Use of computers by FAO for land and water development

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SUMMARY

Information is presented on the use of computers by the Land and Water Development Division in the fields of land and water resources investigation, development, use and management for agricultural purposes.

All appropriate technique and tools are used by FAO to achieve the high purposes for which it was founded just 25 years ago. In the field of land and water resources required for agricultural purposes, the use of computers has now been established as an effective means of accelerating and improving the development process. Factors which have influenced FAO in thus introducing computers to its regular and field programmes include the availability of computer-trained staff and of computer hardware and software, the existence of facilities for programming, the suitability of computers to deal with the problems encountered and the possibilities of training counterpart staff and the continuation of the work in the future.

The use of computers under the FAO regular programme includes work on the Indicative World Plan, the establishment of a « Soils Data Bank » and publications on computers.

Most of the paper concerns the use of computers on 25 UNDP/SF field projects being executed by FAO in cooperation with Governments. The different objectives for which computers are used include : data processing, analysis and retrieval; simulation of surface runoff, of groundwater, and of reservoir operations; optimization of development potential; and project planning and management.

Funds available total $ 260,000 on 23 projects for direct use of computers and analogue models. On a major regional project additional funds amounting to $ 245,000 have been budgeted for data collection, processing and input as well as development alternatives and optimization. In all, more than $ 600,000 will be committed for computer-analogue work on these projects.

There are many basic reasons justifying the use of computers on development projects. It is in line with the thinking of the United Nations General Assembly, it will delegate routine work to the machine, it will expedite development, it will reduce the possibilities of mis-directed investment, and it will ensure that developing countries do not lag behind developed countries in such use of computers.

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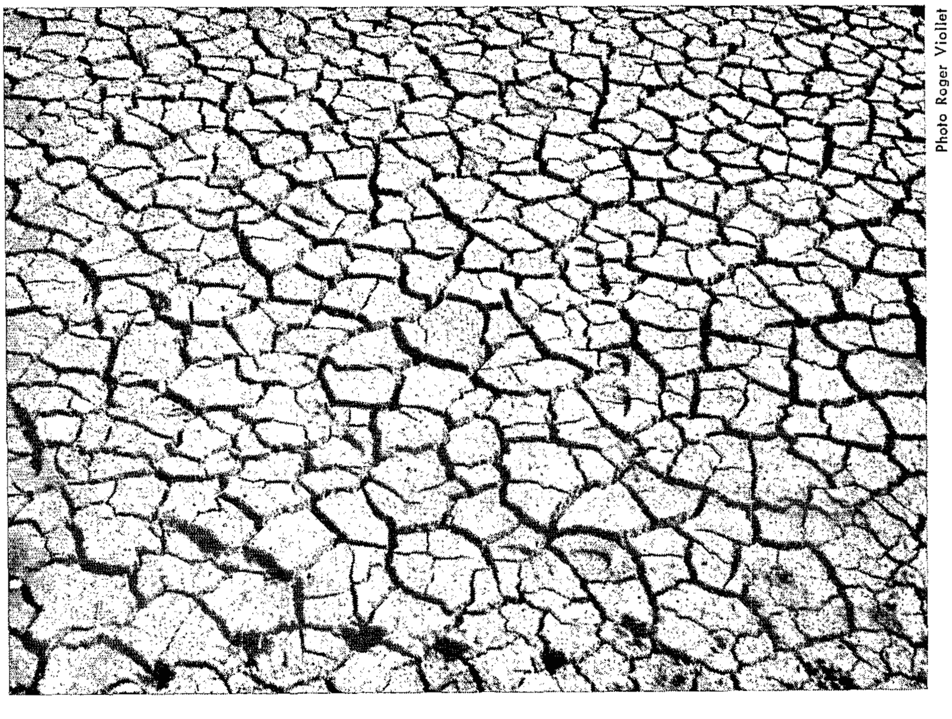

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Use of computers by fao for land and water development

I. INTRODUCTION

This paper presents information on the use of computers by the Land and Water Development Division of the Food and Agriculture Organization of the United Nations in the fields of land and water resources, investigation, development, use and management for agricultural purposes.

FAO was established on 16 October 1945, and as stated in the preamble to its constitution its purposes are :

" raising levels of nutrition and standards of living of the peoples under their respective jurisdictions ;

securing improvements in the efficiency of the production and distribution of all food and agricultural products ;

bettering the condition of rural people ;

and thus contributing towards an expanding world economy and ensuring humanity's freedom from hunger ".

To achieve these high purposes FAO has utilized all the means at its disposal and within the limits set by its constitution during the twenty-five years of its existence. This work covers the collection, analysis, interpretation and dissemination of information, the promotion of all types of activity (scientific, technological, educational and administrative, resources conservation and improved agriculture, as well as marketing, financial, investment and international trade as well as technical assistance (field programme)) which can further its aims and objectives.

In so doing FAO has utilized to the utmost the advances of science and technology which can contribute so much to agricultural development and improvement. Within this wide array, the use of computers to help solve problems in the fields of hydrology and soil science is but one of many applications of tested and new tools and weapons. In so using computers in its field programme, (UNDP/TA, UNDP/SF, FFHC, Funds-in-Trust and others) and providing advice and assistance on this subject through its regular programme, the Land and Water Development Division has endeavoured to hold a balance between being carried away with enthusiasm for some new gadget or device, or too conservatively rejecting a new tool of which proper use can save time and money and enable problems to be overcome so as to speed up the wise development and use of the land and water resources of the world.

II. FAO'S TASK IN LAND AND WATER DEVELOPMENT

Land and water are the two natural resources which are basic to agriculture ; their development, effective use and proper conservation underlie all agricultural development and increased production of food and fibre. Developing countries give a high priority to the assessment and early development of their untapped land and water resources ; failure to use these resources represents a major waste of development potential.

