Decision Support Systems and the Economics of Seeding Rate in Crop Yield

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Abstract

The present study constructs a decision support system to determine the best seeding rate out of a group of seeding rates applied in the field. The DSS has been built receives the field data as inputs, and then apply split plot algorithms of (Gomez & Gomez, 1984) to find the results. These results showed in stepwise manner and specifically similar to that of the manual processing, hence it is so easy to understand. The DSS specific is four folds seeding rates with two cultivars of the crop.

Econometric and Statistical Methods
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1. Introduction

Meeting the increasing demands of the Sudanese food production needs in the coming decades will require substantial innovation and tools from information technologies to offer the promise of transforming the way agricultural research is conduced and how research outputs impact farmers and consumer.

In the 1980s and 1990s new concepts of information systems evolved, managers increasingly need information to make decision about how to organize and control resources effectively. These systems known as decision support systems are quite different from the information systems of the past. They are designed by managers themselves, sometimes with the help of data processing professionals serving as user–consultants. The rapidly growing demand for the application of information technology have induced managers, farmers and policymakers to question the perfomance of the systems when no use of the computer software and information systems applications versus applying the information technology techniques.

In Sudan the agricultural, environmental and resource management researchers suffer more from the insufficiency of information technology applications and computer software support during the period of reseach preparation and results calculation. All the mentioned before causes a very much wasting time and effort after designing the experiment, collect the row data and during the stage of decision creation,which depend on data manipulation that is done normally by the calculater. So the degree of accuracy, reliability and promptness achieved from that clculations, will not satisfy the desired conviction. Also there is no serious sudanese research done on applying computer software to monitor and analyze the reseachers data and help them to achieve their last results and decision such like to determine which seeding rate of specfic crop in specific circumstances or which dose of fertilizer is performing efficiently and to choose the appropriate decision.

2. Decision Support System in Agriculture

A decision support system (DSS) is an integrated analytical tool that describes key processes and spatial and temporal connections within and between human and

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biophysical subsystems from a systems prespective. It uses a multidisciplinary approach to provide a definitive representation of a system, using mathematical algorithms where relevant. Multiple management objectives are recognized and built into the evaluation framework (Guisseppi,1999). Resource constraints are driving research and development organizations to seek increased complementarily among project information as well improved justification and synthesis of research outputs.
Decision support systems is poised to play asignificant role in transformation of every fact of human life ,as the world takes a step ahead to face the challenges envisaged as we march towards the new millennium .
Information requiered in agriculture research and devolepment efforts ranges from project description to specific results of field or laboratory evalutions to qualitative indicators or consumer perspectives.although "information"is use blanket term ,the hierarchy of data,information and knowledge better represents the spectrum used in agricultural research and development (figure 1.). Within "knowledge,"a further distinction can be made between explicit and tacit knowledge.

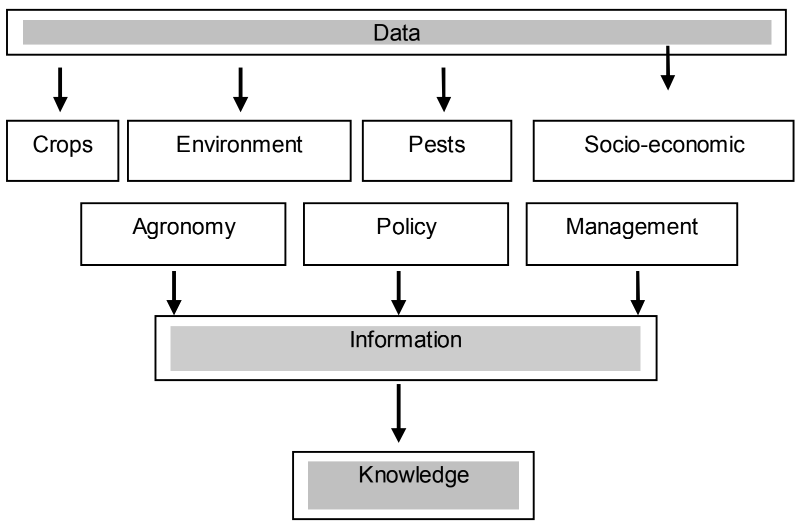

Figure1. The hierarchy of data leading to formation of information and then knowledge.
Source : Modified from (Neuman and Bruggeman, 2000).

