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INDO-US TRAINING WORKSHOP ON AGROMET

DATABASE MANAGEMENT

by

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Gerrit Hoogenboom,

N. V. K. Chakravarty,

and

M. B. Rajegowda

7 November 1990

New Delhi, India

Winrock International

Institute for Agricultural Development

USAID Agricultural Support Service Project

INDO-US TRAINING WORKSHOP ON AGROMET

DATABASE MANAGEMENT

October 22-November 6, 1990

New Delhi, India

by

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Winrock International

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EXECUTIVE SUMMARY

A workshop on climate data management was held in New Delhi, India from October 22 to November 6, 1990. There were twenty one Indian scientists in attendance and four presenters-two each from the U.S.A. and India. Guest speakers at the workshop included Dr. A. Chaudhary, Deputy Director General, Meteorology (AgMet); Dr. I. P. Abrol, Deputy Director General, ICAR; Dr. P. C. Bhatia, Principal Scientist, ICAR; and Mr. B. V. Ramana Rao, Project Coordinator, AICRP on Agrometeorology.

Facilities for the workshop were provided by the Division of Agricultural Physics at the Indian Agricultural Research Institute in the Library Hall of the Department of Plant Physiology. This area was set-up with 8 Personal Computers with 1 to 2 MByte memory and 40 and 60 MByte harddrives. Four printers with sharing devices were also provided. Evening access was available to participants.

The agenda included a combination of lectures, demonstrations, and hands-on computer exercises and practice sessions. During the first four days of the workshop a training session on the use of DOS and Introduction to Computers was conducted by Drs. S. T. Nagaraj, N. V. K. Chakravarty and M. B. Rajegowda. The remainder of the workshop consisted of lectures and demonstrations by Drs. K. G. Hubbard and G. Hoogenboom and hands-on sessions during which all four instructors joined in as resource persons. Both climate data management and applications programs, including an introduction to crop growth simulation modeling, were addressed.

A preworkshop questionnaire was disseminated to determine the expectations of the participants. At the end of the workshop a post-workshop questionnaire was filled out by each participant in order to determine their opinion on the workshop, facilities, etc. From the post-workshop proforma it can be concluded that 85 % of the participants felt confident in installing the

software on their personal computer and operating the data base management programs for their automated weather station.

Several difficulties were experienced. With regard to computers, there were 2 PC compatibles that were secured from the private sector that did not have math co-processors-this made it impossible to run the computer programs that had been brought in by the U.S. instructors on these two machines. Two other machines had math co-processors, but certain of the programs would not run on these machines, none-the-less. In addition on one of the remaining machines the 1.2 MByte disk drives malfunctioned and another was not available for replacement. A 360 KB drive was installed but transfer of data files and software to this machine became difficult.

The participants were serious and hard working scientists with mainly agronomical and physics backgrounds. The latter had somewhat of an easier time with computers. Most participants made excellent progress considering the limited time available and the volume of material to be covered. A list of participants is included in the appendix. Generally they were attentive and enthusiastic although the majority were on the early part of the learning curve with respect to computers.

Based on the participants' evaluation of the workshop, it would appear that this workshop was very successful.

INTRODUCTION

Climate data management is important to climatologists and meteorologists and those working in closely related fields. This is especially true with the entry into the picture of automated weather data collection equipment capable of collecting data on a frequency of 1 minute or less. Scientists need to learn how to manage voluminous data sets and to make good decisions about the types of data to be collected and the analyses to be performed.

BACKGROUND

This workshop was the culmination of an activity begun early in 1990. Two scientists from India- Drs. M. B. Rajegowda and N. V. K. Chakravarty-visited the U.S.A. and spent 5 months mainly at the University of Nebraska for the purpose of being trained in climate data management. There experience included participation in workshops and meetings in Washington, D.C. and Anaheim, CA. as well as visits to Michigan State University and the University of Illinois. Materials for a workshop to be held in India were prepared and plans were made to hold the workshop at the end of October, 1990. This process had been repeated for a number of topics. This workshop on Climate Database Management was the third in a series of workshops organized by Winrock under the All India Coordinated Research Project in Agrometeorology. In addition to training and technology transfer, future collaborative projects between India and U.S. scientists is one of the stated goals of this project.

OBJECTIVES

There were four objectives of the workshop. These were:

1) to understand techniques for automated weather data collection and their role in agrometeorolgy and agroclimatology research.

2) to become familiar with setting up a climate data management system on the micro-computer (the Automated Weather Data Network System).

3) to become familiar with concepts for calibration of sensors and quality control of data.

4) to understand the importance of using mathematical models and crop growth simulation models to analyze and evaluate climate data as it relates to the agrometeorological system.

PROBLEMS ENCOUNTERED AND SOLUTIONS

The computing facilities available for this workshop were the best among all the workshops in this project that have been held to date. However, several computer difficulties were experienced including no math co-processors for two machines, and two machines with math co-processors that would not run certain of the software. On one machine the 1.2 MByte disk drive went out and a suitable replacement could not be found. A portable PC brought by Dr. Hoogenboom was used to transfer files to the machine that had lost its floppy disk drive. Out of the eight computers available this meant that only six were available for hands-on experience. This condition caused more participants to share each of the available computers. In some cases four participants were operating on one computer. It is recommended that in future workshops a maximum of two participants will be assigned to one computer.

Another problem was the lack of computer related experiences by the majority of participants. To counter this problem a 4 day computer training session was held prior to the arrival of the U.S. scientists. U.S. scientists also tried to provide more detailed step-by-step instructions including suggestions on the DOS commands to be used.

Lack of a "computer screen" projection device that would allow all participants to see demonstrations simultaneously was a problem. Instructors had to demonstrate on several machines and also use the regular overhead projector to write the types of computer prompts, etc. that participants would encounter.

The time allowed for crop growth modeling was too short. A very general introduction about crop growth modeling was given, followed by a hands-on session by the participants. Participants had many questions which could not all be answered during this session.

RECOMMENDATIONS

1. It is recommended to define an all-India Automated Weather Station Format.

2. Assign regional Indian experts to follow-up with the participants on the installation of the data base management software.

3. Allocate one or two days during the next workshops to allow for exchange of experience between participants on the installation of the Campbell CR10 weather station, data base management software, and collection of weather data.

4. All centers should obtain an official copy of IBM Professional Fortran or equivalent Fortran compiler.

5. More sessions to practice computer skills and receive training on DOS and general computer application programs.

6. The same scientists should attend subsequent workshops.

7. Concentrate future workshops on one topic to avoid confusion by participants.

8. Hold a special workshop on dynamic crop growth modeling.

9. It is recommended that in future workshops a maximum of two participants will be assigned to one computer.

CONCLUSIONS AND SUMMARY

The presentation of a two-week workshop was not long enough to cover both climate data management and applications programs. Future applications, like crop modeling, will alone require a full 2-weeks for a single topic.

Future collaboration will require new sources of funding beyond those generally available to U.S. scientists. Funding should be identified for international travel and for equipment and research operational expenses.

APPENDIX

Acknowledgements

List of terms

List of Instructors

List of Participants

Activities Report

Preworkshop Proforma

Post-workshop Proforma and responses

Handouts[1]

- Agenda
- Objectives
- CR10 prompt sheet
- Wiring diagram
- CR10 program
- Storage module instructions
- Calibration guides
- AWDN Flow diagram
- AWDN users guide
- DOS Quick Reference Card
- PNUTGRO simulation for India

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1. All overhead transparencies were also photocopied for participants (not available for report).

Acknowledgements

The co-presenters of the workshop would like to thank all those who had a role in making the workshop a successful venture. In particular, we thank Drs. I.P. Abrol and P.C. Bhatia for the support and interest they showed in the workshop as witnessed by their attendance at the inaugural and valedictorial exercises.

Staff members of Winrock including Dr. C. McClung, Dr. Naharaj Singh, and Mr. P. S. Srinivasan were helpful in setting the stage and making various arrangements for the workshop.

We appreciate the role of special speakers at the workshop including: Dr. I. P. Abrol, Deputy Director General, ICAR; Dr. P. C. Bhatia, Principal Scientist, ICAR; Dr. John Becker, Chief Ag. Div. USAID; Dr. S. M. Kulshrestha, Director General, IMD; Dr. N. N. Goswami, Director, IARI; Dr. B. C. Panda, Head Ag. Phys. Div.; Dr. A. Chaudhary, Deputy Director General, Meteorology (AgMet), IMD; Mr. B. V. Ramana Rao; and P. S. N. Sastry, Principal Scientist, IARI.

The U.S. scientists would like to thank Dr. M. B. Rajegowda for his efforts in regard to the workshop including setting up the computers and being a resource person during the hands-on work sessions of the workshop.

We would like to thank Manoj Kumar for helping with the CR10 data logger part of the program.

Local arrangements were handled effectively by Dr. N. V. K. Chakravarty and Mr. P.S.N Sastry. We are grateful to Dr. B. C. Panda for furnishing space for the workshop.

Scope of Work for U.S. Consultants

This two-week workshop was prepared jointly by two U.S. scientists (Dr. Kenneth G. Hubbard and Dr. Gerrit Hoogenboom) and two Indian scientists (Dr. N.V.K. Chakravarty and Dr. M.B. Rajegowda) at the University of Nebraska during Jan-June 1990 when the latter were receiving training with the former.

The principal objectives of the workshop are:

1. To enlarge the pool of adequately trained man power for teaching/research in agrometeorology database management in Research Institutes of the Indian Council of Agricultural Research and the State Agricultural Universities.

2. To provide high quality instructional material for teaching/training agrometeorology database management in the ICAR-SAU system.

3. To formulate a technical program of cooperative research under the All India Coordinated Research Project in Agrometeorology for the development of an agrometeorology data base management system for such purposes as (a) crop planning under rain-fed and irrigated conditions (b) scheduling agricultural operations at field level (c) monitoring crop growth and development (d) weather forecasting to guide decisions in response farming and (e) irrigation water management.

The workshop will be conducted at IARI, New Delhi by the two U.S. scientists in collaboration with the two Indian scientists. The scope of work is given below:

1. To conduct the workshop as jointly prepared and planned.

2. To evaluate the workshop for the relevance and effectiveness.

3. To prepare and submit to Project Director, AGRE, USAID, New Delhi, a comprehensive report on the workshop.

List of Terms

AICRP	All India Coordinated Research Project
AWDN	Automated Weather Data Network
DST	Department of Science and Technology
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
IMD	India Meteorological Department

List of Instructors

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U.S.A.

Dr. N. V. K. Chakravarty
Senior Scientist
Division of Agricultural Physics
IARI
New Delhi

Dr. M. B. Rajegowda
Assistant Meteorologist
University of Agricultural Sciences
Bangalore (Karnataka)

List of Participants

1. Dr. N.N. Angiras
   Assoc.Professor
   Dept. of Agronomy
   H.P.K.V,
   Palampur (H.P)

2. Dr. G.S. Bains
   Asst.Professor
   Dept. of Agrometeorology
   Punjab Agricultural University,
   Ludhiana (punjab).

3. Dr. A.A. Dasan
   Agrometeorologist
   T.N.Agicultural University,
   Kovilpatti (Tamilnadu)

4. Dr. C.B. Gaikwad
   Agrometeorologist
   M.P.Krishi Vidyalaya
   Solapur (Maharashtra)

5. Dr. S.S. Hundal
   Agrometeorologist
   Dept. of Agrometeorology
   Punjab Agricultural University
   Ludhiana (Punjab)

6. Dr. A.V.R. Kesava Rao
   Asst.Professor
   Kerala Agricultural University
   Trichur (kerala)

7. Dr. A.N. Mehta
Professor
Dept.of Agrometeorology
Gujarat Agricultural University
Anand (Gujarat)

8. Dr. N.S. Murty
Senior Research Officer (Agrometeorology)
G.B.Pant University of Agriculture & Technology
Hill Campus,
Ranichauri (Tehri, U.P)

9. Dr. S.T. Nagaraj
Agrometeorologist
University of Agricultural Sciences
Bangalore (Karnataka)

10. Mr. T.R. Rao
Research Scholar
Dept. of Agricultural Physics
IARI
New Delhi

11. Dr. R.S. Singh
Scientist (Agrometeorology)
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Central Arid Zone Research Institute
Jodhpur (Rajasthan)

12. Dr. Ram Singh
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Hissar (Haryana)

13. Dr. A.S.R.A.S. Sastri
Associate Professor
Dept. of Physics and Agrometeorology
Indira Gandhi Agricultural University
Raipur (M.P)

14. Dr. C.V.S. Sastri
Senior Scientist
Division of Agricultural Physics
IARI
New Delhi

15. Dr. R.D. Singh
Senior Scientist
N.E.H.complex
Sikkim

16. Dr. Y.V. Subba Rao
Senior Scientist
Division of Agricultural Physics
IARI
New Delhi

17. Dr. P. Tripati
Assoc. Professor of Biophysics
N.D.University of Agriculture & Technology
Faizabad (U.P)

18. Dr. Upendra Shankar
Agrometeorologist
J.N.K.Viswavidhyalaya
Jabalpur (M.P)

19. Dr. U.S. Victcr
Senior Scientist
Central Research Institute for Dryland Agriculture
Hyderabad (A.P)

20. Dr. A. Yogeswara Rao
Agrometeorologist
A.P.Agricultural University
Anantpur (A.P)

Activities Report

ACTIVITIES LISTING FOR DR. KENNETH G. HUBBARD

Workshop sessions always lasted until 7:00 or 8:00 in the evenings.

22-24 October 1990, Monday to Thursday

In route to Delhi

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25 October 1990, Thursday

8:45	Picked up at the airport by Dr. N. V. K. Chakravarty and Dr. M. B. Rajegowda who accompanied to all meetings on 25-11-90.
9:00	Check in at Hyatt
9:45	Meeting at Winrock offices w. Dr. C. McClung, Dr. Maharaj Singh, and Mr. P. S. Srinivasan
12:00	Meet with the participants at IARI
12:30	Meet with Dr. B.C. Panda, Head Ag. Physics, and P.S.N. Sastry, Principal Scientists
1:00	Lunch at Siddharth Hotel with Dr. B.C. Panda, P.S.N. Sastry, Dr. N.V.K. Chakravarty and Dr. M. B. Rajegowda. Also viewed rooms to determine suitability.
2:45	Meeting with Dr. I.P. Abrol, Deputy Director General, ICAR and Dr. P.C. Bhatia, Principal Scientist, ICAR
4:00	Back to Hyatt Hotel

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26 October 1990, Friday

9:30	Departed Hyatt Hotel for IARI
9:45	Met with participants and other scientists at lecture hall.
10:30	Inaugural function for workshop begins. Met Dr. S.M. Kulshrestha, Director General of Meteorology, IMD and Dr. N. N. Goswami, Director, IARI.

11:45 Met S. Aneja and Manoj Kumar of Elron Instrument Co. PVT. LTD.

12:00 Informal meeting with Dr. J.S.P. Yadav, Dr. Maharaj Singh, Dr. P.C. Bhatia and participants

1:00 Lunch at Siddharth Hotel with Dr. Gerrit Hoogenboom

2:30 Workshop sessions (see agenda)

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27 October 1990, Saturday

9:00 Move from Hyatt to Siddharth Hotel

9:30 Workshop sessions (see agenda)

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28 October 1990, Sunday

Visit to Agra accompanied by Dr. N.V.K. Chakravarty, Dr. M.B. Rajegowda and Dr. Hoogenboom.

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29 October to 3 November 1990, Monday to Saturday

9:30 Workshop Sessions daily till 7:00 or 8:00 p.m.

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3 November 1990, Saturday (cont.)

2:30 Met Dr. A. Chaudhary, Deputy Director General, IMD who also gave a talk at the workshop

Drafted first sections of the report in the late evening.

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4 November 1990, Sunday

Visit sites around Delhi with Drs. M.B. Rajegowda, Dr. Y.V. Subba Rao, S. T. Nagaraj, and Dr. Gerrit Hoogenboom.

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5 November 1990, Monday

9:30 Workshop Sessions (see agenda)

2:30 Cancelled special lecture scheduled for Institute of Science and Technology due to bandh

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6 November 1990, Tuesday

9:30 Meeting with Dr. I.P. Abrol, Dr. P.C. Bhatia, Dr. Ramana Rao, other presentors, and participants to exchange comments on the workshop and to go over the workshop proforma.

3:00 Rescheduled special lecture on automated weather data networks to scientists at the Institute of Science and Technology. Met Dr. J. Bahadur, Director, Dept. Science and Technology and his colleagues.

6:30 Joined Dr. C. McClung and his wife for dinner at their residence.

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7 November 1990, Wednesday

8:30 Meeting with Dr. N.V.K. Chakravarty, P.S.N. Sastry, and Dr. Gerrit Hoogenboom to work on the report of workshop.

11:00 Meeting with Winrock officials to discuss the report

2:00 Checkout from Siddharth Hotel

3:30 Meeting with Dr. John Becker, USAID.

10:00 Reach Delhi International Airport for departure on Pan American Airline flight #67 (3:30 a.m. Thursday)

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8 November 1990, Thursday

In route to Lincoln, Nebraska, U.S.A.

ACTIVITIES LISTING FOR DR. GERRIT HOOGENBOOM

Workshop sessions always lasted until 7:00 or 8:00 in the evenings.

24-26 October 1990, Wednesday to Friday

In route to Delhi

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26 October 1990, Friday

9:30	Departed Hyatt Hotel for IARI
9:45	Met with participants and other scientists at lecture hall.
10:30	Inaugural function for workshop begins. Met Dr. S.M. Kulshrestha, Director General of Meteorology, IMD and Dr. N. N. Goswami, Director, IARI.
11:45	Met S. Aneja and Manoj Kumar of Elron Instrument Co. PVT. LTD.
12:00	Informal meeting with Dr. J.S.P. Yadav, Dr. Maharaj Singh, Dr. P.C. Bhatia and participants
1:00	Lunch at Siddharth Hotel with Dr. Hubbard
2:30	Workshop sessions (see agenda)

---

27 October 1990, Saturday

9:00	Move from Hyatt to Siddharth Hotel
9:30	Workshop sessions (see agenda)

---

28 October 1990, Sunday

Visit to Agra accompanied by Dr. N.V.K. Chakravarty, Dr. M.B. Rajegowda and Dr. Hubbard

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29 October to 1 November 1990, Monday to Thursday

9:30 Workshop Sessions daily till 7:00 or 8:00 p.m.

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1 November 1990, Thursday

3:00 Special lecture on Crop Growth Modeling and Weather Data to scientists at the Department of Science and Technology, Super Computer Center. Met Dr. J. Bahadur, Director, Dept. Science and Technology and his colleagues.

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2 November to 3 November 1990, Friday to Saturday

9:30 Workshop Sessions daily till 7:00 or 8:00 p.m.

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3 November 1990, Saturday (cont.)

2:30 Met Dr. A. Chaudhary, Deputy Director General, IMD who also gave a talk at the workshop

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4 November 1990, Sunday

Visit sites around Delhi with Drs. M.B. Rajegowda, Dr. Y.V. Subba Rao and Dr. Hubbard.

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5 November 1990, Monday

9:30 Workshop Sessions (see agenda)

---

6 November 1990, Tuesday

9:30 Meeting with Dr. I.P. Abrol, Dr. P.C. Bhatia, Dr. Ramana Rao, other presentors, and participants to exchange comments on the workshop and to go over the workshop proforma.

3:00 Meeting with scientists at the Institute of Science and Technology. Met Dr. J. Bahadur, Director, Dept. Science and Technology and his colleagues.

6:30 Joined Dr. C. McClung and his wife for dinner at their residence.

---

7 November 1990, Wednesday

8:30 Meeting with Dr. N.V.K. Chakravarty, P.S.N. Sastry, and Dr. Kenneth Hubbard to work on the report of workshop.

11:00 Meeting with Winrock officials to discuss the report

2:00 Checkout from Siddharth Hotel

3:30 Meeting with Dr. John Becker, USAID.

10:00 Reach Delhi International Airport for departure on Pan American Airline flight #67 (3:30 a.m. Thursday)

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8 November 1990, Thursday

In route to Griffin, Georgia, U.S.A.

CLIMATE DATA MANAGEMENT

PRE-WORKSHOP PROFORMA

Your Name:

Name and Address of Your Institution:

Your Present Position and Title:

Your Job Description:

1. Please describe your present work:

2. If there is any information about your present or future work-related responsibilities that you think will help make this course more useful to you, please explain below:

Your Academic Training:

1. What is the highest degree you have earned?

2. Date earned?

3. Name of Institution granting the degree?

4. Major:

QUANTITATIVE/COMPUTER EXPERIENCE:

1. Have you taken 1 or more courses at the post-graduate level in:

Statistical Inference?	___ Yes	___ No
Sampling?	___ Yes	___ No
Experimental Design?	___ Yes	___ No
Multiple Regression?	___ Yes	___ No
Differential Equations?	___ Yes	___ No

2. Have you previously had training in the mathematical modelling of biological or physical systems?

___ Yes ___ No

If yes, please describe that training.

3. Have you had experience using and operating micro-computers (PC's)?

___ Yes ___ No

If yes, which of the following types of software programs have you used?

Operating Systems:

DOS?	___ Yes	___ No
OS/2?	___ Yes	___ No

Other (Please identify by name)?

Applications Software (If yes, identify by name):

Word processing?	___ Yes	___ No
Spreadsheet?	___ Yes	___ No
Statistical?	___ Yes	___ No
Database?	___ Yes	___ No
Other?	___ Yes	___ No

Languages:

BASIC?	___ Yes	___ No
FORTRAN?	___ Yes	___ No
PASCAL?	___ Yes	___ No

Other (Please identify by name)?

SCORE SHEET (IN PER CENT)

CLIMATE DATA MANAGEMENT

POST-WORKSHOP PROFORMA

PRE-WORKSHOP INFORMATION

Did you receive pre-workshop information?

95 Yes 5 No

If Yes, how clear were the course objectives?
(please circle the appropriate number?

Unclear				Very Clear
5	4	3	2	1
	15	15	55	15

Comments?

COURSE ADMINISTRATION/LOGISTICS

Please indicate your satisfaction with the following support arrangements (please circle the appropriate number):

	Not at all Satisfied				Extremely Satisfied
Training Facilities?	5	4	3	2	1
		5	35	20	40
Housing Accommodations?	5	4	3	2	1
		10	25	45	15
Logistical Support?	5	4	3	2	1
		15	25	35	20

Comments?

COURSE CONTENT

1. At the beginning of the course or during the course, did you discuss with the instructors how the course content would meet your specific needs?

85 Yes 15 No

2. Please indicate your achievement of each of the training objectives listed below (please circle the appropriate number):

	Not at all Achieved				Extremely Achieved
Obj 1: Understand techniques of automated weather data collection and their role in agrometeorology and agroclimatology research.	5	4	3	2	1
			35	40	25
Obj 2: Become familiar with setting up a climate data management system on the micro-computer (the Automated Weather Data Network System)	5	4	3	2	1
		10	40	35	15
Obj 3: Become familiar with concepts for calibration of sensors and quality control of data.	5	4	3	2	1
		30	25	40	5
Obj 4: Understand the importance of using mathematical models to analyze and evaluate climate data as it relates to the agrometeorological system.	5	4	3	2	1
		20	35	35	10

3. Was the level of presentation of the subject matter:

____ Too Simple? 90 About Right? 10 Too Complex?

4. Rate the usefulness of each of the course topics in terms of being able to use the ideas, materials or skills in your work (please circle the appropriate number):

	Not Useful				Very Useful
Intro to PC's	5	4	3	2	1
			15	10	75
Review of weather stations and related equipment	5	4	3	2	1
		5	20	30	45
Review of data logger programming	5	4	3	2	1
		5	10	35	50
Review of storage module	5	4	3	2	1
			15	20	65
Introduction to sensor calibration and maintenance	5	4	3	2	1
		20	10	35	35
Setting up the AWDN (system)	5	4	3	2	1
		5	20	50	45
Role of mathematical crop models	5	4	3	2	1
	5	10	15	15	55
Group exercises (hands on)	5	4	3	2	1.
		15	5	15	65

COURSE DESIGN AND DELIVERY

1. During the course, was the daily schedule:

   5 Too Short? 85 About Right? 10 Too Long?

2. Was the overall length of the course:

   5 Too Short? 15 About Right? 80 Too Long?

3 Indicate how helpful you found each of the following teaching methods to be (please circle the appropriate number):

	Not at all Helpful				Extremely Helpful
Lectures?	5	4	3	2	1
		10	20	35	25
Large Group Discussions?	5	4	3	2	1
		10	15	65	10
Small Group Discussions?	5	4	3	2	1
		15	5	25	55
Hands-on Exercises?	5	4	3	2	1
		10	5	10	75
Individual consultations with instructors?	5	4	3	2	1
			10	20	70

4. How useful were the following types of materials (please circle the appropriate number):

	Not at all Useful				Extremely Useful
Course Manual?	5	4	3	2	1
		10	10	15	65
Handouts?	5	4	3	2	1
		15	–	25	60
Written Assignments/Exercises?	5	4	3	2	1
		5	20	20	55
Audiovisual Materials?	5	4	3	2	1
		5	10	25	60
Computer Assisted Information?	5	4	3	2	1
			20	25	55

Comments on instructional materials?

POST WORKSHOP PROFORMA

INSTRUCTORS

1 Name of First Instructor: Kenneth J. Hubbard

Rate this instructor in the following areas (please circle the appropriate number):

	Poor				Excellent
Knowledge of Subject?	5	4	3	2	1
			5	15	80
Presentation of Material?	5	4	3	2	1
			5	15	50	30
Ability to Relate Material to climate data management	5	4	3	2	1
			5	15	40	40
Encourages Participants to Discuss Material?	5	4	3	2	1
			5	10	7	75

What, if anything, would you suggest this instructor do to improve?

2. Name of Second Instructor: [redacted]

Rate this instructor in the following areas (please circle the appropriate number):

	Poor				Excellent
Knowledge of Subject?	5	4	3	2	1
		5	10	10	75
Presentation of Material?	5	4	3	2	1
		5	10	30	55
Ability to Relate Material to climate data management	5	4	3	2	1
		5	10	30	55
Encourages Participants to Discuss Material?	5	4	3	2	1
		10	-	10	80

What, if anything, would you suggest this instructor do to improve?

OVERALL WORKSHOP SATISFACTION

1. Would you recommend this course to other individuals with a background similar to yours?

   90 Yes 10 No

   Please explain why or why not:

2. In general, how confident are you that you can apply the skills learned during this workshop to your research activities (please circle the appropriate number)?

Not at all Confident				Extremely Confident
5	4	3	2	1
		15	75	10

3. Specifically, which topics do you feel you will be able to apply?

4. Please make any additional comments you would like to about this workshop.

(i) Operational manuals should contain more details

(ii) Practical applications of data base management systems should have been also covered

(iii) More practical exercises on crop growth modelling should have been included

SUMMARY EVALUATION OF THE WORKSHOP

1. Do you recommend that there should be initial training on the use of computers and software packages prior to the actual beginning of the workshop?

Not required	5	4	3	2	1	required
			5	15	80	

2. Do you like to attend the future workshops to be organised under the Indo-US subproject on Agrometeorology?

Not interested	5	4	3	2	1	Very much interested
	-	-	-	-	100	

3. Overall rating on the pre-workshop sessions on Introduction to the use of computers:

Very poor	5	4	3	2	1	Excellent
		5	15	40	40	

Overall rating of the actual workshop on Agromet Database Management

Very poor	5	4	3	2	1	Excellent
		5	20	40	35	

****

Handouts

Agenda

Objectives

CR10 prompt sheet

Wiring diagram

CR10 program

Storage module instructions

Calibration guides

AWDN Flow diagram

AWDN users guide

DOS Quick Reference Card

PNUTGRO simulation for India

INDO-US TRAINING WORKSHOP ON AGROMET DATABASE MANAGEMENT

Division of Agricultural Physics, I.A.R.I., New Delhi

Venue: Library Hall, Division of Plant Physiology

Programme for. 22-10-1990 9.30 a.m. to 5.00 p.m.

9.30 - 10.00	Registration
10.00 - 11.00	Welcome and Introduction
11.00 - 11.30	Tea-Break
11.30 - 1.00	Shaking hands with Computer
1.00 - 2.30	Lunch Break (Sindhu Guest House)
2.30 - 4.00	MS-DOS Commands I
4.00 - 4.15	Tea-Break
4.15 - 5.00	Address by Dr. P.C. Bhatia, I.C.A.R.

Programme for 23-10-1990 9.30 a.m. to 5.00 p.m.

9.30 - 11.00	MS-DOS Commands II
11.00 - 11.15	Tea-Break
11.15 - 1.00	Programming in BASIC I
1.00 - 2.30	Lunch Break
2.30 - 4.00	Programming in BASIC II
4.00 - 4.15	Tea-Break
4.15 - 5.00	Programming in Basic III

Programme for 24-10-1990 9.30 a.m. to 5.30 p.m.

9.30 - 11.00	Application Software I
11.00 - 11.15	Tea-Break
11.15 - 1.00	Application Software II
1.00 - 2.30	Lunch Break
2.30 - 5.30	Presentation of Reports by US - AID Trainees

Programme for 25-10-1990 9.30 a.m. to 5.00 p.m.

9.30 - 11.00	Applicataion Software III
11.00 - 11.15	Tea-Break
11.15 - 1.00	Discussion
1.00 - 2.30	Lunch-Break
2.30 - 5.00	Discussion (contd.)

INDO-US TRAINING WORKSHOP ON AGROMET DATA BASE MANAGEMENT

22nd OCTOBER to 6th NOVEMBER 1990

IARI, NEW DELHI.

PROGRAMME

Date	Time	Code	Topic of the Session
Friday 10/26	10.30		Inauguration (NRL Auditorium)
	11.30		Tea break
	12.00		Visit to Computer Hall
	13.00		Lunch break
	14.00	L	Station Review
		L	DOS and editing files
		LD	Weather Station: Wiring & Programming
		D	Weather Station: Loading and Retrieving
Saturday 10/27	09.00	LP	Writing and using Data Logger Programmes
Sunday 10/28		Reading and Review (No meetings scheduled)	
Monday 10/29	09.00	LD	Maintenance and calibration of sensors
	14.00	P	Hands on calibration
Tuesday 10/30	09.00	L	Introduction to AWDN
	10.00	PD	General AWDN set-up process
	14.00	L	Continuaton of AWDN set-up
Wednesday 10/31	09.00	P	Set-up AWDN System for CR10 Station

PROGRAMME

Date	Timing	Code	Topic of the Session
Thursday 11/1	09.00	L	Special Lecture Gerritt Hoogenboom-Crop models and the need for weather data.
		L	AWDN QualityControl(QC) Topics
	14.00	L	AWDN (QC) (Contd.)
		P	Quality Control(QC)
Friday 11/2	09.00	L	Writing software for use with AWDN System
		L	Deriving Climatological Normals
	14.00	L	Manual Data Entry
	15.00	P	Hands on using manual data entry
Saturday 11/3	09.00	L	Discussion
	11.00	D	AWDN Application Programmes
	14.00	L	Special Lecture
	15.00	L	Backing-up AWDN
Sunday 11/4			TBA
Monday 11/5	09.00	L	Modelling:Soil Moisture, Crops
	14.00	L	Modelling continued
Tuesday 11/6	10.30		Valedictory Function
	12.00	DP	Review Topics
	14.00		Post Workshop proforma Review and adjournment

Tea break :11 .& 16 hrs..

Lunch break: 13-14 hrs.

Distribution: All Participants

CLIMATE DATA MANAGEMENT WORKSHOP
New Dehli, India
October 26-November 7, 1990

by

U.S. Scientists
Dr. Kenneth G. Hubbard
High Plains Climate Center
237 Chase Hall
University of Nebraska
Lincoln, Nebraska 68583
U.S.A.

Dr. Gerritt Hoogenboom
University of Georgia
Ag. Engineering Dept.
Georgia Experiment Station
Griffin, Georgia 30223
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Indian Scientist
Dr. N.V.K. Chakravarty
Division of Agricultural Physics
Indian Ag. Research Institute
New Delhi 110 012
INDIA

Dr. M.B. Rajegowda
Ag. Meteorology Unit
Univ. of Agricultural Sciences
GKVK, Bangalore 560 065
INDIA

Work Shop Objectives

A) Understand techniques of automated weather data collection and their role in agrometeorology and agroclimatology research.

B) Become familiar with setting up a climate data management system on the micro-computer (the Automated Weather Data Network System).

C) Become familiar with concepts for calibration of sensors and quality control of data.

D) Understand the importance of using mathematical models to analyze and evaluate climate data as it relates to the agrometeorology discipline.

