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An Econometrics Assessment of Food Security Estimation Using Fuzzy Logics: A Case in the Arid and Semi Arid Lands of Kenya

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Strictly as per the compliance and regulations of :

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Sulo Timothy [α] & Chelangat Sharon [σ]

Abstract - This paper takes into consideration the severe bottlenecks that have actually bedeviled econometric analysis and documentation of food security since time immemorial. It aims at modeling food security estimation using fuzzy logics. The paper shows econometrically how food security measurement drawbacks are overcome using residual diagnostic analysis by the effects of fuzzy logics on the leverage points of food security predictors. Further, the results indicate that the preliminary econometrics tests on the residual diagnostic analysis on the error variance, co linearity, multicollinearity and mahalanobis distances improved the estimation of food intake (the predicted criterion) because its predictors are stabilized upon data conversion into fuzzy membership functions. To a certain reasonable extent, it may be very safe to conclude that there is something quite positive in econometric research when fuzzy logics are applied in estimating food security, poverty among other similar subjective or qualitative variables.

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I. Introduction

An econometric assessment of food security as socio economic variable is still quite elusive to many researchers. Information available on measurements of variables such as food security, hunger and poverty use absolute, alternative and subjective approach methods. These methods use single indicators such as income, headcount ratios, nutritional variables or household expenditures as proxies (Booth, 1996; Rowtree, 1969 And Orshanski, 1969). Using a single indicator or a few of them as proxies do not capture the real situation of the individual households. There are approximately 200 definitions and more than 450 indicators or explanatory variables of food security (Hoddinot, 1999). This study adopts the most commonly used definition that states "food security is widely defined as access by all people at all times to enough food for active healthy life." It is a condition in which a population has physical, social and economic access to sufficient safe and nutritious food secure population can meet its consumption needs during the given consumption period by using strategies that do not compromise future food security. Food security is therefore a very complex multidimensional phenomenon, which varies through a continuum of excessive stages as the conditions change. Food security is therefore a very complex multidimensional namely, vulnerability access sufficiency and sustainability. Therefore, food security status of a given population is very complex product in a farming system characterized by interdependency and interactions at varying levels between agents such as public sector entities markets NGOs and the community among many others. These interactions result into non-linear effects - population.

The difficulty in documenting an econometric model analyzing food security stems from the fact that 450 variables are really just too many for a model. Whereas food insecurity intervention is multi-criteria in decision making, econometric estimation of parameters in such a model may be impossible because of errors in variables, heteroscedasticity, multicollinearity and autocorrelation. Further, the situation becomes even much more complicated because these relationships arise from the larger systems of food security status. This tasks often difficult and the interaction of the pieces is uncertain and complexity with respect to food security, there is no limitations of uncertainty and complexity with respect to food security and there is no consensus to date among social scientists in how food security should be econometrically documented. This research explores an econometric model approach that can accommodate the imperfect, non linear and uncertain interactions, which can explain much more precisely, the socioeconomic and the ecological outcomes of a food security status in a given population. It is generally agreed that the transition from a state of complete food deprivation to a comfortable state happens rather gradually (Micelli, 1998). Likewise in Kenya, Agricultural growth, an important precursor of food security has been below potential due to poor past policies and this will take some time to remedy (Mbogoh, 2003). This piece of research attempts to model this concept of food security while taking into consideration the severe bottlenecks that have actually bedeviled econometric analysis of food security.

a) Problem Statement

In Kenya, food insecurity in the ASAL areas is quite prevalent with sporadic cases of acute food insecurity leading to malnutrition and deaths. The poor

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account for 80% of the populations in the ASAL Kenya (Republic of Kenya, 1999). The current food policy in Kenya only aims at food production and availability at national level with very little tangible measures to translate to adequate household food security especially in some of the high-risk areas (Atieno, 1996). Nearly 3.3 million people, mostly pastoralists in the northern and eastern parts of the country, need emergency food assistance every year. Their survival is at stake because the farming systems cannot do well. About 83% of the land area in Kenya is ASAL and growth in food production has not kept pace with population growth such that the burden of annual formal food transfers and drought relief supplies is continually increasing (Republic Of Kenya, 1992). About ksh 6 million is used to import food annually so as to meet the recurrent deficits. The share of imports in cereal supply in Kenya is increasing whereas domestic production is decreasing. The volatile socio-cultural, ecological and geographic constraints in the ASAL have limited efforts by the government and other agents to address this problem.

b) Measurement of food security

There are two major methods that are widely used to measure food security although both are subject to measurement problems. The first method involves estimation of gross household production and purchases over a period of time. Estimate growth and depletion of food stocks held over that period. The second method is to undertake a twenty-four hour recalls of food consumption for individual members of a household and analyze each type of food mentioned for its calorific content. This method gives data for one aspect of food security. Food consumption estimates. However, it has several drawbacks such as memory lapses, observer bias, respondent fatigue, a short and possibly unrepresentative recall period and high data collection costs. Further, the two methods do not capture important aspects of food security in relation to vulnerability, access and suitability. The two methods only capture elements of sufficiency none of them has been used to monitor food security include food balance sheets, rainfall and marketing data and even anthropometrical measurements (Maxwell & Frankenberger, 1992). They have noted a variety of indirect indicators that can be used as predictors for food security at the household level. These include; asset ownership, household size, and dependency ratio. Their discussion was based on single indictors and they suggest that combining the indicators could improve specificity. They however do not say how widely different indicators could be combined. The first food security measurement and research conference was held in 1994 in USA. The aim was to synthesize the direction of food security measurement and develop a consensus on the content. The second food security measurement and research priorities. Consequently in the year 2000, a first attempt to measure household food security was done by the United States department of agriculture (USDA).They used a standard six-item subset of indicators to capture two thresholds of identifiable household food security. The measurement that they described was only concerned with food insecurity and hunger when household in the United States. Their measurement technique however cannot be used in developing country like Kenya because of several differences in the structure of wages, livelihood set-ups among others. Food insecurity indicators are also likely to vary very widely between a developed livelihood set-up like USA and in a developing country like Kenya.

A traditional approach to measuring food security has been limited by the fact that food consumption figures are only used or only one indicator or a proxy of food security is used. Hamilton et al 1997, USDA, for instance, uses the 18 item scale that basically captures 4 scenarios of a household's food security. These include food budget and supply inadequacy, inadequate quality, reduced intake and consequences of reduced intake. Blumberg et al 1999 proposes the six item scale that only captures the food eaten in household and whether the household can afford. However the scale developed by Blumberg et al 1999 cannot be used to measure the severe levels of food insecurity especially where hunger is experienced in high-risk groups of developing countries. Maxwell, 1995 measured food security using coping strategies only as an indicator. The above efforts to measure food security have been able account for all aspects of food security as outlined above and there is no consensus to date among social scientists on how food insecurity should be measured and whatever is used for a food security survey is just a matter of convention. Other lessons learned from measurements of other social phenomena such as poverty and childhood development are available. Official poverty line has been used to measure a constant level of purchasing power or constant living standard. Much more recent work on measurement of poverty using fuzzy sets in Switzerland shows that the use of several poverty indicators helps in giving a more complete picture of poverty than the sole use of a few indicators (Miceli, 1998). Williams et al 1999 developed national food insecurity prevalence. The specific scaling procedure that was used in a *Rasch* model, which is a form of non-linear factor analysis that fits within the general family item response theory models. The model is widespread in educational testing where the underlying premise is that the probability of affirming a question increases with the household underlying level of food insecurity and falls as the severity of the condition measured by the particular item goes up.

c) Drawbacks in Food Security Measurement

Whereas research findings in Kenya and other areas indicate that food security is strongly linked to many other factors such as markets and market policies (summer , 2000), infrastructure components such as roads, storage facilities, electricity, financial institutions, telephone, extension services and information technology (Atieno 1996) and income (Midmu 1992, Metzger & zyl 1992, Thimm 1993 & Atieno 1996) there scant literature today that documents measurement of food security with all the above factors taken into account particularly in high risk areas of Kenya. Using a few indicators or proxy to estimate food security does not capture the real situation of individual households. It is argued in this research that using all the possible crucial variables anyhow could actually capture and portray the true picture of food security in high risk food insecurity measurement technique in Kenya today. Argwings-Kodhek et al, 2002 notes that an important priority for food insecure areas should ensure functional departments and communities. However, an effective early warning, monitoring and program performance by these organizations will only be possible if there is more reliable and consistent econometric variable to monitor food insecurity. An earlier mentioned, poverty and food insecurity are really birds of a feather. The two variables have similar characteristics and most of the predictor variables are the same. Literature review on measurement of poverty was therefore found to be quite relevant and necessary for this research. In the past few decades, much contentment on the use of single indicator of resources to measure poverty has led to many authors advocating for use of alternative multivariate methods.

A major advantage of multivariate dimensional measure of poverty over the traditional methods of using one indicator is that it not only captures their general living conditions. In addition, Whenlan, 1993 notes that a global index of poverty based on set of deprivation indicators seems appropriate than indices based on only income or expenditure to assess a situation of permanent poverty. Such an index should ideally take account of the basic needs including food, clothing, housing that are mostly related to social life and sometime exerting some constraints on it. Working conditions leisure, health, education, environment, family and social activities are some examples of some of these kinds of variables. Some authors have tried to emphasize other aspects of poverty than just the monetary ones when measuring poverty. Townsend, 1997 selected sixty indicators that were supposed to summarize the common activities in society. Then he derived a deprivation index based on twelve of the items. There is another interesting approach that was proposed by Mack & Lansley, 1985. They developed and refined the theoretical and empirical work of Townsend and proposed a measure of poverty that is based on the social perceptions of needs, which means that those items classified as necessary by more than 50% of the population are defined as necessities. Hallerod, 1994 suggested a similar method expect that all items are retained as necessities to some extent in the poverty measure. Each item is given a weight based on the proportion of the population that regards it as a necessity. The current practice for measuring poverty by using a poverty line is strongly refuted by Cerioli et al 1990 due to the fact that there is no sharp division of the total population between poor and the non-poor. A poverty line at any rate is unrealistic and cannot be used sustainably.

d) Measurement of poverty using fuzzy sets

Several recent studies have proposed a multidimensional measure of poverty based on the theory of fuzzy sets. Ceriol & Zani 1990 used this method to evaluate living conditions in an Italian county. Others who extended some theoretical aspects have followed their work. The applications that have been followed so far concern mainly Italy and Poland. CERIOLI & ZANI 1990 used fuzzy sets to asses living conditions in Switzerland in 1990. Measurement of poverty using fuzzy sets involves a multidimensional analysis presenting both qualitative and quantitative variables each of them presenting a certain degree of privation. It is assumed that all the modalities can be ranked by increasing risk of poverty. An example is given by a variable showing individual subjective evaluation of their own situation such that the possible values could be very good, fairly good, average, fairly bad and very bad. Given minimum and maximum scores corresponding to those poverty limits, the membership functions as proposed by9 CERIOLI & ZANI 1990, can be expressed as.

$$\Psi_e = \frac{\Psi_{ij} - \Psi^{min}}{\Psi^{max} - \Psi^{min}}$$

Where Ψ_{ij} is the score of individual $_i$ ensuing from indicator j. With this specification, the membership function increases linearly as the risk of poverty rises. Continuous variables such as income and expenditure are also found among living conditions indicators. In literature some authors provide an alternative to the problem of setting a unique clear-cut poverty line. For instance, KAKWANI 1995 proposes a method that takes into account the uncertainty about the exact value of the poverty threshold. On the other hand, ATKINSON, 1987 AND FOSTER & SHORROCKS 1988 suggests an ordinal approach related to stochastic dominance. All these methods suggest an interval supposed to contain the poverty line instead of setting of two limits. The first one is minimum value and the second one is a maximum value of the chosen indicator beyond which an individual can be regarded as out of poverty. For those values of the variable included can be regarded as out of poverty. For those values of the variable included between the two limits, the membership function must take its values in the interval (0, 1). Further, a natural requirement for this function is that it be continuous and decreasing at least for those indicators for which an increase in value means an improvement of well being. CERIOLI & ZANI 1990 define the following membership function.

$$\Psi e = \frac{\sum^{max} - \sum_{ij}}{\sum^{max} - \sum^{min}}$$

where ∑ij is the score of individual I ensuing from indicator j.

In conclusion, multidimensional measurement of poverty using fuzzy sets shows that the use of several not only helps in giving a more complete picture of living conditions, but also gives an image of poverty that is closer to what is perceived head count ratios, discriminant analysis and even to second order stochastic characteristic such that in many writings of poverty food insecurity is mirrored of fuzzy sets when documenting, estimating the phenomenon of programme (PRSP)in Kenya an econometric analysis of food insecurity could be long overdue and handy at any rate.

II. Methodology

a) Theoretical framework

The oxford English dictionary defines the word fuzzy as of something not clear in shape or sound. It implies vagueness in discerning its nature or group belonging. ZADEH 1965 first developed fuzzy concept in 1965. He mentions that some classes of objects encountered do not have a precisely defined criterion of membership. They do not constitute classes or sets in the usual way. Fuzzy concept is an aspect of mathematics and engineering and recent advances show that the same concept can be used in modeling some very important socioeconomic variables that are not clear in nature or generally vague in their description. Humans bring forth the objects of reality as linguistically labeled concepts within the requisites referential domains are chosen and adjusted for the purpose of contextual communication or negotiation. The degrees of fuzziness of linguistic labels are therefore context dependent and implied by the referential choice Zeleney 1991.

b) Definition of fuzzy

Let X be a set and x be some element of X. A fuzzy subset A and X is defined as; A=(x, υA(x) for all x Ex, where υA,is called a membership function and is an application from X in (0,1). This means the function associates a real number in degree of belonging of x to A. because the concept of food security is not sharply defined and multidimensional, the same concept can be used to define the fuzzy set of food security. If A is a fuzzy set, its membership to food security can only take the values between 1 and 0. In that case, Y(x) = (1), Y (x)= (0) or 0 < Ya(x)<(1). The membership function represents the degree of membership to the fuzzy subset. For the case of multidimensional analysis, increasing order of subjective evaluations can rank qualitative variables. An example is given by values attached to, for instance, excellent, extremely good, very good, good, fairly good, average, fairly bad, very bad and worse.

This study adopted a strategy that captured the concept of fuzzy logics while at the same time very adequately represent the degree of membership of the fuzzy subset to the food security indicators in question.

