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# Influence of Speed and Land Slope on uniformity of distribution and metering of Cowpea seeds

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## Abstract

Investigations were carried out to evaluate the effects of field slope and forward speed on the metering uniformity of the grain drills for palnting cowpea. The study was conducted in the laboratory using a John Decre model 8250 grain drill while the field slopes and forward speeds were simulated. The field slopes were varied from zero to 12.5 degrees, while the forward speeds were varied from 3 to 6 km/h. The metering uniformity of the drill was measured in terms of coefficient of variation in the seeds metered and delivered by various seed delivery tubes across the width of the machine. The actual seeding rate delivered by the grain drill under various field and operating conditions was also determined.

Results indicated that the field slope and forward speed had significant effect ($p < 0.01$) on the metering uniformity and seeding rate. There was decrease in the metering uniformity and the seeding rate with an increase in the field slope in the range tested. Similarly, an increase in forward speed resulted in poorer metering uniformity and lesser seeding rate at the field slopes ranging from zero to 12.5 degrees. The interaction between the filed slope and the forward speed appeared to be non-significant.

Statistical models were developed to predict the metering uniformity and the seeding rate delivered by a grain drill operating at various forward speeds for planting cowpea seeds in sloping lands of Oyo State of Nigeria.

## Introduction

Cowpea is an important grain legume crop in tropical Africa where it serves a s a major source of dietary protein (Akingbohungbe, 1980). The average protein content of cowpea is 22.75 percent of its dry matter (Oyenuga, 1968) Traditional method of cowpca production is both labour intensive and time consuming. Technically, cowpea seeds are planted and, hence, not drilled. However, the grain drills, with very little or no major modification can be utilized for planting cowpea if the production is to be profitably maximized.

For increased output, the agricultural land must be farmed intensively. With an ever increasing population and greater food demands, land is becoming a scarce commodity. Farmers in Oyo State of Nigeria make use of almost any land that will support crop growth regardless of topography. It is not uncommon to see farming being done on quite steep lands. Field slopes as high as 25 degrees are not very uncommon. The use of farm machinery on extremely steep lands may be dangerous because of the potential hazard for tractor and implement instability. However, a grain drill could be used for planting under slightly sloping field conditions. It is therefore essential to know how the machine would perform under such conditions.

The performance of the grain drills and planters may be affected by both the machine and seed related factors as well as the soil and meteorological factors. Several investigators have reported the effects of different machine related factors (Bjerkin, 1947; Chhinnan et al., 1975 and Wanjura and Hudspetch, 1968) and seed related factos (Bufton *et al.*, 1974) on the performance of the grain drills and planters. The practical range of forward speeds for the planting implement is normally from 3 to 6 km/h (Culpin, 1981). Little information is, however, available on the performance of grain drills while operating at different forward speeds for planting cowpea on lands with varying slopes.

The present study was undertaken to evaluate the effects of the field slope and forward speed of grain drill on the metering accuracy and seeding rate delivered by the machine. The metering accuracy was measured in terms of a coefficient of variation.

## Materials and Methods

A John Deere fertilizer – grain drill model 8250 was used in this study. All the experiments were carried out in the laboratory where field slopes and forward speeds of the grain drill were simulated. The simulated field slopes were varied from zero to 12.5 degrees, and the simulated forward speed of the drill was varied from 3 to 6 km/h. To simulate the field slopes, the gear-box end of the grain drill was elevated by using a hydraulic jack. This was done to simulate the operation of the grain drill across the slope (rather than along the slope) of the field. The grain drill with its ground wheels removed, was set on wooden blocks and its metering system was powered through a roller chain driven by a 3.6 kW variable speed electric motor. This allowed simulation of its forward speed in the laboratory.

Prior to the experimentation, the grain drill was calibrated using the procedures outlined by Kepner *et al.* (1978). It had a rated width of

2.5m with 14 seed delivery tubes; and alternate entrances into the delivery tubes were block off, starting from the second tube counted from the gear-box end of the machine. Thus, the seed was metered and delivered by the grain drill through seven seed delivery tubes. The seeding rate control lever was adjusted at notch number 18 on the drill to give approximately 25 kg/ha seeding rate.

Two–factor factorial experiments, with four replications, were designed and carried out for four levels of each factor (Walpole and Myers, 1972). The two factors studied were the field slope and the forward speed of the grain drill. The settings of the field slope included 0, 5, 10, and 12.5 degrees while the forward speeds were 3,4, 5 and 6km/h. The performance of the grain drill was measured as: (a) the coefficient of variation (measure of the uniformity of distribution) and (b) the seeding rate of the machine.

