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PHILIPPINE COUNCIL FOR AGRICULTURE, FORESTRY AND NATURAL RESOURCES RESEARCH AND DEVELOPMENT

INTERNATIONAL TRAINING WORKSHOP ON DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER (DSSAT)

"This project was completed through the assistance of the Training and Development Issues (TDI) Project, a United States Agency for International Development (USAID) - assisted project being implemented by NEDA. The TDI Project aims to improve the capability of the Philippine government and other national institutions to analyze development issues and to make sound and timely development-related decisions.

The views, expressions and opinions as contained in this report are the author's and are not intended as statements of policy of either NEDA or USAID."

INTERNATIONAL TRAINING WORKSHOP ON DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER (DSSAT)

December 3-12, 1990
PCARRD Headquarter, Los Banos, Laguna

PROJECT NO: NEDA/TDI PROJECT NO. 57

PROJECT TITLE: Decision Support System for Agrotechnology Transfer (DSSAT) International Training Workshop in the Philippines

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SUMMARY DESCRIPTION OF PROJECT:

Rice and corn are the two major staple food crops in the Philippines. There has been tremendous pressures, both scientifically and politically, to sustain the production of these two crops. While both crops are grown nationwide, the available production data indicate wide variation in yields from one region to another. These regional variations are likely influenced by genetic, spatial, and temporal factors. To be able to sustain production at acceptable and stable levels require an understanding of the interaction of these factors on crop growth and development.

The decision to grow a new crop or cultivars that have not been traditionally grown is risky because there are so many spatially and temporally varying factors that determine the final outcome. It is not possible, for example, to assess the importance of each factor by one or two years of field trials. Because of these factors, a crop cultivar generally performs differently at different regions of a country, and its performance at each location is altered by changes in planting date, planting density, fertilizer source and rate, pest management strategy, and irrigation scheduling. It is not sufficient to know, for example, that fertilizer application increases yield. The decision-maker must be able to estimate the cost benefit of each increment of fertilizer added and know how to further increase the benefits of fertilizer use by altering planting date, planting density, or by irrigation and pest control.

Decision making in agriculture, whether carried out at the farm or policy level, is hampered by the risk and uncertainty of outcomes. Incorrect decisions are made or decisions are not made at all since most decision-makers averse to risk and the information needed to make reliable decisions are rarely available.

The Hawaii-based International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) Project has developed a method for transferring agricultural production technology from its site of origin to new locations with similar or different

environments. The approach made use of a powerful tool of information science and computer technology through a prototype computerized model called Decision Support System for Agrotechnology Transfer (DSSAT). Thus, a training workshop was conducted to provide researchers, teachers, extension agents and policy makers with tools to evaluate and eventually control outcomes of new technology. Specifically, the training workshop aimed to:

a. teach/train a group of researchers on the underlying principles and application of DSSAT with emphasis on rice and corn growth models, possibly including current advances in coupling crop/pest models.

b. provide guidance to the participants in the conduct of the desired field experiments including the gathering of the required minimum data sets.

c. conduct "hands-on" computer sessions that would give the participants the opportunity to install, run and validate the crop models.

METHODOLOGY:

The International Training Workshop on Decision Support System for Agrotehnology Transfer was conducted at the PCARRD Headquarters Los Baños, Laguna from December 3-12, 1990. Five scientists directly involved in DSSAT were invited as resource persons and trainors. The group is composed of CERES-Crop Modelers and computer experts. The Principal Investigator of the said project, Dr. Goro Uehara, personally came over to deliver one of the most important lectures delivered during the course.

Sixteen (16) researchers with computer background and representing the major rice and corn experiment stations in the Philippines were invited to participate in the training workshop. The participants described the bottl necks which influence the advancement of rice and corn researches in the Philippines. The resource persons and participants worked to establish the extent to which DSSAT c n be applied to circumvent the bottlenecks.

Prior to the workshop date, data on soil, weather and crop for rice and corn at different stations were consolidated and validated by the participants. These were used in testing the applicability of DSSAT under the local conditions. Separate field experiments were prepared for rice and corn to provide guidance to the participants in the conduct of the desired field experiments for model validation. Proper gathering procedures were demonstrated for the required minimum data sets.

The IBSNAT Project provided the DSSAT softwares, user's guide, publications, and its underlying philosophies and applications. Sixteen (16) computers with 30 MB hard disk and math-coprocessor were rented to expose the participants in the use of DSSAT and computers.

CONCLUSION AND RECOMMENDATION

The International Training Workshop on Decision Support System for Agrotechnology Transfer introduced a new concept of transferring agricultural production technology from its site of origin to new locations with similar or different environments.

The general approach made use of system analysis and simulation techniques in combination with elements of technology transfer by analogy. The approach adapted a crop and soil simulation model which evaluated a wide range of crop production practices.

The DSSAT program distributed to the participants was an easy-to-use computerized model designed to help farmers, policy makers, and resource planners make decisions regarding problems such as resource allocation, land use planning, environmental protection, and the impact of global warming on crop production. It allowed users to ask "what if" questions in crop production situations. DSSAT provided means to examine alternative solutions to agriculture-related problems. The program allowed entry of experimental data, convenient access to soil, weather, and genetic data bases; operation of crop models; comparison of simulated and observed (actual) data for validation. The different crop models already installed in the DSSAT program were PNUTGRO (for peanut), SOYGRO (for soybean), and CERES models (for rice, corn and wheat).

The following are hypothetical examples given in the workshop where DSSAT simulation models are used to evaluate production technology for a given site. Suppose that corn is being grown in collaborating country, and without irrigation. For a given soil and climate where this corn is produced, what will the expected yield increase be if irrigation is provided? Is it beneficial to increase the current nitrogen fertilizer rates if irrigation is provided? If either or both of these

inputs were changed relative to current practices, how much would one expect year-to-year yields? Are there some soils in the area where management practices should be improved or modified? Supposed, again that plant breeders have just introduced a new corn cultivar that has a longer reproductive growth phase. What are the possibilities that this new technology could be adapted to this site to improve yield and/or stabilize production. Can the planting date or population density be changed to improve production? Are soybean or rice good alternate crops to grow on this area where corn production is marginal?

The capability of the model to predict the effects of a wide range of management strategies for several crops/varieties, soils and climate conditions enabled the participants to design experiments more effectively and evaluate alternate technologies in less time and resources. However, users gained confidence of the crop models once validate.. The success of the system analysis approach of the model for technology transfer applications was entirely dependent on the availability of the following data: 1) site weather data, 2) site experimental data, 3) pedon and profile description data, 4) soil model parameter data, 5) genetic coefficient data, and 6) crop model parameter data. Validation was done by comparing observed crop responses to predicted responses in which the soil, climate, and management conditions from an experiment were used as inputs to the model. The general procedures for validation required: 1) perform an experiment, 2) measure experimental conditions for inputs

required by the model, 3) measure real system performance, 4) run the model to simulate the experiment, and 5) analyze the simulated results in comparison with the observed results.

The DSSAT Program provided the need for standardized minimum site data for agrotechnology transfer. The minimum data set (MDS) was defined to standardize weather data and experiment data, the latter consisting of crop management, soil water, soil nutrient, crop phenology, crop biomass, and final yield data from the experiment.

For analytical pedon characterization and profile description data, the methodology of the U.S. Department of Agriculture Soil Conservation Service (USDA/SCS) was adapted to provide standard data for soils at different sites. The USDA/SCS, through its Soil Management Support Services (SMSS) program, cooperates in this effort by sampling, analyzing, and classifying the soils at collaborator sites. At present, there are more than 25 locations in the Philippines already characterized by IBSNAT/SMSS and are installed in the DSSAT model.

The soil model parameter data were required inputs for the soil water and nitrogen submodel components. These data are site-specific, and were derived from the pedon and profile description data, and from the MDS for a site. The last two types of data - the genetic coefficients and crop model parameters - were also required model inputs. The genetic coefficient file contained information related to crop phenology and development which allowed the model to predict the behavior of different cultivars grown at different sites.

The participants of the training workshop, in collaboration with the IBSNAT Project, came up with a proposal of validating the different crop models in the DSSAT, with PCARRD as the coordinating agency (Appendix A). More experiments at different sites need to be done to solve some problems on calibration which are very much dependent on the data available. The availability of more experimental data will provide the means to conduct in-depth analysis to support the acceptability and applicability of the model. Model performance will be judged based on acceptable measure of closeness of data points (predicted and measured data) to the 45 degree or 1:1 line. The issue on genetic coefficient of our local crop varieties needs to be determined to come up with sensitivity analysis of high level of confidence. Basically, there are four major issues to be resolved in using DSSAT in the Philippines.

1. Implementation of validation projects to provide sufficient experimental data for crop model performance evaluation.
2. Estimation of genetic coefficients for local varieties thru basic experiment.
3. Aggressive program on soil resources inventory and classification using Soil Taxonomy.
4. Validation and analysis of our daily weather data.

With limited resources for Research and Development, validation of the crop models can be done by integrating the proposed experiments on existing/ongoing projects. Some possible

projects where DSSAT validation and application can fit best are studies on irrigation, fertilizer management, and cultural management (i.e. planting dates and plant density). Results from these experiments can be used to forecast the success/failure of the recommended technologies by comparing the simulated (predicted) and the actual crop performance data. Once validated, the said model will provide useful information for decision-makers in agriculture on the suitable agro-environment for rice, corn and other crops. A DSSAT, with modular components and genetic model, maybe the basic tool that will provide the global knowledge base and expertise to produce and update a modern instrument for agro-technology transfer.

INTERNATIONAL TRAINING WORKSHOP ON DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER (DSSAT)

TECHNICAL REPORT

A. Introduction to Microcomputer System

1. Introduction to PC Hardware

PC - PC stands for Personal Computer. The main components of a PC are the SYSTEM UNIT, DISPLAY SCREEN, DISK DRIVES, and a KEYBOARD.

SYSTEM UNIT - contains a system board (or motherboard), power supply, and expansion slots for optional boards. Three important components on the system board are the CPU, ROM, and RAM.

CPU (Central processing Unit) - The CPU is the "brains" of the PC. This chip processes the computer instructions and data whean programs are executed.

ROM (Read Only Memory) - ROM are chips that store specialized computer instructions and data that are cannot be erased. For example, these chips store instructions that tell the computer what to do when the power switch is turned on.

RAM (Random Access Memory) - RAM is the computer's work area. Software programs and data are loaded into RAM before the CPU executes them.

DISPLAY SCREEN or monitors

Monochrome Displays

This type of monitor displays information in one color with a contrasting background, typically, green or amber.

Color Displays

These monitors can display information in more than one color as well as in varying resolutions.

Ie.

CGA — Color Graphics Adapter (640 x 200, 2 colors)

EGA — Enhanced Graphics Adapter (640 x 350, 16 colors)

MCGA — Multi Color Graphics Array (640 x 480, 2 colors)

VGA — Video Graphics Array (640 x 480, 16 colors)

DISK DRIVES

Floppy Disks

Floppy disks vary depending on the size of the disk and the amount of data that can be stored on them. Currently, the two commonly available sizes are the 3 1/2" and 5 1/4" floppy disks. In each size, the disk can either be double density or high density.

Below is a list of the various disk sizes/types and the amount of data that can be stored on each:

1. 5 1/4" DS/DD — Double Sided.Double Density, 360 KBytes.
2. 5 1/4" DS/HD — Double Sided/High Density, 1.2 MBytes.
3. 3 1/2" DS/DD — Double Sided/Double Density, 720 KBytes.
4. 3 1/2" DS/HD — Double Sided/High Density, 1.44 MBytes.

Hard Disks

Hard Disk Drives or Fixed Disk Drives are usually built into the PC. They are not removable, but usually can hold from 10 Mbytes up to 200 Mbytes or more of data. Hard disk drives typically read and write data faster than floppy disk drives.

2. Introduction DOS

DOS — DOS stands for Disk Operating System. DOS is a group of system programs that allows the user to do things with a computer. It provides the user a set of basic commands to control the movement of information on the computer. DOS helps the user to run programs, create and manage files and use devices, such as printers and disk drives.

KEYWORDS

BYTE — is equivalent to the space required for ONE character.

KB, Kbytes, or Kilobytes is equal to 1,024 bytes or about one thousand bytes.

MB, Mbytes, or Megabytes is equal to 1,048,576 bytes or about one million bytes.

DIRECTORY — this is a table of contents for a disk. It contains a list of file names, file sizes, and the dates when each file was last modified.

DISK DRIVES — is a device used to access files stored on floppy disks. These FLOPPY disk drives are commonly referred to as the "A drive" or the "B drive".

Another type of disk drive is a HARD disk drive or FIXED disk drive. This type of drive, normally installed inside your computer, is usually referred to as the "C drive".

DRIVE NAME — a complete DRIVE NAME consists of a drive letter and a colon. If specified, the drive name tells DOS where to find the desired file.

ex. A: <——— refers to the "A drive"

DOS PROMPT — when DOS is ready to receive a command it displays a symbol, called a PROMPT, that contains the default drive letter followed by a greater-than sign(>). Following the greater-than sign is the CURSOR, the blinking box or flashing underline that shows where the next character that is typed.

ex. A> _

FILE — is a collection of related information that is stored on disk.

FILENAME - each FILE on a disk has a name. This nam has two parts: a FILENAME and an EXTENSION.

ex. PROGRESS.RPT

PROGRESS <———— file
.RPT <———— extension

The FILENAME can be from one to eigh characters in length. The EXTENSION consist: of a period followed by one, two, or three characters. Extensions a e optional, but it's a good idea to use them, since they are useful for describing the contents of a file.

Examples or common extensions:

.EXE means EXECUTABLE, this is a program.
.COM mean COMMAND, this is also a program.
.TXT can mean that file contains TEXT data.
.DOC can mean that file is a DOCUMENT
.BAS means that the file is a BASIC program.

MEMORY - is the place in the computer where information is actively used. When a program is run, DOS stores the program and its data into memory. Also called RAM.

PATHNAME - is the location of a file specified as a list of subdirectories followed by a filename. Each directory is separated from the previous one by a backslash (\). See section on DOS FILE STRUCTURE at end of handout.

ex.

[\directoryname] [\directoryname ...] \filename

PROGRAM - also called application programs, applications, or software, are a series of computer instructions stored in a file, telling the computer to perform a task.

