 

# Direct and Indirect Contribution of Yield Components to the Grain Yield of Maize [*Zea mays* ( L.)] Grown at Mubi, Northern Guinea Savanna of Nigeria.

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**Abstracts**

An investigation was conducted in 2011 and 2012 rainy seasons at Mubi in the Northern Guinea Savanna ecology of Nigeria to assess effect of timing of nitrogen application on the performance of maize. The treatments were laid out in a split – plot design. Two maize varieties (OBA -98 and OBA – SUPER) were assigned to the main plots. While nine nitrogen timings and zero fertilization as a control were laid out in the sub-plots. These were replicated thrice .The path analysis showed that cob length gave the highest percentage yield contribution of 10.12%, followed by 100 grains weight (8.69%). The highest combined contribution of 12.58% came from pod length combined with 100 grains weight. This implies that cob length and 100 grains weight should be given emphasis as selection criteria in maize. The residual value was 48.49%., which means the variables considered in this study accounted for 51.51% of the yield contributions

**Key words:** Maize, Path analysis, yield contributions

## Introduction

Maize production is ascending in the savanna ecology of Nigeria and gradually replacing sorghum in many areas of the ecology. This can partly be attributed to the high yield of the crop in contrast to the lower yield of sorghum per unit area. However, the high demand of the crop for nutrient especially nitrogen has made it necessary for farmers to use higher doses of fertilizer continuously than required in sorghum production. High maize yield cannot be sustained without high fertilizer in put. (Kwaga, 1994, Havlin *et al.*, 1984). The native status of soils of the Northern Guinea Savanna of Nigeria is poor with low organic matter. Fertilizer dose of 120:60:60 kgha$^{-1}$ of N, $P_2 0_5$ and $K_2 0$ has been recommended (Enwezor *et al.*, 1989). Although farmers in the ecology have recognized the need to fertilize their maize crops, there has been variation in the timing of their application. Furthermore, since nitrogen is subject to leaching and denitrification, multiples of nitrogen application to crncide with the need of the crop during its growth cycle has been advocated. Tobert *et al.*, (2001) Lack of proper timing of nitrogen application to their maize crops by the farmers has manifested in nutrient deficiency symptoms such as chlorosis for nitrogen deficiency, purple colouration for purple for phosphorus deficiency, resulting in stunted growth and ultimate poor yield. Mengel & Kirby ( 2006), Reddy & Reddy, 2011, Anonymous (2011) noted that nitrogen deficiency at any time of maize life would lead to yield reduction. Wright (1921) developed the method of path analysis as means of interpreting correlation between two variables with respect to hypothetical path of causation between them. Lynch and Walsh (1997) remarked that the purpose of path analysis is the quantification of the relative contribution of causal sources of variance and covariance in a network of interrelationship. According Lleres (2003), path analysis is a statistical technique used primarily to execute comparative strength of the direct and indirect among variables. Rangaswamy (2010) described it as a method of decomposing condition into direct and indirect effects. Therefore path analysis gives insight of the interrelationship that exists between variables that affect the ultimate variable in focus. Different workers have investigated the interrelationship between grain yield and variables such as plant height, 100 grains weight or ear height (Sumathi *et al.*, 2005; Bello *et al.*, 2010.)

## Materials and Methods.

A field trial was conducted at the Teaching and Research Farm of Adamawa State University, Mubi in 2011 and 2012 rainy seasons in the northern Guinea Savanna zone of Nigeria. The soil of the area is classified as Alfisols (Brady & Wails, 1999).The trial was conducted in a split- plot design with three replications. Two maize varieties (OBA-98 and OBA – SUPER) were laid out in the main plots. Time of nitrogen application was assigned to the sub-plots. Each plot was comprised of four rows that were 75cm apart, 4m long and 3m wide (12m$^2$). The experiment was sown on July 9, 2011 and July 7, 2012. Seeds were sown at the intra-row spacing of 75cm and inter-row spacing of 25cm at 2 – 3 seeds per hill. The plants were thinned to one plant per stand at 2 weeks after sowing (WAS). Fertilizer was applied at the rate and time for each treatment. Compound fertilizer (NPK 15:15:15) was used to supply the basal application at 60:60:60 kgha$^{-1}$ N, $P_2O_5$, $K_2O$ at 2 WAS. Urea (46% N was used to supply the latter doses of nitrogen at 4, 6, 8 and 10 WAS as applicable to each treatment. All fertilizer application was done by side placement. Each year the trial was hoe- weeded at 3, 6 and 9 WAS. The harvest was taken from net plot area of each plot (3m x 1.5m = 4.5m$^2$). All data collected were subjected to statistical analysis and the means separated using Duncan Multiple Range Test (Duncan, 1951). Correlation analysis was carried out using the formula given by Steel and Torrie (1984) as below

