 68th session of the UN General Assembly declared December 5 as World Soil Day. The first celebration was held in 2014. Since then, World Soil Day has been celebrated annually with a different theme each year.

In 2021, World Soil Day was commemorated with the theme, “Halt Soil Salinization, Boost Soil Productivity,” which aims to raise awareness on the importance of managing salinity for soil health and crop productivity. However, in the context of Nigeria, soil acidity is significantly more problematic than salinity. Therefore, with the consent of the UN Food and Agriculture Organization, Nigeria’s theme was modified to “Halt Soil Acidification, Boost Soil Productivity” with the intention of raising awareness of soil acidity and its impacts on crop productivity.

In Nigeria, World Soil Day featured a week-long celebration centered around different events. Celebrations were led by the National Soil Science Research Center (NSSRC) and included events such as soil testing at farmers’ fields, television shows discussing the importance of World Soil Day, press meetings, a conference on “ The Management of Soil Acidity for Prosperity,” a walkathon, and a formal closing ceremony in the presence of high government officials.

Soil acidity is one of the major issues for improving soil health and increasing crop productivity. More than 50% of soils in Nigeria are acidic. Therefore, managing soil acidity is critical to increasing soil fertility and the supply of plant nutrients. Although the Government of Nigeria has identified soil acidity as a major challenge in improving soil fertility, there are no comprehensive plans to correct it. In addition to natural sources such as acidic parent materials, teaching of basic cautions due to rainfall and irrigation and anthropogenic activities such as imbalanced fertilization and low use of organic inputs are increasing soil acidity. Increasing acidity reduces the supply of plant nutrients due to reduced microbial activities; thus, it affects the mineralization of nutrients resulting in

lower crop productivity. The increased availability of micronutrients (iron, manganese, and aluminum) due to higher acidity can be toxic to plants.

Management of soil acidity is crucial for improving soil health and crop productivity. Crop productivity is relatively low in Nigeria compared to other countries in Africa. Without managing soil acidity, farmers may not be able to achieve potential yields even after applying the right amount of fertilizers. Application of liming materials is an effective method for managing soil acidity. However, Nigerian farmers do not realize the importance of liming to improve soil fertility and increase crop productivity. Their perception is that the use of nitrogenous fertilizer urea increases yields. Moreover, liming materials are not available in sufficient time periods or quantities.

As soil acidity is their major problem for soil fertility, Nigeria's Government should raise awareness of farmers to correct soil acidity and ensure a reliable supply of quality liming materials. As most other agricultural inputs including fertilizers are subsidized, the government could provide subsidy on liming materials as well, so that famers will give priority for using lime. There is no any pre-existing policy about production and the use of liming materials in Nigeria. Therefore, the government may need to formulate a policy on use of agricultural lime including its production, application protocols for different crops, quality standards, and a design extension campaign to raise farmers' awareness on the use of liming materials. Research institutions should identify appropriate application rates and timing for each crop based on the severity of acidity. Once soil acidity is corrected, then farmers may be able to achieve crop yield potential.

In addition to the use of agricultural lime, farmers should also be advised to use sufficient amounts of organic inputs in soils including well-decomposed farmyard manure, compost, ash, biochar, and green maturing to correct soil acidity. When there is scarcity of liming materials, farmers may also focus on adaptation strategies such as selecting types of crop that can tolerate soil acidity. However, farmers are not currently aware of these options. Hence, government and other development partners should establish an awareness program for farmers.

Maize production in West Africa is set to get a much-needed boost with the release of improved varieties by the Nigeria National Variety Release Committee. These new varieties address many of the major constraints to maize production such as drought, low soil fertility, pests diseases and parasitic weeds. Researchers developed the varieties through conventional plant breeding by tapping naturally-available traits. The varieties were developed by the International Institute of Tropical Agriculture (IITA) in partnership with the Institute for Agricultural Research (IAR) of the Ahmadu Bello University in Zaria and Institute of Agricultural Research and Training (IAR&T) of Obafemi Awolowo University in Ile Ife, Nigeria. The released maize include 13 open-pollinated varieties of extra-early, inter-mediate and late maturity with resistance to the parasitic weed Striga hermonthica and stem borers, tolerance to drought, and with good adaptation to sub-optimal soil nitrogen. Four hybrids with drought-tolerance have been released.

The released varieties will hasten the adoption of improved maize cultivars by farmers in Nigeria, consequently increasing yields, raising farmers' incomes and improving food security. These varieties have the potential to provide farmers with opportunities to overcome the challenges to maize production in Nigeria. Every year, IITA

distributes improved open-pollinated varieties and hybrids to national partners and private sectors within the country through regional trials. These trials have been used as vehicles for selecting promising varieties and hybrids adapted to specific conditions in the different parts of the country for extensive testing and later release.

1.2 Statement of the problem

We go beyond short-term answers to complex problems. To address food insecurity through utilization of mathematical skills, a case study was adopted which targeted Damaturu local government area of Yobe state. This can be done by introducing new improved varieties of maize which can tolerate the nature of our soil. Three different varieties would be tested for a period of one year.

