FAO PROJECT TCP/CPR/2204/T

TRAINING FOR CHINA IN THE USE OF COMPUTERS IN AGRICULTURE

Report by the Consultant
Dr. Frank Cope
(Norsk Hydro Fertilizers Ltd)
Peking August 1982

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FOREWORD

The consultant much appreciated the kind hospitality and efficient organisation of his hosts in China, particularly Mr. Rén Zhi, Mrs. Liu Zhaó Ling and Mr. Yu Xie Zhen. This made his visit enjoyable and enabled him to complete the work on time.

Credit is due to Mr. Wang Xi Wū for his clear interpretation and patience over many hours of highly technical discussions.

There is room for regret that lack of time forced attention largely on outstanding problems and precluded proper appreciation of outstanding research achievements by the CAAS.

Help from Mr. Li Dong Qun and other UNDP staff is acknowledged as well as the valuable pre visit briefings by FAO staff in Rome.

Frank Cope
August 1982

INTRODUCTION

The objectives stated in the original request from Minister Lin Gan (Permanent Representative of China to FAO) to Dr. E. Saouma (Director General FAO) are:

- Long term: Equip the staff (of CAAS institutes) with technology of agro-scientific research and management for the establishment of an Agricultural Computer Centre in the future.

- Immediate: Train 50 persons for related agro-scientific research and teaching institutions and as follow-up conduct research and application in the above mentioned fields.

  The immediate objective has been interpreted as to consider the work of CAAS institutes at national level in relation to computing needs and opportunities and to recommend training in agricultural computing techniques within the terms of project TCP/CPE/2204/T and for which funds have been allocated.

  Towards the long term objective, some comment is made on needs which will remain after the above training (i.e. for provincial as well as national institutes) with a specification for a computer installation which could best suit the current needs of a central CAAS Agricultural Computing Institute.

WORK REVIEWS

1.1 Previsit Briefing

One and a half days were available at FAO in Rome for briefings from representatives of the following sections:

TCP M. de Lambilly gave details of project CPR/2204/T with a budget of $125,000 from FAO and 200,000 yuan from the Chinese government, also of other recent projects in China.

Remote sensing centre (Land and Water Dev. Div) Drs. J.A. Howard and J.G. Schade gave information about the project to provide Dipix remote sensing equipment to the Agricultural University of Peking and a demonstration of some of the features of Dipix.

Farm Management Service M.M.J. Gauchon described the new FAO computer package "FARMAP" for handling economics data.

Crop Ecology Resources & Genetics Section AGP Dr. J.T. Williams described training courses arranged in the USA (Beltsville, Md) on documentation and data management for genetic resources and also the current state of progress of FAO systems (e.g. in BASIC on the APPLE II microcomputer) to handle germplasm data.

Agris Mr. A. Lebowitz provided information about the AGRIS system and current use in the world, and expressed the hope that use could be extended to China.

AGLS Mr. R.G. Thomas gave a briefing on planning and documentation for electronic processing of land and water data and current use of small computers (e.g. HP 85) for hydrologic/erosion computations.

AGLS Mr. G.M. Higgins described the FAO/IIASA system for handling an agroecological data base and its subsequent extension to compute capacity to support a population.

Problems for use in China are the soil classification (Russian system), lack of sufficient meteorological station records and lack of an IBM computer.

AGLS Mr. F.I. Massoud and Mr. P. Arens dealt with soil salinity studies and soil erosion models involving computers (HP85, IBM) and also a current project on loess soils in Inner Mongolia.

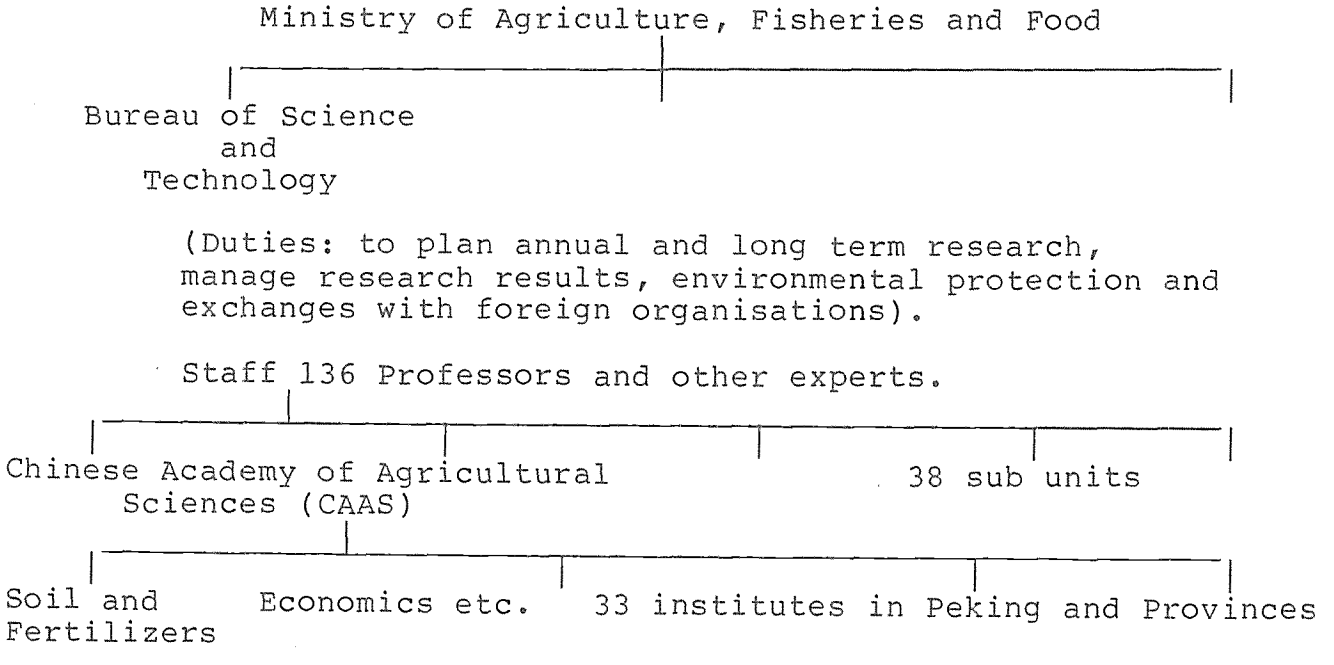
AGP Dr. Popov described the present level of data held by FAO from 70 met. stations in China and stressed the need for more stations if useful predictions of cropping potential were to be made by computer.

1.2 Review and comments on the work of institutes of the CAAS in Peking and of the Agricultural University

a) The agricultural research system overall 17.7.82

i) The Bureau of Science and Technology

Mrs. Liu Zhaó Ling, Deputy Director of the Department for International Exchange, Bureau of Science and Technology, Ministry of Agriculture, outlined an overall organisation on 17th July, 1982 as follows:-



Provinces have some autonomy, the CAAS in each province is controlled by the provincial government, and is responsible for research in that province. Below provincial level are regional and district experimental stations and projects, a total of 676 in China. Total staffing is 28,000, some 10% of staff are employed directly by the Ministry, 43% by provincial government and the remaining 47% by regions or districts. For education and extension, there are some 180 institutes or laboratories situated within agricultural colleges with a total staff of 1686 plus 24,000 extension stations located at county level in each district and province with 205,000 staff, mostly technicians or practical agriculturalists.

Projects by institutes are mainly in basic research at national level. More applied research and extension is done at the provincial/district and county levels.

Mrs. Hui then gave the broad categories for projects and investigations for the use of national resources and regional planning; adapting crop systems to areas; crop and animal breeding (including germplasm resources); land reclamation (e.g. of saline/alkali soils and low temperature zones) disease and pest control in crops and stock; soil survey; improved fertility and fertilizer practice. Also use of organic manures, Azolla etc, cash crop production - tea, tobacco, cotton; use of new techniques - isotopes, biogas, remote sensing and computers; improve extension and practical applications.

Consultants comments referred to the value of computers in economic planning and management of information for such an organisation as the Bureau of Science and Technology.

ii) The Chinese Accidemy of Agricultural Science (CAAS)

Later that day, Mr. Rén Zhi, Deputy President of CAAS, enlarged upon Mrs. Hui's comments. He divided the 33 institutes of the CAAS into two groups 1) crop and 2)

animal husbandry/veterinary. Peking has 14 institutes one is the main CAAS headquarters, the other 13 being: i) crop breeding ii) atomic energy in agriculture iii) plant protection iv) soils and fertilizers v) plant germplasm vi) agricultural meteorology vii) vegetables viii) land survey ix) biological controls x) economics xi) animal husbandry xii) apiculture xiii) post graduate study school.

CAAS institutes in the provinces include: Henan i) irrigation ii) pomology iii) cotton; Hunan i) flax; Shandong i) tobacco; Jiangsu i) sericulture, Hubei ii) oil crops; Anhui i) veterinary; Gansu i) veterinary ii) traditional veterinary science; Shanghai i) pests and diseases of animals; Hanzhou i) tea ii) citrus; Neirnenggu (I. Mongolia) i) grassland; Nanjing i) agricultural history; Heilongjiong i) veterinary ii) sugarbeet.

Mr. Rén made 3 points about computing,

- that use was at a very early stage in CAAS, some projects had been started and would be described later.

- there was a great need in research for a) information processing, b) handling germplasm data, c) in agricultural meteorology i.e. for simulations of climate and production, d) economics models, e) soils and fertilizers and studies of land reclamation; - improving fertility and utilising land and water resources.

- Mr. Rén hoped also to use computers for planning and administration work of the CAAS though he gave this a lower priority than the uses in research and land use planning.

Less than 100 people in the institutes had worked with a computer and less than 50 (including the selected scientists at the reception) might be able to program one. He asked to be told at the end of this consultancy what facilities, training and types of person were needed? The Ministry of Agriculture have charged the CAAS with the duty to set up a centre for agricultural computing at the main institute in the future. At present 14 CAAS institutes in Peking had only six micro computers between them: 2 Cromemco/Zilog, 2 Videoton 20, assembled in Hungary, and 2 MCZ 150 by Zilog.

A Delivery was slow - a PDP11/34A for the soil analysis laboratory had already been on order for more than 2 years.

Mr. Yu Xue Cheng, Senior Agronomist, of the Bureau of Science and Technology, Division of Science and Technology Exchange, who has helped to organise the current consultancy, amplified some of Mr. Rén's remarks. Micro computers were located chiefly in Peking and Shanghai institutes and these were at a similar early stage of computer use; the rest of the country lagged behind them. It was important to improve poor facilities and to provide training, the latter not so much in the hardware and software systems (though that was needed) but in the application to agricultural problems. Mr. Yu thought planning should be in 3 phases:

- to develop present equipment and skills.
- training for new skills.
- new equipment and further training.

Comment

The current project is concerned with training and in particular training in applications as stressed by Mr. Yu. It could not fund computer hardware, though the consultant would be happy to provide advice on suitable hardware for planned future developments

by China, such as the proposed new institute of agricultural computing. Suitable hardware, software and training must go together if real progress is to be made but the first essential is to make the best possible use, through training, of the computers now available in the CAAS institutes. Work of the various institutes would be reviewed, one by one, as Mr. Ren proposed and appropriate recommendations would be made regarding each institute.

It would not be appropriate for FAO to provide purely computer training e.g. in FORTRAN or BASIC languages. Comment is given in Section 2.3 in reply to Mr. Ren's question on the type of people needed for agricultural computing applications.

b) The institute of plant germplasm. 18.7.82

At this meeting the Deputy Director of the institute Mr. Xù Yún Tian, introduced its work and staff i.e. Mrs. Zhān and Mr. Lui who were involved in computing using their Videoton 20 micro. This institute comes directly under the Chinese Academy of Sciences and was reconstituted in 1978 with a staff of 210 (15 Professors) and is responsible for research on germplasm, the organisation of collections and for international exchanges of germplasm. The national collection now consists of 250,000 accessions, mostly from China, and may exceed 300,000 within the next few years. A new centre for storage (Rockefeller funded) has provision for long-term (> 30 years) storage as well as for shorter term. Provincial centres have only short or mid-term storage facilities.