Fortunately, other subjective or qualitative explanatory variables of food security can easily lend themselves for analysis using fuzzy logics. The model adopted in this research can analyze both parametric and nonparametric variables in one econometric formulation and different kinds of data can be compared easily with respect to food insecurity. An empirical relationship function that was initially proposed in this research is represented here below as:

$$Xo=\beta^1x_1 +\beta^2x_2+\beta^3x_3+\ldots\ldots\ldots\ldots.+\beta^{41}x_{41} +\beta^{42}x_{42}+\beta^{43}x_{43}$$

Where, x_0- food intake $0<x_0<20$, x_1- x43 represent the predictors.

However this relationship was subjected to PCA.

Food intake (x0) was used in this research as the explained variable and a proxy of food security. Food intake was chosen to reflect mainly because it is the end result of so many factors (predictors). HAMILTON et al. 1997 method was adopted when estimating this variable (x0).

An alternative total fuzzy approach in defining a membership function for qualitative variables that does not require setting any limit was also explored. CHELI et al 1994 and CHELI & LEMMI 1995 proposed the following membership function for a qualitative polytomic variable.

$$\upsilon Ej(j)=(0)\text{if } \xi ij=\xi j^1 \text{or } \upsilon Ej(j)= \xi j^{max} - \xi ij/\xi j^{max}-\xi j^{min} \text{ if } \xi 1$$

Fuzzy dynamic programming was run using Microsoft excel solver 9.00 package so as to obtain crisp optimal levels of each variable a given target group needs to be food secure. Further, the variables were analyzed using a factor analysis technique in SPSS statistical package version 11.50. Specifically principal components technique was used. The main objective of using principal components method was to identify variable dimensions that give the most explanation for the dynamics of food insecurity in the ASAL of Kenya. Principal components method is data reduction technique that proved to be handy in this analysis. The results were documented and compare in the light of fuzzy sensitivity analysis results.

c) Use of cumulative food security index

Recent research findings reveal that the use of cumulative indices in food security analysis has become popular. MAXWEL 1999 used indices while measuring coping strategies as a food security indicator. He developed a simple scale of 1-4 for the frequency of each individual strategy and multiplied by the weighting factor based on each strategy. Unfortunately, one weakness this method has was that the results could not be compared with other food security data because they were in different units and therefore were measures of totally different phenomenon.

The resulting fuzzified data in this research are more or less indices. The food intake data was also based on an eighteen question simple scale of 1-3 and 1-2 scores, which were also fuzzified to obtain indices. The eighteen question scale of fuzzy data was further aggregated to get a single indicator of food intake (x0). This research adopted Chiappero-Martinnetti 1994 method of using generalized weighted average as the aggregation operator while evaluating the degree of membership of each individual to the fuzzy subset of food intake was therefore obtained from the eighteen question scale of fuzzified data using generalized weighted average as the aggregation operator. The main reason for having all the data fuzzified in this research was to ensure that all the different predictor (explanatory)variables with different units could be decomposed comfortably and compared statistically such that all econometric problems that arise in the process of estimation of parameters may be eliminated.

Justification for using fuzzy theoretical concept.

Application of fuzzy logics in the model has several very crucial advantages if applied in econometrics. Firstly, it attempts to standardize all the variables that have different predictor (explanatory) variables with different units of measurement. Secondly, a preliminary analysis of data reveals that the resulting fuzzified data (standardized variables) offers a solution to the problem of multicollinearity in variables. Farrar – Glauber test 1976 of multicollinearity in the raw data (not fuzzified) was found to be 3.968E-09 whereas the standardized determinant for the fuzzified data was found to be 7.671E-09. The observed chi-square also reduces after conversion into fuzzy membership functions. This implies that multicollinearity reduces. Further, a preliminary analysis on co linearity statistics indicate that the tolerance values obtained from the raw data were lower than tolerance values obtained from the fuzzified data. Further, fuzzified data were found to have lower values of variance inflation factors (VIF). This is indicative of reduced collinearity in the variables once subjected to conversion into fuzzy membership functions.

Thirdly, conversion into fuzzy membership functions of the original data also transforms the model into newly adjusted variables. This kind of adjustment provides a solution for heteroscedastic disturbances in econometrics. A preliminary analysis on heteroscedacity also reveals that plotting studentized residuals against food intake (predicted criterion) for the raw data shows non-linearity and heteroscedasticity. Upon data conversion into fuzzy membership functions, results of plotting the studentized residuals against food intake shows a prototype plot where the residuals approach a uniform spread, though not perfectly, along the zero mean value. These results further revealed that there is a relatively more uniform distribution around the zero mean for the fuzzified data than the raw data. The residual, standardized residuals, studentized residuals, deleted residuals and the deleted studentized residuals all reduced when the observed data was subjected to conversion into fuzzy membership functions. Standard deviation in this case reflects the degree of deviation from the mean 'zero' value. The econometric implication here is that heteroscedastic disturbances during the estimation of food intake (food security) as a dependent variable are minimized though not eliminated. Fourthly, conversion into fuzzy membership functions of the original data also minimizes errors in variables. Errors in variables in econometric analysis arise due to errors in observation, wrongly published data, and omitted data, use of dummy variables and indices. Due to the multidimensional nature of food security in this research, several variables were omitted. This was already an error in the raw data that needed a solution. Further, there were several dummies and indices used in this research. Conversion into fuzzy membership functions of the data could therefore play a very important role in arresting error problems that might have resulted from using raw data in the estimation analysis. The most crucial problem due to errors in variables is that the estimates of the coefficients become both biased and inconsistent.

Fifthly, a preliminary residual diagnostic analysis on the effects of fuzzy logics on the leverage points of food security predictors revealed that more predictors had values larger than the computed point of leverage value. These imply that observations carry a disproportionate weight in determining its predicted dependent variable value, thus minimizing its residual (ROUSSEEUW 1987. These imply that more observations increase increase their degree of influence on the regression results when they are subjected to data conversion into fuzzy membership functions. That is, more of the fuzzified food security data begin to fall in the general pattern of the remaining observations and hence closer to the regression line. The implication of these results is that estimation of food intake (food security) as a dependent variable is reasonably improved.

Further, the impact of fuzzy logics on the mahalanobis distances reveals that the mean and the standard deviation of the mahalanobis distances for the fuzzified data are 36.690 and 25.304 respectively whereas the mean and standard deviation of the mahalanobis distances for the raw data are reduced such that the observation from the mean centre of all other observations decreases. That, is outlier characteristics in the pool of food insecurity data are reduced such that the data are much more uniform than before. The implication is that estimation of food intake or food security as a dependent variable is improved for our case. Mahalanobis distances are essentially a measure of the number of outliers among predictors variables (BELSEY 1980. Further, the studentized residuals analyses show that the range of studentized residuals for the raw data is 2.936 and 3. 071 whereas studentized residuals for the raw data is 1.477 and 2.591. This indicates that for the fuzzified data, more of the studentized residuals tend to fall in the range + 2 and -2 than for the raw data. These imply that the number of outliers tend to reduce such that the mean centre of all of observations decrease. The econometric implications are that the food security predictors are such that they are more uniform than before consequently; the estimation of food intake (predicted criterion) is improved in the regression model under consideration in this research. Loadings such that for n > 50, a loading was regarded as statistically significant at 99% level of significance. The first method was not adopted in this research because it is regarded as rather crude and has little statistical justification.

III. Research Design

A farming systems research approach was used to describe the prevailing food security systems, resource endowments, identify farm household objectives in attaining food security, constraints, the available coping or adaptive strategies and instruments.

a) Sampling procedures

The population was divided into three random sampling units in six villages of West Pokot, Uasin Gishu and Baringo districts of Kenya. The random selection was adopted to ensure that the study population got equal chances of being represented in the study population got equal chances of being represented in the study. Questionnaires were used for eliciting data from the various rural farm households. They include structured questionnaires and a checklist targeting information such as detailed above.

b) Secondary data and sources

Secondary data that was invaluable to this study included world development reports on food security and poverty measurements and livelihoods in the developed and in the developing countries, integrated food development programs in the semi arid lands of Kenya, existing development interventions by the government and non-governmental organizations.

c) Primary data and sources

Primary data such as food consumption data, access and availability, sources of income, income and income generating activities, farm output, yield per unit land area, population, food transfers spatially and temporally, household expenditure, food expenditure, poverty alleviation programmes and inter-sectoral collaboration, human resource development factors such as roads, education, health (number of diseases, distance to hospital), safe water and sanitation, nutritional health care among others were collected. Food intake was obtained using a recall method of eighteen questions each scaled 1-3 and 1-2 indicating the extent to which a household was deprived of food intake. A food intake index was obtained from these 18 questions and was used as the explained (predicted) variable in the econometric for this research.

d) Data analysis

Data was first fuzzified and subjected to various preliminary econometric tests of multicollinearity, heteroscedasticity and autocorrelation. Econometric criterion measures such as the statistical significance of the parameters, t-statistic among others were used to test the validity of the data. To test for multicollinearity, this research adopted Farrar-Glauber method, (1967) of analysis to test both raw and fuzzified data. The Farrar-Glauber test for multicollinearity actually involves the chi-square, F-test and the t-test. A plot of residuals against the fitted values (the predicted criterion) was used to detect whether the variance of the error term is constant or not (Heteroscedasticity). The fuzzified data was further run using Microsoft excel solver 9.0 so as to obtain sensitivity analysis reports of some variables with respect to food intake. This analysis aimed at identifying variables that show the greatest movement of units in the process of optimizing of food intake. Excel solver 9.0 can run a linear programming package of purpose of optimization. Data was also analyzed using factor analysis (principal components methods). This was aimed at arriving at the variables that give the most explanation to food insecurity. The principal components method is a data reduction technique. The principal component matrix was analyzed so as to identify variables that give the highest amount of loadings to the new reduced factors. Using seven different econometric models, a further analysis of specific variables based on principal components output was done so as to identify how they affect the level of household food intake assuming the other factors are held constant forecasting of complex societal variables such as food insecurity and poverty because the fit to the regression model is crucial.

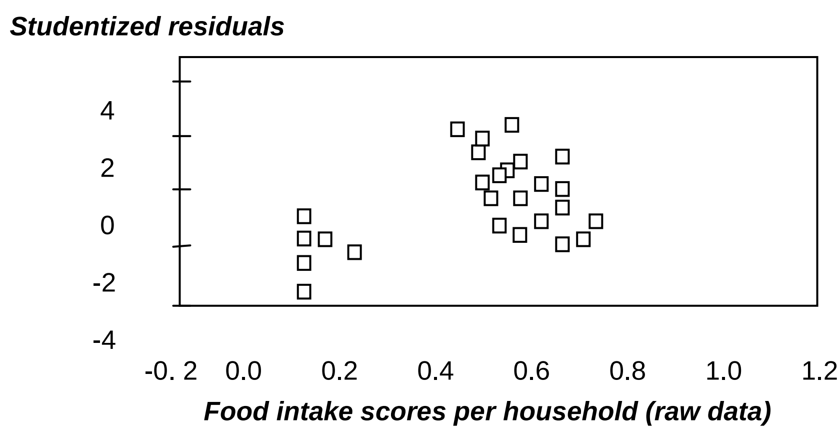
The econometric implications of fuzzy logics in food security estimation

This sub-section briefly aims at showing how fuzzy logics affect factors affecting food intake(predictors) and especially its impact on the accuracy of estimation of the predicted variable (household food intake level) in a regression model. As mentioned earlier, an important problem facing estimation of poverty, food multicollinearity and heteroscedastic disturbances in the usual kind of data used. The impact of fuzzy logics on residual statistics, serial correlation, predictor multicollinearity and heteroscedastic disturbances were critically analyzed using SPSS version 11.5 and the result are shown here below.

The impact of fuzzy logics on residual statistics in food security estimation

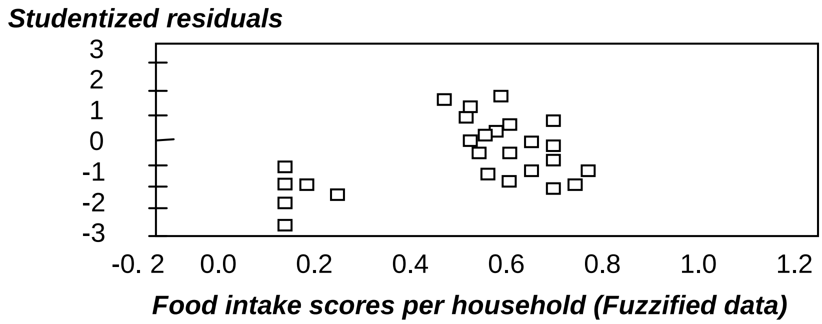
Presence of unequal variance of error is one of the most common violations of assumptions if food security estimation data. Diagnosis in this research was made with residual plots. Studentized residuals were plotted against the predicted plots. A pattern of plots showing the behavior of variance was closely observed for the raw data and for the data converted into fuzzy membership functions. The household food intake data that was used in making the plots were from the three districts in the study areas. Results of plotting studentized residuals against household food intake scores (the predicted criterion) for the raw data shows non-linearity and heteroscedasticity in figure 4.1. The results in figure 4.1 show that the residuals for household food intake scores range between - 4 and 4. Upon conversion of data into fuzzy membership functions, results of plotting the studentized residuals against household food intake in figure 4.2 here below shows prototype plot where the residuals tend to approach a uniform spread, along the zero mean value. The results in figure 4.2 show that the residuals for household food intake membership functions range between -3 and 3. All the residuals reduced. These results therefore suggest that there is a relatively more uniform distribution around and much closer to the zero mean value for the fuzzy membership functions data than the raw data (household food intake scores observed). The residual statistics in tables 1 and 2 further confirm and revealed that the residual standard deviations for residuals, standardized residuals, studentized residuals, deleted residuals and the deleted studentized residuals all reduced when the observed data was subjected to conversion into fuzzy membership's functions. Standard deviation in this research reflects the degree of deviation from the mean 'zero' value. The standard deviations of various residuals for the raw data (household food intake scores observed) in table 4.2 respectively are 0.563, 0.847, 1.169, 1.48 and 1.197. Whereas the standard deviations of same residuals for the fuzzy membership functions data in table 4.1 respectively are 0.153, 829, 1.04, 0.36 and 1.058. These results suggest that the adverse effects of heteroscedasticity in model estimation of food security are alleviated to a reasonable extent when data is converted into fuzzy membership functions. The results of this particular analysis suggest that the standard deviations for all forms and types of residuals computed are reduced. The most important econometric implications here is that heteroscedastic disturbances (stochastic factors) are minimized though not eliminated completely. To all intents and purposes, these results further imply that the estimation of food intake and purposes, these results further imply that the estimation of food intake per household(food security) as a dependent variable or the predicted criterion is improved at any rate in a given regression model.