CODES

P - Practical
L - Lecture
D - Demonstration

SPECIMEN COPY

INDIAN AGRICULTURAL RESEARCH INSTITUTE

DIVISION OF AGRICULTURAL PHYSICS
NEW DELHI

INDO–US TRAINING WORKSHOP ON AGROMET DATABASE MANAGEMENT

This is to certify that Dr. A. Yogeswara Rao participated in the Indo–US Training Workshop on **AGROMET DATABASE MANAGEMENT** held from October 22 to November 6. 1990 in the Division of Agricultural Physics, Indian Agricultural Research Institute, New Delhi. The Workshop was held under the auspices of the Indo–US Sub–Project on Strengthening Agrometeorological Research to enhance Food Production in India.

The Workshop consisted of lectures and practicals on Automatic Weather Data Network System, use of weather data for Crop Growth Modelling and development of Decision Support Systems for Agrotechnology Transfer on regional basis.

B.C. Panda
Head
Div. of Agril. Physics

N.N. Goswami
Dean & Director
I A R I

Dated the 6th November, 1990

HO

CR10 PROMPT SHEET

*MODES

To enter each Mode, key in a * ("star"), followed by the desired mode number. The KEY DEFINITION SUMMARY lists commands that are used to interrogate and program the CR10. Please refer to the CR10 Manual for detailed information and examples.

KEY DEFINITION SUMMARY

- 0-9 Enter numeric data, instruction number, or parameter
- A Advance through a program table or data storage, or Enter the displayed number
- B Back up through a program table or data storage
- C Change the sign of a floating point number or Index an input location
- D Enter a decimal point
- # Clear digit just keyed; display storage location number

***0 – Compile program, LOG data and Indicate Active Table(s)**

***1, *2 – Display or Enter Program Instructions or Parameters in Table 1 or 2**

01:xx	Instruction location to advance to
01:x.xxxx	Execution Interval:

Valid entries are

multiples of:	for Range of:
1/64 (0.015625) s.	1/64 to 1 s.
1/8 (0.125) s.	1 to 32 s.
1 s.	32 to 8191 s.

01:Pxx	Program Instruction (see following pages for Instruction and Parameter listings)

*Commands Specific to *1 and *2 Modes:*

- #A - Advance to next instruction
- #B - Back up to previous instruction
- #D - Delete entire instruction

***3 – Display or Change Subroutine Program Table**

Same as for *1 and *2, except that *3 does not have an Execution Interval

***5 – Display or Set Datalogger Time**

:HH:MM:SS (displays current datalogger time)

05:xx	Year
05:xxxx	Day of Year
05:HHMM	Hours Minutes

***6 – Display or Change Input Storage Data Values, Flags or Port status. Compile Program without resetting Input Storage Data Values, Flags or Ports**

06:xxxx Input Storage Location to advance to

*Commands Specific to *6 Mode while viewing an Input Location:*

- # Display Input Location Number or enter location to advance to
- C Enter value in Input Location
- D Display flags 1-8, toggle flag w/keys 1-8
- 0 Display ports 8-1, toggle port w/keys 1-8

***7 – Display Final Storage Data**

07:xx	Select area 1 or 2 (skipped if 2 not allocated)
07:xxxxx	DSP location; enter location to advance to

*Commands Specific to *7 Mode:*

- # Display Final Storage location number; enter location to advance to, or C to display data
- #A Advance to same element in next array w/ same ID
- #B Back up to same element in previous array w/ same ID

***8 – Start Manual Data Dump**

08:xx	Select Storage Area 1 or 2 (skipped if 2 not allocated)
01:xx	Output Device Code (see Inst. 96 options)
02:xxxxx	Current or start Final Storage Location
03:xxxxx	DSP or end Final Storage Location
04:xx	Enter any number to start dump

Aborts dump

***9 – Storage Module Commands,**

see Storage Module manual

***A – Display or Change Memory Allocation**

01:xxxx	Input Storage Locations
02:xxxx	Intermediate Storage Locations
03:xxxxx	Final Storage Locations - Area 2
04:xxxxx	Final Storage Locations - Area 1
05:xxxx	Remaining program memory (bytes)

***B – Display Signatures/Status**

01:xxxxx	Program signature
02:xxxxx	EPROM signature
03:xx	Kbytes memory: RAM + ROM
04:xx	No. of E08's (key 88 to reset)
05:xx	No. of table overruns (key 88 to reset)
06:xxxxx	PROM number

***C – Display or Change Security**

01:xxxx	Lock *1,*2,*3,*A,*D
02:xxxx	Lock *5 & *6 display only
03:xxxx	Lock *7,*8,*9,*B; telecommunication commands except A,L, and E

***D – Save/Load Programs**

- 1 - Print program (ASCII)
- 2 - Load program (ASCII)
- §3 - Save program on tape
- §4 – Load program from tape
- 7N – Save/Load/Clear program in Storage Module N (N=1-8)
- 1x Store program x in Storage Module
- 2x Load program x from Storage Module
- 3x Clear program x from Storage Module

} (x=1-8

NOTE: x represents a digit from 0 to 9 unless otherwise defined

§ Standard in OS10-1

CAMPBELL SCIENTIFIC, INC.

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CR10 INSTRUCTION AND PARAMETER SUMMARY

INPUT/OUTPUT INSTRUCTIONS

INST.	DESCRIPTION	01:	02:	03:	04:	05:	06:	07:	08:	09:	10:
		PARAMETERS									
1	VOLT (SE)	REPS	RANGE†	IN CHAN	LOC	MULT	OFFSET				
2	VOLT (DIFF)	REPS	RANGE†	IN CHAN	LOC	MULT	OFFSET				
3	PULSE	REPS	IN CHAN	CONFIG†	LOC	MULT	OFFSET				
4	EX-DEL-SE	REPS	RANGE†	IN CHAN	EX. CHAN†	DELAY 0.01s	EXCIT mV	LOC	MULT	OFFSET	
5	AC HALF BR.	REPS	RANGE†	IN CHAN	EX CHAN†	EXCIT mV	LOC	MULT	OFFSET		
6	FULL BR	REPS	RANGE†	IN CHAN	EX. CHAN†	EXCIT mV	LOC	MULT	OFFSET		
7	3W HALF BR	REPS	RANGE†	IN CHAN	EX CHAN†	EXCIT mV	LOC	MULT	OFFSET		
8	EX-DEL-DIFF	REPS	RANGE†	IN CHAN	EX. CHAN†	DELAY 0.01s	EXCIT mV	LOC	MULT	OFFSET	
9	FULL BR. w/ MEAS EX.	REPS	EX RANGE†	BR. RANGE†	IN CHAN	EX CHAN†	EXCIT mV	LOC	MULT	OFFSET	
10	BATT VOLT	LOC									
11	TEMP-(107)	REPS	IN CHAN	EX CHAN†	LOC	MULT	OFFSET				
12	R.H. (207)	REPS	R.H. CHAN	EX CHAN†	TEMP LOC	R.H. LOC	MULT	OFFSET			
13	TEMP-TC (SE)	REPS	RANGE†	IN CHAN	TC TYPE†	REF LOC	LOC	MULT	OFFSET		
14	TEMP-TC (DIFF)	REPS	RANGE†	IN CHAN	TC TYPE†	REF LOC	LOC	MULT	OFFSET		
16	TEMP-RTD	REPS	R/Ro LOC	LOC	MULT	OFFSET					
17	TEMP-INTERNAL	LOC									
18	TIME	OPTION†	MOD/BY	LOC							
19	SIGNATURE	LOC									
20	PORT SET	8765†	4321†								
21	EXCIT-DEL	EX CHAN	DEL w/ ex	DEL after ex	EXCIT mV	(del units 0.01s)					
‡ 23	BURST MODE	NO CHAN	RANGE†	IN CHAN	OPTION†	SCAN(ms)	NO SCAN	YR OFF	TR LIM mV	EXCIT mV	LOC
23	cont									11: MULT	12: OFFSET
24	CALIBRATION	LOC†									
25	READ PORTS	MASK†	LOC†								
26	TIMER	LOC (to reset timer, use LOC = 0)									
27	PERIOD AVG	REPS	OP/GAIN†	IN CHAN	NO CYC	LIM(0.01s)	LOC	MULT	OFFSET		
28	VIB WIRE	REPS†	IN CHAN	EX CHAN	F1†	F2†	NO CYC	DEL 0.01s	LOC	MULT	OFFSET
‡ •101	SDM-INT8	ADDR	C 8765†	C 4321†	F 8765†	F 4321†	OUT OPT †	LOC	MULT	OFFSET	
‡ •102	SDM-SW8A	REPS	ADDR	FUNCT†	CHAN	LOC	MULT	OFFSET			
‡ •103	SDM-A04	REPS	ADDR	LOC							
‡ •104	SDM-CD16	REPS	ADDR	LOC							

† Option Codes

INST. DESCRIPTION

1-14 ***RANGE codes:***

Slow (2.72 ms integration time)
Fast (272 µs integration time)
60 Hz rejection
50 Hz rejection

Slow	Fast	60 Hz	50 Hz	Full scale range
1	11	21	31	± 2.5 mV
2	12	22	32	± 7.5 mV
3	13	23	33	± 25 mV
4	14	24	34	± 250 mV
5	15	25	35	± 2500 mV

3 ***CONFIGuration codes:***

To record all counts:
- 0 High frequency
- 1 Low level AC
- 2 Switch Closure
- 3 High frequency, 16 bit
- 4 Low level AC, 16 bit

To discard counts from excessive intervals
- 1x (x = 0-4 from above)

Discard counts, output frequency (Hz)
- 2x (x = 0-4 from above)

4-12 ***EXcitation CHANnel codes:***
- 0x Excite all reps w/ EX CHAN x
- 1x Increment EX CHAN x w/ each rep

13,14 ***TC TYPE —Thermocouple Type codes:***
- 1 T (copper-constantan)
- 2 E (chromel-constantan)
- 3 K (chromel-alumel)
- 4 J (iron-constantan)

18 ***OPTION codes:***
- 0 seconds into minute (max 60)
- 1 minutes into day (max 1440)
- 2 hours into year (max 8784)

20 ***8765, 4321 Each digit configures respective port***
- 0 Set low
- 1 Set high
- 2 Toggle
- 3 Pulse 1 ms } Duration on
- 4 Pulse 10 ms } subsequent
- 5 Pulse 100 ms } Pulse Port
- 6 Pulse 1 sec. } Command code
- 7 Configure as output
- 8 Configure as input
- 9 Leave alone

23 ***RANGE codes:***

Fast (272 µs integration time)

Fast	Full scale range
13	± 25 mV
14	± 250 mV
15	± 2500 mV

23 ***OPTION code, 4 digits:***

ABCD

A Trigger
- 0 -- Trigger on 1st analog channel
- 1 -- Digital trigger on C1
- 2 -- Same as 0, but sets C1 high on trigger

B Trigger option
- 0 -- Trigger immediately
- 1 -- Trigger if above limit (high)
- 2 -- Trigger if below limit (low)
- 3 -- Trigger on rising edge
- 4 -- Trigger on falling edge

C Destination
- 0 -- Input Storage
- 1 -- Serial port, 9600 baud
- 2 -- Serial port, 76800 baud
- 3 -- Serial port, 76800 baud to SM192 or SM716 Storage Module

D Measurement
- 0 -- Differential measurement
- 1 -- Single-ended measurement

24 ***LOCation (start of 19 calibration values)***
- xxxx Calibrate only when 24 is executed
- xxxx-- (key in C before entering) store results of automatic calibration

25 ***MASK:***

Base 2 representation of ports 8-1; 1 means read, 0 yields 0. Entered as base 10 (0-255)

LOCation:

Result also base 2 converted to 10
1 indicates high, 0 indicates low or masked

27 ***OPtion/GAIN codes:***

Code	Gain
x1	100
x2	33.3
x3	10
x4	1

- x = 0 Output period in microseconds
- x = 1 Output frequency in kHz

28 ***REPS:*** *Hit C (–) to skip repeat of excit.*
- *F1:* Starting frequency of sweep (100 s of Hz)
- *F2:* Ending frequency of sweep (100 s of Hz)

Output is $1/T^2$, T is period in ms

101 ***C:8765, C:4321 Each digit Configures respective channel***
- 0 High level, rising edge
- 1 High level, falling edge
- 2 Low level, rising edge
- 3 Low level, falling edge

101 ***F:8765, F:4321 Each digit sets Function for respective channel***
- 0 No value returned
- 1 Period, ms
- 2 Frequency, kHz
- 3 Time since previous channel, ms
- 4 Time since channel 1, ms
- 5 Counts on 2 since 1, interpolated
- 6 Low resolution frequency, kHz
- 7 Counts
- 8 Integral counts on 2 since 1

101 ***OUTput OPTion***
- 0 Execution interval averaging
- 0-- Continuous averaging
- xxxx Specify average interval in ms
- xxxx-- Capture all events until xxxx edges of channel 1
- 9999-- Test Memory

102 ***FUNCTION***
- 0 Channel state
- 1 Duty cycle
- 2 Counts
- 3 Memory test

• STANDARD IN OS10.0
‡ STANDARD IN OS10-2

PROCESSING INSTRUCTIONS

INST. DESC.	01:	02:	03:
30 Z=F	F	EXP	Z
31 Z=X	X	Z	
*32 Z=Z+1	Z		
33 Z=X+Y	X	Y	Z
34 Z=X+F	X	F	Z
35 Z=X-Y	X	Y	Z
36 Z=X*Y	X	Y	Z
37 Z=X*F	X	F	Z
38 Z=X/Y	X	Y	Z
39 Z=SQRT(X)	X	Z	
40 Z=LN(X)	X	Z	
41 Z=EXP(X)	X	Z	
42 Z=1/X	X	Z	
43 Z=ABS(X)	X	Z	
44 Z=FRAC(X)	X	Z	
45 Z=INT(X)	X	Z	
46 Z=X MOD F	X	F	Z
47 Z=X^Y	X	Y	Z
48 Z=SIN(X)	X	Z	
49 SPA MAX	SWATH	1ST LOC	MAX†
50 SPA MIN	SWATH	1ST LOC	MIN†
51 SPA AVG	SWATH	1ST LOC	AVG

* F is Fixed Data; X,Y and Z are Input Locations

INST. DESCRIPTION	01:	02:	03:	04:	05:	06:	07:	08:	09:
53 A* X+B	STRT LOC	A1	B1	A2	B2	A3	B3	A4 *	B4
54 BLOCK MOVE	NO VALS	S LOC	STEP	D LOC	STEP				
55 POLYNOMIAL	REPS	X	F(X)	C0	C1	C2	C3	C4	C5
56 SAT VP	TEMP	VP							
57 WB/DBT-VP	PRESSURE	DB TEMP	WB TEMP	VP					
58 LP FILTER	REPS	X	F(X)	W					
59 X/(1-X)	REPS	X	MULT						
‡ 60 FFT	LOG₂ (smpl)	OPTIONS†	LOG₂ (BIN/AVG)	IN LOC	MULT				
61 INDIR MOVE	SOURCE	DESTIN							
63 PARA EXTN	†(8 parameters, depend on the inst that 63 follows)								

† Option Codes

INST. DESCRIPTION

49 50 *MAX/MIN:*
- 0xxx Store spatial max or min at loc xxx
- 1xxx Max or min at loc xxx and loc of max or min at xxx+1

OPTION code
- 0x Power Spectra
- 1x Real and Imaginary
- 2x Magnitude and Phase
- x = 0 No Taper
- x = 1 Taper

PARAMETERS 1-8:
Following Inst 97
RF IDs & Phone No , 1 digit at a time
- 32 Between RF IDs (e g repeater & site)
- 72 Between RF & DC112 No
- 13 To end

Following Inst 98 (256 character limit)
Base 10 value of ASCII Character (1-99)
00 To end

‡ STANDARD IN OS10 2

OUTPUT PROCESSING INSTRUCTIONS

INST. DESC.	01:	02:	03:
70 SAMPLE	REPS	LOC	
71 AVERAGE	REPS	LOC	
72 TOTALIZE	REPS	LOC	
73 MAXIMIZE	REPS	TIME†	LOC
74 MINIMIZE	REPS	TIME†	LOC

INST. DESC.	01:	02:	03:	04:	05:	06:	07:
75 HISTOGRAM	REPS	BINS	FORM†	BSEL LOC	WV LOC†	LOW LIM	HIGH LIM
76 W VECTOR	REPS	OUT/SEN†	WS/E	WD/N			
77 REAL TIME	OPTION†						
78 RESOLUTION	OPTION†						
79 SMPL ON M M	REPS	LOC (must follow Inst 73 or 74)					
80 STORE AREA	AREA†	LOC/ID					
82 STD DEV	REPS	LOC					

† Option Codes

INST. DESCRIPTION

73,74 *TIME of max or min:*
- 00 Max/min value only
- 01 With Seconds
- 10 With Hour-Minute
- 11 With Hour-Minute, Seconds

75 *FORM codes:*
- 0 Open form (data beyond limits is included)
- 1 Closed form (data beyond limits is excluded)

WV LOCation:
- 0 frequency distribution

76 *OUTput/SENsor type codes:*
- 0x Avg WS, V mag , V dir, SD dir
- 1x Avg WS, V dir, SD dir
- 2x Avg WS, V dir
- 3x Avg V dir, SD dir
- x = 0 Polar (speed & direction)
- x = 1 Orthogonal (East & North)

77 *OPTION codes:*
- xxx1 Seconds
- xx1x Hour-Minute
- xx2x Hour-Minute, 2400 at midnight
- x1xx Day
- x2xx Day, Previous day at midnight
- 1xxx Year

(0 = no output, e g , 110 = Day, Hour-Minute)

78 *OPTION codes:*
- 0 Low resolution
- 1 High resolution

80 *AREA codes:*
- 1 Final Storage 1
- 2 Final Storage 2
- 3 Input Storage

PROGRAM CONTROL INSTRUCTIONS

INST. DESC.	01:	02:	03:	04:
83 IF CASE < F	F	COMMAND†		
85 LABEL SUBR	SUBR# (1-8, 80-99; 97 & 98 allow special interrupts on C7 & C8)			
86 DO	COMMAND†			
87 LOOP	DELAY	COUNT		
88 IF X <=> Y	X	COMP†	Y	COMMAND†
89 IF X <=> F	X	COMP†	F	COMMAND†
90 LOOP INDEX	STEP			

* F is Fixed Data; X,Y and Z are Input Locations

INST. DESCRIPTION	01:	02:	03:	04:	05:	06:	07:	08:
91 IF FLAG/PORT	OPTION†	COMMAND†						
92 IF TIME	T into INT	INT (min)	COMMAND†					
93 BEGIN CASE	CASE LOC							
94 ELSE								
95 END								
96 SERIAL OUT	OPTION†							
§* 97 INIT. TELE	OPTION†	FLAG	LIM(SEC)	F.DEL (SEC)	NO TRYS	B DEL (MIN)	TRY LOC	ID
98 SEND CHAR	OPTION†							

† Option Codes

INST. DESCRIPTION

83-92 *COMMAND codes:*
- 0 Go to end of Pgm. Table
- 1-9, 79-89 Call Subroutine
- 10-19 Set flag 0-9 high
- 20-29 Set flag 0-9 low
- 30 Then Do
- 31 Exit Loop if true
- 32 Exit Loop if false
- 41-48 Set Port 1-8 high
- 51-58 Set Port 1-8 low
- 61-68 Toggle Port 1-8
- 71-78 Pulse Port 1-8

Ports can be indexed with C (--)

88,89 *COMParison codes:*

1	X = Y	X = F
2	X ≠ Y	X ≠ F
3	X ≥ Y	X ≥ F
4	X < Y	X < F

91 *OPTION codes:*
- 1x Do if flag x is high
- 2x Do if flag x is low
- 4x Do if port x is high
- 5x Do if port x is low

Ports can be indexed with C (--)

FLAG DESCRIPTIONS:
- 0 Output flag
- 1-8 User flags
- 9 Internal proc disable flag

96 *8 OPTION codes:*
- 00 Tape, 512 Loc blocks
- 09 Tape, all new data ††
- Addressed Print Device
- 1x Printable ASCII
- 2x Comma delineated ASCII
- 3x Binary Final Storage format
- Pin Enabled Print Device
- 4x Printable ASCII
- 5x Comma delineated ASCII
- 6x Binary Final Storage format
- x = *Baud Rate Code*
- 7N Storage Module, address N (1-8)
- 80 Other Final Storage Area†† (data since last dump)
- 81 Other Final Storage Area †† (All Data in Active Area)

†† Inst 96 only

97 *OPTION codes:*
- 0x RF
- 1x DIRECT
- 2x DC112
- x = *Baud Rate Code* (97 is followed by Inst 63)

98 *OPTION codes:*
- 1x Addressed Print Device
- 4x Pin Enabled Print device
- x = *Baud Rate Code* (98 is followed by Inst 63)

BAUD RATE CODES

0	300
1	1200
2	9600
3	76800

* STANDARD IN OS10-0
§ STANDARD IN OS10-1

ERROR CODES

3 -- Program Table full
4 -- Intermediate Storage full
5 -- Final Storage Area 2 not allocated
8 -- CR10 was reset by watch dog timer
9 -- Insufficient Input Storage
11 -- Attempt to allocate unavailable storage
20 -- Subroutine encountered before necessary END
21 -- END without IF, LOOP, or SUBROUTINE
22 -- Missing END
23 -- Nonexistant SUBROUTINE
24 -- ELSE in SUBROUTINE without IF
25 -- ELSE without IF
26 -- EXIT LOOP without LOOP
27 -- IF CASE without BEGIN CASE
30 -- IFs and/or LOOPS nested too deep
31 -- SUBROUTINES nested too deep
40 -- Instruction does not exist
41 -- Incorrect Execution Interval
60 -- Insufficient Input Storage for FFT
61 -- Burst Measurement Scan Rate too Short

*D Mode Errors

96 -- Device not connected
97 -- Time out on tape read
98 -- Uncorrectable errors on tape read
99 -- Wrong file type or editor error

DAY OF YEAR CALENDAR

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
JAN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
FEB	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60		
MAR	60	61	62	63	64	65	66	67	68	69	70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	90
APR	91	92	93	94	95	96	97	98	99	100	101	102	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
MAY	121	122	123	124	125	126	127	128	129	130	131	132	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	152	153	154	155	156	157	158	159	160	161	162	163	164	165	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
JUL	182	183	184	185	186	187	188	189	190	191	192	193	194	195	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEP	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	[illegible]	263	264	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
OCT	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304
NOV	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	
DEC	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365

Add 1 to red values during leap years

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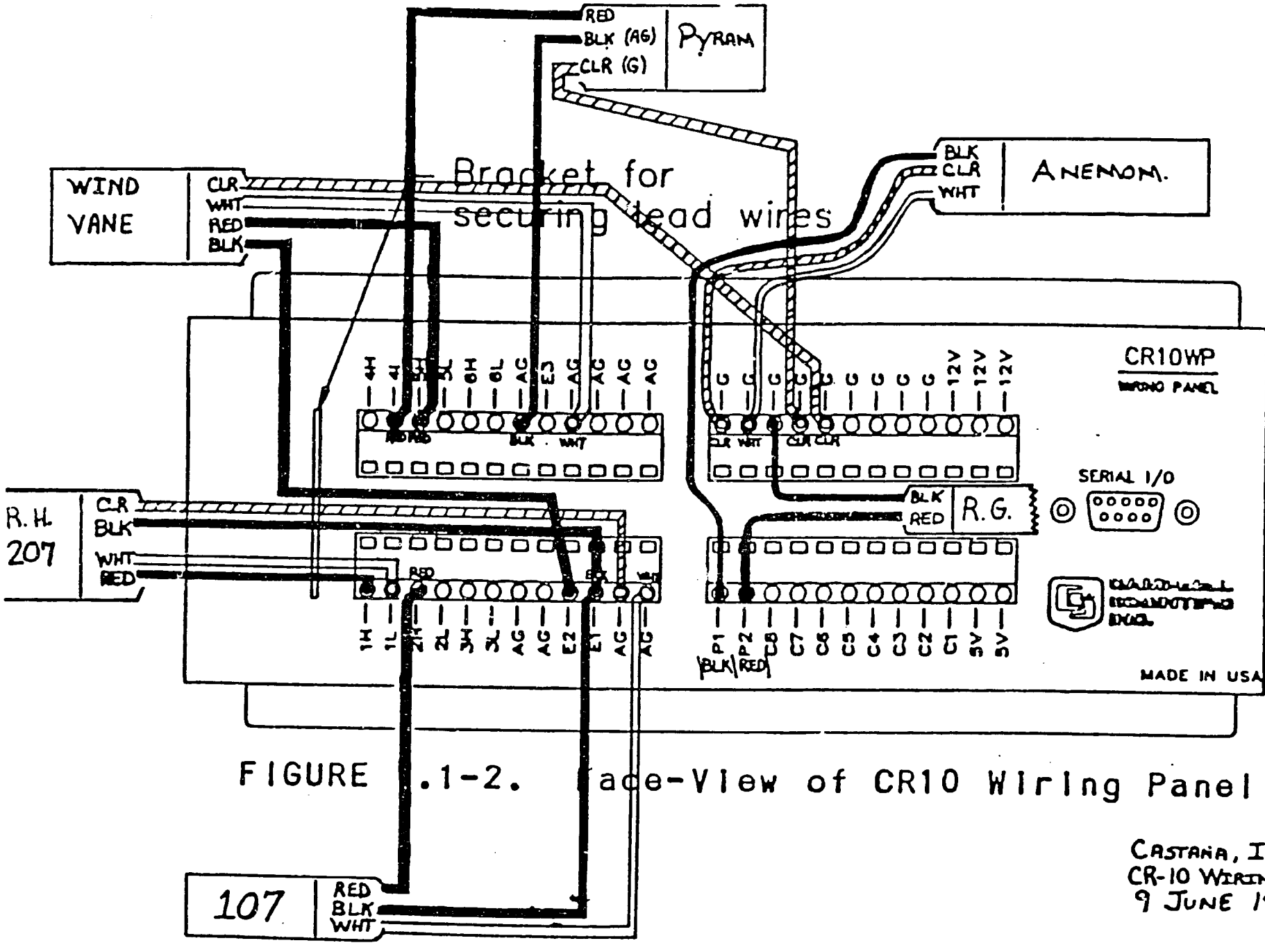

FIGURE .1-2. Face-View of CR10 Wiring Panel

CASTANA, IOWA
CR-10 WIRING DIAGRAM
9 JUNE 1988

```
PROGRAM   : CASTANA SSO
DATALOGGER: CR-10
DOC DATE  : 1-29-89
BAUD RATE : 300
PHONE #   : 712-885-3300


     1        Table 1 Programs
  01: 60      Sec. Execution Interval

 01:  P11     Temp 107 Probe
  01: 1       Rep
  02: 1       IN Chan
  03: 1       Excite all reps w/EXchan 1
  04: 1       Loc [:AIR TEMP ]
  05: 1       Mult
  06: 0       Offset

 02:  P12     RH 207 Probe
  01: 1       Rep
  02: 2       IN Chan
  03: 1       Excite all reps w/EXchan 1
  04: 1       Temperature Loc AIR TEMP
  05: 2       Loc [:HUMIDITY ]
  06: 1       Mult
  07: 0       Offset

 03:  P11     Temp 107 Probe
  01: 1       Rep
  02: 3       IN Chan
  03: 1       Excite all reps w/EXchan 1
  04: 3       Loc [:SOIL TEMP]
  05: 1       Mult
  06: 0       Offset

 04:  P1      Volt (SE)
  01: 1       Rep
  02: 3       25 mV slow Range
  03: 6       IN Chan
  04: 4       Loc [:EFD=W/m^2]
  05: 128.04  Mult
  06: 0       Offset

 05:  P4      Excite,Delay,Volt(SE)
  01: 1       Rep
  02: 5       2500 mV slow Range
  03: 9       IN Chan
  04: 2       Excite all reps w/EXchan 2
  05: 5       Delay (units .01sec)
  06: 1000    mV Excitation
  07: 5       Loc [:WIND DIR ]
  08: .70499  Mult
  09: 0       Offset
```

```
06:  P3        Pulse
  01: 1        Rep
  02: 1        Pulse Input Chan
  03: 2        Switch closure
  04: 6        Loc [:WSPD=m/s ]
  05: .0133    Mult
  06: .447     Offset

07:  P3        Pulse
  01: 1        Rep
  02: 2        Pulse Input Chan
  03: 2        Switch closure
  04: 7        Loc [:RAIN=mm  ]
  05: 1        Mult
  06: 0        Offset

08:  P89       If X<=>F
  01: 4        X Loc EFD=W/m^2
  02: 4        <
  03: 0        F
  04: 30       Then Do

09:  P30       Z=F
  01: 0        F
  02: 0        Exponent of 10
  03: 4        Z Loc [:EFD=W/m^2]

10:  P95       End

11:  P37       Z=X*F
  01: 4        X Loc EFD=W/m^2
  02: .06      F
  03: 8        Z Loc [:ED=kJ/m^2]

12:  P37       Z=X*F
  01: 8        X Loc ED=kJ/m^2
  02: .001     F
  03: 9        Z Loc [:ED=MJ/m^2]

13:  P92       If time is
  01: 0        minutes into a
  02: 60       minute interval
  03: 10       Set high Flag 0 (output)

14:  P69       Set Active Storage Area
  01: 1        Final Storage Area 1
  02: 115      Array ID or location

15:  P77       Real Time
  01: 110      Day,Hour-Minute

16:  P71       Average
  01: 4        Reps
  02: 1        Loc AIR TEMP
```

```
17:  P76      Wind Vector
  01: 1       Rep
  02: 0       WS, Mag, Dir, SD (Polar Sensor)
  03: 6       Wind Speed/East Loc WSPD=m/s
  04: 5       Wind Direction/North Loc WIND DIR

19:  P72      Totalize
  01: 2       Reps
  02: 7       Loc RAIN=mm

19:  P        End Table 1


*     2       Table 2 Programs
  01: 60      Sec. Execution Interval

01:  P92      If time is
  01: 0       minutes into a
  02: 1440    minute interval
  03: 10      Set high Flag 0 (output)

02:  P73      Maximize
  01: 3       Reps
  02: 0       Value only
  03: 1       Loc AIR TEMP

03:  P74      Minimize
  01: 3       Reps
  02: 0       Value only
  03: 1       Loc AIR TEMP

04:  P71      Average
  01: 3       Reps
  02: 1       Loc AIR TEMP

05:  P73      Maximize
  01: 1       Rep
  02: 10      Value with Hr-Min
  03: 6       Loc WSPD=m/s

06:  P56      Saturation Vapor Pressure
  01: 1       Temperature Loc AIR TEMP
  02: 11      Loc [:SAT VP   ]

07:  P36      Z=X*Y
  01: 2       X Loc HUMIDITY
  02: 11      Y Loc SAT VP
  03: 12      Z Loc [:RHX * SVP]

08:  P30      Z=F
  01: 1       F
  02: 2       Exponent of 10
  03: 13      Z Loc [:100.00   ]
```

```
09:  P38      Z=X/Y
  01: 12      X Loc RHI * SVP
  02: 13      Y Loc 100.00
  03: 14      Z Loc [:VAP PRESS]

10:  P35      Z=X-Y
  01: 11      X Loc SAT VP
  02: 14      Y Loc VAP PRESS
  03: 15      Z Loc [:VP DEFIC ]

11:  P71      Average
  01: 2       Reps
  02: 14      Loc VAP PRESS

12:  P72      Totalize
  01: 1       Rep
  02: 7       Loc RAIN=mm

13:  P72      Totalize
  01: 1       Rep
  02: 9       Loc ED=MJ/m^2

14:  P10      Battery Voltage
  01: 19      Loc [:BATT VOLT]

15:  P70      Sample
  01: 1       Reps
  02: 19      Loc BATT VOLT

16:  P        End Table 2


*    3        Table 3 Subroutines

01:  P        End Table 3


*    A        Mode 10 Memory Allocation
  01: 28      Input Locations
  02: 54      Intermediate Locations
  03: 0       Final Storage Area 2


*    C        Mode 12 Security
  01: 0       LOCK 1
  02: 0       LOCK 2
  03: 0       LOCK 3
```

49'

Page 5 Input Location Assignments (with comments):

Key:
T=Table Number
E=Entry Number
L=Location Number

```
T:  E:  L:
1:  1:  1:  Loc [:AIR TEMP ]
1:  2:  2:  Loc [:HUMIDITY ]
1:  3:  3:  Loc [:SOIL TEMP]
1:  4:  4:  Loc [:EFD=W/m^2]
1:  9:  4:  Z Loc [:EFD=W/m^2]
1:  5:  5:  Loc [:WIND DIR ]
1:  6:  6:  Loc [:WSPD=m/s ]
1:  7:  7:  Loc [:RAIN=mm  ]
1: 11:  8:  Z Loc [:ED=kJ/m^2]
1: 12:  9:  Z Loc [:ED=MJ/m^2]
2:  6: 11:  Loc [:SAT VP   ]
2:  7: 12:  Z Loc [:RHZ * SVP]
2:  8: 13:  Z Loc [:100.00   ]
2:  9: 14:  Z Loc [:VAP PRESS]
2: 10: 15:  Z Loc [:VP DEFIC ]
2: 14: 19:  Loc [:BATT VOLT]
```

Page 6 Input Location Labels:

1:AIR TEMP	6:WSPD=m/s	11:SAT VP	16:_____
2:HUMIDITY	7:RAIN=mm	12:RHZ * SVP	17:_____
3:SOIL TEMP	8:ED=kJ/m^2	13:100.00	18:_____
4:EFD=W/m^2	9:ED=MJ/m^2	14:VAP PRESS	19:BATT VOLT
5:WIND DIR	10:_____	15:VP DEFIC	20:_____

Procedure for Loading a programme into the SM192

1. Develope a program on a Computer using EDLOG
   Equipment:
   IBM Compatible Computer
   SM192 Storage Module
   SM192 Interface Cable
2. Connect SM192 to Computer Communication Port (Serial).
3. Reset SM192
   A) Start SMCOM
   B) Select Comm Port being used (Comm 2 on lab Computer)
   C) Answer Question on SM232 or 232A 'N' (NO)
   D) Give a Root file name. 'SMTEST' was used
      1. Carriage Return is needed Here
   E) Enter 'T' for terminal emulator
   F) Enter '1248K' to clear the module
      1.The module responds with a series of +'s and –'s. The module tests its memory by writing to memory, then reading all locations. '+'indicates the writing phase and each '+' corresponds to a memory chip. If there are 6 memory chips, there will be 6 pluses. The '–'indicates reading and will again show one '–' for each IC read.
   G) Enter 100E to test the internal Battery.
      1= Good, 0= Bad
   H) Enter 'Ctrl–' to return to the menu.
4. Select 'D' to store a DLD file in the SM192.
5. 'S60' was used here
   A. The Program is loaded into the SM192
6. Enter 'Q' to quit.