The institutes VT20 computer (Intel 8080 cpu, 64K bytes, 2 floppy disc drives, single sided single density, each ·25 mb) was installed in 1978 from Hungary. Initial work has concentrated on storing data on

wheat and rice. For wheat, 2000 records, each with 98 fields are stored on floppy disc by an Assembler program, in binary coded decimal (BCD) files. BCD was chosen because of the low capacity of the floppy discs. A few other programs, written in BASIC, store wheat and rice experimental results and carry out some analyses of variance. The gene bank is not fully operational and the programs are exploratory, consisting of 6 sub-routines for input, editing, keyword sorting, sorting by parameters, printing output and disc back-up. Later Mrs. Zhān Xian Zhan gave a demonstration of this system printing out accessions sorted by number/name. She also showed an analysis of variance program which was however interrupted by the need to manually look up 't' tests.

Comment

The VT20 computer as it stands, is inadequate for the task of handling 200-300,000 germplasm records even if these are divided into species and allocated to several floppy discs per species. The use of BCD files is unfortunate since most international exchange of data involves ASCII files. Despite the reduced data packing with ASCII, a change to this is advised. The use of Assembler language is also restrictive making programming slow and program maintenance and changes difficult. A good optimising FORTRAN compiler could produce equally efficient code and would overcome these difficulties. To allow cross comparison of data sets held on different discs, under the present system, the use of intermediate (maybe temporary) disc files was suggested. These could easily be built-up using sort programs written in BASIC. One solution to the shortage of disc space could be the addition of hard discs, either exchangeable or Winchester. This would allow an integrated germplasm bank to be built and searched. If 8,000 records are stored per megabyte, an on-line disc capacity of 28 mb (with appropriate disc or streamer tape back-up) would be needed.

The 8080 processor could cope with this task but the addition of other workloads would be impractical whilst the germplasm system was in operation. A more suitable minimum computer installation for this type of on-site, dedicated task is suggested as being a PDP11/23 16 bit microcomputer with 256K bytes memory, 2 28mb discs, 1 magnetic tape drive, 2 VDU's, 1 300 lpm printer, operating under a multi-user system such as RSX-11 or perhaps RT11/TSX+. Data base software such as the DEC 'Datatrieve' system or the Doric 'INFO" system (evaluated by Wellesbourne/Rothamsted studies in the UK as suitable for germplasm data bank work) could then be used to provide a versatile system. A PDP 11/34 based system would be better but more costly.

The UK work in evaluating 'Datatrieve' and 'INFO' was discussed. An SAS based system, as used by the USDA, is of little interest to China unless IBM products are available to the Chinese market for it is IBM dependent. If germplasm data must be microcomputer (VT20) based, the 'CERES' system developed by Jackson & Huyshe in the UK could, with suitable modification, provide an answer. It could also handle the storekeeping of the new germplasm storage laboratory at the institute. Details of these systems were provided for the institute and the possibility of a visit to China by Dr. Jackson for software installation and training of staff was discussed.

Further comment referred to the training in handling germplasm data which has been arranged by FAO (Dr. Williams) at Beltsville USA, also to FAO use of BASIC programs on Apple II microcomputers. Mention was also made of the MSc course in germplasm resources at Birmingham University in the UK. The possibility of using Burroughs mainframe computer at the Peking Computer Technology Institute for germoplasm data not

required on line was raised with institute staff. Data base systems such as Data Designer, Infacs and Catalogue are sold for use with Burroughs computers.

A subroutine to compute the probabilities associated with Students 't' test (and the test statistics Chi squared 'X', normal deviate 'Z', and variance ratio 'F') was was written for Mrs. Zhan to avoid interruption of the analysis of variance routines on the VT20.

c) The institute of scientific information 20.7.82

The work of this institute was introduced by the Deputy Director, Prof. Wang Xian Pu and by Mr. Lui Yuan Pu. The institute which has 130 scientists and technicians and 40 assistants is the centre for the agricultural technical information network in China. It operates in 3 ways:

- a national/provincial system of information from the institute
- 'cells' in each of the 33 CAAS institutes which provide information services for the specialists
- in the agricultural universities and colleges with services for staff teaching and research.

Each operates at 3 levels:

- research and specialist level
- administration/teaching level
- applied technology instruction for workers communes etc.

The wide range of publications by the institute was displayed. These were of several categories:

- abstracts of scientific papers in a range of subjects, e.g. wheat, rice, sericulture, plant pathology, horticulture, veterinary, animal husbandry, and a catalogue of material from abroad.

- full reports and translations of whole articles in sericulture, soils and fertilizers, sugar cane, green crops, atomic energy, animal diseases, grassland, etc.

- extension bulletins to meet the needs of communes - 200,000 copies each month.

- details of recent research in China.

Mr. Wang hopes to make extended use of advanced technology in the future, notably audio-visual presentations, photocopying services, microfilm, improved printing with electronic type-setting, and computerised information. Regarding the latter, the institute has an arrangement with the C.A.B. in the UK and received C.A.B. tapes in 1981/2. These are read, sometimes with difficulty, on an ARCOS 500 Japanese computer. Problems arise due to:

- unfamiliarity with the keyword system (making retrieval efficiency low)

- English text can be read by relatively few Chinese scientists with facility.

The institute would like to import FAO AGRIS tapes; USDA Agricolon and Biological Abstracts. The ultimate aim is to have a Chinese computerised abstracts system similar to that of the CAB if the problems can be overcome. The current estimated annual use of data manually is 115 Mb so a much increased computer input

rate will be needed. At present no optical character recognition equipment is available.

Mr. Lui spoke also of the great need for extension information and was interested in the potential for the ICL SCAPA system in that area.

Comment

A fairly full account of the AGRIS system was given and Mr. Wāng is now very keen to see the system used in China and would welcome detailed discussions and training with Mr. Lebowitz in this context. They would contribute summaries of Chinese material as they do now for the CAB. A visit to China by Mr. Lebowitz, or an expert selected by him, would be very welcome and should prove to be productive.

Software systems for information retrieval mentioned are ASSASSIN (ICI, runs on ICL and IBM) STATUS (AERE Harwell runs on Prime etc.), MINISIS (IDRC, Canada runs on H.P.), CAIRS (Food Research Assoc. Leatherhead runs on VAX etc.)

Comments were made about tape packing and handling to minimise current problems in tape reading. Tapes should be preferably vacuum or dry shrink-packed and opened and used only in the air conditioned environment of the computer. The use of OCR equipment might well be investigated as use of computer stored information systems increased. Mr. Tottle of ICL would be asked to contact Mr. Lui and send him full details of the SCAPA system.

d) The institute of agricultural meteorology 27.7.82

Work of this institute was introduced by Prof. Jian Ai-Laing, consultant to the institute which was formed by merging institutes of geophysics, geography and meteorology and reconstituted in 1978. Projects include:

- Studies in photosynthesis and use of light energy.

- Agroclimatic conditions in relation to crop systems relative to regional planning and creating appropriate models.

- Small project on controlled environments in growth cabinets.

- Measurement of microclimate in greenhouses.

- Study environment in industrial plastic tents and crop houses.

Computer use by this institute was described by Mr. Wu and Mr. Wang. Projects are still largely in the planning stage, viz: a) modelling crop production using climatic factors (Mr. Shar) b) processing data on microclimates (Prof. Jian & Mr. Lui) c) monitoring and control of climate in greenhouse (Mr. Wu). Some work was being done on a Cromemco microcomputer and of the 80 scientists and technicians on the staff four or five could claim experience now, with maybe 20 wishing to use the computer in their work when this becomes possible.

First priority was given to the work on forecasting crop production using agroclimatic data from some 78 stations in China. A total of 108 may be available. An example is the adaptation of winter wheat to cold northern areas.

Comment

The need for a better coverage of China by agrometeorological data stations was stressed and the current limitations of the file of 70 stations held by FAO mentioned with a plea for more data. Some could be provided, and Dr. Frere or Dr. Popov would be asked to contact Prof. Jian Ai-Laing about this and the way in which it would be used by the FAO crop forecasting system. The usefulness of data on pan

evaporation (plus pan coefficients) in China, particularly as a check on Penman type models used for prediction of crop water use, etc, was pointed out. It was said that this data also could be provided for use in FAO studies of Chinese systems. However, the institute will need time to organise collection of Meteorological data from the more distant stations located on communes and experimental farms.

There was much discussion of the techniques needed in modelling work, i.e. curve fitting, multiple regression, non-linear models, solving differential equations, forecasting based on time series data (Box Jenkins and Bayesian methods), etc. A clear need emerged for training scientists in the computer application of these methods. This is covered in Section 2.1. Examples were shown of programs, and of input data, and outputs of models to compute Penman Eo and E crop, to predict radiation from sunshine hours, and of reports to summarise weather data on hourly, daily, weekly, monthly and annual basis etc. After modification such programs should be very useful to institute staff and were left in China.

Time was taken to explain FAO/IIASA work on a land resource/climatic data base and its use to predict potential yield of crops for specific hectarage of soils (as constrained by soil type, slope, erosion, growth period, temperatures, water availability etc.). The recent work of Shah, Higgins and others to extend the predictions to population supporting capacity of rain fed areas was outlined. Some Chinese scientists expressed doubts about population supporting forecasts since Chinese systems differ greatly from the extensive low manpower farming systems of the highly industrialized countries // Some appropriate publications provided by AGLS were left in China for distribution to the institute together with copies of programs (e.g. Penman, weather).

e) <u>The institute of crop breeding 27.7.82</u>

The work of the institute was introduced by Prof. Wang

Heng Li, Deputy Director. It has 157 research and technical staff having started in 1957 and been reconstituted in 1978. Most work concentrated on breeding and genetic studies of wheat, rice, maize and soya bean crops, using polyploidy, hybridisation and other techniques. The projects for 1981 were: breeding of wheats for resistance to rusts, for cold hardiness in winter wheats, for use as early maturing spring wheats in northern regions. Work was also done on Durum wheat. The inter-subspecific crossing of japonica and indica rice was examined for resistance to leaf blight, rust, high yi eld, and use as a second crop after wheat. Other atudies were the breeding of maize varieties for pig feed, the breeding of soya beans for yield, protein, virus resistance and machine harvesting qualities, improved seed setting for tetraploid rice, octaploid triticale varieties for mountain regions, etc. Some first steps in genetic engineering involve leaf tissue cultures, embryonic DNA and attempts to transfer N fixation properties. Work is also done on cultivation practices, mechanised harvesting herbicides and fertilizer use.

Use of microcomputers is organised by Mr. Zeng and Mr. Zhao but started only in 1981 - i.e. later than in other institutes - and so is generally at a planning stage only. Use is made of the VT20 in the Germplasm Institute and help is received from Mrs. Zhan.

Projects planned or started include:

a. data processing and some programs have been written in BASIC for statistical work (e.g. Analysis of Variance of experimental data).

b. quantitative genetics - combinations and groups, use of Cluster analysis methods.

c. filing and sorting a considerable amount of data from regional tests on the stability of varieties.

d. use of correlation, regression and path analysis techniques for breeding data.

e. a data base of parentage of stock, i.e. a hierarchical structure for use in planning research.

A project which has started is in the logging of crop breeding data (Prof. Wang) for use as in project 'e' above. Data has been collected from the early 1970's and the hope is to use the data base to select the best parents e.g. on grounds of disease resistance, for which the data base of the Germplasm institute is said to be inadequate. However the total number of varieties of interest in breeding is much less than the total germplasm variety accessions. Problems occur due to variability in the data, to seasonality and other causes (note: this is not a computing problem but one of technique, though the computer should help to solve it). Use of standard reference varieties to index the data from other varieties was discussed. Some thousands of records are involved for each species and the number of fields in each record is expected to be 126. COBOL is being used for work on the data base and BASIC for other programs (i.e. statistical programs) at present.

Comment

The possibilities for a shared germplasm/breeding data base were raised since some enlargement of the number of fields in the germplasm data bank might allow it to be used for both purposes. This needs more study. In either event compatibility is needed between germplasm and breeding data and storage requirements on computer disc are similar for these two institutes being of the order of 28 Mb for an integral data base.