Figure 4.1 : Scatter plot of studentized residuals against food intake scores per household in west Pokot and Baringo districts, 2010 (raw data).



Source : Authors own Compilation, 2012

Figure 4.2 : Scatter plot of studentized residuals against food intake levels per household in west Pokot and Baringo districts, 2010 (fuzzified data).



Source : Authors own Compilation, 2012

The impact of fuzzy logics on predictor leverage points

Residuals were also used to identify those observations that are from the remaining observations on one or more independent variables of food security. The computed point of leverage value for the observed data that was used in this research was 0.6068. Values larger than the average value imply that these observations carry value, thus minimizing its residual {Rousseeuw, 1987}. The leverage values for the raw data and the data converted to fuzzy membership functions were computed and compared so as to measure the degree of influence and how each of the observation and computed (fuzzified) data had on the predicted dependent variable (household food intake level). The residual statistics results in table 1 and 2 here below show that when data is converted into fuzzy membership functions, the mean and standards deviation of the centered leverage value is 0.310 and 0.205 respectively. When the data is raw (not presented as fuzzy membership functions), the mean and standard deviation of the centered leverage value were 0.281 and 0.220 respectively. These results imply that more observations increase their degree of influence on the regression results when they are subjected to conversion into fuzzy membership functions. That is, more of the fuzzified food security data begin to fall in the general pattern of the remaining observations and hence closer to the regression line. The implication of these results is that estimation of food intake level (a proxy for food security) as a dependent variable is improved to some reasonable extent.

Table 1 : Residuals Statistics for the Impact of Rural infrastructure on household food intake in West Pokot and Baringo Districts, 2010.

	Minimum	maximum	mean	standard deviation	N
Predicted value	-1145	.7745	.3840	.12426	129
Standardized Predicted value	-2.169	3.143	.000	1.000	129
Standard error of Predicted	-1.9382	1.3281	.3512	.31536	127
Residual	-.4796	.2733	.0000	.15346	129
Standardized residual	-2.591	1.477	.000	.829	129
Studentized residual	-2.904	2.650	.016	1.044	127
Delet	-7839	2.4970	.0328	.36862	127
Studentized deleted Residual	-3.037	2.747	.013	1.058	127
Mahalanobis distance	.000	126.834	36.690	25.304	129
Cooks distance	.000	4.433	.070	.413	127
Centered leverage value	.000	.991	.310	.205	129

Note : data in fuzzy membership functions.

Source : Authors own Compilation, 2012

Table 2 : Residual Statistics for the Impact of Rural infrastructure On Food Intake Level per Household in West Pokot and Baringo Districts, 2010.

	Minimum	maximum	mean	std. deviation	n
Predicted value	.2763	2.9279	1.4696	.46138	146
Standard predicted value	-2.586	3.161	.000	1.000	146
Standard error of predicted value	.05503	.66398	.32630	.14451	146
adjusted predicted value	-6.6350	8.1666	1.4063	1.33421	127
residual	-2.0421	1.9527	.0000	.56318	146
standardized residual	-3.071	2.936	.000	.847	146
studentized residual	-3.659	3.610	.028	1.169	127
deleted residual	-6.0555	8.4684	.0633	1.48222	127
Studentized deleted residual	-3.901	3.841	.026	1.197	127
mahalanobis distance	.000	143.569	43.719	34.725	146
cooks distance	.000	3.816	.085	.402	127
centered leverage value	.000	.990	.281	.220	.146

Note: Raw data

Source: Authors own Compilation, 2012

The impact of fuzzy logics on serial correlation.

The kind of data that was used in this research was cross-sectional data. Consequently, the data referred to a given point in time such that temporal dependence was automatically ruled out by the nature itself of cross section random samples. However the impact of fuzzy logics can be observed once time series data is available. The behavior of residuals in this research was found to be near normal. Results in this research indicate that the residuals from the fuzzified data approach the normal curve than the residuals resulting from raw data from the field.

The Farrar – Glauber test for multicollinearity

As earlier noted, multicollinearity is an important predicament in the estimation of household food intake levels because most of the independent variables move together rendering the estimation of parameters indeterminate. This research therefore adopted the Farrar-Glauber test (1976) to test for multicollinearity in the raw data and also in the resulting fuzzified data. To test for the existence and severity of multicollinearity, chi-square test was used. Farrar-Glauber test found out that the quantity x* can be used to test for the severity of multicollinearity from the observed sample and the computed data (fuzzified data). This is given by the formulae:

$x^* = -(n-1-1/6(2k+5)\ \log_e(\text{value of the standardized determinant}).$

Where x* was the observed or the computed value x, n is the sample size, k is the number of explanatory variables. This quantity, x* has a *Chi*-distribution with v=1/2k (k-1) degrees of freedom. A standardized determinant is the determinant of the self-correlation matrix resulting from the explanatory variables of the model. The standardized determinant for the raw data (not fuzzified) was found to be 3.968E-09. Using the above formulae developed by Farrar-Glauber test the observed (computed) x was 2204.40. On the other hand, standardized determinant for the fuzzified data was found to be 7.671E-09. Using the above formulae developed by Farrar and Glauber, the observed (computed) x for the fuzzified variables was 2041.09. According to Farrar-Glauber test, the higher the observed x, the more severe the multicollinearity. It is observed above that the value of the computed *Chi*-square reduces after conversion into fuzzy membership functions. The value of any standardized determinant lies between Zero and unity. The closer the value to zero the stronger the degree of multicollinearity and vice versa. The two most important measures for testing the impact of collinearity are:

- Tolerance levels and variance inflation factors
- Using condition indices and decomposing the regression coefficient variance (BELSLEY 1980 COHEN 1983)

A condition index is a measure of the relative amount of variance associated with an eigen value so that a large condition index indicates a high degree of collinearity. The tolerance value is defined as one minus the degree of collinearity. The tolerance value is defined as one minus the proportion of variables variance explained by the other predictors. Tolerance of a variable is $1-R^2$ where R^2 is the coefficient of determination for the prediction for the variable by the other predictor variables. Tolerance values approaching zero indicate that the variable is highly predicted with the other predicted variables. Thus a high tolerance value indicates little multicollinearity and tolerance values approaching zero the variable is almost totally accounted for by the other variables. Variance inflation factor (VIF) is a measure of the effect of the other predictor variables. Tolerance values approaching zero indicate that the variable is highly predicted with the other predictor variables. Thus a high tolerance value indicates little multicollinearity and tolerance values approaching zero the variable is almost totally accounted for by the other variables. Variance inflation factor (VIF) is a measure of the effect of the other predictor variables on a regression coefficient. Variance inflation factor (VIF) is the reciprocal of tolerance values. Small values of VIF are therefore indicative of little multicollinearity. Tolerance values obtained from the raw data is tables 3 here below were found to be lower than tolerance values obtained from the fuzzified data. further, fuzzified data were found to have lower values of variance once subjected to conversion into fuzzy membership functions. When multicollienarity does not have a substantial impact on the regression variates (variables affecting household food security), it does have an impact on the accuracy in estimating the predicted variable (household food intake) positively for our case. Consequently, data conversion into fuzzy membership functions improves the estimation process of food intake (the predicted criterion in this research).

Table 3 : Coefficient Estimates For The Impact Of Rural Infrastructure On Food Intake Level Per Household In West Pokot and Baringo Districts, 2010.

	Standardized coefficients	Standard error	significance	Tolerance values	Variance inflation factors
Constant					
Distance to tarmac road	0.167	0.011	0.39	0.792	1.262
Distance to hospital	- 0.117	0.063	0.564	0.722	1.386
Distance to rail	- 0.367	0.017	0.181	0.403	2.482
Distance to school	- 0.092	0.058	0.637	0.776	1.288
Distance to financial institution	0.032	0.014	0.882	0.637	1.570
Distance to electricity supply	0.164	0.019	0.444	0.646	1.548
Distance to market	0.350	0.012	0.121	0.601	1.665
Distance to telephone	-0.043	0.014	0.839	0.646	1.547

Source: Authors own Compilation, 2012
Note: Fuzzified Data

Therefore data conversion to fuzzy membership functions reduced the extent to which variables are multicollinear. It is worth noting that changing data to fuzzy membership functions do not make the explanatory variables perfectly orthogonal. That is, multicollinearity is not completely eradicated from the model because the theoretical chi-square (x) in the model is 834, which is far below the observed values for both the fuzzified data and raw data. The implication of these results is that estimation of food intake or food security as a dependent variable is just improved and not made perfect.

The impact of fuzzy logics on the Mahalanobis Distances.

As noted earlier, factors affecting food security are many and widely different either in their measurement characteristics. Therefore, outlier characteristics in a pool of food insecurity data are a very much expected even after discarding observations that are obviously outliers in sets of observation with more uniform characteristics. This is an important predicament that ought to be handled so ass to for the same analysis is the mahalanobis distances which essentially measures the number of outliers among predictor variables (BELSLEY 1980). Mahalanobis distance is a measure of the impact of a single case based on differences between case value and the mean value for all other cases across the independent variables. The source of influence on regression results is for the case to be quite different on one or more predictor variables thus causing a shift of the entire regression equation. Though this method is not widely used, the residual statistics in table 2 above show that the mean and the standard deviation of the mahalanobis distances for the fuzzified data are 36.690 and 25. 304 respectively whereas the mean and standard deviation of the mahalanobis distances for the raw data in table 3 were 43.719 and 34.725 respectively. These results definitely indicate that when the observed data is subjected to conversion into fuzzy membership functions before analysis the distances of the observation from the mean centre of all other observations decrease. That is, outlier characteristics in a pool of food insecurity data are reduced such that the data are much more uniform than before. The implication of these results is that estimation of food intake or food security as dependent variable is improved for our case.

Further, the studentized residual is another primary indicator of observations that are outliers on the dependent variables (Barnet, 1984). With a sample size more than fifty, the rule of thumb is that residuals outside the range of -2 and +2 are significant. Residuals falling outside this range are actually considered outlier. Results in table 2 show that the studentized residuals for the fuzzified data range between 1.477 and -2.591 whereas studentized residuals for the raw data in table 3 are 2.936 and -3.071. These results indicate that for the fuzzified data, more of the studentized residuals tend to fall in the range +2 and -2 than for the raw data. These results suggest that the number of outliers tend to reduce such that the mean centre of all of observations decreases. The econometric implications of these results are that the food security predictors are much more uniform than before. Consequently, the estimation of household food intake (the predicted criterion) is the regression model under consideration in this research.

IV. Conclusions

Based on the preliminary econometrics tests on the residual diagnostic analysis on the error variance, co linearity and multicollinearity, mahalanobis distances and the predictor leverage points, the estimation of food intake (the predicted criterion) is improved because the predictors of food security are stabilized upon data conversion into fuzzy membership functions. To a certain extent, it may be very safe to conclude that there is something quite positive in econometric research when fuzzy logics are applied in establishing food security.

V. Recommendations

Based on the results of this research report, it could be very safe to assert that the use of fuzzy logics in econometric research is a step forward in the improvement of parameter estimation, monitoring and forecasting of important societal variables such as poverty, food insecurity and others subjective variables that have important ramifications to the community well being. Preliminary analysis results shows that fuzzy logics positively change the behavior of residual statistics in food security as the predicted variable. It is therefore recommended to econometricians that the use of fuzzy logics in estimation, monitoring and forecasting of phenomena such as poverty and food insecurity in Kenya be given a priority.

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Estimating Water Availability for Agriculture in Abeokuta, South Western Nigeria

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Abstract - Water availability for Abeokuta, a sub humid part of Nigeria was determined using Blaney-Criddle method and applying 21 years of data on precipitation, sunshine hours, wind speed, minimum and maximum temperature and relative humidity. The water need of certain crops within the study area such as cotton, maize, pepper and tomato were derived. This was done by calculating the evapo-transpiration values for each month within the study period, estimating the growth stages of the crops, the crop factor for each growth stage, the crop factor for each of the month during the growing season, calculating the daily crop water need and the monthly crop water need. Result showed that the crop water need for the growing season of maize is 375 mm. It also showed that maize can be planted conveniently within its growing season without irrigation in Abeokuta. The result obtained for cotton showed that the crop water need for the growing season is 588 mm and that the plant could be planted during its season in the study area with irrigation. The result obtained for tomato showed that the crop water need for the growing season is 498 mm and that it can be planted conveniently within its growing season without irrigation in Abeokuta.

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Strictly as per the compliance and regulations of :

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I. Introduction

Water Balance refers to quantitative expressions of the hydrological and its various components over a specified area and period of time. It also refers to a balance between the input of water from precipitation, snow melt and flow of water by evapo-transpiration, ground water recharge and stream flow. Water balance is an accounting of the inputs and outputs of water. The water balance of a place can be determined by calculating the input, output and storage changes of water at the Earth's surface. Penman (1943) and also Thorntwaite (1943) pioneered the water balance approach to water resource analysis. He used the water balance methodology to assess water needs for irrigation and other water related issues. Water balance helps to manage water supply and predict where there might be water shortages. In water balance estimation, it is commonly assumed that the rates of actual evaporation can be computed as a function of those of potential evapo-transpiration if the available soil moisture held in the soil is known (Ayoade, 1971, 1988; Jackson, 1977).

The study was carried out in Abeokuta, the capital of Ogun State. It is located in the South Western part of Nigeria in the derived savanna region of the country and falls within latitude 7° 10' N and 7° 15' N and longitudes 3° 17' E and 3° 26' E. Abeokuta comprises of three local government areas: Abeokuta North / South local Government Area and parts of Odeda local government area, Ogun state, Nigeria (figure 1). It has an average elevation of 74 m above sea level. Abeokuta lies in the plane which is developed on rocks of the basement complex found in the savanna zone. It covers an approximate area of 40.63 km^2. Abeokuta is drained by River Ogun. The main tributaries of River Ogun are Rivers Oyan, Ofiki and Opeki Rivers. Some of the crops grown in Abeokuta are tomatoes, pepper, maize and cotton.Abeokuta is a historic Yoruba town, formed by the Egbas in 1830. The town has become increasinglycosmopolitan as a result of the elevation in status of Abeokuta to state capital in 1976. The geographical location of the town makes it easily accessible to Lagos, the commercialcapital of Nigeria, industrial state and main seaport.

Development of agricultural production in Abeokuta has not been encouraging. Crop production has to go hand in hand with the estimation of water available for agriculture in Abeokuta to foster the development of crop production. The growing seasons of crops has to be cross-referenced with the water available during the period hence; estimation of water availability for agriculture in Abeokuta has to be emphasized in order to bring a new dawn to agricultural production in the city.