DOS FILE STRUCTURE

The DOS file system is a hierarchical file structure. If you were to visualize it, it would look like an upside-down tree. With the root at the top and the branches going down and the leaves at the bottom.

```
ex.                    \    (root)
                       |
          ------------+------------------------+
          |                                    |
       DANIEL                                UTILITY  <------- node.
          |
  +-------------+-------------+
  |                           |
WORKAREA                  PLAYAREA
```

Each node in the tree is a DIRECTORY. DANIEL, UTILITY, WORKAREA, and PLAYAREA are all directories. The top of the tree, called the ROOT and represented by the backslash (\), is a special directory that is created when a disk is formatted. Each directory may contain one or more files.

Looking at the figure above, DANIEL and UTILITY are sub-directories of ROOT. It can also be said that ROOT is the parent directory of DANIEL and UTILITY. Similarly, WORKAREA and PLAYAREA are sub-directories of DANIEL and DANIEL is the parent directory of WORKAREA and PLAYAREA.

Suppose you want look at a file in the directory WORKAREA with the TYPE command. The command will look like:

C>type \ DANIEL\WORKAREA\junk.dat

where "\DANIEL\WORKAREA\" is the PATH and "junk.dat" is the FILENAME. Note that it is necessary to specify the directories, separated by backslashes (\), that must be traversed to get to the sub-directory in which the desired file is located.

3. Application Programs

Application programs, application, or software are programs that provide the user with a particular type of function. These programs are not part of DOS. An application may be commercial, like LOTUS 123 or dBASE III plus, or customized, such as a mailing list program that a user has created themselves.

General Types

Word Processors

This class of application programs allow the user to create and edit text files. The user can create and edit reports, letters, papers, manuscripts, or any other type of written document. Some of the more common commercially word processors are WordPerfect, WordStar, MicroSoft Word, etc.

Spreadsheets

This class of application allows the user to create and edit a computerized ledger. It is used to do business accounting and budgeting work. Some packages allow the user to generate graphics from the information in a spreadsheet, such as pie charts or bar graphs. A common commercial spreadsheet is LOTUS 123.

Database Programs

This class of application allows the user to create their own computerized collection of data. With a database program, the user can search, sort, or print the data any way they want to. A common commercial database program is dBASE III Plus.

B. Introduction to Decision Support System for Agrotechnology transfer (DSSAT)

Description of DSSAT

DSSAT is a microcomputer software program which integrates the effects that soil, crop cultivar characteristics, weather, and management conditions have on crop growth and production. It was develop by the Hawaii-based International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) Project. The program does the integration by simulating crop growth on day-by-day basis under conditions specified by the users.

As an easy-to-use computerized model, DSSAT has four general functional requirements namely to : 1) input, organize, and store all data; 2) retrieve, analyze, and display the data; 3) validate and calibrate crop models; and 4) assess the prospects for agrotechnology transfer. To meet these functional requirements, DSSAT components consist of a data base management system, crop models, appropriate data files, and computer programs to link components and provide

specific outputs for users.

Data Base Management System

The DSSAT Data Base Management System (DBMS) is used to organize and store the minimum data set, provide user-friendly data entry and retrieval programs, and integrate data from several sources into the model. The DBMS component includes data base structures for site weather and collaborator experiment data; and data for genetic coefficient and crop model parameters for major crops like rice, corn, soybean, wheat and peanut.

Crop models

The different crop models already installed in the DSSAT shell and are available for the users to validate are 1) CERES models (rice, corn, wheat, etc.), and 2) GRO models (for soybean and peanut). For this particular training workshop, the focus was mainly on the CERES models.

The CERES (Crop-Enrichment Resource Synthesis) family of crop models is used in DSSAT to predict the performance of several grain crops. The two most tested models include maize (corn) and wheat. Fully developed but less tested models include rice, sorghum, barley and pearl millet. The models require daily weather data on maximum and minimum temperature, solar radiation and rainfall. They predict crop phasic and morphological development using temperature,

daylength, genetic characteristics, and vernalization whenever appropriate. Leaf expansion, growth, and plant population provide information for determining the amount of light intercepted, which is assumed to be proportional to biomass production. The biomass is partitioned into various growing organs in the plant using a priority system. A water and nitrogen balance submodel provides feedback that influences the development of growth processes.

The CERES - Rice model, which was distributed to the participants and yet to be installed to DSSAT next year, simulates the development, growth, and yield of rice under upland as well as lowland conditions. The model also simulates the effects of cultivar, planting density, weather, soil-water balance, and nitrogen dynamics on crop growth. It has been tested using the minimum data set collected from experiments in Thailand, the Philippines, and the United States (Hawaii). These experiments were conducted under upland direct-seeded rice and flooded transplanted rice conditions.

DSSAT Application

DSSAT possesses the immense computerized power and memory of computers, combined with the experience and knowledge needed to diagnose, interpret, and prescribed solutions to site-specific problems. People are faced with rapid changes that we can no longer afford to conduct only

trial-and-error field experiments. Solutions obtained from such experiments take so long to test that they are often obsolete by the time they are found.

One very important component of DSSAT is the strategy evaluation. Since weather is a major source of variance in farm performance, a given management option maybe simulated over many weather sequences thus subjecting it to the widest possible range of conditions. If for example, a crop is seeded on a particular day of the year, DSSAT will simulate the growth and development of the crop for up to 50 consecutive years. The option might be to delay or advance the planting date, choose a shorter or longer duration cultivar, alter the row spacing or plant population, increase or decrease the nitrogen rate, or compare rainfed with irrigated farming on a sandy or clayey soil. DSSAT allows up to 15 combinations of options to be simulated in a single experiment. A typical scenario might compare two cultivars, seeded on two separate dates, and supplied with three nitrogen rates resulting in 12 treatments combinations. The same experiment can be repeated on different soils using different sources of nitrogen fertilizer, including green manures of varying carbon-nitrogen rations. Today's computer hardware enables DSSAT to generate, in a matter of a few. hours, amounts of data that have traditionally required a lifetime of work by an agronomist. To be useful,DSSAT, must also achieve two other objectives. It must analyze the

simulated results and present them in a manner that enables the user to discriminate and choose from many options, and it must overcome the distrust decision makers have of computer generated information.

One way to gain user confidence is to demonstrate DSSAT's capability to reproduce familiar and remembered historical events to local audiences. Exceptionally bad and good years are often remembered. Good agreement between simulated and remembered events, and good outcome is necessary to build user confidence and to serve as site-validation of the model. Following such a demonstration, users can be encouraged to suggest alternative ways to improve performance.

Individuals may disagree on what constitutes improved performance, but DSSAT offers the decision maker with a choice often depends on the chooser's objectives and attitude towards risk. One farmer may choose to add nitrogen fertilizer in a way that maximizes profit; another may be seeking ways to minimize nitrate contamination of groundwater. In either case, results of long term simulations must be displayed in a way that is easily understood. DSSAT aids individuals simulated results according to rules based on mean-variance and stochastic dominance analysis. A simple application of mean-variance analysis involves a plot of means against variances. Assuming that high means and low variances are the desired trains of a variable quantity, a decision maker can choose strategies having these traits.

In stochastic dominance analysis, probability distributions are displayed as cumulative probability functions (CPF), in which simulated results for a particular management option are ranked and plotted in ascending order. Each result is assigned a probability equal to the reciprocal of the total number of simulations. For easy comparison, DSSAT can display six CPF's on a single graph. In first order stochastic dominance, the CPF of the dominant strategy lies entirely to the right of the dominated strategies. In choosing the stochastically dominant strategy, it is assumed that a decision maker prefers more to less of the uncertain quantity. If the variable were nitrate concentration entering the groundwater, the opposite would be true; for example, the decision maker would want less to more of the variable quantity. In cases where the CPF's are clearly separated, choosing the preferred or dominant strategy is easy. This is not the case when two CPF's intersect one or more times. In such cases, higher stochastic dominance analysis is required to interpret the results. In the current version of DSSAT, stochastic dominance analysis is restricted to the first order.

DSSAT was designed primarily for users working in agriculture, but owing to its break with tradional ways of diagnosing and prescribing solutions, it has been adopted by other types of users. The emergence of issues on

agricultural sustainability and stability which require assessment of conditions that may occur in the future, call for the type of problem solving capabilities of DSSAT.

The Predictive Assessment Network for Ecological and Agricultural Response to Human Activities (PAN-EARTH) a project of Cornell University's Global Environment Program, and Environment Protection Agency (EPA) of the EPA/ARD International Agriculture Project are using DSSAT to assess and predict the effects of greenhouse warming and increased CO_2 levels on sustainable agriculture. Some modelers are working on ways to link pest-crop interaction modules with DSSAT. By coupling the efforts of pest and diseases, systems simulation can more accurately described the interaction, between these factors and crop performance.

C. Minimum Data Set (MDS)

Several types of data are needed to support agrotechnology transfer functions: 1) site weather data, 2) site experimental data, 3) pedon and profile description data, 4) soil model parameter data, 5) genetic coefficient data, and 6) crop model parameter data. Success of the system analysis approach adopted by IBSNAT for technology transfer applications is entirely dependent on the availability of these data.

The MDS was defined to standardize weather data and experiment data, the latter consisting of crop management, soil water, soil nutrient, crop phenology, crop biomass and final yield data for IBSNAT experiments. The coded forms in IBSNAT Technical Report 1 describe these data and data

collection methods, and were prepared so that data could be transcribed by all collaborators into standardized formats.

For analytical pedon characterization and profile description data, the methodology of the United States Department of Agriculture Soil Conservation Service (USDA/SCS) was adapted to provide standard data for soils at different sites. The USDA/SCS, through its Soil Management Support Services (SMSS) program, cooperates in this vices effort by sampling, analyzing, and classifying the soils at collaborator sites, and will also make available to IBSNAT the soils data from the international benchmark soils file.

The fourth type of data- soil model parameters- are required inputs for the soil water and nitrogen submodel components. These data are site-specific, and are derived from the pedon and profile description data, and from the MDS for a site.

The last two types of data- the genetic coefficient and crop model parameters- are also required model inputs. The genetic coefficient file contains information related to crop phenology and development which allows a model to predict the behavior of different cultivars grown at different sites. Genetic coefficients are available for many maize, wheat, and soybean cultivars and this collection of data files is supplied by the model developers. In the future, genetic coefficients will be needed for other crop

cultivars, and procedures to help collaborators estimate these coefficients are being developed. For each crop model, these required data inputs are supplied although collaborators may need to change some parameters in the calibration process for their sites.

D. DSSAT Crop Model Validation

Users gain confidence of the crop model once validated. Validation is done by comparing observed crop responses to predicted responses in which the soil, climate, and management conditions from an experiment are used as inputs to the model. In other words, the model is used to simulate or predict crop responses to specific treatment conditions for which observed data are available. The general procedures for validation require: 1) performance of an experiment, 2) measurement of experimental conditions for inputs required by the model, 3) measurement of real system performance, 4) running of the model to simulate the experiment, and 5) analysis of the simulated results in comparison with the observed results. Model performance is judged based on the acceptable measure of closeness of data points (predicted and measured data) to the 45 degree or 1:1 line.

E. Case Study Reports of Participants

The main focus of the training workshop was the application of DSSAT under the Philippine conditions. Participants were given the task to ferform the case study on

rice and corn production using the available soil, weather, and crops data from the Philippines. Appendix B presents the individual case study developed by the participants during the conduct of the training.

PROBLEMS AND RECOMMENDATIONS

Prior to the conduct of the training workshop, the participants were requested to bring weather, crop, and soil data sets from their respective station. The weather data include a 10-year daily records of rainfall, maximum and minimum temperatures, and solar radiation (shunshine hours). Crop data include historical yield performance of rice/corn in the area. Soil data, in particular, include the soil characterization of the area as classified by the Bureau of Soils and Water Management or any institution working on said classification and using the concept of Soil Taxonomy. However, during the conduct of the training workshop some participants were not able to bring any crfop and weather data. This resulted to an option of using data of other institutions/stations in simulating the effects of crop in their locations.

The validity and completeness of daily weather data in some locations affected the quality of the workshop output. The participants, in the absence of complete minimum data set, confined their work on different case studies using the complete daily weather data from the University of the Philippines at Los Baños and Mariano Marcos State University in Batac, Ilocos Norte.

Length of record of daily weather data is another problem which has to be considered in using DSSAT Program to get a more reliable evaluation, especially in an environment where there is wide climatic variation, the user would then need to decide the

duration of analysis. As a rule of thumb, the duration should be long enough to characterize variation or cycles in the local climate.

One of the limitations of DSSAT Crop Models is the exclusion of the pests and diseases effects. There are also other factors, particularly in the soil, that are not included in the model (i.e. plant nutrients or calcium effects on fruiting). Therefore, results from the model should be viewed as potential yields under the specified regions of weather and soil conditions. Other factors could be limiting and further reduce yields.

The issue on genetic coefficients of our local crop varieties needs to be considered to come up with sensitivity analysis of high level of confidence. Nevertheless, the conduct of more validation experiments will provide essential input data to support the acceptability of the model.

APPENDIX A

PROJECT TITLE: Application of the Decision Support System for Agrotechnology Transfer (DSSAT) Crop Models in the Philippines

COORDINATING AGENCY: PCARRD

IMPLEMENTING AGENCY: MMSU, DA-Reg. 2, ISU, UPLB, VISCA, USM, BSWM, PAG-ASA, PhilRice

FUNDING AGENCY: United Nations Development Program

DURATION: January 1991 - December 1993

RATIONALE:

Agrotechnology transfer is presently the major focus of researchers and extensionists, and it appears to be an attractive proposition for policy makers and administrators. The possibility of transferring agrotechnology among biophysically similar environments had been proven by the erstwhile Benchmark Soil Project, of which the Philippines was one of the project sites. After such project, the International Benchmark Site Network for Agrotechnology Transfer (IBSNAT) Project is now being undertaken on a global scale to create a prototype network of national, regional, and international institutions which enable a ready exchange of agricultural technology among tropical and subtropical countries. With the recent advances in computer technology, IBSNAT has adapted a system-based approach to agrotechnology transfer which is capable of processing enormou amount of crop data for practical interpretation and application. These advances in information technologies include crop simulation models and expert systems which require data bases to predict production and prescribe management procedures. To date,

there are already some existing crop models like CERES-MAIZE, CERES-RICE, SOYGRO, PNUTGRO, etc. which are ready for validation under our local condition.