The importance of soil and water to increased agricultural production has been emphasized by the findings of FAO's studies under the " Indicative World Plan (IWP) for Agricultural Development ", submitted to FAO's Conference in November 1969 and to be studied at the Second World Food Congress in June 1970. " Preliminary estimates of the IWP for Asia, South America and Africa south of the Sahara indicate that only 44 % of the potential arable land is under cultivation. The IWP study suggests that this percentage be increased to 51 % by 1985, which is equivalent to 80 million hectares of new land, of which 30 million hectares would be under irrigation " (FAO's Programme of Work and Budget, 1970-71 ; Land and Water Development Division, p. 133). To bring 30 million additional hectares (an area representing 55 % of the whole of France) under irrigation calls for the use of the most efficient modern techniques if the work is to be done in time to meet the growing demands for food and fibre by the peoples of the world. And since development funds are limited, each dollar invested must bring the maximum returns in terms of agricultural output. There is no margin for mistakes.

The use of computers in hydrology and soil science is not exactly new ; but the possibilities of using them effectively on a worldwide basis, and in the developing countries, has only recently become feasible. Not so long ago there were very few computers in existence ; now there are some 16.000 outside the United States of America, and their number is increasing rapidly. In this paper reference is made mainly to the general-purpose digital computers, though in places where special-purpose devices such as analogue models are required ; they have, of course, been used by FAO.

III. FACTORS GOVERNING THE USE OF COMPUTERS

In introducing the use of computers in FAO's field programme of technical assistance, and in recommending their use in connection with land and water resources development, a great number of factors have had to be considered. These include :

(*i*) Knowledge and experience that the use of computers in hydrology and soil science will give useful and satisfactory results. This is now accepted, as from papers, reports and seminars, such as the 1968 Symposium " The Use of Analogue and Digital Computers in Hydrology ". A series of lectures on " The Use of Computers for River Basin Development Studies " given at FAO in February 1969 (by Sogreach) and similar lectures at other times, emphasised the success achieved by such use.

(*ii*) Availability of trained staff to use computers in these fields. While consultants and new staff can be brought in from outside, it has also been necessary to help existing highly-qualified headquarters and field staff to become skilled in programming and use of computers. A new headquarters post for a hydrologist skilled in computer work is provided under the 1970/71 budget.

(*iii*) Existence of computer hardware in the country of operation, or at some nearby centre, and possibilities of renting computer time when required, FAO has installed a computer at Rome headquarters, which will be mainly for management-administrative purposes ; but time for field project work can be provided. Quite a few Governments have now purchased or rented computers, and are glad of operations which will permit of their intensive use. Private companies likewise can now supply or rent computer time in most of the larger cities of the world.

(*iv*) Existence of facilities and staff for the preparation of the " software " on each problem or project. While standard programmes are useful, much of FAO's work requires that existing programmes be modified or new ones created.

(*v*) Suitability of the problem or problems to solution on computers.

FAO does not wish to try untested approaches in the developing countries, whose shortage of staff, funds and time means that mistakes cannot be allowed to occur.

(*vi*) Proper budgeting of funds and planning of the use of the computer so that the desired results are achieved. In the UNDP/SF projects, money for computers can be in part from UN funds, from Government counterpart contributions, and through sub-contacts, as in Table 2.

(*vii*) Availability of counterpart staff for training. Technical assistance implies that counterpart staff must be trained to take over the work when the FAO expert leaves ; this is an essential ingredient in the use of computers in developing countries.

(*viii*) Continuity of the work must be assured. This means that funds are available for rent of computer or for proper maintenance and use of a purchased computer. Input of data, particularly hydrological data, whould continue on the same lines and in the light of the continuing requirements of the project, region or country. The level of achievement reached on the project should be such that it can be maintained by the country after completion of the project.

(*ix*) The fact that computer equipment, software and hardware, as well as computer techniques in hydrology and soil science are evolving rapidly.

Thus it was only some five years ago that computers were first considered and used for field operations, essentially under the UNDP Special Fund projects. And it is only since the beginning of 1967 that their use has been foreseen and planned in project preparation. But since then, their use has increased rapidly, so that at present they have been, are, or will be used on the 25 UNDP/SF projects listed in Appendix A to this paper.

Under the regular programme of technical assistance, a small working paper on " Computers in Hydrology and Water Development Planning " (Underhill 1967) was prepared and used mainly to inform Government and FAO field experts, as well as those engaged in project formulation, of the value and need to incorporate the use of computers in projects with hydrological or soil science components.

IV. EXAMPLES OF USE OF COMPUTERS

The following examples of the use of computers, mainly in the field of hydrology, are drawn from the work of the Land and Water Development Division in executing UNDP/SF projects in cooperation with the Governments of various countries. However, the regular programme work, as on the soil data bank and on the proposed (1970/71) publication " Use of Computers and models in Study and Use of Water for Agriculture " should not be forgotten.

The use of computers on field projects can be classified according to the purpose for which they are employed, and an idea of the range of uses may be seen in Table I. The work under each heading is described in more detail under sub-headings in this section of the paper.

Passage de siphon du fleuve côtier du Vidourle, à la limite des départements du Gard et de l'Hérault.

Objectives	Examples
1. Data Processing, Analysis and Retrieval	Soil Data Bank, FAO headquarters; Saudi Arabia, TF 117; Indicative World Plan
2. Simulation: Surface Runoff	Cyprus (CYP 6); Greece (GRE 17); Lebanon (LEB 13)
3. Digital Simulation: Groundwater	Cyprus (CYP 6); Greece (GRE 17); Iran (IRA 12); Lebanon (LEB 13); Romania (ROM 1); Spain (SPA 16)
4. Analogue Simulation: Groundwater	Morocco (MOR 17); Niger (NER 8); Chad (AFR/REG 79)
5. Simulation: Reservoir Operations	Cyprus (CYP 6); Greece (GRE 17); Lebanon (LEB 13); Peru (PER 23)
6. Optimization:	Cyprus (CYP 6); Greece (GRE 17); Iran (IRA 12); Mauritius (MAR 2); Romania (ROM 1); Senegal (AFR/REG 61)
7. Project Planning and Management	FAO headquarters

TABLE 1. Examples of the use of computers on soil and water studies and investigations undertaken by FAO, mainly on UNDP/SF projects

Considerable funds have been made available for the use of computers on UNDP/SF projects dealing with land and water projects. The figures given in Table 2 are drawn from the budgets of 23 UNDP/SF projects under execution by FAO. It will be seen that for computers (including analogue models), the total amount comes to $ 260,000, of which the greater part is for the rental of computer time. Other inputs to the work, as by consultants and headquarters staff, come from other budgetary headings. Likewise, the budget items for computers may cover other related matters (as collection of data); such figures have been excluded from Table 2, but it does mean that the totals may not be quite exact, and of course are subject to change as the projects progress.

