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Australian co-operation with the national agricultural research project Thailand Computing Needs for the Thai Department of Agriculture

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Australian Co-operation with the
National Agricultural Research Project

Thailand

COMPUTING NEEDS FOR THE THAI DEPARTMENT OF AGRICULTURE

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Western Australia
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ACKNOWLEDGEMENTS

I wish to express my appreciation for the interest and co-operation of the many officers with whom I had discussions, in the Thai Department of Agriculture, other government organisations, international organisations working in Thailand, and supplies of computer equipment.

I would particularly acknowledge the effort, consideration and friendship of Khun Veerasak Surapit, who organised appointments and travel arrangements, and assisted with interpretation and discussions throughout the consultancy. His good company and interest was greatly appreciated.

I am grateful to the members of the ACNARP team in Thailand for their advice and interest, especially Mr Des Smith and Mr Ron Parkin.

GLOSSARY

ACNARP	Australian Co-operation with the National Agricultural Research Project
ADPC	Agricultural Development Planning Centre (ASEAN)
AGRIS	International Information System for the Agricultural Sciences and Technology
AIT	Asian Institute of Technology
BOB	Bureau of Budget
CARIS	Current Agricultural Research Information System
CSC	Civil Service Commission
DBMS	Data Base Management System
DOA	Department of Agriculture
DOAE	Department of Agricultural Extension
EBIS	ESCAP Bibliographic Information System
ESCAP	Economic and Social Commission for Asia and the Pacific (UN)
FADINAP	Fertiliser Advisory, Development and Information Network for Asia and the Pacific (ESCAP/UN)
FAO	Food and Agriculture Organisation
IBM	International Business Machines
IBM/PC	IBM Personal Computer
KU	Kasetsart University
MB	Megabytes
MOAC	Ministry of Agriculture and Co-operatives
NARP	National Agricultural Research Project
OAE	Office of Agricultural Economics (MOAC)

1. TERMS OF REFERENCE

Consultancy on the computing needs of the Department of Agriculture, Thailand.

1.1 To assess the access to Department of Agriculture of the Ministry of Agriculture and Co-operatives Sperry Univac computer system.

1.2 To assess the computer requirements of the Department of Agriculture in relation to library/information data bases.

1.3 To report on the feasibility of computerised storage and retrieval of experiment programmes, projects and results.

1.4 To examine the capabilities of the NARP accounts computer beyond accounts and personnel records.

1.5 To examine the need for computerised services at regional centres.

1.6 To produce guidelines for the integrated computer development within the DOA.

1.7 To prepare a draft report on the consultancy while in Thailand and to discuss the recommendations with the Department of Agriculture leadership, the NARP Manager and the ACNARP Director before leaving Bangkok.

1.8 To present a final written report within two months of returning to Australia with recommendations formally presented to the Director General of the Thai Department of Agriculture, with transmission through the Director of Agriculture, Western Australia and the ACNARP Director, Bang Khen.

2. RECOMMENDATIONS

2.1 Establish a Computing and Information Systems Policy Committee (CISPC) at the top level of Department of Agriculture, chaired by the Director General, with the Chief of Planning and Technical Division as Executive Officer. The Committee's functions would be:-

2.1.1 To formulate and periodically revise a Computing/Information Systems Strategic Plan which sets out the guidelines and constraints within which Institutes, Divisions and Research Centres can plan for their computing resources.

2.1.2 To consider submissions for, and negotiate with, MOAC, BOB and CSC concerning computing and information systems resources for the Department of Agriculture.

2.1.3 To consider submissions for computing resources (equipment, systems and staff) associated with any research or administrative project and to establish priorities among competing claims for computing/information systems resources.

2.1.4 To promote the co-ordination and integration of computing and information systems development, to ensure that effective exchange of data is possible between all units of the Department, and between the Department and outside organisations.

2.2 Establish a Computer Services Sub-Division within the Planning and Technical Division.

2.2.1 The Sub-Division would have three major functions:

* To advise the CISPC on technical matters relating to research or administrative project proposals involving computing or word processing systems.

* To assist the CISPC in the preparation and implementation of strategic plans in computing and information systems.

* To co-ordinate computer services and word processing for the DOA, including the operation of a central computer system (or systems), and support (including training) for divisional and Research Centre micro computer systems.

2.2.2 The Sub-Division should be headed by an experienced graduate in agriculture, science or statistics, with post-graduate training in computer applications or systems analysis. A second staff person should be a graduate in computer science, or have proven experience in systems analysis, design and implementation.

Additional staff would be required to provide training and support for computer systems at Regional Research Centres and Divisions and Institutes in Bang Khen. Existing systems and programming staff attached to the NARP office should be transferred to the Computer Services Sub-Division when the NARP Computer is transferred to the DOA. These staff would form the computer centre Operations Section.

2.2.3 The head of the Computer Services Sub-Division would report to the Chief, Planning and Technical Division, as indicated below:

PLANNING AND TECHNICAL DIVISION

Administrative Section

Computer Services Sub-Division

Computer Centre Operations	Training and Support Services

NARP Foreign Projects Sub-Division

Statistics Sub-Division

Research Registration and Documentation Sub-Division

Public Relation and Transfer of Technology Sub-Division

2.3 A phased programme of micro computer installation[1], computer training, system development and system support services should be prepared and implemented in the Department of Agriculture. This would embrace the needs of Regional Research Centres as well as areas of need within Institutes and Divisions.

2.3.1 Phase One

It is proposed that four installations be included in Phase 1, to commence as soon as possible. The participating groups should be (i) the Computer Services Sub-Division, (ii) the Research Registration and Documentation Sub-Division, and (iv) Pathum Thani Regional Research Centre (Rangsit) and Germ Plasm Bank.

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(1) See Appendix 1 for details of proposed micro computer specifications

Short term fellowship. A four-week fellowship should be provided for the head of the Computer Services Sub-Division to gain experience in the management and use of micro computers in agricultural research and administration. This could be carried out at the Western Australian Department of Agriculture.

One year consultant. A one-year consultancy, desirably from an agricultural research organisation, should be sought to guide the establishment of the Computer Services Sub-Division and the implementation of Phase 1. Her/his appointment should commence on the return to Thailand of the short-term fellowship recipient.

2.3.2 Phase Two

Installation of further micro computer systems should proceed in a step-wise fashion along with Research Centre developments. Location of these installations would be determined by the CISPC in accordance with DOA priorities.

In this phase the Computer Services Sub-Division should have established its function of providing training for staff from Research Centre due to receive a micro computer. On-going support would also be required for Research Centres and other groups who received equipment in Phase 1. Such training is best accomplished by Computer Services staff visiting a centre for several days and conducting on-site training courses.

Transfer of operational control of the NARP System/34 should be undertaken in this phase, during the term of the long-term ACNARP consultant on Finance and Administration.

2.4 Administrative Systems

The NARP System/34 Computer should be used as originally intended, to provide timely and accurate reports for centralised administrative systems, viz:

Finance and Accounting
Programme budgeting
Personnel records
Inventories - land, equipment, motor vehicles
Fleet management

Use of the System/34 is not recommended for non-administrative purposes, such as for statistical analysis of research data.

Use of the System/34 is not recommended for the Research Projects Inventory. The System/34 is not suitable for direct data/information exchange with micro computer systems proposed for Regional Research Centres, using 5.25 inch magnetic diskettes. However, some form of data communication between the System/34 and DOA micro computers is desirable. This is available for the IBM PC, and possibly for other similar micro computers.

2.5 Research data management and analysis

2.5.1 The Computing facilities of the Statistics sub-division should be enhanced to include a sixteen-bit micro computer with winchester disk storage[1]. This unit is one of four proposed in Phase One of the micro computer installation programme. Subject to recommendations of the short-term ACNARP statistical consultant, it is anticipated that the Statistics Sub-Division will be called up on to provide training and support for biometric specialists appointed to Regional Research Centres.

2.5.2 The NARP System/34 is not suited to research data applications. Such applications have quite variable processing requirements which are not fully specifiable in advance, and input and report formats must be flexible and easily modified. Such facilities are provided in recent statistical software packages designed for 8-bit and 16-bit microcomputers. Output of summary information resulting from statistical and other forms of analysis will likewise be ad hoc or one-off, and dependent on the outcome of the analysis.

Further, access to the System/34 by the Statistics Sub-Division could only be on a "scheduled time" basis which is not acceptable or appropriate for investigative data analysis.

2.5.3 The present project being undertaken by the Statistics Sub-Division, to produce a computerised form of the Research Projects Inventory on the Wang 2200 computer should be halted. The Wang does not have the disk storage capacity to carry out a sort of the full Research Inventory of current projects. Further, for research workers particularly, information on past as well as current research projects will be a very important source of information. The Research Inventory must be developed on a micro computer system with at least 10 megabytes of fixed disk storage. Such a system is proposed for installation in the Research Registration and Documentation Sub-Division.

2.5.4 A system specification, design and implementation of the Research Documents Inventory should be a first priority of the proposed Computer Services Sub-Division and may even preceed it, provided a trained systems analyst was available to ensure the specification was adequate. Consultation with Institutes and Regional Research Centres on the inputs and outputs of this data base should take place before computerised implementation takes place. The Research Documents Inventory computerisation project should be considered as a pilot project in the sense that many end-users of the final system will be affected by the Inventory's effectiveness and efficiency.

2.6 Access to the Ministry of Agriculture's Sperry Univac computer would provide a viable solution to only one or two specialised computing needs in the DOA. It should not be considered as a major part of departmental computing/information services planning.

2.6.1 The specialised needs which are forseen, but not immediately required are:

(a) linear programming software for modelling farm management systems;
(b) access to GENSTAT, a powerful statistical software package. This facility will be further investigated by the ACNARP statistical consultant.

2.6.2 Two terminals and a printer, linked to the MOAC computer will be installed in the near future at the ASEAN Agricultural Development Training Centre at Kasetsart. It will be possible for DOA staff to use the terminals on an informal "as-available" basis. A third terminal is planned for the Technical and Survey Branch of the office of Agricultural Economics located nearby.

2.7 The Asian Institute of Technology (AIT) will soon offer training with microcomputers. AIT would organise one-off courses for the DOA, provided a minimum of 15 attendees could be guaranteed, and a charge would be made for conduct of the course. DOA should consider this option when planning the training needs of research and services staff who will be using micro computers at Regional Research Centres. AIT would provide excellent facilities, close to Bankghen, requiring minimum co-ordination by the Computer Services Sub-Division.

2.8 AIT also has a Computer Centre with many software packages available on a large IBM 3031 computer. Research projects which involve the generation of large data sets, especially of the survey type, should budget for the cost of data processing and statistical analysis using AIT Computer Centre facilities, if DOA computing resources are not sufficient.

2.9 Computer requirements in relation to library/information systems.

2.9.1 Access to a micro computer would enable the DOA Library/Information Services Centre of the Public Relation and Transfer of Technology Sub-Division to develop a computerised index of DOA publications. It could be searched for information in a similar manner to that proposed for the Research Projects Inventory, by Author, commodity, or selected key words.

2.9.2 Access to on-line international information data bases via dial-up telephone modem might be available soon, at least for one service (DIALOG). However, it is recommended that such a service would be best utilised through the Kasetsart University library.

2.9.3 Computerisation of the Research Projects Inventory should enable the Research Information section of the Research Registration and Documentation Sub-Division to provide annual updates of current research to KU Library for inclusion in CARIS international data base. KU Library is the national centre for CARIS documentation.

2.9.4 Library catalog and administration. Computerisation proposals should be included in a long-term plan for a large mini-computer system system for the DOA (see Recommendation 2.11).

2.10 Word Processing (WP) software should be included with all micro computers for Regional Research Centres, Divisions, or Sections. WP enables the re-formatting of tables of data, and accelerates the preparation of project submissions and periodic reports. Research workers should be encouraged to use this facility in the interests of clear presentation to superiors and review committees. W.P. is also valuable in the preparation of material for dissemination to farmers at field days or demonstrations.

2.11 Long-term planning for compting and information system requirements should include provision for a multi-user "mini" computer system with a virtual memory operating system, such as those supplied by Prime Computer (Prime series), Digital Equipment Corporation (Vax series), Data General and others. Such a computer must have an upgrade path which does not require a change of operating system. It should have sufficient power to run 8-16 terminals initially, with on-line access to a data management package, statistical package, text information storage and retrieval package and FORTRAN, BASIC and PASCAL programming languages. The computer system would also provide good communications between itself and micro computers, enabling them to be logged in as terminals. Software to enable communication with the MOAC Univac computer would be desirable.