The general statistical programming requirements of the institute are similar to those of several other institutes (with some changes in emphasis) and are covered in Section 2.1. One specialist requirement is

for the path analysis technique but this is already used by staff. For planning the breeding research and estimating chances of success, it is likely that a technique such as the Research Planning Diagram method developed at the Fulmer Research in the UK could be useful. It can be operated on minicomputers such as the PDP11/34A or larger. There were some questions about modelling 'ideal' plants and comments were made on leaf area/arrangement models, source/sink photosynthetic models and root growth models e.g. (Wellesbourne UK work) and references were given (App. 5).

f) The institute of soils and fertilizers 23.7.82

The Deputy Director, Prof. Lui Gang Ling, gave an introduction to the work with staff members Prof. Zhang Nài Fang, Mr. Zhang Nim, Miss Lui and Mrs Li. The total staff is 260 with 180 scientists and technicians organised in 7 sections.

- Soils - resource surveys, changes in arable soil fertility.
- Chemical Fertilizers with N, P, K and Trace Elements groups.
- Organic and green manures and recycling.
- Cultivations, including cycling organic material and areas.
- Land reclamation (saline alkali and red soils).
- Microbiology.
- Soil analysis (new) laboratory with modern equipment.

There are also two satellite experimental stations one in S. China for reclamation of red soils and one in N. China for the reclamation of saline and alkali soils. The institute also organises a network of 100+ sites throughout China used for work on fertilizer application, green manures, organic matter, trace elements and monitoring soil fertility. A large amount of data is collected from these and needs to be processed; however, a PDP11/34A computer ordered by the institute has been on order more than 2 years.

Computer applications were introduced by Mr. Lui as,

- optimum application rates for fertilizers
- movement of salt and water in soil
- soil (survey) data base
- data logging from analytical instruments
- planning economic management
- a possible future data base on microbiological data

At present some work is done on a) using a Japanese ARCOS 500 microcomputer and for b) the VT20 of the Germplasm institute is used.

The soil survey provides a great deal of data. The current survey is the second national survey involving 2000 + counties of which 400 have completed the survey to-date. The procedure is 'standardised' - but not to a computing standard though some compromise is now being sought. About 400,000 production brigades will provide soil records - an average of 10 per brigade. There are 46 soil types, 119 sub types and 470 soil families to record under the Russian classification used. If each soil record takes (say) 100 bytes the total computer storage would be 400,000 x 10 x 100 = 400 mb, plus soil class keys, etc.

The PDP 11/34A minicomputer, made by DEC (USA), when availabe will have a configuration of 128 kb 16 byte memory, 2 x RK07 28 mb discs, 2 x RX02 floppy discs, 2 x Magnetic tape drives, 1 x 180 cps printer, 1 x LXY 11 plotter, 2X VT100 VDU's, 2 x LA120 printing terminals.

When delivered it will provide quite extensive computing capabilities for the institute and will be installed in an air conditioned room in the new soils laboratory. A visit was made to the new soils laboratory to see the impressive range of new test equipment.

Comment

When delivered, the PDP 11/34A will provide a generally adequate computing service for the work of the institute, but the soil survey data bank poses a possible problem. It can be stored on magnetic tapes and part files transferred to the RK07 discs for subsequent manipulation. However if the data is to be fully utilized it would be desirable to have one (Winchester type) disc of about 500 mb capacity on which all the survey data could be held, with back-up on magnetic tapes. The general computing needs of this institute are very firmly in the area of data handling, statistics and modelling (including economic modelling) and are covered in Section 2.1.

Soil water/salt movement models are a special case perhaps and here comment was made about the use of D'Arcy equations, citing work of Talsma and others in Australia; of compartment models for salt movement (see: Burns, Wellesbourne, UK) and various hydrological models including those available from the FAO, AGLS Division (contacts Mr. Higgins, Mr. Massoud) for salt movement, drainage and erosion studies, and the extensive work, e.g. Euromodel, of the Hydrology Research Institute, Wallingford in UK.

Some AGLS work and computer models, available from Mr. Thomas in AGLS (Land and Water), run on small Hewlett Packard microcomputers, are also of interest as are their techniques for data processing of land and water survey.

Since this institute will have a DEC computer it should take any early opportunity to contact the DEC User Group (DECUS) which has a large selection of applications software available to members for a nominal handling charge only.

The soil and fertilizer institute has particular applications for programs to design (randomise) experiments, analysis of variance, fit yield curves, calculate economic optimum rates and other cost/value ratios and to relate fertilizer recommendations to soil types and areas by multiple regression or by cluster analysis techniques. Mr. Liu Ji Lin is working with soil data, Mr. Zhān Ning with fertilizer data and Miss Liu Gussen with water/salinity modelling. The Director expressed special interest in the N fertilizer recommendations model developed at Levington and Prof. Zhang in Levington work on soil reserve K; details of these were, or will be, provided. The other subjects are covered in Section 2.1. However, as with the new testing laboratory in Wuhan, more could be done in the soils laboratory to log data in computer readable form directly from instruments where digital signals are often available.

g) <u>The institute of animal husbandry 24.7.82</u>

The work of this institute was reviewed by Prof. Zhang Zi Yǐ, Head of the Animal Nutrition Section. There are 8 sections,

- nutrition
- breeding
- cattle

- pigs
- poultry
- germplasm (animal) resources
- computing
- management

Present computer work is done on the institutes Zilog 64 Kb micro computer; earlier work whilst the institute was in Ching Hai was done on another computer (probably the China made DJS 130, similar to a PDP 11/20 of c1970). The main projects are (Mrs. Mian Ze Rong)
i) To calculate the nutrient element content of forages using a version of a model developed at Harris University Utah. At present there is only a small data base and much more data requires computer entry i.e. only 1,600 selected forage types are on file from a total of c7,000. To date requirements of pigs and poultry have been worked out and can be related to the forage data base. Results of animal live-weight gain are now used to check purely chemical/physical resources of animal requirement. This data varies due to age, sex, temperature, etc. so statistical methods are needed to interpret the data and to relate animal and chemical measures of the animals needs.

Whilst the current data is limited to 1600 types of forage records with 50 fields per record the eventual number of forage records may be 10,000 with a storage need of 0.5 - 1 mb. The floppy discs available are double-sided, double-density so storage of this order is available on the Zilog microcomputer.

Comment

Apart from the more obvious statistical programs needed and which are discussed in Section 3.1 this institute could make good use of current 'systems' approaches to animal husbandry management problems.

These would require some economics and operational research methods and some use of simulation modelling (in 3.1). The institute's microcomputer could handle small Linear Programming programs, e.g. for optimising forage/nutrient blends for animal feed from perhaps 30-50 components but not the larger LPs needed for systems management. Mention was made of L.P. work at Guelph University (Canada) by Dr. Pfeiffer and the Agricultural University have a copy of the reference paper. The institute might also adapt the programs published for L.P. by Drs. Land & Powell of the London School of Economics which are in Fortran and allow several hundred line matrices to be solved. A small L.P. program in BASIC suitable for nutrient blends was left for use in China on microcomputers.

Discussions covered the calculation of gross margin and other economic measures of efficiency of animal enterprises. Several examples were shown, e.g. Fisons 'Milkplan', Reading University 'Daisy' system for dairy, the 'Pigtales' package for pig breeding, etc. Versions of some of these could run on a Zilog microcomputer.

h) The institute of atomic energy in agriculture 24.7.82

In the absence of the Deputy Director, Mr. Shu, the introduction was given by Mrs. Cheng Hong Min, Head of Neutron Activation Laboratory. The institute consists of several laboratories:

- radio active plant breeding
- labelled isotopes
- N15 fixation
- male sterility in insects
- neutron activation analysis
- environmental protection analysis
- microbiology

The institute has 2 microcomputers, one a French machine with 8 kb memory and 2400' magnetic tape is built into a multi-channel analyser in the neutron laboratory; the second a Cromemco system has 64 kb memory, 2 floppy discs with a capacity of 1 mb and operates under CP/M (or CDOS) operating system with Fortran, Basic and Cobol languager. Computer applications were described by Mr. Xiao Yi Sheng, i) the institute provides training courses of 30 days in programming (Basic or Fortran) for scientific staff from various provinces of China; these include practical use of the computers. ii) computations of bio-statistics including regression iii) processing data on radioactivity i.e. identifying peaks and digitising voltage data iv) various simulations of insect release e.g. of sterile weevils. v) automatic control of environment (temperature/humidity in insect rooms. vi) real time control of 'zero power' nuclear reactor viii) scientific information retrieval (library centre) is planned. ix) nitrogen fixation and chemotaxis simulations. x) data bank of genetic mutations - maximum 100,000 records with 30 fields.

Comment

The institute has some good computer expertise in the persons of Mr. Wang Xi Wu, who was trained in Canada, Mr. Xiao, who trained in Hong Kong, and Mrs. Wang Jing Qin. The training detailed in Section 2.1 will meet the statistical computing requirements of the institute. Help can then also be given with the mathematical basis for some of the required simulations. As an example a model to estimate populations of corn boll weevils (following release and repeated recapture of normal insects and sterile males) was programmed in Fortran for the institute. The model uses the stochastic method of Jolly GM (1965) Biometrika 52 225-247, and follows that paper quite closely.

Questions on the use of special simulation modelling languages such as CSMP were dealt with by describing the major feature of such languages - sorting and solving a series of differential equations and pointing out that most agricultural modelling is done very adequately by scientists using Fortran. Fortran is available to institute scientists, special modelling languages are not.

There was little time to discuss the real-time process control applications (on the neutron accelerator and in the environmental cabinets) but in neither case did the number of control loops involved seem very large. It is rarely worthwhile to develop special process control microcomputers when so many excellent ones are commercially available at modest cost. The Texas Instruments range (TM 990 etc.) was recommended as being of low cost for the 8, or so, loops needed and is easy to program and to use. Further details of these will be sent by post. The genetic mutation data bank poses the largest data storage requirement - maybe 3M bytes or more at maximum size, but by judicious splitting between floppy discs, with the use of intermediate (or temporary) files to combine data from 2 or more discs when required, this could be accommodated on the Cromemco microcomputer. This institute could play a useful role in the preliminary computer language training for scientists who attend FAO courses in applications programming.

h) <u>The institute of agricultural economics. 27.7.82</u>

Work was introduced by the Deputy Director, Prof. He Chang Mão. After refounding in 1978 the staff is now 70, mostly scientists and technicians. Major projects are:

- Problems of the national agricultural sector economy e.g. future cereal production for wheat and rice etc.

- Improving the management of lower yield regions
- Making more effective use of pasture lands
- Production economics development and use of new methods
- Achieving the correct balance between agriculture and (other) industries in the communes, and the right pattern of ownership between commune production brigade and production team; this being a currently unstable situation.

The institute is learning techniques from overseas experience and trying to adapt mathematical economic models to (particularly) planning work such as that on low yielding land and on future crop production. At present the institute has no computer but a few staff make some use of the computer and mathematical expertise of the mathematics institute of the Chinese Academy of Sciences. They plan to do the following:

- evaluation of scientific projects and those in extension, taking account of government policies and using contribution to production as a measure.
- try to identify which developments contribute most (i.e. alternative use of resource?) e.g. from crop breeding - as most people seem to think, or fertilizer use. etc.
- channel investment according to the economic evaluations made.

There is a view in the institute that microcomputers are not large/powerful enough to handle many of their problems and they wish some attention paid to mainframe computer work in any training given. They also believe that they have a lot to learn from study tours abroad.

Comment

The projects of the institute are intended to tackle facets of the same general problems - those of satisfactory planning, economic evaluation and management in a variety of agricultural projects. Computer techniques for this type of problem are well established ones of operational research, linear programming (LP) and integer programming, forecasting, financial models - e.g. of discounted cash flows, and planning e.g. Visicalc type programs, network (critical path) analysis and perhaps research planning diagrams. The techniques, packages available, and the size of computer needed were discussed. It is generally true that LP models with matrix sized for a large project (or national planning) need a large computer. An ideal combination for the institute would be the LAMPS package to run on a DEC VAX 780 such as will be installed at the agricultural university. The LAMPS package includes integer programming, sensitivity analysis, etc. Some customising of the front end (matrix generator) and rear end (report writer) routines is generally desirable. The forecasting elements of the work could be handled by Box Jenkins packages. These are included in the excellent package GENSTAT which will run on a VAX computer and which the agricultural university hopes to acquire.

Financial models, usually including a DCF forecast are quite common and it is not too difficult to write suitable versions for use in China. Several packages available now are listed in the programs section.

A little thought will show that cash values make a better basis that most artificial units for the comparisons which must be made and the Chinese realise this.