Of the total amount, about $ 90,000 has been firmly included in FAO project budgets, and has been or is now being expended. About $ 100,000 is proposed for existing or new projects, and the funds will soon be released for expenditure. About $ 37,000 is included for use of computers within sub-contracts with consulting firms ; and about $ 34,000 has been made available from other sources outside the true project budgets (as University research funds, free use of computer time, demonstrations by firms, etc.) for the rental and use of computers.

In addition to the $ 30,000 shown in Table 2 for AFR/REG 61 (Hydro-Agricultural Survey of the Senegal River Basin), there is a total of $ 275,000 on that project for collection of data, the building of the mathematical model, the establishment of the equations and the input of data of the regime of the Lower Senegal River to permit studies of different modes of development and optimization planning for water development and use.

TABLE 2. Provision of funds for use of computers on hydrological calculations and investigations in 23 UNDP Special Fund Projects under execution by FAO

Project	Funds for Computer, including Analogue Models, US $			
Reference Number	Allocation in Plan of Operations	Included in Sub-Contract Work	Other Sources (Government, Private)	Totals
ALG 9	5,000*	—	—	5,000
CYP 6	30,000	—	—	30,000
FIJ 55	5,000	—	—	5,000
GRE 17	5,000	—	—	5,000
INS 18	10,000	—	—	10,000
IRA 12	1,000	—	20,000*	21,000
JAM 3	10,000	—	—	10,000
JOR 9	20,000	—	—	20,000
KOR 16......	10,000	—	—	10,000
LEB 13	30,000	—	—	30,000
MAG 14	10,000	—	—	10,000
MAR 2	—	—	5,000*	5,000
MLW 2	5,000	—	—	5,000
MOR 17	30,000*	—	—	30,000
NEP 7	—	5,000*	—	5,000
NER 8	5,000	—	—	5,000
PAK 29	—	2,000*	—	2,000
ROM 1	—	—	5,000*	5,000
SPA 16	—	—	4,000*	4,000
UAR 58......	3,000*	—	—	3,000
URU 13	10,000	—	—	10,000
AFR/REG 61	—	30,000*	—	30,000
LAT/REG 35.	10,000	—	—	10,000
	189,000	37,000	34,000	260,000

* estimate.

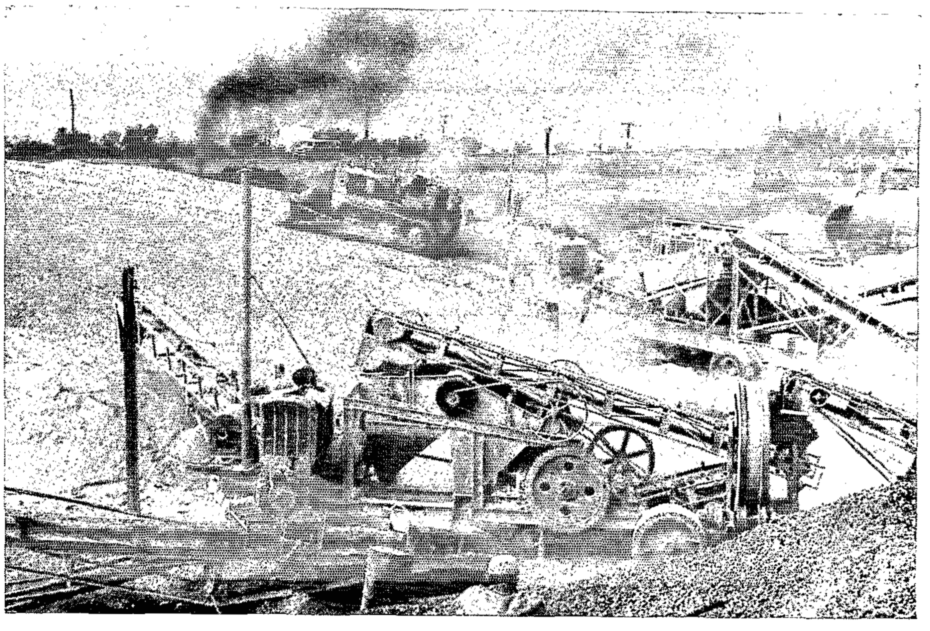
1. Data Processing, Analysis and Retrieval.

There has been only limited work done in FAO projects on machine processing of various types of water data. Interest exists in many countries where large volumes of data are being collected. The complex and time-consuming work of adapting data collection methods, forms and organizations to machine processing tends to delay serious attempts to utilize computers. The difficulty is compounded since computers are not easily available to the organizations concerned in most developing countries.