3. METHOD AND ITINERARY

The consultant spent three weeks in Thailand, from August 25, 1984. Discussions were held with senior staff in the Directorate, Divisions and Institutes of the DOA, and visits were made to Pathum Thani Rice Research Centre and Suphan Buri Experiment Station.

Discussions were also held with staff involved with computing at MOAC, Kasetsart University Computer Centre, KU Department of Engineering, ASEAN Agricultural Development Planning Centre, National Statistics Office, the Narcotics Control Board Computer Centre, the Asian Institute of Technology and the UN/ESCAP Computer Centre.

Information concerning computing equipment was obtained from a number of suppliers of computer equipment in Bangkok.

August 5 — Arrive Bangkok airport 2215PM

August 6

AM — At DOA Bankhen. Met :
Dr Yookti Sarikaphuti, Director General;
Dr Ampol Senanaroug, Deputy D.G. Research;
Dr Riksh Syamanouda, D.D.G. Admin and Finance;
Dr Tanongchit Wongsiri, D.D.G. Technical Services;
Mr Des Smith, ACNARP Adviser, Administration;
Dr Frank Roberts, Adviser, Station Development;
Dr Vijai Noparmornbodi, NARP Project Manager;
Mr Veerasak Surepat, Statistician, and delegated DOA counterpart for this consultancy.

Discussions with Mr Des Smith concerning the ACNARP IBM System/34 Computer installation.

PM — Statistics Sub Division of the Planning and Technical Division. Met Ms Sanga Duangratana, Chief Statistician, and Ms Wanna Kaewmong kol, Computer Section.

August 7

AM — MOAC Office of Agricultural Economics Computer Centre. Mr Winai and Mr Porntep described facilities available on Sperry Univac 1100 computer.

PM — KU Computer Centre. Mr Papatuadi - use of CDC 1820 for administration/research.
KU Department of Engineering. Mr Yuen - use of micro computers in teaching and research. Discussion with Mr Des Smith on possible use of System/34 computer by Statistics Sub-Division.

August 8

AM — Statistics Sub-Division. Further discussions concerning computing needs and facilities with Khun Wanna Kaewmongkol.

PM — National Statistics Office. Review of use of computer system with Khun Voranoot Treetipbut.

August 9

AM — Narcotics Control Board Computer Centre. Discussions with Director, John Hilton-Thorpe.

PM — Digital Information Associates, distributors for Prime Computers. Khun Sorasith Buddheri, Marketing Director. Use of Prime computers in Government agencies.

Innovation Corporation Ltd, Wang Computer distributors. Khun Somchai Lovatcharakul, Marketing representative. Upgrade to Wang 2200 MVP. Wang PC options.

August 10

AM — At ACNARP office.
Visit to Asian Institute of Technology (AIT), Division of Computer Applications. Assoc. Prof. Kanchit Malaivongs and Dr H. N. Phirn. Training Courses (short term) in use of computers, especially PC's.

PM — United Nations ESCAP Computer Centre. Miss Y. Mizuno and Mr Akimasa Nishizono, ESCAP Data Processing Section.

Computer Union Co Ltd. Khun Pilastpong Suksermsi, Managing Director. IBM PC.
Discussions with Khun Yattana Boonyasopon, President of Thai AM Systems Consultants, on IBM PC application software.

August 11-12 — Weekend.

August 13

AM — Pathum Thani Rice Research Centre at Rangsit. Director Boonlert Klayprayong. Deputy Director: Udom Simaban. Senior Research Scientist: Nopporn Supapoj. Germ Plasm Centre: Songkran Chitrakon.
Discussions on structure and administration of research centre, plant breeding data management. Special requirements of the Rice Germ Plasm Bank inventory control and data base.

PM — ACNARP office.

August 14

AM — Suphan Buri Rice Experiment Station and Farmer Training Section, Farm Systems Research Institute. Inspection of facilities for training in use of pocket computer/calculators. Director: Thanad Sukprakan. Rice Specialist: Dr Tetsujiro Sugahara. Viewed new NEC 8001 Mk II micro computer.

August 15

AM — Planning and Technical Division. Discussions with Khun Chanuan Retanawaraha on program budgeting system, Research Inventory, project evaluation.
Rubber Research Institute. Dr Sermlarp Wasuwart.
Field Crops Research Institute. Director: Dr Wichit Benjasil

	PM	ACNARP office.
August 16		
	AM	Planning and Technical Division. Khun Virayut Vatanakul, head of Information Service Centre. Khun Rangutawan Pushpavesa, Research and Documentation Sub-Division. Sericulture Research Institute. Lunch with Dr Kwanchai Gomez. Director, Statistics Department, IRRI, Philippines, and staff of DOA Statistics Sub-Division.
	PM	Rice Research Institute. Deputy Director: Prapas Weerapat. Horticulture Research Institute. Deputy Director: Sansern Piriyathamwong. Farming Systems Research Institute. Khun Wicharn Wothong.
August 17		
	AM	Presented seminar on use of computers in Agricultural Research to DOA staff.
	PM	Indisposed.
August 18-19		Weekend.
August 20		Consolidation of notes and interviews, preparation of interim report.
August 21		
	AM	ACNARP office.
	PM	Discussions with Dr Donald Puckridge, IRRI Representative, on use of microcomputers in agricultural research. Discussions with Khun Wanna Kaewmongkol and Veerasak Surapit, Statistics Sub-Division, on some computing problems.
August 22		
	AM	ACNARP office. Kasetsart University Library. Director: Piboonsin Watanapongsil Reference Librarian: Predita Siripan.
	PM	Discussions with Mr Des Smith at ACNARP. Brief meeting with Mr Earl Krup, private US consultant interested in farming systems analysis.
August 23		
	AM	Review of recommendations and exit interview with Dr Riksh Syamanonda (Acting Director General), Mr Des Smith and Khun Chanuan Ratanawaraha, Chief of Planning and Technical Division.
	PM	ACNARP office. Refinement of draft document of recommendations. Discussions with Des Smith, Ron Parkin, John Gartrell.

August 24		
	AM	ACNARP office. Discussions with Ron Parkin, Des Smith.
	PM	To airport to meet Jane Speijers and Brian Gorddard. Brief discussions on computing consultancy recommendations.
August 25		Depart Bangkok for Perth, WA at 12.45PM.

4. NOTES AND COMMENTS ON THE TERMS OF REFERNCE 1 TO 6

4.1 Assess access to DOA of MOAC Sperry Univac.

4.1.1 Present Situation

Access to the MOAC Sperry Univac computer system presently would require staff to travel to the Centre, having previously arranged for time to use the terminals, or submit batch data for processing. This is unlikely to be acceptable except for some one-off projects which might be greatly assisted by the use of Mapper DBMS, or statistical packages (GENSTAT is listed as available, but no one knows how to use it). DAS II is a project evaluation package. FMPS is a linear programming package (financial modelling?). These packages might be of use to visiting specialists with knowledge of the package. Training is offered for users of the Mapper package.

4.1.2 The short te rm

ASEAN Agricultural Development Planning Centre (ADPC) have negotiated to connect two work stations and a printer to the Sperry Univac, through one 2400 bps leased data communications line. OAE Technical and Survey Branch located in adjacent building expect to use this facility too. Access for selected DOA staff should be negotiated, mainly to assess the potential for use of the MOAC computer by statisticians, farm systems analysts, the Information Service Centre and the Monitoring and Evaluation Unit.

4.1.3 Long-term

I was not able to obtain any policy statement or guidelines for prospective users of the MOAC Computer Centre facilities. The following points would need clarification before DOA could make any plans concerning its use in any substantial way:

(a) Plans for expansion of the system, to maintain response time and adequate on line storage, as demand increases.

(b) On line access to critical data bases at all times during working hours.

(c) Addition of multipurpose information storage and retrieval software, such as STATUS.

(d) Customer Services for software and system problems.

(e) Reliability of the telephone system for data communications.

4.2 Assess the computer requirements of the DOA in relation to library/information data bases.

4.2.1 Goss[2] recommended that, (1) DOA should cooperate with Kasetsart University Library to set up an SDI service for DOA staff, (2) Continually monitor the feasability of on-line access to international bibliographic data bases. There appears to be little real demand yet for either service. Possibly this will change as more staff return from overseas training with some experience in the use of such facilities.

4.2.2 Library catalog and administrative
Goss[2] also recommended that the DOA Library/Information Source Centre should have a computerised library administration system. Packaged systems can be purchased but are not cheap ($30,000 up, for the software) and to date are system specific. Many large organisations have developed library systems using STATUS, but they are custom built for special libraries and may contain non-standard routines which are hardware dependent.

Micro computer-based library administration systems are being developed now but I am not aware of any yet available "off the shelf". Local systems consultants could be contracted to design and install a library system, but it would require an experienced qualified and computer-literate librarian to lead the project.

4.2.3 A short-term objective
A 16 bit microcomputer (IBM PC/XT or equivalent) could be used now by the Library/Information Service Centre to commence a bibliography of departmental publications (no abstracts), and a proposed newsletter. Hard copy of the bibliography could be distributed to Regional Centres and regularly updated. As the bibliography expands, hard copy might be replaced by computer output microfiche. Word processing software (e.g. Wordster) with Thai language option, and a Thai-English typewriter/printer for high quality master copy would be required.

4.3 Computerised storage and retrieval of experiment programmes, projects and results.
In this context I define "results" as the researcher's summary of results and conclusions, in descriptive form, except in the case of long-term projects such as plant breeding, where a structured numeric or coded data base is required.

4.3.1 Option A - PRIME 2250 or equivalent, with STATUS or INFOTEXT.
The "ideal" solution in terms of search power and flexibility is the free-text data base using a package such as STATUS. It is also very expensive ($60,000 for STATUS) and requires a computer system using "virtual memory", 1-2 megabytes of central memory, and plenty of on-line disk storage. Allow for five times the total

number of characters to be stored in the data base for holding the text file, concordance and "scratch" space for backup, sorting selected outputs etc.

A Prime 2250 (bottom of the range, "office environment") computer system with 16 terminals, 2 MB memory, 316 MB fixed disk storage, with STATUS software would cost around US$200,000. It would naturally be used for many other purposes, with additional software (SPSS, GENSTAT, FORTRAN, BASIC, COBOL) costing, say $50,000. It could be linked to the MOAC Univac, with special software developed for the Tasmanian Government, which allows up to 16 Prime VDU's to fully emulate the UNIVAC Superscope 200 work station. (Estimated additional cost $10,000). Henco Software Inc. now offer a free-text storage and retrieval utility called INFO-TEXT. It is a new product and I have not had an opportunity to check user satisfaction. It could be a considerably cheaper alternative to STATUS, combining a "4th generation" language, relational DBMS and optional free-text retrieval. Estimated cost $30,000. This would reduce the cost of Option A to $170,000, with annual maintenance estimated at $17,000.

4.3.2 Option B Terminals to MOAC UNIVAC, use MAPPER. A less-than-ideal solution at much lower cost. Obtain 1 or 2 terminals plus printer connected to MOAC UNIVAC via leased telephone line.

A more structured relational data base using Mapper would provide text search capability limited to keyword references, short title, Author etc. Full documentation could be stored on microfiche, with a microfiche reference number included for each project in the on-line research inventory.

The work stations would also be available for other activities and applications.
Estimated costs for two Univac work stations and printer connected to the MOAC computer :-

	First year costs US$	Annual maintenance or rental US$
2 work stations, 1 printer	17,500	2,800
Leased data communication line		
Connection Fee	200	-
Annual rental	1,800	1,800
	$29,500	$3,800

Major advantages of Option B :-

1. Lower cost, initially and annually.
2. Powerful DBMS software available (Mapper).

Major disadvantages of Option B are:

1. Total reliance on telecommunication line for access to computer system.
2. Limited possibilities for expansion of facilities.
3. DOA may have little influence on the policies and operations of the computer centre to which it is attached.

4.3.3 Option C Use of a micro computer with DBMS software

A research inventory with limited keyword search capability could be developed on a microcomputer (IBM PC/XT or equivalent) using a DBMS package, with report generation in either English or Thai language. Coded values in the data base could be mapped to alternative Thai/English phrases. A word processing package on the same microcomputer could be used to edit or reformat ad hoc extracts from the data base. Assuming each Institute/Division/Research Centre eventually acquires a compatible micro computer, sub-sets or copies of the central data base could be sent to each, for on-line access on their own computer.