1.3 OBJECTIVE OF THE RESEARCH

The objectives of this research are :

(i) To examine the soil acidity.
(ii) To find out the challenges faced by farmers concerning maize farming
(iii) To suggest possible mitigation strategies to address the situation.

1.4 RESEARCH QUESTIONS

The following research questions provide guide for this Research:

(i) What are the root causes of low yield in relation with the soil acidity?
(ii) What are the challenges faced by farmers of maize farming?
(iii) What technologies and strategies should be adopted ?

1.5 RESEARCH HYPOTHESES:

Based on the ongoing research questions, the following hypotheses are raised**:**

1. H_0: Farming methods frequently applied have no effect on the yield? H_1 : Farming methods frequently applied have great effect on the yield
2. H_0: Challenges faced by farmers have no effect on the output. H_1: Challenges faced by farmers have effect on the output
3. H_0: Modern technologies and strategies have no effect on the yield H_1: Modern technologies and strategies have effect on the yield.

1.6 CONTRIBUTION OF THE RESEARCH TO KNOWLEDGE

The aim of learning mathematics is not only to know how to add, subtract or multiply numbers, but also to have knowledge and understanding of some of the objectives which include;

(i) To acquire and develop skill in the use and understanding of mathematics,
(ii) To learn and develop technique of problem solving,
(iii) To develop the ability to apply mathematics in his future vocational life,
(iv) To develop the habit of systematic thinking and objective reasoning,
(v) To develops self-confidence for solving mathematical/ other problems,
(vi) To show originality and creativity,
(vii) To develop , appreciate skill in drawing, reading , interpreting graphs and statistical tables,
(viii) To develop skill in measuring, weighing and surveying.
(ix) To generate interest in mathematics and to provide a solid foundation for everyday living.
(x) To develop computational skills
(xi) To foster the desire and ability to be accurate to a degree relevant to the problem at hand like food insecurity
(xii) To develop the precise, logical and abstract thinking
(xiii) To develop the ability to recognize problems and to solve them with related mathematical knowledge
(xiv) To provide necessary mathematical background for further research.
(xv) To stimulate and encourage creativity .

1.7 SIGNIFICANCE OF THE RESEARCH

Mathematics as a subject is very essential for the development of any society. No wonder it is presented as a compulsory subject for learners in both primary and secondary school and also a pre-requisite for gaining admission into tertiary institutions. At the tertiary levels, it is taught so as to produce graduates who are highly skilled to make positive impact on the society (Odili, 1986). The significance of introducing the improved varieties of maize is to have bomber harvest of maize which will boost the food security in Damaturu.

2.1 RESEARCH METHODOLOGY

The method is to sample some hectares of land and apply it for a period of one year using the modern technologies of farming

2.2 RESEARCH LOCATION

This research will be conducted within Damaturu local government area of Yobe State in Northeast geo – political zone of Nigeria. More specifically, the research will be carried out on two hectares of land in two different locations within Damaturu local government.

2.3 METHOD OF DATA COLLECTION

The written (questionnaire) mode of survey administration will be use because it requires minimum resources (time and cost) and is best suited to eliciting confidential information. Written survey allows the respondent the greatest latitude in pace and sequence of response.

2.4 INSTRUMENT OF DATA COLLECTION

The instruments that the researchers will use in collecting primary data for the research is questionnaire. This will be developed on the basis of the literature review that will be conducted. However, secondary sources of data will be utilized.

2.5 METHOD OF DATA ANALYSIS

For the purpose of data analysis and presentation, standard deviation and Chi-Square of descriptive statistics will be used. Generally, descriptive statistics will be used in describing the various features of the research problems. This will also be use to test hypotheses, predict and generalize the research problem based on the sample data collected (Ragasa, 2013).

3.1 BRIEF LITERATURE REVIEW

Many authors observed that there was great progress and improvement from the improved maize variety(IMV) which is measured in terms of genetic gain(Ahmed , 2015), and more recently developed varieties generally confer higher genetic gain. An average gain in grain yield of 13.5 kg ha^{-1} yr^{-1} was reported under drought, 41 kg per hectare per year under Strga. Between 30% and 50% of farmers productivity can be traced back to genetic gain, while the remaining is due to improved agronomy, better market and extension system. Breeding for stress tolerance has resulted in genetic gains under conditions that are similar to farmers' conditions (Weber et al., 2013) and sometimes averted losses after the emergence of new devastating diseases.