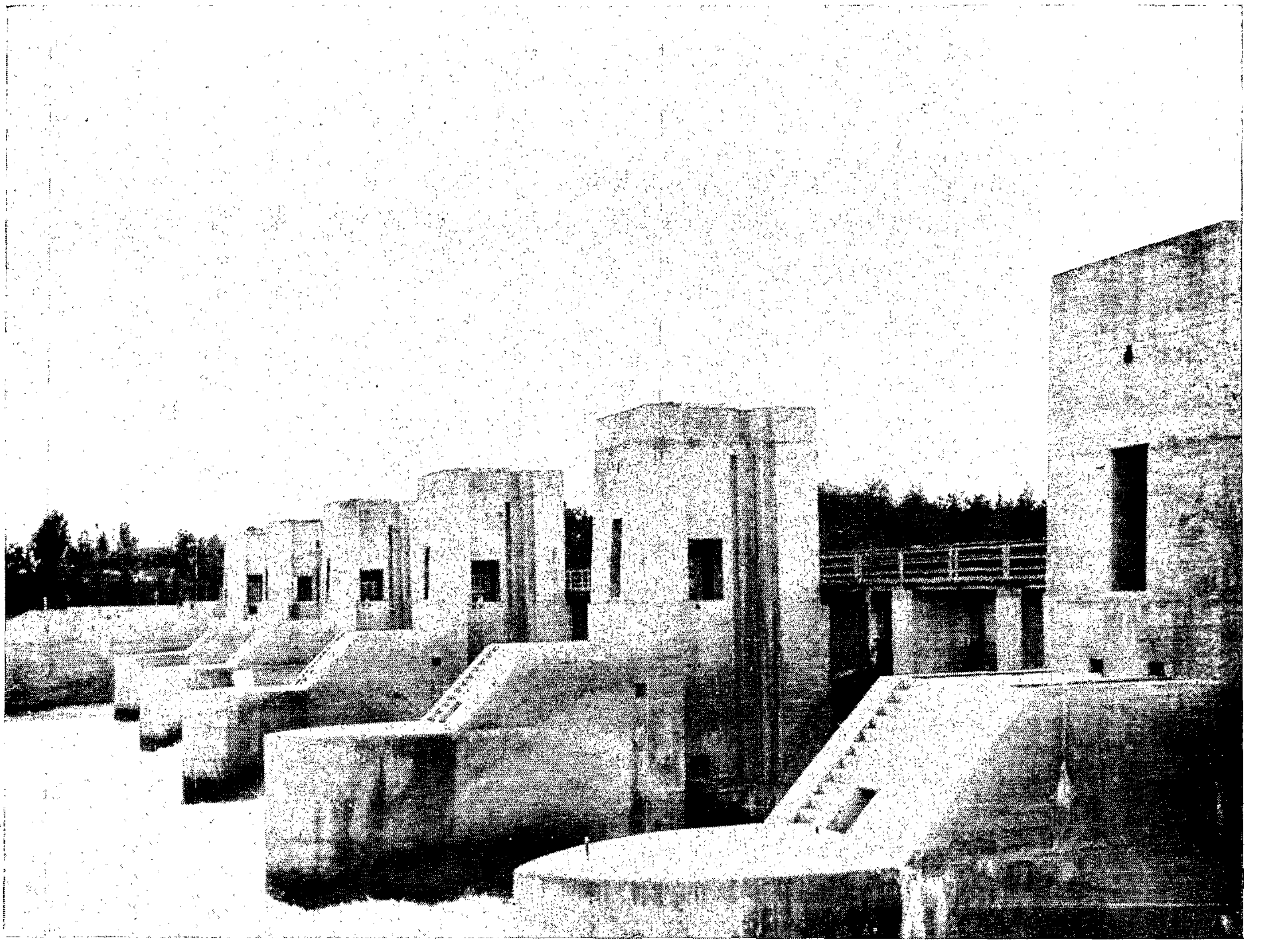
However, in some countries it has been possible to plan ahead for the storage and retrieval of hydrological data from a computer. In 1964/65, when advising the Government of Saudi Arabia (under Funds-in-Trust Project No. 117) on the method to be used by consulting firms undertaking the agricultural resources surveys of the Kingdom, FAO advised that data should be so collected, recorded and filed as to permit ready feed into a computer (when one became available) for data storage, analysis, retrieval and up-dating as required.

The checking of precipitation and other basic data for consistency is of most direct value. Statistical analysis of rainfall, runoff and other data can easily be done using available programmes. Processing of stream flow data to compute and compile runoff would be very useful in countries with many

Photo O.C.D.E.



Travaux de terrassement entre Istambul et Ismir. (Turquie).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Barrage dans la plaine d'Adana (Turquie).

stream gauging stations. Annual publication of runoff, water levels in wells, water quality, land use and agricultural data by computer is extremely useful. Cost of such report preparation is minimal *after* the system has been set up, and may justify the expense of conversion to machine processing of data. After data has been stored, it can then be easily retrieved if the storage system is set up with this in mind.

In connection with the Indicative World Plan, use has been made of the computer at the University of Southampton in the United Kingdom for the storage, analysis and retrieval of much data collected from all over the world, including data on water and soils. This use of a computer under the regular programme has produced excellent results, and much facilitated the work.

A particularly interesting example of the use of computers for data processing and retrieval is a current project being initiated at FAO headquarters to establish a " Soil Data Bank " of informations which can be used by field experts to help them correlate soil characteristics and classification with the types of crops which can be grown. After inserting the actual soil, climate and other physical factors into the computer, the physically feasible crops will be listed, based on the data stored in the " Soil Data Bank ". So, the Soil Data Bank will provide the field staff with specific data about the potential and possible uses of soil and level of production ; it will also establish the necessary correlations for determining the significance of various uses for each variety of soil. It is expected that this programme will eventually be used on all irrigation or dry land farming projects.

To achieve these goals a wide variety of statistical and related techniques will be tested and, if found useful, made available to FAO and counterpart staff on a routine basis.

The first requirement is an efficient system for retrieval of stored information. The basis of retrieval may be an already existing classification, e.g. that used in the preparation of the FAO/-UNESCO Soil Map of the World. But equally well, it may be a single soil parameter or a combination of parameters. In the latter case, some of the techniques of numerical taxonomy may be borrowed to provide an integrated measure of similarity between soil or land units, which could be used as a criterion for retrieval. This has already been done for climatic data and could undoubtedly be extended to soil, the other major aspect of land.

Multiple regression is a well known statistical technique which will enable the elucidation of relationships between various land parameters on the one hand and between these parameters and crop productivity on the other. In FAO field projects involving crop responses to fertilizers, the use of production functions are already well established, both univariate and multivariate (i.e. the fitting of yield response curves and response surfaces, respectively).