Procedure for Loading a program from the SM192 to the CR10 using the CR10KD.

Equipment:

CR10	Datalogger
CR10KD	Keyboard
SM192	Storage Module
SM12	Interface Cable

1. Connect CR10, CR10KD, and SM192.
   NOTE: The keyboard may respond with 'HELLO' or random number.
2. Enter *D [13:00]
3. Enter 71 [13:71] (addresses SM192 #1)
   A) Enter A [71:00]
4. Enter 21 [71:21] (addresses program #1)
   A) Enter A [71:21]
   B) After loading program, LCD responds with [13:0000]
5. Set time and Date in the usual manner. (*5 mode)
   A. *5A [05:00]
   B. Enter year, [05:90], Enter A [05:000]
   C. Enter Julian Day [05:291], Enter A [05:0000]
   D. Enter (HH MM SS or HH MM) [05:1101]
      Enter [:11:01:xx]
6. Enter *0 [LOG12]
   A. Datalogger is now operational.
   B. Disconnect CR10KD.

Tandy 102 operations

Procedure for Loading a program from the SM192 to the CR10 using a Tandy 102 Lap top Computer.

Equipment:

CR10 Datalogger
SM192 Storage Module
SC32A Interface
SC12 Interface Cable

1. Connect the Tandy RS232 port to the SC32A. Connect the SC32A to Cr10 and the SM192. Power up.
2. From the Tandy main menu select TELCOM.
3. Select F4 (TERM)
   A. Press enter until Tandy resoponds with a*
4. Enter 7H Display changes to > (Greater than)
5. Enter *D Display shows 13:00
6. Enter 71A Display shows 71:00
7. Enter 21A Display shows program loading upon Completion, Display shows >
8. Set Data and time in *5 mode.
   A. *5A
   B. Enter (year) A.
   C. Enter (julian day) A.
   D. Enter (time) A.
9. Enter *0
10. Disconnect SC232 from CR10 and SM192. (CR10 and SM192 remain connected)

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Group Calibration of Silicon Cell Pyranometers for Use in an Automated Network*

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30 October 1987 and 21 March 1988

ABSTRACT

Techniques for simultaneously calibrating a number of pyranometers for use with automated weather stations are examined. The procedure involves taking data from an Eppley precision spectral pyranometer and from up to 11 LI-COR pyranometers using a specially built sensor plate. Results of a group calibration of six pyranometers using 10-minute data over a 3-day period are given. Three best-fit lines were determined for full-scale (5–960 W m^{-2}), midscale (300–650 W m^{-2}) and midrank (400–800 W m^{-2}) datasets. The full-scale calibration technique proved most useful, resulting in a standard error of estimate of less than 20 W m^{-2} in all cases.

1. Background

Pyranometers are sensors that measure the solar radiation received from the hemisphere to which they are exposed. When installed facing up in a horizontal plane tangent to the earth's surface, they measure the total incoming shortwave radiation from the sun and sky. The Eppley[1] Precision Spectral Pyranometer (180 pyrheliometer) is the operational standard for solar radiation measurements in the United States (Houghton 1985). As the use of automatic weather stations in state and research networks has become more widespread, less expensive pyranometers have often been employed. A silicon cell pyranometer manufactured by LI-COR is used in Nebraska's Automated Weather Data Network (AWDN) (Hubbard et al. 1983). Even though these pyranometers are reasonably accurate, they must be periodically calibrated against a standard pyranometer, in this case an Eppley Precision Spectral Pyranometer (PSP).

Calibration is defined as the operation of making, or checking a scale so that the reading of an instrument or measurement system conforms to an accepted standard. The instrument may be calibrated against a primary standard, but a secondary standard is often employed when it is sufficiently accurate and more convenient. Although the Eppley Precision Spectral Pyranometer (PSP) is a secondary standard, it is widely accepted as a standard against which other pyranometers are calibrated (Unwin 1980).

AWDN calibration is now performed at least once a year, although there is no clear recommendation of a standard calibration schedule in the literature. Previous quality control procedures in use for AWDN identified when a pyranometer showed significant deviations from those at surrounding stations. This involved estimating the hourly solar radiation at the station being checked by a weighted interpolation technique (based on inverse distance from the station). When the average difference between the estimated and measured values exceeded a preselected threshold, the pyranometer in use at the station would be recalibrated. A quality control procedure automatically sets the nighttime values from the pyranometer to zero. Frequent calibration, however, will eliminate significant deviations and, therefore, the question of which sensor is responsible for observed differences. It is our contention that calibration should be performed on a schedule that precludes taking questionable data. Based on our experience with AWDN, one year is the longest period that should transpire between calibrations. Current calibration procedures developed for use with AWDN pyranometers are discussed in this paper.

2. Calibration procedure

The introduction in the United States of automated meteorological stations for agricultural purposes is so recent that information about the appropriate calibration procedure is scarce and undefined, although some guidelines for solar radiation calibration are presented by Bahn and Nakos (1979).

[1] Mention of manufacturer's name does not imply endorsement of a product over those offered by other manufacturers but is merely provided for the convenience of the reader.

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Staff members at the Center for Agricultural Meteorology and Climatology (CAMaC) at the University of Nebraska—Lincoln have developed a calibration procedure for silicon cell pyranometers. This procedure, which may be useful in other existing and/or future Automated Weather Data Networks (AWDN), can be described as follows:

a. Equipment and materials

1) Data logger (model CR21X from Campbell Scientific Inc.) with capacity for simultaneously recording up to 16 pyranometers.
2) Eppley PSP (the standard).
3) Silicon cell pyranometers (to be calibrated).
4) Aluminum plate with predrilled holes to set the Eppley and silicon pyranometers; the current plate has capacity for 11 LI-COR pyranometers.

The leveled aluminum plate with pyranometers attached is shown in Fig. 1.

The equipment is set up at a location where there is no chance of shadowing from surrounding buildings or trees, in our case, on the roof of a building. A bubble level on the aluminum plate serves to check the level of the pyranometers during calibration in the same fashion as leveling fixtures used at field sites. All lead wires are connected to the CR21X data logger, which was programmed to take readings every minute; 10-minute average readings were recorded. All readings were recorded as an average flux density (W m^{-2}). The calibration was carried out over a 3-day period; depending on day length and sky conditions, this period may require adjustment so that 50–100 clear sky data points are acquired for the linear regression. A station in the network takes data 24 hours per day; however, during calibration, only readings from sunrise to sunset are used. During the night the sensors both record zero, so that these values are eliminated prior to running the regression.

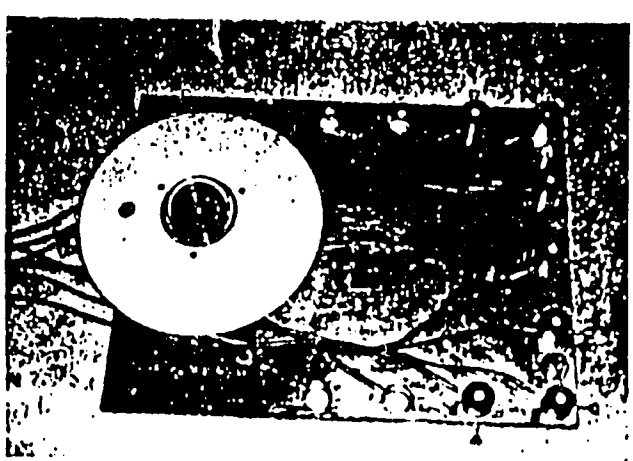

FIG. 1. Aluminum plate used for calibration with Eppley PSP and seven Li-Cor silicon pyranometers mounted in place

b. Data analysis

The data collected are analyzed using regression analysis techniques, setting as the "independent" variables the values from the silicon cell pyranometer and the "dependent" variables the value from the secondary standard. The analysis is performed individually for each sensor. The resulting regression equation, with coefficients for slope and intercept, is then taken as the "current" calibration for use when the sensors are placed at a field site. This linear regression is justified because the signals from the pyranometer rise and fall linearly with the signal from the standard. The linearity can be checked by examining the regression coefficients to ensure that they approach unity.

The meteorological predictor and predictand view of regression analysis (Panofsky and Brier 1968) has been employed. The known variable (predictor) at a weather station is the signal from the silicon cell pyranometer, and the unknown variable (predictand) is the solar energy that would be measured by an Eppley PSP if it were present. Calibration in this case can be thought of as a matter of determining how to predict what an Eppley PSP would measure based on what a silicon pyranometer is measuring. Therefore:

$$y' = a + bx, \tag{1}$$

where y' is the predicted solar radiation of the standard (Eppley PSP); x is the sensor signal from pyranometer being calibrated; and a, b are the intercept and slope, respectively, of the regression line. The intercept and slope in (1) will correct linear systematic error occurring in the pyranometer being calibrated.

The degree to which data scatter about the regression line indicates the impact that random differences, and possibly nonlinear systematic differences between sensors, may have. A measure of this scatter is the standard error of estimate (SE)

$$\mathrm{SE} = \sqrt{\frac{\Sigma (y - y')^2}{N}}, \tag{2}$$

where SE is the standard error of estimate; y is the measurements from the standard (Eppley PSP), and N is the number of observations employed.

If two lines are drawn parallel to the regression line, one at a perpendicular displacement +SE above it and another at −SE below it; then (if the scatter is normally distributed about the regression line) approximately 68% of all measurements will fall between the two lines. When the displacements are ±2SE and ±3SE, then the number of points falling between the corresponding lines will be approximately 95% and 99%, respectively. The assumption of normal scatter has not been verified

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in this case and may not be justified if significant nonlinearities are present in the data.

The error associated with a specific measurement is the difference between the measured value and the "true" value of the quantity being measured. Errors can be systematic and/or random in nature. Systematic errors are those "relatively constant errors" caused by sensitivity shift and nonlinearities that have not been accounted for. In this experiment, systematic error between a network sensor and a standard should be expected. The goal is to use statistical procedures to determine coefficients that can be used in minimizing this error. By employing the new coefficients, the majority of systematic error can be eliminated. The remaining unexplained deviation or error, is assumed to be randomly distributed, and the laws of probability apply.

3. Results

Values of a calibration experiment performed in Lincoln, Nebraska, consisting of data from six LI-COR silicon pyranometers and the corresponding standard (Eppley), will be used to illustrate the analytical procedure. The dataset was collected in May 1986, and consists of 82 values of solar radiation for each sensor, collected on 3 consecutive days under clear sky conditions; readings ranged from 5 to 960 W m^{-2} (obviously, readings between sunset and sunrise must be eliminated prior to the analysis). A linear regression analysis was performed using the full scale explored in the experiment; i.e., the total dataset of 82 values.

Table 1 shows the statistical parameters determined by the regression analysis—intercept, slope, regression coefficient, and standard error of estimate—for each of the six sensors. The coefficients a and b are employed in (1) to minimize systematic error. Equations using these coefficients will be referred to as the full-range equations. A scatter plot showing how the data pairs from the Eppley PSP and the first silicon pyranometer (#3719) compare is shown in Fig. 2. The points lie very near the regression line except in the 400–500 W m^{-2} range. The larger scatter in this range, present in all sensor plots for this calibration period, cannot yet be explained, and further testing of the sensor is planned to determine its source.

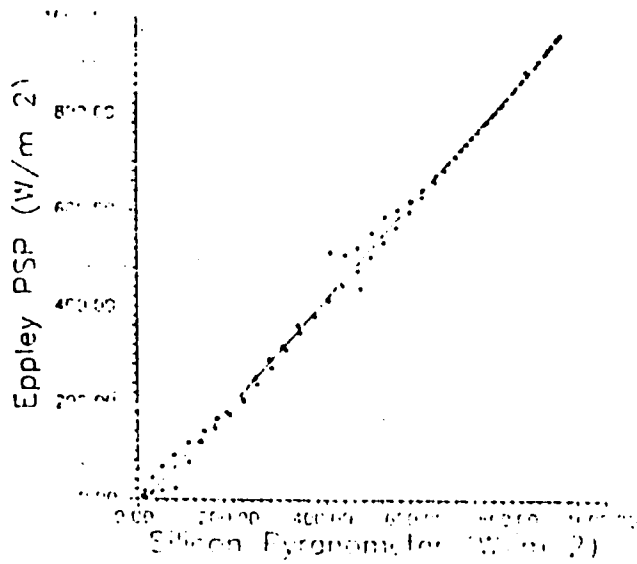

FIG. 2. Typical scatter plot showing the data pairs from the Eppley and LI-COR pyranometer (#3719) and the best-fit line.

Cerni and Foster (1962) suggest that increased accuracy in the calibration procedure may be realized by refinement in the calibration methodology. According to them, if calibration includes samples from near zero and near full scale only, the error in subsequent readings is usually greatest at the center of the measurement range. However, if calibration is made with values near one-third and two-thirds of full scale, then the error is distributed in such a way that a definite error will be found at both zero and full scale. Errors on measurements that fall close to one-third and two-thirds of full scale will be near zero. Another advantage they attribute to the midscale calibration is that error due to nonlinearity is zero at the points where the greater proportion of measurements fall.

Table 2 shows the same statistical parameters presented in Table 1 but, in this case, using only those values of solar radiation ranging from 300 to 650 (W

TABLE 1. Intercept (a), slope (b), regression coefficient (r), standard error of estimate (SE) for six different pyranometers in a calibration experiment using the full scale of radiation values.

Sensor I.D.	a	b	r	SE (W m^{-2})
3719	17.80	1.080	0.998	18.3
3139	8.74	0.964	0.999	16.9
2008–8012	14.23	1.004	0.998	18.5
3893	17.07	1.059	0.999	16.5
4484	22.83	1.028	0.999	15.8
7272	16.55	0.991	0.998	17.6

TABLE 2. Intercept (a), slope (b), regression coefficient (r), standard error of estimate (SE) for six different pyranometers in a calibration experiment using solar radiation values ranging from one-third to two-thirds of the full scale.

Sensor I.D.	a	b	r	SE (W m^{-2})
3739	−5.29	1.060	0.960	28.5
3119	14.60	0.938	0.970	24.9
2008–8012	5.30	0.982	0.967	25.9
3893	0.45	1.035	0.970	24.7
4484	−10.92	1.016	0.978	21.4
7272	14.19	0.944	0.967	25.8

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TABLE 3. Standard error of estimate (W/m²) for the equations derived when applied in different ranges of data.

Sensor I.D.	All data		Midscale data (300–650 W m⁻²)	
	Full-range eq. (W m⁻²)	Midscale eq. (W m⁻²)	Full-range eq. (W m⁻²)	Midscale eq. (W m⁻²)
3739	18.3	19.3	28.7	28.5
3119	16.9	20.7	26.9	24.9
2008-8012	18.5	21.0	27.3	25.9
3893	16.5	18.6	25.5	24.7
4484	15.8	17.0	22.3	21.4
7272	17.6	23.4	27.1	25.8

m^{-2}), corresponding to one-third to two-thirds of the full scale of data collected. This table shows a set of regression equations that differ from those presented in Table 1, because a subset of the same data was used, resulting in a slightly different best fit. Equations using these coefficients will be called midscale equations.

A meaningful comparison of the accuracy of the two equations can only be made by applying them identically, i.e., to the same dataset. Table 3 shows how the two equations (full-scale and midscale) compare when all data are used and again when only midscale data are used.

In general, the midscale equations produced standard errors of estimate only slightly lower than did the full-range equations in the case of midscale data. The full-range equation outperformed the midscale equation by as much as 5 W m^{-2} (sensor 7272) when all data were used. The slight gain in accuracy in the midscale data range by using the midscale equations did not seem reason enough to recommend using the midscale calibration technique.

It was decided to rank the calibration measurements (by the Eppley PSP values) and repeat the experiment using only those values found in the middle one-third of all data points. The data values in this subgroup ranged from 400 to 800 W m^{-2}. Results of this analysis are shown in Table 4. Equations formed from the coefficients in Table 4 will be called midrank equations.

TABLE 4. As in Table 1, except for the values that rank in the middle one-third of all data points (approximately 400–800 W m⁻²).

Sensor I.D.	a	b	r	SE (W m⁻²)
3739	22.20	1.013	0.977	23.9
3119	58.82	0.868	0.985	19.2
2008-8012	52.74	0.909	0.980	22.4
3893	41.83	0.966	0.985	19.4
4484	35.62	0.939	0.989	16.2
7272	54.13	0.884	0.984	19.9

TABLE 5. As in Table 3, except for ranking experiment.

Sensor I.D	All data		Midrank data	
	Full-range eq. (W m⁻²)	Midrank eq. (W m⁻²)	Full-range eq (W m⁻²)	Midrank eq (W m⁻²)
3739	18.3	27.2	25.0	23.9
3119	16.9	37.6	23.5	19.3
2008-8012	18.5	37.7	26.3	22.4
3893	16.5	33.4	22.4	19.4
4484	15.8	32.8	19.6	16.2
7272	17.6	39.4	24.1	19.9

The full-range and midrank equations were tested in the same manner as before, and the results are shown in Table 5. The disparity between the two equations was greater in this case. For instance, the SE for the midrank equation is more than double that of the full-range equation in the case of all data. The midrank equation outperforms the full-range equation by more than 4 W m^{-2} using the midrank data. Thus, the tradeoffs are larger, but still present.

4. Conclusions

A procedure is proposed for calibrating multiple solar radiation sensors simultaneously for Automated Weather Data Networks (AWDN), using a data logger and calibration plate. The procedure includes recording solar radiation in 10-minute intervals over a 3-day period under clear sky conditions, or over a longer period when necessary to obtain an equivalent amount of data.

Nighttime values were eliminated prior to statistical analysis. Silicon cell pyranometers were found to give SE (standard error of estimates) of less than 20 W m^{-2} when applied to the full range where a calibrated Eppley PSP was used as a standard. The SE was generally less than 30 W m^{-2} for midscale and less than 25 W m^{-2} for midrank (middle one-third by ranking) calibration techniques.

In contrast to statements of Cerni and Foster (1962), midscale calibration resulted in little improvement over full-range calibration. The midrank calibration technique performed better over the midrank data than did the midscale calibration over the midscale data, where the full-range equation was used as a reference. But the relative increase in accuracy of the midrank equations at the midrange must be weighed against its poor performance over the full range of data.

Pyranometers should be carefully calibrated according to the range in which greatest accuracy is desired. The full-range calibration technique will be utilized for sensors in the Nebraska AWDN because its accuracy is better over the full range of data and nearly as good in the midrange.

Operationally, the calibrated pyranometers are sam-

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pled once each minute, and 1-hour values are formed. This practice should result in even lower errors than those associated with 10-minute data in this calibration experiment, because with the greater number of samples (60 compared to 10), the variability of the value for the period will be less.

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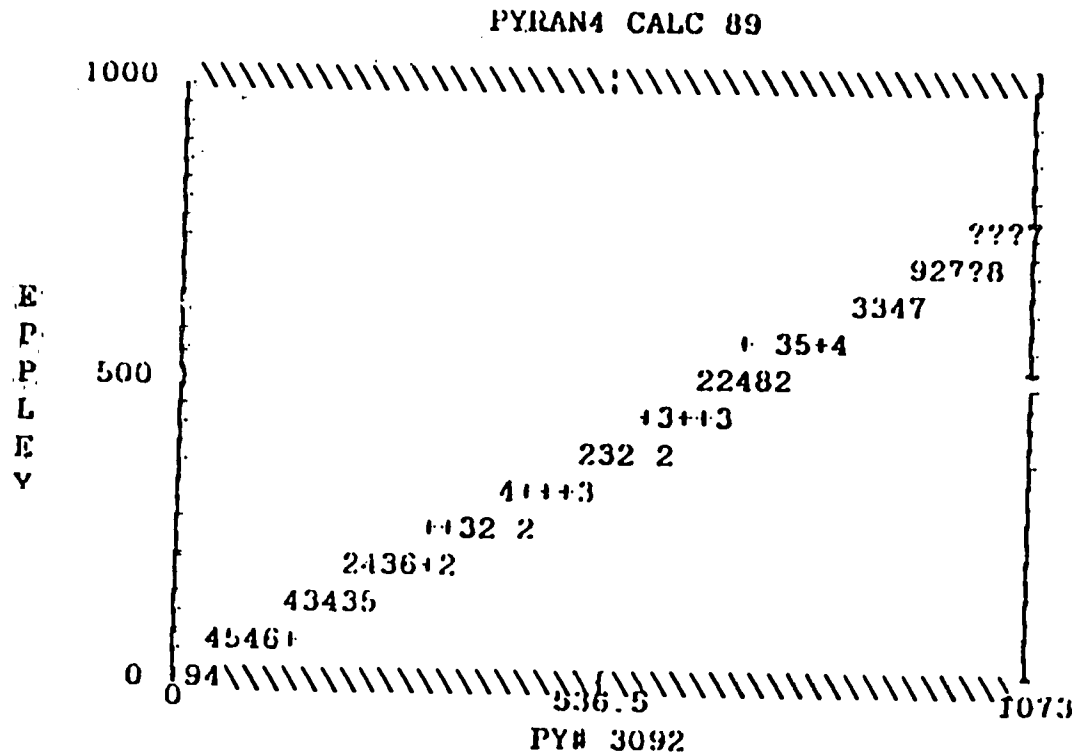
Julian Test Date

262
265
263



Statistics
No. Obs.= 214

	Y	X
Means	= 432.4872	615.178
S.D.	= 261.6616	363.3391
Coef. Var.=	.6050159	.5906244

Regression Equation
Y= 10.25427 + .7196965 * X 199.8
Std. Err. = 9.368496
r= .9993588 r= .9987182

$\boxed{M = 143.80 - 10.254}$

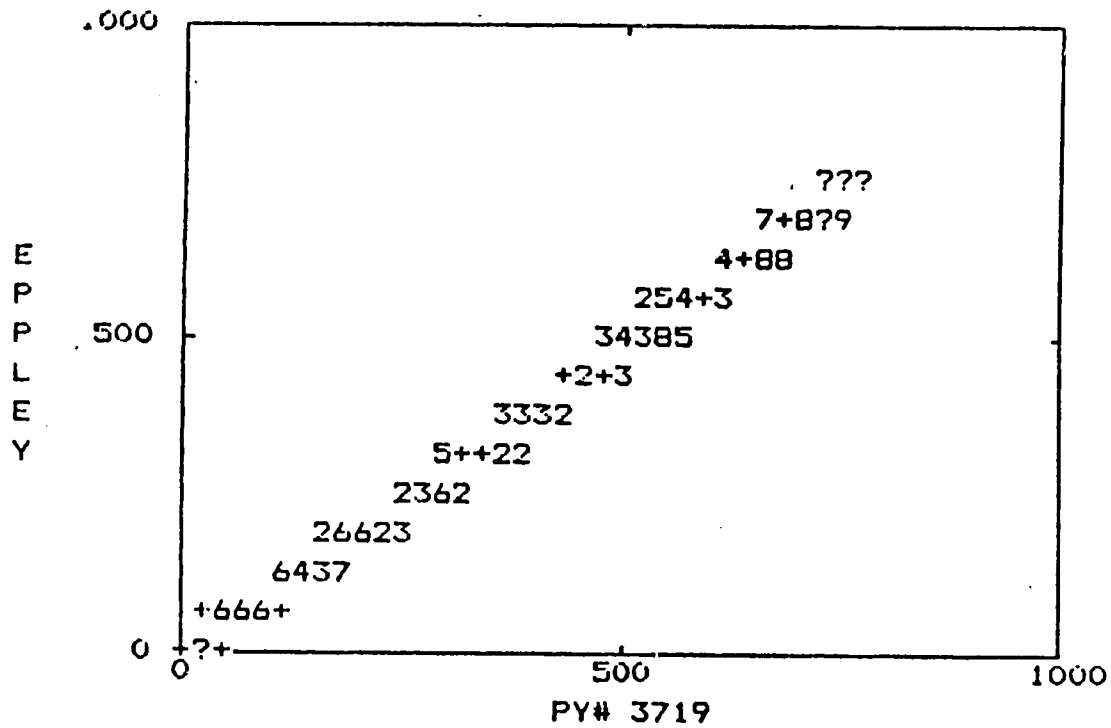
old $P_{yr} = 199.8 \times I$

$E_{pr} = -10.254 + .7197 * P_{yr}$

$E_{pr} = -10.254 + .7197 \times 199.8 \times I$

$= -10.254 + 143.8\ I$

PYRAN4 CALC 89



Mean	= [illegible]	[illegible]
S.D.	= [illegible]	[illegible]
Cor. Coef.	= [illegible]	[illegible]

Regression Equation 144.5

Y= - [illegible] + [illegible] * X

Std. Error = [illegible]

r= [illegible] r= [illegible]

$\boxed{M = 142.37 - 10.89}$

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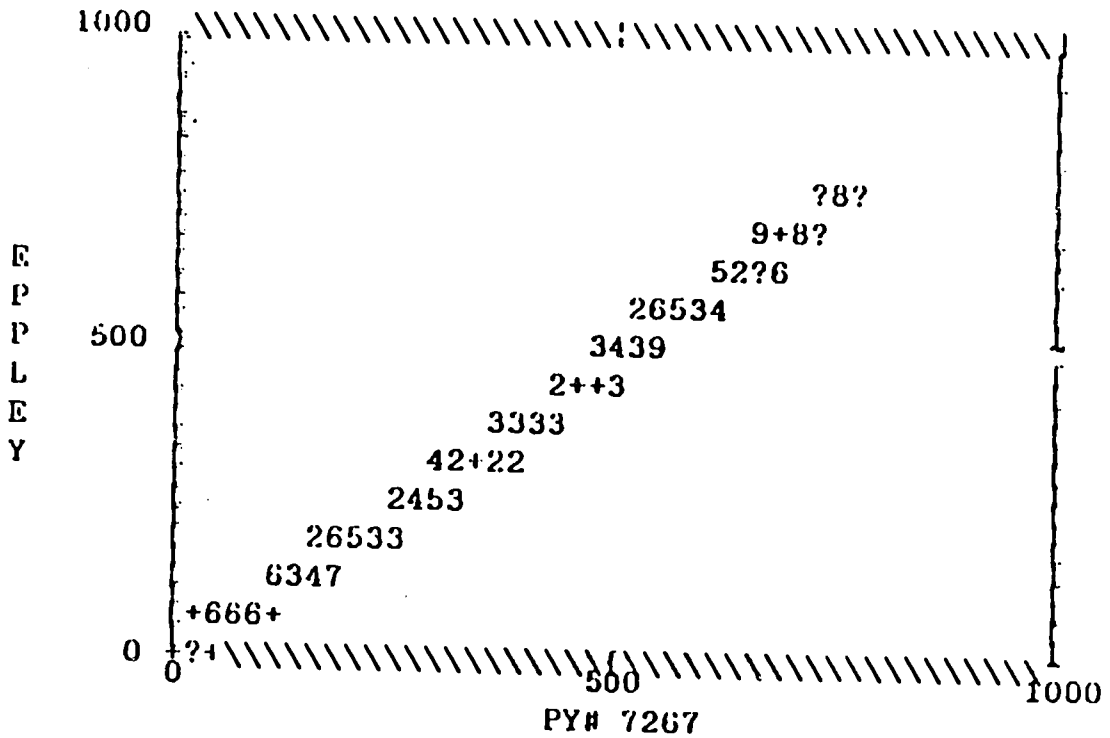
PYRAN4 CALC 89



Statistics
No Obs.= 214

	Y	X
Means	= 432.4872	448.4965
S.D.	= 261.6616	263.4582
Coef. Var.	= .6050159	.5874253

Regression Equation
Y= -12.63222 + .9924699 * X 156.9
Std. Err. = 9.898569
r= .9992842 v= .9985688

NEW Multip.
155.7 -12.63

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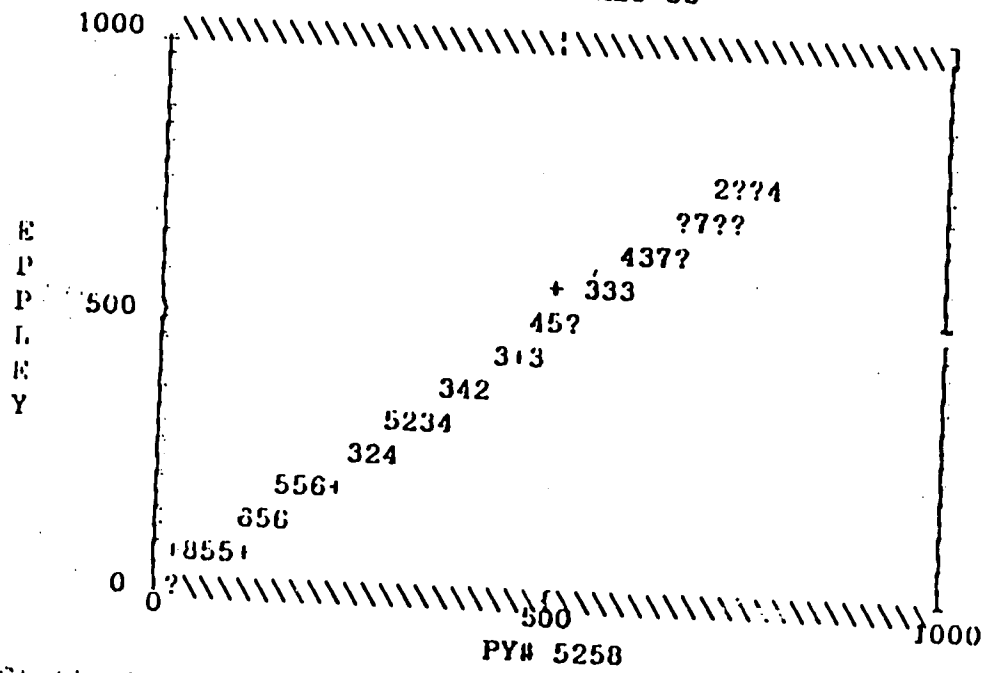
PYRAN4 CALC 89



Statistics
No. Obs.= 214

	Y	X
Means	= 432.4872	437.2327
S.D.	= 261.6616	258.3966
Coef. Var.=	.6050159	.590982

Regresion Equation
Y= -10.08438 + 1.012211 * X
Std. Err. = 7.577267
r= .9995807 v= .9991615