3. Farm Management DSS

The need for more and better information on which to base decision is not anew problem. However, in recent years, this problem has becomes even more important, particularly for capital-intensive farming in industrialized countries (Kuhlmann and Brod,1991). Information is required for different levels of farm management ranging from very short–term decision such as applying and insecticide, to very long–term decision, such as building a hog-barn. In addition, the information needs for the capital-intensive farming deviates from those extensive farming. Capital-intensive farming is characterized by high sales volume in comparison to the generated net value added, e.g. layer hens or feeder pigs range cattle where the monetary input is high in relation to sales volume. Thus, in capital–intensive farming small changes in input-output coefficients and or prices can cause net income to switch from positive to negative. Due to these facts, the inputs and outputs need to be monitored and controlled much more closely than in extensive farming. Therefore the information required for capital-intensive farming needs to be on higher levels with respect to quality as well as quantity. Providing farm managers with better information has been an evolutionary process. These efforts include developing electronic data processing systems, such as linear programming, management information systems (MIS) and currently, decision support systems (Kuhlmann and Brod,1991).

4. Material and Methods

The actual practical field work and the actual experiment design that applied by a M.Sc. research with the title " Effect of Seeding Rate on Growth and Yield of Two Alfalfa – *Medicago sativa* – Cultivar by (Abdel-Rahman ,2003) has been considered, the field experiment was conduced at the Demonstration Farm of the Fuculty of Agriculture, University of Khartoum at Shumbat during the period November 2001 to June 2002 to study the effect of seeding rates on growth and yield of two Alfalfa cultivars (Abdel-Rahman, 2003). The treatments consisted of four seeding rates (10, 15, 20, and 25 kg/ ha) and two Alfalfa cultivars viz ; the local cultivar Higazi and the introduced cultivar Siriver. The treatments were randomly assigned in a split-plot design with four replications (Abdel-Rahman ,2003), with a (2*4) split-plot design. The experiment was layed as (figure 2.) illustrates.

Replication 1	Replication 2	Replication 3	Replication 4
GUARD	GUARD	GUARD	GUARD
GUARD	GUARD	GUARD	GUARD
V2 S1	V1 S1	V2 S 1	V2 S3
V2 S3	V1 S2	V2 S2	V2 S1
V2 S4	V1 S4	V2 S3	V2 S2
V2 S2	V1 S3	V2 S4	V2 S4
V1 S1	V2 S2	V1 S4	V1 S4
V1 S3	V2 S3	V1 S2	V1 S2
V1 S2	V2 S1	V1 S1	V1 S1

V1 S4	V2 S4	V1 S3	V1 S3
GUARD	GUARD	GUARD	GUARD
GUARD	GUARD	GUARD	GUARD

Figure 2. The layout of the field experiment.
Source : Modified from (Abdel-Rahman ,2003) practical work report.

Definition of terms: With respect to (figure 2.) this terms are required:

1. GUARD : a protective area of the experiment that normally found at the outer sides of the experiment that subjected to the attack of animal and thiefs. So the intended crop is protected by the GUARDs.

1. Vi : Cultivars (the factors that represents the main plots).
2. Si : The seeding rates which the subplot factor.
3. Replication i : The number of times that the reseacher repeats his treatments.
4. Vi Si : Means the treatment applied to one plot in specific replication.
5. Treatment : Aplying one seeding rate of specific cultivar on specific plot of a replication.

So : the number of treatments = cultivar number * seeding rates.

Split-plot Design: The split-plot design is experimental design that specifically suited for a two factor experiment that has more treatment, then can be accommodated by a complete block design in splot-plot design,one of the factors is assigned to the main plot. The assigned facter is called the mainplot facter.the mainplot is divided into subplots to which the second factor,called the subplot facor,is assigned. Thus ,each mainplot becomes a block for the subplot treatments (Gomez & Gomez,1984).

Analysis of Variance: The analysis of variance of a split-plot design is devided into the mainplot analysis and the subplot analysis. Let A denote the mainplot factor and B,the subplot factor.Compute analysis of variance:

- **STEP 1.** Constuct on outline of the analysis of variance for a split plot design .
- **STEP 2**. Calculate totals and means as:
- **STEP 3.** Compute the correction factor : $C.F. = \frac{GT^2}{R*v*sr}$
- **STEP 4**. Conduct the table of totals for the mainplot analysis :
- **STEP 5.** Compute the sums of squares for the mainplot analysis :

$$\text{Total SS} = \Sigma X^2 - C.F.$$

$$\text{Replication SS} = \frac{\Sigma R^2}{v*sr} - C.F.$$

$$\text{A(cultivars)SS} = \frac{\Sigma A^2}{R*sr} - C.F.$$

$$\text{Error(a)SS} = \frac{\Sigma RA^2}{sr} - C.F. - RSS - ASS$$

- **STEP 6.** Compute the sums of squares for the subplot analysis :

$$\text{B(Seeding Rates)SS} = \frac{\Sigma B^2}{R*v} - C.F.$$

A*B(Cultivar * Seedin Rates)SS

$$= \frac{\Sigma B^2}{sr} - C.F. - BSS - ASS$$

Error(b)SS = TSS – (sum of all other SS)