The development of simulation models for crop productivity is a rapidly developing area of research and the Land and Water Development Division will watch its progress closely. The ultimate emergence of reliable modelling techniques, integrating data drawn from the Soil Data Bank with climatic and crop physiologic data, will enable prediction of crop productivity from basic data, supplementing the ad hoc, site-specific, field experiment approach, which is currently used almost exclusively in agronomic research and extension.

The use of simulation leads us now to consider this technique in more detail, particularly in relation to the development of water resources.

2. Simulation.

Of the many uses of computers, simulation techniques are perhaps the most interesting and the easiest to understand. The land and water resources projects in FAO have done more with simulation than with other computational aspects, primarily because the study of water lends itself well to various simulation techniques.

Because computers vary widely around the world, it is not possible to have ready-made simulation programmes which are easily applicable to all computers. However, an attempt is being made to keep a file of all programmes so that field projects can more easily adapt prepared programmes to their local computer. Use of consultants to help FAO and counterpart staff in the early stages of simulation is important for clear understanding and for training.

It is important to recognize that it is possible to simulate a system and, in the same programme, to optimize some aspect of the system. A good example is simulation of operation of a reservoir, a classical engineering study. When this is done by hand relatively few conditions can be simulated. On a computer, one can make many repeated simulation studies changing one factor until, let us say, a minimum water cost is obtained by an optimizing technique.

In this brief report simulation problems are discussed here, while optimization problems are dealt with in the next section.

Simulation has been used in FAO field projects for reservoir operation, for determination of runoff from rainfall, for flood determination, and for groundwater basin studies. Objectives of most of these simulation techniques are to determine what will happen under future conditions. The greatest real value to those doing the studies may be to obtain a much clearer knowledge of how a system operates, how well the model represents the real system and what kind of data are needed for better studies.

Simulation may be done in stages. A complex, large system may be broken down into more easily handled components, and the components studied first, later putting a more complete model together. Sometimes a complex system can be greatly simplified in order to make a first approximation of what is happening. Some problems of a larger nature can often be solved by a simpler model much more easily than by a very detailed model. Once the more general aspects are clear, new, more detailed models can be used.

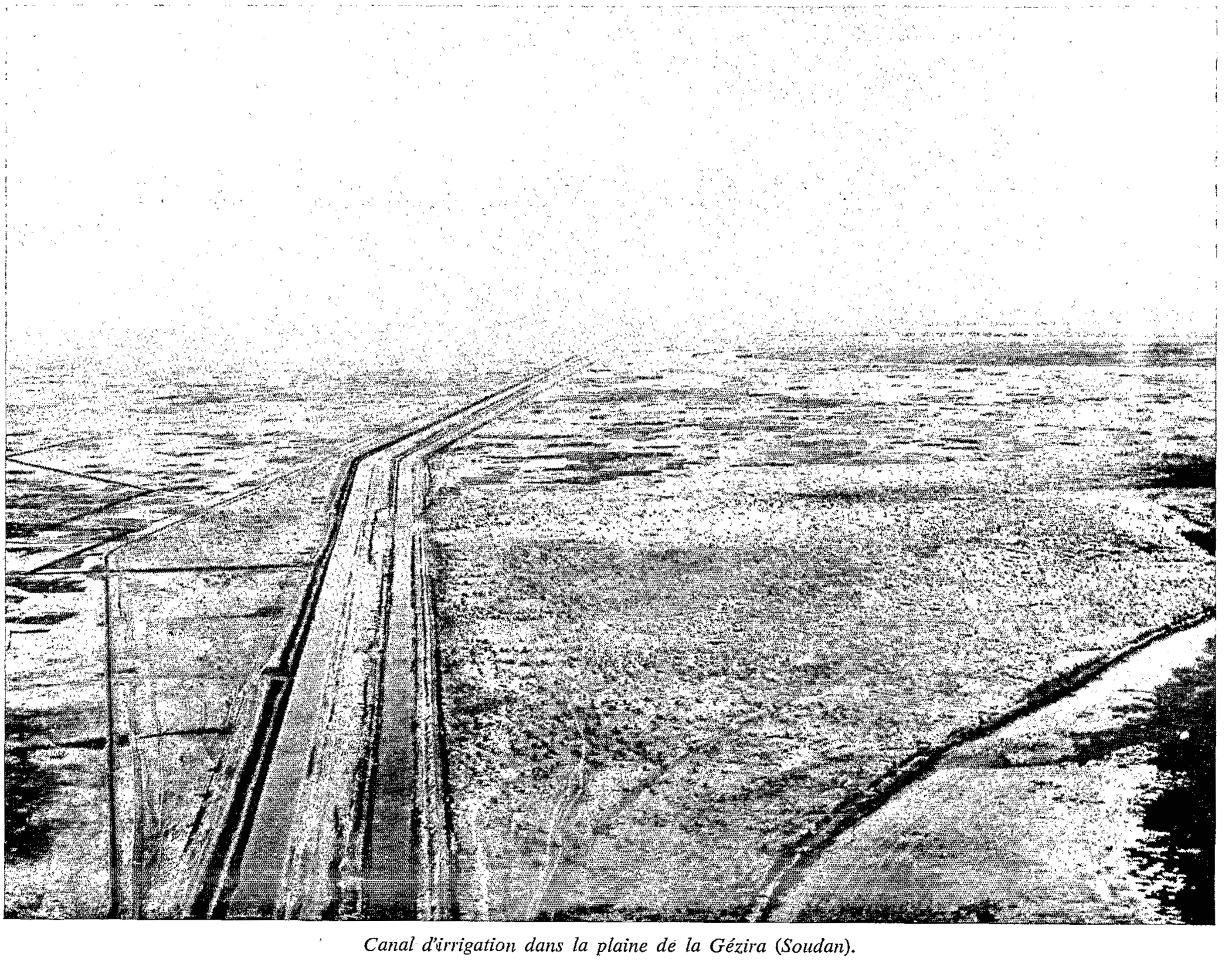
Simulation of surface water runoff using rainfall input is being used in Cyprus (CYP 6), on Crete in Greece (GRE 17) and in Lebanon (LEB 13). This technique will spread to similar projects as hydrologists become more familiar with its uses and advantages.