This project estimated the water availability for agriculture in Abeokuta at the general overview of the water condition of the study area in terms of amount of precipitation, actual and potential evapo-transpiration, soil moisture storage and change; assessed the suitability of the study area for crop production through analysis of the growing season, the water requirement of the crops and the quantity and frequency of possible irrigation requirements.

The most general and widely used equation for calculating reference ET is the Penman equation. The Penman-Monteith (1948) variation is recommended by the Food and Agriculture Organization. The simpler

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Blaney-Criddle (1950; Blaney et al, 1942; Blaney and Criddle, 1962) equation was popular in the Western United States for many years. Other solutions used include Makkink (1957) which is simple but must be calibrated to a specific location, and Hargreaves and Samani, (1985).

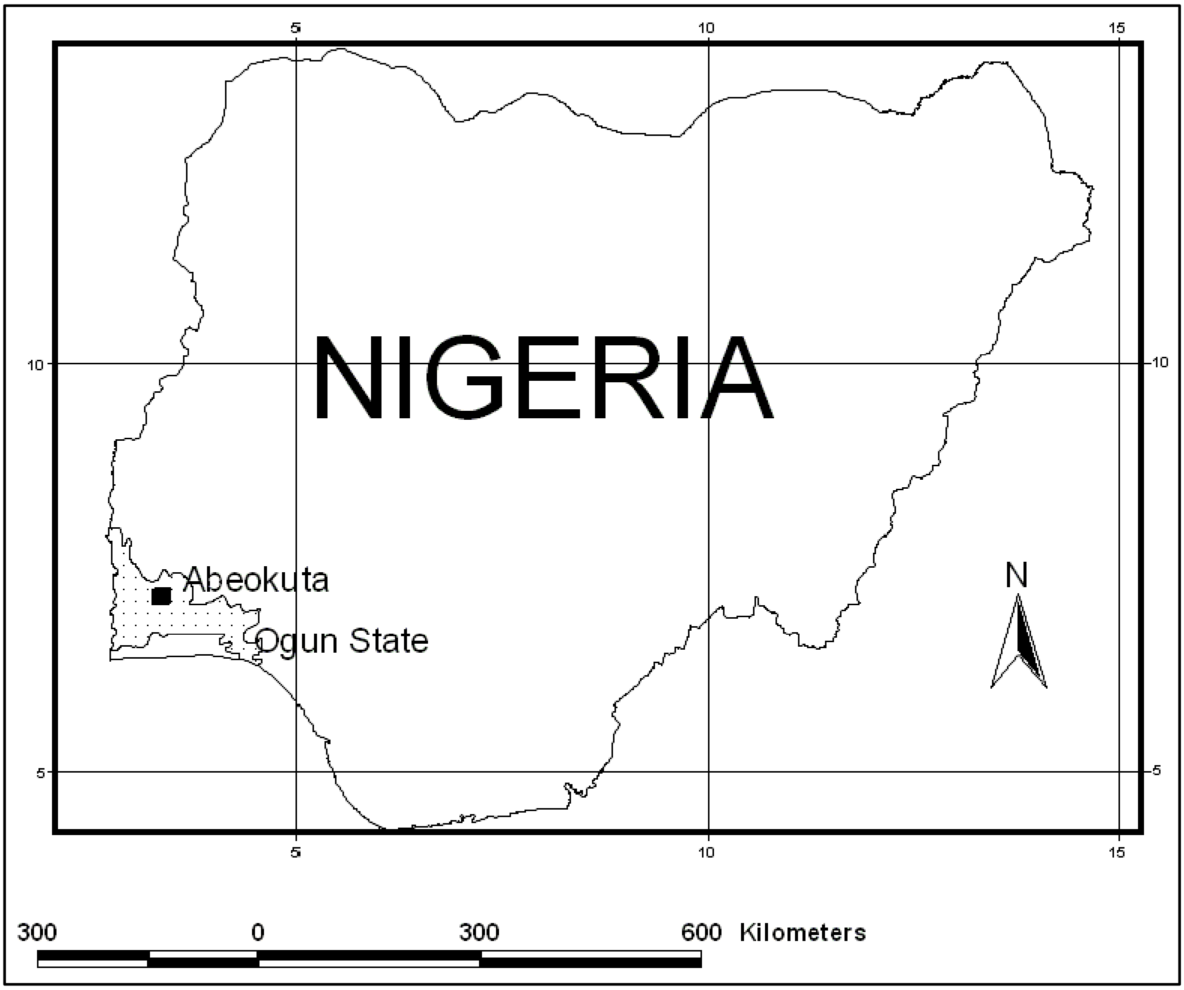

Figure 1 : Map of Nigeria showing Abeokuta

II. Method

Mean monthly data were collected from the archives of Nigeria Meteorological Services Oshodi (NIMET) with the help of a computer. The data were collected for a period of twenty-one (21) years from 1990 – 2010. The parameters collected are: Minimum and maximum temperature, Solar Radiation, Relative humidity, Wind speed and Rainfall values. The collated data were compiled and tabulated for proper co-ordination. The processed data were used in the estimationof monthly evapo-transpiration in different location by using BlaneyCriddle method.

The Blaney-Criddle formula: $\text{ETo} = \text{p}(0.46\text{Tmean} + 8$

ETo = Reference crop evapo-transpiration (mm/day)

T mean = mean daily temperature (°C)

p = mean daily percentage of annual daytime hours

The use of Blaney-Criddle formula involves:

- Determination of the mean daily temperature: T mean

$$\text{T max} = \frac{\text{sum of all T max values during the month}}{\text{Number of days of the month.}}$$

$$\text{T min} = \frac{\text{sum of all T min values during the month}}{\textit{Number of days of the month}}$$

$$Tmean = \frac{\text{T max} + \text{T min}}{2}$$

- Determination of the mean daily percentage of annual daytime hours: P
- Calculate ETo, using the formula: ETo = P(0.46 T mean + 8)
- Find the relationship between the reference grass crop and the crop actually grown is given by thecrop factor,Kc, as shown in the following formula:

$$ET_o \ x \ K_c \ = \text{ET crop}$$

Where: ET crop is crop evapo-transpiration or crop water need (mm/day).

$$\text{Kc} = \text{crop factor.}$$

ETo = reference evapo-transpiration (mm/day)

Both ET crop and ETo are expressed in the same unit: usually in mm/day (as an average for a period of one month) or in mm/month.

a) Determination of the Total Growing Period

The total growing period is the period from sowing or transplanting to the last day of the harvest. It mainly depends on the type of crop and the variety, the climate and the planting date.

b) Determination of The Various Growth Stages

Once the total growing periods is known, the duration of the various growth stages has to be determined.

The total growing period is divided into four growth stages.

1. **The initial stage:** this is the period from sowing or transplanting until the crop covers about 10% of the ground.
2. **The crop development stage:** this period starts at the end of the initial stage and lasts until the full ground cover has been reached (ground cover 70-80%); it does not necessarily mean that the crop is at its maximum height.
3. **The mid - season stage:** this period starts at the end of the crop development stage and lasts until maturity; it includes flowering and grain-setting.
4. **The late season stage:** this period starts at the end of the mid season stage and lasts until the last day of the harvest; it includes ripening.

c) Determination of Crop Factors

For every crop to be treated, four (4) crop factors have to be determined. One crop for each of the four growth stages.

Determine the crop water need for tomatoes, given monthly evapo-transpiration for the growing season (table 1).

Table 1 : Crop water need of tomatoes during the growing season

MONTH	Mar	Apr	May	Jun	Jul	Aug	Sep
ETo(mm/day)	4.85	4.73	4.83	3.7	2.62	1.99	2.63
HUMIDITY	65.00	71.27	75.33	79.42	82.05	82.05	80.29
WIND SPEED	2.86	2.89	2.52	2.41	2.41	2.41	2.36

Duration of growing period: 150 days and Planting date: March 1

SOLUTION

Step 1 : Estimate duration of the various growth stages (table 2).

Table 2 : Duration of the various growth stages of tomato

CROP	Total growing period	Initial stage	Crop development stage	Mid-season stage	Late season stage.
Tomatoes	150	35	40	50	25

Step 2 : Determine the ETo values and the duration of the growth stages (table 3).

Table 3 : ETo values and the duration of the growth stages of tomato.

Months	March	April	May	June	July	August	September
ETo(mm/day)	4.85	4.73	4.83	3.70	2.62	1.99	2.63
Growth stages	Initial stage	Crop development stage	Mid-season stage		Late season stage		

Step 3 : Determine the Kc factors for each of the growth stages consideringthe humidity and wind speed.

Kc, initial stage = 0.45

Kc, crop development stage = 0.75

Kc, mid-season stage = 1.15

Kc, late season stage = 0.8

Table 4 : Crop factors (kc) for each of the growth stages of tomato

Months	March	April	May	June	July	August	September
ETo(mm/day)	4.85	4.73	4.83	3.70	2.62	1.99	2.63
Growth stages	Initial stage	Crop development stage	Mid-season stage		Late season stage		
Kc per Growth stage	0.45	0.75	1.15		0.84		

From the above table, the months and growth stages do not correspond thus the ETo and the Kc values do not correspond. Yet the ETcrop = ETo x Kc has to be determined on a monthly basis.

March: Kc March = 0.45

April: 5 days Kc = 0.45

25 days Kc = 0.75

Kc April: Kc = (5/30 x 0.45) + (25/30 x 0.75)

Kc = 0.07 + 0.62

Kc = 0.69 approx 0.70.

Note: Kc values are rounded to the nearest 0.05 or 0.00.

Thus Kc, April = 0.70.

May: Kc

15 days: Kc = 0.75

15 days: Kc = 1.15

Kc May: (15/30 x 0.75) + (15/30 x 1.15)

Kc = 0.38 + 0.58

Kc = 0.96 approx 0.95.

June: Kc June = 1.15

July: 5 days: Kc = 1.15

25 days: Kc = 0.80

Kc, July: (5/30 x 1.15) + (25/30 x 0.80)

Kc = 0.19 + 0.67

Kc = 0.86 approx 0.85

The kc per month is estimated in table 5.

Table 5 : Crop factor (Kc) for each month of the growing season.

Months	March	April	May	June	July	August	September
ETo(mm/day)	4.85	4.73	4.83	3.70	2.62	1.99	2.63
Growth stages	Initial stage	Crop development stage	Mid-season stage		Late season stage		
Kc per Growth stage	0.45	0.75	1.15		0.84		
Kc per month	0.45	0.70	0.95	1.15	0.85		

Step 4 : Calculate the water need on a monthly basis using the formula:

ETcrop = ETo x Kc (mm/day).

March ETcrop = 4.85 x 0.45 = 2.2 mm/day.

April ETcrop = 4.75 x 0.70 = 3.3 mm/day.

May ETcrop = 4.83 x 0.95 = 4.6 mm/day.

June ETcrop = 3.70 x 1.15 = 4.3 mm/day

July ETcrop = 2.62 x 0.85 = 2.2 mm/day

The monthly crop water need is estimated in table 6.

Table 6 : Monthly crop water need of tomato.

Months	March	April	May	June	July	August	September
ETo(mm/day)	4.85	4.73	4.83	3.70	2.62	1.99	2.63
Growth stages	Initial stage	Crop development stage		Mid-season stage	Late season stage		
Kc per Growth stage	0.45	0.75		1.15	0.84		
Kc per month	0.45	0.70	0.95	1.15	0.85		
ETo mm/day	2.2	3.3	4.6	4.3	2.2		

Step 5 : Calculate the monthly and seasonal crop water needs.

All months are assumed to have 30 days.

March ETcrop = 30 x 2.2 = 66 mm/month.

April ETcrop = 30 x 3.3 = 99 mm/month.

May ETcrop = 30 x 4.6 = 138 mm/month.

June ETcrop = 30 x 4.3 = 129 mm/month.

July ETcrop = 30 x 2.2 = 66 mm/month.

The seasonal crop water need is estimated in Table 7.

Table 7 : Seasonal crop water need of tomato

Months	March	April	May	June	July	August	September
ETo(mm/day)	4.85	4.73	4.83	3.70	2.62	1.99	2.63
Growth stages	Initial stage	Crop development stage		Mid-season stage	Late season stage		
Kc per Growth stage	0.45	0.75		1.15	0.84		
Kc per month	0.45	0.70	0.95	1.15	0.85		
ETo (mm/day)	2.2	3.3	4.6	4.3	2.2		
ETcrop (mm/month)	66	99	138	129	66		

This table shows that the total crop water needed for the whole growing season of tomato is the summation of the total ETcrop (mm/month) is 498mm.

Determination of Irrigation Requirement of Tomato

In a quantitative study of infiltration in basement complex in South Africa area, a linear rainfall – infiltration relationship was obtained (Bredenkamp, 1990). This relationship yields an infiltration equation as follows:

I = A (P – B)

Where: I = Recharge.

P = Precipitation

A and B are simulated parameters.

Considering the general applicability of this method and the soil type together with the range of annual rainfall in Abeokuta area,the following simulated parameters were applied bearing in mind that these factors that influences precipitation in Nigeria: A = 0.2 and B = 395. The relation now becomes

$$I = 0.2\ (P - 395)$$

Where:P = Precipitation during growing season.

I = Infiltration.

To get the amount of infiltrated water;

I = 0.2 (P – 395)

P = 52.66 + 129.27 + 146.92 + 188.66 + 205.4

Thus P = 722.91

Using the formulae;

I = 0.2 (722.91 – 395)

I = 0.2 x 327.91

I = 65.58 mm

To get the amount of run off;

Q = KP

Where: Q = discharge/ run-off.

P = precipitation during growing season.

K = run-off coefficient which is 0.09

Q = 0.09 x 722.91

Q = 65.06 mm

To determine the change in storage;

P – ET – R – I – S = 0

Where: P = precipitation during growing season.

ET = total crop water needed for the whole growing season of the crop.

R = run-off.

I = infiltration.

S = change in storage.

From the data collated above;

P = 722.91 mm

ET = 498 mm

R = 65.06 mm

I = 65.58 mm

Thus S = 722.91 – 498 – 65.06 – 65.58

S = 94.27 mm.

Since change in storage is positive, tomatoes can be grown conveniently within its growing season in Abeokuta without need for irrigation.

VI. Results

a) Rainfall

The result of the mean annual rainfall averaged over the period of twenty – one (21) years is shown in table 8.

Table 8 : Mean monthly rainfall (mm) 1990 – 2010.