The simulation modelling approach used by IBSNAT must be adequately validated in order for collaborators to have confidence in their predictive ability at new sites. Such model evaluation requires that experiments be conducted and that in each experiment, a standardized minimum set of soil, crop, weather, and management data be recorded.

The DSSAT model envisions to predict yield of under different water management, fertilizer rates, and population density. Results of these experiments will be used to forecast the success/failure of the recommended technologies by comparing the simulated (predicted) and actual crop performance data. Once validated, the said models will provide information on the suitable agro-environment for crops production. Hence, decision making will be facilitated as well as management strategies and techniques.

OBJECTIVES:

The project aims to:

1. test/validate the IBSNAT Crop Models in the different areas of the Philippines
2. transfer agrotechnology and solve agricultural problems through less expensive, system-based research.

METHODOLOGY:

A. Site Selection and Characterization

Crop experiments will be conducted in areas easily accessible for routine observation and sampling. The areas will be situated near permanent or portable weather stations to permit collection of accurate weather data on a daily basis. As much as possible, an area consisting of a single soil series will be considered to minimize or eliminate soil variability that may affect crop performance.

The sites will be characterized as fully as possible to permit valid extrapolation of results to similar locations and provide much information about the condition of the experimental area. In the absence of the soil classification of the area (according to Soil Taxonomy), the services of a competent pedologist will be requested to describe the soil profile and collect samples from each soil horizon. This activity will be done prior to the conduct of the experiment.

B. Data Gathering

The experiments will require IBSNAT minimum data set (MDS) of weather, soil, management, and crop response data. These data sets will be accurately measured so they can be used to run the models and validate outputs. Table 1 presents the summary of the suggested data requirements of the IBSNAT minimum Data Set for validation experiment. The 19 coded Forms A through S for reporting the MDS will be used to minimize the amount of time required to record the necessary information.

Tables 2 and 3 present the growth analysis, harvest, and final yield components data which are to be obtained from the two experiments at different (selected) vegetative and reproductive stages. For practical purposes, the minimum data sets will not necessarily be collected for each plot or each treatment of the experiment. Instead, the optimum treatment or a combination of representative treatments will be selected for MDS collection.

C. Model Validation

The minimum data set that will be obtained from the experiment for three years will be consolidated for the validation of the DSSAT Models. The predicted yield and other agronomic parameters will be compared with the actual data. Sensitivity analysis will be done to determine the accuracy required in measuring or estimating the various coefficients in the model. This analysis will be carried out by running the model several times, each time incrementing the value of the particular coefficient and examining the effect that this has upon the output. Once validated, the different models will be used to identify appropriate crop technology in a manner that is not too cumbersome, slow and costly.

Table 1. Summary of the data requirements of the IBSNAT Minimum Data Set (The minimum requirements are indicated with X, and optional data are indicated with O).

TYPE OF DATA	FORM	TYPE OF EXPERIMENT: Fertility suboptimal or variable	Water suboptimal or variable	All other experiments
Institutional information	A	X	X	X
Nearby long-term climatic stations	B	O	O	O
Daily weather data during the experiment	C	X	X	X
General information about the experimental area (site)	D	X	X	X
General information about the experiment	E	X	X	X
Experimental factors and levels	F	X	X	X
Experimental layout	G	X	X	X
General plot information	H	X	X	X
Soil fertility	I			
Preplant surface samples		X	X	X
Postharvest surface samples		X	O	O
Preplant and postharvest subsurface samples		X	O	O
Preplant and postharvest volumetric soil water in profile	J	O	X	O
General tillage information	K	X	X	X
Crop cultivar information	L	X	X	X
General planting information	M	X	X	X
General information on fertilizer, inoculant, and amendment application	N	X	X	X
General information on biocide and hormone application	O	X	X	X
Irrigation information	P	X	X	X
General information on damage to the crop	Q	X	X	X
Data on growth stage and yield components several times during the season	R	X	X	X
Plant nutrient concentrations	S	X	O	O

Table 2. Growth analysis, harvest, and final yield components for soybean experiment (NOTE: Harvest code is indicated to facilitate the use of Form R-2).

HARVEST CODE	COMPONENTS	UNITS
1	Plant population of harvest area	plants/m^2
2	Area harvested	m^2
3	Above ground biomass (dry)	g/m^2
4	Seed weight (undried)	g/m^2
5	Seed weight (dry)	g/m^2
6	Seed number	seeds/m^2
7	Pod number	pods/m^2
8	Leaf blade weight (dry)	g/m^2
9	Petiole weight (dry)	g/m^2
10	Stem weight (dry)	g/m^2
11	Empty shell weight (dry)	g/m^2
12	Root weight (dry)	g/m^2
13	Leaf area index	m^2/m^2
14	Nodule weight (dry)	g/m^2
99	Other (specify)	g/m^2

Table 3. Growth analysis, harvest, and final yield components for corn experiment.

HARVEST CODE	COMPONENTS	UNITS
1	Plant population of harvest area	plants/m^2
2	Area harvested	m^2
3	Above ground biomass (dry)	g/m^2
4	Seed weight (undried)	g/m^2
5	Seed weight (dry)	g/m^2
6	Seed number	seeds/m^2
7	Ear number	ears/m^2
8	Leaf blade weight (dry)	g/m^2
9	Leaf sheath weight (dry)	g/m^2
10	Stem + tassel weight (dry)	g/m^2
11	Cob + shuck weight (dry)	g/m^2
12	Root weight (dry)	g/m^2
13	Leaf area index	m^2/m^2
14	Leaf number	
99	Other (specify)	

BUDGETARY REQUIREMENT
(January 1991 - December 1993)

ITEM	Budget (₱'000) Year 1	Year 2	Year 3	Total
A. Personal Services	1,200	1,200	1,200	3,600
B. Maintenance and Operating Expenses	3,300	3,300	3,300	9,900
C. Equipment	1,000	1,000	1,000	3,000
TOTAL	5,500	5,500	5,500	16,500

APPENDIX B

DETERMINATION OF THE BEST RICE VARIETY AND MANAGEMENT STRATEGY COMBINATIONS FOR RICE IN COTABATO USING LOS BAÑOS WEATHER DATA: A CASE STUDY

BY:

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For the:

International Workshop on Decision Support System
for Agrotechnology Transfer (DSSAT)
December 3-12, 1990

OBJECTIVES:

1. To determine the best rice variety suited in Cotabato.
2. To determine the management strategy combinations that can maximize rice production in Cotabato using Los Baños weather data.

METHODOLOGY:

A. Selection of best rice variety under two water regimes planted on different rates

Three rice varieties namely: (1) Labelle, (2) IR-64 AND (3) RD-23 were used for strategy evaluation. The soil used was pedon no. 85P062 classified under the US Taxonomy as fine, mixed, isohyperthermic fluventic Eutropept. The weather data was taken from Los Baños.

Two water regimes: (1) rainfed (RF) and irrigated (IR) were imposed. The total rainfall during the simulation was 1569.4 mm and 260 mm for the RF and IR regimes, respectively. Planting for the RF was July 1 and January 1 for the IR regime. The selection of planting date was based on the rainfall pattern. Automatic irrigation at 20 cm depth, 25% triggering water availability and 0.70 efficiency was used for the IR regime. To test the adaptability of the rice varieties to the soil, no nitrogen fertilizer was added.

B. Determination of N requirement of IR-64 under two moisture regimes

IR-64 was grown in RF and IR water regimes with nitrogen fertilizer applied at the rate of 0, 25, 50, 75, 100, 125 and 150 kg/ha. Nitrogen in the form of urea was

applied in 3 split basis at 0(50%), 15(25%) and 45(25%) days after transplanting. The yield, nitrogen loss, nitrogen uptake, water stress and nitrogen stress were evaluated.

C. Experiment on rice: synthetic

In the synthetic experiment where a lot of changes had been done, IR-64 was again used as the test crop. IR and RF water regimes were compared in a 5 year simulation period. Fertilizer treatments (serving as strategies) were changed one after the other to select the best strategy (rate). Automatic irrigation with a bund height of 10 mm, water depth of 5 mm was employed in the IR regime. Urea was used and applied at 5 cm depth and the method used was deep incorporation (No. 8). In the RF bunded-transplanted, planting was done in July 1, plant population - 25/sq. m. or 3 plants/hill, age of seeding - 25 days, seeding depth - 3 cm, water depth - 0.0, rate of fertilization - 150, 175 and 200 kg N/ha applied in three split basis - 50, 25 and 25% at 180, 195 and 230 days, respectively. These rates were used because they gave the biggest return in the previous strategy evaluation. Parameters as mentioned in the other experiments were likewise determined.

RESULTS AND DISCUSSION

A. Selection of best rice varieties under two moisture regimes

The result showed that IR-64 is much better than Labelle and RD-23. IR-64 outyielded Labelle and RD-23 both in the RF and IR regimes. Yields of 1.8, 3.09 and 3.8 t/ha

were obtained from Labelle, RD-23 and IR-64, respectively in the RF, while in the same order, yield of 1.8, 3.1 and 3.7 t/ha were recorded in the IR regime. This is the basis why IR-64 was chosen and used in the succeeding evaluations.

B. Determination of N requirement of IR-64 under two moisture regimes

In the RF, the yield of IR-64 increased (3.97 to 7.05 t/ha) as the rate of N applied (0-150 kg N/ha) is increased. Similar trend was noted in the IR regime. The yield increased from 2.32 to 7.03 t/ha. No water and N stress was recorded. It was also observed that N uptake and N loss increased as the rate of N fertilizer is increased. Comparing the net return, however, it is more profitable to grow rice under RF condition. A net return of ₱ 18,515.00 was realized at 150 kg N/ha rate of fertilization. Lower value was taken from the IR regime at the same level of fertilization.

C. Synthetic Experiment

Based on the result, a comparable yield was obtained at 200 kg N/ha. RF gave 7.3 t/ha while 7.4 t/ha for the IR. The net return, however, was lower in the IR. Only 6,760.00 was realized. In the RF-bunded transplanted, a lot of trials was made. At zero N fertilization, the yield was only 0.97 t/ha with a negative net return. As the amount of N is increased (0-200 kg/ha) the yield also increased (0.97-7.3 t/ha). However, in terms of net return, a peak was obtained at 175 kg N/ha. At this level of N fertilization, a net

return of 14,232 was obtained. Going beyond 175 kg N/ha will still give a little increase in yield of 0.3 t/ha, but this cannot compensate the additional cost of the fertilizer applied. N uptake in the RF increased up to 154 kg N/ha in the 175 kg N/ha treatment. Water stress was noted only in the vegetative stage (0.14) for the IR regime. N loss was 13 kg N/ha. In the RF, water stress (0.15) was recorded during the vegetative stage. N stress (0.02) was also observed during the reproductive stage. Both the water and N stress, however, were recorded only at 200 kg N/ha. All the rest of the treatments did not show any kind of stress.

SUMMARY AND CONCLUSION

1. Based on the strategies used, IR-64 was identified to be the best variety suited in the soil and the weather data used.
2. It is more profitable to grow rice (IR-64) under rainfed-bunded-transplanted method fertilized with 175 kg N/ha. Planting should, however, coincide with the rainy season, i.e., July.
3. The lower net returns observed in the IR regime could be due to the cost of production particularly irrigation. The cost seems to be overestimated. In reality, however, higher net return can be obtained if rice is grown with irrigation.

Case Study Title: Determination of the best rice variety and cultural management practices for Cagayan soil using Batac weather condition.

Researcher: Leandro V. Buendia
PCARRD

A. Objectives:

1. To determine the best rice variety and cultural management practices for Cagayan soil using Batac weather condition.

2. To come up with the best component technologies for high net return.

B. Assumptions:

1. Average annual temperature = 27.1 °C
2. Mean amplitude = 7.0 °C
3. Mineralization = 1.0
4. % coarse fraction in soils = 0 for all layers
5. Soil classification = fine, mixed, isohyperthermic Udic Haplustalf
6. Initial condition at planting
   - moisture content is filled to the drain upper limit
   - soil pH is 6.8 for all layers
   - soil mineral nitrogen is low (50 kg/ha)
7. Costs

a. Market price/T	₱5,000.00
b. Base production costs/ha	10,000.00
c. N fertilizer cost/kg	5.50
d. Cost/fertilizer app'l/ha	130.00
e. Irrigation cost/mm	25.00
f. Irrigation fixed cost/ha	1,750.00
g. Cost/irrigation app'l	1,020.00
h. Cost of 1000 seeds	18.00
i. Organic residue costs	300.00
j. Plant breeder costs	2 x E6

C. Testing for 3 rice varieties using the same strategic conditions

1. Varieties:
   a. Labelle
   b. IR64
   c. RD23

2. Strategic conditions:
   a. Planting dates = September 3
   b. Beginning dates = September 2
   c. Plants/sq. m. = 25
   d. Row spacing = 0.2 m
   e. Soil type = Udic Halplustalf
   f. Irrigation = Rainfed
   g. Nitrogen fertilizer = default (N balance off)
   h. Initial conditions = defined (see assumptions)
   i. Weather data = MMSU, Batac, Ilocos Norte

3. Evaluation result (yield in t/ha)
   a. Labelle = 0.37
   b. IR64 = 1.314 (dominant strategy)
   c. RD23 = 1.27

D. Determination of the best planting date and beginning date using the dominant variety (IR64). All conditions were set constant except for planting date and beginning date.

Planting date/beginning date	Yield: t/ha
June 15/ June 10	6.55
July 15/ July 10	4.276
Aug 15/ Aug 10	1.58
May 15/ May 10	7.23

Reasons for highest yield in May planting:
   a. Longest sowing to flowering duration = 100 days
   b. Longest sowing to maturity duration = 123.4 days
   c. No water stress in vegetative stage same with June planting. July and August plantings experienced water stress of 0.056 and 0.338, respectively.
   d. No water stress in reproductive stage. June, July and August plantings experienced water stress of 0.074, 0.52, and 0.82, respectively.
   e. Highest total evaporation was obtained in May (645.6mm) which favored the photosynthetic activity of the crop. The months of June, July, and August gave a total ET of 644.0, 543.8, and 372.4 mm, respectively.
   f. The demand for the highest total ET in May was compensated by the highest total rainfall of 1904.4 mm. The total ET requirement in May is supplied by the rain water which resulted to zero water stress condition.
   g. Highest total biomass of 12.97 t/ha was obtained in May which indicates a favorable crop growth.