Recent releases of new software packages for 16-bit microcomputers, such as DBASE III and STATUS-M, would provide superior speed and flexibility in information retrieval, but may not be available with Thai language options.

For long-term experiments and plant-breeders data bases there is no doubt that a system developed with DBASE II or DBASE III on an IBM PC/XT could provide a valuable data management tool for Research Centres. The advantage of a computerised system is even greater where data is collected over many years or locations. The scope would only be limited by the volume of magnetic disk storage which can be managed by a stand-alone microcomputer, and the problems of archiving and back-up of data bases as large as 20 or 30 megabytes. In addition of a streaming magnetic tape cartridge system should be seriously considered, to provide quick and reliable back-up of data bases greater than 10 MB in size.

Cost of a micro computer system for the Research Inventory is estimated to be :-

	First year costs US$	Annual maintenance or rental US$
Hardware (IBM PC/XT with printer)	12,000	1,200
Software - DBASE3, Wordstar	1,500	150
	$13,000	$1,350
Additional cost of using STATUS-M text retrieval software package	$5,000	$500
Additional cost (estimate) of magnetic tape cartridge system for back-up of data base	$1,500	$150

Advantages of Option C:

(1) DOA has full control of its computer-based Research Inventory.

(2) Equipment and software would be compatible with that recommended for Research Centres.

(3) The system can be expanded and/or linked to other systems at a later stage.

Disadvantages of Option C:

(1) Initial size of the data base would be restricted to about 8 megabytes, allowing for system software.

(2) DOA staff would be fully responsible for back up of data base information, and for operation and care of the hardware.

(3) Back up of a 8 MB data base will require 25 diskettes, and would take 75 minutes each time. Alternatively a magnetic tape cartridge drive could be purchased, which could reduce the time to 10 minutes.

4.3.4 Option D Use of NARP System/34 computer. A research Inventory system with limited keyword searching capability could be implemented on the IBM System/34, programmed in COBOL by existing staff.

Advantages

(1) Low capital cost. One additional workstation is estimated to cost $2,800.

(2) Approval to purchase add-on equipment may be easier to obtain than approval for new computers.

Disadvantages

(1) A second printer would be required to cope with the additional load. The present printer could provide output for the Research Inventory (English language only). A new high speed printer for the accounting and administrative functions would cost an estimated $8,000.

(2) Project development time using COBOL is 3 to 10 times longer than using a DBMS package such as DBASE III.

(3) System maintenance is dependent on keeping skilled COBOL programmers on staff.

(4) The system would not be compatible with proposed systems for Research Centres for exchange of copies or sub-sets of the Research Inventory on diskette.

(5) The Research Inventory data base would have to be "backed off" during end-of-month production runs for Accounts, payroll etc.

4.3.5 Recommended Option

It is recommended that Option C - use of a standalone micro computer system - be considered for the implementation of a computerised Research Inventory. An IBM PC/XT would provide sufficient capacity to begin development of the data base. Depending on the extent to which historical information is retained on-line, magnetic disk storage capacity in excess of 10 MB may be required. A magnetic tape cartridge system for data base back-up and archival should also be considered. A DBMS package such as DBASE III, with a word processing package for text editing and report writing, would provide a facility for keyword information retrievel.

A computerised data base should assist considerably in retrieving information for the research monitoring and evaluation process recommended by Carroll[1].

4.4 Examine the capabilities of the NARP computer beyond accounts and personnel records.

The ACNARP Adviser, Administration has indicated that in addition to the Accounting and Personnel functions, there were plans to implement an inventory system (for land, equipment and motor vehicles), and a fleet management system. These applications are likely to fully utilise the capacity of the System/34.

The development and effective use of a Research Inventory will require a two way flow of information between DOA headquarters and the Centres. This process will be considerably simplified if information stored on magnetic diskettes can be interchanged. This would not be possible if the Research Inventory System were implemented on the NARP IBM System/34 computer.

4.5 Examine the need for computerised services at the Regional Centres.

The consultant visited the Regional Centre Pathum Thani, and had several discussions with the ACNARP Advisers on Administration and Station Development.

There are four principal areas of activity in which a computer will assist the effective operation of Regional Centres - 1) financial administration and budget control, 2) word processing, 3) research data management, and 4) statistical analysis. In the past the use of computers in agricultural research has been mainly for mathematical or statistical analysis of data. With the availability of powerful micro computers, and software packages which can be used after a minimum amount of training, financial administration, word processing and routine data management are now justifiable and important uses for the Regional Centre's computing resource.

The Pathum Thani Rice Research Centre should be used as the "pilot" research centre for implementing computerised systems. The centre is relatively close to DOA headquarters, and has a broad range of administrative and research applications which could benefit immediately from the use of a large micro computer. A more detailed examination of this Centre's requirements is presented in Part 5 of this report.

4.6 Guidelines for integrated computer development within the DOA

Centralised versus decentralised systems

In the 1960' and 1970's, the preference for centralised computer systems was largely based on the high cost and complexity of computer hardware, and the shortage of skilled personnel to operate these systems. In the 1980's these issues are no longer of overriding importance. It is now possible to implement quite large administrative or research applications using relatively small desk top computer hardware, and for it to be operated by non-specialist staff. The decision to centralise or decentralise such information systems should thus be made according to:

(1) the organisation's requirements for access to that information, and
(2) the effectiveness of the system for the largest number of staff.

In a large organisation such as the DOA, with such a diverse range of administrative, technical, service and research activities, the potential for decentralised and/or specialised computer systems is considerable. At the same time there is a need to bring together information of a corporate nature, particularly for use by senior management.

While computer hardware technology now makes it possible and often desirable to decentralise computing power, it may be necessary to centralise training and support services, because of a scarcity of skilled personnel or resources. Section 7 of this report presents a proposal for the formation of a Computer Services Sub-Division, which would provide such a central skills resource, to service a widely distributed range of computing facilities. The Sub-Division would be responsible for the management of a central computer system, and the coordination of decentralised systems, both in Divisions and Research Centres.

Side Effects of introduction of computers

The introduction of computer-based systems, which may replace established manual systems, will have a number of side effects:-

. Possible displacement and/or de-skilling of clerical staff. Previous manual recording methods may not have required any typing or keyboard skills, but high volume data entry via a computer terminal requires the operator to have keyboard skills.

. Change in formal and informal relationships among employees within a section. Those selected to operate VDUs or manage the operation of a computer-based system will inevitably be elevated to a position of greater prestige and authority than previously.

. The organisation becomes increasingly dependent on computer systems, as more and more information processing is transferred to this technology.

These effects may call for adjustments to the physical work place, re-training of staff to operate a VDU terminal, relocation of staff made redundant by the new system, and even a review of the organisational structure to cater for changes in work flow, authority, and information flow.

Thecritical importance of the human-computer interface

The implementation of computer-based systems is too easily left to the "experts" in hardware and software technology. This is likely to increase the mystique already surrounding computers, and to reduce the extent to which computer systems will be effectively used in the organisation. The most important aspect of any computer-based application is the human-computer interface. To effectively establish this interface, there must be a commitment to adequate training of staff at both supervisor and operator level. Users must have a sufficient understanding of what the computerised system does, how components of the system are related and at what points the computerised system connects to other systems, manual or computerised. User guides and documentation must be developed and supplied with the system. This is in addition to the documentation supplied with the computer hardware and software.

Scrutiny and audit of information from computer-based systems

There is a tendency to assume that any output from a computerised information system must be correct, but information is only as

good as the data from which it is derived, regardless of the system used to store and analyse it. Therefore it is important to maintain, even increase, the scrutiny and periodic auditing of reports from computerised systems, compared with manual systems.

Prevention of loss of data

The potential for loss of data stored on the magnetic media used by computer systems must be clearly understood by all staff involved in using computer-based applications. The user documentation mentioned above must include procedures for back up and archive of data on the system. These back up procedures are time consuming, and tend to be neglected if not built into the daily routine of the person or section responsible for the computerised application. With large centralised computer systems, back up and archive procedures are usually the responsibility of the Computer Services or Data Processing section. With stand-alone micro computer systems, the responsibility may lie with different people or groups for different applications on the same computer. However, it is preferable to allocate this responsibility to one "computer manager" for all applications on the one micro computer. The added cost and time requirements involved in back up of computer-based systems must be taken into account when examining the desirability of converting from a manual to a computer-based system.

Staff training and recruitment

One problem facing research organisations like the DOA is to retain staff with skills and interest in computer systems analysis, system design and programming. Those staff recruited, who also learn on the job, are likely to find promotion outside rather than inside the organisation. Consequently the turnover of staff in computer services is likely to be high. Valuable on-site experience and links with staff in client divisions are continually eroded. The rate of development of new computer applications and maintenance of existing applications will be effected. This applies particularly to systems developed in "3rd Generation" languages such as COBOL, FORTRAN and BASIC. There is also a considerable workload involved in preparing and maintaining documentation of such systems - user procedure guides, system design, revisions to source code listings when modifications are made, data dictionary, data base maintenance procedures, backup, archiving and recovery procedures. Except in very well staffed computer centres, it is frequently the production and maintenance of documentation which suffers when there is pressure to implement computerised systems on time.

"Fourth Generation" languages and data base management systems (DBMS) off a partial solution to shortages of specialist computer programming staff. For the development of applications on micro computers, using packages such as DBASE II or Lotus 123, previous computer programming experience is not essential. It is possible to recruit staff and train them in two to four weeks.
"Introductory" computer courses which teach programming in BASIC are counter productive. Computer concepts, keyboard (touch typing) skills and the use of a word processing package or good screen editor are more useful as an introducting to computing.

These should be followed by courses in systems concepts and structured design. For projects which are significant in size, complexity or number of users it is desirable for development staff to have had training and experience in systems analysis and design. Incidentally, it is equally valid to argue that any agricultural research scientist should have training in a systems approach to complex research problems. In developing a computer application, as in developing an applied research project, the aim is usually to solve a problem, or to improve the effectiveness of an existing system. In both cases a process of "structured common sense" generally works well, provided that tools available are effective and easy to use.

An alternative to training research staff at regional centres in computer use would be to appoint staff with biometrical and computing experience to manage Data Processing Service Cells at each centre, as proposed by the ACNARP Research Centre Development Adviser (Roberts[4, 5, 6]). This would be a logical grouping of service/consultant functions in the area of data management and data analysis. It is one being considered for larger regional offices and research institutes of the Western Australian Department of Agriculture.

5. PATHUM THANI RICE RESEARCH CENTRE (RANGSIT)

5.1 Administrative Structure

Located 40 km from Bang Khen, Pathum Thani Rice Research Centre is responsible for four other major research centres, covering 22 provinces. The administrative structure is presented in Figure 5.1. In the Technical Division, only those activities marked with an asterisk (*) were located at Pathum Thani. Others were awaiting construction of new buildings.

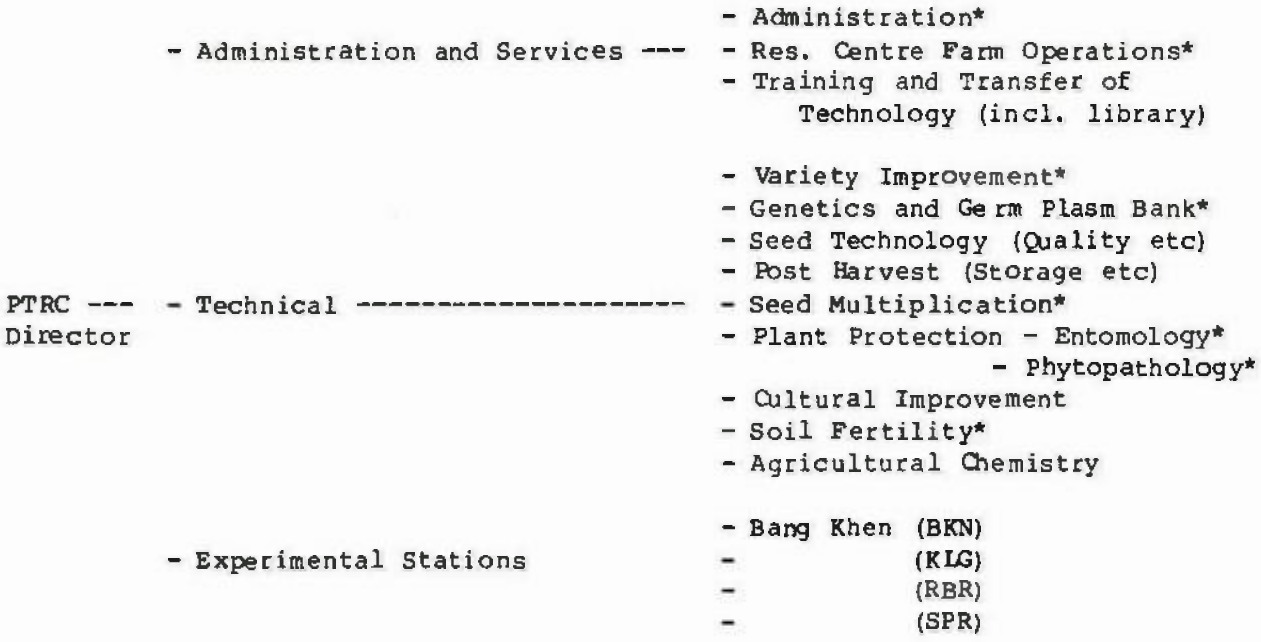

FIGURE 5.1 PATHUM THANI RICE RESEARCH CENTRE ADMINISTRATIVE STRUCTURE

5.2 Areas of Activity with Potential for Immediate use of a Computer

Two areas are recommended for immediate development of computer-based applications - the Rice Germ Plasm Bank, and the Rice Breeding programme.