At a training level - and institute staff present were not very familiar with the above methods, very small LP programs in BASIC or FORTRAN are available which will run on microcomputers. Examples are the Levington 'FARMLP' and the University of Guelph, Canada, small LP package which is available from Prof. Pfeiffer. Network analysis programs which will handle quite large jobs are available to run on minicomputers or even on larger microcomputers and an example was shown.

Other topics included optimisation of returns, e.g. economic optimum use of fertilizer and sample calculations of gross margins for various enterprises. The working of the research planning model developed by the Fulmer Institute in the UK was described in outline. This method overcomes problems of discontinuity which would preclude use of a standard network/CPA package and it should be adaptable to the work of the institute i.e. for forecasting the chances of success for a project (Contact: Davies, Fulmer Institute, Stoke Poges, Buckingham, England).

i) The institute of resource management. 27.7.82

Work of this institute was described by Mrs. Wang Li. It has 61 staff mostly scientists and technicians, 4 senior research staff (including Mrs. Wang) and is divided into 3 sections:

- Agricultural natural resources - survey and utilisation.

- Regional planning - mapping by sectors on county basis

- Library and information service

The major projects of the institute are:

- To act as consultant to the National Agricultural Committee.

- Co-ordination of provincial resources institutes - one in each province.

- Planning cropping according to soil, weather, water (note overlap with Economics and Agrometeorology institutes).

- Regional mapping by counties - started 1 year ago.

- The institute has plans for an information network involving 2048 counties from which 200 will be selected to be representative. From these 1600 selected communes will provide information on:

  - agricultural statistics
  - agrometeorology
  - water resources and geography
  - crop failures and other 'disasters'.

  Each point on the network will have 2 experimental plots (or sites).

Mrs. Wang believed that a computer could be very helpful and the institute had access to a Televideo microcomputer (assembled in Hungary and similar to that in the Germplasm Institute). However they had no staff with computer experience and nothing has yet been started in this area, though several are anxious to learn and would attend training courses.

Comments

There seems a fair degree of overlap between the work of this institute and others. Staff could make good use of computerised data from, e.g. soil survey and economics surveys. The first need is for some basic training in computer use and terminology and in a language such as FORTRAN or BASIC. This should be provided by present resources in China by e.g. the institute of germplasm or of atomic energy. Following this the staff have need of the same data handling, statistical and economic/operational research techniques as many other institutes and a selected few could acquire these at the FAO courses. There may well be less need here for mathematical/ simulation modelling but some knowledge within the institute of these methods could well be put to good use. The total storage called for by the network information project with 1600 locations is fairly considerable but with a logical breakdown into the 4 classes of data mentioned it should be accommodated on floppy discs. These should be of the 2 sided double-density type, the single density type as on the Germplasm institute microcomputer being scarcely adequate. Similarity of interests between this institute and those of economics and soils and agrometeorology call for careful compatibility in the data files created so that data may be used by all three in common.

j) The institute of plant protection. 27.7.82

Work of the institute was described by Prof. Xie Shen Xian. It is one of the oldest, started in 1957, has 203 staff with 130 scientists and technicians and 35 senior researchers. There are 8 sections or laboratories:

- plant pathology
- virus and bacteria technology
- wheat rust diseases

- insect pests of crops
- migrating insects
- pesticides
- investigations in crop pests and diseases
- library and information services

Projects consist of investigations of diseases and pests in various parts of China, e.g. cotton diseases in S. China, wheat virus, wheat rust, cotton pests, corn boll weevil, undersoil pests (armyworm cutworm). There is also work on methods of applying pesticides.

In 1981 the institute acquired a BCM Microcomputer based on the Zilog Z80 and assembled from Japanese parts. To date 2 or 3 staff have been trained to use it. The intention is to use computing for these purposes:

- to process experimental data

- for forecasting models of pest/disease based on weather and biological data, being guided by overseas experience of this

- economic measures of pest and disease control i.e. treatment costs/value of production saved. A major problem is in the estimation of populations of organisms.

Comments

Some of these requirements in data handling and use of standard statistical methods in agricultural research coincide with those of many other institutes and are covered in Section 3.1. The BCM microcomputer configuration was not seen nor could staff present describe it but it seems adequate for this type of work. The forecasting models for pests and disease will require liaison with the Chinese meteorological Service (who have a large Amdahl mainframe for weather

forecasting). The biological models are the smallest input for such forecasts. It is likely that a overseas scientist would benefit from a study tour of/institutes which use these forecast methods (e.g. the UK Meteorological Office MAFF/Plant Disease Intelligence Unit at Bristol and the 'EPIPRE' system in Holland as well as several similar models used by the USDA throughout America. Models of the life cycle of pests or epidemiology of diseases in China could be worked up using the microcomputer but linked in to weather data and run finally on the large meteorological service computer. Comment was made about computer statistical methods for estimating populations in the field and reference made to the program for Jolly's stochastic method which the consultant passed to the atomic energy institute for use in a similar project (sterile male method of corn boll weevil control). The savings both in spray and in possible environmental pollution which can ensue when spraying is based on good forecasting, rather than on a blanket or calendar system, were mentioned.

k) A proposed computer centre for the CAAS. 28.7.82

Administrati

Mr. Xin Nái Guán, Deputy Director

In the discussion asked for a summary of the consultants recommendations (i.e. Section 2), and this was given. He seemed in general agreement regarding the training proposals but stressed the need for a more substantial computer in the CAAS Centre. If appears that there is some disagreement regarding the present choice of a Rumanian computer. The consultant agreed to provide technical comments regarding the type of computer needed and these are in Section 3.

The computer facilities which Mr. Xin has at his present disposal are those microcomputers described for the various institutes. He has not attempted to make use of the Burroughs computer installation at the Peking Institute of Computer technology and it was suggested that this possibility might be explored. Future use of the Agricultural University VAX computer was also mentioned to Mr. Xin as a useful possibility. It is Ministry of Agriculture policy to develop a CAAS computer centre. For reasons given in Section 3 the consultant agrees with this view.

1) The Agricultural University of Peking

The university is not administered by the CAAS but is included in this section as the most appropriate. Introductions were given by Prof. Shan Fu Song, Head of Biophysics and Micrometeorology and Head of Computer Centre and by representatives of other departments particularly Prof. Yu He Quan, Head of the remote sensing laboratory. The University has 8 departments with 720 staff (180 Professors or Associate Professors) to 800 students. The university was reconstituted in 1978 formerly student numbers were 3,000+. There are 3 experimental stations controlled by the university located at provincial centres. The departments and their specialities are:

- agonomy (agonomy, genetics and crop breeding, plant physiology),
- horticulture (pomology, vegetables),
- plant protection (pathology, entomology, microbiology),
- soil science and agro chemistry,
- animal science,
- veterinary medicine (also Chinese Traditional, Animal physology),
- Economics,
- Agro-meteorology and agrophysics.

The university computer centre, located in the institute of computer science, was started in 1979 and now has 2 computers. One is similar to the old DEC PDP11/20 machine but is made in China and called the NF DIS 183 with 64k bytes memory, 80k bytes drum store and paper tape reader/punch units 300/30 cps, and printer terminals. The operating system is RT-11. The second is a Cromemco micro computer 64k bytes, 2 double sided double-density floppy disc drives (1 mb capacity Dynabyte) with VDU and printer etc. also with paper tape units. In addition the Dipix remote sensing system incorporates a DEC PDP 11/23 computer for image analysis, etc.

There is on order, in common with several other Universities and colleges in China, a DEC computer for installation in the Agricultural University probably late in 1983. This is the very powerful VAX 780 Super minicomputer with 32 bit memory of at least 1mb (maximum which can be supported is 8 mb.) for which a range of hard disc systems with capacities from 28 to 256 mb (500 mb. Winchester discs) are available. The project to equip Chinese universities with VAX computers is funded by the World Bank. The operating system of all VAX machines is VAX/VMS i.e. a virtual memory system allowing almost unlimited program size.

The computer centre has a staff of 20, 1 Professor, 4 lecturers plus assistants and technicians. Courses are offered for students and post graduates. Students are trained in the high level languages Fortran, Cobol, and Basic, and in computer mathematics and numerical analysis. Despite this expertise, the university feels the need for help on applications programming and the use of various packages. They stressed particularly mathematical modelling, simulations and software for economic and financial planning.

The remote sensing laboratory was equipped by an earlier FAO project. The equipment, a Canadian made Dipix Aries 11 system, is of the second level which it is intended to upgrade to 3rd level in 1983 together with an Optronics high resolution camera. However the present equipment has yet to be unpacked and assembled. There is a lack of trained staff and Mr. Kalensky of FAO and a member of Dipix staff are expected to arrive in China in October to advise and train Chinese scientists in the use of the equipment. At present China has no receiving station for satellite data and must buy tapes from abroad, e.g. Landsat tapes from USA. Problems are anticipated in correcting images for distortion due to lack of a Chinese national grid map and ground reference points.

Other topics raised in wide ranging discussions included forecasting crop pest and disease attacks, modelling of salt and water movements in soils, micro computer based data logging, and use of hand held terminals for input of field data.

Comments

The university is fortunate in expecting delivery of a VAX 780 system which is an ideal choice for the type of scientific and technical computing which they wish to develop. This system has the power and capability of a small/medium size mainframe but with lower costs for in housing, software, maintenance, etc. It is especially encouraging that the unverisities have standardised their choice. This will allow very ready exchange of data, programs and other know-how whilst minimising cost of spares and maintenance. The DEC VAX has a further advantage in having a fair degree of compatibility with DEC PDP 16 bit computer software which can be run in emulation mode. Such 16 bit machines are likely to be found in a number of Chinese institutes and laboratories e.g. the soil analysis laboratory of the CAAS.

Two highly recommended statistical and mathematical program packages, GENSTAT and NAG (see Appendix 3(6), available from Rothamsted Experimental Station, UK, or NAG Software, Oxford, will run very well indeed on the VAX 780. Thus it could provide excellent statistical services both for the university and for some CAAS institutes. Work could include computation of economic optimum levels, and the LP package LAMPS, which is probably the best available at present for linear/integer programming, also runs well on the VAX 780. Details of the sources of these were provided.

1.3 Meetings and discussions with provincial institutes and colleges in Hubei and Hunan provinces Central China

a) The Agricultural college of central China, Hubei. 30.7.82

An introduction to the work of the college was given by the Deputy President, Mr. Li Shang. It covers an area of 7225 mu (1 mu = 1/15 ha) of which 1900 is used for experiments. There are 8 departments:

- Agronomy
- Soils and Fertilizers
- Plant Protection
- Forestry
- Animal Husbandry
- Agricultural economics
- Fish and Water products
- Agricultural mechanization

Basic departments teach Mathematics, Physics, etc. to students and a post-graduate study school has 71 graduate students. Refresher and training courses are provided for agricultural extension workers, leaders of communes and production brigades and teachers. Total enrolment is 2,000+ students but intake increases each year and may reach 5,000 eventually. There are 734 teaching staff, 104

Professors, about one third of whom do research. The college has 8 research laboratories; most projects are applied but a few are more fundamental. As a matter of policy teaching, research and extension work are combined.

The computer department headed by Mr. Li, was described by Mrs. Chang. Nine staff are trained; though there is no computer at present a VAX 780 has been ordered under the World Bank loan project and a new computer centre is under construction. After delivery of the VAX in 1983, courses will be organised in computer languages and computer use for students and research staff. However help is needed on the applications programming side. Some needs are foreseen in planning land use (economics department) in investigating factors which influence yield and in genetics research. It is necessary to educate agriculturists in computing - or computer specialists in agriculture in order to satisfy the need for skills in the combined discipline.

Comments

The college is fortunate in expecting delivery of a VAX 780 which will be a good machine for their type of work. The important packages available such as Genstat for statistical work, NAG for mathematical modelling and LAMPS for Linear Programming were discussed with Mr. Li and Mrs. Chang together with the importance of building compatible files and programs which can be exchanged with other colleges and institutes. Note was taken of DECUS and programs available from them. There was a discussion on the alternative use of desk-top microcomputers such as the low cost Sharp 80K or Commodore PET for student training laboratories. These offer adequate power and considerable redundancy and would free the larger VAX machine for research and planning tasks whilst each costs no more than each additional VDU terminal on the VAX.