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pptn	4.77	25.7	52.66	129.27	146.92	188.66	205.4	105.71	202.91	125.70	16.33	10.13

Where pptn is the precipitation value.

The highest rainfall for the study area is recorded in June, July and September while the minimum rainfall is exhibited in January and December.

b) Temperature

The result of the mean monthly temperature over the period of twenty-one years is shown in table9.

Table 9 : Mean monthly air temperature (^{0}C) 1990–2010.

Months	Mean monthly maximum temperature	Mean monthly minimum temperature	Mean monthly air temperature
January	34.48	22.96	28.72
February	36.27	24.70	30.49
March	35.65	24.41	30.54
April	34.16	24.60	29.38
May	32.46	24.07	28.28
June	31.00	23.52	27.26
July	29.69	23.00	26.35
August	28.80	22.78	25.79
September	30.10	23.13	26.62
October	31.90	23.62	27.76
November	33.62	23.65	28.64
December	34.16	23.82	28.99

The mean monthly maximum and minimum temperature are observed in February and August which are 36.27 and 22.78 respectively. The minimum air temperature is 25.79 in August and the maximum air temperature is 30.54 in March.

c) Wind speed

The result of the mean monthly wind speed computed for a period of twenty – one years is given in table 10 below.

Table 10 : Mean monthly wind speed (m/s) 1990 – 2010.

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
m/s	2.55	3.00	2.86	2.89	2.52	2.41	2.41	2.41	2.36	2.37	2.37	2.4

The maximum wind speed value id obtained in February (3.00 m/s) and the minmimum wind speed value is obtained in September (2.36 m/s).

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d) Humidity

The result of the mean month relative humidity (%) is computed in table 11.

Table 11 : Mean monthly relative humidity (%) 1990 – 2010.

Months	RH @ 0900 hours	RH @ 1500 hrs	Mean monthly RH %
January	70.29	42.29	56.29
February	73.29	41.57	57.43
March	78.24	51.76	65.00
April	81.29	61.24	71.27
May	82.33	68.33	75.33
June	85.14	73.7	79.42
July	87.43	76.67	82.05
August	87.67	76.43	82.05
September	86.86	73.71	80.29
0ctober	85.38	67.62	76.50
November	82.76	54.10	68.43
December	75.81	48.91	62.36

Where RH is relative humidity.

The maximum relative humidity value is found in July and August with RH value of 82.05 while the minimum RH value is found in January with RH value of 56.29.

e) Solar radiation

The result of the mean monthly sunshine hours for a period of twenty – one years is given in table 12.

Table 12 : Mean monthly sunshine hours 1990 – 2010.

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SH (hrs)	5.13	5.15	5.24	5.15	5.55	4.25	3.15	2.45	3.0	5.8	6.1	5.6
P (%)	0.21	0.22	0.22	0.22	0.23	0.18	0.13	0.10	0.13	0.24	0.25	0.23

Where SH is sunshine hours and P is the percentage duration of sunlight.

The maximum sunshine hours is recorded in October (5.8 hours), while the minimum sunshine hours is recorded in August (2.45 hours)

Potential evapotranspiration values

The result of Potential evapo-transpiration (ETo) values for Abeokuta between 1990 – 2010 using Blaney-criddle method is given in table 13.

Table 13 : Potential evapo-transpiration values for Abeokuta

Months	T mean (^{0}C)	P	ETo (mm/day)
January	28.72	0.21	4.45
February	30.49	0.22	4.85
March	30.54	0.22	4.85
April	29.38	0.22	4.73
May	28.28	0.23	4.83
June	27.26	0.18	3.70
July	26.35	0.13	2.62
August	25.79	0.10	1.99
September	26.62	0.13	2.63

September	26.62	0.13	2.63
October	27.76	0.24	4.98
November	28.64	0.25	5.29
December	28.99	0.23	4.91

Result For Crop Factors And Crop Water Need

The crops to be examined are maize, cotton, tomatoes and pepper.

Crop 1: Maize

The duration of total growing period is 110 days. The initial stage is 20 days, the crop development stage is 30 days, and the mid-season stage is 50 days while the late season stage is 10 days. The Crop factors, Kc has the initial stage as 0.40, the crop development stage as 0.80 and the mid-season stage as 1.15 while the late season stage as 1.00. The planting date is April 1; the result for crop water need for maize is given in table 14.

Table 14 : Result of Crop water need for maize

Months	April	May	June	July	August	September
ETo (mm/day)	4.73	4.83	3.70	2.62	1.99	2.63
Growth stages	Initial stage	Crop development stage	Mid-season stage	Late season stage		
Kc per growth stage	0.40	0.80	1.15	1.00		
Kc per month	0.4	0.91	1.15	0.71		
ETo (mm/day)	1.9	4.4	4.3	1.9		
ETcrop(mm/month)	57	132	129	57		

The table shows that the total crop water needed for the whole growing season of maize is 375 mm. From table 14, the potential evapotranspiration increased from April at 4.73 mm/day to reach its peak in May at 4.83 mm/day. It later decreased from May to August at 1.99 mm/day before it appreciated in September to 2.63 mm/day. The crop factor per month increased from 0.4 in April to attain its peak of 1.15 in June during the growing season before decreasing back to 0.71 in July. Likewise the daily crop water need increased from April at 1.9 mm/day to reach its peak at 4.4 mm/day in May during its growing season before dropping back to 1.9 mm/day in July. The monthly crop water need for maize increased from 57 mm/month in April to attain its peak of 132 mm/month in May before declining back to 57 mm/month in July.

Crop 2: Cotton

The duration of total growing period is 165 days. The initial stage is 25 days, the crop development stage is 45 days, and the mid-season stage is 50 days while the late season stage is 45 days. The Crop factors, Kc has the initial stage as 0.45, the crop development stage as 0.75 and the mid-season stage as 1.15 while the late season stage as 0.75. The planting date is August 1; the result for crop water need for Cotton is given in table 15.

Table 15 : Result of crop water need for Cotton

Months	Aug	Sep	Oct	Nov	Dec	Jan	Feb
ETo (mm/day)	1.99	2.63	4.98	5.29	4.9	4.45	4.85
Growth stages	Initial stage	Crop development stage	Mid-season stage	Late season stage			
Kc per growth stage	0.45	0.75	1.15	0.75			
Kc per months	0.51	0.75	1.02	1.15	0.75	0.38	
ETcrop (mm/day)	1.00	2.00	5.10	6.10	3.70	1.70	
ETcrop(mm/month)	30	60	153	183	111	51	

The table shows that the total crop water needed for the whole growing season of cotton is 588 mm. From table 15, the potential evapotranspiration increased from August at 1.99 mm/day to reach its peak in November at 5.29 mm/day. It later decreased from November to January at 4.9 mm/day before it appreciated in February to 4.85 mm/day. The crop factor per month increased from 0.51 in August to attain its peak of 1.15 in November during the growing season before decreasing back to 0.38 in January. Likewise thedaily crop water need increased from August at 1.00 mm/day to reach its peak at 6.10 mm/day in November during its growing season before dropping back to 1.70 mm/day in January. The monthly crop water need for cotton increased from 30 mm/month in August to attain its peak of 183 mm/month in November before declining back to 51 mm/month in January.

Crop 3: Tomato

The duration of total growing period is 150 days. The initial stage is 35 days, the crop development stage is 40 days, and the mid-season stage is 50 days while the late season stage is 25 days. The Crop factors, Kc has the initial stage as 0.45, the crop development stage as 0.75 and the mid-season stage as 1.15 while the late season stage as 0.80. The planting date is March 1; the result for crop water need for tomato is given in table 16.

Table 16 : Result of crop water need for tomato

Months	March	April	May	June	July	August	September
ETo(mm/day)	4.85	4.73	4.83	3.70	2.62	1.99	2.63
Growth stages	Initial stage	Crop development stage	Mid-season stage	Late season stage			
Kc per Growth stage	0.45	0.75	1.15	0.84			
Kc per month	0.45	0.70	0.95	1.15	0.85		
ETo mm/day	2.2	3.3	4.6	4.3	2.2		
ETcrop mm/month	66	99	138	129	66		

The table shows that the total crop water needed for the whole growing season of tomato is 498 mm. From table 16, the potential evapotranspiration decreased from March at 4.85 mm/day to September at 2.63 mm/day. The crop factor per month increased from 0.45 in March to attain its peak of 1.15 in June during the growing season before decreasing back to 0.85 in July. Likewise the daily crop water need increased from

2.2 mm/day in March to reach its peak at 4.6 mm/day in May during its growing season before dropping back to 2.2 mm/day in July. The monthly crop water need for tomato increased from 66 mm/month in March to attain its peak of 138 mm/month in May before declining back to 66 mm/month in July.

Crop 4: Pepper

The duration of total growing period is 170 days. The initial stage is 30 days, the crop development stage is 40 days, and the mid-season stage is 70 days while the late season stage is 30 days. The Crop factors (Kc) has the initial stage as 0.35, the crop development stage as 0.70 and the mid-season stage as 1.05 while the late season stage is 0.90. The planting date is March 1, the result for crop water need for tomato is given in table 17.

Table 17 : Result of crop water need for pepper

Months	March	April	May	June	July	August
ETo (mm/day)	4.85	4.73	4.83	3.70	2.62	1.99
Growth stages	Initial stage	Crop development stage		Mid season stage	Late season stage	
Kc per growth stage	0.35	0.70		1.05	0.90	
Kc per month	0.35	0.70	0.9	1.05	1.0	0.6
ETcrop (mm/day)	1.7	3.3	4.4	3.9	2.60	1.20
ETcrop (mm/month)	51	99	132	117	78	36

The table shows that the total crop water needed for the whole growing season of pepper is 513 mm. From table 17, the potential evapo-transpiration decreased from March at 4.85 mm/day to August at 1.99 mm/day. The crop factor per month increased from 0.35 in March to attain its peak of 1.05 in June during the growing season before decreasing back to 0.60 in August. Likewise the daily crop water need increased from 1.7 mm/day in March to reach its peak at 4.4 mm/day in May during its growing season before decreasing to 1.2 mm/day in August. The monthly crop water need for pepper increased from 51 mm/month in March to attain its peak of 132 mm/month in May before declining to 36 mm/month in August.

Results for Irrigation Requirement of the Crops

Crop 1: Maize

Applying the linear rainfall – infiltration relationship (Bredenkamp and Burkhant, 1990), there is enough water for planting of maize in the study area. More importantly, since the crops is grown in major rainy seasons there is enough water to enhance germination hence, no need for irrigation if planted within its season. The growing season for maize records increasing amount of rainfall, the precipitation value increased from 129.27 mm in April to 205.4 mm in July during the estimated period.

Crop 2: Cotton

Applying the linear rainfall – infiltration relationship (Bredenkampand Burkhant, 1990), there is no enough water for planting of cotton in the study area (during the growing season), hence, the need for irrigation. Since cotton is a dry season crop, it requires water for irrigation. The period through which cotton is planted records the least mean precipitation values.

Crop 3: Tomato

Applying the linear rainfall – infiltration relationship (Bredenkampand Burkhant, 1990), there is enough water for planting of tomato in the study area. More importantly, since the crops is grown in major rainy seasons there is enough water to enhance germination hence, no need for irrigation if planted within its season. The growing season for maize records increasing amount of rainfall, the precipitation value increased from 52.66 mm in March to 205.4 mm in July during the estimated period.

Crop 4: Pepper

Applying the linear rainfall – infiltration relationship (Bredenkamp 1990), there is enough water for planting of pepper in the study area. More importantly, since the crops is grown in major rainy seasons there is enough water to enhance germination hence, no need for irrigation if planted within its season. The growing season for pepper records increasing amount of rainfall, the precipitation value increased from 52.66 mm in March to 205.4 mm in July before decreasing to 105.71 mm in August during the estimated period.

VII. Discussion

The study area received the highest precipitation of 205.4 mm in July, followed closely by 202.91 mm in September. The least rainfall received was 4.77 mm in January, followed closely by the precipitation value recorded in December. The water available for agriculture in the study area was estimated by calculating the crop water needs of selected crops which were derived using 21 years data on rainfall values, sunshine hours, temperature, relative humidity and wind speed. The selected crops are maize, cotton, tomato and pepper.

Maize has a total growing period of 110 days; the stages of development which are initial, crop development, mid-season, late season have varying crop factors. The growing period for maize falls between April 1st and July 20th. The crop factor for each of the month during the growing season is 0.4, 0.91, 1.15 and 0.71 in April, May, June and July respectively. The daily crop water need for each of the month is 1.9 mm/day in April, 4.4 mm/day in May, 4.3 mm/day in June and 1.9 mm/day in July. The crop water need during the growing season was estimated as 57 mm in April, 132 mm in May, 129 mm in June and 57 mm in July. The total crop water need during the growing season of maize is 375 mm. From the present study it is clear that a planting-window from 1st April to 20th July can be safely considered for grain maize planting. This study also indicatesthat it is not advisable to go for maize planting after August.

Cotton has a total growing period of 165 days; the stages of development which are initial, crop development, mid-season, late season have varying crop factors. The growing period for cotton falls between August 1st and January 15th. The crop factor for each of the month during the growing season is 0.51, 0.75, 1.02, 1.15, 0.75 and 0.38 in August, September, October, November, December and January respectively. The daily crop water need for each of the month is 1.00 mm/day in August, 2.00 mm/day in September, 5.10 mm/day in October, 6.10 mm/day in November, 3.70 mm/day in December and 1.70 in January. The crop water need during the growing season was estimated as 30 mm in August, 60 mm in September, 153 mm in October, 183 mm in November, 111 mm in December and 51 mm in January. The total crop water need during the growing season of maize is 588 mm. From the present study it is clear that a planting-window from August 1st and January 15th can be safely considered for cotton planting. This study also indicatesthat it is not advisable to go cotton planting during rainy season. Cotton is a dry season crop thus, requires minimal amount of rainfall at various stages of development. The planting of cotton in Abeokuta requires irrigation due to the low precipitation values recorded during the growing season.

Tomato has a total growing period of 150 days; the stages of development which are initial, crop development, mid-season, late season have varying crop factors. The growing period for maize falls between March 1st and July 31st. The crop factor for each of the month during the growing season is 0.45, 0.70, 0.95, 1.15 and 0.85 in March, April, May, June and July respectively. The daily crop water need for each of the month is 2.2 mm/day in March, 3.3 mm/day in April, 4.6 mm/day in May, 4.3 mm/day in June and 2.2 mm/day in July. The crop water need during the growing season was estimated as 66 mm in March, 99 mm in April, 138 mm in May, 129 mm in June and 66 mm in July. The total crop water need during the growing season of tomato is 498 mm. From the present study it is clear that a planting-window from 1st March to 31st July can be safely considered for grain maize planting. This study also indicatesthat it is not advisable to go for pepper planting after July.