For each source of variation, compute the mean squrae by dividing the SS by its corresponding degree of freedom :

$$\text{Replication MS} = \frac{\text{Replication SS}}{R-1}$$

$$\text{A(Cultivar) MS} = \frac{\text{Cultivar SS}}{v-1}$$

$$\text{Error(a) MS} = \frac{\text{Error(a) SS}}{(R-1)(v-1)}$$

$$\text{B(seeding rate) MS} = \frac{\text{BSS}}{(R-1)(v-1)}$$

$$\text{A * B MS} = \frac{\text{A * B SS}}{(v-1)(sr-1)}$$

$$\text{Error(b) MS} = \frac{\text{Error(b) SS}}{V^* (R-1)(sr-1)}$$

- **STEP 7.** Compute the F value for each effect that needs to be tested, by deviding each mean square by its corresponding error term:

$$F(A) = \frac{\text{A MS}}{\text{Error(a) MS}}$$

$$F(B) = \frac{\text{B MS}}{\text{Error(b) MS}}$$

$$F(A * B) = \frac{\text{A * B MS}}{\text{Error(b) MS}}$$

$$F(R) = \frac{\text{R MS}}{\text{Error(a) MS}}$$

- **STEP 8.** For each effect whose computed F value is not less than 1, obtain the corresponding tabular F value and check the significance.

RESULTS

A decision support system model has been built. This model consists of three important components (Siddig,2004). The first component is the database, which gathered consecutively from the field by the researcher and ordered in a matrix form. (show figure 2.). The second component is the algorithmic model which explains the modules of DSS model and shows the general structure of the work (show Figure 1). The third component is the software that translates the DSS model into a computer-based model to create the last decision.

The DSS Algorithmic Model:

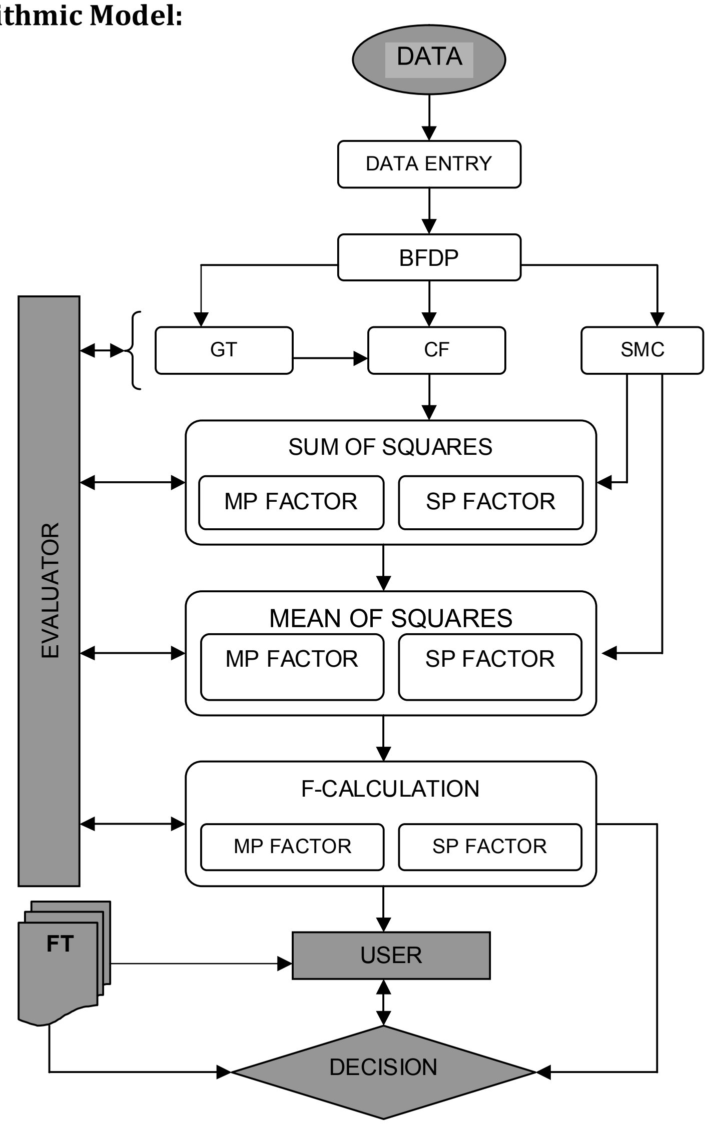

Figure 3. The Decision Support System Model.
Source: Constructed.