NEW MULTIP.
174.20 - 10.08

TABLE ID	DATE	TIME	EPPLEY	PYR 3092	PYR 3719	PYR 7267	PYR 5288
201	262	0					
107	262	720	6.25	14.16	[illegible]	10.12	9.91
107	262	730	10.15	16.66	[illegible]	[illegible]	[illegible]
107	262	740	16	23.67	[illegible]	17.1	17.1
107	262	750	21.64	32.42	[illegible]	27.3	27.28
107	262	800	34.56	46.64	[illegible]	33.58	33.54
107	262	810	53.53	74.9	57.91	54.32	53.78
107	262	820	84.8	123.8	85.4	80.4	89.5
107	262	830	84.4	120.4	85.7	87.1	86.4
107	262	840	86.6	121.4	67.6	87.9	87.1
107	262	850	77.4	104.1	74.8	75.4	75.2
107	262	900	134.6	185.7	134.8	136.4	135.1
107	262	910	243.3	346.3	253.5	256	252.7
107	262	920	286.5	404.7	296.4	298.2	294.4
107	262	930	328.6	463.9	[illegible]	341	336.9
107	262	940	358.4	503.7	[illegible]	369.6	365.1
107	262	950	385.2	545.7	399.8	399.8	395
107	262	1000	411.5	585.2	428.4	428.1	422.6
107	262	1010	442.7	628.6	460.2	459	453.1
107	262	1020	479.4	683	499.9	495.1	491.2
107	262	1030	516.1	739	539.6	539.6	531.2
107	262	1040	517.1	739	541.1	538.5	530.3
107	262	1050	542.5	772	564.9	561.	552.9
107	262	1100	550.8	780	[illegible]	566.8	557.6
107	262	1110	590.5	836	612.1	607.9	597.6
107	262	1120	616.4	857	[illegible]	632.9	612
107	262	1130	629	867	[illegible]	645.1	633.3
107	262	1140	649.6	916	[illegible]	665.1	652.6
107	262	1150	668.2	940	683.7	683.3	669.7
107	262	1200	694.1	976	717	709	694.9
107	262	1210	720	1012	749	735	721
107	262	1220	721	1010	739	733	718
107	262	1230	721	1006	735	731	715
107	262	1240	728	1015	742	737	721
107	262	1250	733	1024	748	743	727
107	262	1300	738	1032	754	749	733
107	262	1310	739	1038	758	752	736
107	262	1320	737	1035	757	751	735
107	262	1330	738	1035	756	751	734
107	262	1340	739	1036	758	752	735
107	262	1350	734	1030	753	747	730
107	262	1400	729	1024	749	743	726
107	262	1410	724	1021	747	741	723
107	262	1420	711	1005	735	729	712
107	262	1430	696.1	989	723	718	700
107	262	1440	685.8	978	715	709	691.5
107	262	1450	674.8	960	703	696.7	679.2
107	262	1500	665.5	946	692.5	686.4	669.7
107	262	1510	645.2	919	672.2	666.6	648.8
107	262	1520	629.4	898	657.5	651.5	634.1
107	262	1530	629.6	901	657.7	653.5	636.1
107	262	1540	596.7	855	[illegible]	620.4	603.2
107	262	1550	566.9	815	593	591.8	574.6
107	262	1600	543.6	784	575.4	569.4	552.3
107	262	1610	517.2	747	549	547.1	525.9
107	262	1620	494.3	715	525.5	519.7	502.6
107	262	1630	469.6	681.3	[illegible]	495.6	479.7
107	262	1640	442.6	645.2	[illegible]	469.5	452.8
107	262	1650	412.3	606.6	[illegible]	441.7	425.6
107	262	1700	[illegible]	567.1	[illegible]	413.5	397.3

107	265	1500	564.8	817	[illegible]	592.[illegible]	575.4
107	265	1510	546	792	591.6	575.1	557.1
107	265	1520	522.2	759	557.1	550.0	532.7
107	265	1530	475	719	523.2	520.1	504.7
107	265	1540	468.7	684.7	504.6	495.6	480.5
107	265	1550	432.8	640.7	472.3	466.6	446.7
107	265	1560	400.9	595.4	441.4	436.6	419.1
107	265	1570	372.6	562.9	415.9	411.6	392.6
107	265	1580	343	512.7	379.7	37[illegible]	359.[illegible]
107	265	1590	306.3	474.2	346.1	344.9	3[illegible]
107	265	1600	278.1	437.1	31[illegible]	313.9	297.1
107	265	1610	249	3[illegible]	284.9	2[illegible].2	266.9
107	265	1620	217.3	341.8	254	253.1	237.1
107	265	1630	187.6	296.3	227.3	226.1	205
107	265	1640	148.6	244.9	182.4	1[illegible].7	169.9
107	265	1650	123.9	204.1	152	152.8	140.5
107	265	1660	96.9	164.9	122.6	123.9	113.2
107	265	1850	69.65	124.8	92.8	93.[illegible]	84
107	265	1900	46.29	85.1	63.4	63.34	56.73
107	265	1910	25.59	49.74	36.7	36.72	32.85
201	265	0					
107	265	740	6.843	9.37	6.614	6.762	6.766
107	265	750	12.24	17.08	12.99	12.31	12.34
107	265	800	19.38	26.94	19.16	19.56	19.47
107	265	810	18.44	26.82	19.1	19.42	19.2[illegible]
107	265	820	33.71	47.99	34.24	34.36	34.53
107	265	830	48.45	69.21	49.5	50.49	49.[illegible]
107	265	840	74.5	105.9	76.2	77.3	76.5
107	265	850	67.04	94.3	67.91	69.25	68.27
107	265	900	107.9	153.8	110.8	112.4	111
107	265	910	154.7	214.6	154.5	156.3	153.6
107	265	920	170.1	220.4	166.2	165	166.2
107	265	930	151.7	248.9	179.5	181.4	179.8
107	265	940	201.7	281.3	203.1	205.2	203
107	265	950	152.6	215.2	154.8	156.6	154.9
107	265	1000	190.7	265	191	193	190.9
107	265	1010	260.2	365.7	263.8	266.3	263.6
107	265	1020	298.9	416.2	301.3	307.8	304.2
107	265	1030	377.2	527.1	381.8	394.5	379.[illegible]
107	265	1040	493.7	696.2	504.4	507.6	501.4
107	265	1050	476.9	657.9	479.8	481.3	474
107	265	1100	637	890	650.6	651.3	641.6
107	265	1110	667.2	930	679.7	679.8	669.3
107	265	1120	636	893	645.6	645	634.4
107	265	1130	659.7	918	669.4	669.3	657.9
107	265	1140	680.7	943	688.1	689.1	676.2
107	265	1150	701	968	707	707	691.1
107	265	1200	716	989	722	722	702
107	265	1210	729	1006	733	734	719
107	265	1220	746	1027	749	750	734
107	265	1230	757	1042	759	760	744
107	265	1240	768	1058	770	771	755
107	265	1250	769	1061	773	774	757
107	265	1300	771	1064	776	776	759
107	265	1310	774	1069	778	779	762
107	265	1320	776	1072	780	781	764
107	265	1330	777	1073	782	782	765
107	265	1340	774	1070	780	780	762
107	265	1350	768	1062	774	774	756
107	265	1400	763	1056	770	770	752
107	265	1410	750	1044	761	761	742
107	265	1420	743	1035	756	756	738
107	265	1430	730	1022	744	745	72[illegible]
107	265	1440	718	1006	733	737	[illegible]
107	265	1450	731	1027	749	749	[illegible]
107	265	1500	535.4	757	520.[illegible]	526.5	515.9

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107	265	1510	683.1	[illegible]	709	[illegible]	691.2
107	265	1520	595.7	842	614.3	615.3	599.6
107	265	1530	503.3	723	528.9	531.1	518.2
107	265	1540	644.8	909	664.3	664.7	645.7
107	265	1550	680.8	967	707	708	688
107	265	1600	534.2	754	552.4	552.6	536.5
107	265	1610	521.8	737	541.2	541.8	524.3
107	265	1620	434.6	606.1	443.6	444.6	431.5
107	265	1630	504.5	735	540	541.2	523.9
107	265	1640	499.1	719	530.2	530.4	511.2
107	265	1650	509.9	737	540.3	541	522.9
107	265	1700	169.7	240.4	172.7	174.7	172.4
107	265	1710	109.3	155.5	114	116.1	114.4
107	265	1720	126	182.7	130.7	133	130.9
107	265	1730	265	387.4	284.1	285.8	273.3
107	265	1740	162.8	236.4	172.7	174.2	167.3
107	265	1750	192.3	280.7	208.2	209.8	197.8
107	265	1800	196.3	290.8	215.8	217	203.1
107	265	1810	184.8	286.3	213.5	215.7	199.9
107	265	1820	154.3	242.4	181	183.4	168.6
107	265	1830	123.5	195.8	146.9	149.6	136.6
107	265	1840	96.5	155.9	116.9	119.5	107.9
107	265	1850	67.81	115.3	85.9	87.2	77
107	265	1900	43.12	72.2	53.56	54.38	47.66
107	265	1910	24.88	42.65	31.29	31.91	28.22
107	265	1920	9.77	19.91	13.99	14.61	13.62

```
PROGRAM   : PYRANOMETER CALCULATION #4
DATALOGGER: CR10

*     1        Table 1 Programs
  01: 60       Sec. Execution Interval

01:  P1        Volt (SE)
  01: 1        Rep
  02: 3        25 mV slow Range
  03: 1        IN Chan
  04: 1        Loc [:EPPLEY   ]
  05: 112.7    Mult
  06: 0.0000   Offset

02:  P1        Volt (SE)
  01: 1        Rep
  02: 3        25 mV slow Range
  03: 2        IN Chan
  04: 2        Loc [:PY# 3092 ]
  05: 199.8    Mult
  06: 0.0000   Offset.

03:  P1        Volt (SE)
  01: 1        Rep
  02: 3        25 mV slow Range
  03: 3        IN Chan
  04: 3        Loc [:PY# 3719 ]
  05: 144.5    Mult
  06: 0.0000   Offset

04:  P1        Volt (SE)
  01: 1        Rep
  02: 3        25 mV slow Range
  03: 4        IN Chan
  04: 4        Loc [:PY# 7267 ]
  05: 156.9    Mult
  06: 0.0000   Offset

05:  P1        Volt (SE)
  01: 1        Rep
  02: 3        25 mV slow Range
  03: 5        IN Chan
  04: 5        Loc [:PY# 5258 ]
  05: 172.1    Mult
  06: 0.0000   Offset

06:  P89       If X(=)F
  01: 1        X Loc EPPLEY
  02: 3        >=
  03: 5.0000   F
  04: 30       Then Do

07:  P92       If time is
  01: 0        minutes into a
  02: 10       minute interval
  03: 10       Set high Flag 0 (output)
```



```
08:  P77       Real Time
  01: 110      Day,Hour-Minute

09:  P71       Average
  01: 5        Reps
  02: 1        Loc EPPLEY

10:  P95       End

11:  P37       Z=X*F
  01: 1        X Loc EPPLEY
  02: .00006   F
  03: 6        Z Loc [:MJ EPPLEY]

12:  P37       Z=X*F
  01: 2        X Loc PY# 3092
  02: .00006   F
  03: 7        Z Loc [:MJ #3092 ]

13:  P37       Z=X*F
  01: 3        X Loc PY# 3719
  02: .00006   F
  03: 8        Z Loc [:MJ #3719 ]

14:  P37       Z=X*F
  01: 4        X Loc PY# 7267
  02: .00006   F
  03: 9        Z Loc [:MJ #7267 ]

15:  P37       Z=X*F
  01: 5        X Loc PY# 5258
  02: .00006   F
  03: 10       Z Loc [:MJ #5258 ]

16:  P         End Table 1

     2         Table 2 Programs
  01: 60       Sec. Execution Interval

01:  P92       If time is
  01: 0        minutes into a
  02: 1440     minute interval
  03: 10       Set high Flag 0 (output)

02:  P77       Real Time
  01: 110      Day,Hour-Minute

03:  P72       Totalize
  01: 5        Reps
  02: 6        Loc MJ EPPLEY

04:  P         End Table 2

*     3        Table 3 Subroutines
```

Page 4 Input Location Assignments (with comments):

Key:
T=Table Number
E=Entry Number
L=Location Number

```
T:  E:  L:
1:  1:  1:  Loc [:EPPLEY   ]
1:  2:  2:  Loc [:PY# 3092 ]
1:  3:  3:  Loc [:PY# 3719 ]
1:  4:  4:  Loc [:PY# 7267 ]
1:  5:  5:  Loc [:PY# 5258 ]
1: 11:  6:  Z Loc [:MJ EPPLEY]
1: 12:  7:  Z Loc [:MJ #3092 ]
1: 13:  8:  Z Loc [:MJ #3719 ]
1: 14:  9:  Z Loc [:MJ #7267 ]
1: 15: 10:  Z Loc [:MJ #5258 ]
```

Page 3 Table 3

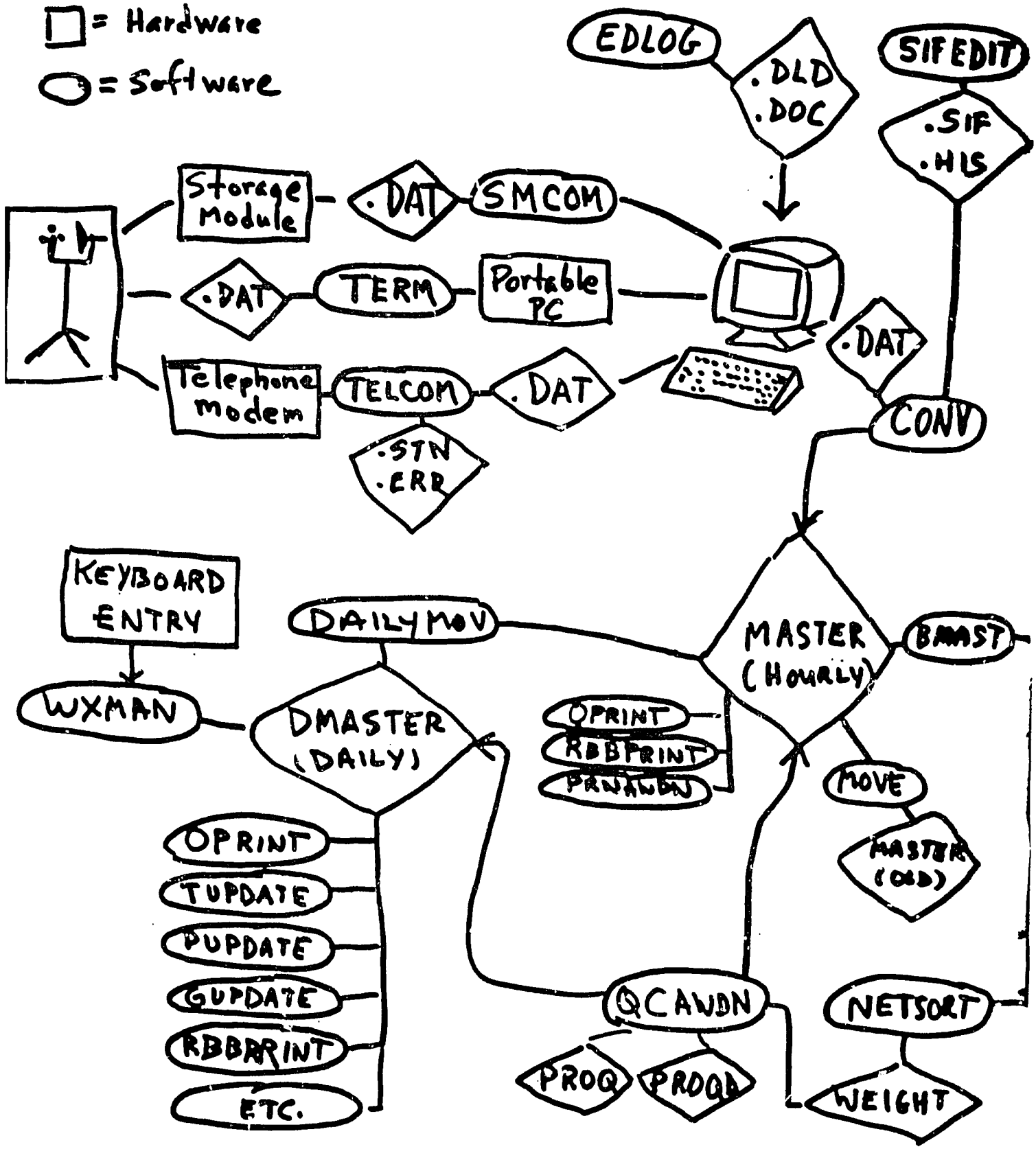
```
01:  P        End Table 3

*    A        Mode 10 Memory Allocation
  01: 28      Input Locations
  02: 64      Intermediate Locations
  03: 0.0000  Final Storage Area 2

*    C        Mode 12 Security
  01: 0000    LOCK 1
  02: 0000    LOCK 2
  03: 0000    LOCK 3
```

Page 5 Input Location Labels:

1:EPPLEY	4:PY# 7267	7:MJ #3092	10:MJ #5258
2:PY# 3092	5:PY# 5258	8:MJ #3719	11:_____
3:PY# 3719	6:MJ EPPLEY	9:MJ #7267	12:_____


= Data File
= Hardware
= Software
EDLOG
.DLD
.DOC
SIFEDIT
.SIF
.HLS
Storage Module
.DAT
SMCOM
.DAT
TERM
Portable PC
Telephone modem
TELCOM
.DAT
.STN
.ERR
.DAT
CONV
KEYBOARD ENTRY
WXMAN
DAILYMOV
DMASTER (DAILY)
MASTER (HOURLY)
BMAST
OPRINT
RBBPRINT
PRNAWDN
MOVE
MASTER (OLD)
OPRINT
TUPDATE
PUPDATE
GUPDATE
RBBPRINT
ETC.
QCAWDN
PROQ
PROQA
NETSORT
WEIGHT

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USER GUIDE FOR THE

AUTOMATED WEATHER DATA NETWORK (AWDN)

SYSTEM

by

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I. BACKGROUND.

This manual should help to define an Automated Weather Data Network (AWDN) system on a micro-computer. The system can be configured to satisfy the data collection requirements that are set forth. The AWDN system has been used successfully since January 1986 at the High Plains Climate Center in the form described below. No guarantees however, are made with respect to the use of this software. Problems with the software or documentation should be reported to the address shown on the front cover. The design of this system does not accommodate the storage of data that is taken on less than a one-minute sampling interval, or more than 50 different types of readings from a given station.

A. System Requirements.

Requirements for the AWDN software involve both hardware and software. The minimum system configuration is listed below followed by optional system hardware and software.

HARDWARE REQUIREMENTS

IBM Computer (or Compatible)
Hayes modem[1] (or Compatible)
Printer
Hard drive (30-70 Mb)
Math Coprocessor (Not needed with Microsoft Fortran)

SOFTWARE REQUIREMENTS

AWDN software
IBM Professional Fortran (Version 1.14 or greater)
(Microsoft Fortran should work but not fully tested)
IBM Professional Editor (or comparable editing tool)
IBM DOS (Version 3.1 or greater, Version 3.3 for IBM LAN)
Campbell PC208 data logger support software

HARDWARE (OPTIONAL)

External Disk Drives
Local Area Network (IBM Token Ring Network has been used)
Laser Printer
Plotter
Optical Drive

SOFTWARE (OPTIONAL)

Plotting package for Fortran (eg. Plot88 software by Plotworks Inc.)
Mapping Packages (eg. Surfer by Golden Software Inc.)
Communications Packages (eg. Crosstalk)

NOTE This manual assumes you fully understand the Campbell's software Version PC208 or a more recent version (if you do not, refer to the Campbell Scientific documentation). This manual also assumes you fully understand IBM DOS.

B. General Description of the System.

The Campbell software calls the stations and downloads the data into *station*.DAT files where *station* is the prefix selected by the user. An AWDN program called CONV reads these .DAT files and converts them into a master file called MASTER. A program called QCAWDN performs quality control of the data in the Master file.

The data can then be retrieved from the master file with AWDN programs that use very fast random access methods. Applications programs can print, plot, and summarize this data from the Master File. Generally, data from the data loggers is stored in the Master File and the master is not used to store calculated data.

The many components of the system can be organized under the two headings Weather Station and Computer. Under each heading there are important items to consider which all fall into three main categories:

1) Input
2) Processing/Storage, and
3) Output.

The following schematic lists some of the important components under the above headings.

Weather Station			Computer		
Input	Processing/ storage	Output	Input thru TELCOM	Processing/ storage	Output
Sensors	Programs	Modem	Modem	AWDN software	Printer
Program/ Download	Storage	Satellite Transmitter	Direct Linkage	QC software	Plotter
		Tape Recorder		Applications Software	LAN Device
		Storage Module			Modem

Data from other weather data systems or data loggers can optionally be collected and stored in the Master file by the AWDN system.

C. A Typical System.

The computer hard disk should be configured with three (3) different drives, M:, N: and O:. These drives can be individual physical devices or they can be portions of a drive that are referenced by directories or subdirectories. This manual assumes that M:, N:, and O: are directories that have been established on the physical drive C:. In fact, all three drives (M:, N:, and O:) do not have to be located on the same physical drive. For example, they can be set up on drive D or E or they could be set-up on a network drive. A typical system might have the following physical drives and ports:

Drives:
- A: - Diskette drive
- C: - 30-70 MB hard drive

Com Ports:
- Com1: - RS232 card or PC205 card
- Com2: - HP plotter

Parallel Ports:
- Lpt1: - printer
- Lpt2: - Laser printer

II. GETTING STARTED.

In this section you will learn how to create the AWDN system on your computer. Diskettes with AWDN software described herein are available from the High Plains Climate Center at the address shown on the front cover.

A. Setting up an AWDN Framework.

This is a two-part process. First, the computer is prepared for the AWDN system. Next the system files are transferred to the computer and/or created as described below.

BUILDING DIRECTORIES AND SUBDIRECTORIES

Let's start by building the necessary directories on the ROOT directory of drive C. The directories that you need to build are AWDN, STATFILE and MASTFILE. To do this go the root directory and issue the DOS command MKDIR:

```
CD \
MKDIR AWDN
```

Repeat the MKDIR command for each of the directories listed above.

Let's also build a number of subdirectories under the directory AWDN. These subdirectories are: SOURCE, XTALK, DAILYARC, ARCHIVES, CAMPBELL, AWDNPROG, FILES, QC, and QCSOURCE. To make the subdirectories go to the AWDN directory and use the DOS command MKDIR.

```
CD \AWDN
MKDIR SOURCE
```

Repeat the MKDIR command for each of the subdirectories listed above.

These directories and subdirectories and a brief description are given below:

AWDN - contains the subdirectories of AWDN files
- SOURCE - contains fortran source code for programs in AWDNPROG
- XTALK - Crosstalk subdirectory
- STATFILE - contains the .STN, .ERR, .TRM and .DAT files that the Campbell software uses and the .SIF and .HIS files that the AWDN software uses
- DAILYARC - contains the .DAT files from last night's calls
- ARCHIVES - contains the archived .DAT files
- MASTFILE - contains the MASTER files
- CAMPBELL - contains Campbell PC208 software
- AWDNPROG - contains the .EXE files for the system
- FILES - contains input and batch files for the system
- QCSOURCE - fortran source code for quality control programs
- QC - files for quality control of AWDN.

Add the following lines to the AUTOEXEC.BAT to enable the system to use drive letters instead of subdirectory names to refer to files:

```
SUBST O: C:\MASTFILE
SUBST N: C:\STATFILE
SUBST M: C:\AWDN
```

After making these changes be sure to reboot the system.

And add the following to the path M:\FILES;M:\AWDNPROG.

Add the following lines to the CONFIG.SYS so the SIFEDIT program of the AWDN system will work properly:

```
DEVICE=ANSI.SYS
FILES=20
BUFFERS=20
LAST DRIVE=Z
```

LOAD FILES INTO THE SUBDIRECTORIES

The AWDN software is on sub-directories of diskettes that can be loaded to your hard drive. To load your software to the hard drive, put the correct diskette in drive A and enter the following commands:

```
COPY A:\AWDNPROG\*.* M:\AWDNPROG  ( \AWDNPROG is provided on four diskettes)
COPY A:\SOURCE\*.* M:\SOURCE
COPY A:\STATFILE\*.* N:
COPY A:\FILES\*.*  M:\FILES
COPY A:\QCSOURCE\*.* M:\QCSOURCE
COPY A:\QC\*.* M:\QC
```

Also load the software (PC208) you purchased from Campbell Scientific into M:\CAMPBELL

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B. Defining the AWDN System Files.

Certain file naming conventions must be followed in setting up a station in the AWDN system. The following are extensions that must be used.

.STN - created by TELCOM when user is editing a new station
.ERR - messages output from TELCOM during telecommunications
.DAT - output of TELCOM the contents of which are datalogger data
.SIF - Station Information File created or edited by using SIFEDIT
.HIS - a record of changes made by SIFEDIT

All of the above extensions have a prefix *station*, eg. *station*.STN, where the prefix is the name that you have chosen for your station in TELCOM.

.INP - redirected input file to programs, ie. an input file holds all the relevant user responses required by a program in the order in which they are requested by the program

Assume you have 4 stations whose names (station prefixes) are MTNTOP, FARWAY, VALLEY and NEXTDOR. The objective is to define various AWDN files in order to achieve unattended or automated operation.

BUILDING CAMPBELL .STN FILES

Start the Campbell program TELCOM. Build a .STN file for each station and call the stations N:MTNTOP, N:FARWAY, etc. To do this requires that you answere the prompts in TELCOM with appropriate responses. This will create the Campbell files on the N drive, which is really C:\STATFILE. This will help organize your files on the hard drive. Data Collection Method should be set to Since Last Call; Append File. Data File Format should be set to Printable ASCII. (See Telcom documentation from Campbell)

BUILDING AWDN .SIF FILES

Build an .SIF file for each station. The SIF file contains all the information and parameters of the station that the AWDN system needs to know. You can build a .SIF file with the program SIFEDIT. Start the program by entering the following:

SIFEDIT/R 4096

(/R 4096 is needed when starting most AWDN programs). Enter N:SAMPLE for the Input File name and N:MTNTOP for the Output File name. Now make the changes that are necessary in the file following the general guidelines set forth below. Do this for all 4 stations. Note: Once N:MTNTOP.SIF is built you can use it for the Input File when building N:FARWAY.SIF. As you can see, the .SIF files are

also created on drive N. In general the use of SIFEDIT requires an input station name and an output station name:

Input -- station name (N:MTNTOP)
Output -- station name (N:MTNTOP)

The following keys are active:

cursor up
cursor down
cursor right
cursor left
pgup - previous screen
pgdn - next screen
F9 - enter blanks into alpha field
F10 - finish

If you want to create a new .SIF file, enter SAMPLE or a previously defined .SIF file as the Input File and enter your new station name as the Output File and make the needed additions or corrections (See APPENDIX A for typical screens supported by the SIFEDIT program).

SIFEDIT divides the .SIF file into 8 update screens:

1 - STATION SPECIFICATIONS
2 - STATION TIME SPECIFICATIONS
3 - LOGGER OUTPUT TABLES
4-8 - VARIABLE OUTPUT TABLES

There is also an Input and Output definition screen and a Close File screen. The Input and Output screen is displayed at the beginning of the program and the Close File Screen is displayed when F10 is pressed.

Use the pgup and pgdn key to go from screen to screen. When updating is complete use the F10 key to go to the Close File screen.

Note that the latitude and longitude are in units of degrees and minutes where a decimal point separates the two (eg. 40.23 is equivalent to 40 degrees and 23 minutes).

Note: On the Station Time Specifications Screen set the Station Startup time to the date and time when you started taking data for that station. Set Station Ending Time to a time in the future like 1999 365 0. The Quality Control Marker, Agnet Marker and Last Date Received Marker should be initially set to the starting time. They are then used by the system.

SIFEDIT can update a .SIF file in the AWDN system. Start the program by entering SIFEDIT/R 4096. For example, if you want to update N:MTNTOP.SIF enter N:MTNTOP as both the Input and Output File. You do not have to worry about any variable in the .SIF file that has to do with AGNET, this is an option that pertains to the Univ. of Nebraska and can be used as a field for numbering your stations.

The OUTPUT ARRAY ID in the .SIF files must match the OUTPUT ARRAY ID create by the Campbell dataloggers in their .DAT files.

The ID NUMBER OF VARIABLE comes from APPENDIX B, AWDN Variable Codes. The FLAGS column will use this letter code as the default when the data is converted into the Master file by CONV. TOP and BOTTOM LINE of LABEL are used in OPRINT and TIMEPLOT as column or axes labels.

The unused lines in the LOGGER OUTPUT TABLES and VARIABLE OUTPUT TABLES must

be set to 9999.

STATION# AND STATE# must be unique numbers. (We use a quasi-NWS numbering system for our stations) DATA LOGGER CLOCK ERROR is used with a CR21 datalogger whose clock is not set to the correct time. TIME ZONE DIFFERENCE is used if the station is in a different time zone than the calling computer. DATA EXCLUSION WINDOW is used to create a time window outside of which data will not be converted into the the archive.

TIME AFTER MIDNIGHT OF FIRST TABLE is usually set to 0. If you took two daily tables one at midnight and one at noon the first one (midnight) would be set to 0, the second one (noon) would be set to 12x60=720. The units are minutes.

SIFEDIT can also be used to edit a .SIF file in place. Just enter the same station name as both the Input File and Output File to SIFEDIT.

A record of the changes made to the .SIF files is automatically kept by the system in files that end with the .HIS extension, ie. N:MTNTOP.HIS. Any time SIFEDIT is used to change the table identification number from the data logger, the location of a variable in the table, the code number of a variable or flags in the variable a record is made in the appropriate .HIS file. Also noted are the changes to data logger clock time and the data exclusion window. The .HIS files can be referred to at any time to review the history of changes to the .SIF file. This feature is useful when one wishes to reconvert data from a time period when changes were being made at the station.

<u>How do Changes in SIFEDIT affect the MASTER file?</u>

When making changes to the station information files one should be aware of how the changes will affect the total AWDN system. Any given change may cause one of several actions to be necessary. These are: re-index the master file; create a new master file and move data from the previous master to the new master; or create a new master file and convert data to the new master file. Each of the major sections of the .SIF file are identified below along with any action that is needed with regard to the MASTER file if specific parameters are changed during an SIFEDIT session.

<u>Below are the actions required for changes made in various sections of the .SIF file.</u>

STATION SPECIFICATIONS

If you change the following parameters you must RE-INDEX MASTER

STATION #
STATE #

STATION TIME SPECIFICATIONS

If you change the following parameters you must
CREATE NEW MASTER AND USE THE MOVE PROGRAM

STATION START-UP TIME
STATION ENDING TIME

LOGGER OUTPUT TABLES

If you change the following parameters you must
CREATE NEW MASTER AND CONV DATA

ARRAY OUTPUT INTERVAL
TIME AFTER MIDNIGHT OF FIRST TABLE

VARIABLE OUTPUT TABLES

If you change the following parameter you must re-index MASTER

ID NUMBER OF VARIABLE

PRINTING AWDN .SIF FILES

To print .SIF files, execute the program SIFPRINT. Start the program by entering SIFPRINT/R 4096. For the Input File name, enter N:MTNTOP. (SEE HOW TO USE SIFPRINT). A listing of all the information in the .SIF file will be dumped to the printer. This information should be checked and re-checked before using the .SIF files in the next steps. An input is required and is entered in the same way as the input to the SIFEDIT program.

Input -- station names (N:MTNTOP)
Output -- printer listings

SIFPRINT lists all information contained in the .SIF file of the requested station. SIFPRINT must be started with the /R 4096 option. SIFPRINT can be used with redirected input to obtain a listing of all stations.

CREATE CAMPBELL.SFN

A file named CAMPBELL.SFN in the M:\FILES subdirectory should be made which contains all station names and a carriage return on the last line. This file will be used as redirected input to a number of AWDN programs during night operation.

N:MTNTOP
N:FARWAY
N:VALLEY
N:NEXDOR
(CR)
EOF

BUILDING THE MASTER FILE

After all the .SIF files are created and the contents have been checked, you can build the master file. The program can be started by the following command:

BMAST/R 4096

The program builds a file with a location saved for each parameter of each time interval for each station. All data locations are set to zero and all flages to "M" for missing by the BMAST program.

The master file usually is created with the name O:MASTER.

Input -- station name (N:MTNTOP), keyboard input
Output -- Master File, Printer listings

BMAST builds a Master File that stores data in the AWDN system. The Master File is usually built by the name O:MASTER. BMAST must be started with the /R 4096 option. The Master File is a random access file made up of an index and the data. The index contains the beginning and ending time of each station, variable codes of each station and a pointer indicating the start of the data within the file.