Programs used in genetics research such as CERES, INFRO and DATATRIEVE for germplasm data banks and path analysis techniques were described. The general statistical work was covered in more detail in a lecture given the next day to an audience of scientists from Wuhan area.

b) The provincial academy and agricultural testing centre, Hubei. 30.7.82

A brief outline of the institutes of the Hubei Academy of Agricultural Sciences was given by Prof. Zhang Yi Chun followed by a detailed visit to the modern testing centre. The academy has 11 institutes or laboratories:

- cereal crops
- cotton
- soils and fertilizers (Director, Prof. Yu Yang Xi)
- plant protection
- animal husbandry and veterinary science
- tea
- sericulture
- herbs and traditional medicine
- atomic energy in agriculture
- agricultural modernisation.
- testing centre

These have a staff of 3,000 with 491 scientists and control 10,000 mu of land. The academy is a joint responsibility of the Ministry of Agriculture and the provincial government. Time was very short but it appeared from the discussion that the computing requirements of the institutes coincided fairly closely with those of the equivalent institutes in Peking. (Some special projects were noted and followed up during a lecture session next day).

The testing centre introduced by Prof. Li Shēng is of recent modern design and equipped with the latest instruments housed in air conditioned laboratories in 3 departments:

- inorganic analysis under Prof. Li, using direct reading spectrometry (plasma, arc and spark) X ray diffraction spectrometry, Technico Auto Analyser IIC (computer controlled), CR-12 carbon and automatic N determination, ultra filtration, automatic soil particle analyser, atomic absorption spectrophotometry etc.

- chromatography and electron microscopy with gas and high pressure liquid chromatographs, ultra centrifuge, microtome etc. for analyses of pesticides and phytocides in soil, water and products etc.

- biochemical analysis with infra-red, UV/VIS, and fluorospectrometry, amino acid analyser, grain quality analyser and liquid scintillation counter for analysis of biochemical constituents, vitamins and trace elements.

The laboratory has 68 staff and is one of nine such modern laboratories set up in China (another is the soils and fertilizers laboratory in Peking). The laboratory has no free-standing computer at present but a Hewlett Packard 9845B microcomputer is on order. Some of the instruments have built-in microprocessor controls and the Technicon system has a control computer attached. The needs are primarily in logging data and despite the modernity of the equipment the digitised outputs are not currently stored in computer readable form (cassette, paper tape, etc). The Technicon computer control system is not yet operational.

Comment

Having gone so far (with help from the Federal Republic of Germany) it would be a pity not to capture the more useful data for long term storage and for cross comparisons e.g. of traces, peaks etc. For many instruments this could be done at little extra expense since digital signals are available. Ideas for this were presented.

Although the HP9845B is a largish configuration for a desk top computer, it would have difficulty in logging from so many instruments of high output and also in storing the results. However it should prove adequate for any subsequent statistical work on manually input data and can be used for some simulation modelling work in which staff wish to engage. An example program, to model the distribution of heavy metal pollutants in soil around factory chimneys taking into account variations in wind direction, was written for use by Prof. Li. Advice was also given on curve fitting and the use of programs for calculating economic optimum levels. Some assistance was given in the short time available to sort problems on the Technicon microcomputer controller.

c) Lecture on agricultural computing and discussion at the Hubei Academy. 31.7.82

About 40 Professors and scientists from various institutes of the academy attended this formal lecture an outline substance of which is given in Appendix 3 It was followed by a two hour period of discussion on specific problems raised by the audience.

Comments

The problems were generally those met previously at other institutes. Staff of the Hubei Soils and Fertilizer Institute had made progress in using multiple regression models to compute optimum levels of NPK nutrition. Unfortunately neither of the two programs in use appeared to give acceptable results,

nor did they agree for the same data. A program in Fortran run on a 36 bit word computer should have no problems of precision but the Basic version run on 8 bit micro computer almost certainly did. Suggestions were made regarding checking precision at points in the program and checking calculated optima against individual nutrient values. Comment was made on the need for careful choice of statistical methods and critical review of computer results. Details of the orthogonal transform/polynomial approximation method favoured by Colwell in Australia and also of work by Greenwood, etc., at Wellesbourne in the UK were provided. Mention has been made of the chimney fall-out model written for Prof. Li as a general example of how such models are developed with the aid of a comptuer. There is no doubt that staff from this academy could benefit greatly from the type of applications training proposed under this project in Peking.

d) <u>The academy of agricultural sciences, Hunan province, and visits to some institutes. 2.8.82</u>

An introduction to the work of this academy was given by the Deputy President Prof. Fú Shéng Gēn and by representatives of six of the eight institutes. These are:

- rice breeding (Director Prof. Zhén Lǐ Wǔ)
- horticulture (Director Mr. Shǐ Guo Xiang)
- dry land crops
- soils and fertilizers (Director Prof. Xiao Zhé Wang
- plant protection (Prof. Li Pǔ)
- natural resources and regional planning
- atomic energy in agriculture.

In addition the computer centre (Director Mr. Zhou Lud Xiang) was represented by Miss Tang. Mr. Fú stressed the great agricultural importance of the province which exports much food to other parts of China.

Main emphasis is on rice and rice breeding where international co-operation (e.g with IRRI Philippines) has followed the successes at the institute with hybrid rice. Breeding by conventional methods has also had good success and a variety by Prof. Sha (Sha ai Min) is now grown over 1m ha. of land.

Computer applications were described by Miss Tang:

- most important is a bank of rice breeding and germplasm data. This consists of about 8,000 variety records each with 90 fields.
- statistical analysis of data on forestry experiments including hybrids of willow species and determining optimum growing conditions for the China fir.
- logging weather data and subsequent use in models to forecast pests and diseases of rice.
- a model of the cultivation conditions for rice, suiting methods to conditions (Mr. Chen).

The first has been progressed using programs written in Basic, the files being in ASCII form. The second now uses some elementary statistical programs, the third and fourth are at an exploratory or planning stage. Much of this work is done on a Zilog 80 micro with double-sided, double-density floppy discs giving 1 mb capacity, other work is on the CJ 709 described below.

There are also developments in another project: Agricultural systems for planning purposes i.e. to relate crop and animal husbandry, fishing etc. currently on a commune scale but later on a larger scale if possible.

This is being done on a CJ 709 computer, made in China, with 32K memory of 18 bit words a 64K drum store and 2 magnetic tapes, using Algol.

Comments

The germplasm data can probably be handled by the Zilog microcomputer for a single crop but not much more. By allocating floppy discs to each crop, other crops can be handled separately but not simultaneously.

It is important to standardise formats and the use of ASCII, as now, is commended particularly in view of international exchange committments. Germplasm systems in use elsewhere were described, e.g. SAS by the USDA (but this needs an IBM), DEC Datatrieve - approved by Rothamsted/ Wellesbourne in trials, as is INFO by DORIC in UK. The CERES system, developed by Jackson & Huyshe on small microcomputers, was also described.

Statistical requirements are fairly straightforward and were described in the lecture next day. Modelling needs were stated vaguely and training will be needed before staff can define these more exactly. The forecasting of pest/disease attack is a general problem in China and should receive a high priority in overseas training visits as well as in the lecture courses. There was time only to describe the working of such models (e.g. UK Meteorological Office/ADAS system and Dutch Epipre system) in a general way.

The remaining 'models' referred to, of cultivation methods for rice and particularly of commune economy seem to call for linear programming/simulation approaches with which staff were unfamiliar. As elsewhere, details of LP programs and packages available were given and a sample small LP to run on the Zilog 80 was left with Miss Tong. More training will be needed before LP methods can be applied here but the approach should be very effective for the problems presented.

e) Visits to institutes in Hunan Province 2/3.8.82

A visit was made to the rice breeding institute (Director Prof. Zhén Yi Wǔ) to see the great range of breeding work in progress there. These institutes are less well equipped than those seen in Hubei or Peking though the importance of the work would justify more investment in resources. Particularly impressive was the efficiency with which improved varieties (such as Sha ai Min) were introduced to communes to grow over wide areas. This institute seems to do very good work but fails to publish it in order to attract funds. Ideas on extension work of this kind were discussed.

A visit was also made to the horticulture institute (Deputy Director, Mr. Shī Guo Xíóng) which has cooperative links with institutes in Australia (e.g. CSIRO Irrigation Research Station at Griffith). Much of the work is on varieties and cultivation methods, e.g. crop spacing for oranges, but work is also done on other deciduous fruits (apple, pear, peach, etc.), vegetables, melons and on plant protection. One million mu of Satsuma oranges are grown in Hunan province making this a substantial industry.

Comments

Neither institute has on-site computer facilities and both make use of the computer centre. Whilst this is not specifically a computing problem, more use of computer methods could help improve the collection and use of data especially at the Horticulture institute. More could be done to measure and relate the growing conditions of crops. An experiment on cotton, comparing ploughing and 'no cultivation', showed advantage from the latter, perhaps due to improved drainage and aeration in the undisturbed soil. Measurements by borehole logging with a neutron meter would add greatly to the information on this project.

Needs of the Institute of Plant Protection were shortly discussed with the Prof. Li Pŭ. Head of Section). As at the similar institute in Peking the emphasis was on the need for pest and disease forecasting models, especially for the rice crop.

A short account of work at the Soil and Fertilizers Institute was given by the Deputy Director Prof. Xiao Zhé Wóng. He drew attention to the need to calculate optimum sales for fertilizers and the problems in relating recommendations to specific agrometeorological areas.

Comment

As elsewhere account was given of pest/disease models used in the UK and Holland and details and contacts provided. The computer based statistical and economic optima programs used for fertilizer research were presented in some detail.

2. PROJECT RECOMMENDATIONS BY THE CONSULTANT

2.1 Training in China under TCP/CPR/2204/T

Detailed discussions with 14 institutes of the Chinese Academy of Agricultural Sciences and also with two agricultural universities or colleges show considerable similarity and overlap between their requirements for training in computer applications. This is not surprising during the early introduction of the techniques into China; later developments will bring out more diverse and sophisticated needs. Pretraining in a computer language is a prerequisite for those attending courses in applications programming. Current needs may be divided into four groups which are however, interdependent. It may be possible, for economy reasons, to cover the four groups with 3 lecturers.

a) Specification of course material content

Course 1

Organisation of data-design (including computer design) of data input forms - methods of data capture (autologging, hand terminal, pen, OCR, graphics pads, light pen) - programs for data input (prompting, error checking) - file organisation (standardisation, ASCII, BCD etc). file conversion, transfer between computers, editing and data manipulation, packing, long term storage, meaning of the data base packages available e.g. Datatrieve (DEC), INFO, SAS (IBM only). Image and Query (Hewlett Packard) Data Designer (Burroughs).

Course 2

Statistical computing - randomising, design of experiments - data input - analysis of variance - error checking - curve fitting - calculating economic optima and sensitivity analysis - multiple regression models (step wise regression) - cluster analysis - principle components. Sorting and organising data

for input to programs, elementary statistics (mean, mode sd, distributions), non parametric statistics (Chi squared, ranking). Contents and use of packages, particularly GENSTAT and NAG. Applications of these methods in agricultural research - a good selection of appropriate programs should be provided.

Course 3

Modelling and simulation methods - parameter studies - numerical integration (e.g. Simpsons rule) solving differential equations (e.g. Runge Kutta methods) - deterministic and stochastic models - randomness and testing - features of modelling languages (e.g. CSMP, SIMULA) - testing models on new data. Specific applications in agricultural research (e.g. insect populations and disease prediction, hydrologic models, photosynthesis and plant growth - source/sink models, soil models, salt movement, compartment models, fertilizer use models). Working programs suitable for development should be provided and models developed to meet some of the needs of scientists attending the courses as practical examples.

Course 4

Economics and planning (operational research) models techniques of OR - linear programming and integer programming - packages (e.g. LAMPS on VAX), financial models - DCF calculations, networks - critical path analysis - research planning methods (e.g. the Fulmer Institute RPD), forecasting (exponential smoothing, Box Jenkins package, Bayesian methods) economic simulations. Applications on microcomputers where possible, or mainframes. Use for agricultural sector planning and extension. Provision of appropriate programs for (at least training) applications of the techniques.

Materials and teaching aids:

- a good quality slide and overhead projector and screen plus a large supply of transparencies and pens.
- a supply of programs written in Fortran and Basic to teach or to carry out the methods taught.
- a demonstration desk-top microcomputer such as the large screen (80 column) Commodore 8000 with floppy discs and printer at a European cost of $US 5000 (but loan/hire may be possible).