Rice Germ Plasm Bank

Some 9,000 accessions are currently held in a germ plasm storage centre donated by the Japanese Government. Accessions are held in one of three storage levels - short term (3 years), medium term (10 years) and long term (50 years at - 10°C). Seed to be held for medium and long term is stored in sealed tins after careful drying at 45-48°C. The system costs about US$4,500 per month in electricity charges alone. Currently all records of accessions held in the bank are kept manually. These comprise:-

(a) Passport data - initial information on collector name, location (altitude added recently), accession number, plant type, name of variety (in Thai and/or Egnlish), flowering data, special characters (salt tolerance, cold tolerance etc., aromatic seed).

(b) Germ plasm bank data. Accessions which have been grown from original seed are described in detail (see Appendix 2 for English version of data sheet). This information falls in three main groups:-

Station where grown, seeding data, transplanting date,
Passport data plus Genetic Stock Number,
Morphological and anatomical descriptions (coded), seed quality data.

(c) Germ Plasm Bank Register
Genetic Stock Number, date of entry to short, medium or long term storage, germination percentage.

(d) Special Collections Registers (24 collections)
Records of genetic stocks known to be, for example, salt tolerant or cold tolerant.

(e) Province Register
Records of genetic stocks from each of 72 Provinces

(f) Alphabetical Index by Name (Card Index)
This is kept to assist in indentification of duplicate accessions of the same genetic stock.

The present collection of about 9,000 genetic stocks is expected to peak at about 15,000. It should be noted that in a computerised Genetic Stock data base, the listings identified in (d), (e), and (f) above could be produced as by-products of the Germ Plasm Bank data (b). This would eliminate the need for multiple manually kept indexes, each of which is subject to errors of transcription.

A computerised Germ Plasm Bank Register, as well as providing inventories of each storage type (short, medium or long term), could produce periodic reports based on date of initial storage. These would indicate which genetic stock were due for re-constitution. Records of quantities of seed released from the short-term data bank could automatically update the balance of stocks held. A computerised data base of germ plasm descriptive data would permit much more detailed checking of suspected duplicate samples, based on one or several of the 60 attributes recorded for each Genetic Stock Number.

The Curator of the Rice Germ Plasm Data Bank indicated that while his duties were also supposed to include genetic research, the administration of the germ plasm bank leaves him no time for other activities. A well designed computer-based system would enable the Curator to have time for rice genetic studies.

Based on the number of alphabetic and numeric characters recorded in the data information sheet filled out for each genetic stock number, it is estimated that the Germ Plasm Data Bank would take up about 2.5 megabytes of magnetic disk storage (assuming 9,000 entries), rising to 4.0 megabytes for 15,000 entries. It is estimated that additional disk space required for data management, program storage, report generation etc. would double the disk space required, i.e. 5.0 megabytes rising to 8.0 megabytes.

Rice Breeding. I was advised that some 10,000 entries would be involved in the next season's rice breeding programme. In a fully computerised system, such as used by plant breeders in the Western Australian Department of Agriculture, this number of entries is estimated to require some 10 megabytes of magnetic disk storage. Even without concurrent field mechanisation for sowing plant breeders' lines, there would be scope for automated generation of seed packet labels, harvest bag labels, loose-leaf field books with entry numbers and names already printed in planting order, ready for recording field results. Such a procedure greatly reduces the occurrence of transcription errors. The field books are used to record field data, such as time of flowering, disease scores etc., and can be used as a data entry source for the computerised system.

Recommendation

Pathum Thani Rice Research Centre should be a priority candidate for allocation of a micro computer system with a minimum of 10 megabytes of sealed (Winchester) magnetic disk storage. The computer should have a 16-bit central processing unit (CPU), with a minimum memory of 256K bytes, expandable to at least 512K bytes. The chosen computer must also be able to be fitted with an additional 20 megabytes of magnetic disk storage, and with a magnetic tape cartridge unit for rapid backup and archival storage of the data base information. The computer system should be operated in an air conditioned environment - "split-system" office air conditioning should be adequate. The computer system should be operated from a power conditioner unit which can be connected to the normal power supply, but which provides a regulated 230 volt supply, and eliminates electrical "spikes".

Software: A commercially available data base management system (DBMS) package is preferred, because it eliminates a substantial computer programming requirement. With the advice of an experienced systems analyst, and a short period of training, the user is often able to design and implement the data base. The DBMS package DBASE III (an advanced version of the very popular DBASE II) should be a suitable package for developing the Rice Germ Plasm Bank data base and passport data files, and for producing a wide variety of standard reports, such as the listings of genetic stock classified by Province, alphabetical order of name, or special collection characteristic. Additional software packages which should be purchased to assist in the administration and operation of the Rice Research Centre, are Microsoft BASIC, Wordstar or a similar word processing package, and a "spreadsheet" package. A combined word processing and spreadsheet package such as Lotus 123 would probably be very suitable. The word processing and DBMS software supplied should have optional Thai/English characters and command structure. For research data analysis a copy of a statistics package such as MASS could be supplied. This would enable routine statistical analysis of experiments to be completed at the Research Centre. This recommendation is conditional on the recommendations of the Statistical Consultant[7].

The plant breeders' system is a more specialised area. A fully automated system may require a large computer than is proposed at this stage. Since rice breeding is a very significant area of Thai agricultural research, it is recommended that consideration be given to obtaining the services of a plant breeding consultant familiar with computerised systems for field crop breeding.

It is essential that computer systems proposed for Regional Research Centres be totally compatible with systems recommended for use at DOA Bang Khen. This will facilitate training, dissemination of software revisions, and data transfer by means of magnetic diskettes.

Estimated cost of hardware and software for a suitable initial configuration of the computer system for the Pathum Thani Rice Research Centre is based on current costs of the IBM PC/XT, but it should be noted that there may be alternative suppliers of equipment who could meet the requirements laid down in Appendix 1. The proposed system would comprise:-

IBM PC/XT micro computer, with 256K bytes memory, 10 megabytes sealed magnetic disk drive, 320K bytes flexible disk drive, monochrome visual display, keyboard. MSDOS or equivalent operating system (DOS 2.0). 132 column dot matrix printer (Epsom FX100). Thai language option, DBASE III, Wordstar, Lotus 123. Power conditioner, 2KVA 230 volt.

Estimated cost $15,000

6. STATISTICS SUB-DIVISION

The Statistics Sub-Division (SSD) has been involved for many years in the use of computers for statistical analysis of research data. The Sub-division has its own Wang 2200 min-computer, comprising a 64K byte CPU, two VDU terminals, two printers and three 8 inch diskette drives. The professional statisticians are familier with the BASIC programming language used on the Wang 2200, and have developed many statistical analysis programs for their own use.

6.1 Statistics, Computing and the Role of SSD

The need for expanded computing facilities has been recognised within the Sub-Division, and submissions have been presented to DOA from time to time for upgrades to the facility. These submissions have naturally been primarily concerned with the increasing demands being placed on the SSD for research data analyses, and for these analyses to be completed speedily. The possibility does not seem to have been considered that a large proportion of research data manipulation and (at least) preliminary statistical analysis might be undertaken by research staff using micro computers. This option is worth close scrutiny by the Sub-Division, assuming the recommendations regarding computer systems for Regional Research Centres are acted upon.

Regardless of the change in research organisation structure, there is a significant role for the SSD, particularly in the analysis of large or complex data sets covering several seasons and/or regions. A Statistical consultant has been appointed to investigate the requirements of the DOA in this area, and her report will cover in much greater depth of requirements of the SSD in terms of computing facilites. However, it is pertinent to recommend, from an overall coordination perspective, that the SSD should acquire computer hardware of the same type as that recommended for the larger Research Centres (see Appendix 1).

It is recommended that the SSD should be regarded as a major use of computing equipment, but not as the group responsible for overall coordination and administration of computer services for the DOA. The latter activities are significantly divergent from the present activities of the SSD and sufficiently specialised in nature to warrant the formation of a separate Sub-Division (see Section 7). However, given that a significant proportion of computer use at both head office and regional centres will concern research data collection, manipulation and analysis, it is expected that the SSD would be closely consulted in the processes of equipment and software selection, training and implementation of micro computer systems for research purposes.

6.2 Hardware andSoftware Options for SSD

The recommended change from Wang 2200 to IBM PC/XT will involve re-writing of some of the software presently used on the Wang system. However, it may be possible to replace many of the one-off statistical analysis programs with a single statistical software package such as MASS (see Appendix 1). Again this proposal is contingent on the recommendations of the Statistical consultant.

Use of the NARP System/34 computer. I can see no advantage to the DOA in the use of the System/34 for statistical computing. The principle arguments against such a proposal are:-

(1) There are several more administrative applications planned for implementation on the System/34. These, added to the existing work load, would leave little time available during office hours for use of the System/34 by SSD staff.

(2) The existing programs in Wang BASIC would have to be completely re-written. Further, the System/34 has only a COBOL compiler, a language not well suited to statistical methematical programming.

(3) The nature of research data analysis is such that standardised input and report procedures are often an inconvenience. Also it is often necessary to carry out a series of exploratory data analyses on the one data set before deciding on the most appropriate final method of analysis. Such procedures call for continuous on-line access to the computer system, which would not be desirable or possible on the System/34.

(4) Use of the System/34 for statistical work would not be consistent with the recommendation that the SSD should have equipment closely compatible with that proposed for installation at regional research centres.

Use of the MOAC Sperry Univac Computer. The Statistical Consultant for ACNARP has recommended[7] that, in the short term, SSD should acquire hardware, software and communications facilities to enable the DOA statisticians to access the MOAC Sperry Univac computer, with its range of data base management and statistical software. The Sperry PC recommended as a terminal to this system is a micro computer closely compatible with the IBM/PC range, and therefore should be compatible with those recommended for Research Centres. However, my reservations still stand concernig the reliance on telecommunications to MOAC for the significant proportion of the Sub-Divisions computing work (see Section 4.3.2).

7. PROPOSED COMPUTER SERVICES SUB-DIVISION

It appears that to be generally recognised in the DOA that increased use of computing and information technology can play a significant part in the effective application of the results of agricultural research. Recommendations of previous consultants have included the use of computer-based information systems in a number of areas. Carroll[1] recommended consideration of computer systems for research programme monitoring, and for a research inventory. The research inventory would provide summary information on all past and current research projects conducted by the DOA, and would be accessible to all research staff. Goss[2] recommended planning for a computer-based library administration system as a means of improving user services to regional centres, and to monitor the possibility of on-line access to overseas information data bases. Martin[3] recommended that the Integrated Farming Systems Branch should have two portable micro computers with spread-sheet facility.

It is important that structures and procedures are set up so that computer-based applications are chosen, and development proceeds in such a way, as to show greatest benefit to the organisation. There are also efficiencies to be gained in centralising the coordination and administration of computer services for the DOA, including the development of training courses for a wide range of staff. The centralisation of these activities is compatible with decentralisation of the computing resources, given the availability of powerful micro computers (see section 4.6). For the effective coordination and administration of computer services in the DOA it is recommended that a Computer Services Sub-Division be established within the Planning and Technical Division. The suggested new organisational structure of the Division is presented in Figure 7.1.