The grain drill was utilized to meter and deliver the cowpea seed through seven seed delivery tubes. Polyethylene bags were used to collect the metered seed from each delivery tube for each setting of the field slope and forward speed. The metered seed for each tube were weighed separately on an electric-beam balance. The mass of the seed delivered through each tube was used for the computation of the coefficient of variation for each experimental run (Allam and Wiens, 1982).

A two factor analysis of variance was carried out, as outlined by Walpole and Myers (1972), to determine the significance of the effects of the two factors considered, and their interaction.

Attempts were made to develop both the linear and non-linear models to predict the metering uniformity and the seeding rate of the grain drill operating at various forward speeds while planting cowpea on lands with varying slopes. In spite of the comprehensive nature of the non-linear models, they did not yield significant improvement over the linear models in predicting the response of the machine under most of the field and operating conditions. Thus, only the linear models are reported in this paper.

## Results

The factorial analysis of variance is shown in Tables 1 and 2 for the coefficient of variation and the seeding rate, respectively. From these tables, it is obvious that both the field slope and the forward speed had significant effect ($p \leq 0.01$) on the performance of the grain drill. The interaction between the factors appeared to be non-significant.

TABLE 1: FACTORIAL ANALYSIS OF VARIANCE FOR THE COEFFICIENT OF VARIATION FOR THE DISTRIBUTION UNIFORMITY OF COW-PEA SEEDS BY A GRAIN DRILL

| Source of variation | Sum of squares | Degrees of freedom | Mean square | Computed F | $F_{(p<0.01)}$ |
|---|---|---|---|---|---|
| Forward speed | 4.11 | 3 | 1.37 | 8.56 | 4.24 |
| Field Slope | 6.85 | 3 | 2.38 | 14.25 | 4.24 |
| Interaction between speed and slope | 0.70 | 9 | 0.08 | 0.5 | 2.82 |
| Error | 7.49 | 48 | 0.16 | | |
| Total | 19.15 | 63 | | | |

TABLE 2: FACTORIAL ANALYSIS OF VARIANCE FOR THE SEEDING RATE OF COWPEA BY A GRAIN DRILL

| Source of variation | Sum of squares | Degrees of freedom | Mean squares | Computed F | $F_{(p<0.01)}$ |
|---|---|---|---|---|---|
| Forward speed | 0.68 | 3 | 0.23 | 23 | 4.24 |
| Field slope | 1.26 | 3 | 0.42 | 42 | 4.24 |
| Interaction between speed and slope | 0.26 | 9 | 0.03 | 2.77 | 2. 82 |
| Error | 0.55 | 48 | 0.01 | | |
| Total | 2.75 | 63 | | | |

The average coefficient of variation and the seeding rate are plotted against the field slope for various forward speeds in Figs. 1 and 2, respectively. The data were subjected to linear regression analysis, using the method of least squares (Box *et al.*, 1978) to determine the best fitting straight lines. The models so developed to predict the coefficient of variation and seeding rate for a given field slope are also presented in Figs. 1 and 2, respectively, for four different forward speeds namely 3, 4, 5 and 6 km/h. The average coefficient or variation generally increased (i.e. the distribution uniformity decreased) linearly with an increase in the field slope for all the forward speeds tested

(Fig. 1). Similarly, the seeding rate delivered by the grain drill decreased linearly with an increase in the field slope for all the forward speeds less than 3 km/h (Fig. 2). The response was non-linear when the grain drill was operated at a forward speed of 3 km/h