Before proceeding check the start and end time in your .SIF files. Note that the start and end time you enter for building the master file below cannot lie outside those specified in the .SIF file. Also note that this program will build the master file large enough to hold all the data that you have indicated is being taken (in the .SIF files) for the period you indicate. If you are not sure how to calculate the amount of disk space that this will tie up then first run the BMAST program with start and end time of one day and check the resulting size of the master file. You should then be able to determine the trade off between start and end data for your master file and the disk storage requirement.

Below is a typical run of BMAST. The program prompts the user for the starting and ending time of the file, name of the Master to be created, and station names as shown in the example below -- user response in bold:

```
BMAST/R 4096
PLEASE ENTER STARTING JULIAN DATE AND YEAR -
1 1987
 STARTING JULIAN DATE AND YEAR -     1  1987
 PLEASE ENTER ENDING JULIAN DATE AND YEAR -
1 1988
 ENDING JULIAN DATE AND YEAR -       1  1988
 PLEASE ENTER NAME OF MASTER FILE TO BE BUILT
O:MASTER
 NEW MASTER - O:MASTER
 PLEASE ENTER STATION NAME
N:MTNTOP
 PLEASE ENTER STATION NAME
N:FARWAY
 PLEASE ENTER STATION NAME
(cr)
```

Another way of accomplishing the above without entering all of the necessary responses from the keyboard is to use redirected input. The Master File was built on O:MASTER from Jan 1, 1987, to Jan 1, 1988, with two stations (MTNTOP and FARWAY). The same results could be obtained by using redirected input from a file (BMAST.INP). BMAST.INP would be created by an editor with the following lines:

```
1 1987
1 1988
O:MASTER
N:MTNTOP
N:FARWAY
(cr)
EOF
```

The contents of this file represent the user's response to each of the prompts of the BMAST program. The program would then be started by typing

```
BMAST/R 4096 < BMAST.INP
```

If, at some time after the Master File was built it becomes necessary to modify the MASTER this can be accomplished by again running BMAST. Some common reasons for modifying MASTER are either a station is being added to your network or sensors are being added to a station in the network or an error in the SIF file is discovered.

<u>Always backup your Master file prior to attempting any changes shown below. A small error may require that you start over and this will only be possible if the Master file has been backed up.</u>

If it is necessary to add a third station (N:VALLEY), it could be done by changing BMAST.INP to the following and running BMAST.

```
1 1987
1 1988
O:MASTER
N:MTNTOP
N:FARWAY
N:VALLEY
(CR)
EOF
```

The only changes that can be made in BMAST.INP are additions of stations to the bottom of the file. The STATION START-UP TIME and STATION ENDING TIME of the original stations in their respective .SIF files must not be changed. The number of variables in the VARIABLE OUTPUT TABLE of the .SIF files also must not be changed.

If a data logger at an existing station were reprogrammed to add additional variables that are needed in the Master File, it would be necessary to rebuild the Master File. This can be done by changing the .SIF file for that station and changing the O:MASTER to O:MASTER.NEW in BMAST.INP.

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```
1 1987
1 1988
O:MASTER.NEW
N:MTNTOP
N:FARWAY
N:VALLEY
(CR)
EOF
```

Then BMAST can be run to build the new Master File, called O:MASTER.NEW.

The program MOVE would then be run to move data from O:MASTER to O:MASTER.NEW.

MOVE/R4096 <MOVE.INP

The contents of MOVE.INP are as follows:

```
O:MASTER
O:MASTER.NEW
N:MTNTOP
N:FARWAY
N:VALLEY
(CR)
EOF
```

After moving the data to the new master you will want to do some checking to see that all data has been moved. This can be done by checking the output that MOVE generates at the printer. If everything is correct you can rename MASTER.NEW to MASTER.

If an error is discovered in the ID NUMBER OF VARIABLE in the VARIABLE OUTPUT TABLE of a .SIF file, it can be corrected, and then run BMAST/R 4096 < BMAST.INP.

When updating the Master File, great care must be taken, since a small change to any .SIF file could ruin a Master File. Always back up your Master File before updating it. When a Master File is built it is created with all variables set to 0.0 and all Flags set to "M".

6. Use of the MASTER data file.

The AWDN system interacts with the MASTER file to accomplish several functions. The building of the Master file (BMAST) was discussed above in section 2.2. In addition the system can process raw data files (those obtained from the data loggers or other sources) and write the desired information in the Master file; quality control the recently converted data; and retrieve the data for printing, plotting or building special station data files. These interactions are discussed separately in the following section. The use of the programs described below will be generalized to the unattended mode in section 3.0.

CONVERTING DATA

Raw Campbell data (.DAT files) are converted into the Master file by the program CONV. The program is started by the following command: CONV/R 4096. First enter the Master File name to the prompt, then enter the station names, ie. O:MASTER, N:MTNTOP, N:FARWAY, etc. Data is now in the master file. The above assumes that the data was retrieved directly from stations by calling with TELCOM, downloading with TERM, or downloading with SDCOM and that one of these programs has created the files N:MTMTOP.DAT, N:FARWAY.DAT, etc.

Input -- master file name and station names (N:MTNTOP)
Output -- printer listing
Update -- Master File, station names.SIF (N:MTNTOP.SIF)

CONV converts Campbell .DAT files that were stored in Comma Delineated ASCII or Printable ASCII into a master file. The master file is usually O:MASTER. The name of the Master File is requested from the user. The program must be started with the /R 4096 option. CONV can be driven by keyboard input. During night operation this input can be from a redirected source such as CONV.INP. Respond to the prompts in the following fashion:

```
ENTER MASTER FILE NAME:
O:MASTER
PLEASE ENTER STATION NAME:
N:MTNTOP
PLEASE ENTER STATION NAME:
N:FARWAY
etc.
(CR)
```

When a station name of N:MTNTOP is entered, CONV reads N:MTNTOP.SIF. With the information from this file CONV knows which data fields of N:MTNTOP.DAT to convert and which variable codes to assign to this data.

CONV will check input data for proper time and proper data format. Blank lines in the input file will be skipped. Campbell table numbers will also be checked. Messages will be written to the printer when these conditions appear in the raw input files.

CONV will update the LAST DATE RECEIVED MARKER in the .SIF file.

If you get an error message "NO PARAMETER FROM STATION" check to see that the OUTPUT ARRAY ID in Screen 4 and 5 matches the OUTPUT ARRAY ID's in Screen 3.

If you get an error message "?? TABLES ARE INVALID IN ????" check your OUTPUT ARRAY ID in Screen 4, 5 and 6.

If you get an error message "DATA LOGGER TIME NOT WITHIN LIMIT" check the input file (.DAT) that the data in the file is within the window specified in the .SIF file (Screen 1).

QUALITY CONTROL OF DATA

Strictly speaking quality control and use of files discussed below need not be carried out to make the AWDN software work. If quality control is not part of the system however, it becomes only a storage and retrieval system with no quality assurance. The advantages associated with testing the data for outliers, for interruptions in sensor function etc. make it well worth while to define the quality control portion of the system. This is particularly true if a long term network is to be operated.

Quality control is accomplished for the data collected by running the program QCAWDN:

```
QCAWDN/R 4096 <QCAWDN.INP
```

Users should use redirected input according to the example shown below. The program will not prompt at the screen for information or the names of stations to be quality controlled that is N:MTNTOP etc.

QCAWDN.INP would look like this (note: you could build QCAWDN.INP by copying the CAMPBELL.SFN file to QCAWDN.INP and modifying the lines at the top of the new file). Before attempting this step develop the files WEIGHT.ONE and PROQ2 as shown in the sections immediately following.

```
O:MASTER
M:\FILES\WEIGHT.ONE
M:\FILES\PROQ2
M:\FILES\PRNHRLY
N:MTNTOP
N:FARWAY
N:VALLEY
(CR)
EOF
```

The PRNHRLY file is a file created by QCAWDN and it summarizes the actions taken by the program as well as locations of suspicious data.

BUILDING WEIGHT.ONE FILE

This file contains the distance between each station and the closest neighboring stations for each variable measured at the station and is used in estimating missing data. You can run the NETSORT program after the .SIF files have been built. Use the command:

```
NETSORT/R 4096
```

Note that this program resides in the \QC directory. Any old versions of WEIGHT should be deleted or renamed prior to execution of NETSORT. The NETSORT program requires two station lists as input. If you want to quality control stations among themselves you simply enter the list twice as in:

```
M:\CAMPBELL.SFN
M:\CAMPBELL.SFN
```

In this instance, the NETSORT program will search out the closest surrounding stations for each station in the list and for each variable at that station.

Subsequently, any estimates made by the QC program would use the closest stations and an inverse distance weighted scheme. When a WEIGHT file has been created in the \QC subdirectory, it should be copied to the \FILES subdirectory. Different extensions can be used for the WEIGHT files if different networks are being run on the same computer.

BUILDING THE PROQ2 FILE

This file is created and updated manually. There is a separate line for each variable that will be addressed by the quality control program. A printout of a typical PROQ2 file is shown in Appendix D. The first entry in a line is the code number for a variable (all codes currently defined are listed in Appendix B). The second entry is an associated code, used to check max against min etc. This is followed by the upper and lower limits that are not expected to be exceeded by the variable identified by the first variable code in the line. The remaining entries on a line are the quality control procedures that will be used with this variable. A list of all quality control procedure numbers and their definition is given in Appendix C. An example PROQ2 file is included in the M:\FILES subdirectory.

QUALITY CONTROL OF ONE NETWORK WITH ANOTHER

If you want to subdivide your data for the purpose of quality control (eg. you may more faith in some stations than others) you can use two different lists as input to the NETSORT program:

N:\FILES\LIST1.SFN
N:\FILES\LIST2.SFN

The more trusted stations would be in LIST2.SFN.

PRINTING AND PLOTTING

Start these programs with the /R 4096 option.

Now OPRINT can be used to print data to the printer and TIMEPLOT to make plots. They are both started with the /R 4096 option. Remember the stations names are N:MTNTOP, N:FARWAY, etc. Note: When year is asked for it must be entered as 1987, not 87. The OPRINT program is a generalized print program which prints according to the information stored in the .SIF files.

A daily printout program is also available to summarize the hourly measurements. This program assumes that hourly and daily data are collected in a manner compatible with that used with automated stations in the High Plains Automated Weather Data Network. Start this program with the command: PRNAWDN/R 4096 and it will prompt you to select options like which system of units should be used to printout the daily values and which stations to print ie. N:MTNTOP etc.

USE OF RBBPRINT

RBBPRINT was designed to dump many ASCII files to our Remote Bulletin Board. It can be used to dump data from the master file to the printer, screen, or disk file. Data can be dumped form more than one station. RBBPRINT must be used with redirected input. The input into RBBPRINT is very column dependent. See APPENDIX G for format of this file. A sample input file that can be used for redirected input is in M:\FILES\RBBPRINT.INP.

III. UNATTENDED OPERATION.

The AWDN system has been developed to run in unattended mode. This is accomplished by certain uses of the .BAT files (usually includes the AUTOEXEC.BAT file) together with a timer. The Campbell PC203 power-up control box or any timer that can control power to the computer can be used. I would also be possible to leave the computer on continuously and use the /W options of TELCOM.

SETTING UP TO RUN AWDN SOFTWARE ON TELCOM

Build a script file in TELCOM that looks like this:

```
N:MTNTOP
N:FARWAY
N:VALLEY
N:NEXDOR
M:\FILES\CONVARC
M:\FILES\QC
M:\FILES\PLOT
/W
```

CONVARC, QC and PLOT are "DOS Commands" within TELCOM. Each is set up to execute a .BAT file, CONVARC.BAT, QC.BAT or PLOT.BAT (See APPENDIX E) (see page 2-5 in the Campbell Telcom Manual).

HOW TO USE PRINTIME

Input -- none
Output -- printer

PRINTIME prints the data and time to the printer on the system. PRINTIME is used to time mark the printout during unattended operation.

HOW TO USE BUILDBAT

Input -- station names (N:MTNTOP etc.)
Output -- ADDCRLF.BAT, DEFILES.BAT and BUILDARC.BAT

BUILDBAT builds the batch files, ADDCRLF.BAT, DEFILES.BAT and BUILDARC.BAT. BUILDBAT is executed by CONVARC.BAT during night operation. BUILDBAT uses redirected input of CAMPBELL.SFN when started. The three batch files that are created are also executed by CONVARC.BAT.

ADDCRLF.BAT -- will add a carriage return and linefeed to the end of each .DAT file.
DELFILES.BAT -- will delete the .DAT and .ERR files created by TELCOM.
BUILDARC.BAT -- will add the .DAT file to the .DAT file on the subdirectory DAILYARC.

HOW TO USE PRINTERR

Input -- station names (N:MTNTOP)
Output -- printer listing

PRINTERR reads .ERR files created by TELCOM, creates a header with the station name in it, and adds all lines in the .ERR file. All the above information is listed to the line printer for each station entered into PRINTERR. PRINTERR can be used with redirected input (CAMPBELL.SFN) to obtain an error listing of all stations.

INFORMATION ON OPRINT

Input -- station name (N:MTNTOP), Master file (O:MASTER)
Output -- printer, disk or screen output

OPRINT will generate a listing of data for the variables of an output table of a given station from the Master File. OPRINT must be started with the /R 4096 option. The user is asked for data output location, Master File name, date of desired data, station name, and output table number.

HOW TO USE CHANFLAG

Input -- keyboard
Update -- flags in the Master File

CHANFLAG changes the flags of any variable of any station in a master file for any time period. CHANFLAG will not change the data for that station. A "M" usually means missing data; "E" is an estimate and " " is good data. You must know the variable codes that need their flags changed before starting the program. Care must be taken when using this program.

INFORMATION ON BUILDSIN

Input -- keyboard input
Output -- TSING.INP, CSING.INP, COPYSING.BAT, OSING.INP

BUILDSIN is started by the batch file SINGLE.BAT. SINGLE.BAT will request from the user the station name of the station that will be called, updated and printed. BUILDSIN will build the 4 files that will be needed as redirected input to do the above. (See SINGLE.BAT in APPENDIX C)

HOW TO USE MOVE

Input -- old master and station names (N:MTNTOP)
Update -- new master

MOVE moves data from the Input Master to the Output Master. MOVE must be started with the /R 4096 option. Input Master and Output Master are entered as well as the station names. If N:MTNTOP is entered as a station name, MOVE will check the Output Master for the beginning and ending time that it was

created with and then move all data for that station from the Input Master to the Output Master.

INFORMATION ON TIMEPLOT

Input -- keyboard, Master File (O:MASTER), CONTROL.PAR
Output -- plots

TIMEPLOT will plot AWDN data against an x-axis of time. TIMEPLOT must be started with the /R 4096 option. TIMEPLOT can plot to Hercules Graphics Card, EGA, CGA, HP plotter, HP laser and Epson printer. TIMEPLOT reads the file CONTROL.PAR for control parameters. CONTROL.PAR must be in your current directory when you use TIMEPLOT. CONTROL.PAR is in M:\FILES\RBBPRINT.INP.

IV. MANAGEMENT OF AWDN.

A. A Perspective on Daily Management of the AWDN.

AWDN is checked for problems each morning. When the computer goes through its call-up sequence, it generates a printout that indicates which stations responded, whether observations were received, and whether data received during the call-up were acceptable. Stations that did not respond are recalled using either the TELCOM or SINGLE command. (TELCOM calls the station and receives raw data, but does not convert it; SINGLE calls the station, receives raw data, and converts it.) Recalls and failed recalls (as well as all other problems with sensors, data loggers, and so forth) are noted on a work sheet designed to record any problems during the week with AWDN stations.

During the call-up sequence, AWDN also runs a quality control program that checks all data received against certain predefined upper and lower limits. Data that do not fall between the limits for each parameter are identified as questionable. The results of this program, QCPRN, are printed out each morning and checked. To determine if problems actually do exist at the questionable sites, the raw data for the station is examined. (Raw data is found in the DAILYARC and ARCHIVES directories.) If data is found to be inaccurate, the sensor is "officially" flagged in the station information file. By using the SIFEDIT command, a technician can tell the quality control program to automatically flag that sensor as missing; the flag will remain there until it is removed by the technician. The quality control program will sometimes identify good data as questionable if that data stays below (or above) a certain threshold for a number of consecutive hours. Wind speed, for example, often stays at a low number for several hours during the night; this data is generally accurate, but the quality control program will draw attention to it as a precaution. When a large amount of data must be flagged (for example, when a problem is not discovered right away), the CHANFLAG command can be used. The command asks for beginning and ending dates and times for the flag, parameters to be flagged, and type of flag ("missing" or "good"). It can be used either to flag a large amount of bad data or to remove flags placed on good data. Once a sensor is repaired, the technician must remove the flag from the SIFEDIT file, or the quality control program will continue to flag the sensor.

Not all problems noted by the quality control program are the result of bad sensors. If few or no hours of data have been received from a station, the program will note those hours as missing. Quality control does not indicate the reason for the missing data, which may include the following: failed call, Julian date error, clock error, or incomplete data table in .DAT file. These problems can be determined from the printout generated by the system during its call-up sequence. For a Julian date error or a clock error, the printout will indicate that the data logger is not within the time limit. A Julian date error occurs when the data logger transmits an unrecognizable Julian date or time (e.g., "2985" for 1987 or "2003" for 2 AM). These errors can be corrected by finding the inaccurate date or time in the DAILYARC station file, typing in the correct number, moving the corrected file into N:,

and reconverting the station's data (using CONV/R 4096).

Clock errors are more difficult to correct. The data logger's clock sometimes jumps forward (or backward) in time. All data received from the data logger after a time jump is therefore transmitted with an inaccurate time and is not properly recognized by the convert program. To correct a time jump, the technician must determine the point at which the jump occurred and also the length of the jump. The OPRINT command will indicate when the jump occurred, since all data transmitted after the jump will have been estimated by the quality control program. The raw data files (in DAILYARC and ARCHIVES) will also indicate when the jump occurred as well as whether the time jumped forward or backward, because these files list only the raw data sequentially; they do not put it into a format as OPRINT does. After determining the length (in minutes) of the time jump, the technician enters this number (a negative number if the time jump is forward, a positive number if the time jump is backward) into the station information file (using the SIFEDIT program). The station information file will add this number (positive or negative) to each hour in that station's .DAT file when it is converted. By selecting only those hours which need to be corrected and moving them to an N: file, the technician can reconvert and therefore correct the inaccurately labeled data.

Data can also be noted as missing if an incomplete data table occurs at the beginning of an N: file. The CONV program will not be completed for any station file that begins without the first line of a table--that is, the first line of any .DAT file must contain the Julian date and time. To correct the problem, the incomplete table must be deleted so that the first line of the .DAT file is also the first line of a table; the data can then be reconverted.

For the quality control program to properly function after using CHANFLAG, the "last data received" pointer in that station's information file must be changed to include the time period involved in the correction. The SIFEDIT program allows a technician to set the Julian date and time of last data "quality controlled" back in such cases.

B. AWDN System Backup.

This system should be backed up on a weekly basis in order to insure against data loss or loss of system changes (in .SIF files etc.). The method of backing up the system will vary according to the hardware configuration but, it is most important to keep a backup of the system in a safe place in case of non-recoverable disk errors that might wipe-out a portion of the AWDN system.

It is probably a good idea to print the data from all stations for at least one day during the week. Some one experienced in the weather data interpretation and who has knowledge to the weather patterns for that day should scan the data to determine if any problems exist at the station.

V. APPENDICES.

A. Appendix-SIFEDIT screens.

(see APPENDIX F for input information)

-------Input and Output Screen -------

```
*************************************************************
*                                                           *
*        AWDN  --  STATION INFORMATION FILE EDITOR          *
*                                                           *
*                 WRITTEN BY:  JAMES HINES                  *
*                                                           *
*************************************************************
```

INPUT FILE ---> N:MTNTOP

OUTPUT FILE --> N:MTNTOP

------ Screen 1 ------

```
*************************************************************
*                                                           *
*                STATION SPECIFICATIONS                     *
*                                                           *
*************************************************************
```

STATION NAME: MTNTOP
STATE NAME: NEBRASKA
LATITUDE: 41.08
LONGITUDE: 96.30
ELEVATION (M): 366.00
STATION #: 5369
STATE #: 25
AGNET STATION #: 1
DATA LOGGER CLOCK ERROR (MINS.): 0
TIME ZONE DIFFERENCE (MINS.): 0
DATA EXCLUSION WINDOW (MINS.): 14400

INPUT FILE - N:MTNTOP.SIF
OUTPUT FILE - N:MTNTOP.SIF

DATE - 10/ 7/1987
CALENDAR DAY - 280

-- Screen 2 ------

```
*************************************************************
*                                                           *
*              STATION TIME SPECIFICATIONS                  *
*                                                           *
*************************************************************
```

	YEAR	CALENDAR DAY	HOUR	MINUTE
STATION START-UP TIME	1981	139	0	0
STATION ENDING TIME	1999	365	0	0
QUALITY CONTROL MARKER	1987	277	1	0
AGNET MARKER	1987	277	1	0
LAST DATE RECEIVED MARKER	1987	277	1	0

INPUT FILE - N:MTNTOP.SIF

OUTPUT FILE - N:MTNTOP.SIF

DATE - 10/ 7/1987

CALENDAR DAY - 280

------ Screen 3 ------

```
*************************************************************
*                                                           *
*                  LOGGER OUTPUT TABLES                     *
*                                                           *
*************************************************************
```

AFTER OUTPUT TABLE (MINUTES) #	AGNET CODE 0-NOT SEND 9999-EOF 1-SEND	OUTPUT ARRAY ID	ARRAY (MINUTES) INTERVAL	LOCATION OF CALENDAR DAY 0-LAST TIME IN TABLE	LOCATION OF HR/MIN IN TABLE	TIME MIDNIGHT OF FIRST TABLE
1	1	102	60	2	3	0
2	1	201	1440	0	0	0
3	9999	0	0	0	0	0
4	9999	0	0	0	0	0
5	9999	0	0	0	0	0

INPUT FILE - N:MTNTOP.SIF

OUTPUT FILE - N:MTNTOP.SIF

DATE - 10/ 7/1987

CALENDAR DAY - 280

------ Screen 4 ------

```
*************************************************************
*                                                           *
*                VARIABLE OUTPUT TABLES                     *
*                                                           *
*************************************************************
```

VAR-IABLE TABLE #	OUTPUT ARRAY ID	LOCATION OF VARIABLE IN ARRAY	ID NUMBER OF VARIABLE	FLAGS "M"-MISSING " "-GOOD	LOCATION OF VARIABLE IN RECORDS TO AGNET	TOP LINE OF LABEL	BOTTOM LINE OF LABEL
1	102	4	100	" "	1	"AIR TEMP"	" C "
2	102	5	200	" "	2	"REL HUM "	" % "
3	102	6	300	" "	3	"SOIL TMP"	" C "
4	102	7	400	" "	4	"WIND SP "	" M/SEC "
5	102	8	500	" "	5	"WIND VEC"	" M/SEC "
6	102	9	600	" "	6	"VECT DIR"	" "
7	102	10	700	" "	7	"VECT SD "	" "
8	102	11	800	" "	8	" RAD "	" W/M2 "
9	102	12	900	" "	9	" PRECIP "	" MM "
10	201	2	110	" "	1	"MAX TEMP"	" C "
11	201	3	111	" "	2	"MIN TEMP"	" C "

------ Screen 5 ---

```
*************************************************************
*                                                           *
*                VARIABLE OUTPUT TABLES                     *
*                                                           *
*************************************************************
```

VAR-IABLE TABLE #	OUTPUT ARRAY ID	LOCATION OF VARIABLE IN ARRAY	ID NUMBER OF VARIABLE	FLAGS "M"-MISSING " "-GOOD	LOCATION OF VARIABLE IN RECORDS TO AGNET	TOP LINE OF LABEL	BOTTOM LINE OF LABEL
10	201	2	110	" "	1	"MAX TEMP"	" C "
11	201	3	111	" "	2	"MIN TEMP"	" C "
12	201	4	509	" "	0	"MAX WIND"	" SPEED "
13	201	5	510	" "	0	" TIME "	" OF MAX "
14	201	6	1300	"M"	0	"AV VAPOR"	"PRESSURE"
15	201	7	1301	"M"	0	"VAP PRES"	"DEFICIT "
16	201	8	930	"M"	0	" PRECIP "	" MM "
17	9999	0	0	" "	0	" "	" "
18	9999	0	0	" "	0	" "	" "
19	9999	0	0	" "	0	" "	" "
20	9999	0	0	" "	0	" "	" "

97

```
----- CLOSING SCREEN -----

*************************************************************
*                                                           *
*                    CLOSE FILE SCREEN                      *
*                                                           *
*************************************************************

Q - QUIT AND DO NOT UPDATE OUTPUT FILE

S - SAVE INFORMATION TO OUTPUT FILE

C - MORE CHANGES TO OUTPUT FILE


ENTER Q,S OR C (CR) -->

INPUT FILE  - N:MTNTOP.SIF                    DATE  - 10/-7/1987

OUTPUT FILE - N:MTNTOP.SIF                    CALENDAR DAY - 280
```

B. Appendix-AWDN Variable Codes.

AWDN Variable Codes-Revised 1-9-1989

Code Number	Description	Units
11	Maximum Daily Temperature	Farenheit
12	Minimum Daily Temperature	Farenheit
20	Average Daily Humidity	%
30	Soil Temperature	Farenheit
40	Wind Speed	mi/hr
80	Solar Radiation	Langley
90	Precipitation	Inches
64	Accum. GDD 40 from Jan. 1	
65	Accum. GDD 50 from Jan. 1	
70	ET	Inches
71	Accum. ET	Inches
91	Accum. Precip. from Jan. 1	Inches
100	Average Air Temperature (1.5m)	Celsius
109	Sample Air Temperature	Celsius
110	Maximum Air Temperature (1.5m)	Celsius
111	Minimum Air Temperature (1.5m)	Celsius
120	Maximum Air Temperature (1.5m)	Farenheit
121	Minimum Air Temperature (1.5m)	Farenheit
122	12-hour Min. Air Temp. (1.5m)	Farenheit
130	Time of Maximum (110 or 120)	HHMM
131	Time of Minimum (111 or 121)	HHMM
140	Average Air Temperature (2 cm)	Celsius
141	Maximum Air Temperature (2 cm)	"
142	Minimum Air Temperature (2 cm)	"
150	Average Air Temperature (3 cm)	"
151	Maximum Air Temperature (3 cm)	"
152	Minimum Air Temperature (3 cm)	"
154	Average Air Temperature (4 cm)	"
156	Average Air Temperature (2 cm)	"
158	Average Air Temperature (1 cm)	"
180	Average Air Temperature #2 (1.5m)	Celsius
181	Maximum Air Temperature #2 (1.5m)	Celsius
182	Minimum Air Temperature #2 (1.5m)	Celsius
190	Average Air Temperature #3 (1.5m)	Celsius
191	Maximum Air Temperature #3 (1.5m)	Celsius
192	Minimum Air Temperature #3 (1.5m)	Celsius
200	Average Relative Humidity (1.5m)	%
201	Average Relative Humidity #2 (1.5m)	%
209	Sample Relative Humidity (1.5m)	%
219	Maximum Humidity (1.5m)	%
220	Minimum Humidity (1.5m)	%
229	Time of Maximum Humidity	HHMM
230	Time of Minimum Humidity	HHMM

300	Average Soil Temperature (10cm)	Celsius
301	Average Soil Temperature (5cm)	Celsius
302	Sample Soil Temperature (5cm)	Celsius
303	Sample Soil Temperature (20cm)	Celsius
304	Sample Soil Temperature (50cm)	Celsius
305	Sample Soil Temperature (100cm)	Celsius
306	Sample Soil Temperature (180cm)	Celsius
309	Sample Soil Temperature (10cm)	Celsius
310	Average Soil Temp under T-grass(10cm)	Celsius
311	Average Soil Temp under B-grass(10cm)	Celsius
319	Maximum Soil Temperature (10cm)	Celsius
320	Minimum Soil Temperature (10cm)	Celsius
329	Maximum Soil Temperature (5cm)	Celsius
330	Minimum Soil Temperature (5cm)	Celsius
339	Time of Max Soil Temp (10cm,319)	HHMM
340	Time of Min Soil Temp (10cm,320)	HHMM
350	Average Soil Temp under TURF (10cm)	Celsius
351	Average Soil Temp under TURF (10cm)	"
352	Maximum Soil Temp under TURF (2.5cm)	"
353	Minimum Soil Temp under TURF (2.5cm)	"
360	Average Soil Temp under mulch(10cm)	Celsius
370	Average Air Temp above TURF (5cm)	"
371	Maximum Air Temp above TURF (5cm)	"
372	Minimum Air Temp above TURF (5cm)	"
380	Average Soil Temp under corn (75cm)	"
400	Average Wind Speed (3m)	m/s
500	Wind Vector Magnitude (3m)	m/s
509	Maximum Wind Speed (3m)	m/s
510	Time of Maximum Wind Speed	Minutes past midnight
519	Maximum Wind Speed (10m)	m/s
520	Time of Maximum Wind Speed	HHMM
600	Wind Vector Direction (3m)	degrees from North
609	Wind Average Direction (3m)	Degrees
700	Vector Standard Deviation (3m)	degrees
800	Radiation Flux	Watts/m**2
801	Radiation Flux #2	Watts/m**2
809	Radiation Flux	Langleys
825	Total Radiation(1hr) Horizontal	KJ/M**2
835	Total Radiation(1hr) Angle,south-east	KJ/M**2
845	Total Radiation(1hr) Angle,south	KJ/M**2
855	Total Radiation(1hr) Angle,south-west	KJ/M**2
900	Total Precipitation	mm
901	Total Precipitation	inches
920	Snow Depth	inches
930	Total Precipitation 24 hrs	mm
1000	Shadow Band Radiation (2m)	Watts/m**2
1100	PAR-Photosyn. Active Radiation (2m)	uE/m**2

1101	Photosyn. Irrad	Watts/m**2
1200	Infra-Red Eq. Temperature (corn)	Celsius
1300	Average Vapor Pressure	Kilopascal
1301	Vapor Pressure Deficit	Kilopascal
1400	Soil Heat Flux (5cm)	W/m**2
1800	Net Radiometer	W/m**2
1900	Eppley Downward	W/m**2
1901	Eppley Upward	W/m**2
2000	Everest Nadir	C
2030	Everest-thirty degrees	C
2040	Everest-corn-70 degrees	C
2041	"	"
2042	"	"
2043	"	"
3000	Pyrgeometer (up)	W/m**2
3005	Pyrgeometer's temperature	C
3010	Pyrgeometer (down)	W/m**2
000	Battery Voltage	Volts

C. Appendix-Quality control procedures used by the AWDN system

Procedure no.	Definition
01	Sets negative values of a variable to zero e.g. solar radiation data.
02	Checks solar radiation output against sunrise and sunset times to check data logger clock.
03	Upper and lower limit check. Alert status.
04	" . Set to limit, E.
05	" . Set to zero, M.
10	" . Set to limit, " ".
06	If flag is M set value to zero and flag to E.
07	Check that variable code is > related code
08	Check that variable code is < related code
09	If variable becomes constant, alert status.
11	Sets value to upper limit when it is > the upper limit, e.g. RH>100%
12	Sets value to lower limit when it is < the lower limit and sets the flag to M.

Flags are F-S where: S-" " for good, S-M for missing and S-E for Estimated.

D. Appendix-Input file for QCAWDN program.

This is the PROQ2 file used by the High Plains AWDN system. The headings do not actually appear in the file.

Variab. Code	Rel Code	Upper Limit	Lower Limit	Procedures	
100		40.	-30.	5	
109		40.	-30.	5	
110	111	40.	-20.	57	
111		30.	-30.	5	
120	122	110.	5.	57	
121	120	80.	-20.	58	
122	120	80.	-20.	58	
130		2400.	0.	5	
131		2400.	0.	5	
200		100.	0.		1112
201		100.	0.		1112
209		100.	0.		1112
219	220	100.	0.	7	1112
220		100.	0.		1112
229		2400.	0.	5	
230		2400.	0.	5	
300		40.	-20.	5	
301		40.	-20.	5	
302		40.	-20.	5	
303		40.	-20.	5	
304		40.	-20.	5	
305		40.	-20.	5	
306		40.	-20.	5	
309		40.	-20.	5	
319	320	40.	-20.	57	
320		40.	-20.	5	
329	330	40.	-20.	57	
330		40.	-20.	5	
339		2400.	0.	5	
340		2400.	0.	5	
350		40.	-20.	5	
360		40.	-20.	5	
400		25.	0.	419	
500		25.	0.	419	
509		90.	0.	419	
510		2400.	0.	5	
519		100.	0.	419	
520		2400.	0.	5	
600		360.	0.	4	
609		360.	0.	4	

APPENDIX D (cont.)

Variab. Code	Rel Code	Upper Limit	Lower Limit	Procedures	
700		100.	0.	51	
800		1999.	0.	215	10
801		1999.	0.	215	10
809		1499.	0.	215	10
900		150.	0.	651	
901		4.	0.	651	
920		11.	0.	651	
1000		1299.	0.	21	10
1100		9999.	0.	21	10
1101		9999.	0.	21	10
1200		40.	0.	5	
1300		99.	0.	51	
1301		99.	-99.	51	

E. Appendix-Batch files used by the AWDN system.

CONVARC.BAT

```
CTTY PRN
REM  ****************************************************************
REM  ****  CONVERT AND ARCHIVE                    CONVARC.BAT   4/20/88
REM  ****************************************************************
CTTY CON
PRINTIME
REM  ****************************************************************
REM  ****  DELETE YESTERDAYS .DAT FILES CREATED BY TELCOM          ****
REM  ****************************************************************
DEL M:\DAILYARC\*.DAT
REM  ****************************************************************
REM  ****  BUILD THREE BATCH FILES THAT WILL BE LATER EXECUTED     ****
REM  ****  STATIONS DETERMINES THE LENGTH OF THE BATCH FILES       ****
REM  ****************************************************************
BUILDBAT/R 4096 < M:\FILES\CAMPBELL.SFN
REM  ****************************************************************
REM  ****  EXECUTE THE BATCH FILE ADDCRLF  THIS BATCH FILE WILL    ****
REM  ****  ADD A CARRIAGE RETURN AND LINE FEED DO EVERY N:SXX.DAT ****
REM  ****  CAMPBELL FILE                                           ****
REM  ****************************************************************
COMMAND /C M:\FILES\ADDCRLF
REM  ****************************************************************
REM  ****  PRINT OUT ALL CAMPBELL *.ERR FILES TO THE PRINTER       ****
REM  ****  WITH HEADERS                                            ****
REM  ****************************************************************
PRINTERR < M:\FILES\CAMPBELL.SFN
REM  ****************************************************************
REM  ****  CONV WILL CONVERT DATA FROM N:SXX.DAT FILES INTO THE    ****
REM  ****  MASTER WEATHER FILE (MASTER)                            ****
REM  ****************************************************************
CONV/R 4096 < M:\FILES\CONV.INP
REM  ****************************************************************
REM  ****  EXECUTE THE BATCH FILE BUILDARC   THIS BATCH FILE WILL ****
REM  ****  ADD THE FILE N:SXX.DAT TO C:\ARCHIVES\SXX.DAT           ****
REM  ****************************************************************
COMMAND /C M:\FILES\BUILDARC
REM  ****************************************************************
REM  ****  EXECUTE THE BATCH FILE DELFILES   THIS BATCH FILE WILL ****
REM  ****  DELETE ALL N:SXX.DAT AND N:SXX.ERR FILES                ****
REM  ****************************************************************
COMMAND /C M:\FILES\DELFILES
```

105

SINGLE.BAT

```
ECHO OFF
REM   ****************************************************************
REM   ************************  SINGLE.BAT   ****************  11/13/86
REM   ****************************************************************
REM   SINGLE.BAT IS IN AWDN DIRECTORY
REM   ****************************************************************
BUILDSIN
COPY M:\FILES\TSING.INP+CRLF M:\FILES\TSING.INP
TELCOM  < M:\FILES\TSING.INP
COMMAND/C M:\FILES\COPYSING
CONV/R 4096  < M:\FILES\CSING.INP
OPRINT/R 4096 < M:\FILES\OSING.INP
ECHO ON
```

QC.BAT

```
CTTY PRN
REM  ****************************************************************
REM  ****  QUALITY CONTROLS THE DATA                    QC.BAT   4/20/88
REM  ****************************************************************
PRINTIME
COPY M:\FILES\PRNHRLY.2 M:\FILES\PRNHRLY.3
COPY M:\FILES\PRNHRLY.1 M:\FILES\PRNHRLY.2
COPY M:\FILES\PRNHRLY M:\FILES\PRNHRLY.1
QCAWDN/R 4096 < M:\FILES\QC.INP
CTTY CON
```

PLOT.BAT

```
REM   ****************************************************************
REM   ************************   PLOT.BAT     ****************  11/13/86
REM   ****************************************************************
TIMEPLOT/R 4096 <MTNTOP.INP
TIMEPLOT/R 4096 <FARWAY.INP
```

106

MTNTOP.INP

```
Y
10
Y
N:MTNTOP
1
100
2
300
1
99
```

FARWAY.INP

```
Y
10
Y
N:FARWAY
1
100
2
300
1
99
```

F. Appendix-Example output arrays in raw data file.

Example of a raw data file with output arrays 102 and 201. Parameters shown in SIFEDIT files indicate what information is contained in each position of the output array.