The model is a composition of a serialized algorithms (figure 3.) ordered like:

- Data: it is the data collected by the researcher from the field (the crop yield).
- Data entry: the user will enter it to the DSS software.
- BFDP: a briefiation to the phrase: before field-data processing. In this module the number the treatments are being calculated out of the number of the mainplot and subplot factors cases that entered in the previous step.
- GT: the module that calculate the grand total which uses in the determination of the correction factor.
- CF: the module that calculate the correction factor which uses in the calculation of the square sums and means.
- SMC: a briefiation to, sums and means calculation. This module calculates the vertical and horizontal totals and means of the field data matrix.

- SUM OF SQUARES: The aggregation of the field data matrices square for the two factors.
- MEAN OF SQUARES: The calculation of the field data matrices means of squares for the two factors.
- F-CALCULATION: The calculation of the F-value out of the squared means matrices and error mains for the two factors (the mainplot and subplot).
- FT: The tabulated value F, used by the user to be compared with the calculated F to determine the last decision.
- EVAUATER: An expert whose revise and check the accuracy of the results in any step.

5. Discussion

Universities and specialized research centers and computer programmers should try to study and produce more programs to serve this discipline. Also the Government represented in the ministry of science and technology and universities should plan for a reasonable level of computer software applications and decision support systems in research centers and universities so as to achieve adequate researches and researchers.
This program needs to be expanded so as to cover many circumstances and variations and to have more flexibility [any number of mainplot and subplot] covering other situations besides seeding rate.
For best use it is better to :
1. To obtain a high degree of precision the user of the software must be careful when entering the row data, because all the results precision depends directly on the inputs precision.
2. The file is better to be an executable (*.exe) file so as to have the ability of execution in the computer with out the existence of a C++ source, and also better to make a shortcut of the program on the desktop of the computer to simplify the first run of it.

6. References

1. Abdel-Rahman, E.M. (2003). Effect of Seeding Rate on Growth and Yield of Two Alfalfa (*Medicago sativa* L.) Cultivars. M.Sc. Thesis- Department of Agronomy,Faculty of Agriculture , University of Khartoum.
2. Alavi, M. (2000). System for Managing Organizational Knowlwdge. Tips and Tools. Internet(2003).
3. Bouma, J. A. ; Kuyvenhoven, B. A. M.; Bouman, J. C. (1995) : Eco-regional Approaches for Sustainable Land Use and Food Production. Internet(2003).
4. Gomez, K. A. and Gomez A. .A. (1984). Statistical Procedure for Agricultural Research 2end Ed. John Wiley and Sons. Inc. New York. U.S.A.
5. Guisseppi A. F. HMSS (1999): A Management Support System for Concurrent Hospital Decision Making. Information Systems Department, University of Maryland Blatimore County, Catonsville, USA.
6. Hammer, G. L. Hansen, J. W. (2000): Advances in Application of Climate Prediction in Agriculture.

7. Kuhlmann, F. ; Brod, C. (2001): Information Technology and Farm Management, Development and Prespectives. Institute of Farm Management, Justus- Liebig-University Giessen, Senckenbergstrass 3, D-35390 Giessen, Germany.
8. Neuman, F. A. ; Crul, R. ; Bruggeman, H. (2000): Developing a Shared Information Reservior From a Regional Prespective. Internet(2003).
9. Neuman, F. A. ; Bruggman, H. (2000): WISARD Web-based Information System on Agricultural Research for Development, a Platform for Sharing Information in an international Context. Internet(2003).
10. Siddig, K.H. (2001). Measuring Market Integration With an Econometric Technique (Co-Integration): An Application to Selected Sesame Markets in The Sudan (M.Sc. thesis, agricultural Economy. university of Khartoum).
11. Shulthsis, R. ; Summer, M. (1988): Management Information Systems- manager view.
12. Wanger, P. ; Kuhlmann, F. (1991): Concept and Implementation of an Integrated Decision Support System (IDSS) for Capital-Intensive Farming, Institute of Farm Management, Justus- Liebig- University Giessen, Senckenbergstrass 3, W- 6300 GiesBen, Germany.