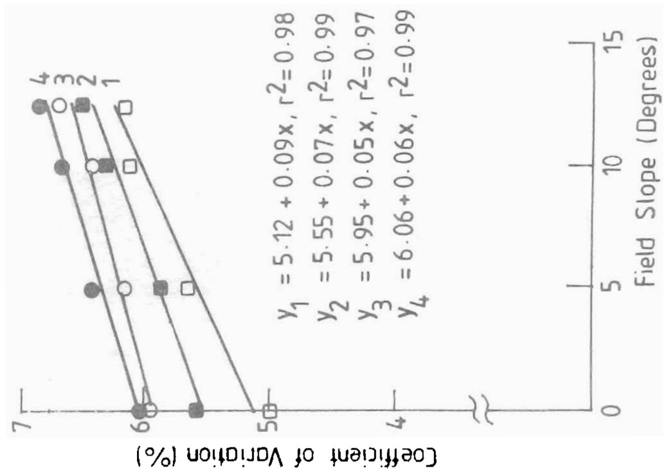


Figure 1: G.S. SAQIB & O.O. SEGUN

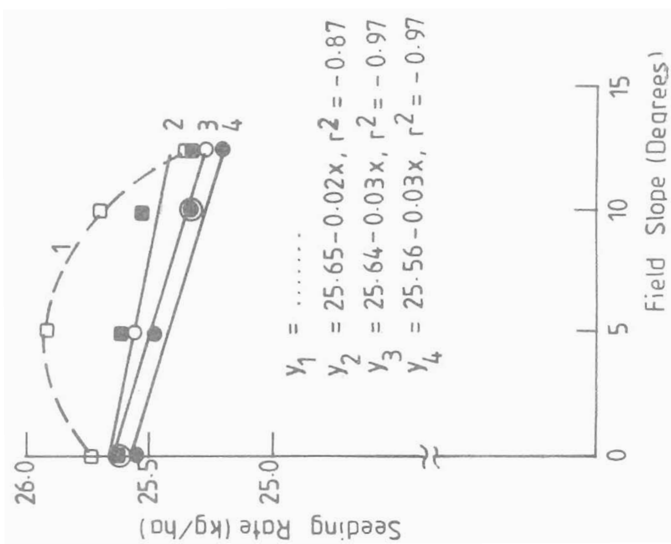


Figure 2. G.S. SAQIB & O.O. SEGUN

Figures 3 and 4 show the effect of forward speed on the average coefficient of variation and the seeding rate, respectively. The statistical models developed to predict the coefficient of variation and seeding rate for a given forward speed are also shown in Figs. 3 and 4, respectively, for four different field slopes namely 0,5, 10 and 12.5 degrees. From Fig. 3, it is clear that the average coefficient of variation increased (i.e. the distribution uniformity decreased) linearly with an increase in the forward speed for all the field slopes tested. Similarly, the seeding rate decreased linearly when the forward speed was increased, and it was so irrespective of the field slope (Fig. 4).

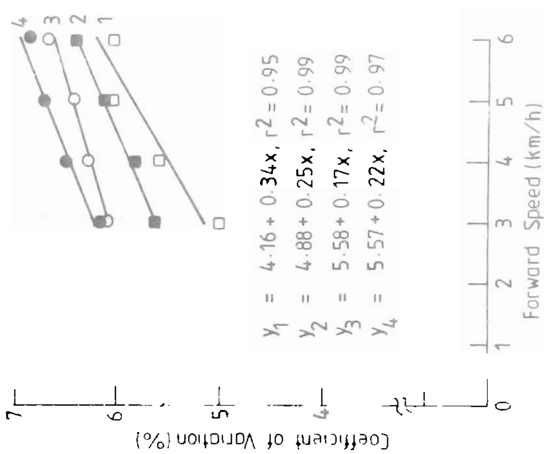


Figure 3: G.S. SAQIB & O.O. SEGUN

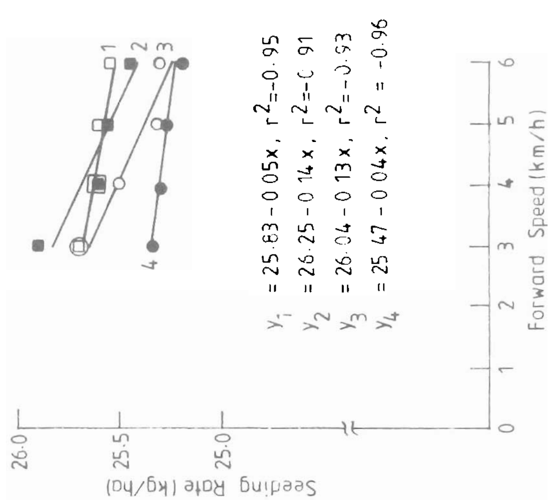


Figure 4: G.S. SAQIB & O.O. SEGUN

## Discussion

From the results, it can be noted that the average coefficient of variation ranged between 5 and 7 percent, and the seeding rate varied from 25.2 to 25.9 kg/ha. For an ideal performance, the grain drill should deliver as close to the calibrated seeding rate as possible while maintaining the coefficient of variation as close to zero as possible. The Prairie Agricultural Machinery Institute (PAMI) in Canada accepts the following criteria for rating the metering accuracy or distribution uniformity for seeding implements (Allam and Wiens, 1982):

C.V. greater than 15 percent, unacceptable distribution uniformity.
C,V. between 10 and 15 percent, acceptable distribution uniformity.
C.V. less than 10 percent, good distribution uniformity

From the results of this study, it can therefore be concluded that the distribution uniformity of cowpea seeds by the grain drill was good, when judged by the PAMI criterion, under the field and operating conditions tested. Higher than 12.5 degree field slopes were not tested in the present study because of the potential hazard for tractor and implement instability which precludes their use. The forward speed ranging from 3 to 6 km/h gave satisfactory performance of the grain drill. An attempt made to exceed the forward speed beyond 6 km/h resulted in excessive breakage of the seeds which is undesirable. The grain drill is therefore recommended to operate in the range from 3 to 6 km/h which agrees with the suggestions of Culpin (1981) regarding the practical range of forward speeds for the planting implements.

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