Pepper has a total growing period of 170 days; the stages of development which are initial, crop development, mid-season, late season have varying crop factors. The growing period for maize falls between March 1st and August 20th. The crop factor for each of the month during the growing season is 0.35, 0.70, 0.90, 1.05, 1.0 and 0.6 in March, April, May, June, July and August respectively. The daily crop water need for each of the month is 1.7 mm/day in March, 3.3 mm/day in April, 4.4 mm/day in May, 3.9 mm/day in June, 2.60 mm/day in July and 1.20 mm/day in August. The crop water need during the growing season was estimated as 51 mm in March, 99 mm in April, 132 mm in May, 117 mm in June, 78 mm in July and 36 mm in August. The total crop water need during the growing season of pepper is 513 mm. From the present study it is clear that a planting-window from March 1st and August 20th,can be safely considered for grain maize planting. This study also indicatesthat it is not advisable to go for pepper planting after September.

VIII. Conclusion

This study found that tomato, pepper and maize could perform conveniently during their growing season without the need of irrigation in Abeokuta. These crops are planted and reach maturity during raining seasons. It was also derived that cotton needed irrigation during its growing season to perform optimally. Cotton is a dry season crop that does not require excess water. The precipitation values for the growing season was low thus, making need for irrigation necessary to complement for the minimum precipitation received over the study area.

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Determinants of Farmers' Participation in Food Market in Ogun State

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Abstract - This study was carried out to access the determinants of farmers' participation in food market in Odeda L.G.A. of Ogun state. Simple random sampling technique was used in the selection of the respondents and a well structured question was used to gather information on the determinants of farmers' participation in food market. A total of 100 questionnaires were administered but only 70 could be retrieved and subjected to analysis. The analytical technique includes descriptive statistics and Probit regression analysis. The result shows that the average age was 45yrs. Probit analysis shows that the major determining factors influencing farmers participation in the market were age, marital status, source of labor, farming experience, farm size, and which were significant at $p \leq 0.05$ and $p \leq 0.01$ respectively. It is therefore recommended that government should intensify efforts through the extension agents in organizing programs which will enhance farmers' participation in market through training, disseminating market information and better utilization of farmland.

Keywords : Participation, Market, and Ogun State.

GJSFR-D Classification: FOR Code: 070199

DETERMINANTS OF FARMERSPARTICIPATION IN FOOD MARKET IN OGUN STATE

Determinants of Farmers' Participation in Food Market in Ogun State

Egbetokun, O.A. [α], & B.T. Omonona [σ]

Abstract - This study was carried out to access the determinants of farmers' participation in food market in Odeda L.G.A. of Ogun state.

Simple random sampling technique was used in the selection of the respondents and a well structured question was used to gather information on the determinants of farmers' participation in food market. A total of 100 questionnaires were administered but only 70 could be retrieved and subjected to analysis. The analytical technique includes descriptive statistics and Probit regression analysis.

The result shows that the average age was 45yrs. Probit analysis shows that the major determining factors influencing farmers participation in the market were age, marital status, source of labor, farming experience, farm size, and which were significant at $p \leq 0.05$ and $p \leq 0.01$ respectively.

It is therefore recommended that government should intensify efforts through the extension agents in organizing programs which will enhance farmers' participation in market through training, disseminating market information and better utilization of farmland.

Keywords : Participation, Market, and Ogun State.

I. Introduction

The vital role and importance of marketing in agricultural and economic development have been emphasized by many development economists and policymakers. Dittoh (1994), Njoku (1994) and Bruno *et al.* (1998) stressed that agricultural food marketing is the major determinant of agricultural growth and contributes to the overall development.

The key to increasing agricultural output in most developing countries is improving the productivity of farmers, which cannot be achieved without markets that would effectively bind the increasingly specialized activities of thousands of widely dispersed producers into an integrated national economy. Thus, an efficient and responsive marketing system for agricultural products is an indispensable component of the development process (Southworth, 1981).

Commenting on the importance of marketing, Abbot (1993) opined that marketing fulfils the important role of stimulating and extending development. By this opinion, the producer is enabled to move from semi-subsistence to growing produce regularly for sales. Furthermore, the author noted that an efficient marketing sector does not merely link buyers to sellers and react to the current situation of supply and demand; it also has a dynamic role to play in stimulating output and consumption, the essentials of economic development.

Bruno *et al.* (1998) remarked that the production of food crops in any specific area cannot be expected to increase more rapidly than the farm population unless an effective demand from outside that population can be transmitted to the producer. The transmission of this effective demand from outside the farm population to the producer contributes the primary function of marketing system.

Market participation among farmers has long been on agricultural economist research agenda in both developed and developing nations (Barret, 2007). In sub-Saharan Africa, the question has taken a renewed urgency as policymakers seek ways of reducing external payment imbalances, caused largely by secular declines in per capita food production and concomitant reduction in marketed food surpluses (Goetz, 1992).

Recent empirical findings in Zimbabwe, Rwanda, Somalia, Mali and Senegal (Weber et al., 1988) and Burkina Faso (Delgado, 1995 and Reardon, 1999) raised serious question about the use of food policy, even when combined with input distribution programmes as an instrument of raising short run marketed surplus and rural welfare. Some farmers are net purchasers of food items, even in years of average rainfall, while others fail to participate in the markets, altogether, either as buyers or sellers. The consumer-producer price dilemma clearly is not limited to rural-urban tradeoffs; it exists with equal force in rural area (Goetz, 1992). So, why do many smallholder farmers in low income rural areas opt out of markets? Surely, this reflects something more than just widespread error. Instead, the problem is that farmers' participation in food market is a consequence as much as a cause of development (Barrett, 2007).

Just getting prices right does not induce broad-based welfare enhancing market participation (Barrett, 2007). Farmers must have access to productive technologies and adequate private and public goods and improved technologies require that farmers earn enough that they can save and invest. Moreover, the institutional and physical infrastructure necessary to ensure broad-based low cost access to competitive, well functioning market; likewise requires significant investments, typically by the public sector paid for out of

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tax revenues or aid flows. One thus has to get institution and endowment as well as prices right in order to induce market-based development.

Other studies have shown that the return on investment by smallholder is quite poor (Diehl and Winch, 1979; Eze, 1989; Orebiyi and Ugochukwu, 2004; Asemota, 2004; Babatunde and Oyatoye, 2005). Emphasizing on the issue of poor returns to farmers on their invetstments, Eze (1989), Babatunde and Oyatoye (1998) specifically noted that the middlemen's share of total marketing margin was higher when compared with the farmers' returns. Agbaje *et al*. (2005) confirmed this statement pointing out that farmers complain of low and unattractive prices, which do not cover their cost of production. According to the farmers, this is perceived as market exploitation because not much value is added to the food by the middlemen to justify the very high margin collected. This exploitation directly or indirectly leads to loss of interest in farming and subsequently food insecurity in the country.

There is therefore need to encourage farmers by integrating them into the markets, and this will only happen when smallholder farmers fully participate in the market. This study therefore aims a identifying the main socioeconomic factors influencing the farmer's decision to sell and the volume of sales, the various market options used by the farmers, the major constraints faced by the farmers and to proffer solutions that can lead to an increase in market participation.

II. Sampling and Data Collection

Simple random technique was used during this research work, to determine villages of the LG covered and include Olodo, Odeda and Eweje. 100 questionnaires were randomly distributed among respondents in these three areas. However, 70 were retrieved and used for the analysis. Data were collected for this study with the aid of a well structured questionnaire. The target population for this study was arable farmers in the state. Key information gathered included socioeconomic characteristics, some of the food items produced for the market, and volume of sales. The data were collected on determinant of farmer's participation in the food market, as well as their socio economic characteristics.

III. Analytical Technique

Data analysis involved the use of descriptive statistics and regression model Probit. Descriptive analysis such as frequency distribution tables, percentage, mean, standard deviation was used to analyze the respondent's socioeconomic characteristics.

In the regression model analysis, the Gragg Double Hurdle Model consists of two stages. The Probit model was employed. The Probit model was used to determine the probability of participation in the market. When the Heckman model was employed, the regression coefficient on the IMR was statistically insignificant and this suggests the absence of sample selection bias. The procedure for analyzing the Probit model start with identifying the dependent variable, which is a dummy and can assume only two values (either 0 or 1). The Probit model is specified thus:

$$P_{(sy-1)} = f(z_1) = \frac{1}{\sqrt{2\pi}} \sum_{\infty}^{z_1} \frac{\ell U^2 du}{2} \quad (1)$$

Where the unobservable z_1 is a linear combination of the observable explanatory variables. The explanatory variables are specified thus;

X_1 = Age of farmer

X_2 = Sex of farmer

X_3 = Marital Status of farmer

X_4 = Family size of farmer

X_5 = Level of education

X_6 = Farmer experienced

X_7 = Farm size

X_8 = Source of labour

IV. Results and Discussion

a) *Socio-economic characteristics of the respondents*

In recognition of the significant role played by the demographic and socio-economic attributes of the farmers on participation in market-oriented decisions, the study accessed household socio-economic characteristics in relation to market participation. Majority (62.6%) was of productive age between 31 and 50 years, 26% were over 60 years and 11.4% were below 30 years (Table 1). This shows that there was potential for productivity to be high in the area thus increased market participation (Benfica et al., 2006). About 75% of male were found to be participating more in market than female (24%). This result shows a contradiction to what other studies such as Key *et al*., (2000); Olarinde and Kuponiyi (2005) and Omonona and Agoi, (2007) have found out. The reason could be that farm produce were mainly being sold at farm gate by male gender before getting to the local markets where the control is left to the female. A greater percentage of the respondents were married (77%) having a modal household size of between 4 – 6 persons per household. This is an indication that the household size was high implying relative high food demand. Therefore, participation in the food market is inevitable whereby a household would sell part of its produce to get money to buy what it could not produce to cater for the members of its household. The cultivation of farmland was a small scale enterprise as 71% engaged in cultivation of between 1 – 5 hectares of farmland (Table 1). This has being undertaken by the respondents for over 10 years. The years of farming experience shows that the situation has been repeating itself for a long time. In addition, the source of labour used on the farm was family labour (45.7%) and hired labour (34.3%) (Table1). Family labour was higher because of the small scale nature of the farm among the respondents.

b) Determinants of Farmers Participation in Food Market

The important factors which influence farmers' participation in the food market in the study area were identified and analyzed. The result shows that variables conform to a prior expectation with appropriate signs. It is shown that as age increases there is a decrease in participation in market (Table 2). A unit increase in age of the respondent will lead to probability of 0.01% decrease in market participation (P> 0.05). Marital status was significant (P> 0.05) and positive. This implies that a unit increase in marital status will lead to probability of 0.18% increase in market participation. Family size was significant (P> 0.05) and positive. The implication is that a unit increase in the size of the family will probably lead to 0.02% increase in market participation. This would be so because it has been shown earlier that the respondents used more of family labour for farming activities. Also, the source of labour was significant (P>0.05) and exact a positive influence on market participation. Thus, if there is increase in family size, there would be increase in farm size cultivation thereby increase in farm produce to sell. The level of education was significant (P> 0.10) but have a negative sign. This means that a unit increase in level of education will probably reduce market participation by 0.03%. The implication is that as the level of education increases, the respondent would like to disengage in farming in the village and migrate to the urban centre. The years of experience was significant (P>0.01) and positive. The implication is that a unit increase in farming experience will lead to a probability of increasing market participation by 0.06%. Farm size was significant (P>0.01) but with negative sign. This implies that a unit increase in farm size there is probability of 0.02% decrease in market participation. This result deviates from what other researchers (Adenegan et al., (2004); Eskola (2008); Heltberg and Tarp, (2002)) have found out.

V. Conclusion and Recommendation

The results shows that majority of the farmers are well advanced in age and youth are rarely engages in farming in the study area. Also, most of the farmers are male and almost all the farmers are married hence; the use of family labour on the farm is effective.

Illiteracy level was high among the farmers in the study area and majority of them use farm labour for their marketing activities, there is a big house hold size in the area. Federal Government should assist the rural farmers by introducing more adult literacy programmes which would encourage the farmers to participate in the food market. This would expose the farmer to the latest findings. The Government should also introduce more programme and policies aimed at increasing the interest of farmers.

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Table 1 : Socio – economic characteristics of the respondents

Characteristics	Frequency	Percentage
Age		
21 – 30	8	11.4
31 – 40	22	31.3
41 – 50	22	31.3
51 – 60	9	12.9
61 – 70	6	8.7
70 above	3	4.4
Total	**70**	**100**
Gender		
Male	53	75.7
Female	17	24.3
Total	**70**	**100**
Marital Status		
Single	13	18.6
Married	54	77.1
Widowed	3	4.3
Total	**70**	**100**
Educational Status		
Primary Education	18	25.27
Secondary Education	12	17.1
Tertiary Education	10	14.3
No Formal Education	30	42.7
Total	**70**	**100**
Family Size		
1–3	20	28.5
4 –6	42	60
7–9	8	11.5
Total	**70**	**100**

Farm size (Ha)		
1 – 5	50	71.4
6 – 10	12	17.1
11 – 20	7	10.1
Above 20	1	1.4
Total	**70**	**100**
Farm Experience (yrs)		
Less than 2yrs	10	14.3
3 – 5yrs	15	21. 4
6 – 10yrs	19	27.1
Above 10yrs	26	37.2
Total	**70**	**100**
Source of Labour		
Family	32	45.7
Hired	24	34.3
Both	14	20.0
Total	**70**	**100**

Table 2 : Probit Analysis on Determinants of Farmers Participation in Food Market

Variables	Coefficient	T – Value
Age	-.012	-1.974**
Sex	.042	0.668
Marital Status	.177	1.918**
Family Size	.020	2.326**
Education	-.029	-1.684*
Farmer Experience	.057	2.555***
Farm size	-.020	-3.129***
Source of Labour	.042	2.331**
Chi Square	**10.8777**	

, **, * indicate 10, 5 and 1percent level of significance respectively.*

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Bioassay of *Mundulea sericea* Ethanol Leaf Extract and Leaf Powder against *Callosobruchus maculatus* (F.) on Stored Cowpea

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Abstract - Bioassay of ethanolic crude extract of *Mundulea sericea* (Willd.) A. Chev. (syn. *M. suberosa* Benth.) was compared with the leaf powder for their insecticidal potential against *Callosobruchus maculatus* on stored cowpea using actellic (25 EC) and actellic (2 %) as standard checks with an untreated control. Five pairs of day old adult *C. maculatus* were sexed and used to infest 100 g IAR-48 (SAMPEA 7) cowpea seeds stored for three months containing 1, 2 and 3 ml or g of the treatments with each replicated three times. All treated jars were shaken thoroughly to ensure effective coating of seeds with treatments and left on laboratory benches in the Storage Entomology Laboratory of Crop Protection Department, Institute for Agricultural Research(IAR)/Faculty of Agriculture, Ahmadu Bello University, Zaria under open conditions of 28± 2OC and 70± 10 % relative humidity. Insect mortality, oviposition, progeny emergence as well as percentage seed damage and viability were assessed.