Groundwater basins in Cyprus (CYP 6), Crete in Greece (GRE 17), Iran (IRA 12), Lebanon (LEB 13), Romania (ROM 1) and in Spain (SPA 16) have been simulated on computers. Analogue models of groundwater basins have been or will be used in Morocco (MOR 17), Niger (NER 8), and Chad Basin (AFR-/REG 79).

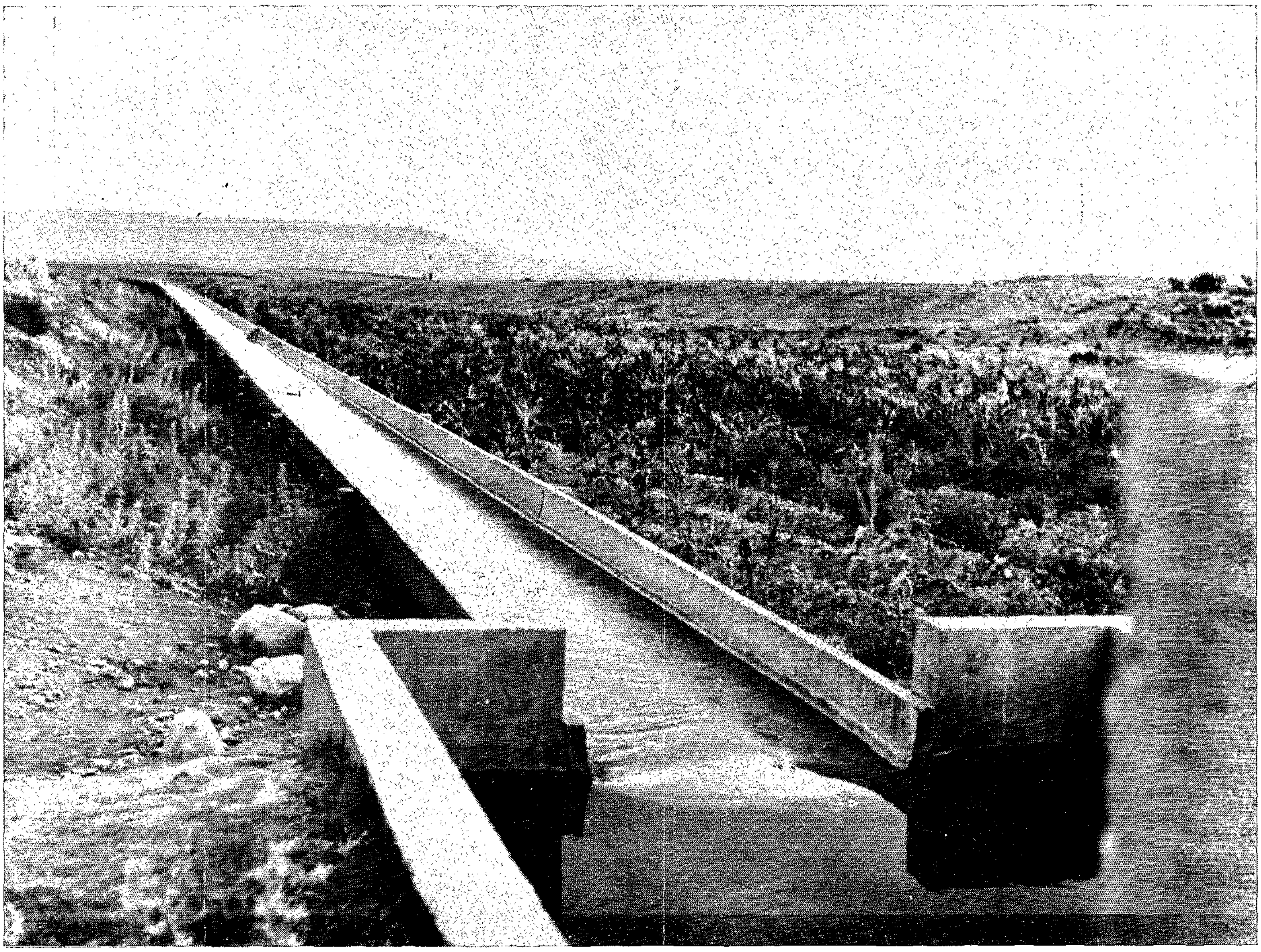
Reservoir operation studies were done on a computer in Peru (PER 23) and are being done in Cyprus (C P 6).

3. Optimization.

In this section the use of optimizing techniques is briefly discussed. Simulation models give insight into how a complex system works and how it may form under future conditions. While this objective is of great value for technical and design purposes, decisions usually cannot be based only on use of such models. In order to make decisions, alternatives and their costs and



Canal d'irrigation dans la plaine de la Gézira (Soudan).



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Centre d'irrigation de Sbiba (Tunisie).

benefits must usually be determined. Costs and benefits can be easily determined for a given alternative. In today's complex projects there are usually wide ranges of alternatives. Optimization tests these ranges of alternatives to find the optimum solution.

There are several optimizing techniques, some of which can be used to optimize the same problem. For example, water pollution and reservoir system problems can be optimized using dynamic programming or linear programming. Other optimizing techniques may well be applied to these same problems.

Prepared linear programmes are usually readily available so that less computer programming time is required and therefore this method is often used where programmers are scarce or not highly skilled. In contrast a special dynamic programme must be prepared for each application and a computer programme prepared. On the other hand, it is easier for a problem to be formulated using dynamic programming than it is using linear programming. Of course, other considerations are also taken into account including complexity of problem and type of computer.