Considerable literature exists in explaining factors influencing adoption decisions of IMV using different econometric techniques, some of which are mention above. Most previous and recent studies have shown that household characteristics, farm-specific and institutional factors have a significant influence on adoption of farm technology. Gecho (2011) using logit model posited that farmers' age, maize farming experience, and household labor, among others, significantly explain the adoption of improved maize seed varieties in Southern Zambia. Educational attainment also plays vital roles in enhancing production through farm technology adoption by increasing the capacity of farmers to access market information easily. (Zakazriya, 2013) used Tobit regression model to study the determinants of allocation of farmland to improved wheat variety in Northern Ethiopia. The study found that farmers with higher years of formal education have a higher probability of allocating a significant proportion of their farmlands to an improved variety of wheat seeds. This is because educated households are better skilled and can quickly synthesize production technologies and market information.

Other relevant variables that have been documented by many studies to have significant effects on agrarian technology adoption are on-farm and off-farm income. Diiro (2013) analyzed the impact of off-farm income on agricultural technology adoption intensity and productivity among rural maize farmers in Uganda. The empirical results revealed that income from off-farm activities induces adoption of improved maize variety. However, farm households without off-farm income were more productive than households with off-farm income. Similar results on the influence of off-farm activities on farm technology adoption

were reported by Etoundi (2008) while previous income from rice farm was found to positively and significantly influence the adoption of improved rice varieties among farm households in rural Nigeria. Other farm households' assets and farm-specific characteristics have been reported by many pieces of literature to influence adoption of farm technology including IMV positively. For instance, Ragasa C. et al. (2013) found that household ownership of assets such as radio, television and mobile phones are significant sources of information for new farm technology and hence the likelihood of increasing the level of adoption. A study by Weber et al (2014) in South-Western Nigeria found a negative and significant relationship between total farm size and adoption of improved cassava variety.

Regarding the effects of extension services on agricultural technology, a study by Ahmed et al. (2015) found a positive and significant influence of extension services on an improved variety of cassava among Nigerian farmers. A similar study suggested that credit constrained conditions of farmers explain both probability and the intensity of adoption of sustainable farming practices.

4.1 RESULTS

Research Question 1: What are the root causes of low yield in relation with the soil acidity? The farmers were asked to respond on the root causes of low yield in the area. The result is as shown in table 1.

Table 1: The responses were based on the teaching methods:

S/N	FARMING METHODS FREQUENTLY APPLIED	RESPONSES IN PERCENTAGE
1	Mono-cropping	45
2	Mixed cropping	78
3	Relay cropping	25
4	Shifting cultivation	40

From the table 1 above, the result shows that mixed cropping is the most frequently utilized in Yobe state among the farmers more than the other methods (milet, corn and groundnut) which is one of the root causes of low yield.

Research question 2: what are the challenges faced by farmers for farming maize in the area? The farmers' response on the challenges faced for growing maize in the area are given below in table 2.

Table 2: CHALLENGES FACED BY FARMERS FOR GROWING MAIZE IN YOBE

S/N	CHALLENGES FACED BY FARMERS	NUMBER OF RESPONSES
1	Inadequate rainfall in the area	166
2	Nature of the soil	345
3	Lack of capital	330
4	Lack of awareness on modern farming	400

The table above shows that lack of awareness among farmers on modern system of farming has contributed a lot in having low yield in the area. That is most farmers were not aware of the modern farming system and the improved varieties of maize that can grow easily in the area which will lead bomber harvest in Damaturu doubling the productivity of the outcome.

Research question 3. What technologies and strategies will farmers adopt? The ratings of the farmers' responses on which technologies and strategies to be employed in modern farming system is shown below in table 3.

Table 3: Farmers' perceptions on which technologies and strategies of modern system of farming would be employed are shown in the table 3 below.

S/N	FARMING TECHNOLOGIES & STRATEGIES	PERCENTAGE RESPONSES
1	Application of herbicides	0.80
2	Application of chemical fertilizers	0.75
3	Adopting improved varieties	0.90
4	Early planting	0.65

From table 3 above, you will observe that adopting the improved varieties and application of herbicides or chemical weed control carried the highest percentage followed by the application of chemical fertilizers. These will surely increase the yield and change the life of the farmers positively in Damaturu Local Government area of Yobe State.

5.0 CONCLUSION

Mathematics is an important subject useful in every facet of human endeavour. A good foundation in mathematics is considered a great asset for successful farmers and others.

That is why in concluding, we believe that with mathematical knowledge and skills, food security is guaranteed in Damaturu local government area of Yobe state and Nigeria at large. A mathematical skill enhances significantly creativity in all human endeavours especially in farming and business development. There is need for Yobe state government to encourage the farmers by subsidizing the prices of fertilizers and herbicides to affordable price. Also there should be awareness through agricultural extension services to all farmers in the region both in the rural and urban areas. This will enhance the productivity and food insecurity will be a thing of the past in Damaturu.

5.1 **RECOMMENDATIONS**

In order to get bomber harvest of maize in Damaturu, the following measures are being recommended:

1. Farmers should always be in touch with the experts in field in order to move forward.
2. Government should subsidize the price of fertilizers and other herbicides for farmers.
3. There should be awareness to farmers through radio stations, television, and other social media in order to adopt the new modern farming system.

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