While a computer Services Sub-Division will provide the structure to coordinate computing systems in the DOA, the executive of the organisation should establish computing and information technology policy, and the setting of priorities for the allocation of limited resources for computing across all Divisions and Regions of the DOA. For this purpose it is recommended that a Computing and Information Systems Policy Committee (CISPC) be established, chaired by the Director General, with the Chief of Planning and Technical Division as Executive Officer. The Committee's functions would be:-

(1) To formulate and periodically revise a Computing/Information systems Strategic Plan. In developing this Plan, the Committee would issue guidelines and constraints within which Institutes, Divisions and Research Centres would prepare their plans for the use of computing resources.

(2) To consider submissions for computing resources (including human resources) associated with any research or administrative project, and to establish priorities among competing claims for the resources available. The Committee would ensure that new projects involving significant use of computer resources were catered for by planned expansion of computer services. It would ensure that additional equipment could be adequately located and serviced, was sufficiently compatible with existing equipment to ensure satisfactory data exchange, and that system support and training would be available from the Computer Services Sub-Division.

(3) To consider submissions for, and negotiate with, MOAC, BOB and CSC concerning computing and information systems resources for the Department of Agriculture.

(4) To promote the coordination and integration of computing and information systems development, to ensure that effective data exchange is possible between all units of the DOA, and between the DOA and outside organisations. Information systems development policy would be such as to ensure an efficient and effective level of information retrieval is possible at all levels or the organisation.

PLANNING AND TECHNICAL DIVISION

Administrative Section

Computer Services Sub-Division

Computer Centre Operations

Training and Support Services

NARP Foreign Projects Sub-Division

Public Relations and Transfer of Technology Sub-Division

Research Registration and Documentation Sub-Division

Statistics Sub-Division

FIGURE 7.1 Proposed organisational structure of the Planning and Technial Division to incorporate a Computer Services Sub-Division. Sections and Sub-Divisions are listed in alphabetical order.

The Computer Services Sub-Division (CSSD) would have three major functions:-

- To advise the CISPC on technical matters relating to proposals for the development of computing or word processing applications. These proposals may form part of a research or administrative project, or be related to the central computing facility.

- To assist the CISPC in the preparation and implementation of strategic plans for computing and information systems.

- To coordinate computer services and word processing for the DOA, including the operation of a central computer system (or systems), and support for Division, Institute and Research Centre micro computer systems. An important component of Computer Services support would be the coordination of training in the use of computer systems by a wide range of DOA staff.

The CSSD should be headed by an experienced graduate in agriculture, science or statistics, preferably with post-graduate training in computer applications or systems analysis. A second-in-charge should be a graduate in computer studies, or have proven experience in systems

analysis, design and implementation. It is recommended that the operations of the CSSD be divided into two sections:-

- A computer Centre Operations Section would be responsible for day to day management of central computer systems, and the design and development of new applications intended to be managed by the CSSD. Existing systems and programming staff attached to the NARP office should be transferred to the CSSD when the NARP computer system is transferred to the DOA. These staff would form the nucleus of the Computer Centre Operations Section.

- A Training and Support Services group would be responsible for training and support services for all DOA computer systems, paying particular attention to the needs of the Regional Research Centre. Additional staff would be required to adequately service the on-going training needs within the DOA. In the initial phases of micro computer installation in Regional Centres, consideration should be given to organising training programmes with the assistance of outside contract organisations.

8. REFERENCES

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5. Roberts, F.J. (1983) Regional Crop Research Centre Development - Research Programming and Staffing Aspects. Short Paper 83/2 - Organisations and Management of Multi-disciplinary Research. ACNARP. Thailand.

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APPENDIX 1

MICRO COMPUTER SYSTEMS FOR THE THAILAND NATIONAL AGRICULTURAL RESEARCH PROJECT

Important considerations in the selection of suitable micro computer systems are:-

1. All processors and disk storage devices should be of the one brand to ensure compatibility for exchange of data on magnetic media, and to simplify the distribution to regional research centres of software and systems developed by the Computer Services Sub-Division.

2. The equipment must be supplied by a well established business firm, able to offer good training and support facilities, as well as technical and repair services.

3. It is desirable that the equipment be able to communicate (if required) with the NARP IBM System/34 computer. This option is available with the IBM/PC and IBM/XT micro computers.

4. It would be an advantage to some Divisions of DOA if the chosen micro computer could interface to the MOAC Sperry Univac 1100 computer system. However, such an option is not seen as having a high priority.

5. Computers with sealed magnetic disk storage in excess of 10 megabytes should be supplied with a magnetic tape cartridge backup/archiving unit. Such a unit should also be considered for systems with large data bases (4-8 megabytes) which are frequently updated. Otherwise the time and effort required in backing up regularly to diskettes becomes excessive.

TENTATIVE SPECIFICATIONS

MICRO COMPUTER SYSTEMS

THAILAND NATIONAL AGRICULTURAL RESEARCH PROJECT

SPECIFICATION 1: Basic Unit for most Research Centres

Hardware

IBM/XT with 256KB memory
Disk storage: 2 x 360KB diskette (5.25 in) drives
Monitor: Green or amber monochrome display
Printer: EPSON FX-100 (132 col., draft plus n.l.q. fonts)
Thai language modification included.

Software

Operating System: DOS 2.0
Data base management system: DBASE II or DBASE III
Word Processing: WORDSTAR . Spreadsheet: MULTIPLAN
Statistical Package: MASS
Compiler language: Microsoft BASIC

Voltage Regulator

To be determined

Estimated Total Cost (duty free): US$12,000

SPECIFICATION 2: As for Specification 1, plus
10 megabyte fixed disk
(replaces 1 floppy disk drive)

Estimated Total Cost (duty free): US$15,000

SPECIFICATION 3: As for Specification 2, but with
additional magnetic tape cartridge
system (minimum 1 mb per tape) for
backup and archive of large data bases

Estimated Total Cost: US$17,000

MASS©

PRODUCT DESCRIPTION

Microprocessor Applied Statistics System

MASS is a microcomputer program for elementary and advanced statistical analysis of large data sets. It is written in Pascal in order to facilitate overlaying procedures and to enhance its portability to various types of computers. MASS is currently available for microcomputers of the Z80/8080 and 8088/7/6 classes.

MASS is designed to be both userfriendly and fast. The user communicates with it through simple commands and menus, and it provides extensive optional prompting and "help" files. It also accepts shortened versions of commands and has default selections for the options needed most frequently. In addition, command strings can be stored in files and referenced for execution.

MASS will handle large datasets with ease. Current versions support files with up to fifty variables and up to 6000 cases —large enough for most survey and experimental problems. The statistical procedures which the current version provide are the following:

Summary statistics: MASS allows the user to readily obtain summary statistics from the data. Histograms, plots and frequency tables are available through simple commands.

Two-sample statistics: MASS provides a number of ways of comparing and relating variables. These include t-tests, correlations, and non-parametric methods.

Regression: MASS can form correlation matrices for a number of variables and obtain multiple regression fits. This is made very flexible through facilities for defining orthogonal polynomials and dummy variables.

Tabulation: MASS can create multifactor cross-tabulations of counts, totals, means, minima, maxima, and variances and can print or store them.

Analysis of variance: MASS can perform one- and two-way analysis of variance on data which is either extracted from disk files or entered directly.

MASS Version 3.0 is part of an ongoing development process. Future enhancements will include a more general analysis of variance which will analyse most balanced designs, a time series module, generalised linear model regression, and non-linear modelling. It is our policy that future versions of MASS maintain compatability with Version 3.0 and that owners of Version 3.0 may obtain updates at reduced cost.

Enquiries should be directed to:

Your distributor:

or The MASS Office
P.O. Box 247
Nedlands 6009
Western Australia
Tel: (09) 386 4647

The following description of specific commands indicates the nature of most of the facilities provided by the current version of MASS.

A) Description and Input of Data

ENTER Prompts for the data size are displayed, and the data itself is then typed in by the user on the keyboard. At the conclusion, the data is stored and the MASS directory is updated. Variants enable external data to be entered in free-field format.

ATTACH Attaches a MASS-generated data file for current analysis.

SELECT Within an attached data set, individual records can be selected or rejected on the basis of arithmetic and logical operations.

VARNAMES The user may name variables or accept default options. It is assumed for most procedures that the data will exist in a 'record' (row) by 'variable(column) format, with limits of 6000 and 50 respectively.

BATCH A powerful Batch facility enables users to define standard production procedures easily. It also functions as an elementary Macro facility.

B) Output of Data and Results

LIST Active records on a data file can be listed on the screen.

CREATE Writes ASCII data to an external disk file.

FILE Reroutes input from or output to an external disk file.

C) Manipulation and Transformation of Data

EDIT Data known to the MASS directory is recovered and edited.

TRANSFM RECODE New variables are generated by transformations and recoding.

SORT Data is sorted on a sequence of name keys.

FORMAT Read/write fixed format data.

D) Statistical Computations

Statistical computations are carried out only on the selected (active) records of the specified data set. All computations will be performed only on those currently active records, until new ATTACH or SELECT instructions are declared. The most important facilities which are currently available are described as follows:

SUMMARY Summary statistics (mean, standard deviation, minimum, maximum, and range) of the specified variables.

XTABLES Multi-factor cross-tabulations of counts, means, variances, ranges, etc. are generated and printed by this unique and powerful command. Many options exist for storage and recovery of results at all stages.

HIST Histograms for each of a number of specified variables.

FREQ Frequency tables for each of a number of specified variables.

PLOT Multivariate plotting on the same graph, with range scaling options.

CORR Correlation coefficient matrix formation.

TTEST t-tests on variable means, with many options.

REGRESS Multiple linear regression.

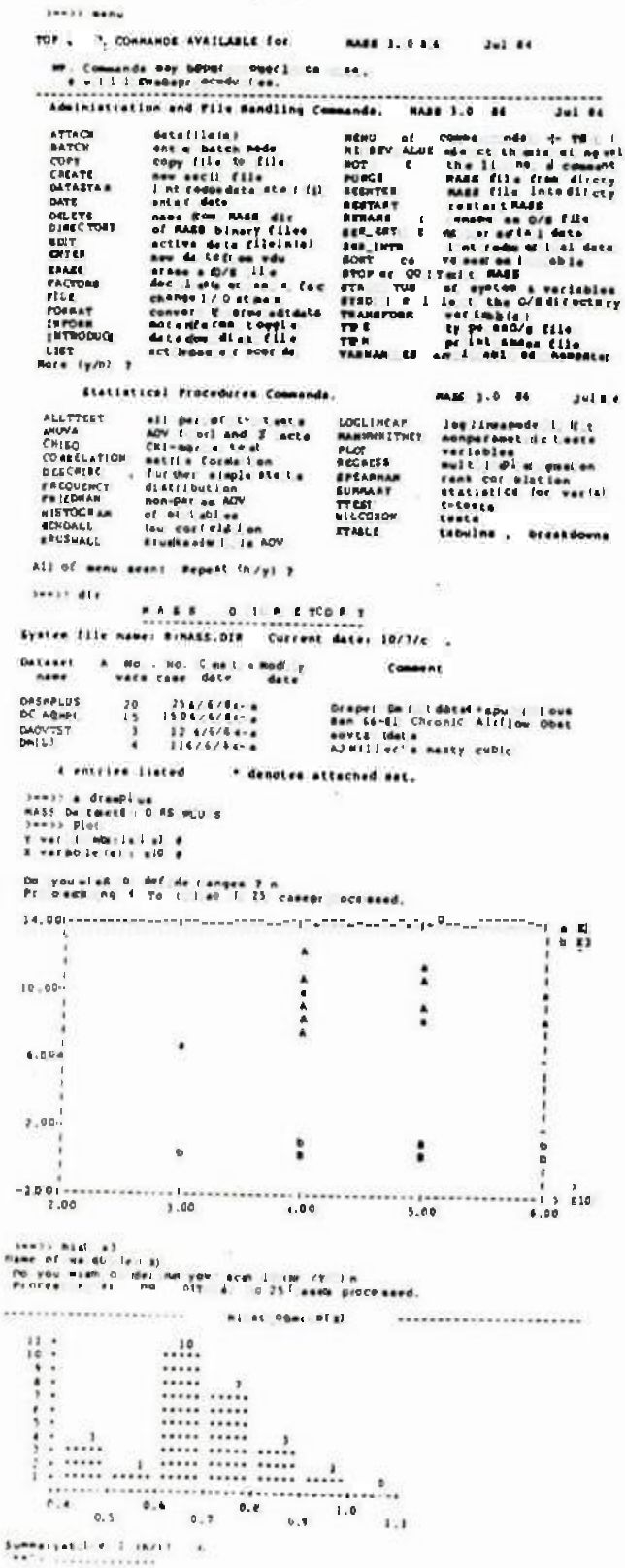
MANNW SPEARMAN WILCOX KENDALL Mann-Whitney and other non-parametric tests.