Keywords : Bioassay, Mundulea sericea, C. maculatus and mortality.

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Abstract - Bioassay of ethanolic crude extract of *Mundulea sericea* (Willd.) A. Chev. (syn. *M. suberosa* Benth.) was compared with the leaf powder for their insecticidal potential against *Callosobruchus maculatus* on stored cowpea using actellic (25 EC) and actellic (2 %) as standard checks with an untreated control. Five pairs of day old adult *C. maculatus* were sexed and used to infest 100 g IAR-48 (SAMPEA 7) cowpea seeds stored for three months containing 1, 2 and 3 ml or g of the treatments with each replicated three times. All treated jars were shaken thoroughly to ensure effective coating of seeds with treatments and left on laboratory benches in the Storage Entomology Laboratory of Crop Protection Department, Institute for Agricultural Research(IAR)/Faculty of Agriculture, Ahmadu Bello University, Zaria under open conditions of 28± 2^{O}C and 70± 10 % relative humidity. Insect mortality, oviposition, progeny emergence as well as percentage seed damage and viability were assessed. The results revealed that, the plant materials like their synthetic counterparts (Actellic 25 EC and 2 % dust) significantly ($P< 0.05$ %) caused higher insect mortality, reduced oviposition and inhibited progeny emergence with not much damage to seed integrity and viability. Though both plant materials were found to be effective in protecting cowpea seeds against *C. maculatus* attack however, the *Mundulea* ethanolic extract was significantly better than the dust which was in turn better than the untreated control but was not as good as the synthetic pesticides.

Keywords : Bioassay, Mundulea sericea, C. maculatus and mortality.

I. Introduction

The toxicity of most tropical flora as biopesticides against a number of field and stored-product insect pests have been evaluated (Arnason, 1989) however, scanty information is available for some important medicinal plants like *Mundulea sericea*(Wild) A. Chev. (syn.*M.suberosa* Benth), a leguminous shrub belonging to the family fabaceae. It is widely distributed in some parts of tropical Africa and India: The bark, leaves, seeds and roots of this plant have been found to be good fish poison, insecticide and as an aphrodisiac (Luyengi, 1994). Furthermore, Phytochemicals like rotenoids,flavones,chalcones and imidazole derivatives have been extractected from the plant some of which have antifungal effect (Eksteen, *et al.,* 2001).

C. maculatus is a field-to-store beetles seriously pestivorous on stored cowpea and other legumes at the larval stage especially at optimum conditions of 30-35 ^{O}C and70% and above relative humidity, creating many adult emergence holes, subsequently reducing stored grains to powder form loaded with frass, unpleasant odour and culminating to loss of weight and seed viability as well as and marketability. Singh *et al.,* (1978) reported 100% cowpea seed infestation by *C. maculatus* within 3-5 months of storage period. Similarly, Tanzubil, (1991) showed 100% seed damage causing 60% weight loss within 6 months storage period. Loss of cowpea grains to the pest in Nigeria has been estimated to be about 29000 tonnes (dry weight only) (Caswell, 1973). Fumigants like aluminium phosphide (Phostoxin) tablet and pirimiphos- methyl (Actellic 25EC and 2% dust) are the current pesticides used to manage this pest on stored cowpea and other legumes which are associated with the problems of insect resistance and resurgence, ecological pollution, side effects on non-target organisms, pesticide misuse by illiterate farmers as well as cost of the chemicals has made a global search into novel botanicals and other chemical-free storage strategies inevitable. It is against this background that the bioassay of *Mundulea seracea* ethanolic crude extract and leaf powder were evaluated.

II. Material and Methods

Adult *C. maculatus and* cowpea (SAMPEA-7) used for this research were both obtained from Crop Protection Department, Institute for Agricultural Research, Ahmadu Bello University Zaria. Two trials were carried out from April –August 2009 and October, 2009-February 2010 under 27± 3^{0}C and 70-80% relative humidity.

Culture of *C. maculatus*: Adult *C. maculatus* from naturally infested cowpea were identified, sexed and thirty (30) pairs introduced into 500 g uninfested cowpea in two insect-proof Kilner jars and kept under laboratory conditions. After about thirty-five (35) days, newly emerged F_1 adults were collected and used to

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infest the cowpea samples tested during the investigation.

Plant materials:

a. Mundulea leaf ethanolic extract; About 1 kg of shade- dried *mundulea sericea* leaves collected from the surroundings of IAR was powdered using a Retsch SM2000 cutting mill and soaked in 100% methanol for a night. The suspension was filtered twice, first under vacuum through a double layer Whatman filter paper and then by gravity through a single sheet of Whatman number one(No.1) filter paper.The methanol was recovered through vacuum distillation at 30-35^{O}c using a rotary evaporator. The process was repeated three times and subsequently concentrated to dryness and the resultant product diluted with distilled water for use in the experiment.
b. Leaf powder; About 1 kg of fresh *mundulea sericea* leaves was pounded using local wooden pestle and mortar. The product obtained was shade-dried for three days and pounded, sieved and the resultant powder used for the experiment.

Standard checks: Actellic (25EC) and actellic dust used as standard checks for the ethanolic extract and leaf powder respectively were bought from an agro-allied shop in Samaru market, Zaria, Kaduna State Nigeria.

Application rates: All treatments except the untreated control were applied at three concentrations of 1, 2 and 3 ml/100g and g/100g of cowpea seeds for crude extract and leaf powder respectively. Each was replicated three times and all the jars thoroughly shaken to ensure adequate mixing and coating of seeds by the treatments before infestating all jars with five pairs of newly emerged *C. maculatus*. The set up was left on laboratory benches in a completely randomized design layout (CRD).

The parameters evaluated include mortality, oviposition, progeny emergence, seed damage and viability. Insect mortality counts was conducted at 24, 48 and 72 hours post-treatment and two weeks later, all introduced insects were sieved out and oviposition assessed by randomly picking 20 seeds from each jar and the number of eggs laid on each counted and recorded. F_1, F_2 and F_3 progeny emergence was carried out at 4, 8 and 12 weeks post-treatment while damage and seed viability tests were conducted at the end of the three months storage period.

III. Results

Treatments result on insect mortality as shown in figure 1 revealed that all treatments significantly ($p<0.05$) caused higher mortality of adult *C. maculatus* compared to the untreated control. Most insects died within 24 h post-treatment with 100% mortality records at all levels in actellic (25EC) as well as in 2 and 3 g/100g cowpea seeds of actellic dust. This was closely followed by ethanolic extract of *Mundulea sericea* leaf with 90% mortality at 3ml/100g cowpea seeds and 80% at 1 and 2ml as well as at 3g/100 of cowpea seeds of *Mundulea sericea* leaf powder. The untreated control had the least mortality count of about 40%. At 48 hours post-treatment, 30% mortality count was further recorded at the untreated control, 20% each of 1ml level of the crude extract and at all levels of *mundulea sericea* leaf powder with no mortality count at the standard checks. Mortality of about 25%, 23% and 10% were recorded in the untreated control, 1g/100g cowpea seeds of Mundulea leaf powder and at 3ml/100g cowpea seeds of crude extract respectively on the third day (i.e. 72 hours post-treatment).

Results on oviposition in figure 2, showed that all treatments at all levels applied, significantly ($p<0.05$) reduced oviposition by adult *C. maculatus* when compared with the untreated control. There was a significant difference in oviposition between the plant materials and the synthetic pesticides used in which actellic (25EC) had the least (1.2) number of eggs laid followed by actellic dust at 2 and3g/100g cowpea seeds with 12.2 number of eggs each. *Mundulea seracea* ethanolic extract suppressed oviposition more than the powder however, not in quite a significant manner and both were better than the untreated control with the highest oviposition record (219.9). Oviposition was generally observed to decrease with increased levels of all the treatments applied. Reduction in oviposition has inhibited progeny emergence especially the F_3 generation where emergence was only recorded in the untreated control (1025). Few F1 and F_2 insects were recorded particularly at levels 1 and 2/ 100g cowpea seeds of *Mundulea sericea* ethanolic extract and leaf powder.

In terms of damage, all treatments significantly $P<0.05$) protected cowpea grains against damage by *C. maculatus.* The highest seed damage was recorded in the untreated control (217) followed by *Mundulea sericea* ethanolic extract at 1ml/100g cowpea seeds (24) and at 1 and 2g/100g cowpea seeds with10 and 4 respectively.Seed viability was also not affected by the treatments especially at the lowest concentration. Hihgest percentage viability was recorded at 1ml/100g cowpea seeds of actellic (25EC) with 97%, followed by *Mundulea sericea* powder at the same concentration with 93.1% while the untreated control had the least percentage viability (22.4%).

Figure1:Effects of *Mundulea* ethanolic Extract and Leaf Powder on *C. maculatus* Mortality