  An alternative could be regular access to an existing Cromemco/Zilog or similar microcomputer with VDU display and printer in one of the CAAS institutes.

- access to efficient photocopying equipment
- camera and film to photograph VDU screen.

  A suitably sized air conditioned room, which can be darkened, is needed for lectures.

b) Timing and Staffing

Courses should not start before spring 1983 to allow time for organisation and for the necessary pretraining by Chinese teachers. Courses 1 and 2 might be combined under one lecturer. Three lecturers would then be needed each for a period of 3 months. At least one week overlap should be allowed so that the lecturers can integrate the courses, i.e. the second and third lecturers should arrive 1 week early prior to starting their course. A very experienced interpreter who is also familiar with computing and scientific terminology should be assigned to the courses.

Lecturing staff

The work is demanding for the subjects are quite complex yet must be clearly explained through an interpreter. Lecturers should understand the delays which this imposes and the extra need for written/graphic display. Computing is a youthful technology and one may recruit competent men who are younger than might be expected in other disciplines. Experience needed by the lecturers is:

Courses 1 and 2

Background in mathematics or physical sciences with subsequent specialisation in computer applications in research and particularly the statistics used in agricultural research. Familiarity with the techniques specified for courses 1 and 2, stressing practical applications rather than theoretical basis for the methods. Good ability to communicate clearly, adaptable to change e.g. in timing or content of course to suit Chinese requirements. Access to appropriate programs for teaching and demonstration. Familiarity with microcomputers such as the Cromemco Zilog or Commodore 8000. Fluent in FORTRAN and BASIC languages. Knowledge of GENSTAT and NAG packages.

Course 3

Background in agricultural/biological sciences but with a strong mathematical basis, or in mathematics or engineering with considerable later experience of agricultural/biological computer modelling. This is the most difficult of the courses and calls for great experience probably as advisory statistician to an organisation where much computer modelling and simulation is practiced. Even so a briefing tour to gain further experience of specific modelling methods needed in China would be a worthwhile prerequisite. Should have access to software and the ability to

develop quickly mathematical algorithms to express modelling ideas in programs. Adaptable and able to communicate effectively. Should have worked on micro as well as larger computers.

Course 4

Background in mathematics, perhaps allied to a physical science or geography. Subsequent specialisation in operational research and business (financial) statistics, preferably in the agricultural sector. Possibly an agricultural economist with O.R. training or a lecturer with experience of practical applications in agricultural planning etc. Familiar with the O.R. and financial methods listed with access to suitable demonstrational software capable of being run on a micro computer. Familiar with the use of micro computers and mainframes and with a knowledge of the packages available such as LAMPS, GENSTAT, VISICALC etc. Adaptable and able to communicate well.

c) Pre-training and preconditions

The above speciications are clearly ambitious with regard to the time and funds available. For example the content of course 4 above as listed is that of a 1 year MSc course. The lecturer must therefore be able to depend upon these factors:

- those selected for training should be competent scientists who are used to acquiring new knowledge and absorbing it rapidly, scientists with mathematical and computing experience to be preferred.

- first class translation of material and of speech.

- all those attending to be familiar with the Fortran and Basic languages (statements, syntax) and with a good range of special computing

words (e.g. bit, byte, memory cpu, disc store, VDU, ASCII, etc).

- trainees to come prepared, particularly for courses 3 and 4, with details of their own problems and with sample data which can be used as examples by the lecturers.

- trainees should attend regularly to get maximum benefit and should recognise that the courses are complimentary to each other (e.g. the background in 1 and 2 is needed to understand 3 or 4).

- however courses 3 and 4 may be taken optionally or as alternatives to each other where trainees have insufficient time.

- access to CAAS institute computers will be needed frequently for workshop (practical) classes. Should the VAX 780 computer be installed at the Agricultural University during the training period very good use could be made of it, in courses 2,3, and particularly 4.

d) Selection of trainees

This is a matter for the CAAS, but there will be a top limit (between 25 and 30) to the number which can be effectively instructed by one lecturer and for which class material can be provided. Consideration should be given to ability in mathematics and in the English language and to prior interest and aptitude for computing. Ideally one would wish to see representatives from provincial institutes as well as from Peking. More trainees might be accommodated on course 1 with the help of the Chinese computer experts so simultaneous workshop sessions could be organised.

Allowing for different trainees to attend courses 3 and 4 the total number receiving training may be more than 30 but it is difficult to see how as many as 50 could be organised without additional lecturers.

e) Other training or activity in China

There would be a good case for Mr. A. Lebowitz (or one of his AGRIS staff) to visit China for discussions with the institute of scientific information regarding the introduction of AGRIS to China. The Deputy Director of that institute, Prof. Wang, is very keen that this should happen and has expressed his intention to co-operate fully in such an arrangement.

Should funding permit there is a specific need for the establishment of a system to handle germplasm and crop breeding data on the computer of the Germplasm institute. Whilst some help should come from the proposed study tours abroad, which it is suggested would include a member of the institute, a more certain way would be to bring an expert to China to actually modify and install the software of an existing systems package. Several approaches are possible such as the use of the DEC Datatrieve system on a PDP 11 or VAX or the use of the CERES system on the existing Cromemco microcomputer (after some enhancement of disc storage).

'Teach yourself' computer language training programs may have a place in China to augment the efforts of the present trained teachers. several are available at low cost to run on microcomputers.

f) Results expected from the training course

Mr. Ren requested comment on the type of people needed for the research projects which he listed (page 4) and this is dealt with in section 2.3...

2.2 Recommendations for overseas training of Chinese scientists under project TCP/CPR/2204/T

Projects for which overseas study tours might be appropriate are many but some suggestions regarding priorities may be of interest to the CAAS when selecting candidates. It is likely to be more efficient to send the 4 scientists for whom tours are available as a group for this would ease problems of translation and organisation. All would have at least one interest in common - the application of computing to agriculture.

The selection of institutions to be visited will depend upon the subjects which it is wished to study but if the number of countries is limited, as it must be on financial grounds, then the USA (including perhaps Canada) and the UK (including perhaps Holland) are logical choices.

The consultants priorities would be as follows:

a) Germplasm/crop breeding - visiting in the UK Rothamsted, Wellesbourne, Plant Breeding Institute Cambridge, Birmingham University (Genetics Dept - Germplasm Resources Course) and in the USA, USDA Beltsville (Germplasm Resources course) and other centres to be specified by Dr. Williams of FAO.

b) Computer models for the prediction of pest and disease attack in crops and stock - visiting, in the UK, the Meteorological/ADAS unit in Bristol, Rothamsted, University of Reading, Environmental Management Unit, Imperial College, London, Wageningen in Holland and if possible IIASA Laxenberg, Austria, University of British Colombia and other centres in the USA to be suggested later. It should be noted however, that work in the West in this field is less advanced than many Chinese scientists seem to believe.

c) Animal husbandry - visiting, in the UK, University of Reading, Grassland Research Institute, Hurley, Rowett Institute, Wye College, Milk Marketing Board. In the USA, Purdue University, Indiana, Michigan State University, Oregon State University, and the University of Guelph in Canada.

d) Applications in Agricultural Sector Planning and Economics, visiting in the UK, Rothamsted, London School of Economics, MAFF, Milk Marketing Board Farm Management Services etc.; in Holland, Institute for Land Reclamation and Improvement. In the USA, Purdue University, Ohio State University, Michigan State University, etc. In Canada the CANFARM unit and University of Guelph. Also IIASA, Laxenberg, Austria.

Also well in contention for places must be the study of information retrieval systems e.g. at CAB in UK, AGRIS at FAO and USDA, also further study of applications of remote sensing at FAO, Rome, NERC in UK and US. There is equally need for training in the survey of natural resources and in the modelling predictions of cropping potential after the techniques used by FAO (Messrs. Frere & Popov, Higgins and Arens)

The group should be able to spend some time with FAO sections on its way to or from Europe particularly with AGRIS Agricultural Economics, Remote Sensing, Land and Water, Genetics and Fertilizer Sections where important applications of computers can be shown.

2.3 Type of staff needed to develop use of computers in agriculture in China

Mr. Rĕn posed the question dealt with here of "what type of people were needed?" The consultant's answer is, "those with the flexibility to be able to combine a sufficient knowledge of mathematics and statistics with an understanding of the needs of the agricultural sciences."

They may come by either of these routes, mathematicians who learn agriculture or agriculturists who learn mathematics and computing. In many institutes it is common for one or more statisticians with a good knowledge of computing and of the way mathematical models can be built-up, to be available to advise the agricultural scientists who have less knowledge of these techniques. A similar disposition of resources would be advisable in China also.

3. DISCUSSION AND COMMENTS ON NEEDS NOT MET BY THE PRESENT FAO TRAINING PROJECT

3.1 Hardware for a CAAS central institute of agricultural computing

The CAAS and Ministry of Agriculture have asked the consultant to comment on somewhat wider issues than the immediate provisions of training. In particular the longer term strategy which will be required to develop the use of computers in agriculture in China.

It is noted elsewhere in this report that several super minicomputers (DEC VAX 780, etc.) have been ordered for Chinese Universities and colleges under an arrangement made with the World Bank. This should provide a major boost for computer education throughout China as future graduates in sciences, mathematics and agricultural sciences acquire computing skills. In the consultant's opinion the choice of the VAX is an excellent one and it should serve the technical needs of each fortunate college for some years to come.

However, one should also point out that the provision of computers for University training and the provision for the graduates so trained to use computers in their work will then be grossly out of balance. Each college will have its powerful VAX super mini (comparable in functionality to a small/medium size mainframe). The entire organisation of the CAAS, with 33 institutes and some thousands of staff, has only a few small microcomputers to do its work. Whilst the universities and colleges do some good research in the agricultural area most of that research in this most important of all industries must be carried out by the CAAS.

It may be argued that some of the computers now in China are not fully utilised and this is probably true in some cases. If so, that can be remedied by training and by organisational changes which allow computers to be

shared without prohibitive cross charges. On the whole - and the consultant visited some 15 institutes - he found that the very limited computer resources available to them were being used but that storage capacity in particular was limiting. Also these institutes were sharing their meagre computer resources with other institutes which had none.

An excellent case can be made for at least one super mini VAX 780 or 782 computer to be provided for the CAAS and to form the basis for an institute of agricultural computing. Major arguments are:

a) The VAX is a more appropriate machine for CAAS use than is a commercial mainframe. It can run essential software such as GENSTAT, NAG and LAMPS and handle major tasks which are not possible on current micros. It is fairly compatible with other DEC Machines such as the PDP 11 16 bit range which are appropriate for the work of smaller and remote institutes thus allowing ready exchange of programs and data and eventually (if phone line quality permits) on line links

b) Use of the same computer as the universities would provide compatibility in use by graduates, easy software exchange and lower cost maintenance and spares.

c) A CAAS centre would provide continuity of the training (started by FAO project TCP/CPR/2204/T) and most important provide standards in data and programming throughout the organisation, rather than the wasteful proliferation of languages, data codes and inadequate hardware which is happening now.

d) The centre would be large enough to provide a clearing house for good software provided by FAO and other world sources, or written in China.

e) Overseas experience shows that such centres of excellence are needed in different sectors and that it is important for scientists, e.g. in agriculture, to have control of their computing and not merely to receive a service from some all purpose computer centre at which there is no knowledge of the problems of the discipline (agriculture) which is involved; e.g. Rothamsted does this for many institutes in the UK, Wageningen in Holland whilst the USA has many such agricultural computing centres.

f) Initial and running costs of a VAX based computer centre are much lower than for a mainframe centre and should not be prohibitive - effectively costs are reducing in real terms year by year.

g) The value of the contribution to production which the computer centre should be able to make is on the other hand likely to increase year by year as more effective use is made of information allowing more effective planning and use of resources.

h) It is particularly important in China to install well established computers of modern design and therefore reliability and ease of maintenance, the VAX fills this requirement.

i) Even more important is the range of software available to run on the chosen computer. Agricultural research is well served by the VAX software.