E. Population density and spacing

Number of plants per area is maintained at 25.0/sq. m. and spaced at 0.2m between rows. These density and spacing are used to facilitate other farm operations like weeding and fertilization.

F. Irrigation

Base on the result of the evaluation, there is no need to apply water in May planting since no water stress can be experienced in the vegetative and reproductive stages.

G. Determination of the best fertilizer management

1. Three level of fertilization treatments were used based on the recommended N rate of 120 kg/ha:

Treatments	Yield: t/ha
a. DAP = 30 Amount = 120 - 50 = 70 kg/ha Depth = 20 cm Material = Urea	6.51
b. DAP = 30 Amount = 35 kg/ha Depth = 20 cm Material = Urea DAP = 60 Amount = 35 kg/ha Depth = 20 cm Material = Urea	6.57
c. No fertilization	4.3

Observations:

1. Lowest nitrogen stress (0.24) was experienced in applying Urea of 70 kg/ha at 30 DAP. Split application experienced an N stress of 0.28.

2. No N stress was experienced during the reproductive stage for all treatments.
3. Total N uptake was high for the first two treatments using Urea; 136.96 and 138.28 kg/ha, respectively.
4. Total biomass was high for the first two treatments; 11.126 and 11.12 t/ha, respectively.

H. Net Return

A net return of ₱17,435.00 per ha was obtained in Cagayan soil when planted to rice using the following component technologies :

a. Variety: IR64
b. Planting date: May 15
c. Beginning date : May 10
d. Plants/sq. m. : 25.0
e. Row spacing : 0.2 m
f. Irrigation : Rainfed (no irrigation)
g. Nitrogen Fertilizer:
   DAP = 30
   Amount = 70 kg/ha
   Depth = 20 cm
   Material = Urea

By splitting the N application, a net return of ₱ 10,621.30 per ha is obtained due to additional cost of labor in applying fertilizer. However, if the farmer decides not to apply N fertilizer, a net return of ₱9,024.04 per ha can be obtained.

DECISION SUPPORT SYSTEM APPLICATION ON RICE PRODUCTION IN REGION 02, PHILIPPINES: A CASE STUDY

Lorenzo M. Caranguian *

RATIONALE

Various field experiments are being conducted year-in and year-out by different research institutions. This undertaking usually employ the traditional approach of conducting research which is characterized by a slow and tedious process of trial and error. The approach not only entail huge expenses but derived results have often limited applications to end users like farmers and extentionists. Experimental results are, in most cases, averages of only short-duration and representative/ favorable production years and do not represent extreme conditions such as typhoon and drought years which are prevalent in the Philippines.

Better approaches and strategies must replace this cumbersome and expensive traditional approach. The International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) Project had successfully developed decision aids i.e., the Decision Support System for Agrotechnology Transfer (DSSAT) which offers a totally systems-based approach to the conduct of research. The applicability of the DSSAT models in local conditions, however, has to be tested. Hence, this case study.

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OBJECTIVES

General Objective:

- To demonstrate the utility/applicability of IRSNAT decision support systems in crop research activities.

Specific Objectives:

- To test the capability of the DSSAT CERES-Rice Model in determining and evaluating varied rice research options and/or strategies.
- To identify the best rice variety that can be grown profitably under Region 02 condition.

STRATEGIES

Materials/Input:

The simulation activity made use of the DSSAT V.2.1 computer software. Weather, soil and crop data inputs available in the DSSAT data bases were retrieved for this purpose. In this particular case study, the Fine Mixed Isohyperthermic Udic Haplustalf type of soil (San Manuel Series - Ilagan, Isabela; with Pedon No. 85P0857) and weather data at Los Baños, Laguna were utilized.

Methodology:

The different evaluation strategies/treatment combinations employed in determining the best rice variety suited for Region 02 condition is presented in Fig. 1.

Three (3) test varieties namely Labelle, IR-64 and RD 23 (cal) grown under upland irrigated condition were evaluated. Water regime in the soil was controlled by automatic irrigation with a water management soil depth of 0.3 m, available soil moisture of 18% and irrigation efficiency of 70%.

The other strategies i.e., eight (8) planting dates, three (3) N-fertilization rates and five (5) planting densities were subsequently evaluated after identifying the best rice variety grown at optimum fertilization and specified/ideal planting date. All strategies were evaluated from five (5) years simulation outputs.

RESULTS AND DISCUSSION

First Strategy: Rice Variety Evaluation

At constant planting date which is January 15, optimum N-fertilization, planting density of 25 plants/sq.m. and automatic irrigation, IR-64 obtained the highest yield of 8.932 t/ha.

Second Strategy: Planting Date Evaluation

Using IR-64 variety and with similar conditions specified in the First Strategy, the crop planted in February 1 outyielded those planted in January 1, March 1, May 1, June 1, July 1, November 1 and December 1. However, the May 1 planting had a higher and dominant net return compared to the February 1(highest yielder) and the rest of the treatments. The low return on investment in the February 1 planting was due to the large irrigation cost because rainfall during this growing period is minimal compared to that of the May 1 planting.

Third-Strategy: Fertilizer and Planting Density Evaluations

The different treatment combinations evaluated in this strategy is presented in Table 1. The N-fertilization treatments were 90+135, 90+90 and 67+90 kgs N/ha. applied at 0 DAT and 50 DAT respectively. Each of the three fertilization rates were evaluated with respect to five different plant populations namely 17, 20, 25, 33 and 50 plants/sq. m.

Results showed applying 90+135 and and 90+90 kgs N/ha. at a planting density of 50 plants/sq. m. gave the highest yields of 7.998 t/ha. However, decreasing the fertilizer rate to 67+90 kgs N/ha. and the planting density to 20 plants/sq.m. gives the most profitable return ₱21,836.00/ha. Although the yield for this treatment was only 7.662 t/ha, the high net return was attributed to the reduction in the cost of fertilizer, seeds and the corresponding labor requirement.

RECOMMENDATIONS

Based on the five-year simulated output of this particular rice experiment, the following component technologies are recommended:

Rice variety ..... = IR-64

Planting date ..... = May 1

Fertilizer recommendation ..... = 67+90 kgs/ha. applied at 0 DAT and 50 DAT respectively.

Planting density ..... = 20 plants/sq.m.

The above recommendations are valid only for the following environmental conditions: fine mixed isohyperthermic udic isohyperthermic type of soil and weather condition that is similar to Los Baños, Laguna.

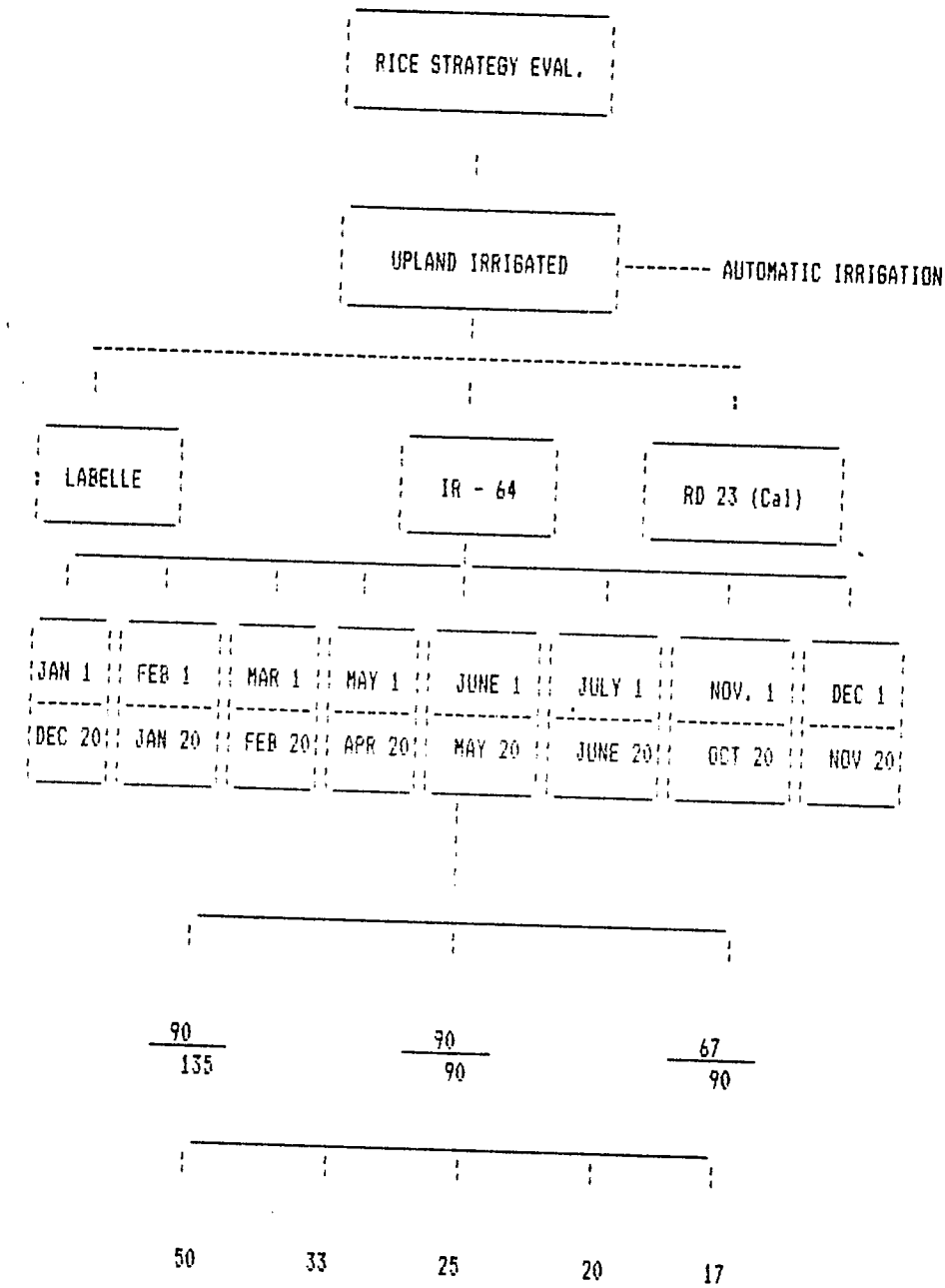

Fig. 1. Flow Diagram of the Rice Strategy Evaluation for Upland Condition in Region 02, Philippines

CASE STUDY EXERCISE

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INTRODUCTION:

Among the constraints of the filipino farmer which usually dictates the yield of his crop are the weather and climate.

Climatic factors such as temperature, solar radiation, moisture or rainfall influence growth and hence yield of rice.

Fertilizer management was also required in successful agricultural development and nitrogen is generally needed in most rice soils.

Rice plants require a large amount of nitrogen at the early and mid tillering stages to maximize the number of panicles. Nitrogen absorbed at the panicle initiation stage may increase spikelet number per panicle. Some nitrogen, however, is also required at the ripening stage.

The main objectives of this case study is to determine the best level of nitrogen suited for rainfed upland rice using strategy evaluation.

METHODOLOGY:

The weather data that was used in this case study was obtained from MMSU Agromet station, Batac, Ilocos Norte (120 32' E longitude; 18 03'N) and the soil was classified as fine, montmorillonitic, isohyperthermic pellustert (Pedon No. = 8400059).

. The first step that was made was the selection of best variety, planting date and plant population. Varieties used were Labelle, IR64 and RD23; planting date - May, June and July; plant population - 25, 35, 45 plants/sq m (Table 1). Planting dates were obtained based on the rainfall pattern (distribution) in Batac, Ilocos norte. Rainfall is started on May and has its peak on August.

There were 11 strategies that were simulated to find the best fertilizer rate for rainfed upland rice. The selection of fertilizer rate was based on the national recommendation for rice in the Batac that is 120-60-60 kg/ha. Urea (46-0-0) was used in this study and the placement method was broadcasted, incorporated (code No. 2). Fertilizer was applied twice, at planting time (0 DAP) and 30 days after planting (30 DAP).

DISCUSSION:

IR64 planted in May with a plant density of 25 plants/sq m seemed to be the best. Fertilizer rate of 100 kg/ha of urea and 160 kg/ha applied at planting time (0 DAP) and at 30 days after planting (30 DAP), respectively gave the highest yield of 7.12 t/ha with a net return of ₱17,680.00/ha. If the fertilizer were applied the other way around (160 kg/ha at 0 DAP) and 100 kg/ha at 30 DAP), the yield and net return was almost the same with strategy 1 but there is more nitrogen loss (Table).

Increasing the rate from 100 kg/ha at 0 DAP and 160 kgg/ha at 30 DAP to, say, 200 kg/ha at 0 DAP and 250 kg/ha at 30 DAP gave a yield of &.2 t/ha which is higher than strategy 1 but lesser net return and more nitrogen loss.

The lowest rate of fertilizer gave the highest efficiency but the yield obtained was low and unprofitable.

In the study (Figure 1), it was revealed that decreasing the amount of fertilizer gave lesser nitrogen loss but the yield is lower and it begins to have a nitrogen stress at vegetative and reproductive stage.

Table 1. Variety and planting date of rice

Strategy	Variety	Pltg Date	Yield
1	Labelle	May	5.13
		June	5.40
		July	3.70
2	IR 64	May	6.58
		June	5.13
		July	5.13
3	RD 23	May	5.13
		June	4.94
		July	4.87

STRATEGY EVALUATION FOR MAIZE PRODUCTION: A CASE STUDY

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.NTRODUCTION

Corn is the second most widely grown crops in the Philippines and about eighty percent of the Filirinos consumed corn as their staple food. It has a national average of only 1.0 t/ha, so far, the lowest in Asia. Agricultural researchers found out that it will take two to five years just to verify a single experiment and oftentimes ending with an uncertain results. These results can not be recommended to farmers for trial due to the high cost of production.

The International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) Project created a decision tool to be used to diagnose and prescribe alternative solutions to these problems. The DSSAT, Decision Support System for Agrotechnology Transfer was then created by IBSNAT to be used for strategic planning by government planners and researchers. Wit.. the proper natural resource data base, a planner may simulate the performance of a crop, or practice at any location in a country for any season and for a wide range of user options. For this particular case study, maize strategic plans were simulated within a period of 5-years.