$$r = \frac{SPX}{(SSX.SSY)^{1/2}}$$

SPX=Correlation coefficient between X and Y
SPX= Sum of product
SSX= Sum of squares of X
SSY= Sum of squares of Y
X= Independent variable
Y= Independent variable

A simultaneous equation using the correlation values was developed for calculating the path coefficient (P) values as shown below.

P1 + r12P2 + r13P3 + r14P4 + r15P5 = r16
r12P1 + P2 + r23P3 + r24P4 + r25 P5 = r26
r13P1 + r23P2 + P3 + r34P4 + r35P5 = r36
r14P1 + r24P2 + r34P3 + P4 + r45P5 = r46
r15P1 + r25P2 + r35P3 + r45P4 + P5 = r56

This equation was entered in matrix form in Scientific workPlace student edition 2.5 soft ware to obtain the P values The direct and indirect effects were separated using the method described by Rangaswamy (2010). The percentage contribution was calculated as follows:

(i) Direct percentage contribution $(P)^2$
(ii) Indirect percentage contribution between two variables = (2PiPjrij)
(iii) Result effect (R) = 1- (P1r16 + P2r26 + P3r36 + P4r46 + P5r56)

**Results**

The direct and indirect components of maize grain yield are presented in Table 1. Direct contribution of plant height to the grain yield of maize was 0.1679, while indirect contributions via cob length, cob diameter 100 grains weight and kernel depth were 0.1664, 0.0368, 0.1063 and 0.0001 respectively; giving a total contributions of 0.4775. Direct contribution of cob length to the grain was 0.3181 whereas indirect contributions through plant height, cob diameter 100 grains weight and kernel depth were 0.0878, 0.0533, 0.1979 and -0.003 respectively.Direct contribution of cob diameter to maize grain yield was 0.0790, while indirect contribution via plant height, cob length, 100 grains weight and kernel depth were 0.0782, 0.2147, 0.1843 and -0.0004 respectively, giving a total contribution of 0.5558. Direct contribution of 100 grains weight to the grain yield was 0.2948, with indirect contribution through plant height, cob length, cob diameter and kernel as 0.0606, 0.2134, 0.0494 and 0.0001 respectively resulting in total contributions of 0.6183. Direct contribution of kernel depth to grain yield was -0.0056 whereas indirect contributions via plant height, cob length, cob diameter and 100 grains weight were -0.0040, 0.0171, 0.0058 and -0.0071 respectively; giving total contribution of 0.0062.

The direct and combined percentage contributions of the yield components to the grain yield of maize are shown in Table 2. The direct percentage contributions from the various yield components to the grain yield of maize indicated that the highest direct yield contribution of 10.12% came from cob diameter. It was followed by 100 grains weight which gave 8.69% and thirdly by plant height with 2.82%. The value from kernel depth was 0.00% which appears to have no meaningful contribution. The combined effect showed that cob length and 100 grains weight exhibited the highest contribution of 12.58%; followed by plant height combined with length which gave 5.5%. The third, fourth and fifth were plant height combined with 100 grains weight (3.57%), cob length combined with cob diameter (3.39%) and cob diameter combined with 100 grains weight (2.91%). Plant height combined with cob diameter gave 1.24%, while cob diameter combined with kernel depth had 0.01% contribution. Plant height combined with, kernel depth appeared to have made no recognizable contribution. In contrast to the others, cob diameter combined with kernel depth, cob length combined with kernel depth had negative contributions of -0.01 and -0.02 respectively. The residual value was 48.49%..