In FAO projects, a complex water distribution system has been optimized in Mauritius (MAR 2), and a combined surface water/groundwater system has been studied in Iran (IRA 12) as reported by de Ridder and others (1969); a detailed paper on the use of computers in this project is being prepared. Optimization of development of the water resources or the lower part of the major international basin of the Senegal River (Guinea, Mali, Mauritania and Senegal) will be carried out with the help of digital models, for which an overall sum of $ 275,000 has been provided in the budget of AFR/REG 61. And through an associate project, now being prepared, the work will extend to a detailed development study of the Gorgol River, a major tributary of the Senegal River.

These methods are now being introduced by FAO into other countries and projects in line with its policy of developing and utilizing land and water resources to the utmost for the benefit of the people, and considering unused land and water resources as waste.

Optimization techniques do not provide decisions. The techniques can present results of a rather complex analysis in fairly simple terms so that responsible agencies have more information on which to base their own technical decisions. The primary difficulty seems to be definition of objectives when applied to a particular problem. The computer, being mindless, does only what it is instructed to do. If the objectives are unrealistic, incomplete or unstated, results will be interesting but useless. On the other hand, stating all objectives possible may show that certain of them are in conflict, that is, that two objectives cannot be fully met at the same time. With optimizing techniques it is possible to make trials to arrive at combinations of objectives and at the same time new ideas may be generated and lead to a different way of solving the problem.

4. Project Planning and Reporting.

At the present time FAO is studying the possibility of implementing a network analysis system (also called the critical path method) for project planning and reporting. In its preliminary phases, computer use may be minimal, but eventually the headquarters computer may be used to bring project records up to date and to provide management information reports.

Such a system will, of course, affect FAO's land and water projects as well as its other activities.

V. APPRAISAL OF RESULTS

It is as yet too early to appraise the results obtained from the use of computers by the Land and Water Development Division of FAO. Such a study may form part of the publication " Use of Computers and Models in Study and Use of Water for Agriculture " planned for the 1970-71 biennium. Some preliminary indications have already been given in a paper " Use of Digital Computers in International Water Resources Investigations " (Thomas 1969) presented to the Tucson, Arizona, Symposium.

However it is clear that there are several basic reasons which not only justify the use of computers on land and water development planning and execution, but which make it essential that this comparatively new tool in the field of hydrology and soil science should be utilized to the full. Some of the basic reasons may be listed as follows :

(*i*) The use of computers in land and water projects in developing countries is in harmony with Resolution No. 2458 of the XXIII General Assembly of the United Nations (20 December 1968) on " International cooperation with a view to the use of computers and computation techniques for development ".

(*ii*) Routine arithmetic calculations can be delegated to the computer, freeing the technical expert and allowing him to devote more time on understanding and analysing the problems with which he has to deal.

(*iii*) The use of computers can save time, and reduce the lag between water and soil investigations and their development for agricultural production.

(*iv*) Better answers can be obtained to the complex problems posed in land and water development planning; this will minimize the risk of making unwise or poorly-considered capital investments.

(*v*) Training of counterpart staff in the use of computers for hydrology and soil science will help to prevent a widening of the technological gap between the developed and the developing countries.

Since investment in water resources development to increase agricultural production will be very large over the coming decades (as indicated by the Indicative World Plan), and should form a high percentage of the overall investment budgets of the developing and indeed developed countries, the minimizing of the risk of unwise investment (Item iv above) may well be the most important basic reason for the use of computers on the UNDP Special Fund projects under execution by FAO.

VI. FAO REFERENCES ON USE OF COMPUTERS

The following references are restricted to papers and publications issued by FAO on the use of computers and land and water resources investigation and development projects. They do not include reports of the projects themselves.

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Mortier (F.), Thomas (R.G.), and Trac (N.-Q.) (1969). — Utilisation d'un modèle mathématique pour l'étude hydrogéologique appliquée de la Vega de Granada (Espagne): *Bulletin of the International Association of Scientific Hydrology*, XIV, 1, pp. 7-17.

Thomas (R.G.) (1968). — Use of Digital Computers in International Water Resource Investigations : IASH/UNESCO Symposium on Use of Analog and Digital Computers in Hydrology, Tucson, Arizona, pp. 531-534.

Underhioll (H. W.) (1967). — Computers in Hydrology and Water Development Planning : FAO Miscellaneous Publication (LA : Misc/68/2).

APPENDIX A

REFERENCE NUMBERS AND TITLES OF 25 UNDP/SF PROJECTS MENTIONED IN TEXT

ALG 9	Natural Resource Survey, Agricultural Experimentation and Demonstration in the Hodna Region, Central Algeria.
CY 6	Surveys, Demonstration and Planning of Water Resources Utilization, Cyprus.
FIJ 55	Development of Rice Growing in the Rewa River Basin, Fiji.
GRE 17	Study of Water Resources and their Exploitation for Irrigation in Eastern Crete.
INS 18	Land and Water Resources Development in South Eastern Sumatra.
IRA 12	Integrated Plan of Irrigated Agriculture in the Varamin and Garmsar Plains, Iran.
JAM 3	Groundwater Survey in Two Areas of the Interior, Jamaica.
JOR 9	Investigation of the Sandstone Aquifers of East Jordan.
KOR 16	Pre-Investment Survey of the Naktong River Basin, Korea.
LEB 13	Hydroagricultural Development, Lebanon.
MAG 14	Agricultural Development of the Morondava Plain, Madagascar.
MAR 2	Land and Water Resources Survey, Mauritius.
MLW 2	Land and Water Resources Development in Southern Malawi.
MOR 17	Irrigation Improvement in the Souss Valley, Morocco.
NEP 7	Feasibility Study of Irrigation Development in the Terai Plain, Nepal (Phase II).
NER 8	Surveys for the Agricultural Development of the Dallol Maouri, Niger.
PAK 29	Second Hydrological Survey in East Pakistan.
PER 23	Land and Water Use Surveys for the Development of the Huaura River Basins, Peru.
ROM 1	Establishment and Operation of Pilot Irrigation Stations in the Danube Plain, Romania.
SPA 16	Pilot Project of Groundwater Utilization for Agricultural Development in the Gualdalquivir River Basin, Spain (Phase II).
UAR 58	Lake Nasser Development Centre, Aswan, UAR.
URU 13	Study of the Economic Feasibility and Organization of the Irrigation District of the Olimar River, Uruguay.
AFR/REG 61	Hydro-Agricultural Survey of the Senegal River Basin (Guinea, Mali, Mauritania, Senegal).
AFR/REG 79	Survey of the Water Resources of the Tchad Basin for Development Purposes (Cameroun, Tchad, Niger, Nigeria).
LAT/REG 35	Development of the Merim Lagoon Basin (Brazil, Uruguay).