PROCEDURE

The weather data used in this study was taken from the Agromet Station of Los Baños, Laguna with a latitude of 14 degrees 13 minutes N and a longitude of 121 degrees and 15 minutes E. On the hand, the soil data used was fine mixed, isohyperthermic fluventic eutropept with a pedon number of 80P60502. The weather data used was estimated using the WGEN weather estimator. Three varieties, namely; PI03382, CORNL281 and SUWAN-1 were used to determine which of these cultivars is a highest yielder. From the selected cultivar, PI03382, a 5-year strategies were simulated using one of the DSSAT component, the Agrotechnology Transfer Application, under Strategy Evaluation. This variety was used to all the strategies generated.

There were nine nitrogen treatments used, with a depth of 5 cm, that were applied two times, one at the time of planting and the other at 30 days after planting (DAP).

Treatment used were as follows:

1. 220 kg N/ha
2. 120 kg N/ha
3. 150 kg N/ha
4. 300 kg N/ha
5. 325 kg N/ha
6. 400 kg N/ha
7. 300 kg N/ha
8. 325 kg N/ha
9. 400 kg N/ha

RESULTS AND DISCUSSION

There were 18 maize strategies that were simulated using two water regimes of rainfed and automatic; one type of soil: fine mixed, isohyperthermic fluventic eutropept; two planting season (dry and wet); nine nitrogen rates and two crop residues. A common variety, PIO3382, was used in the conduct of this case study.

Rainfed Condition

Strategy 1 of the dry season planting got the highest net return of P15,583.00 with a yield of only 7.95 t/ha, while strategy 1 of the wet season planting was P12,787 with a yield of 7.27 t/ha. There was only a slight difference of P2,796 in net return which was brought about by the same nitrogen inputs of 220 kg/ha and same irrigation method.

When nitrogen input was decreased to 60 kg/ha, there was also a corresponding decrease in yield of 0.49 and 2.03 t/ha for dry and wet season, respectively. This result gave a difference of P7,806.00 in net return. The decrease in yield in strategy 2 of the wet season planting was brought about by a heavy rain that drains away the fertilizer applied at 30 days after planting (DAP).

On the other hand, when 150 kg of N/ha was applied at zero and 30 DAP, the yield obtained was 7.70 t/ha and with a net return of P14,935.00. This result showed a difference of P680.00 which is much lower compared to strategy 1.

Automatic Irrigation Application

Strategies four, five and six got a net return ranging from ₱11,666.00 to ₱14,339 considering automatic irrigation application and a nitrogen rates ranging from 300 to 400 kg/ha.

Evaluation of strategies four, five and six under dry season planting showed that at nitrogen rates of 300, 325 and 400 kg/ha gave a net returns of ₱11666.00, ₱13,226.00, and ₱12,584, respectively. While planting during wet season gave a net returns of ₱13,987.00, 14,228, and 14,339 using nitrogen rates of 300, 325 and 400 kg/ha, respectively. This shows that a yield of 8.58 t/ha, which is the highest yield for 18 strategies, gave only a net return of ₱12,584 which is much lower compared to strategy 1 of dry season with a yield of 7.95 t/ha and a net return of ₱15,583. This is due to the high rate of nitrogen inputs and irrigation costs.

Table 1. Showing the six strategies planted under dry (Nov. 30) and wet (Oct. 20) season.

PARAMETERS/VARIABLES	STRATEGIES					
	DRY SEASON			WET SEASON		
	1	2	3	1	2	3
VARIETY, PI03382						
PLANTING DATE	30 Nov.	30 Nov.	30 Nov.	20 Jul.	20 Jul.	20 Jul.
BEGINNING DATE	22 Nov.	22 Nov.	22 Nov.	12 Jul.	12 Jul.	12 Jul.
SOIL TYPE	FINE MIXED, ISOHYPERTHERMIC FLUVENIC EUTROPEPT					
IRRIGATION METHOD	RAINFED CONDITION			RAINFED CONDITION		
NITROGEN INPUT (KG)						
0 DAP	100	60	75	100	60	75
50 DAP	120	60	75	120	60	75
YIELD (t/ha)	7.75	7.46	7.70	7.27	5.92	6.49
NET RETURN (₱)	15,583	14,099	14,935	12,787	7,777	9,843
STRATEGIES	4	5	6	4	5	6
VARIETY, PI03382						
PLANTING DATE	30 Nov.	30 Nov.	30 Nov.	30 Nov.	20 Jul.	20 Jul.
BEGINNING DATE	22 Nov.	22 Nov.	22 Nov.	22 Nov.	12 Jul.	12 Jul.
SOIL TYPE	FINE MIXED, ISOHYPERTHERMIC FLUVENTIC EUTROPEPT					
NITROGEN INPUTS -						
0 DAP	150	150	200	150	150	200
50 DAP	150	175	200	150	175	200
IRRIGATION						
Irrig. depth (mm)	0.20	0.25	0.30	0.20	0.25	0.30
Available water (%)	20.0	20.0	20.0	20.0	20.0	20.0
Efficiency (%)	60.0	60.0	60.0	60.0	60.0	60.0
YIELD (t/ha)	8.39	8.50	8.58	7.67	7.80	7.89
NET RETURN (₱)	11,666	13,226	12,584	13,987	14,228	14,339

In summary, strategy 1 is the best among the 18 maize strategic plans that were simulated for a period of 5-years. Pioneer cultivar, 3382, is best planted during the dry season with rainfed irrigation option. Probably because there is sufficient moisture in the soil from the time of planting up to early maturity of the plant. Highest yield is obtained using 220 kg of N/ha with a displacement width of 5 cm. Application was

done two times, one is 100 kg of N/ha applied at the time of planting (basal) and the remaining 120 kg of N/ha at 30 DAP (sidedressed).

CASE STUDY REPORT: STRATEGY EVALUATION EXERCISE FOR LOWLAND RICE PRODUCTION USING DSSAT VER. 2.1

Danilo F. Guinto

A. OBJECTIVE

This crop simulation exercise using DSSAT's CERES Rice model and the Strategy Evaluation package aims to find out the "best" management package for lowland rice production given a set of initial conditions (e.g. weather, soil, and production cost data) and a created synthetic data file. The acceptability of any given management option is measured in terms of mean grain yield and net return over a 5-year period.

B. PROCEDURE

The weather data set was obtained from the Agromet Station of the International Rice Research Institute at Los Baños, Laguna. This data set was used to generate weather coefficients using the WGEN weather estimator. The soil used was a Cauayan series from Isabela State University classified in Soil Taxonomy as a fine, mixed, isohyperthermic, Udic Haplustalf which is predominantly grown to corn. This particular soil exists in the master soil data file listing by the USDA Soil Conservation Service and was then easily accessed under code 8500586. Basic rice production cost was provided by PCARRD.

For the rice crop simulation, there are several options available as regards culture. These include: rainfed lowland transplanted, rainfed lowland (direct seeded) rainfed upland (direct seeded), irrigated lowland (transplanted) and irrigated lowland (direct seeded). At first it was decided to do simulation experiment under irrigated lowland conditions (transplanted) but the initial simulation run gave relatively low net return (₱ 1910.00) even though grain yield was over 6 t/ha with 100 kg N/ha in two splits. It was therefore decided to try other irrigation options but net return still remained low. Finally, it was decided that a rainfed lowland (transplanted) rice simulation be made to see if rainfall is adequate for the growing or rice.

C. SIMULATION RESULTS AND DISCUSSION

The following strategies were tested using the rice model and the strategy evaluation procedure:

Str. No.	Var	Trans. Date	Begin Date	N Fertilizer Julian Date	Amt.	Typ.	Dep. (cm)	Inc.	Plt. Dens.	Plt/ Hill	Eff. Bund Ht. (mm)	Init. Flood Depth (mm)
1	IR64	246	246	246	45	5	15	8	25	3	100	50
				291	45	5	15	8	25	3	100	50
2	IR64	246	246	246	60	5	15	8	25	3	100	50
				291	60	5	15	8	25	3	100	50
3	IR64	246	246	246	75	5	15	8	25	3	100	50
				291	75	5	15	8	25	3	100	50
4	IR64	246	246	246	75	5	15	8	25	3	100	50
				246	75	5	15	8	25	3	100	50
5	IR64	246	246	246	75	5	15	8	25	1	100	50
				246	75	5	15	8	25	1	100	50
6	IR64	150	150	150	75	5	15	8	25	1	100	50
				195	75	5	15	8	25	1	100	50

DESCRIPTION OF STRATEGIES

In strategy 1, the default transplanting date of 246 (Sept. 3) was accepted and the beginning simulation date was synchronized with it. The effective bund height of 100 mm and initial floodwater depth of 50 mm were likewise accepted as defaults. Nitrogen was applied in two split doses of 45 kg N/ha each with urea as the N source, placed at 15 cm depth. Strategies 2 and 3 are similar to strategy 1 with progressively higher N rates (120 and 150 kg N/ha, respectively). Strategies 4 to 6 were not run until the results of the 3 preceding strategies were already available. Results of the simulation exercise in terms of grain yield and net return are shown in the table below:

Strategy Number	Grain Yield (tons/ha)	Standard Deviation	Net Return (Pesos/ha)	Standard Deviation
1	5.866	0.4787	5750	2393
2	6.318	0.4781	7170	2390.4
3	6.443	0.4992	7635	2496.1
4	6.386	0.4802	11845	2401
5	6.164	0.4861	15235	2430
6	7.618	0.3311	22505	1655

Strategies 1 through 3 gave progressively increasing average grain yield and net incomes. This was due to the increasing rates of nitrogen applied which have been effectively taken up by the rice crop as evidenced by zero nitrogen str ss and minimal losses (not shown in the above table). The e yields and net returns are higher than those obtained for the irrigated lowland case suggesting that rainfed farming is feasible. It was later thought that the cost of seedlings given was a bit too high (₱ 18/1000 seeds) and so it was decided to run Strategies 4 and 5 (similar to Strategy 3) with only two and one seedling(s) per hill, respectively. These produced relatively high net returns of ₱11845 and ₱15235, respectively confirming the sensitivity of net return to changes in number of seedlings per hill although one seedling per hill is a rare cultural practice by local farmers. Lastly, a decision was made to move the

transplanting date from September 3 to May 30 to coincide with the period of high rainfall availability using only one seedling per ill. By so doing (Strategy 6), grain yield increased from just over 6 t/ha to more than 7.5 t/ha while net return increased from P15235 to P22505.

CASE STUDY REPORT: STRATEGY EVALUATION FOR MAIZE PRODUCTION

Dr. Rolando F. Hechanova

A. INTRODUCTION

Agricultural decision makers are confronted with economic risks because of the uncertainties associated with the management and production of crops. In most agricultural countries, voluminous amount of data being generated/collected by different agencies/institutions could provide useful information to researchers, extension workers, farmers and policy makers. But often, the data are not accessible or are not interpreted/analyzed in a way understood by the end-users. If these information are fed into some kind of model, these can be utilized in predicting/explaining the outcome for planning purposes.

Agrotechnology transfer is presently the major focus of scientists, researchers and extensionists, and appears to be an attractive proposition for policy makers and administrators. The probability of transferring agrotechnology among biophysically similar environments had been proven by the Benchmark Soil Project.

Based on this premise, the IBSNAT, International Benchmark Sites Network for Agrotechnology Transfer Project is now undertaking a wider/global scale in recognition to the need to integrate the performance of a given crop at any given

environment and time. The IBSNAT has adopted a system-based approach to agrotechnology transfer, which enables enormous amount of information to be processed for practical interpretation and application.

To date, there are already some existing crop models ready for validation/verification by cooperators such as CERES-RICE, CERES MAIZE, SOYGRO, PNUTGRO, etc. There is only a need to collate regional database and train regional staff in order to operationalize these models and expert system, hence this training workshop.

B. OBJECTIVES

1. To identify the best maize cultivar under two water regimes, rainfed and irrigated.
2. To identify the best cultivar under different planting dates and nitrogen fertilizer rates.

C. PROCEDURE

In this specific simulation exercise, the weather data utilized was taken from the Agromet Station of the International Rice Research Institute (IRRI) based at Los Baños, Laguna. This data set was used to generate weather coefficients using the WGEN weather estimator for a 5-year period. The soil data was taken from Isabela State University described by Dr. Escaño and Dr. Yeck which fortunately was included in the soil directory of the IBSNAT/DSSAT and was easily accessed in this exercise. Some of the important features of said soil is shown below :

Series : Cauayan
Location: Isabela State University
Echague, Isabela (Reg. 2), Philippines
Classification : Fine, mixed, isohyperthermic, Udic, Haplustalf
Pedon No: 8500586

The basic cost for maize production was utilized in the exercise provided by PCARRD. For the maize simulation study, there are two options as regard to water regimes is concerned i.e. irrigated and rainfed conditions. For the varietal options, three cultivars were selected (i.e. CornL281, Suwan-1 and Pioneer 3382). In the selection of the best cultivar, the first step is that each cultivar was simulated using irrigated and rainfed conditions without fertilizer application. The second simulation procedure was to make the fertilizer non-limiting (default). The result of both simulation showed that Pioneer 3382 has the highest net return and was utilized in this study. In. like manner, the selection of the better moisture regime was done in which case the rainfed condition gave a better result in terms of the average yield and net return than the irrigated regime. Based on the above premise, Pioneer 3382 under the rainfed condition was utilized in the selection of the best planting dates and nitrogen rates options.

RESULTS AND DISCUSSION

As regards to the cultivars, Pioneer 3382 was utilized since it gave the highest mean yield and net return as compared to Suwan-1 and Corn L281, both in the irrigated and rainfed

conditions. For the water regime, rainfed condition option gave a better response to maize planted in May (wet season period) than during the dray season planting (i.e. Nov. or Dec.). Generally, the irrigated option resulted in lesser net returns both in the wet and dry seasons planting than in the rainfed water regime. This is due to the fact that the Los Baños rainfall was abundant for the five-year period considered for the wet season as reflected in the simulation results which shows that no water stress throughout the year. Using the irrigated option the best planting date was observed to be during the dry season (i.e. Nov 30) as compared to wet season planting (May), since soil water for the dry season planting is enough to offset the irrigation effect. Automatic irrigation with a fertilizer rate of 220 kg N/ha and 160 kg N/ha applied during planting and 32 days after planting, respectively gave the highest mean yield and net return of 7.948 t/ha and ₱10,520, respectively as compared to the other ten nitrogen fertilizer rates options (Figure 1).

