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Change in Yield and Profitability of Improved Soybean Production in Guinea Nigeria (Case Study of Borno and Kaduna States)

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Abstract **– The study analysed the Profitability of Improved Soybean Production as a result of improvement in yield in Nigeria. Nigeria. Primary data was collected from 162 respondents in the (Tropical Legume II) TL II and non-TL II communities in the study area using multistage sampling technique. Findings from double difference (DD) estimate showed that clear difference in crop yields exist between before and after the project. Result from gross margin analysis revealed that the average gross income of the TL II participants was higher by ₦36, 770.5 than the non-TL II participants indicating that improved soybean production is profitable in the study area. Findings from descriptive statistics showed that major constraints faced by the respondents include pest and diseases, lack of market and low price of soybean among others. In view of the above, it is recommended that TL II project be replicated by Borno and Kaduna State Governments and other interested organizations. Non- TL II farmers should copy from the improved soybean farmers. Farmers should be properly linked to existing soybean markets and more should be created by the TL II project to consume the surplus. Farmers need to be trained on the management practices and how to control pest and diseases of soybean by the TL II project.**

Keywords **– Improved Soybean, Profitability, Tropical Legume II (TL II) and Yield.**

I. INTRODUCTION

Soybean cultivation in Nigeria has expanded as a result of its nutritive, economic and diverse domestic uses. Industrial and domestic processing of soybean have given rise to numerous products utilized for both human and animal consumption.

Soybean performs well in the southern and northern Guinea savannas of Nigeria where rainfall is more than 700 mm. The best yield is obtained in well-drained sandy loam to clay loam soils with PH 6 to 7 [6].

Newer soybean inoculants products now offer several advantages over traditional products. The new formulations deliver high populations of bacteria, on the order of 10 to 100 times more than traditional product. Also, newly rhizobia strains have demonstrated improved nitrogen-fixing ability in some studies [11].

The contribution of soybean to the farming system of Nigeria has been recognized [8] primarily to improve nutrition of farm families and diversify income sources. They added that among the grain legumes, interest has often centered on soybean because it has a high commercial value and it is well adapted to the Savannah. Soybean being a leguminous crop has the ability to fix atmospheric nitrogen in the form that can be absorbed by plants and thus improves soil fertility. The [10] advocates that the crop can also be used to control *striga* in addition to its role in improving the yield of cereal crops when grown as crop mixtures or in rotations.

The Tropical Legumes II (also known as TL II) Project, funded by the Bill and Melinda Gates Foundation (BMGF) aims to bring about significant increases in the productivity and production of tropical legumes to improve farmers' income, nutrition quality and livelihoods in the drought-prone areas of sub-Saharan Africa (SSA) and South Asia (SA). The TL II project was implemented in Borno and Kaduna States in collaboration with the International Institute of Tropical Agriculture (IITA). The TL II project developed, tested and promoted improved crop varieties and associated crop management practices which can enhance legume productivity and production primarily to diversify the income sources of the farming households. These new varieties are often referred to as dual-purpose varieties since they are accompanied by many attributes including grains, cash, and net-N incorporation in the soil from which subsequent crops can benefit. As a result, the integration of improved soybean varieties into the existing farming system creates potential benefits from which smallholder farmers can benefit. Due to their attributes and potentials (high Nfixation, ability to suppress Striga, high net returns and also presents the farmers with the much needed alternative cash income source.), the promiscuous dual purpose soybean varieties could trigger and sustain the acceptance of soybean in African countries.

This study will examine soybean yields and profits made as a result of improved soybean technology and agronomic practices. These include variety selection, planting practices (row width, planting date and seeding rate), soil fertility, crop rotation, weed control, use of inoculants and other practices.

The major objective of the study is to analyze the profitability of improved soybean technology due to changes in yield among farming households in Borno and Kaduna States, Nigeria. Other specific objectives were to: asses the soybean yield before and after adopting the improved soybean technology; evaluate the cost and returns associated with the improved soybean technology among the respondents and examine the constraints of using the improved soybean technology among the study area.

II. METHODOLOGY

2.1 *Study Area*

Borno State lies between latitudes 11°30′ N to 14°30′N and between longitudes 10° 30′E to 14°13′E in Savannah of Nigeria. Kaduna state lies between latitudes 09° 20′N to 12° 25′N and between longitudes 06°33′E to 09° 75′E [3]. The agro-climatic conditions of the study area in the two states have remarkable common features. They are both located in the southern part of the states. The vegetation for the two states is guinea savannah type. These make the study area conducive for soybean production. The crop may be grown sole, multiple, mixture, or in relay. It may also be grown in rotation or as mixed cropping depending on preference.

2.2 *Data Collection*

Data was collected from the respondents in the TL II and some from non-TL II communities in the study area using simple random sampling technique.