```
01+0102.  02+0327.  03+1200.  04+4.716  05+68.77  06+1.225  07+07.40  08+07.31
09+305.6  10+08.75  11+389.1  12+0.000
01+0102.  02+0327.  03+1300.  04+5.762  05+63.83  06+1.771  07+6.936  08+6.753
09+311.6  10+13.15  11+433.7  12+0.000
01+0102.  02+0327.  03+1400.  04+07.02  05+58.73  06+2.469  07+6.043  08+5.900
09+309.6  10+12.48  11+399.4  12+0.000
01+0102.  02+0327.  03+1500.  04+07.85  05+52.47  06+3.112  07+5.180  08+5.057
09+310.2  10+12.46  11+317.6  12+0.000
01+0102.  02+0327.  03+1600.  04+08.06  05+49.41  06+3.638  07+4.219  08+4.138
09+314.0  10+11.26  11+190.0  12+0.000
01+0102.  02+0327.  03+1700.  04+5.759  05+53.06  06+3.889  07+2.746  08+2.725
09+311.8  10+07.11  11+46.54  12+0.000
01+0102.  02+0327.  03+1800.  04+1.991  05+64.43  06+3.826  07+2.103  08+1.964
09+335.0  10+20.79  11+2.439  12+0.000
01+0102.  02+0327.  03+1900.  04+1.011  05+68.96  06+3.467  07+2.370  08+2.316
09+334.5  10+12.28  11+2.179  12+0.000
01+0102.  02+0327.  03+2000.  04+0.682  05+070.7  06+3.040  07+1.445  08+1.214
09+321.2  10+32.40  11+1.987  12+0.000
01+0102.  02+0327.  03+2100.  04-0.730  05+073.3  06+2.623  07+1.170  08+0.393
09+302.2  10+65.99  11+1.897  12+0.000
01+0102.  02+0327.  03+2200.  04-0.958  05+077.4  06+2.287  07+0.699  08+0.418
09+328.6  10+51.35  11+2.111  12+0.000
01+0102.  02+0327.  03+2300.  04-01.47  05+078.4  06+1.978  07+1.155  08+0.841
09+07.19  10+42.26  11+2.055  12+0.000
01+0102.  02+0327.  03+2400.  04-02.24  05+079.8  06+1.722  07+0.833  08+0.808
09+170.2  10+13.89  11+1.999  12+0.000
01+0201.  02+08.54  03-03.43  04+09.34  05+1148.  06+0.492  07+0.199  08+0.000
01+0102.  02+0328.  03+0100.  04-02.88  05+082.4  06+1.524  07+0.896  08+0.565
09+090.5  10+49.25  11+1.976  12+0.000
```

G. Appendix-Input file for RBBPRINT.