For the rainfed conditions, Pioneer 3382 (the best cultivar among the three varieties considered) responded very well to the wet season planting (i.e. May 30) than in the dry season planting. The reason behind these outcome is that, the wet season planting has enough moisture that even without applying irrigation, the maize plant did not suffer a water stress as shown in the simulation runs as compared to the dry season planting which encountered water stress. Also, said planting date (May) reduces the input e.penses, since irrigation

was not considered as an additional input. Among the seven (7) nitrogen fertilizer rates options, the fertilizer rate of 120 and 90 kg/ha applied during planting and 32 days after planting, respectively gave the highest average yield and net return of 8.09 t/ha and ₱17,854 as compared to the other six fertilizer rates option (Table 1 and Figure 1).

In this particular case study/exercise, the best strategy chosen using the weather data set at Los Baños and Cauayan soil series (Strategy 15) has the following information:

Variety	:	Pioneer 3382
Plant density	:	7.5 plants/ha
Water regime	:	Rainfed
Planting date	:	May 30 (wet season)
Fertilizer rate	:	120 kg/ha during planting (code 5) 90 kg/ha at 32 DAP (code 5) depth of placement : 5 cm

Table 1. Summary of strategies for maize production under rainfed water regime

STRATEGY	PLANTING DATE	DAYS AFTER PLANTING	AMOUNT (KG/HA)	DEPTH (CM)	CODE	MEAN YIELD (T/HA)	SD	Net RETURN (P)	SD
S1	Nov. 30	0	60	5	5	6.22	1.44	10682	5926
		32	60	5	5				
2	Nov. 30	0	45	5	5	5.95	1.59	9740	6501
		32	45	5	5				
3	Nov. 30	0	90	5	5	6.31	1.46	10705	5991
		32	90	5	5				
4	Nov. 30	0	90	5	5	6.31	1.46	10556	5985
		32	120	5	5				
5	Nov. 30	0	120	5	5	6.33	1.53	10481	6263
		32	120	5	5				
6	Nov. 30	0	120	5	5	6.33	1.53	10638	6261
		32	90	5	5				
7	Nov. 30	0	90	5	5	6.31	1.47	10886	6032
		32	60	5	5				
8	Nov. 30	0	150	5	5	6.36	1.53	10761	6291
		32	60	5	5				
9	Nov. 20	0	90	5	5	6.66	1.43	12164	5868
		32	90	5	5				
10	Nov. 15	0	90	5	5	6.73	1.42	124436	5857
		32	90	5	5				
11	Dec. 7	0	90	5	5	5.41	2.01	7055.6	8289
		32	90	5	5				
12	May 30	0	50	5	5	7.59	1.32	16118	5414
		32	90	5	5				
13	May 30	0	120	5	5	7.93	1.14	17363	4777
		32	60	5	5				
14	May 30	0	90	5	5	7.85	1.11	17134	4537
		32	75	5	5				
15	May 30	0	120	5	5	8.09	0.96	17854	3962
		32	90	5	5				
16	May 30	0	120	5	5	7.69	0.62	16362	2557
		32	60	5	5				
17	May 30	0	120	5	5	8.12	0.95	17820	3880
		32	120	5	5				
18	May 30	0	120	5	5	7.76	0.79	16666	3253
		32	60	5	5				

CASE STUDY REPORT ON THE SELECTION OF COMPONENT TECHNOLOGY FOR CORN UNDER UPLB CONDITION

Submitted by:

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As an output requirement for the :

International Workshop on Decision Support Systems
for Agrotechnology Transfer (DSSAT)
December 2-12, 1990

A) Background Information

Location of weather station	:	UPLB
Latitude	:	15.7
Corn varieties tested	:	CornL281, PIO 3282, Suwan-1
No. of years simulated	:	5
Soil classification	:	Typic Eutropept
Based on information used in the simulation:		
Market price	:	4,100.00
Base production cost/ha	:	12,400.00
N-fertilizer costs/kg	:	5.50
Cost/fertilizer application	:	130.00
Irrigation cost/mm	:	37.00
Irrigation fixed cost/ha	:	2,000.00
Cost/irrigation application	:	400.00
Cost of 1,000 seeds	:	20.00

B) Methodology

- a software package called the Decision Support System for Agrotechnology Transfer (DSSAT) v.2.0 was used as a tool to determine the best variety of corn and possible management practices that will suit to the prevailing biophysical condition in the area under study, in this case, in UPLB.

- weather data i.e. rainfall, min. and max. temperature, solar radiation, as well as the soil parameters were collected from the UPLB Agromet Station and DBMS provided in the package, respectively. he data above were used as inputs to the maize crop model

- the best strategy was evaluated in terms of highest net returns out of thecombinations analyzed. Strategies that showed higher yield but with lower net returns were discarded.

C. Results of the Simulation

- a series of runs were made to determine the best planting and beginning dates for each variety. PIO 3382 was found promising under the following conditions:

  c1) planted during Nov. 10
  c2) number of plants/sq.m. = 7.5
  c3) row spacing at .75 cm
  c4) rainfed condition
  c5) receiving nitrogen level at the rates of 60-30-60 kg N using ammonium nitrate as the source. It was incorporated at the depth of 5 cm.
  c6) N levels were applied at 1 days after planting (DAP), 30 and 60 DAP, respectively.

- results indicated that highest net returns can be realized under the component technology indicated above due to the following reason:

  c7) there was enough rainfall coupled with high solar as well as temperature regimes for the month of January compared to the rest of the planting dates tested (Appendix Table 1). These factors consequently contributed to the high yield of the crop.

- an optimal yield of 6.39 t/ha was obtained from POI 3382 (Appendix Table 2). The net return obtained was ₱9,100 with a standard deviation of 5667.9. Although highest yield was recorded from the same variety using different combinations, this however resulted to negative net returns.

- although highe yield can be obtained on January planting with irrigation and nitrogen application (Appendix Table 3), the net returns were lower because of the additional cost incurred from irrigation (see cost in the Background Information)

D) List of Appendix Tables for the Simulated Strategies

Table 1. Yield of 3 corn varieties at different planting dates, grown in Typic Eutropept soil, rainfed and without N application

Strategy	Varfiety	Planting Date	Beginning Date	Yield (kg/ha)	Net* Return (₱/ha)
ST1	CornL281	May 10	May 2	286	–
ST2	–do–	Jun3 10	June 2	40	–
ST3	–do–	July 10	June 2	48	–
ST4	–do–	Aug. 10	Aug. 2	210	–
ST5	–do–	Sept. 10	Sept. 2	56	–
ST6	–do–	Oct. 10	Oct. 2	66	–
ST7	–do–	Nov. 10	Nov. 2	414	–
ST8	–do–	Dec. 10	Dec. 2	678	–
ST9	FT03382	May 10	May 2	400	–
ST10	–do–	June 10	June 2	68	–
ST11	–do–	July 10	July 2	108	–
ST12	–do–	Aug. 10	Aug. 2	388	–
ST13	–do–	Sept. 10	Sept. 2	116	–
ST14	–do–	Oct. 10	Oct. 2	136	–
ST15	–do–	Nov. 10	Nov. 2	816	–
ST16	–do–	Dec. 10	Dec. 2	54	–
ST17	Suwan–1	May 10	May 2	322	–
ST18	–do–	June 10	June 2	92	–
ST19	–do–	July 10	July 2	192	–
ST20	–do–	Aug. 10	Aug. 2	242	–
ST21	–do–	Sept. 10	Sept. 2	176	–
ST22	–do–	Oct. 10	Oct. 2	350	–
ST23	–do–	Nov. 10	Nov. 2	888	–
ST24	–do–	Dec. 10	Dec. 2	618	–

* negative net returns

Table 2. Yield and net returns of 3 corn varieties planted under rainfed condition and applied with different rates of nitrogen

Strategy	Variety	Planting Date	Beginning Date	N* Rates (kg/ha)	Yield (t/ha)	Net Returns (₱/ha)
ST25	PI03382	Nov. 10	Nov. 2	30-30-30	4.90	3,444
ST26	-do-	-do-	-do-	60-30-60	6.39	9,100
ST27	-do-	-do-	-do-	30-60-60	5.97	7,386
ST28	CornL281	Dec. 10	Dec. 2	30-30-30	4.79	2,704
ST29	-do-	-do-	-do-	60-30-60	5.06	3,316
ST30	-do-	-do-	-do-	30-60-60	4.88	3,994
ST31	Suwan-1	Nov. 10	Nov. 2	30-30-30	4.85	3,363
ST32	-do-	-do-	-do-	60-30-60	5.74	4,752
ST33	-do-	-do-	-do-	30-60-60	5.72	5,022

* applied at 1, 30, and 60 days after planting (DAP, respectively

Table 3. Yield and net returns of 3 corn varieties under irrigated condition and applied with different rates of nitrogen

Strategy	Variety	Planting Date	Beginning Date	N* Rates (kg/ha)	Yield (t/ha)	Net Returns (₱/ha)
ST34	PI03382	Jan. 10	Jan. 2	30-30-30	6.90	- 214
ST35	-do-	-do-	-do-	60-30-60	8.42	6,189
ST36	-do-	-do-	-do-	30-60-60	8.78	7,626
ST37	CornL281	Jan. 10	Jan. 2	30-30-30	4.93	3,289
ST38	-do-	-do-	-do-	60-30-60	6.30	1,761
ST39	-do-	-do-	-do-	30-60-60	6.01	1,651
ST40	Suwan-1	Jan. 10	Jan. 2	30-30-30	6.46	1,320
ST41	-do-	-do-	-do-	60-30-60	8.28	2,292
ST42		-do-	-do-	30-60-60	8.44	2,000

* applied at 1, 30 and 60 DAP, respectively

CASE STUDY EXERCISE
(A Simulation Using DSSAT)

by

Bonifacio G. Pajuelas

I. INTRODUCTION

A rice farmer has three choices of seeds (IR 64, Labelle and RD 23) which is to be grown on his clay , kaolinitic, isohyperthermic typic eutropept soil. The climatic condition of his area is defined. With this limitation he is faced with the problem of getting a good return from his harvest. Will he plant IR 64? Labelle? or RD 23? Will he irrigate? Or just wait for rains to come then puddle the soil and plant.

The solution to this case was attempted through simulation using DSSAT (an acronymn for Decision Support System for Agrotechnology Transfer). DSSAT is a computer software with combined soil, crop, weather and farm management databases and simulation models that allow a user to do strategic planning and decisions on day to day farming activities.

II. METHODS, RESULTS AND DISCUSSIONS

Using the software,IR 64 gives the best yield. This variety was subjected to three treatments as shown below.

Treatment Number	Planting Date (Julian day)	Definition of treatment
1	103	Completely rainfed
2	103	Rainfed with 1 irrigation
3	103	Rainfed with maintained floodwater

All treatments used the same fertilizer inputs. One during transplanting (30 kg./ha) and another application 25 days after transplanting (90 kg/ha). Urea is the source of Nitrogen incorporated beneath the soil surface at 10 cm depth.

Treatment 1 which is completely rainfed, simulated the best result. (Table below).

Trtmnt No.	Nitrogen Uptake	Nitrogen Loss	E-M Days	E-M Rain	Water Strs1	Water Strs5	Nitrogen Strs1	Nitrogen Strs5
1	114-145	3-32	108-114	541-1123	0-0.5	0-0.1	0	0.1-0.2
2	55-66	11-32	107-112	511-1171	0-0.6	0-0.1	0	0.1-0.2
3	49-64	12-41	128-131	645-1059	0-0.1	0-0.3	0	0 -0.2

Treatment No.	Yield (T/ha)	Net Return Pesos
1	7.2	9695
2	3.9	-6930
3	3.5	-8705

Note:

Strs1 = stress at growth stage 1 (vegetative phase).
Strs5 = stress at growth stage 5 (grain filling stage).
E-M = emergence to maturity.

Weather was 10 years generated by DSSAT Weather generator.

Initial Soil conditions

Depth of layer (cm)	SW content (cm3/cm3)	NH4 N/kg soil	NO3	pH
5	0.285	7.0	0.7	5.2
10	0.290	7.0	0.7	5.2
15	0.295	7.0	0.7	5.2
20	0.310	5.0	0.7	5.5
20	0.320	5.0	0.7	5.5
20	0.315	5.0	0.7	5.5
20	0.330	5.0	0.7	5.5

DSSAT MODEL APPLICATION IN CORN
A case Study in Region 02

Valentino C. Perdido

INTRODUCTION

The concept of determining location specific technologies prompted researchers to test technologies through on-farm trials in various locations in the farmers' fields in various parts of the country The strategy is effective, but somehow it is time consuming, laborious and expensive.

The advent of DSSAT is on the rescue from this traditional approach of technology transfer in the country. It is regarded at present as the most practical, reliable and fast approach of technology transfer.

Utilizing previously generated informations, these when assembled together could form part of the most powerful tool that facilitates decision making regarding technology transfer which policy makers should adopt.

OBJECTIVE

To run simulations on corn and identify the best strategy for corn production in region 2 condition under specified weather and soil conditions.

PROCEDURE

The DSSAT version 2.1 computer software was used for this purpose under given soil and weather conditions.

Various production components assembled together to form strategies were run for five years simulation. The weather information was taken adapted from the U.P. at Los Baños weather data belonmging to type III climate whih is very similar to the climatic conditions of Isabela where the situation was located. Fortunately, the soil at the Ilagan Experiment Station, Ilagan, Isabela which represents the dminant soil condition of the region's (Cagayan Valley) corn producing areas had been included in the soils classified and described by Escaño and Yeck (1985). With a pedon no. 85P0587, the soil at the Ilagan experimeent station falls under San Manuel Series, classified as fine, mixed isohyperthermic Udic Haplustalf.

The production component composed of three (3) corn varieties grown under varying planting dates, plant densities, irrigation methods/management, and fertilizer rates. The different strategies were simulated for five (5) years.