2.3 *Analytical Techniques*

The Following analytical techniques were used to analyse the data.

i. *The Simple Version of the Double Difference Model*

The model can be specified as follows:

$$DD^{S} = \left[\frac{I}{P}\sum_{i=1}^{P}(Y_{1ia} - Y_{1ib})\right] - \left[\frac{I}{C}\sum_{j=1}^{e}(Y_{0ja} - Y_{0jb})\right] \qquad \text{(i)}$$

DD^S = the difference between the average changes in the two groups

Y_{1ia} = Yield of soybean (Kg) of participants after TL II project

Y_{1ib} = Yield of soybean (Kg) of participants before TL II project

Y_{0ja} = Yield of soybean (Kg) of non-participants after TL II project

Y_{0jb} = Yield of soybean (Kg) of non-participants before TL II project.

P = number of participants

C = number of individuals in the control group

ii. *Margin (GM) analysis*

In order to determine the cost involved in improved soybean production and the profitability before and after the TL II project gross margin was used to achieve this objective. Gross Margin (GM) analysis involves evaluating the efficiency of an enterprise or farm plan so that comparison can be made between enterprises or different farm plans. It is a very useful planning tool in situations where fixed capital is a negligible portion of the farming. Gross margin is therefore applicable in analysing the profitability of improved soybean in the study area since the respondents are small-scale farmers. Gross Margin is the difference between the gross farm income (GI) and the total variable cost (TVC) [9]. The Gross Margin equation is given as:

$$GM = P.Q - \Sigma \beta X_i \qquad \text{(ii)}$$

Where:

P = Price in (₦)

Q = Quantity in (kg)

Xi = Quantity of variables (kg)

β = Unit price of X in (₦)

iii. *Descriptive Statistics*

Descriptive statistics such as frequencies, percentages and standard deviation were used to analyze the problems encountered by the improved soybean technology farmers in the study area.

III. RESULTS AND DISCUSSION

3.1 *Selected Crop Yield (kg/ha) among TL II Participants and Non-participants Before and After TLL II Project*

The researcher principally selected cereals such as maize, sorghum and rice and legumes-cowpea and groundnut cultivated by the TL II participants and non-participants and their yields compared before and after the TL II project. Previous study [12] in the area revealed that (i) incorporation of soybean into the maize-based cropping system has a key role in soil fertility improvement, (ii) grain legumes can be grown in rotation with cereal and also as a second crop using residual moisture, (iii) legume has the capacity to fix atmospheric nitrogen in soils and thus improves soil fertility and save fertilizer costs in complementary crops. This promotes more intensive and productive use of land, particularly in areas of land scarcity. Table 1: presents the yields of selected crops among the participants and non-participants before and after in the study area

Table i. Selected Crop Yield (kg/ha) in TL II Communities Before and After.

Crop	TL II Participants Difference in Yield (before and after)	Non-Participants Difference in Yield (before and after)	DD
Maize	391.7	47.0	344.7
Cowpea	335.8	40.3	295.5
Sorghum	382.7	45.9	336.8
Rice	1020.9	122.5	898.4
Groundnut	837.6	100.5	737.1
Soybean	1164.3	139.7	1024.6

Source: Field Survey, 2015.

Tables i: revealed that difference in yield of crops of the participants after the TL II participation were higher than yields before the TL II project. The high mean difference of yields between the participants and non-participants before and after the project can be seen in the yields of soybean, rice and groundnut. This may likely be as a result of the following reasons: (i) farmers likely to use improved seed, (ii) improved management practices (iii) farmers involvement in the soybean project might have added knowledge on other crops and (iv) access to inputs, especially fertilizers, through TL II project contributed to these higher yields.

The DD result also showed that the mean yield of soybean, rice, groundnut, maize and sorghum among the

participants were higher after TL II project compared to non-participants. This is as a result of introduction and adoption of the technology on soybean and cereal rotation by farmers in the project communities. Typically maize derives benefit from the maize/soybean rotation. Soybean incorporation either in rotation or intercrop with a cereal constitutes one of the low-cost soil fertility management options to smallholder farmers. This has been indicated by [5] that grain legumes (soybean, groundnut, cowpea, chickpea etc) have significant potential to enhance soil fertility, generate cash income, reduce poverty and food insecurity.

3.2 *Costs and Returns Associated with Improved Soybean Production*

The average yield realized from the cultivation of improved soybean in the study area was found to be 33 (50 kg) bags per hectare by the TL II participants and 23 (50 kg) bags per hectare by the non-participants after the TL II project. The soybean yield obtained by the participants is equivalent to 1, 650kg per hectare. The result revealed in this study is close to the estimated average yield given by the Tropical Legume II project [1]. According to the study average estimated yield of improved soybean in Nigeria was expected to be 1, 767kg per hectare. The small disparity between the yield obtained from the study area and the estimated average yield is reflective of farming systems and technology differentials that exist among farmers and agro-ecological zones.