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— Help farmers improve productivity.

« We view our computer-based services as a bridge into tomorrow, both for the farmer and agri- business, » said H. G. E. Fick, president. « We are helping them achieve the full potential of their resources.

« Forecasts for preplanning would be impossible without a thorough historical knowledge plus an assessment of today's situation, area by area, across the nation. We have this from years of farm management and farm publication experience, as well as from our current farm panel surveys. »

The 360/30 will be used to analyze historical and current data to provide meaningful information on current and projected agricultural needs as well as market forecasts.

Most of the nation's major farm equipment and chemical manufacturers make use of this analysis for marketing plans, Mr. Fick said. Doane reports current farm needs and assesses the probable reception which new products would receive based on responses by its nationwide panel.

A study of fertilizer use and production, for example, fills the gap between speculation and fact for both dealers and manufacturers. One such study showed that last season farmers used only 4 per cent more fertilizer than in the previous year, while other figures indicated that some 13 per cent more was shipped by manufacturers.

Mr. Fick said, « This difference indicated a buildup in fertilizer inventories with an unusually large volume not moving onto farms before the end of the fertilizer year.

« This up-to-the-minute reporting helps manufacturers and dealers accurately gauge the next season's demands-something they couldn't do from sales records alone. »

The surveys also help determine the demand among farmers for products not yet on the market.

« It isn't unusual for an equipment or farm chemical manufacturer to modify his product line on the basis of our reports, » Mr. Fick added. « This improves the sa'es picture for the manufacturer and helps the farmer obtain the products he most needs. »

The Doane official pointed out that rising costs and lower per cent of net income emphasize the importance of finding ways to aid the individual farmer.

Doane's System soon will be applied to helping determine the most profitable use of land, labour, livestock, capital and machinery.

Farmers planning their next crops already benefit from these computerized projections of market demands and price levels. The firm plans to offer enterprise accounting which will provide farmers with unit costs of producing crops and livestock.

Doane plans to computer analyze the data and provide a breakdown of costs to produce a bushel of grain, pound of beef and similar unit costs. These costs will be analyzed to assist farm managers in making management decisions.

According to the Arkansas Farm Bureau Federation, a soybean and cotton farmer added $ 46,000 to his annual net income in two years.

Another, who also operated a feed lot, overcame a 15,0000 deficit and posted a $ 30,0000 profit.

A dairy farmer changed his feeding operations and increased his profit by 40 per cent.

These three are among 86 farmers in a continuing computer-based management program conducted by the Arkansas Farm Bureau. Teaming a Computer system with agricultural know-how, the bureau helps farmers juggle resources to increase income.

« The demands of modern agriculture on enlarged and specialized farms surpass the do-it-yourself capability of the unaided farm manager or owner, » said Waldo Frasier, executive vice president. « Especially when he is engaged fulltime in working his land.

« But the computer can weigh all the factors such as seed, fertilizer and gasoline costs, equipment depreciation, labour expenses and product prices and present them in whatever form we require.

« This is the information the farmer needs to make decisions giving him the best chances for profit. »

Lloyd Satterfield, program director, said the service will be offered to the bureau's 56,000 members, whose farms range from 40 to 10,000 acres.

Each farmer, working from daily activity records kept in a pocket notebook, submits monthly reports on livestock, crops, feed, machinery, labour and land use. Ihe bureau also uses its System/360 Model 30 to analyze cash flow form copies of his checks and deposit slips.

Its monthly, year-to-date and annual summaries indicate profit or loss products in terms of land use, actual hours and cost of labour, machinery and material for each. Based on this, the farmer may abandon, diminish or expand a product area ; alter labour assignments ; sell, repair or buy machinery ; sell, store or use supplies.

For example :

— The 850-acre cotton and soybean farmer learned that while cotton was profitable generally, two fields lost money. He concentrated attention on labour and costs for those fields and increased his net income sixfold in two years-from $ 8,797 in 1966 to $ 54,860 in 1968.

— A 1,167-acre cotton and soybean farm maintained a feed lot for cattle and hogs. The bureau's detailed 1966 reports pinpointed most of a $ 15,047 loss in the feed lot. A more prudent and efficient job of buying and feeding animals moved the farm's net income to $ 30,068 on the plus side in 1967 and $ 31,111 in 1968.

— Records on a young farmer's 160-acre dairy operation showed his low-cost production methods resulted in low average milk production. By following advice to use higher quality feed and breed his own heifers, his net income increased from $ 5, 386 in 1966 to $ 7,249 in 1967, and to $ 7,594 in 1968.

Mr. Satterfield said a 1963-64 American Farm Bureau Federation study uncovered the need and demand for such accounting. Through 1966 the University of Arkansas' agricultural extension service ran a pilot project using the Farm Bureau's equipment.

« Extension agents still are vital in helping the farmer interprete and analyse the reports we generate, » Mr. Satterfield said.

« Also, using our reports the University conducts pure research that we expect will improve farm management in general within the decade. »

As the program spreads, M. Satterfield hopes to :

— Refine income and expense data to provide even more useable information for the farmer.

— Compile country-wide averages to give the farmer a valid comparison with others sharing similar terrain, soil types and climate conditions.

— Expand Farm Bureau participation in extension agent-farmer consultations.