In the process of analysis, decision was based not only on the yield levels but also on the economics particularly on the net returns. In determining the best strategy, careful analysis was done to consider the variances of the strategies such that under situation where two or more variances show dominance, the one with the lowest variance (with acceptable yields) was selected.

RESULTS

Presented in figure 1 are the corn strategies evaluated for five years simulation under a specified weather and soil conditions, and the flow of the sequence of the production components.

It was noted that PIO 3382 corn variety excelled over the other varieties in all planting dates. For all varieties evaluated, high density to as much as 7.5 plants/m2 have shown the best. To maximize production, irrigation was also applied but unfortunately the stratefgy that has the least irrigation and Urea was the most profitable strategy.

An examination on the fertilizer (N) and water stresses was done and found out that under the most profitable strategy, there was no stress both on water and nitrogen fertilizer. Another run was therefore made reducing the N rate and irrigation water (to as much as zero) and again stress was analyzed. Under this condition, yields, were acceptable and more important is the net returns that was substantially increased due to elimination of irrigation. It should be mentioned, however, that rainfall during the period is sufficient to provide the water requirement of the crop for a substantial and profitable yield.

In table 1, the list of promising corn strategies is shown. Results revealed that during the May planting, using corn variety PIO3382 grown under rainfed condition under Ilagan soil (Udic, Haplustalf) and at plant density of 7.5 plants/m^2 could give

yield to as much as 10 tons/ha comparable to the highest yielding strategy. An advantage of the strategy (Strategy 7), however, is on the point that due to rainfed condition and lower inputs due to fertilizer, the return was highest (more than ₱ 26,000.00/ha). It was not only on the basis of yield and profit that this strategy (Strategy 7) was selected but also based on the variance which was the lowest.

Table 1. List of promising corn strategies.

STRATEGY/TREATMENT	IRRIG. (30-45 DAP)	N-RATE (0-32 DAP)	YIELD (kg/ha)	NET RETURN (₱)	VARIANCE
STR-1	50 + 50	100 + 200	10680	21,478	3286
STR-2	50 + 50	100 + 150	10680	21,753	3286
STR-3	60 + 0	100 + 200	10682	23,366	3287
STR-4	60 + 0	100 + 150	10682	23,641	3287
STR-5	50 + 0	90 +120	10674	23,198	3302
STR-6	50 + 0	90 + 135	10674	24,115	3302
STR-7	0 + 0	90 + 100	10666	26,525	3268*

Dominant Strategy: STR-7

Conditions:

Corn variety	:	PIO 3382
Planting date	:	May 1
Beginning date	:	April 1
Climate data	:	UPLB
Soil data	:	Udic, Haplustalf (Ilagan, Isabela)
Row spacing	:	0.75
Plant Density	:	7.5 plants/m^2

CASE STUDY REPORT ON RICE AND CORN USING DSSAT Ver. 2.1

Submitted by:

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International Workshop on Decision Support Systems for Agrotechnology Transfer (DSSAT)
December 3-12, 1990

Group 5: P.C. Sta. Cruz and P.G. Pangilinan

CASE STUDIES

CASE 1 : UPLAND RICE under RAINFED condition (unbunded)

CASE 2 : LOWLAND RICE under RAINFED condition (bunded)

CASE 3 : CORN under IRRIGATED condition

Soil : Fine, Montmorillonitic, Isohyperthermic Vertic Haplaquoll (84F0056)

Weather Data: Los Baños, Laguna

Average Temp: 27.1 ^{o}C

CASE STUDY 1 (Rice, Rainfed Upland, unbunded)

Objective: To deteterminе the best variety, plantinqg month, N level and plant population under direct seede rainfed upland (unbunded) condition in terms of ne return using soil no. 84P0056 and Los Baños weather

BASIC INFO

1. Weather : Los Baños
2. Soil : Fine, Montmorillonitic, Isohyperthermic Vertic Haplaquoll
3. Planting Method : Direct Seeded
4. Irrigation : Never irrigated, Rainfed
5. Latitude : 15.7
6. Sowing Depth : 5 cm

TREATMENT VARIABLES

1. Variety (LABELLE, IR 64, RD 23)
2. Planting Month (July, November

Selection under NO Nitrogen and water stress condition

3. Nitrogen level (30, 60, 90 kg/ha)

   3 Applications

Depth, Fertilizer & Incorporation	Julian Date (DAP)	Amount of N 30N	60N	90N
15,5,9	184	10	10	50
5,5,5	217	10	10	20
5,5,5	224	10	10	20

4. Plant population (25,50,75 plants/m^2)

STRATEGY EVALUATION RESULTS

1. The best planting month for rainfed rice is July 1, using IR 64.

2. Yield increases with plant population from 25 to 75 plants per m^2 regardless of N level. Increases, however, ranges from 0.1 to 0.3 t/ha only.

3. Significant yield increases were noted with increasing N level. Highest yield were obtained in 90 N at 75 plants per m^2.

4. In terms of net returns, highest values were obtained in 90 kg/ha at 25 plants per m^2.

5. Smallest standard deviation were noted in lower N levels, however, it increases with increasing plant population.

CONCLUSION

Based on grain yield, net return and standard deviations, direct seeded IR64 in July 1 can give highest net return under 90 kg N/ha at 25 plants per m^2.

COMMENT

The linear response to N level even up to 120 kg N/ha of IR 64 under rainfed upland condition must be corrected.

CASE STUDY 1 (Rice, rainfed upland)

Treatment N (kgq/ha)	Population m^2	Grain Yield t/ha	SD	Net Return ₱
30	25	5.70	0.157	13,265
	50	5.85	0.155	9,705
	75	5.80	0.134	4,965
60	25	6.31	0.257	16,330
	50	6.57	0.268	13,140
	75	6.61	0.264	8,850
90	25	6.70	0.360	18,115
	50	7.01	0.378	15,185
	75	7.11	0.386	11,165

* July 1 direct seeded

* IR 64

CASE STUDY 2 (Rice, Rainfed Lowland)

OBJECTIVE: To determine best variety, planting month, N level and plant population under trasplanted rainfed lowland condition in terms of net returns using soil no 84P0056 and Los Baños weather.

BASIC INFO

1. Weather : Los Baños, Laguna
2. Soil : Fine, Montmorillonitic, Isohyperthermic Verdic Haplaquoll
3. Planting Method : Transplanted
4. Irrigation : Rainfed and Bunded
5. Latitude : 15.7

TREATMENT VARIABLES

1. Variety (LABELLE, IR 64, RD 23]
2. Planting Month (July, November)]

Selection under NO N and water stress condition

3. Nitrogen level (80,100,120 kg N/ha)

   3 Applications

Depth, Fertilizer & Incorporation	Julian Date (DAP)	Amount of N 80N	100N	120N
15,5,9	184	40	60	80
5,5,5	217	20	20	20
5,5,5	224	20	20	20

4. Plant population (25,50,75 plants/m^2)

STRATEGY EVALUATION RESULTS

1. The best planting month for rainfed bunded using IR 64 is July 1.

2. Yield increases with plant population but net return substantially decreases in all N levels.

3. Increase in yield due to increasing N level is minimal but decrease in net return is significant.

4. Highest net returns were obtained in 25 plants per m^2 population regardless of N level.

CONCLUSION

Transplanting IR 64 in July 1 under rainfed bunded condition can give an optimum net return under 120 kg N/ha application using 25 plants/m^2 plant density.

COMMENT

The model is not responsive to increase in plant density.

CASE STUDY 2 (Rice, rainfed lowland)

Treatment N (kg/ha)	Population m^2	Grain Yield t/ha	SD	Net Return ₱
80	25	6.84	0.515	18,390
	50	7.23	0.510	16,310
	75	7.37	0.504	12,530
100	25	6.90	0.503	19,060
	50	7.33	0.522	16,700
	75	7.49	0.510	13,040
120	25	6.92	0.488	19,040
	50	7.35	0.509	16,700
	75	7.54	0.509	13,180

* July 1, transplanted

* IR 64

CASE STUDY 3 (Corn, Irrigated)

OBJECTIVE: To determine best variety, planting month, N level and plant population under irrigated condition in terms of net returns using soil no. 84P0056 and Los Baños weather.

BASIC INFO

1. Weather : Los Baños, Laguna
2. Soil : Fine, Monthmorillonitic, Isohyperthermic Vertic Haplaquoll
3. Planting Method : Direct seeded
4. Irrigation: Automatic irrigation (0.5 m, 50% SAT, 70% irrigation efficiency)
5. Latitude : 15.7

TREATMENT VARIABLES

1. Variety (CORNL281, PI003382, SUWAN-1)]
2. Planting Month (Jan, Apr, Jul, Nov)]

Selection under NO N and water stress condition

3. Nitrogen level (150,200,250,300 kg n/ha)

3 Applications

Depth and Fertilizer	Julian Date (DAP)	Amount of N 150N	200N	25N	300N
15,5	0	50	67	90	100
5,5	38	50	67	80	100
5,5	73	50	67	80	100

4. Plant population (6,8,10,12 plants/m^2)

STRATEGY EVALUATION RESULTS

1. The best planting month for maximum yield (no N and water stress condition) is January.

2. Grain yield increases with N level, i.e. highest grain yield was observed in 300 kg N/ha application.

3. Net return increases in N level, i.e. highest net return was noted in 300 kg n/ha application.

4. Standard deviation for grain yield and net return increased with increased N level.

5. Regardless of N level, grain yield and net return increased with plant population wherein highest values were observed in 12 plants per m^2. Likewise standard deviations increased with increasing plant population for both parameters.

CONCLUSION

The maximum corn yield, January 1 planting under irrigated condition using FOI 3382 variety with 300 kg N/ha at 12 plants per m^2 is the best strategy.

COMMENT

The linear yield increase to increasing plant dates does not reflect the optimum LAI, canopy structure variation and quality (size) of ears produced.

Incorporate ROI or BCR as parameter for evaluation.

CASE STUDY 3 (Corn Irrigated)

Treatment N (kg/ha)	Population m^2	Grain Yield t/ha	SD	Net Return (₱)
150	6	9.66	0.77	11,458
	8	10.53	0.81	14,369
	10	11.14	0.86	16,499
	12	11.53	0.71	17,490
200	6	10.12	0.82	13,121
	8	10.91	0.83	15,901
	10	11.53	0.85	17,928
	12	12.05	0.90	19,328
250	6	10.31	0.84	13,577
	8	11.16	0.85	16,615
	10	11.79	0.89	18,522
	12	12.30	0.98	20,070
300	6	10.54	1.22	14,222
	8	11.48	1.26	17,327
	10	12.11	1.28	19,786
	12	12.67	1.36	20,914

* Jan 1 planting

* PIO 3382

* Automatic irrigation (0.5 m, 50% SAT, 70% efficiency)

REPORT ON THE CASE STUDY ASSIGNMENT

NELLY U. UTRERA
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Critical factors like environment, soil, fertilizer and water and variety interplay for the production of a certain crop. Comoinations of these factors would contribute to the productivity and profitability of the crop. However, the most determining factor for production is the environment especially weather and climate.

Different strategies (combinations of planting date, variety, planting density, water management and fertilizer) were done to identify among which will give the highest yield and maximum profit of corn production. This wa done to simulate the effect of Batac weather condition and the kind of soil present in the same environment using the combinations of the above variables.

The three varieties used for comparison were L281, PIO 3382 and SUWAN -1. Different planting dates were also tried to see the effect of dry and wet season.

Among the three varieties PIO 3382 was the best when planted on May with a population density of 7.5 plants per meter square. The rate of fertilizer was also varied starting from the recommended rate of 90 kg N/ha to as high as 250 kg N/ha. Water management was also varied from rainfed, pre-scheduled irrigation and automatic irrigation.

It was found out that the yield of corn can be increased with increasing rate of fertilizer. The optimum nitrogen requirement of corn (FIO 3382) under Batac condition is 200 kg N per hectare. Authomatic irrigation was identified to be the best irrigation management of corn during May planting. With these combinations, a yield of 7.11 t/ha was obtained and a net return of ₱ 11,720 was realized. Under rainfed condition and with a fertilizer rate of 250 kg N/ha the same yield of 7.11 t/ha but a lower net return was realized.

During the whole duration of May planting high amount of rainfall was accumulated i.e. 876 mm and the evaporation rate was relatively low (340 mm). This might contributed to the absence of water stress conditions in corn during its vegetative and reproductive stages. Although the irrigation was set to automatic, with the amount of rainfall accumulated practically a minimum number of irrigations was done.

The differences therefore on the net returns wa on the amount of fertilizer. Rainfed conditions was provided with higher amount of nitrogen i.e. 50 kg higher than the automatically irrigated corn. With this increase in fertilizer as was discussed earlier, the yield remained the same and additional cost was incurred by increasing the N levels by 50 kg, there is a corresponding decreased in profit.

There was a minimal nitrogen stress during the vegetative growth of maize but no nitrogen stressed was observed during reproductive stage. Water stress was never observed from both

vegetative and reproductive stage. The amount of water and nitrogen applied was just enough to give a balance of high yield and maximum profit. In addition, these were utilized efficiently by the corn plants thus a minimal N loss was observed.

Yield can also be increased with increasing plant density from 5.95 plants per to as high as15 plants/per meter square. However, with the corresponding increased in yield there is a corresponding decreased in net return. It is because that when planting density is increased more seed is required which eventually increase the seedcost in particular and the production cost in general. The increase in yield was not able to compensate the added seed cost.

It can be said that the most critical factors for corn production is in the management of water and fertilizer. Irrigation and fertilizer are most expensive production input in corn production. These two factors must be utilized efficiently by the plants so that maximum yield and profit will be obtained with the application of minimal amount of these production factors.

The population density of corn is also be considered. With increasing plant population, the yield is increased correspondingly but there is a maximum requirement to give a maximum profit.

CASE STUDY REPORT: STRATEGY EVALUATION FOR RICE PRODUCTION IN LOS BANOS

By: Eduardo Ramos

INTRODUCTION

Crop simulation models have been used in a number of situations to mimic biophysical processes that occur in the real world in order to have a better insight and a better understanding of a process. Several models have now been developed which include not only crops but pest and disease models as well.

One of the many applications of crop models is in policy decision making where appropriate alternative technologies have to be evaluated for their merits in unknown agroenvironmental conditions. Traditionally, the approach was to conduct numerous experiments in as many locations possible with the hope that by doing so, one alternative may come out to be the best in all of these sites. Unfortunately, results have been shown and proven to be different everytime and that no amount of experimentation could quite pinpoint which among these alternatives to use.