Table ii. Estimated Production Costs and Returns of Improved Soybean Production among the TL II Participants and Non-participants (₦/ha)

Items	**Participants**	**Non-participants**
Variable Cost:	9,716.70	5,472.13
Fertilizer	152.92	478.66
Herbicide	65,66	109.43
Insecticide	2,805.73	3,099.44
Seed	4,539.56	2,580.94
Others	17,80.56	11,740.61
Total Variable Cost (TVC)	145,536.25	103,225.80
Gross Revenue (GR)	128,255.69	91,485.19
Gross Margin (GR-TVC)		**36,770.5**
Mean Difference		

Source: Field Survey, 2015

From the result obtained, it shows that TL II participants seem to be better than the non-TL II participants after the project participation. The average gross income of participants was higher by ₦36770.5 than the non-participants (Table ii). The non-TL II participants spent more on variable inputs such as herbicide, insecticide and seed than the participants. This is an indication that the improved seed used by the TL II participants has the ability to resist pest and diseases among other advantages. The participants rather spent more on fertilizer which results in an increase in yield. This is in conformation to the findings by Macharia *et al.* (2012) on an *ex-ante* evaluation of the potential impacts of adoption of improved chickpea varieties in Ethiopia. The benefit cost ratio was estimated at 5:1 and an internal rate of return of 55%, indicating that the investment is profitable.

The high mean difference is an indication that the profitability in improved soybean production is higher among the TL II project participants. This could be as a result of the; (i) Perceived knowledge on improved technology on soybean and other crops, (ii) the potential of soybean in fixing nitrogen which resulted in improved farming system-legume cereal rotation, (iii) increased production, productivity and subsequent increase in yield, (iv) enlargement in income due to high sales from the high yield.

3.3 *Major Problems Encountered by TL II Participants*

The perceived problems faced by the TL II participants are presented in Table iii. The findings indicated that among the various problems analyzed the TL II farmers said that they experienced pest and diseases of soybean followed by poor access to market, price instability and high rainfall among others. It has been deduced that high rainfall duration has great effect on the quality and the marketability of the soybean. Over the years, (three years back) during the interview the explanations made by the beneficiaries of TL II project revealed that high rainfall duration on soybean facilitate pest and disease infestation which affects the soybean maturity and drying.

If the quality of the soybean is affected by pest and diseases or heavy rainfall, the markets will devalue the product and farmers will be forced to sell at a loss; in view of the above farmers need to use the improved soybean variety suitable to their ecological zones and follow the management practice strictly. Also about 22% of the respondents said that there is high cost of labor. This can be explained among the labor operations in soybean production and the most labor-intensive operations were land preparation, weeding and harvesting. This is in line with the study by [4] where it was pointed out that lack of proper market linkages, cost involved in soybean production are some of the challenges faced by soybean farmers in Kenya.

Table iii. Major Problems Associated with Improved Soybean Technology (n = 107)

Variable (Nature of problem)	**Frequency***	**Percentage**
Duration of Rainfall	34	31.78
Pests and Diseases	101	94.39
Laborious work in Soybean production	23	21.50
Poor access to market/price	54	50.49
Small farm size	24	9.35

Source: Field Survey, 2015. *Multiple Responses Exist

Thorough land preparation is especially needed particularly in order to make it free from weeds and favorable for growing soybean, for root development and for better water retention and weed control. Harvesting, on the other hand also required much manual labor for the cutting of stems (using a scythe). All the above contributed to the laborious work in soybean production.

It is noteworthy that the variable farm size of soybean also exerts some effects on the TL II participation in the

study area. The most probable reason could be because the farming households preferred growing soybean on a small portion of land, such as road side, portion of residential areas or incorporated with another crop such as cereal than using a whole plots of their farm for soybean production. The scene of soybean all over in the study area is evident.

The aforementioned major problems of improved soybean production in the study area have either direct or indirect effect on the following: (i) Soybean production (ii) productivity and (iii) marketability and profit. This is possible because, infected soybean crop by pest and diseases will consequently affect productivity and impaired yield thereby rendering the value of the crop very low.

IV. CONCLUSION

Clear differences in crop yields exist between before and after the project. On average TL II households have obtained higher yield for all crops after the project. The DD result also showed that the mean yield of soybean, rice, groundnut, maize and sorghum among the participants were higher after TL II project compared to non-participants. This is as a result of introduction and adoption of the technology on soybean and cereal rotation by farmers in the project communities. Typically maize derives benefit from the maize/soybean rotation. Soybean incorporation either in rotation or intercrop with a cereal constitutes one of the low-cost soil fertility management options to smallholder farmers.

High profitability has been demonstrated with improved practices and value addition. The average gross income of the TL II participants was higher by ₦36, 770.5 than the non-TL II participants indicating that improved soybean production is profitable in the study area. However, the realization of this potential will depend on a consistent effort to addressed the major challenges faced by the respondents which include pest and diseases, lack of market and low price of soybean among others.

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