```
O:MASTER  N:S01      0060 0000 01  D  I:NE01.HR      Y      0    0    0
O:MASTER  N:S10      0060 0000 01  D  I:NE10.7HR     L      7    0    0
O:DMASTER N:NE01     1440 0000 04  D  I:NE01.14D     L     14    0    0
O:DMASTER N:NE04     1440 0000 04  D  C:MCCOOK       I     85 1988  300
O:DMASTER N:NE04     1440 0000 04  S                 D      0    0    0
XXXXXXXXX XXXXXXXXXX XXXX XXXX XX  X  XXXXXXXXXXXX    X    XXX XXXX  XXX
    |         |       |    |   |  |       |         |     | YEAR   |
 MASTER   SIF FILE    -------   T  | NAME OF OUTPUT |     #   |   START
  FILE                  SEE     Y  |   DISK FILE    |   DAYS  |    DATE
  NAME                   #1     P  |                |         |     |
                                E  |                |         -------
                                   |         (CODE) |           SEE
                               -----         --------           #2
                               |             |
TYPE 1 NO FLAGS IN ENGLISH  D - DISK          I - CERTAIN PERIOD
     2 FLAGS IN ENGLISH     P - PRINTER       Y - YESTERDAY
     3 NO FLAGS             S - SCREEN        L - LAST DAYS
     4 FLAGS                                  D - YEAR TO DATE
     5 NO FLAGS IN SI UNITS, WITH DEWPOINT
     6 FLAGS IN SI UNITS, WITH DEWPOINT
     7 DAILY TABLES IN SI UNITS
     8 DAILY TABLES IN SI UNITS WITH FLAGS
```

TYPE 1 AND 2 WILL RUN ON HOURLY DATA ONLY

TYPE 3 AND 4 WILL HAVE THE SAME UNITS THAT ARE IN THE MASTER FILE
#1 These two variables must match an OUTPUT TABLE line from the LOGGER OUTPUT TABLE screen from the .SIF file. The first number must be an ARRAY OUTPUT (MINUTES) INTERVAL and the second number must match TIME AFTER MIDNIGHT OF FIRST (MINUTES) TABLE.

TYPE 7 AND 8 WILL RUN ON DAILY DATA ONLY FROM O:DMASTER

#2 Need these two variables only when CODE=I

#3 TYPE 3 and 4 gives English Units when working with the Daily Master (O:DMASTER)

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DEBUG Commands

Replaces memory contents
E *address* [*list*]

Changes memory blocks
F *range list*

Executes with optional breakpoints
G[=*address*][*address*[*address* ...]]

Hexadecimal add subtract
H *value value*

Reads and displays input byte
I *portaddress*

Loads file or absolute diskette sectors
L[*address*[*drive sector sector*]]

Moves memory block
M *range address*

Defines files and parameters
N [*d:*][*path*]*filename*[.*ext*]

Sends output byte
O *portaddress byte*

Proceed with statements after jump
P [=*address*][*value*]

Ends DEBUG program
Q

Displays registers flags
R [*registername*]

Searches for characters
S *range list*

Executes and displays
T [=*address*][*value*]

Unassembles instructions
U [*address*]

or

U [*range*]

Writes file or absolute diskette sectors
W [*address*[*drive sector sector*]]

CONFIG.SYS Commands

Sets BREAK = ON or OFF
BREAK = [ON | OFF]

Sets number of buffers DOS will allocate.
BUFFERS = *x*

Specifies date and time format for a given country.
COUNTRY = *xxx*

Installs a device driver.
DEVICE = [*d:*][*path*]*filename*[.*ext*]

Sets number of control blocks that can be concurrently open.
FCBS = *m*, *n*

Sets maximum number of files that can be concurrently open
FILES = *x*

Sets maximum number of drives that can be accessed.
LASTDRIVE = *x*

Loads a top level command processor.
SHELL = [*d:*][*path*]*filename*[.*ext*]

Disk Operating System Version 3.10

Quick Reference Card

Programming Family

IBM

Personal Computer Software

DOS Editing Keys

[Del]	Skip one character in retained line
[Esc]	Cancel current line
[F1] or [→]	Copy and display one character from retained line
[F2]	Copy all characters up to specified character
[F3]	Copy all remaining characters from retained line
[F4]	Skip all characters to specified character of retained line
[F5]	Accept edited line for more editing as retained line
[Ins]	Toggle—insert characters

Typing a DOS Command

Type the DOS commands using the following format notation:

[ ]	Items shown inside square brackets are optional. To include optional items, only type the information inside of the brackets. Do not type the brackets.
CAPS	Words shown in capital letters are called *keywords*. The DOS command names are keywords. You must type the keywords, however, you can type keywords in any combination of uppercase and lowercase letters.
italics	Items shown in lowercase italic letters mean that you are to substitute the item. If italic items are inside of brackets, then they are optional. For example:

filename

means type the name of your file in place of the word filename.

A vertical bar means either/or. Choose one of the separated items and type it as part of the command. For example:

ON | OFF

means you can type ON or OFF, but not both.

An ellipsis indicates that you can repeat an item.

Include all punctuation such as commas, equal signs, question marks, colons, slashes, and backslashes. Punctuation shown inside brackets is optional.

Batch Commands

Executes batch file
[*d*:][*filename*[.BAT]][*parameters*]

Inhibits screen display
ECHO [ON | OFF | *message*]

Iteractive execution of commands
FOR %%*variable* IN (*set*) DO *command*

Transfers control to line following the label
GOTO *label*

Conditional execution of commands
IF [NOT] *condition command*

Provides a system wait
PAUSE [*remark*]

Displays remarks
REM [*remarks*]

Shifts command lines
SHIFT

DOS Commands

Routes requests to a different drive
[*d*:][*path*]ASSIGN [*x* [=] *y* [...]]

Mark a file as read-only or archive
[*d*:][*path*]ATTRIB
[+ | −R][*d*:][*path*]*filename*[.*ext*]

Backs up disk files*
[*d*:][*path*]BACKUP *d*:[*path*][*filename*[.*ext*]]
d: [/S][/M][/A][/D:*mm-dd-yy*]

Checks for control break
BREAK [ON | OFF]

Changes current directory
CHDIR [*d*:][*path*]

or

CD [*d*:][*path*]

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6138562

DOS Commands

Removes a sub-directory
RMDIR [d:]path

or

RD [d:]path

Selects the keyboard layout and date and time format
[d:][path]SELECT xxx yy

Inserts strings into the command processor's environment
SET [name=[parameter]]

Loads support for file sharing
[d:][path]SHARE[/F:filspace][/L:locks]

Sorts text data
[d:][path]SORT [/R][/+n] d:

Uses a different drive specifier to refer to another drive or path
[d:][path]SUBST[d: d:path][/D]

Transfers DOS
[d:][path]SYS d:

Enter time
Time [hh:mm[:ss[:xx]]]

Displays all directory paths
[d:][path]TREE [d:][/F]

Displays file contents
TYPE [d:][path]filename[.ext]

Displays DOS version number
VER

Verifys data
VERIFY [ON | OFF]

Displays volume identification
VOL [d:]

EDLIN Commands

Appends Lines
[n]A

Copies Lines
[line][,line],line[,count]C

EDLIN Commands

Deletes Lines
[line][,line]D

Ends Edit, Saves Changes
E

Inserts Lines
[line]I

Lists Lines
[line][,line]L

Moves Lines
[line],[line],lineM

Page
[line],[line]P

Quits Edit
Q

Replaces Text
[line][,line]['][R[string][<F6>string]]

Searches Text
[line][,line]['][S[string]]

Transfers Lines
[line]T[d:][filename[.ext]]

Write Lines
[n]W

DEBUG Commands

Assembles statements
A[address]

Compares memory
c range address

Displays memory
D[address]

or

D[range]

DOS Commands

Checks disk and reports status
[*d*:][*path*]CHKDSK
[*d*:][*path*][*filename*[.*ext*]][/F][/V]

rs the display screen
CLS

Compares files
[*d*:][*path*]COMP [*d*:][*path*][*filename*[.*ext*]]
[*d*:][*path*][*filename*[.*ext*]]

Copies files
COPY [/A][/B][*d*:][*path*]*filename*[.*ext*][/A][/B]
[*d*:][*path*][*filename*[.*ext*]][/A][/B][/V]

or

COPY [/A][/B][*d*:][*path*]*filename*[.*ext*][/A][/B]
[+[*d*:][*path*]*filename*[.*ext*][/A][/B]...]
[*d*:][*path*][*filename*[.*ext*]][/A][/B][/V]

or

COPY[/A][/B][*d*:][*path*]*filename*[.*ext*][/A][/B]
[+[*d*:][*path*]*filename*[.*ext*][/A][/B]...]
[*d*:][*path*][*filename*[.*ext*]][/A][/B][/V]

...nges to an auxiliary console
CTTY *device-name*

Enters date
DATE [*mm-dd-yy*] | [*dd-mm-yy*] | [*yy-mm-dd*]

Deletes files
DEL [*d*:][*path*]*filename*[.*ext*]

Lists filenames
DIR [*d*:][*path*][*filename*[.*ext*]][/P][/W]

Compares diskettes
[*d*:][*path*]DISKCOMP [*d*: [*d*:]][/1][/8]

Copies diskettes
[*d*:][*path*]DISKCOPY [*d*: [*d*:]][/1]

Erases files
ERASE [*d*:][*path*]*filename*[.*ext*]

ers .EXE files to .COM format
[*d*:][*path*]EXE2BIN [*d*:][*path*]*filename*[.*ext*]
[*d*:][*path*][*filename*[.*ext*]]

DOS Commands

Prepares fixed disk for DOS
FDISK

Searches files for strings of text
[*d*:][*path*]FIND[/V][/C][/N] "*string*" [[*d*:][*pc*
filename[.*ext*]...]

Formats diskettes or fixed disks
[*d*:][*path*]FORMAT [*d*:][/S][/1][/8][/V][/B][/4]

Loads character table
[*d*:][*path*]GRAFTABL

Prints graphics display screen
[*d*:][*path*]GRAPHICS[*printer type*][/R][/B]

Connects a drive to a directory on another drive to
produce a single directory structure
[*d*:][*path*]JOIN[*d*: *d*:*directory*][/D]

Loads a keyboard program
[*d*:][*path*]KEYBUK

or

[*d*:][*path*]KEYBGR

or

[*d*:][*path*]KEYBFR

or

[*d*:][*path*]KEYBIT

or

[*d*:][*path*]KEYBSP

Create, change, or delete a volume
[*d*:][*path*]LABEL [*d*:][*volume label*]

Creates a sub-directory
MKDIR [*d*:]*path*

or

MD [*d*:]*path*

DOS Commands

Set mode on printer/display
[*d*:][*path*]MODE LPT #[:][*n*][,[*m*][,P]]

or

[*d*:][*path*]MODE *n*

or

[*d*:][*path*]MODE [*n*],*m*[,T]

or

[*d*:][*path*]MODE
COM*n*[:]*baud*[,*parity*[,*databits*[,*stopbits*[,P]]]]

or

[*d*:][*path*]MODE LPT=[:]=COM*n*

Displays a screen-full of data
[*d*:][*path*]MORE

Searches directories for commands or batch files
PATH[[*d*:][*path*][;[*d*:][*path*]...]]

Prints and queues data files
[*d*:][*path*]PRINT[/D:*device*][/B:*buffsiz*]
[/U:*busytick*][/M:*maxtick*][/S:*timeslice*]
[/Q:*quesiz*][/C][/T][/P]
[[*d*:][*path*][*filename*[.*ext*]...]

Sets new prompt
PROMPT [*prompt-text*]

Recovers files from disk
[*d*:][*path*]RECOVER [*d*:][*path*]*filename*[.*ext*]

or

[*d*:][*path*]RECOVER *d*:

Renames files
REN[AME] [*d*:][*path*]*filename*[.*ext*]
filename[.*ext*]

Restores backup files from one disk to another disk
[*d*:][*path*]RESTORE *d*:
[*d*:][*path*]*filename*[.*ext*][/S][/P]

PNUTGRO V1.02

K. J. Boote, J. W. Jones, G. Hoogenboom,
G. G. Wilkerson, and S. S. Jagtap

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University of Florida, Gainesville, Florida

PNUTGRO is a process oriented peanut growth and yield model developed at the University of Florida. The PNUTGRO model is similar to SOYGRO V5.42 which has coding and input-output structures developed for use in the IBSNAT project. A number of minor coding changes were made and crop and genotype-specific coefficients were developed for peanut from literature and experimental data. PNUTGRO was developed to satisfy needs of the above IBSNAT project and as part of a Peanut Systems Research project. Users can simulate experiments for validation and also change model inputs for sensitivity analysis in adapting it for their own uses.

Program Support : V. C. Chang, and M. D. Fishwick

Press < ENTER > key to continue

1)	Groundnut modeling trial	HA	HS	01	1987	Hissar
2)	PEANUT PLANT POPULATION TRIAL	IT	RC	05	1987	
3)	PEANUT MODELING - PAULU	PU	LU	01	1986	Ludhia
4)	IRRIGATION SHEDULING IN PEANUT	PU	LU	01	1987	
5)	IRRIGATION MANAGEMENT IN GROUNDNUT	TN	BS	01	1987	Bhavani
6)	CROP WEATHER MODELING ON GROUNDNUT	TN	CB	01	1986	Coimbat
7)	Groundnut Modeling Experiment	TN	CB	01	1987	
8)	IRRIGATED, FLORUNNER	UF	GA	01	1976	
9)	GNUT POPULATION*ROW SPACING EXPT.	IT	RC	03	1986	
10)	GROUNDNUT POPULATION*ROW SPAC. EXPT	IT	RC	02	1985	
11)	PEANUT MICROCLIMATIC STUDIES EXPT.	IT	RC	01	1984	
12)	CROP-WEATHER RELATIONSHIP IN PEANUT	AP	AT	01	1986	Anantha
13)	Groundnut Modelling Experiment	IT	RC	04	1987	
14)	Groundnut modelling experiment	IT	RC	06	1988	
15)	Groundnut irrigation experiment	GU	AN	01	1986	

More.... PRESS ENTER KEY

16)	Groundnut modeling experiment	GU	AN	01	1987	Anand
17)	CROP-WEATHER RELATIONSHIP IN GNUT	AP	AT	01	1987	
18)	DL X FUNGICIDE WITH 5 GENOTUPES	LT	GP	00	1986	

1] <=== CASE STUDY SELECTED
<--- NEW SELECTION?

TRT NO.	Groundnut modeling trial	INST. ID	SITE ID	EXPT. NO	YEAR
1)	V1 ROBUT 33-1;S1 30cm ROW SPACING;	HA	HS	01	1987
2)	V2 MH 2;S1 30 cm ROW SPACING;	HA	HS	01	1987
3)	V1 ROBUT 33-1;S2 15 cm ROW SPACING;	HA	HS	01	1987
4)	V2 MH 2;S2 15 cm ROW SPACING;	HA	HS	01	1987

1] <=== TREATMENT SELECTED
<--- NEW SELECTION?

EXPERIMENT : Groundnut modeling trial
TREATMENT : V1 ROBUT 33-1;S1 30cm ROW SPACING;
WEATHER SET : HISAR
VARIETY : ROBUT 33-1 (tim) MATURITY GROUP : 1
IRRIGATION : ACCORDING TO THE FIELD SCHEDULE
PLANTING DATE: JUL 26 PLANTS/M2: 22.33 ROW SPACING: .300m PLANT SPACING: .149m

SOIL PROFILE DATA FINE LOAMY MIXED CALCAREOUS HYPERTHERMIC TYPIC USTOCHREPT
SOIL ALBEDO : .13 U: 9.5 SWCON: .40 CURVE NO.: 60.0 PHFAC3: .78

DEPTH-m	LL	DUL	SAT	EXTR	INIT	ROOT	KSAT
.00- .05	.086	.253	.333	.167	.209	1.000	-9.000
.05- .15	.086	.253	.333	.167	.209	1.000	-9.000
.15- .29	.097	.258	.338	.161	.206	1.000	-9.000
.29- .40	.097	.258	.345	.161	.154	.500	-9.000
.40- .48	.116	.295	.349	.179	.149	.500	-9.000
.48- .57	.116	.295	.349	.179	.149	.500	-9.000
.57- .68	.117	.301	.349	.184	.151	.200	-9.000
.68- .80	.117	.301	.349	.184	.152	.200	-9.000
.80- 1.03	.128	.310	.350	.182	.310	.200	-9.000
1.03- 1.27	.128	.310	.350	.182	.310	.200	-9.000
1.27- 1.50	.120	.333	.348	.213	.333	.200	-9.000
1.50- 1.75	.120	.333	.348	.213	.333	.200	-9.000
SUM mm	201.5	527.4	606.4	325.8	442.9		

Press < ENTER > key to continue

RUN NO. 1 SIMULATION OUTPUT

HA HS 1987 V1 ROBUT 33-1;S1 30cm ROW SPACING;

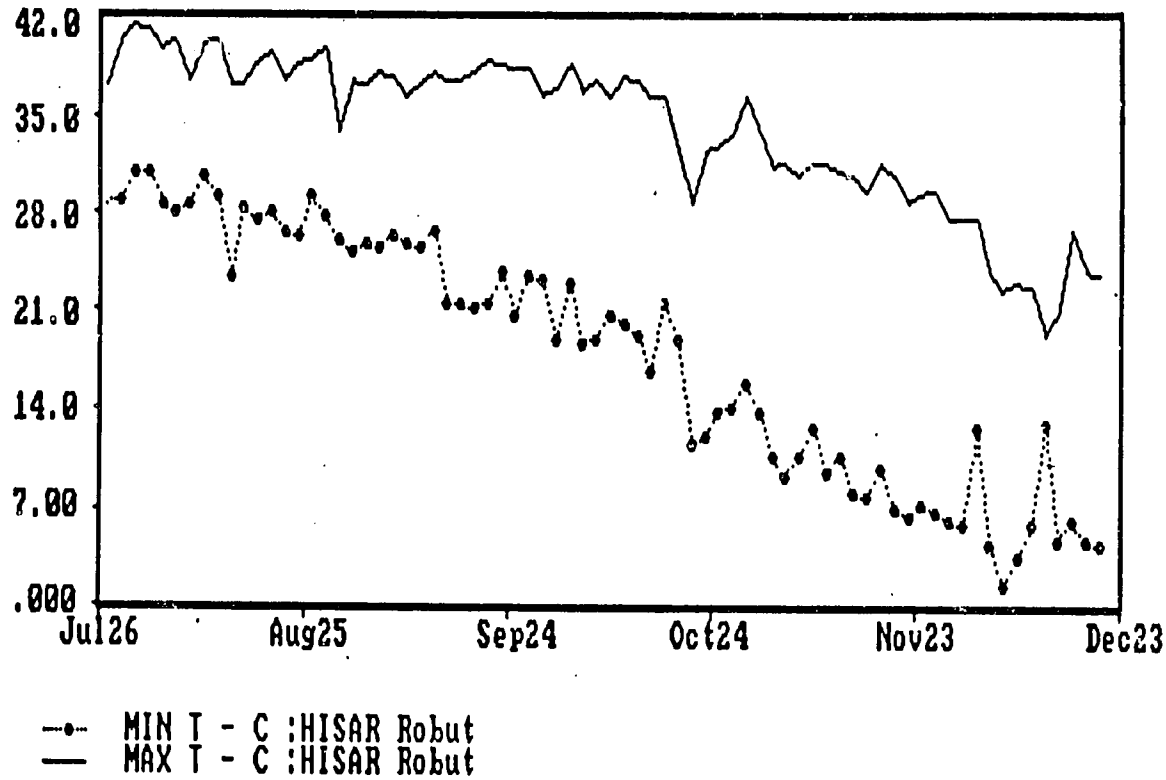
DATE	CROP AGE	GROWTH STAGE	BIOMASS KG/HA	LAI	V-STAGE	WATER BALANCE COMPONENTS ES mm	EP mm	ET mm	RAIN mm	IRRIG mm	DROUGHT STRESS PHOTO	TURGO
JUL 26	0	SOWING	0.	.00	.0	1.	0.	1.	0.	0.	.000	.000
AUG 1	6	EMERGENCE	37.	.05	.1	6.	0.	6.	0.	0.	.000	.000
AUG 5	10	V1 STAGE	54.	.08	1.2	8.	1.	9.	0.	0.	.000	.000
AUG 27	32	FLOWERING	526.	.65	7.4	32.	39.	72.	0.	85.	.038	.115
SEP 8	44	R2 STAGE	1530.	1.79	11.5	55.	85.	140.	49.	85.	.000	.000
SEP 18	54	R3 STAGE	2558.	2.57	14.2	59.	141.	199.	49.	170.	.039	.185
SEP 27	63	R4 STAGE	4032.	3.82	17.0	73.	190.	263.	49.	170.	.000	.000
OCT 6	72	R6 STAGE	5526.	4.77	19.5	74.	241.	315.	49.	170.	.000	.000
OCT 12	78	END POD	6393.	5.06	20.9	74.	277.	351.	49.	170.	.000	.057
NOV 24	121	END LEAF	10792.	4.85	26.7	92.	438.	530.	51.	340.	.000	.023
DEC 20	147	PHYS. MAT	11415.	4.45	26.7	96.	502.	597.	57.	340.	.113	.211
DEC 20	147	HARV. MAT	11415.	4.45	26.7	96.	502.	597.	57.	340.	.113	.211

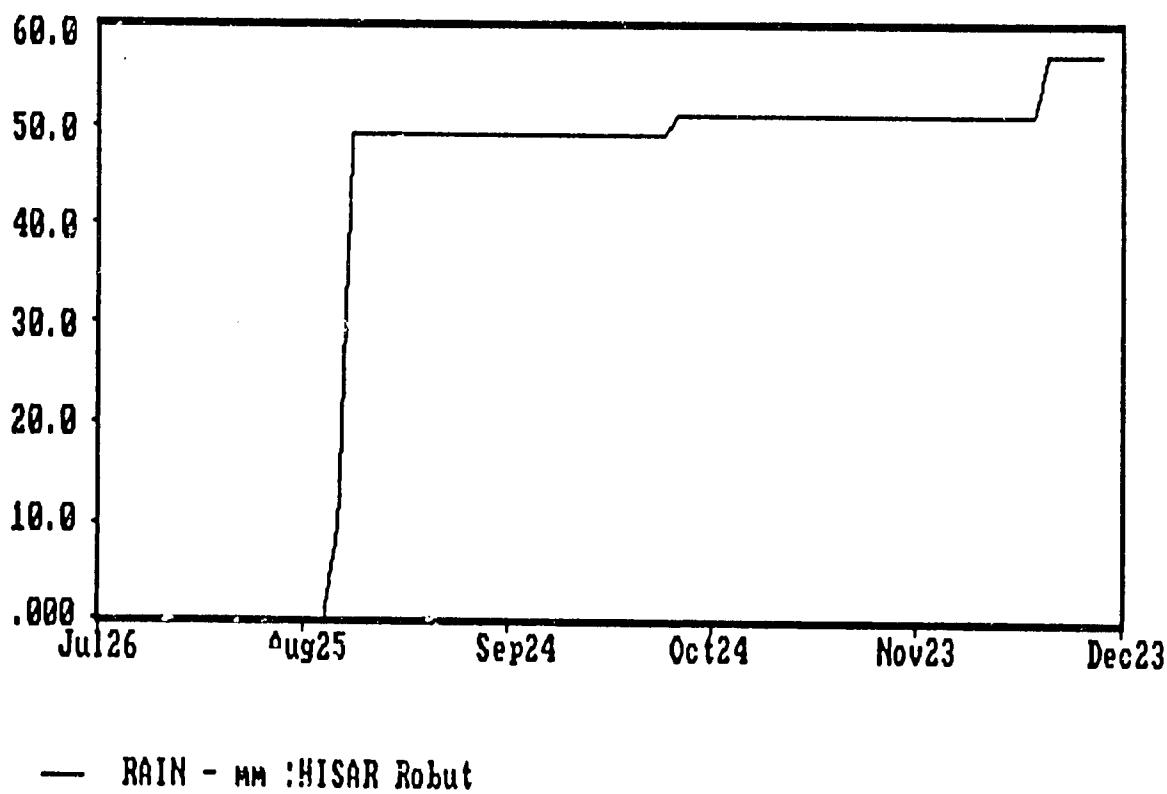
Press < ENTER > key to continue

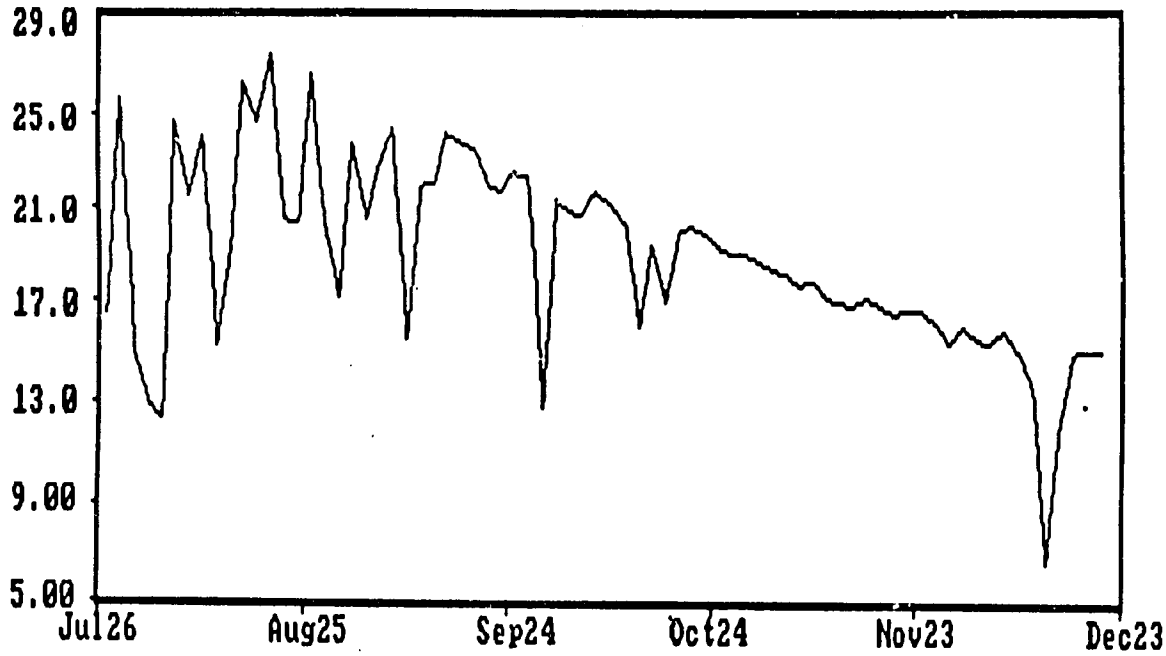
HA HS 1987 V1 ROBUT 33-1;S1 30cm ROW SPACING;

	PREDICTED	MEASURED
R1, BEGINNING FLOWER	239	238
R2, BEGINNING PEG	251	250
R3, BEGINNING POD	261	264
R4, 1ST FULL SIZE POD	270	279
R5, BEGINNING SEED	270	283
R6, 1ST FULL SIZE SEED	279	299
R7, 1ST POD COLORATION	-9	310
R8, 3/4TH PODS MATURE	354	342
POD YLD (KG/HA)	3920.00	3749.00
SEED YLD (KG/HA)	2493.00	2169.00
SHELLING PERCENTAGE	63.61	57.86
PERCENT MATURE PODS	43.73	83.93
WT. PER SEED (G)	.412	.347
SEED NUMBER (SEED/M2)	606.00	654.00
SEEDS/POD	1.52	1.28
MAXIMUM LAI	5.25	5.70
BIOMASS (KG/HA) AT R8	11415.00	9738.00
STALK (KG/HA) AT R8	4813.00	5989.00
HARVEST INDEX (PODS)	.343	.385

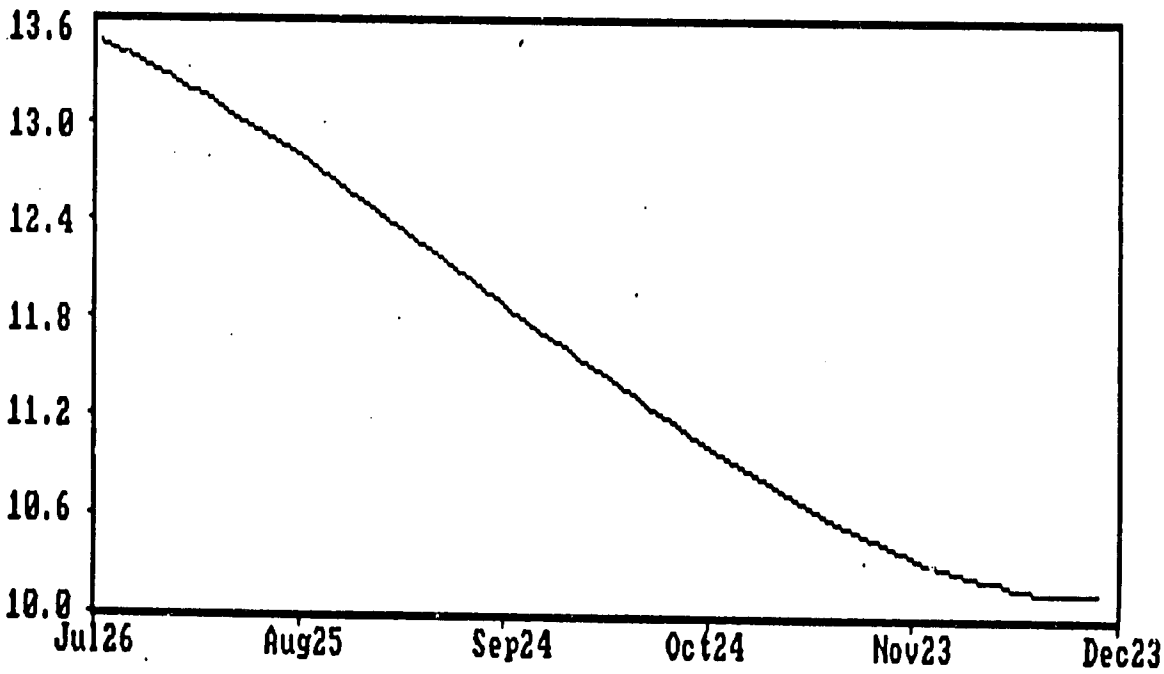
Press < ENTER > key to continue


42.0
35.0
28.0
21.0
14.0
7.00
.000
Jul26
Aug25
Sep24
Oct24
Nov23
Dec23
MIN T - C :HISAR Robut
MAX T - C :HISAR Robut

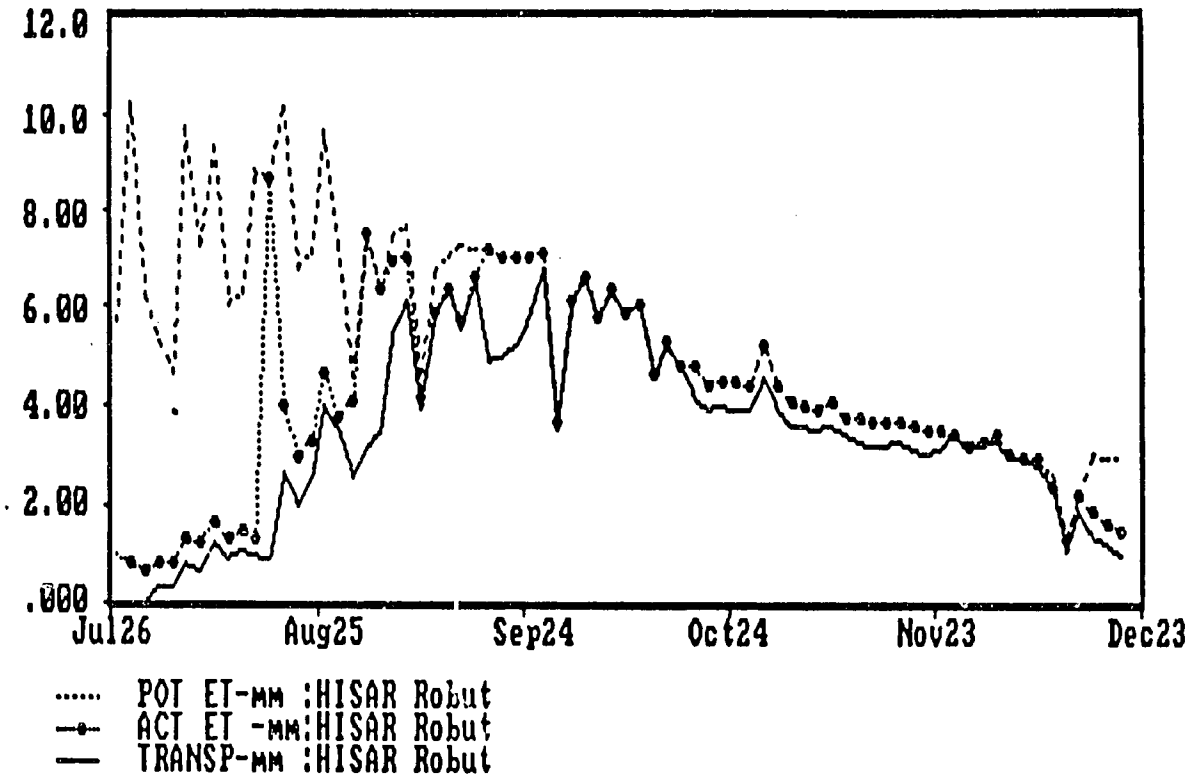

60.0
50.0
40.0
30.0
20.0
10.0
.000
Jul26
Aug25
Sep24
Oct24
Nov23
Dec23
RAIN - mm :HISAR Robut

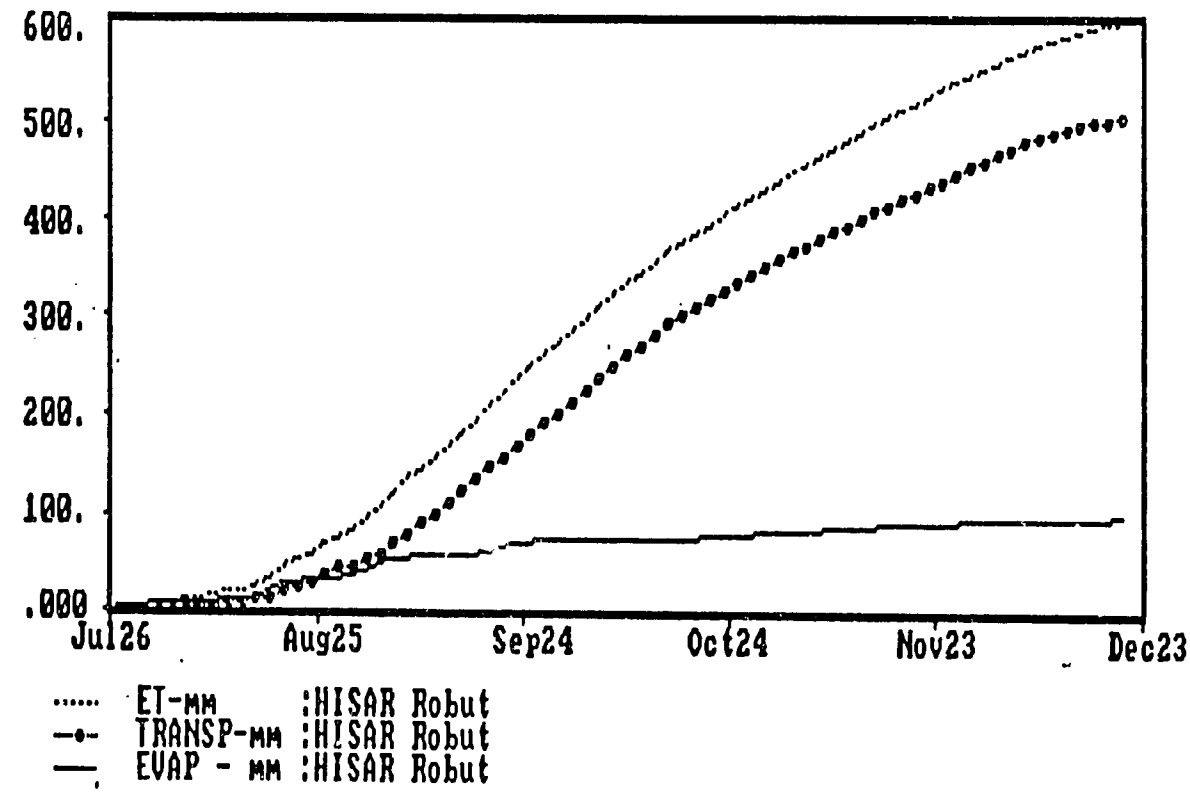


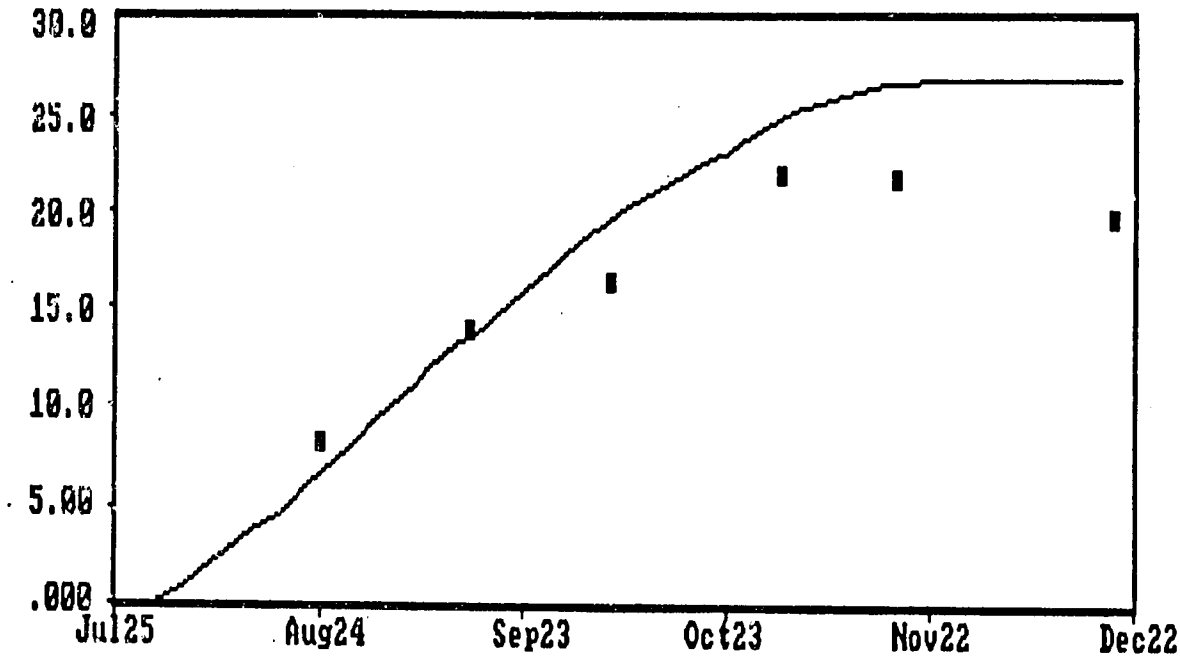
— RAD - MJ :HISAR Robut



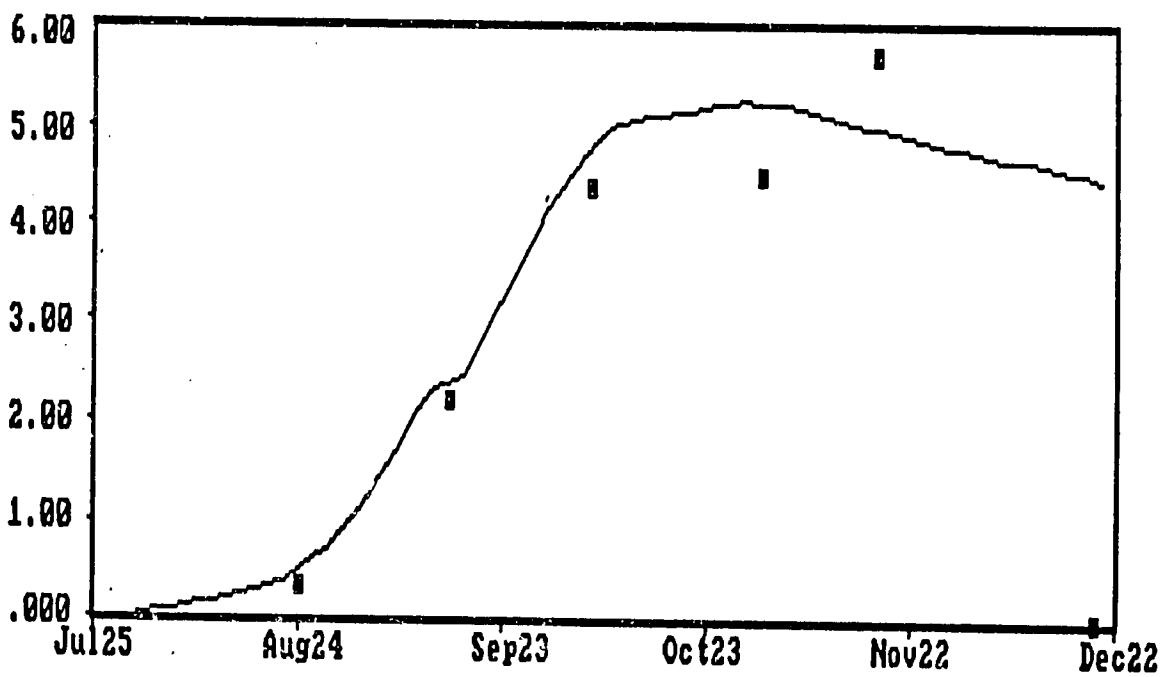
— DAYL - h :HISAR Robut


12.0
10.0
8.00
6.00
4.00
2.00
.000
Jul26
Aug25
Sep24
Oct24
Nov23
Dec23
POT ET-mm :HISAR Robut
ACT ET -mm:HISAR Robut
TRANSP-mm :HISAR Robut

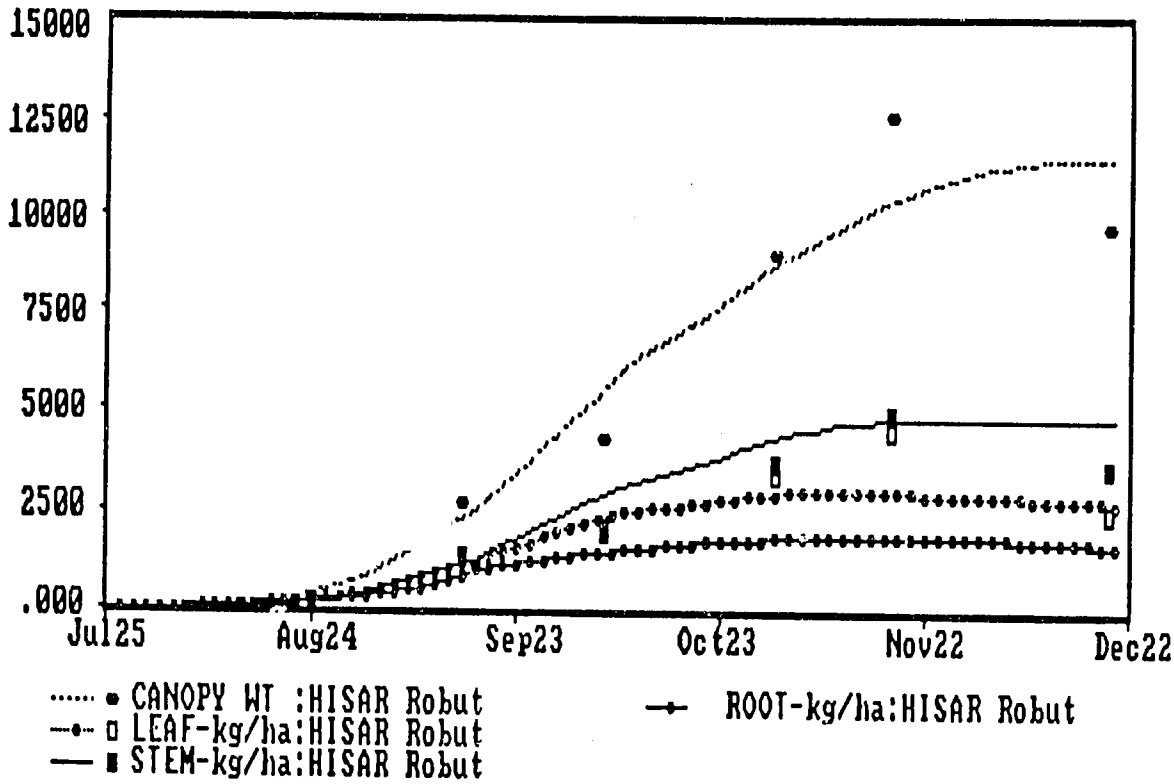

600.
500.
400.
300.
200.
100.
.000
Jul26
Aug25
Sep24
Oct24
Nov23
Dec23
ET-mm :HISAR Robut
TRANSP-mm :HISAR Robut
EVAP - mm :HISAR Robut

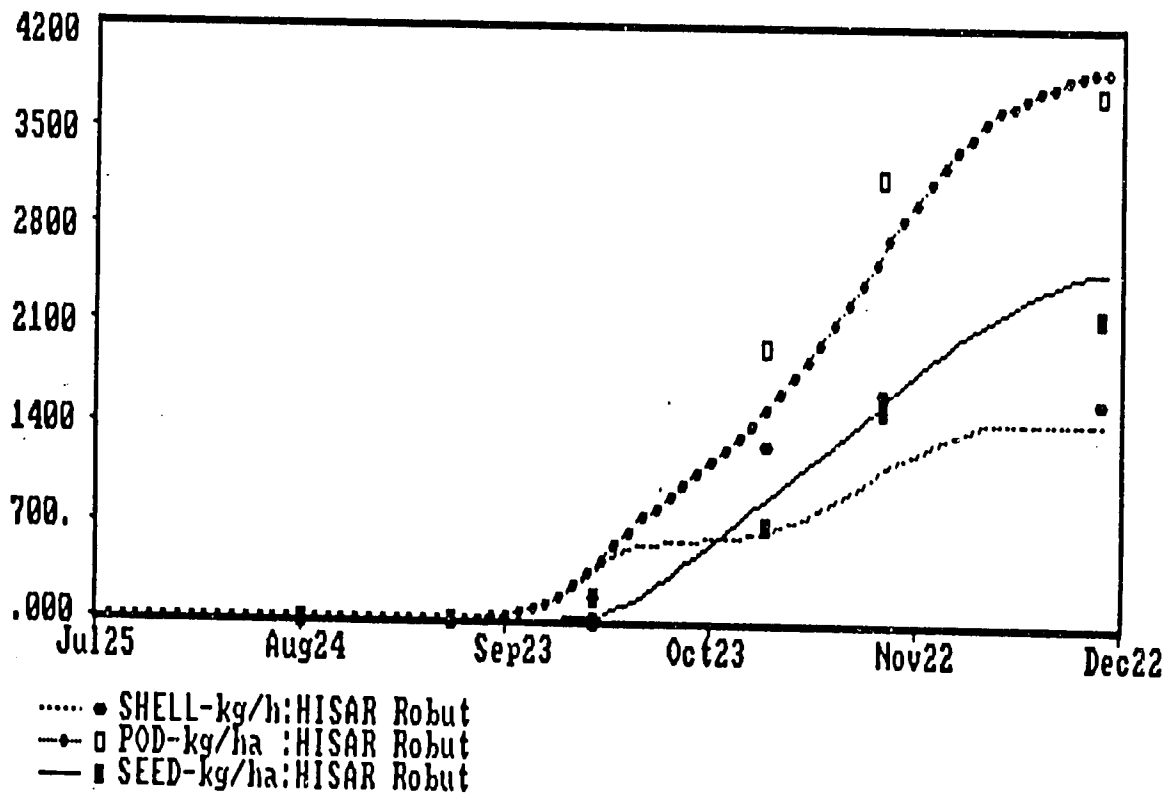


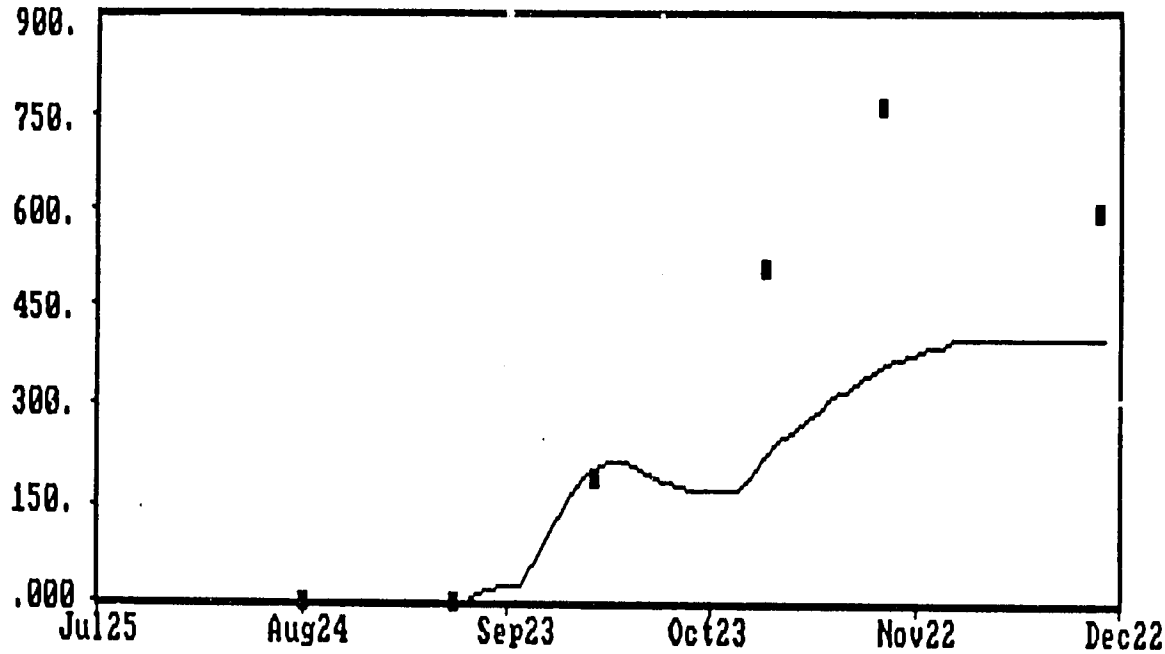
— ▮ V-STAGE :HISAR Robut



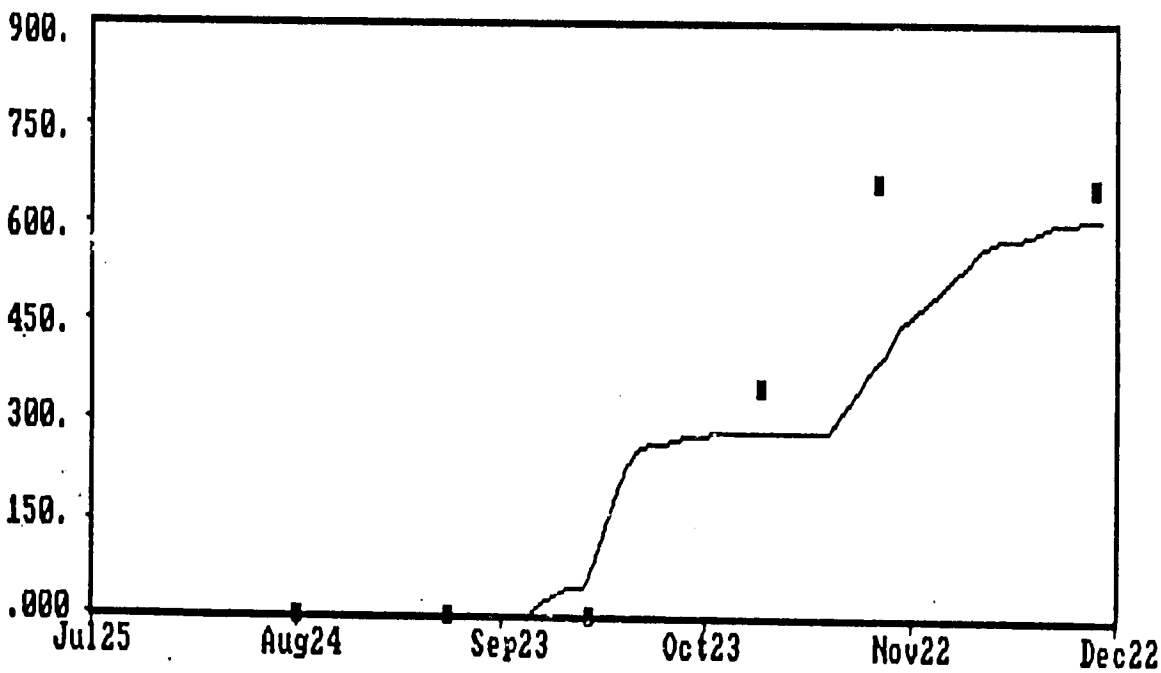
— ▮ LAI :HISAR Robut


15000
12500
10000
7500
5000
2500
.000
Jul25
Aug24
Sep23
Oct23
Nov22
Dec22
CANOPY WT :HISAR Robut
LEAF-kg/ha:HISAR Robut
STEM-kg/ha:HISAR Robut
ROOT-kg/ha:HISAR Robut

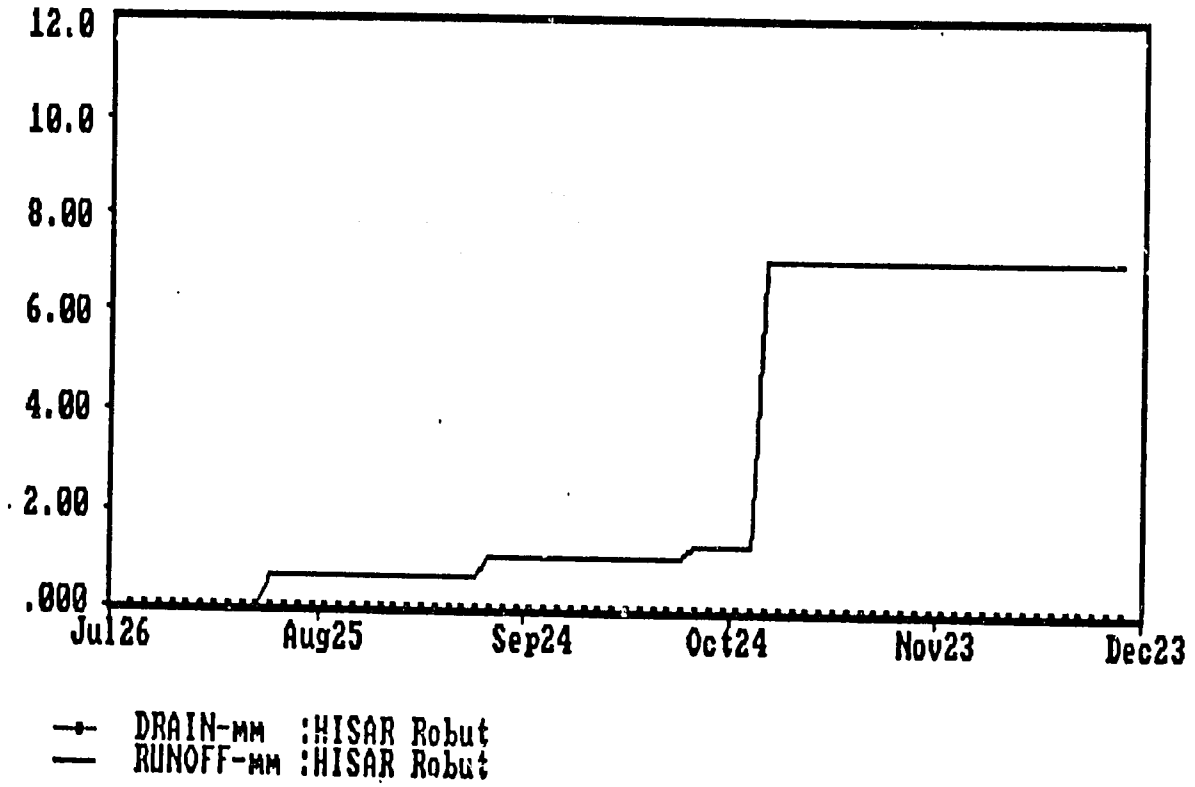

4200
3500
2800
2100
1400
700.
.000
Jul25
Aug24
Sep23
Oct23
Nov22
Dec22
SHELL-kg/h:HISAR Robut
POD-kg/ha :HISAR Robut
SEED-kg/ha:HISAR Robut

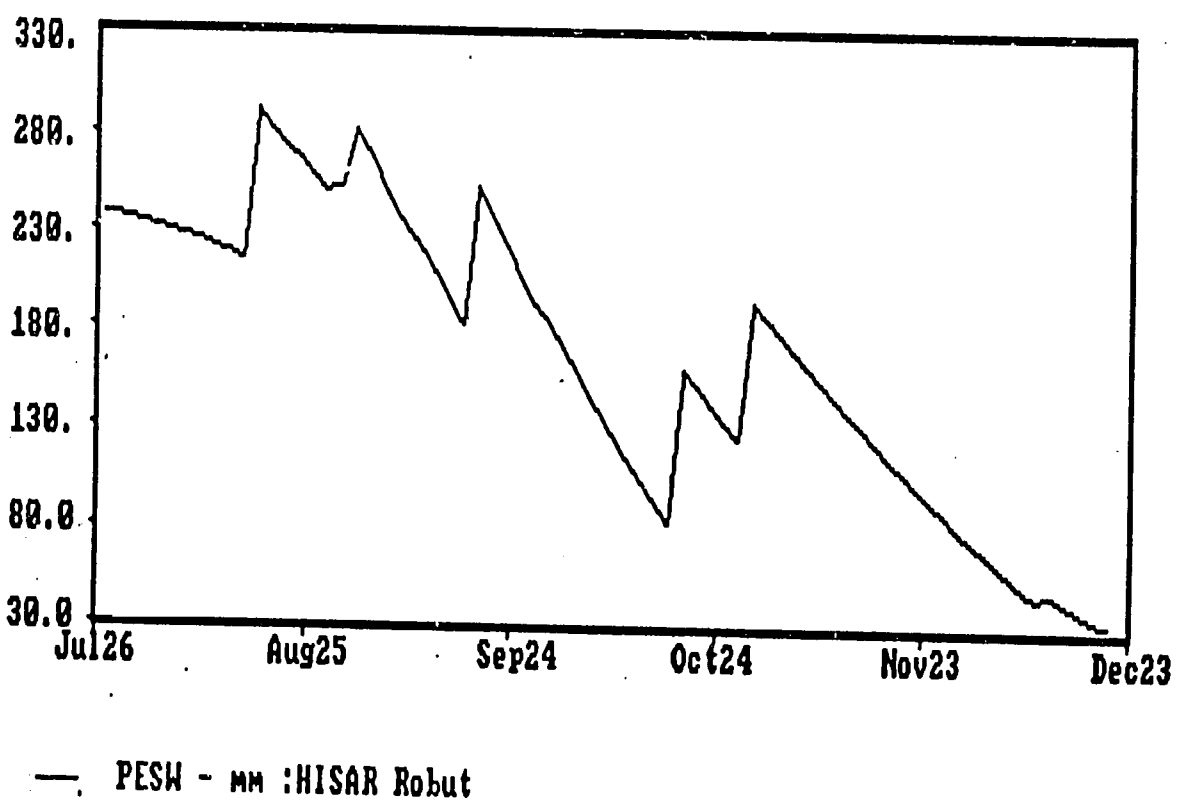


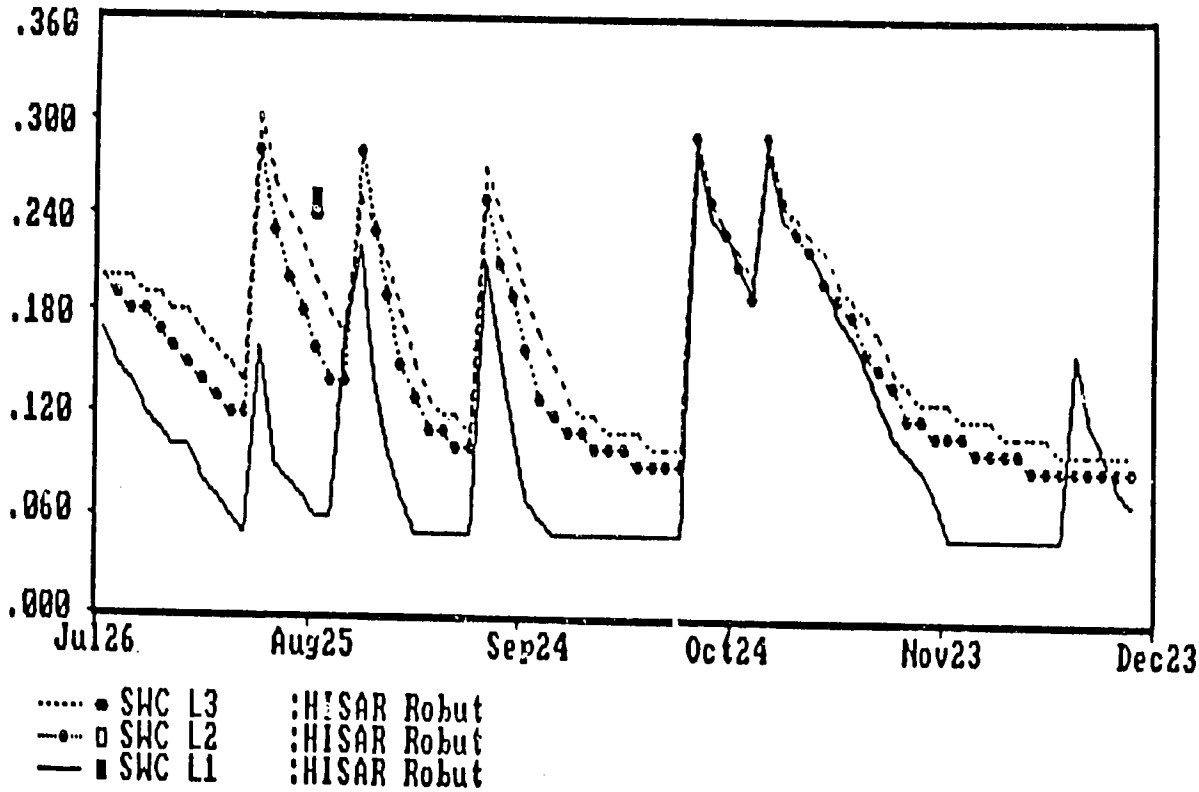
— ▮ POD NO-M2 :HISAR Robut

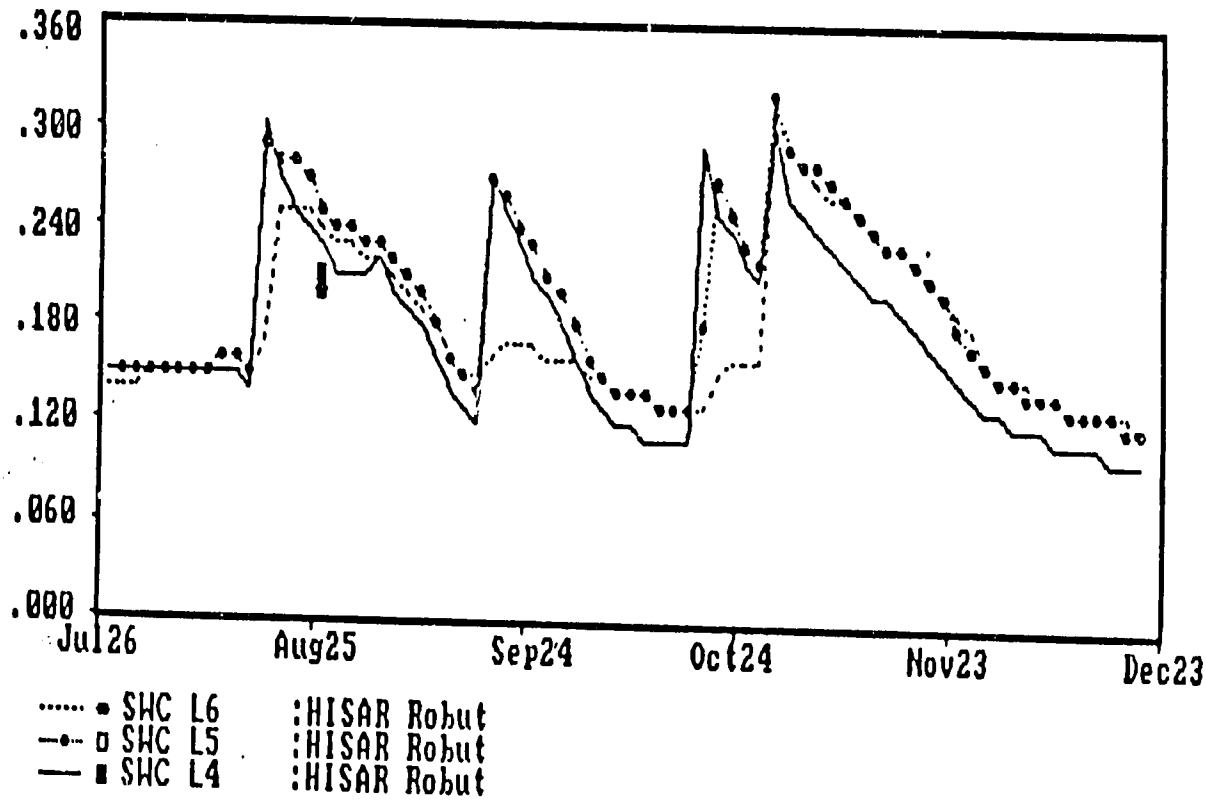


— ▮ SEED no-m2:HISAR Robut


12.0
10.0
8.00
6.00
4.00
2.00
.000
Jul26
Aug25
Sep24
Oct24
Nov23
Dec23
DRAIN-mm :HISAR Robut
RUNOFF-mm :HISAR Robut


330.
280.
230.
180.
130.
80.0
30.0
Jul26
Aug25
Sep24
Oct24
Nov23
Dec23
PESW - mm :HISAR Robut


.360
.300
.240
.180
.120
.060
.000
Jul26
Aug25
Sep24
Oct24
Nov23
Dec23
SWC L3 :HISAR Robut
SWC L2 :HISAR Robut
SWC L1 :HISAR Robut


.360
.300
.240
.180
.120
.060
.000
Jul26
Aug25
Sep24
Oct24
Nov23
Dec23
SWC L6 :HISAR Robut
SWC L5 :HISAR Robut
SWC L4 :HISAR Robut

WEATHER DATA SETS AVAILABLE	DATES AVAILABLE FROM	UNTIL	INST ID	WEATHE STATIO ID
1) ANANTHAPUR RESEARCH STATION	08/01/86	12/02/86	AP	AT
2) HISAR	07/01/87	12/31/87	HA	HS
3) ICRISAT, HYDERABAD, INDIA, 1984	01-01-84	12-31-84	IT	IM
4) ICRISAT, HYDERABAD, INDIA, 1985	01-01-85	12-31-85	IT	IM
5) ICRISAT, HYDERABAD, INDIA, 1986	01-01-86	12-31-86	IT	IM
6) ICRISAT, HYDERABAD, INDIA, 1987	01-01-87	12-31-87	IT	IM
7) ICRISAT, HYDERABAD, INDIA, 1988	01-01-88	12-31-88	IT	IM
8) ICRISAT, HYDERABAD, INDIA, 1989	01-01-89	12-31-89	IT	IM
9) PUNJAB AGRICULTURAL UNIVERSITY	06/01/86	10/31/86	PU	LU
10) PUNJAB AGRICULTURAL UNIVERSITY	06/01/87	10/31/87	PU	LU
11) Bhavanisagar	01/01/87	12/31/87	TN	BS
12) coimbatore	09/05/86	12/19/86	TN	CB
13) coimbatore	05/01/87	12/31/87	TN	CB
14) GAINESVILLE, FLORIDA 1976	03-01-76	10-31-76	UF	GA
15) ICRISAT CENTER,PATANCHERU,INDIA	01/01/89	04/30/89	IT	IM

More.... PRESS ENTER KEY

2) HISAR	07/01/87	12/31/87	HA	HS
3) ICRISAT, HYDERABAD, INDIA, 1984	01-01-84	12-31-84	IT	IM
4) ICRISAT, HYDERABAD, INDIA, 1985	01-01-85	12-31-85	IT	IM
5) ICRISAT, HYDERABAD, INDIA, 1986	01-01-86	12-31-86	IT	IM
6) ICRISAT, HYDERABAD, INDIA, 1987	01-01-87	12-31-87	IT	IM
7) ICRISAT, HYDERABAD, INDIA, 1988	01-01-88	12-31-88	IT	IM
8) ICRISAT, HYDERABAD, INDIA, 1989	01-01-89	12-31-89	IT	IM
9) PUNJAB AGRICULTURAL UNIVERSITY	06/01/86	10/31/86	PU	LU
10) PUNJAB AGRICULTURAL UNIVERSITY	06/01/87	10/31/87	PU	LU
11) Bhavanisagar	01/01/87	12/31/87	TN	BS
12) coimbatore	09/05/86	12/19/86	TN	CB
13) coimbatore	05/01/87	12/31/87	TN	CB
14) GAINESVILLE, FLORIDA 1976	03-01-76	10-31-76	UF	GA
15) ICRISAT CENTER,PATANCHERU,INDIA	01/01/89	04/30/89	IT	IM

More.... PRESS ENTER KEY

16) ANAND	07/01/86	11/10/86	GU	AN
17) ANAND	06/01/87	12/31/87	GU	AN
18) ANANTAPUR	01/01/87	12/31/87	AP	AT

2] <=== WEATHER DATA SELECTED.
2] <=== CASE STUDY WEATHER DATA.
<--- ALTERNATE SELECTION?

VARIETY SELECTION.
==========

NO.	VARIETY	GROUP
1)	STARR	1
2)	FLORUNNER	2
3)	FLORIGIANT, HYP	3
4)	VALENCIA	1
5)	OK-FH15	2
6)	PRONTO	1
7)	KADIRI 3	1
8)	ICGV 86709	1
9)	NCAC 17090	1
10)	NCAC 17142	1
11)	EC 76446(292)	1
12)	FLORUNNER, MAR	2
13)	TMV2	1
14)	TMV-2, ICRISAT	1
15)	ROBUT-33, ICRSAT	1

More.... PRESS ENTER KEY

16)	GAUG-10	1
17)	GAUG-2	1
18)	JL-24	1
19)	CO1	1
20)	CO2	1
21)	ICGS(E) 22	1
22)	M-13 PULU	1
23)	EARLY BUNCH, AUS	3
24)	ROBUT-33, ICRSAT	1
25)	MH-2, HISAR	1
26)	ROBUT 33-1 (tim)	1
27)	FDRS-10	1
28)	M-37 PULU	1
29)	ROBUT 33-1 (.37)	1
30)	KADIRI	1

More.... PRESS ENTER KEY

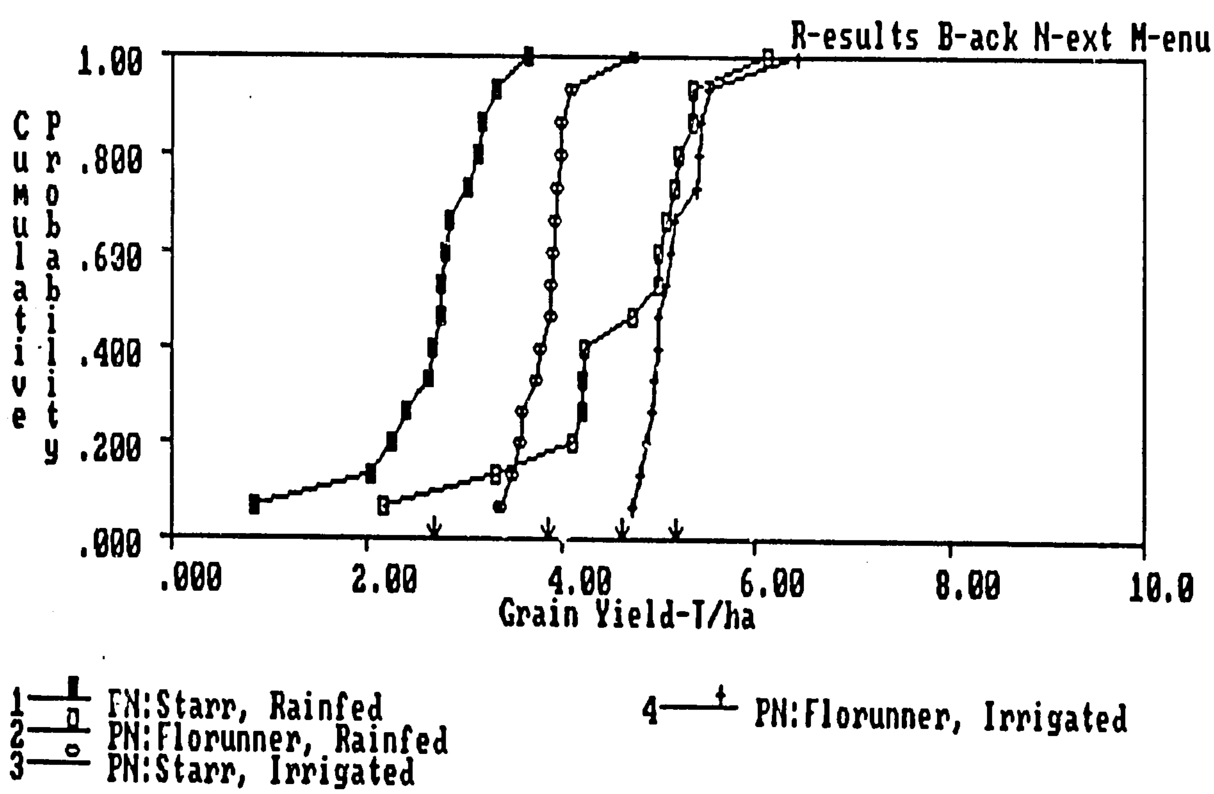
31) ROBUT VARTH=2.6 1

26] <======== VARIETY SELECTED
26] <======== CASE STUDY VARIETY
<-------- NEW SELECTION?