**Discussion**

In the present study, path analysis has shown that pod length exhibited the highest positive direct effect and percentage yield contribution on the grain yield of maize. This implies that the longer the cob the greater the space it has for carrying more grains which can lead to higher yield. This is yet more evident by the fact that100 grins weight came second with respect to direct effects. This is agreement with the report of Amin *et al* (2013) who noted that 100 seeds weight had high positive direct \effect on seed yield per plant. This shows the significance of grain filling in determining maize yield. Poorly filled grains can reduce the yield of maize. Therefore factors that enhance grain filling such as fertilization sufficient mature availability in the soil especially during the period of grain filling can enhance maize yield. Plant height was found to have direct positive effect on maize grain yield. Bello *et al.*, (2003) and Amin *et al*., (2013) also noted direct positive effect of plant height on maize grain and seed yield per plant respectively. However, Sumathi *et al.*, (2005) noted non significant negative effect of plant height on grain yield in maize. Since plant height is one of the expressions of vegetative vigour in plants; its positive direct effect on crop yield should be expected. The vegetative part of the plant serves as sink for production of assimilates which is transported to the grains in cereal crops. Therefore plant with very poor vegetative performance can have drastic influence in reducing grain yield in cereals, whereas those that are vigorous can enhance crop yield.

Combination of cob length and 100 grains weight gave the highest combined percentage contribution. This stresses further the impact of these two highest direct contributors on grain yield in maize. This is in agreement with observation of Ogedegbe *et al*., (2012) who reported that different variables worked together to increase grain in lablab. It is also in consonance with the findings of Rueben and Mreme (1990) who remarked that yield is the outcome of several quantitative variables working together. Plant height and cob length produced the second to the highest combined percentage yield contribution, which can be attributed to the significance of the two variables in determining grain yield in maize. Very short statured maize plant may hardly produce and sustain long cobs, but plants which are appreciably tall with vigorous foliage can produce considerable assimilates to sustain long cobs and effect appreciable yield in maize. The residual value of 48.49% implies that there are other variables that influenced the grain yield of maize whose effects were not reflected in the present analysis.

**Conclusion**

Cob length exhibited the highest direct positive effect on maize grain yield, followed by 100 grains weight and thirdly by plant height. The combined contribution showed that combination of cob length and 100 grains weight had the greatest effect on grain yield.It appears that cob length, 100 grains weight and plant height could be considered as prominent selection criteria in works on maize.

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(Table 1:). The direct and indirect contributions of maize yield attributes on grains yield of maize at Mubi during 2011 and 2012 rainy seasons (combined).

| Yield characters | | Effect | Through | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| **0.1679** | 0.1664 | 0.0368 | 0.1063 | 0.0001 | 0.4775 |
| 0.0878 | **0.3181** | 0.0533 | 0.1978 | -0.0003 | 0.6567 |
| 0.0782 | 0.2147 | **0.0790** | 0.1843 | -0.0004 | 0.5558 |
| 0.0606 | 0.2134 | .0494 | **0.2948** | 0.0001 | 0.6183 |
| -0.0040 | 0.0171 | 0.0058 | -0.0071 | **0.0056** | 0.0062 |

Direct effects are in bold characters in contrast to indirect effects.

1 = Plant height (9WAS)
2. = Cob length
3. = cob diameter
4. = 100 grains weight
5. = Kernel depth
6. = Total contribution

WAS = Weeks after sowing.

 

Table 2: Percentage contributions of various yield attributes to the combined grain yield of maize grown at Mubi during 2011 and 2012 rainy seasons.

| | Yield Attribute | | | Percentage contribution (%) |
|---|---|---|---|---|
| A. | Individual direct contribution $(Pi)^2$ | | | |
| | Plant height (9WAS) | - | - | 2.82 |
| | Cob length | - | - | 10.12 |
| | Cob diameter | - | - | 0.62 |
| | 100 grains weight | - | - | 8.69 |
| | Kernel depth | - | - | 0.00 |
| B. | Combined contribution (2Pipjrij) | | | |
| | Plant height and cob length | | - | 5.59 |
| | Plant height and cob diameter | | - | 1.24 |
| | Plant height and 100 grains weight | | - | 3.57 |
| | Plant height and kernel depth | | - | 0.00 |
| | Cob length and cob diameter | | - | 3.39 |
| | Cob length and 100 grains weight | | - | 12.58 |
| | Cob length and kernel depth | | - | -0.02 |
| | Cob diameter and 100 grains weight | | - | 2.91 |
| | Cob diameter and kernel depth | | - | -0.1 |
| | 100 grains weight and kernel depth | | - | 0.01 |
| | Residual | - | - | 48.49 |
| | Total | - | - | 100.00 |

WAS = Weeks after sowing.