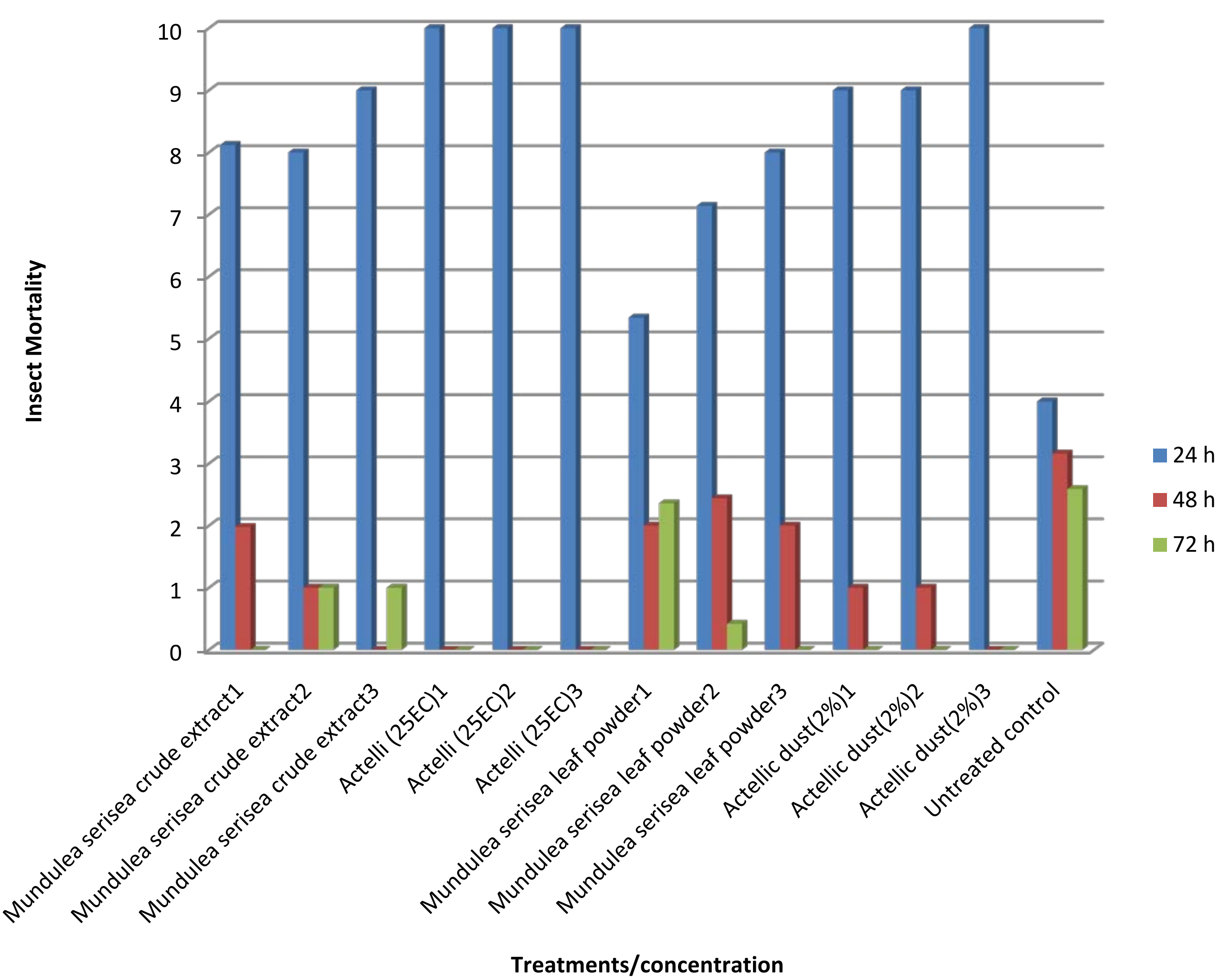
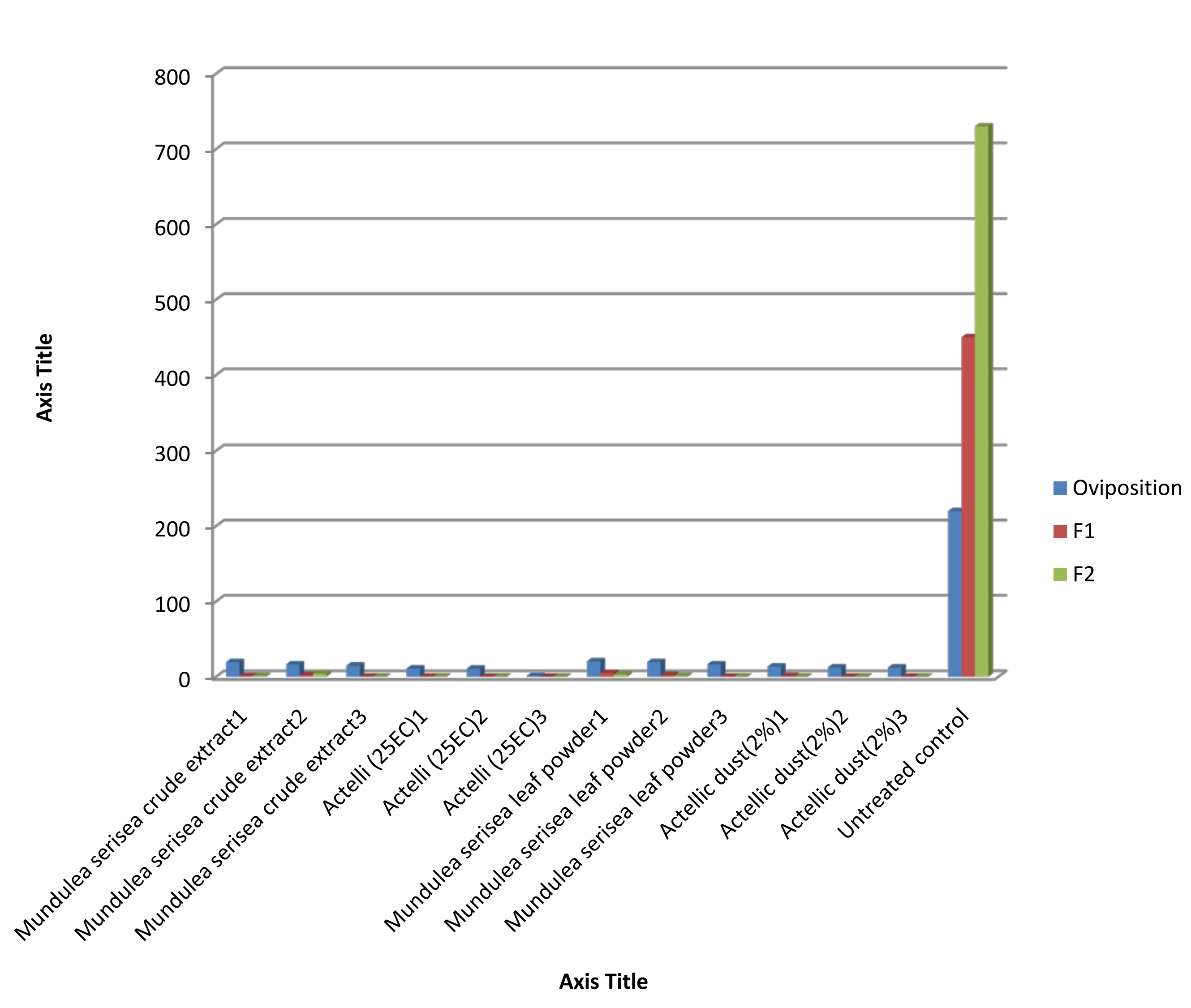
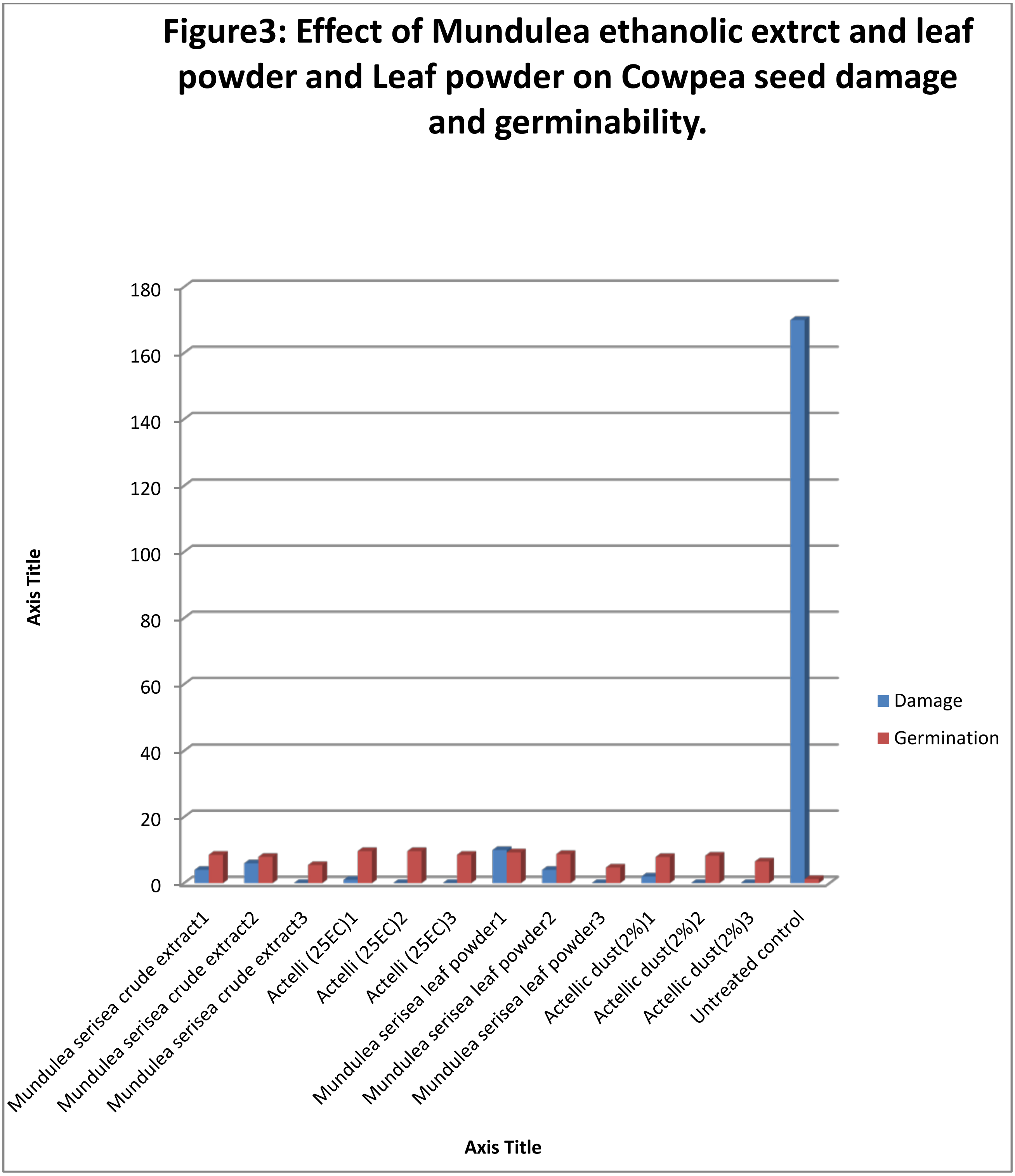


Figura2: Effect of Mundulea Ethanolic extract and Leaf powder on C. maculatus oviposition and Progeny rmergence.





IV. Discussion

Potency investigation of *Mundulea sericea* ethanolic extract and leaf powders against *C. maculatus* attack on stored cowpea revealed that, the botanicals like their synthetic counterparts significantly ($P<0.05$) caused higher insect mortality, reduced oviposition and inhibited progeny emergence without interfering with seed integrity in terms of seed damage and germinability, However, the synthetics were more effective in all the parameters evaluated as complete 100% mortality was achieved in their treated jars within 24 hours post-treatment. *Mundulea sericea* crude extract was also found to be more effective than the

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powder which was in turn better than the untreated control.

The knock –down effect exhibited by the plant materials could be attributed to some active compounds contained (rotenoids, flavones, isoflavones, chalcones and some imidazole derivatives) in the plant materials and exposed to action through methanolic extraction and pulveristion of the leaf powders. These compounds have been found to exhibit potent inhibitory activity against phorbol ester-induced ornithine decarboxylase in mouse epidermal cells (Luyengi, 1994). Several authors Like Okonkwo and Ewete (1998) acheived 100% protection of cowpea grains against *C. maculatus* attack by admixing 3g/25g cowpea seeds of *Dennatia tripetala* (pepper*)* fruit powder. Oparaeke and Dike (1996) used botanical extracts and powders of garlic and lemon grass to protect cowpea against *C. maculatus* and *C. chinensis.* Oviposition and progeny emergence were also found to be significantly ($P<0.05$) reduced by all treatments compared to the untreated control however, actellic (25EC) was outstanding in performance followed by the dust and then *Mundulea sericea* ethanolic extract and leaf powder.

Complete inhibition of progeny emergence was observed in all actellic treated seeds while few F_1, F_2 and F_3 were seen particularly at the lower levels of the botanicals. This outcome suggests that oviposition and progeny emergence was dose dependant since both were observed to decrease as the levels were increased. Shortened adult life-span by treatments must have been responsible for reduced oviposition and progeny emergence which is in agreement with the findings of [Sowumi and Akinusi 1983; Bhaduri *et al.,*1985; Ali, *et al.,* 1981] who used neem kernel,tridax procumbense and custard apple seed powders against *C. chinensis* and *C. maculatus* on stored cowpea without harm to seeds in terms of damage and viability.

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First Report of a New Bruchid Species "Megacerus *cubiculus* (Coleoptera; Chrysomelidae)' Found on Cowpea in Nigeria and a Brief Description of the Species

By Magaji, B.T. , Dike M.C. Onu, I. & Kashina, B.D.
Ahmadu Bello University, Zaria

Introduction - The large-horned bruchid (*Megacerus* Fahraeus) is a distinct genus of Bruchinae that merits being the sole member of the tribe Megacerini in the subfamily Bruchinae, with more than 50 species distributed from U.S.A. and Canada to Chile and Argentina (Tera´n and Kingsolver 1977; McNamara 2004). These bruchids have been reported to feed only on the seeds of the morning glory family (Convolvulaceae), with an occasional unconfirmed exception (Center and Johnson 1974; Maes and Kingsolver 2003). Recently the larvae of *Megacerus flabelliger* were found feeding on seeds of *Merremia macrocalyx a* convuolvulaceous weed in Venezuela (Johnson and Raimundez-Urrutia, 2008). The weed (*M. macrocalyx*) produces fruits with one to four seeds and the bruchid was found to oviposit more frequently on fruits with multiple seeds but only one seed was attacked while in some cases fruits with multiple seeds had eggs. Oviposition occurred most frequently on seeds still on the plant and only eggs of *M. flabelliger* that were found on seeds of *M. macrocalyx* (Johnson and Raimundez-Urrutia, 2008).

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FIRST REPORT OF A NEW BRUCHID SPECIES MEGACERUS CUBICULUS COLEOPTERA CHRYSOMELIDAEFOUND ON COWPEA IN NIGERIA AND A BRIEF DESCRIPTION OF THE SPECIES

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First Report of a New Bruchid Species "Megacerus *cubiculus* (Coleoptera; Chrysomelidae)' Found on Cowpea in Nigeria and a Brief Description of the Species

Magaji, B.T. [α], Dike M.C. Onu, I. [σ] & Kashina, B.D. [ρ]

I. Introduction

The large-horned bruchid (*Megacerus* Fahraeus) is a distinct genus of Bruchinae that merits being the sole member of the tribe Megacerini in the subfamily Bruchinae, with more than 50 species distributed from U.S.A. and Canada to Chile and Argentina (Tera´n and Kingsolver 1977; McNamara 2004). These bruchids have been reported to feed only on the seeds of the morning glory family (Convolvulaceae), with an occasional unconfirmed exception (Center and Johnson 1974; Maes and Kingsolver 2003). Recently the larvae of *Megacerus flabelliger* were found feeding on seeds of *Merremia macrocalyx a* convuolvulaceous weed in Venezuela (Johnson and Raimundez-Urrutia, 2008). The weed (*M. macrocalyx)* produces fruits with one to four seeds and the bruchid was found to oviposit more frequently on fruits with multiple seeds but only one seed was attacked while in some cases fruits with multiple seeds had eggs. Oviposition occurred most frequently on seeds still on the plant and only eggs of *M. flabelliger* that were found on seeds of *M. macrocalyx* (Johnson and Raimundez-Urrutia, 2008). In another development, *Megacerus discoidus* a native of North American seed feeder developed to adulthood in hedge binweed *Calystegia sepium* and heavenly morning glory *Ipomoea tricolor* without appreciable interference with plant growth (Wang and Kok, 1986). C. D. Johnson (1998) reported *Ipomoea longifolia* as a new host to *Megacerus shaefferianus* where adult congregated on flowers to feed on nectar and pollen prior bouting and oviposition. Eggs were later glued seeds on the pods.

Little research has been conducted on the life history of species of *Megacerus*. They are mostly univoltine except *M. baeri* that is multivoltine (Teran and Kingslover, 1997) and only one larva develops in a seed. Oviposition occurs mainly on the sepals or in the capsule of the fruits and occasionally on seeds after the valve of fruit had opened while still on the plant (Teran and Kingslover, 1997). Some studies on the morphology and larvae of several species of *Megacerus* together with information about the mode of attachment of eggs to seeds are available (Pfaffenberger, 1980; Pfaffenberger *et al.*, 1984) but scanty information exists with regards to damage to seeds caused by *Megacerus* species. Of these are predation values on ipomoea ranging from very low (<10%) to considerable (>70%) seed destruction (Keeler, 1980; Devall and Thien, 1989; Scherer and Romanowski, 2005).

Generally, most of the reports on the hosts of *Megacerus* species are predominantly members of the Convolvulaceae with none on leguminosae. But in the course of sorting out cultured bruchids from cowpea for identification and subsequent morphometric studies, I saw this novel insect with strongly flabellate antenna that was later identified to be *Megacerus cubiculus* Casey.

I report here for the first time the presence and brief description of the bruchid (*Megacerus cubiculus*) found on cultured cowpea collected from Katsina State Nigeria along with other bruchids like *Callosobruchus maculatus*, but its pest status and severity of damage to cowpea is been investigated. Subsequently, its ecology and evolution has generated much interest and will be investigated.

Description: The insect is about 2.9mm in length and the width 1.5mm measured using calibrated handheld digitalized MIScope microscope (40-140X). Head is somehow yellowish with white patches above the eye and adjoining frontal carina. Eyes are narrowly separated with ocular index at 24:1 in males and 7:1 in females.

Antenna strongly flabellate with eight finger-like projections in males and serrated in the females . Pronotum is yellow in colour, bell-shaped, convex with white stripes and some black spots. Scutellum is white, quadrate and bifid apically. Elytral colour is brownish to maculate with elongate black patches at the middle, base and apex. The elytra together are slightly longer than wide, convex, partially depressed medially and apices not extending beyond basal margin of the

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pygidium except the hind membranous wings. Elytral striae finely punctured, elongate and not encroaching on margins of interstices.

A bove is a picture of the bruchid (male *Megacerus cubiculus* Casey).

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Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

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Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

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the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

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12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

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18. **Pick a good study spot:** To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

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20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. **Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page

- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.
- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

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- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.

- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

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