The computer era has introduced a new methodology for identifying alternative technologies that are productive, stable and sustainable through crop simulation models. While it may take several years to accomplish the same task if they were conducted in the field, these experiments take only minutes of a researchers time to conduct the same multilocation, and multiyear experiments.

Crop modelling can aid the policy maker to decide which is the best time of the year to plant a particular crop, what are the best technology packages to use, and most importantly, what are the expected net returns from each of these strategies.

OBJECTIVES

1. To identify the best rice cultivar, time of planting and best method of fertilizer application under Los Baños conditions
2. To maximize net income from rice production

INITIAL CONDITIONS

Site. The proposed experimental site is located in Los Banos, Laguna, (15.7 latitude N, 121 longitude E). It is about 20 m above sea level and typicaly flat. The area is traditionally planted to rice and corn.

Soil. The soil was characterized as fine-loamy, mixed, non-acid, isohyperthermic Ae ic Tropaquept. Some of the typifying soil profile data of this type of soil are:

Pedon number	:	85P0054
Soil albedo	:	0.13
Runoff curve number	:	84.0
CEC	:	40.0

SOIL PROFILE DATA [PEDON: 84P0054]
SOIL ALBEDO= .13 U= 7.7 SWCON= .05 RUNOFF CURVE NO.= 84.0

DEPTH-CM	LO LIM	UP LIM	SAT SW	EXT SW	IN SW	WR	NO3	NH4
0.- 5.	.247	.376	.400	.129	.376	.750	1.0	1.0
5.- 8.	.247	.376	.400	.129	.376	.750	1.0	1.0
8.- 20.	.238	.365	.407	.127	.365	.500	1.0	1.0
20.- 30.	.145	.274	.381	.129	.274	.200	1.0	1.0
30.- 40.	.145	.274	.381	.129	.274	.200	1.0	1.0
40.- 55.	.126	.255	.377	.129	.255	.333	1.0	1.0
55.- 70.	.126	.255	.377	.129	.255	.333	1.0	1.0
70.- 88.	.099	.223	.363	.124	.223	.170	1.0	1.0
88.- 107.	.099	.223	.363	.124	.223	.170	1.0	1.0
107.- 118.	.128	.257	.380	.129	.257	.105	1.0	1.0

Weather. Climate data was obtained from the International Rice Research Institute (IRRI) Weather Station located near the proposed experimental site. A minimum of 6 years of daily rainfall, solar radiation , and minimum and maximum temperature data was available. A ten year weather data was further generated using the Weather Generator subroutine for use in the simulations.

EXPERIMENTAL DETAIL

Variety. The variety IR 64 was used in all simulations. This variety was found to be superior over the other two varieties because of its high thermal time requirement from anthesis to maturity thus increasing the period of grain filling and more importantly its high Potential spikelet number coefficient of 90 as compared to 75 for both Labelle and RD 23, respectively. The single grain weight of IR 64 although smaller than that of Labelle (0.027 for IR 64 and 0.028 for Labelle) did not drastically affect its performance during the simulations.

GENETIC SPECIFIC CONSTANTS OF IR 64

P1 = 550.00	P20 = 10.5	P2R = 150.00
P5 = 520.00	G1 = 90.0	G2 = .0270
G3 = 1.00	G4 = 1.00	

Method of planting. All simulations whether it was under rainfed upland or rainfed lowland condition begun at transplanting and commenced at physiological maturity. Seedlings were transplanted at a depth of 5 cm and were assumed to be about 20 days old at transplanting.

Floodwater management. Floodwater depth was set at 0.00 cm. Except for the rainfed upland condition where the possibility of modifying these option did not exist, bund height was set at 10 cm. Perched water table was not modified and was assumed to be 0.00.

Population density. Plant population was maintained at 25 plants/m2 with a row spacing of 0.2 m. Only 1 plant was transplanted per hill in order to allow comparison between upland and lowland conditions. However, traditional rice culture requires 3-4 seedlings per hill.

Irrigation inputs. Three methods of irrigation were evaluated in the strategy evaluation. However, only the rainfed system was found to be economically feasible.

Fertilizer treatments. In all simulations, a single fertilizer rate of 150-0-0 per hectare was used. Ninety kg of N

from urea was applied basally at transplanting and the remaining fertilizer was applied 30 days after transplanting (30 DAP).

Three methods of fertilizer application were evaluated in the simulation and will be described as follows:

a) *Existing practice* - basal application is done during the second and last harrowing where the fertilizer is thoroughly incorporated in the upper 20 cm of the soil layer. The rest of the fertilizer is always applied as a broadcast. Done in rainfed lowland conditions.

Methods evaluated	0 DAP	90 kg N	6 Incorporated
	30 DAP	60 kg N	1 Braodcasted

b) *Rainfed upland* - Placement of the fertilizer at a depth of 20 cm is practiced before seeding. The fertilizer is applied using a furrow wheel applicator and immediately covered with soil .o reduce volatilization/nitrification losses.

Methods evaluated	0 DAP	90 kg N	8 Deep placement
	30 DAP	60 kg N	8 Deep placement

c) *Rainfed lowland* - Placement of fertilizer at a depth of 20 cm immediately after transplanting and 30 DAP. The fertilizer is applied in the form of mudballs (fertilizer is rolled into a small amount of mud prior to placement)

Methods evaluated	0 DAP	90 kg N	8 Deep placement
	30 DAP	60 kg N	8 Deep placement

SIMULATION PROCEDURE

All strategy evaluations for UPLAND condition and net income analysis were carried out inside the Strategy Evaluation subroutine of the DSSAT shell. However, all LOWLAND condition simulations were done using the CERES RICE model wherein all input parameters i cluding lowland condition were entered interactively.

The results of the RICE model were then used as an input file of the Strategy evaluation subroutine for the net income analysis and graphics.

Figure A shows the schematic flow of the operational procedure followe

Figure A. Schematic flow of the operational procedure followed.

1. INPUTS

Soil	Pedon 85P0054
Varieties	Labelle, IR 64, RD 23
Field condition	Rainfed
Fertilizer management	250-0-0 split into 2 equal parts applied 30 DAP
Date of planting	Monthly
Number of strategies	36

OUTPUTS

Best variety, Best planting date, N stress at vegetative stage, N stress at flowering stage

2. INPUTS

Different combinations of fertilizer amount at 0 DAP and 30 DAP

Number of strategies

OUTPUT

Best amount of N to apply basally and at 30 DAP

3. INPUTS

Three methods of fertilizer placement Number of strategies 3

OUTPUT

Best method of applying fertilizer under rainfed lowland or upland conditions using 1 rice cultivar

RESULTS AND DISCUSSION

Best planting date

Monthly planting of IR 64 using Los Banos weather and soil data showed that September was the best time to plant the rainfed crop. The total amount of rainfall (mm) collected during this period was 1094.5 which was sufficient to maintain the crop until maturity. The least amount of rainfall was obtained in December until February. Although April was the start of the rainy season in Los Banos, growth and yield was not as high as those obtained in September. This reduction in yield could be due to other weather factors like solar radiation which could have affected the yield. Another probable reason is the availability of too much water which may have carried away some of the nutrients present in the soil hence the lower N uptake.

Month	Yield	Amount of water	N uptake
January	3.531	224.50	48.90
February	3.270	389.50	48.95
March	3.370	709.50	53.85
April	3.135	1041.50	56.70
May	3.530	1277.00	56.65
June	3.770	1327.50	61.55
July	5.145	1383.50	99.70
August	5.775	1231.50	100.35
September	6.030	1094.50	145.35
October	6.000	926.50	113.85
November	4.040	514.00	44.30
December	3.810	163.00	48.85

Productivity

Table 1 shows the 10 year simulation outputs for the three different methods of fertilizer applications. Highest maximum yields for IR 64 under Los Banos conditions were obtained from the deep placement treatments regardless of whether they were under upland or lowland conditions. These observatins can be attributed to increased efficiency of nitrogen uptake as well as decreased nitrogen loss resulting from improved application techniques.

The superiority of these methods is further reinforced by the observation that a higher degree of stress was obtained after the vegetative stage from the broadcasting treatment (Table 1). This suggests that N losses occured at a much faster rate than N uptake. Several possible avenues of losses are nitrification followed by leaching in lowland conditions and higher volatilization of applied N during broadcasting. In contrast to these, deep placement results in lower nitrification loss because of incorporaion of N into the reduced zone of the lowland soil profile.

No significant difference between upland and lowland condition grain yield was observed among the two deep placement treatments. Our conclusion is that regardless of the field condition, deep application of N fertilzer is a more efficient method than soil incorporation and broadcasting.

Net income

Figures 1, 2, and 3 show the cumulative probability distribution of net income from the three different methods of fertilizer applications under Los Banos conditions. Highest net income was obtained from the RAINFED UPLAND DEEP PLACEMENT treatment although not significantly different from the LOWLAND RAINFED DEEP PLACEMENT treatment (13,960 and 13875, respectively). These findings are in agreement with the previous results in that highest net return were obtained from treatments with higher grain yields, while keeping all other parameters constant.

Stability

The UPLAND RAINFED DEEP PLACEMENT treatment had the highest stability among the 3 treatments evaluated as shown in Figures 4, 5 and 6. Grain yield, however was widely distributed throughout the 10 year simulation period and that even the best yielding method showed a high degree of standard deviation. A high degree of variability is to be expected from these treatments.

SUMMARY

Three different rice cultivars namely Labelle, IR 64 and RD 23 were evaluated under Los Banos conditions to determine the best technology package that could be recommended to farmers under rainfed and irrigated conditions. The package consisted of the best cultivar, the best time of planting, the optimum amount of fertilizer and the most efficient method of fertilizer application and the highest net return.

Results of the strategy evaluation showed that IR 64 under upland or lowland irrigated conditions applied with a minimum of 150 kg N/ha and placed near the root zone (20 cm deep placement) was the best alternative under Los Banos conditions. .pa

Table 1a. Simulation Outputs sorted according to yield (DEEP PLACEMENT, LOWLAND RAINFED)

#	GRAIN YIELD	MATURE BIOMASS	ANTHES BIOMASS	N UPTAKE	N LOSS	E-M DAYS	E-M RAIN	WAT STRS1	WAT STRS5	NIT STRS1	NIT STRS5	YR
1	5146.	9716.	7695.	140.	5.	107.	991.	.0	.0	.0	.0	2.
2	5811.	10019.	7189.	128.	25.	106.	921.	.0	.0	.0	.0	5.
3	5938.	11064.	8837.	130.	30.	108.	730.	.1	.0	.0	.0	8.
4	6035.	10117.	7222.	142.	15.	107.	1052.	.0	.0	.0	.0	1.
5	6047.	10366.	7128.	120.	36.	108.	1230.	.0	.0	.0	.0	7.
6	6289.	10729.	7729.	129.	26.	108.	909.	.3	.0	.0	.0	10.
7	6549.	11372.	8336.	147.	9.	109.	745.	.2	.0	.0	.0	4.
8	6660.	10875.	7749.	133.	22.	110.	1348.	.0	.0	.0	.0	9.
9	6761.	11255.	7568.	131.	27.	109.	1047.	.2	.0	.0	.0	3.
10	7176.	11817.	8768.	134.	23.	108.	1186.	.1	.0	.0	.0	6.

Table 1b. Simulation Outputs sorted according to yield (INCORPORATED AND BROADCAST)

#	GRAIN YIELD	MATURE BIOMASS	ANTHES BIOMASS	N UPTAKE	N LOSS	E-M DAYS	E-M RAIN	WAT STRS1	WAT STRS5	NIT STRS1	NIT STRS5	YR
1	3825.	6980.	5716.	67.	43.	108.	730.	.1	.0	.0	.2	8.
2	3985.	6393.	4329.	56.	63.	108.	1230.	.0	.0	.0	.2	7.
3	3993.	6754.	4743.	59.	36.	106.	921.	.0	.0	.0	.2	5.
4	4339.	7071.	4989.	63.	38.	108.	909.	.3	.0	.0	.1	10.
5	4842.	9279.	7251.	97.	5.	107.	991.	.0	.0	.0	.1	2.
6	5092.	8260.	5610.	72.	30.	110.	1348.	.0	.0	.0	.2	9.
7	5329.	8927.	5995.	74.	38.	109.	1047.	.2	.0	.0	.2	3.
8	5651.	9077.	6524.	79.	31.	108.	1186.	.1	.0	.0	.2	6.
9	6034.	10118.	7218.	103.	20.	107.	1052.	.0	.0	.0	.0	1.
10	6083.	10491.	7234.	96.	11.	109.	745.	.2	.0	.0	.1	4.

Table 1c. Simulation Outputs sorted according to yield (RAINFED, UPLAND)

#	GRAIN YIELD	MATURE BIOMASS	ANTHES BIOMASS	N UPTAKE	N LOSS	E-M DAYS	E-M RAIN	WAT STRS1	WAT STRS5	NIT STRS1	NIT STRS5	YR
1	5565.	9772.	7754.	162.	15.	117.	748.	.0	.2	.0	.0	8.
2	5921.	9537.	6642.	147.	15.	117.	933.	.0	.0	.0	.0	2.
3	6111.	10196.	6844.	144.	20.	117.	903.	.0	.2	.0	.0	10.
4	6123.	10326.	7257.	153.	22.	117.	1142.	.0	.0	.0	.0	7.
5	6317.	10269.	7223.	145.	18.	116.	903.	.0	.0	.0	.0	5.
6	64 3.	10638.	7103.	146.	21.	117.	1017.	.0	.0	.0	.0	1.
7	6473.	10651.	6868.	136.	28.	119.	1373.	.0	.0	.0	.0	9.
8	6488.	10578.	6335.	126.	20.	117.	1041.	.0	.0	.0	.0	3.
9	6579.	11095.	7475.	146.	21.	116.	1173.	.0	.0	.0	.0	6.
10	6591.	11214.	7848.	170.	14.	119.	785.	.0	.0	.0	.0	4.

APPENDIX C

INTERNATIONAL TRAINING WORKSHOP ON DECISION SUPPORT SYSTEM FOR AGROTECHNOLOGY TRANSFER (DSSAT)
December 3-12, 1990

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