Suggested initial configuration for a VAX in an agricultural computing institute:

Hardware

1 VAX 780 cpu 8M byte memory
4 256 MB disc drives (possibly plus Winchester discs and streamer tapes if licenses are available
2 Floppy disc drives
2 Magnetic tape drives 800/1600 b/in

1 600 lpm printer
1 Versatec printer plotter and software
16 VT100+ VDU terminals
1 Paper tape reader 600cps/punch 80 cps unit
1 Floating point accelerator

3.2 Software

A computer is only useful in terms of the software which it will run. The VAX is well provided for and the following programs and packages should be considered:-

VAX/VMS operating system (supplied with the VAX)
General utilities (Editor, Runoff, Sort/Merge etc.)
Fortran, Basic, Cobol
Datatrieve, ISAM, FMS, DX/VMS
Statistical Package, Research package
DEC net - VAX™

Non DEC Software

LAMPS, CAP Scientific Ltd.
GENSTAT, NAG, GLIM: NAG Ltd, 7 Banbury Road, Oxford, UK of Rothamsted Experimental Station, Harpenden, Herts, UK.
DESFLEX FAO Fertilizer Section
FARMAP, FAO Economics Section
TEACH YOURSELF (language training on the computer)

The configuration can be expanded later e.g. to a 782, or other VAX processors (750, 730) added. More than 16 VDUs can be supported if required.

Staffing

Initial Chinese staff should be supported initially by a VAX systems expert for 3 months and by an applications expert for up to 1 year. The institute would have a staff of about 40 computer scientists and technicians.

Operation

A major task would be to provide training for scientists from institutes in Peking and in the provinces. This would make full use of the specified 16 terminals and more could be needed.

Safe archival storage will be needed for tape back-up copies of data and programs. The Versatec should help in development work involving Chinese character printing but its main job will be to produce maps and graphic output as well as providing a fast printing back-up.

3.3 Data Base

The question of a fully integrated data base, referred to in initial briefing notes, was not again raised by the scientists in China. Such a massive base - covering all disciplines, of agricultural science, is impractical and unnecessary. What is important is to ensure compatibility of data between institutes/disciplines which do need to use the same files. However, a further argument for a CAAS central computer of reasonable size, such as the VAX 780, would be that it could hold more comprehensive data bases e.g. of soil survey plus agroclimatic data, which current microcomputers cannot.

3.4 Full utilisation of computer resources in China

The views of Miss Leitner, Assistant Resident Representative of UNDP are of value here. She stressed the need for full use to be made of existing computer installations in China (and particularly the Burroughs installation at the Peking Institute of Computer Technology) before further investment was made. It is clearly important that such resources should be well used and not wasted and similar views were put by the consultant to the CAAS and to the Ministry of Agriculture, Bureau of Science and Technology.

Two comments are worth making, the first is that a mainframe installation at some distance from the CAAS is far from ideal for the type of computing work which the CAAS requires. The second that it would be unreasonable to expect that China, unlike any other country, should make resources located in one sector easily available to all other sectors. The CAAS is making quite good use of its currently limiting resource of microcomputers. After the training programme outlined above it should be able to make very good use of these and of a VAX computer within the CAAS if provision for this can be arranged.

APPENDIX 1

List of Institutes and persons contacted in China

Chinese Academy of Agricultural Sciences

Mr. Rén Zhi	Deputy President
Mr. Xin Nái Guan	Deputy Director of Administration
Mr. Rén Zun Xian	Administration
Mr. Hán Lin	Administration
Mr. Wang Xi Wu	Software Engineer-Interpreter

Institute of Germplasm

Prof Xǔ Yún Tian	Deputy Director
Mrs. Zhan Xian Zhan	Software Engineer

Institute of Crop Breeding

Prof. Wāng Heng Li
Mr. Zeng Qu Ming
Mr. Zhao Shuang Ning

Institute of Scientific Information

Prof. Wang Xián Pǔ	Deputy Director
Mr. Liu Yuan Pǔ	Software Engineer

Institute of Soils and Fertilizers

Prof. Liu Gang Ling	Deputy Director
Prof. Zhang Nāi Fáng	
Mr. Zhang Ning	

Institute of Atomic Energy in Agriculture

Prof. Mrs. Cheng Hong Min	Head of Neutron Activation laboratory
Mr. Xiao Yi Sheng	Hardware Engineer
Mrs. Wang Jing Qin	Software Engineer

Institute of Agro Meterology

Prof. Jian Ai Liang	Consultant
Mr. Luo Zong Ling	Scientist

Institute of Animal Husbandry

Prof. Zhang Zi Yi	Head of Animal Nutrition
Mrs. Mian Zé Rong	Software Engineer

Institute of Plant Protection

Prof. Xie Shei Xian

Institute of Agricultural Economics

Prof. He Chang Mao	Deputy Director

Peking Agricultural University

Prof. Shen Fú Seng	Director Computer Centre
Prof. Yu Hé Quan	Head of Remote Sensing Laboratory
Mr. Huang Yin Long	Software Engineer
Mr. Mai Jiān Dei	Hardware Engineer

Ministry of Agriculture Fisheries and Food

Mrs. Liu Zhaó Ling	Deputy Director, Exchange Office, Bureau of Science and Technology
Mr. Yu Xie Zhen	Exchange Office
Mr. Zhang Xi Qui	Bureau of Foreign Affairs

Institute of Resource Management

Mrs. Wang

Three institutes only in Peking were not contacted formally.

1) The post graduate institute
2) Vegetable institute
3) Apiculture institute

Hunan Province Academy of Agricultural Sciences

Prof. Fú Shéng Gēn	Deputy President
Prof. Zhén Yi Wǔ	Deputy Director, Rice Breeding Institute
Mr. Déng Liān Xi	Deputy Director, Administration
Prof. Xiao Zhé Wong	Deputy Director, Soils & Fertilizers Institute
Prof. Xia Ai Min	Rice Breeding Institute
Prof. Li Pǔ	Director Section 1, Plant Protection Institute
Mr. Shī Guo Xióng	Deputy Director, Horticulture Institute
Mr. Hung Rui Kang	Institute of Horticulture
Mrs. Yang Shi Rong	Chief of Management Office, Institute of Scientific Research

Institute of Computer Technology - Hunan Province

Mr. Zhou Lua Xiang	Deputy Director
Mrs. Tang Kang Nen	Software Engineer
Mr. Chen Zhong Pie	Software Engineer

Hubei Province - Agricultural College of Central China

Prof. Li Shēng	Deputy President
Mr. Lǐ Guo Zhi	Director - Basic Studies Section
Mrs. Chang Shyne Jne	Software Engineer
Mr. Li Xing Chang	Hardware Engineer

Hubei Academy of Agricultural Sciences

Prof. Zhang Yi Chun	Deputy President
Mr. Feng Xian Lui	Director of Administration
Mr. Zhao Lin Shan	Administration Officer
Prof. Yu Yong Xi	Director, Institute of Soil and Fertilizers
Prof. Li Yao Xing	Head of 1st Section, Testing Centre

APPENDIX 2

Timetable and route in China July - August 1982

July

12. Arrive Rome from UK
13 Briefing from FAO AGL staff etc.
14 a.m. Briefing p.m. Fly to Peking
15 Arrive Peking
16 Meetings with Ministry of Agriculture and CAAS
1 Visits to CAAS institutes in Peking, UNDP
28 Lecture on Agricultural Computing
29 Fly to Wuhan (Hubei Province)
30 Visit Agricultural College of Central China
31 and CAAS institutes in Hubei
Lecture on Agricultural Computing

August

1 By train to Changsha (Hunan Province)
2
1 Visit CAAS institutes in Hunan
5 Lecture on Agricultural Computing
6 Fly to Peking
7
1 Complete report, final meetings with Ministry
8 CAAS, UNDP
9 Fly to Rome
10 Arrive Rome
11) Debriefing at FAO with AGL staff etc.
12)
13 Fly to UK

Review of World uses of Computers in Agriculture

1. Models of World Resources

Usually greatly simplified to show relationships -

1) Relational resource models. e.g. Club of Rome (Jay Forester) WORLD 3; fluorocarbons - ozone, and MOIRA, predictions are pessimistic

2) Socio economic, human adaptation

3) Short term math, e.g. de WITT, on Mainframe or (because over simplified) Mini versions available.

2. International Weather Forecasting

Value in Agric. Use satellite + ground station data to give Forecast charts and maps. Complex, large computers needed. Also analysis of long term climatic patterns - pattern recognition. Time penalty, so not usually on minis.

3. Survey of Resources

Satellite + ground data - both needed. Landsat - I^2S, Dipix. Analogue versions analyse images, correct distortions, scale and produce maps e.g. hardwood forests, wheatland. Mini computer for analysis (no time penalty) larger for long term storage. Land use; water use [5 SLIDES Landsat/pictures].

4. National resource/financial models

Usually macroeconomic e.g. UK Treasury model of economy (Agric sector). Important in planning and control, best deployment of limited (e.g. fertilizer) resources, LP and Simulation. Also large projects, e.g's Korean Ag. Sector (KASM) Model (Michigan U), Venezualan Cattle Industry (Hatter), Model of System Analysis Medit. Ecosys NE Egypt 'SAMDENE', CANFARM system is an example of a farm economy model operating on full data. Many predictions are wrong! [6 SLIDES].

5. Information and Extension

Library systems CAB, AGRIS, USDA, AIBA (Asia). Generally on larger computers - info transfer on different media. Maybe in several languages (Chinese Script?). Extension e.g. CANFARM, Disease Warning, Irrigation Prediction, SCAPA.

6. Agricultural Research (in general)

Many of the requirements are broadly similar across disciplines. Research = observations - hypothesis - test by experiment - revise hypothesis. Computers used at each stage. Often v. large data. Maybe auto logged e.g. for Agri Met; usually pen/paper but in suitable form. Input programs should include as many data checks as possible. Aim for compatible data files, Computer sorting. Experimental - Computer designs and prints forms. Analysis of Variance, Signif. checks (e.g. 2 x SE) Effects of measured independent variables on result by stepwise regression. Fit function curves (e.g. to yield) Calculate economic info e.g. cost/value, econ. opt. use of fertilizer. Association of variables by Cluster Analysis & Principal Components. Print graphs, table, and a paper! by Word Processor.

Statistical Packages

Since needs are similar, institutions such as Rothamsted have developed packages specially for Agric Research
GENSTAT has these functions [9 SLIDES].
NAG from UK Univ & R. Inst. has these [3 SLIDFS].
However Genstat needs a larger computer ICL/IBM/VAX and NAG a medium sized Mini (e.g. PDP11/34) to run FORTRAN; both run on the VAX 780. Others: Statistical Routines of IBM, DEC, HP are also 'portable' but SAS is not. Colwells, programs some from FAO, US Universities, user groups etc. Need for a good package for but this is more difficult so cost is high but return on micro software is low.

Word Processing

All researchers will wish to publish. Some excellent word processing programs now available on minis and micros with scientific notation, table drawing, graphs.
Wordstar, Wordplex etc.
Also programs of "Visicalc" type. Can 'model' with these.
Modelling - aid to Hypothesis - later under disciplines.

7. Agroclimatic/Hydrology Research

Auto logging of Met data, catchment data-t°, wind, rh., 24 hour integrated basis. Irrigation [2 SLIDES].
Computer inter/extrapolation of station networks data.
Instrument calibration, correction e.g. isotope probe data.
Models are widely used to predict inmeasured variables from related ones; e.g. Penmgn Eo,E_t from tD, w, rh, sun, latitude
In hydrology stream flows (FAO program avail), catchment water balance, water supply (for irrigation) are all modelled. Also erosion of soils, movement of tides.
Trend forecasts crop growth zones are defined using rf, Et, t, etc. and maximum yield using rf + radiation. Related to energy o/p population carrying capacity by FAO IIASA package.

8. Soil Research (Chemical, Physical)

Physical models of soil structure and pore space are used e.g. for water flow, aeration, ion exchange, root develop., draining, infiltration. Engineering models, sheer strength, soil structure - use of ameliorants. Erosion and soil loss (Weiss-meyer)
Salt movement in soil is modelled.
Soil survey data is stored and may be classified by cluster/principal components and other multivariate analysis.
Soil analytical data stored over period of years can be used to indicate trends in nutrient status, lime status etc.

9. Soil Microbiology

Computers are increasingly used to predict population levels and cycles in soil organisms from counts, nutrient release e.g. from Rhizobia and in Mycorhizal fungal research. Maybe a breakthrough from genetic engineering?