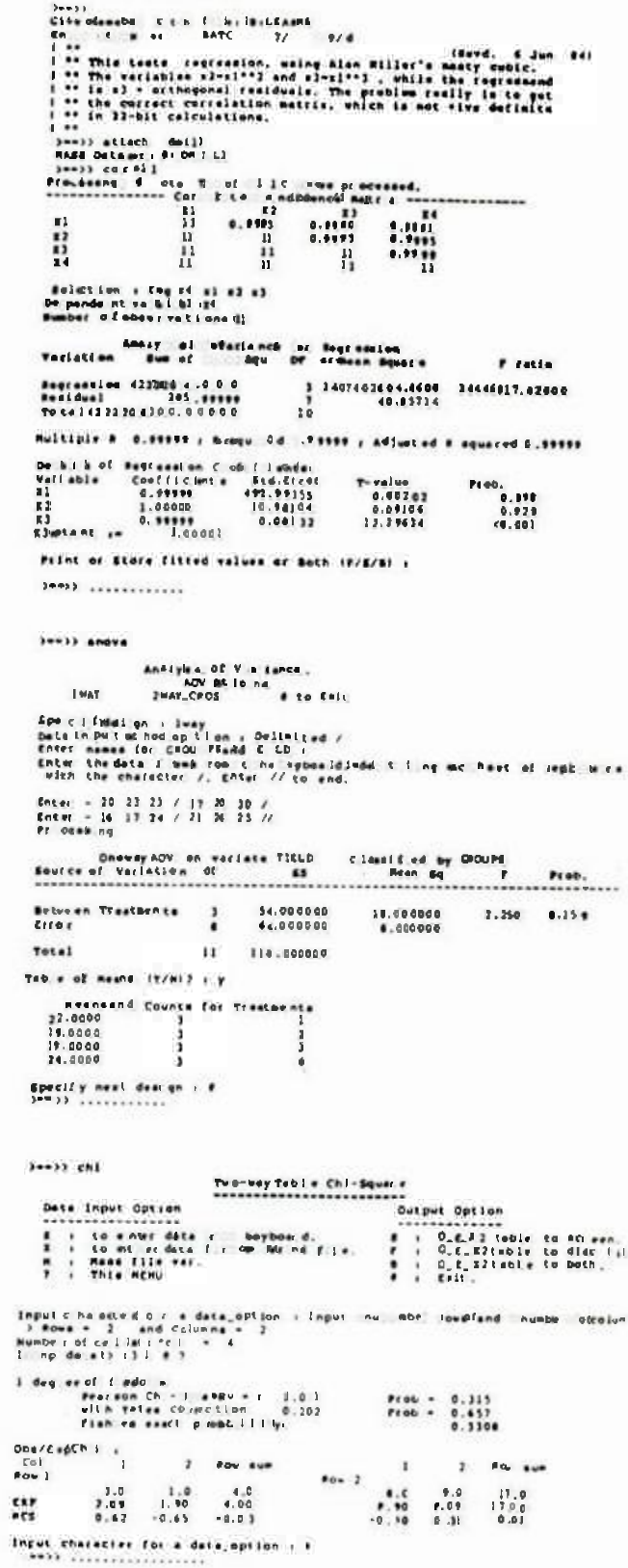
LOGLIN Log-linear modelling for multi-dimensional contingency tables.

ANOVA Elementary analysis of variance for 1- and 2-way crossed designs. Missing values are properly accommodated.

CHISQ Two way table analysis.

EXAMPLES from the `LEARN´ files





The MASS Office
P.O. Box 247
Nedlands 6009
Western Australia
Tel: (09) 386 4647

```
>==>>
Give name of batch file: B:LCABM2
Enter BATCH          7/              8/a
! **   Now try to demonstrate ... operation and print ... here
! **   here  procedure ... added to be ... to ... re, and even
! **   to meet me in data.
! **
! **   The data are 15 variables, of which 13 are here used.
! **   There are 150 cases, so it will take some time !
! **        ---------------------------------
! **        Micros ... (TET ... cases ! ! !
! **        ---------------------------------
>==>> attach dcasmpl

MASS Dataset : B:DCASMPL

! **   now override the default variable names.

>==>> varname
Next name to change is ID
Give names: id age jobclass fev1 fev2 fev3 fev4 fev5 fev6 slope
Give names: sdev smkct1 smkct2 smkct3
Give names: ?
Current names are :
ID          AGE         JOBCLASS    FEV1        FEV2        FEV3
FEV4        FEV5        FEV6        SLOPE       SDEV        SMKCT1
SMKCT2      SMKCT3      X15
Next name to change is X15
Give names: #

! ** summarise a subset of the data.
! **

>==>> sum age to fev6 smkct1 to smkct3
Processing ######
Total of 150 cases processed.
```

Variable name	Cases active	Mean value	Min value	Max value	Standard deviation	Stnd Err of Mean
AGE	150	48.3666	21.0000	84.0000	14.7158	1.2015
JOBCLASS	150	4.7199	3.0000	6.0000	1.1807	0.0964
FEV1	150	326.9066	80.0000	553.0000	87.8364	7.1718
FEV2	144	321.6319	0.0000	611.0000	112.6576	9.3881
FEV3	138	305.1159	55.0000	625.0000	101.1183	8.6077
FEV4	109	310.8499	0.0000	420.0000	94.6433	9.0651
FEV5	104	300.0961	0.0000	660.0000	111.3341	10.9174
FEV6	86	271.7674	0.0000	590.0000	116.5219	12.5650
SMKCT1	150	2.6733	1.0000	5.0000	1.4859	0.1213
SMKCT2	150	2.6466	1.0000	5.0000	1.5670	0.1280
SMKCT3	150	2.7466	1.0000	5.0000	1.5421	0.1259

```
! **   enter the tables section.

>==>> xtab
D>> ! **
! **   Override the default level names.
lnam
Variable : jobclass
 Reading 4 level names for JOBCLASS   Names : home office miner farmer
Variable : smkct1
 Reading 5 level names for SMKCT1   Names : nonsmk exsmk pipe modrte heavy
Variable : smkct2
 Reading 5 level names for SMKCT2   Names : nonsmk exsmk pipe modrte heavy
Variable : smkct3
 Reading 5 level names for SMKCT3   Names : nonsmk exsmk pipe modrte heavy
Variable : >

D>> ! **
! **   Now we define some tables.
! **
table
 TABLE>smkct1 * smkct2 * smkct3

 Tabno Variable   Mode     Cells  Base   Factors
   1              COUNT     126      0   SMKCT1    SMKCT2    SMKCT3
 Total used                 126  Cells
 Remaining                 2874  Cells
 Room for                    49  Tables

 TABLE>> jobclass * smkct3 ( mean count ) fev1 fev3 fev5

 Tabno Variable   Mode     Cells  Base   Factors
   2    FEV1      MEAN       21    126   JOBCLASS SMKCT3
   3              COUNT      21    147   JOBCLASS SMKCT3
   4    FEV3      MEAN       21    168   JOBCLASS SMKCT3
   5    FEV3      COUNT      21    189   JOBCLASS SMKCT3
   6    FEV5      MEAN       21    210   JOBCLASS SMKCT3
   7    FEV5      COUNT      21    231   JOBCLASS SMKCT3
 Total used                 252  Cells
 Remaining                 2748  Cells
 Room for                    43  Tables

 TABLE>> #

go
 Processing ######    Total of 150 cases processed.


! **   tables are now done so let's print them all.
Print # 1 2 3c


 TABLE NUMBER : 2                              page: 1
 TABLE OF MEAN  OF FEV1      OVER : JOBCLASS SMKCT3
```

> SMKCT3	HOME	OFFICE	MINER	FARMER	TOTAL
NONSMK	238.57	382.87	354.66	375.21	349.75
EXSMK	206.33	319.60	293.92	326.37	301.87
PIPE	*	*	344.00	457.00	366.60
MODRTE	367.28	292.85	369.25	474.66	360.75
HEAVY	285.07	306.20	339.00	306.87	305.00
TOTAL	278.33	329.66	328.67	352.31	326.90

```
        0 Incomplete Observations encountered.

>==>>

! **   tables are now done so let's print them all.
Print # 1 2 3c

 TABLE NUMBER: 1                               page: 1
 TABLE OF  COUNT OVER : SMKCT1  SMKCT2 SMKCT3
```

SMKCT2 > SMKCT1	SMKCT3	NONSMK	EXSMK	PIPE	MODRTE	HEAVY	TOTAL
NONSMK	NONSMK	38	0	0	0	0	38
	EXSMK	7	0	0	0	0	7
	PIPE	0	0	0	0	0	0
	MODRTE	0	0	0	0	0	0
	HEAVY	0	0	0	0	0	0
	TOTAL	45	0	0	0	0	45
EXSMK	NONSMK	1	0	0	0	0	1
	EXSMK	1	32	0	0	0	33
	PIPE	0	0	0	0	0	0
	MODRTE	0	0	0	0	0	0
	HEAVY	0	0	0	0	0	0
	TOTAL	2	32	0	0	0	34
PIPE	NONSMK	0	0	0	0	0	0
	EXSMK	0	9	0	0	0	9
	PIPE	0	0	5	0	0	5
	MODRTE	0	0	0	7	0	7
	HEAVY	0	0	0	0	0	0
	TOTAL	0	9	5	7	0	21
MODRTE	NONSMK	0	0	0	0	0	0
	EXSMK	0	0	0	0	0	0
	PIPE	0	0	0	0	0	0
	MODRTE	0	2	3	7	0	12
	HEAVY	0	0	0	0	12	12
	TOTAL	0	2	3	7	12	24
HEAVY	NONSMK	0	0	0	0	0	0
	EXSMK	0	0	0	0	0	0
	PIPE	0	0	0	0	0	0
	MODRTE	0	0	0	5	0	5
	HEAVY	0	0	0	0	21	21
	TOTAL	0	0	0	5	21	26
	NONSMK	40	0	0	0	0	40
	EXSMK	8	40	0	0	0	48
	PIPE	0	0	5	0	0	5
	MODRTE	0	2	3	19	0	24
	HEAVY	0	0	0	0	33	33
	TOTAL	48	42	8	19	33	150

```
        0 Incomplete Observations encountered.


 TABLE NUMBER : 2                              page: 1
 TABLE OF MEAN  OF FEV1      OVER : JOBCLASS SMKCT3
```

> SMKCT3	HOME	OFFICE	MINER	FARMER	TOTAL
NONSMK	238.57	382.87	354.66	375.21	349.75
EXSMK	206.33	319.60	293.92	326.37	301.87
PIPE	*	*	344.00	457.00	366.60
MODRTE	367.28	292.85	369.25	474.66	360.75
HEAVY	285.07	306.20	339.00	306.87	305.00
TOTAL	278.33	329.66	328.67	352.31	324.90

```
        0 Incomplete Observations encountered.

 TABLE NUMBER : 3                              page: 1
 TABLE OF  COUNT OVER : JOBCLASS SMKCT3
```