10. Fertilizers and manures

Computers are used as described in part 6 to design and analyse trials, store, test and sort data, fit curves and regress variables, calculate optimum rates and specify zones Larger scale simulation models may be used - e.g. UNIFERT model to show the factors concerned in policy making for fertilizer purchase and use in developing nations. LP is used to optimally blend fertilizer components. Spreading models to indicate best machine practice. The handling policy for fertilizers (location of stores etc.) on a farm or plantation can be modelled, also road and rail transport. Microscale models examine diffusion of ions, breakdown of urea, immobilisation of phosphate etc. Other models are used in extension - to advise farmers on the best practices e.g. for applying fertilizer to winter wheat [9 SLIDES].

11. Crop growth ecology

Computer used for simulation models of crop growth based on photosynthetic source/sink, leaf development, and root uptake of nutrients. Seasonal growth patterns and defoliation e.g. of grass for silage/hay.
Pasture models (Goodall) and water supply for animals, Australia, USA. Canopy and forest development - ecosystems series. Storage of crop nutrient data e.g. forage analyses for animal husbandry.

Diffusion/absorption models for root uptake of nutrient.
Alternative cropping strategies e.g. rotations, by P optimising.
Predict maximum potential growth.
Instruct on husbandry e.g. using SCAPA. Calculate gross margins for grass and arable enterprises.

12. Crop breeding and germplasm

Store, sort and retrieve data on germplasm resources e.g. SAS; locate resources in germplasm storerooms (CERES). Exchange of international data. Medium size disc store is needed. Store crop breeding data, carry out path analysis, analyse for success, disease suscept. etc.

Planning controlled breeding projects. Studies on gamma fields for radiation induced mutations.
Storage of chromosome /gene maps for genetic engineering.
INFO from DORIC and DATATRIEVE from DEC.

13. Crop protection

Store data on life cycle of pests and diseases and on weather and crop, etc.; use to model epidemiology of disease or pest attack, i.e. predict attack and advise on spraying. Store details of pesticides, antidotes, shelf life, compatibility with e.g. fertilizers. Save money/reduce pollution of environment by accurate prediction not blanket spray, Epipre Holland and UK ADAS/Met Office Models [SLIDES].

Sterile male technique, simulate population rates and ratios from capture + release data (Jolly's method etc). Spray pattern analysis - optional coverage, nozzle design, atomised spray.

Model translocation of systemic insecticides.
Persistence of chemicals in soil.
IIASA work (Norton) green rice leafhopper, in Egypt alfalfa weevil studies.

14. Agricultural Engineering

Aid in CAD design of machinery. Calculation of shear strengths etc. Project networks, CPA e.g. for irrigation schemes. Micro control of tractors, grain harvesters, potato graders.

15. Animal Husbandry

Most actual on farm use in highly industrialised nations is in this area.. Whole range of computer simulation/financial models are available for management, veterinary care, profitability, breeding success, milk yield, gross margins, etc. [SLIDES]. Poultry Improvement Plan PCP Egypt (O'Day USDA).
Stud book records - breeding animals.
Design of experiments, selection of test animals.
Nutrient requirements of animals - nutrient in forage, concentrates. Optimal blending of feeds by LP. Evaluation of grassland enterprises. Stocking densities, NZ pasture model.

16. Agricultural Economics

Use of LP for selection of optimal strategies both of national project level and at individual farm level. Simulations of social structures, infrastructure (storage and marketing) transportation models. Prediction of requirements; forecasting - Box Jenkins, Bayesian methods. Costings. Farm survey data collection and storage, FAO FARMAP, CANFARM. ICL SCAPA (Malay Rubber). Farm budgeting. Discounted cash flows. UNFERT Model. Brazil alcohol model, Cuban Sugar model, LP in India for irrigation. Indonesian Land Settlement model.

17. Horticulture

Soil, crop, experimental work as for Agriculture plus glasshouse and sheltered crop data auto log + control. More scope for autoweighing and crop sorting. Composts landscape planning. Marketing LP's.

SUM UP

Computer not end in itself. Needs data discipline. China must put together 1) Hardware 2) Software 3) Application training. Pace is rapid - easy to fall behind. However advanced technology is often not quite so advanced as Chinese scientests believe e.g. in the are of agricultural modelling.

APPENDIX 4

Software provided for Institutes in China

Critical Path Analysis of Network (FORTRAN)
Critical Path Analysis of Network (BASIC)
Statistical programs for:
Mean, Standard Deviation, Variance, Linear regression, Contingency tables, Chi squared test, Polynomials, Integration by Taylors Approximation.
Solving Differential Equations, Ranking, Vectors and Matrices
Drawing histogram (BASIC)
Matrix inversion (FORTRAN)
Statistical programs for:
Variance, Standard Deviation, Linear regression, Comparison of 2 lines, Ranking, 2 way Contingency tables, Data Summary, Running Mean, Analysis of Variance.
Graph plotting (FORTRAN)
Quadratic regression (FORTRAN)
Forecasting by Holt-Winters method (BASIC)
Insect population prediction, Jolly's method (FORTRAN)
Small Farm Linear Program (BASIC)
Calculation of land drainage (BASIC)
Relating production to radiation
Calculation of Penman Eo and Et (FORTRAN)
Calculation of Penman Eo and Et (BASIC)
Calculation of accumulated temperatures and Ontario Heat Units.
Relating sunshine hours and radiation (BASIC)
Calculation of E by Blaney and Criddle Method (BASIC)
Calculation of E by Thornthwaite Method (BASIC)
Calculation of Economic Optima (BASIC)
Handling of isotope probe data (FORTRAN)
Crop growth leaf production model(BASIC)
Mitcherlich model (BASIC)
Programs for handling weather data (BASIC)
Chimney fallout model for Prof Li (BASIC)
General curve fitting (BASIC)
Output from irrigation appraisal
Computer meteorological report, day, week, month and year.
Output from Grassplan Enterprise Planning Program
Flowsheet and synopsis for UNFERT model program.

APPENDIX 5

REFERENCES

5.1 References provided in China

FAO Desflex printout

FAO List of computer programs available

FAO AGRIS literature

FAO Plant Production and Protection Bull. 17; Agrometeorological crop monitoring

FAO Agricultural Services Bulletin 34

FAO Soil Bulletin 11; Soil Fertility Investigations [Extracts]

FAO Irrigation Bulletin 24, Crop water requirements

FAO Land resources for populations of the future, 1980

FAO World Soil Resources Report 48/3, Agro-ecological Zones Report V3 S. America 1981

FAO Electronic Data Processing System Land and Water Data Vol I and Vol II 1981

FAO Miscellaneous Publications AGL 77/6 Guidelines for coding soil data

FAO/IIASA Production Potential and Assessment of Population Shah M.M.et al 1980

FAO Data from 70 meteorological Stations in China

Cope F (1980) Computerised Soil Analysis, Fisons AgTech

Cope F (1965) Measuring Soil Moisture, Soils & Fertilizers

Cope F (1980) Computers in Agriculture, Fisons AgTech

Cope F (1981) Computers make agriculture more efficient, London Press Service

Cope F (1981) Computer Training for the Third World, London Press Service

Cope F (1980) Calculating when to apply water, Water Man. 8

Cope F & Dowers L.R. Recording meteorological data. IEEE paper 1966.

From Computing for National Development, British Computer Society IT 82 1982:-

Johnson I.M.'Application of microcomputers to agricultural engineering in developing countries'

Strangeways I.C. & Templeman R.F. 'Hydrological data collection and processing'

Wright H.L. 'The role of computers in forestry and forest industries in developing countries'

Leakey C.L.A. & Tottle GP 'A system for computer aided agricultural planning and action'

Warren M.E. 'Recording, predicting and monitoring dairy yields and veterinary health and their application in developing countries'

Bachus S.C. 'The impact of microcomputer technology on water resource development'

Parkes M.G. 'Computer aided management of surface irrigation schemes'

Cope F.'Handling soil meteorological and other experimental data on computers'

Lunsa J.P. 'Role and benefits of computing for a development bank'

Hay R.W. & Brookes S. 'Towards appropriate computer technology for large-scale survey data processing in 3rd world countries

Tottle G.P. (1979) 'Computers in support of agriculture in developing countries', ICL Tech J.

Computer Users Yearbook 1982 - Extracts

International Directory of Software (1982) - Extracts
Details of current hardware and software systems application software, suppliers etc. etc. in use in the UK and USA.

NAG (1982) Specifications of NAG and GENSTAT Software packages

USDA (1982) Training course in gene resources at Beltsville, Maryland, USA

Meteorological Office UK (1981) Services for Agriculture - pest/disease production etc.

International Board Plant Genetic Resources
Crop Genetic Resources' Report

McKenzie K.J. (1972) Canfarm. Can.Farm Econ. 6 No. 6

Bauer L (1973) Canfarm Can.Farm Econ. 7 No. 5

Greenwood D.J. et al (1971) A theory for fertilizer response. J. agric Sci, 77 511-523

Colwell J.D. (1981) Modelling the effects of fertilizers on crop yeild. J. Aust. Inst. Agr. Sc. 81

Colwell J.D. (1977) The national soil fertility project, I and II, CSIRO Australia (Extracts)

5.2 Some Additional References

Barnett E.C. & Curtis L.F. (1976) Environmental Remote Sensing Chapman & Hall, London

Mills L.D. & Laplante A.A. (1951) Infection periods. Cornell Ext. Bull. No. 711

Conway E.R., Norton G.A., Small N.J. & King A BS (1975) Systems approach to control of sugar cane froghopper, in Study of Agricultural Systems, Editor G.E. Dalton Appl. Sci. Pub. London

Jones F.F.W., Parrot D.M., & Russ G.J.S. (1967) Mathematical models to simulate effects of growing eelworm resistant potatoes. Ann. Appl. Biol. 60 151-171

Prediction & Measurement of Photosynthetic Productivity Proceed. IBP/PP Tech. Meeting Trebon Sept 1969 Agr. Pub. Centre Wageningen Holland 1970

Smith L.P. (1975) Methods in Agricultural Meteorology Elsevier, Amsterdam

Smith L.P. & Ollerenshaw C.B. (1967) Climate & Animal Disease Agriculture, London 74 256-60

Wallers C.J. (1980) Systems approach & mathematical models in ecology in Fundamentals of Ecology. 3rd Edit. Ch. 10 p276-92, Saunders, London

Lewis C.D. (1982) Industrial and Business Forecasting Methods. Butterworth, London.

Aris R. (1978) Mathematical Modelling Techniques Res. Notes in Math. 24. Pitman, London.

Beament J.W.L. (1960). Models and Analogues in Biology Cambridge Univ. Press

Smith J.M. (1974) Models in Ecology Cambridge Univ. Press

Yaron D. and Tapiero C.S. (1980) [Editors] Operations Research in Agriculture and Water Resources. N. Holland Pub. Co. Amsterdam.
p161 Project Evaluation in Risky Markets
p239 Systems Approach to Developing Cropping Systems
p249 Mathematical Models for Cotton Crop Management

Newman J.E. (1974) Applying Meteorology to Agriculture Agric. Met. 13 1-3

Majone G. and Quade E.S. (1980) [Editors] Pitfalls of Analysis. IIASA. Wiley, Chichester.

Land A. and Powell S. (1973) Fortran Codes for Mathematical Progamming. Wiley, London

Hadfield J.L. & Thomason I.J. [Editors] (1982) Biometeorology in Integrated Pest Management Publishers: Academic Press, London.

5.3 Some Computer Programs & Packages

ASSASSIN	Agricultural System for the Storage and Subsequent Selection of Information. ICI, UK. (ICL, IBM).
SAS	Statistical Analysis System - SAS Institute USA. (IBM only).
NAG	Numerical Algorithms Group. NAG Group
GLIM	General Linear Modelling . NAG Group
GENSTAT	General Statistical Program . NAG Group Numerical Algorithms Group, 7 Banbury Road, Oxford (IBM, ICL, CDC, DEU, Univac, Burroughs).
BOX-JENKINS	Time Series Forecasting. Irish Management Institute (PDP).
PROSPER	Financial Planning and DCF. Dataskil UK (ICL).
CPM	Critical Path. Tech. Economics Inc. USA (IBM, DEC, Honeywell).
PERT	Critical Path. Micromedia UK (Cromemco, North Star, Commodore).
METEOSAT	Image Processing. Land Res. Mon. USA. (PDP).
SCAPA	Computer Aided Planning and Action. ICL, UK (ICL).
LINEAR PROGRAM	Land and Powell System. NCC, UK.