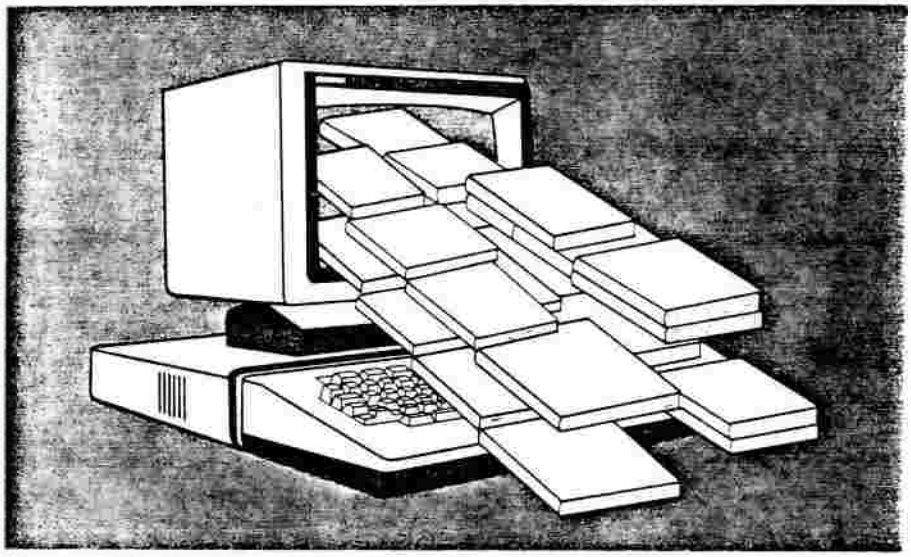
JOBCLAS> SMKCT3	HOME	OFFICE	MINER	FARMER	TOTAL
NONSMK	6	8	5	19	38
EXSMK	5	4	10	24	43
PIPE	0	0	0	2	5
MODRTE	6	7	0	6	23
HEAVY	10	4	7	6	26
TOTAL	27	23	30	56	138

```
        12 Incomplete Observations encountered.
                    HELP/?
P>> end
! **
 **   and exit back to the monitor.
! **

>==>> ...............


>==>> logl
                         Log_Linear  Modelling
                         ---------------------
  Data Input Option                      Data Input/Results Output
  -----------------                      --------------------------
  F  : Factor_levels.                    DK : Data in from keyboard.
  M  : Model.                            DX : Data in from external file.
  +  : Add configs.                      DM : Data in from MASS dataset.
  -  : Delete configs.
  G  : Go  (fit)                         P  : Print (obs/exp/res).
                                         PM : Print Model.

  ?  : This menu !   I  : Inform on/off.          # : Exit.

 FACTOR LEVELS:  New / more data required.
 # levels read, with total  45  .0  Maximum ... 1  and minimum     1.00

LL> model size = 3 Model = 1/2/3
    DF (ZEROS)    LIKECHISQ    PROB   PEARCHISQ    PROB
     4     0           9.14  0.0367        9.32  0.0536

LL> model size = 3 Model = 12/13/23
    DF (ZEROS)    LIKECHISQ    PROB PEARCHISQ    PROB
     1     0           5.45  0.0183        5.49  0.0179

LL> model size = 1 Model = 123
    DF (ZEROS)    LIKECHISQ    PROB   PEARCHISQ    PROB
     0     0           0.00  1.0000        0.00  1.0000

LL> #
>==>> ..........
```

STATUS

THE PREMIER TEXT STORAGE AND RETRIEVAL SYSTEM

STATUS is a text management system designed to complement Office Automation. It enhances your word processing capabilities by providing an easy link for searching through, and retrieving, textual information. Any data items in the database including words, phrases, combinations of words, numbers and number/text combinations can be retrieved.



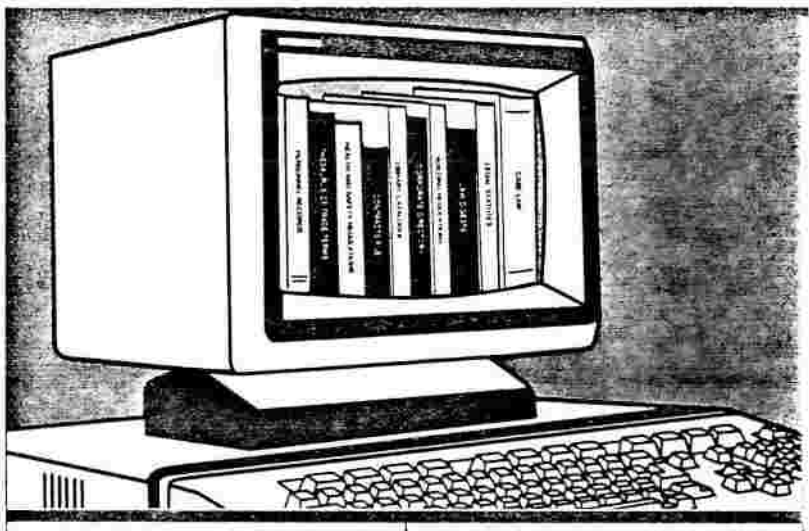
With STATUS any information can be simply and quickly retrieved with just a few commands.

COMPUTER POWER
STATUS
The Premier Text Storage and Retrieval System

COMPUTER POWER

STATUS IS TOTAL INFORMATION MANAGEMENT

FEATURES	BENEFITS
EASE OF USE	STATUS is immediately useable by anyone. There is no formal training necessary.
FLEXIBLE	STATUS allows you to simply ask for your information. Any information, regardless of its structure, can be stored and retrieved.
POWERFUL	STATUS stores both structured data, such as traditional records, and free-form textual information efficiently and effortlessly.
COMPATIBLE	STATUS is compatible with your existing word processor. No reformatting or special characters are required.
SECURITY	STATUS includes a set of powerful security features insuring total data privacy by controlling access to the stored information.
EASY INSTALLATION	STATUS installs in minutes and without the dependence on your in-house DP department. In only hours all the powers of STATUS will be at your fingertips.
SUPPORT	STATUS is supported by a staff of professionals who are familiar with both your computer and our software.
TRANSPORTABLE	STATUS runs on micros, minis and main frames using the same simple commands, therefore all environments are transparent to the user.



SYSTEM OVERVIEW

TEXTUAL INFORMATION

The world of Data Processing and Information Centres is changing more quickly than ever before. Users now want accurate and immediate access to information without having to rely on data processing. Their applications also require a system that is able to handle textual data with the same ease as is associated with numeric, formatted data.

This trend also exists in the Office Automation area — users require access to anything contained in their textual libraries. Access that is as simple as entering a word or phrase. They do not want this access to be dependent on remembering which document, letter, memo or mail, contained the information requested. A system intelligent enough to know which pieces contain what information, yet simple enough to use without a lot of formal training.

STATUS addresses these needs with the solution that provides key-word and/or phrase searching and retrieval. A system that complements your Office Automation by being easy to use, integrated, efficient and intelligent enough to remember where information is. Used in conjunction with word processing, any information created filed or mailed is instantly accessible with just a few simple commands. This information can then be browsed, changed, added to, deleted or passed back for further editing.

EXTENDED USE

Additionally, STATUS is an on-line information storage and presentation system that greatly expands a computer's capabilities of providing rapid access to accurate and up-to-date information.

In addition to storing traditionally computerized information such as structured data, STATUS allows the system to store unstructured information such as letters and memos.

STATUS stores both types, structured and unstructured information, in the same logical database for rapid query response. This capability greatly extends both the volume and quality of the information that can now be made available through the computer.

While providing access to a greater variety of information than is available through any other software, STATUS makes it easy for any user to find the exact information needed. The simple command language and inter-active query capability give all users instant access to all the information vital for today's business decision-making. A few simple commands and the full range of Boolean logic allow the user to qualify the information they are looking for simply, accurately and quickly.

SUPPORTING TOTAL INFORMATION NEEDS

Companies dedicated to maximizing the potential of their information will use STATUS to provide unrestricted, free-form information retrieval. Since it forces no restrictions on the data presented, STATUS spans industry boundaries and application areas. Its powerful method of referencing information, combined with its simple and flexible query language, allows STATUS to bridge the gap between 4th Generation DBMS' and single-user query systems.

For the first time, all of a company's recorded information can be readily available to any number of users. The possibilities are limited only by the imagination.

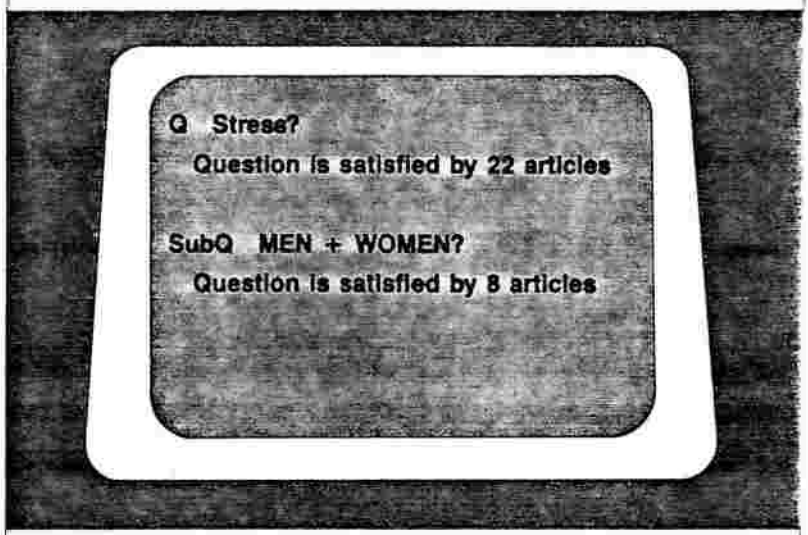
SEARCH TECHNIQUES

A database search is carried out in response to a user's question. In most cases this is as simple as a single word:

Q (question) STRESS?
Find all articles containing the word 'STRESS' or further qualified by the use of sub-questions.

Sub Q MEN + WOMEN
Find only the articles which contained 'STRESS' and the words 'MEN' and 'WOMEN'

Finding Information . . .



A SIMPLE TO LEARN AND EASY TO USE LANGUAGE . . .

TEXT RETRIEVAL

Once information has been successfully searched, the retrieval of that text can be accomplished with just a few simple commands:

- DISPLAY allows the display of the text
- FORWARD/BACK allows the user to browse through the database
- CONTEXT allows just those portions of the retrieved text to be displayed
- DISSEC allows the display of text of specific named sections in the information selected.
- CONTENTS allows display of lists of chapter titles
- SECTIONS allows display of lists of all named sections
- CHAPTER allows selection of a limited set for searching

Displaying Information . . .

WHICH ALLOWS ON-LINE ACCESS TO ALL YOUR VITAL INFORMATION . . .

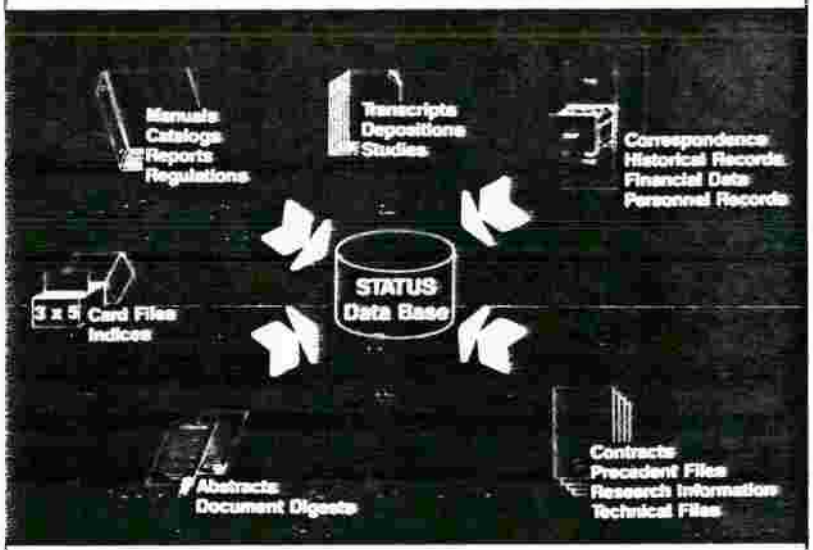
DATABASE MODIFICATION

STATUS allows for efficient updating or modifying in a number of ways:

- bulk addition of further articles
- addition of single articles
- extension of existing articles
- editing of existing articles using the STATUS editor
- deletion of articles

All updates can be made on-line, real-time or deferred until later to insure system efficiency, data integrity or system security.

Source of Information . . .



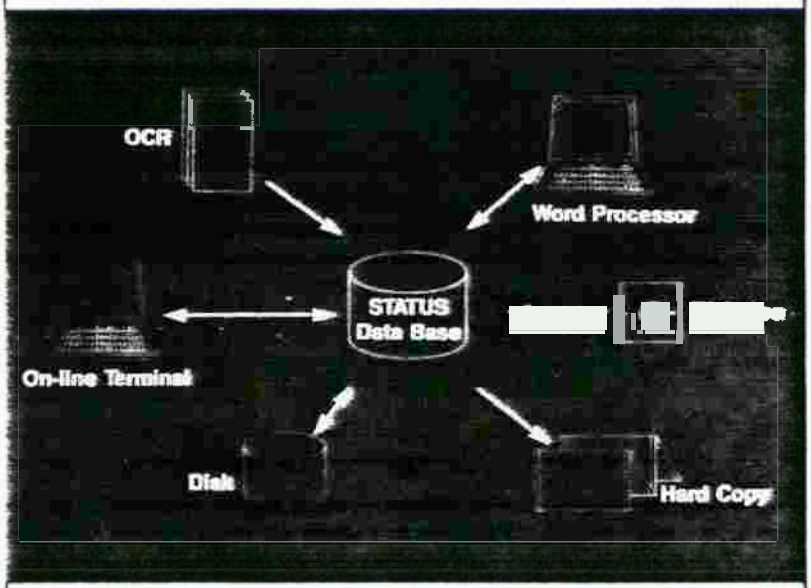
WHILE PROVIDING FOR IMMEDIATE, REAL-TIME UPGRADING AND VERIFICATION . . .

DATABASE CREATION

A STATUS database can be created by the user from the terminal, a word-processor, a computer typesetting system, or any other external source. The only additional information required for building a new database is prompted for. This additional information is used for security, internal structuring and to provide for the ease of retrieval.
These include:

- database name and title
- database managers
- special characters and numerals
- a common word list
- database size
- keyed fields

Updating Information . . .



REGARDLESS OF FORM OR FORMAT

DATABASE MODIFICATION

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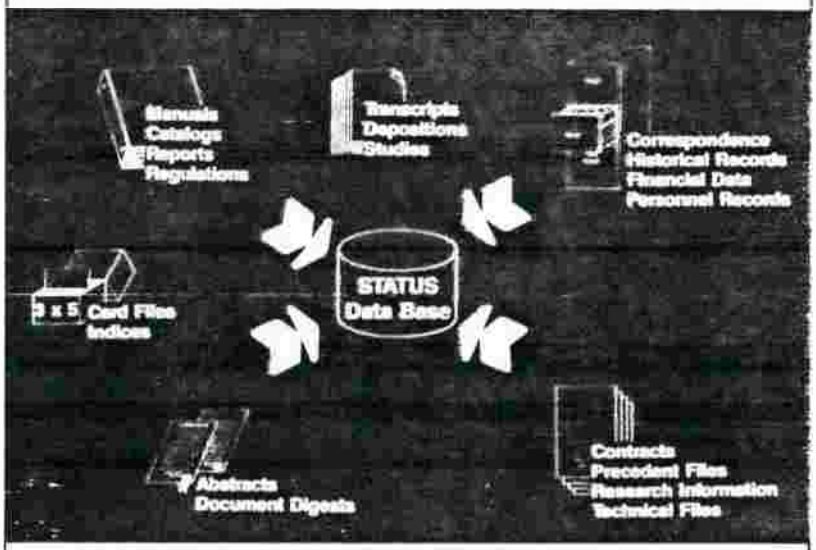

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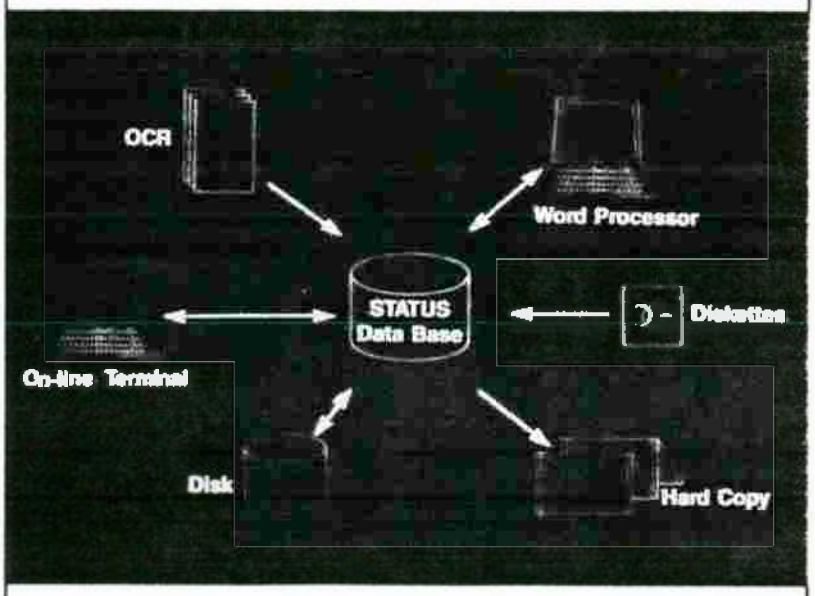
Updating Information . . .



REGARDLESS OF FORM OR FORMAT.

KEY FIELDS

Not all information can be retrieved by simply matching command words with the words in the stored text. Sometimes you will want to select certain values. For example, you may only be interested in people who earn a certain salary or who were born after a certain date. This information can be sifted out by creating keywords at input time which have values attached to them like dates, reference numbers and so on.

TRUNCATION SEARCHING

It is also possible to search for words which share a common root. For example, all words which begin with the letters 'str'. This method is usually used in conjunction with other commands which limit the search. This feature is useful for finding singular and plural nouns, finding misspellings and all occurrances of the root word itself.

SYNONYM TABLE

STATUS also has a synonym feature which enables users to compile a list of synonyms for a word before typing the word itself. The search will identify examples of the original word and its synonyms. Very useful for words with multiple spellings, abbreviations and foreign language translations.

MACROS

To avoid having to type the same thing over and over again, STATUS allows users to pre-define a command which can be initiated by typing a single word. These macro commands, as they are called, allow detailed questions to be asked with very little keying effort. Macros are also used to automate repetitive questions — the question you will ask today, tomorrow and again next week. These questions can be recalled with just a single word.

SECURITY

A system of passwords and security keys protects a STATUS database from unauthorized access. Access to the information within the database can be controlled at the level of chapter, document or named section.

Users cannot discover what is contained in any section of the database for which they do not have clearance.

STATUS APPLICATIONS

There is virtually no limit to the type of information that can be stored on a STATUS database. Like many of the most successful software products, it was designed for ease of use and flexibility for problem solving. STATUS is now in use throughout the world in a variety of applications.

Examples of STATUS applications.

- ☐ Technical abstracts
- ☐ Research data
- ☐ Library cataloguing and issuing
- ☐ Mailing lists
- ☐ Market research information
- ☐ Legal publications
- ☐ Personnel records
- ☐ Subscriptions
- ☐ Catalogues
- ☐ Data on chemicals and pharmaceuticals
- ☐ Client records
- ☐ Contracts

DOCUMENTATION AND SUPPORT

A full set of manuals are provided for each user. These consist of: STATUS Users and Utilities Manuals; Report Generator; and other STATUS support manuals.

PORTABILITY

- ■ Completely transparent to the user
- ■ No re-training
- ■ Runs on most machines, such as:
- • Micros
  — IBM PC/XT/AT — Etc.
- • Minis
  — Data General
  — Wang — DEC
  — Prime — Etc.
- • Mainframes
  — IBM — Univac
  — Honeywell — Etc.

THE COMPANY

COMPUTER POWER is one of Australia's largest and most experienced software companies. Formed in 1968, the company now employs more than 500 people throughout Australia (including contract staff) and has expanded operations to New York, Singapore and Hong Kong.

The company specializes in supplying advanced total solutions to meet client needs: software, hardware and professional services. The organisation's growth has been based on a history of successful large projects for large commercial and government organisations.

Computer Power supplies a full range of system consulting and training services for its range of advanced software products. It also provides software development and conversion services for both textual and general information systems.

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COMPUTER POWER

APPENDIX 2

Germ Plasm Bank Data for Oryza sativa

Rice Division. Department of Agriculture

Wet

Station..... Seeding date..... Transplanting Date.....

Dry

1. G.S.No.....
2. Name .....
3. Former designation. .....
4. Seed source. .....
5. Country of Origin .....
6. Variety group: indica (1), japonica (sinica) (2),
   javanica (3), intermediates (hybrids) (4)
7. Seedling height (cm):. .....
8. Leaf length (cm):.....
9. Leaf width (cm):. .....
10. Blade pubescence: glabrous (1), intermediate (2), pubescent (3)
11. Blade color: pale green (1), green (2), dark green (3), purple tips (4),
    purple margins (5), purple blotch (6), purple (7).
12. Basal leaf sheath color: green (1), purple lines (2), light purple (3)
    purple (4)
13. Leaf angle: erect (1), horizontal (5), drooping (9)
14. Flag leaf angle: erect (1), intermediate (3), horizontal (5), descending (7)
15. Ligule length (mm):. .....[0 for leguleless, tincturaless or auricleless]
16. Ligule color: whitish (1), purple lines (2), purple (3)
17. Ligule shape: acute to acuminate (1), 2-cleft (2), truncate (3)
18. Collar color: pale green (1), green (2), purple (3)
19. Auricle color: pale green (1), purple (2)
20. Number of days from seeding to 50% headed: .....
21. Culm length (cm):. .....
22. Culm number:.....
23. Culm angle: erect(1), intermediate (3), open (5), spreading (7), procumbent (9)
24. Culm diameter of basal internode (mm):. .....
25. Internode colour: green (1), light gold (2), purple lines(3), purple (4)
26. Culm strength: strong (no lodging) (1),
    moderately strong (most plants showing leaning) (3),
    intermediate (most plants moderately lodged) (5),
    weak (most plants nearly flat) (7),
    very weak (all plants flat) (9)

APPENDIX 2

Germ Plasm Bank Data for Oryza sativa

Rice Division. Department of Agriculture

27. *Panicle elngth (cm):.....

28. Panicle type: compact (1), intermediate (5), open (9)
(angle of panicle branches)

29. Secondary branching: absent (0), light (1), heavy (2), clustering (3)

30. Panicle exsertion: well exserted (1), moderately well exserted (3),
just exserted (5), partly exserted (7), enclosed (9)

31. Panicle axis: straight (1), droop (2)

32. Panicle shattering: very low (less than 1%) (1), low (1-5%) (3),
moderate (6-25%) (5), loose (26-50%) (7),
high (more than 50%) (9)

33. Panicle threshability: difficult (1), intermediate (5), easy (9)

34. Awning: absent (0), short & partly awned (1),
short & fully awned (5), long & fully awned (9)

35. Awn color: straw (1), gold (2), brown (tawny) (3)
red (4), purple (5), black (6)

36. Apiculus color: white(1), straw (2), brown (tawny) (3), red(4),
red apex (5), purple (6), purple apex (7)

37. Stigma color: white (1), light green (2), yellow (3),
light purple (4), purple (5)

38. Lemma and palea color: straw (0), gold & gold furrows on straw(1),
brown spots on straw (2), brown furrows on straw (3)
brown (tawny) (4), reddish to light purple (5),
purple spots on straw (6), purple furrows on straw (7)
purple (8), black (9)

39. Lemma and palea pubescence: glabrous (1), hairs on lemma keel (2)
hairs on upper portion (3), short hairs (4),
long hairs (velvety) (5).

40.* Sterile lemma color: straw (yellow) (1), gold (2),
red (3), purple (4).

41.* Sterile lemma length: short (not longer than 1.5 mm) (1),
medium (1.6-2.5 mm) (3),
long (longer than 2.5 mm, but shorter than the lemma) (5)
extra long (equal to or longer than the lemma) (7)
asymmetrical (9)

APPENDIX 2

Germ Plasm Bank Data for Oryza sativa

Rice Division. Department of Agriculture

42.* Spikelet fertility: highly fertile (>90%) (1), fertile (75-90%) (3),
partly sterile (50-74%) (5)
highly sterile (<50% to trace) (7),
completely sterile (0%) (9)

43.* 100-grain weight(g):. . . . .

44.* Grain length (mm):. . . . .

45.* Grain width (mm):. . . . . .

46.* Seed coat color: white (1), light brown (2), speckled brown (3), brown (4),
red (5), variable purple (6), purple (7)

47.* Endosperm type: non-glutinous (non-waxy) (1), glutinous (waxy) (2)

48.* Scent: non-scented (0), lightly scented (1), scented (2)

49.* Leaf senescence: late & slow (1), intermediate (5), early & fast (9)

50. Maturity (days):. . . . . .

51.* Chalkiness: No chalkiness (1), slightly chalky (2), moderately chalky (3),
chalky (4), very chalky (5)

52.* Brown rice width. . . . . mm.

53.* Brown rice length. . . . . mm.

54.* Brown rice thickness. . . . . mm.

55.* Brown rice shape: long slender (1), intermediate (2), bold (3)

56.* Amylose content (%):. . . . . .

57.* Protein content (5):. . . . . .

58.* Spreading value in alkaline test: high (1) high intermediate (2),
intermediate (3), low (4)

59.* Embryo size

60. Others

* Items marked with asterisk are taken in laboratory room.