```
§êêêêêêêêêêêÛGrain Yield-T/haâêêêêêêê§êêêêêêêêêêêêêêêêÛExplanationâêêêêêêêêêê
ÛNo STRATEGY DESCRIPTION  Mean      SDÛVARIABILITY ANALYSIS:  This involves a
Û 1 PN:Starr, Rainfed    2.6827 0.6497Ûpair-wise comparison of the cumulative
Û 2 PN:Florunner, Rainf 4.6167 0.9631Ûprobability  functions (CPF) of the
Û 3 PN:Starr, Irrigated 3.8487 0.3189Ûstrategies defined.  The program
Û 4 PN:Florunner, Irrig 5.1907 0.4196Ûattempts to find the strategy or
Û                                     Ûstrategies that result in the maximum
Û                                     Ûresponse for the selected variable.  In
Û                                     Ûa pair-wise comparison, one strategy
Û                                     Ûwill dominate another if the CPF lies t
Û                                     Ûthe right of another strategy over its
Û                                     Ûentire range; in other words, for all
Û                                     Ûclimate conditions considered the
Û                                     Ûstrategy whose CPF lies entirely to the
Û                                     Ûright always performs better than its
Û                                     Ûrival, over the long term, in terms of
Û                                     Ûthe variable of interest.  Thus, if the
Û                                     ÛCPF for strategies A and B cross, once
Û                                     Ûor many times, then neither is eliminat
Û                                     Ûed from the analysis, since over some c
¥êêêêêêêêêêêêêêêêêêêêêêêêêêêêêêêêêêêêê¥êêêêêêB-Backward, S-kip or PRESS 1¦ëKEY
```

Dominant strategy or strategies: 4

NOTE: Mean values are shown by vertical arrow's in all the plots.



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Grain Yield-T/ha — Explanation

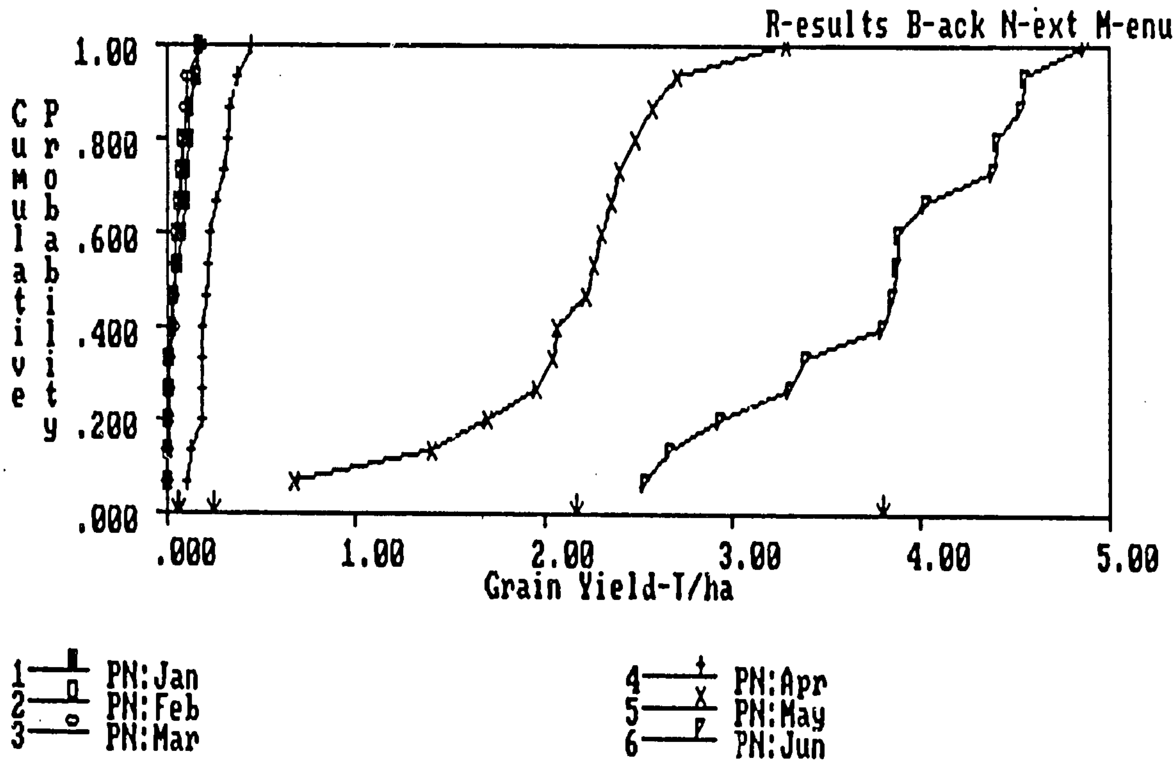
No	STRATEGY DESCRIPTION	Mean	SD
1	PN:Jan	0.0607	0.0586
2	PN:Feb	0.0493	0.0551
3	PN:Mar	0.0507	0.0506
4	PN:Apr	0.2453	0.0953
5	PN:May	2.1620	0.5980
6	PN:Jun	3.8033	0.7111

VARIABILITY ANALYSIS: This involves a pair-wise comparison of the cumulative probability functions (CPF) of the strategies defined. The program attempts to find the strategy or strategies that result in the maximum response for the selected variable. In a pair-wise comparison, one strategy will dominate another if the CPF lies to the right of another strategy over its entire range; in other words, for all climate conditions considered the strategy whose CPF lies entirely to the right always performs better than its rival, over the long term, in terms of the variable of interest. Thus, if the CPF for strategies A and B cross, once or many times, then neither is eliminated from the analysis, since over some of

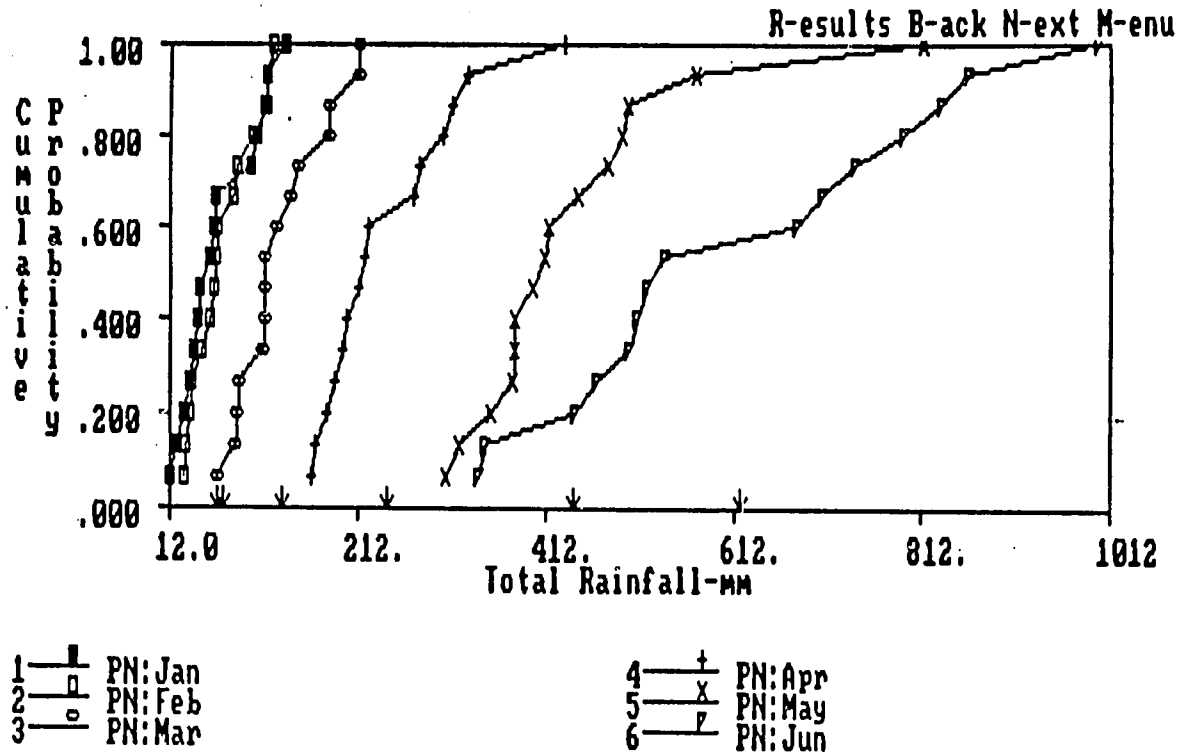
B-Backward, S-kip or PRESS 1¦ëKEY

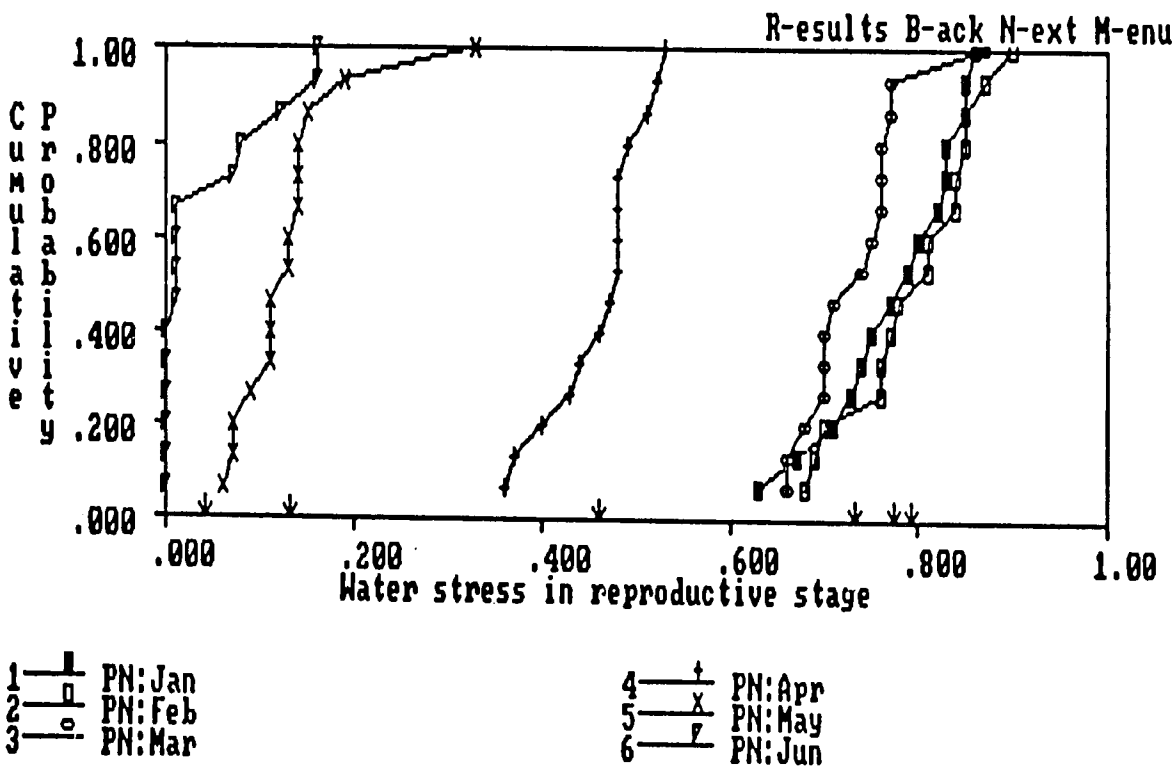
Dominant strategy or strategies: 6

NOTE: Mean values are shown by vertical arrow's in all the plots.



129


R-esults B-ack N-ext M-enu
Cumulative Probability
1.00
.800
.600
.400
.200
.000
12.0
212.
412.
612.
812.
1012
Total Rainfall-MM
1 PN:Jan
2 PN:Feb
3 PN:Mar
4 PN:Apr
5 PN:May
6 PN:Jun


R-esults B-ack N-ext M-enu
Cumulative Probability
1.00
.800
.600
.400
.200
.000
.000
.200
.400
.600
.800
1.00
Water stress in reproductive stage
1 PN:Jan
2 PN:Feb
3 PN:Mar
4 PN:Apr
5 PN:May
6 PN:Jun

CLIMATE DATA MANAGEMENT

POST-WORKSHOP PROFORMA

PRE-WORKSHOP INFORMATION

Did you receive pre-workshop information?

___ Yes ___ No

If Yes, how clear were the course objectives?
(please circle the appropriate number?

Unclear				Very Clear
5	4	3	2	1

Comments?

COURSE ADMINISTRATION/LOGISTICS

Please indicate your satisfaction with the following support arrangements (please circle the appropriate number):

	Not at all Satisfied				Extremely Satisfied
Training Facilities?	5	4	3	2	1
Housing Accommodations?	5	4	3	2	1
Logistical Support?	5	4	3	2	1

Comments?

COURSE CONTENT

1. At the beginning of the course or during the course, did you discuss with the instructors how the course content would meet your specific needs?

___ Yes ___ No

2. Please indicate your achievement of each of the training objectives listed below (please circle the appropriate number):

	Not at all Achieved				Extremely Achieved
Obj 1: Understand techniques of automated weather data collection and their role in agrometeorology and agroclimatology research.	5	4	3	2	1
Obj 2: Become familiar with setting up a climate data management system on the micro-computer (the Automated Weather Data Network System)	5	4	3	2	1
Obj 3: Become familiar with concepts for calibration of sensors and quality control of data.	5	4	3	2	1
Obj 4: Understand the importance of using mathematical models to analyze and evaluate climate data as it relates to the agrometeorological system.	5	4	3	2	1

3. Was the level of presentation of the subject matter:

____ Too Simple? ____ About Right? ____ Too Complex?

4. Rate the usefulness of each of the course topics in terms of being able to use the ideas, materials or skills in your work (please circle the appropriate number):

	Not Useful				Very Useful
Intro to PC's	5	4	3	2	1
Review of weather stations and related equipment	5	4	3	2	1
Review of data logger programming	5	4	3	2	1
Review of storage module	5	4	3	2	1
Introduction to sensor calibration and maintenance	5	4	3	2	1
Setting up the AWDN (system)	5	4	3	2	1
Role of mathematical crop models	5	4	3	2	1
Group exercises (hands on)	5	4	3	2	1

COURSE DESIGN AND DELIVERY

1. During the course, was the daily schedule:

____ Too Short? ____ About Right? ____ Too Long?

2. Was the overall length of the course:

____ Too Short? ____ About Right? ____ Too Long?

3. Indicate how helpful you found each of the following teaching methods to be (please circle the appropriate number):

	Not at all Helpful				Extremely Helpful
Lectures?	5	4	3	2	1
Large Group Discussions?	5	4	3	2	1
Small Group Discussions?	5	4	3	2	1
Hands-on Exercises?	5	4	3	2	1
Individual consultations with instructors?	5	4	3	2.	1

4. How useful were the following types of materials (please circle the appropriate number):

	Not at all Useful				Extremely Useful
Course Manual?	5	4	3	2	1
Handouts?	5	4	3	2	1
Written Assignments/Exercises?	5	4	3	2	1
Audiovisual Materials?	5	4	3	2	1
Computer Assisted Information?	5	4	3	2	1

Comments on instructional materials?

INSTRUCTORS

1. Name of First Instructor: Kenneth G. Hubbard

Rate this instructor in the following areas (please circle the appropriate number):

	Poor				Excellent
Knowledge of Subject?	5	4	3	2	1
Presentation of Material?	5	4	3	2	1
Ability to Relate Material to climate data management	5	4	3	2	1
Encourages Participants to Discuss Material?	5	4	3	2	1

What, if anything, would you suggest this instructor do to improve?

2. Name of Second Instructor: [redacted]

Rate this instructor in the following areas (please circle the appropriate number):

	Poor				Excellent
Knowledge of Subject?	5	4	3	2	1
Presentation of Material?	5	4	3	2	1
Ability to Relate Material to climate data management	5	4	3	2	1
Encourages Participants to Discuss Material?	5	4	3	2	1

What, if anything, would you suggest this instructor do to improve?

OVERALL WORKSHOP SATISFACTION

1. Would you recommend this course to other individuals with a background similar to yours?

   ___ Yes ___ No

   Please explain why or why not:

2. In general, how confident are you that you can apply the skills learned during this workshop to your research activities (please circle the appropriate number)?

Not at all Confident				Extremely Confident
5	4	3	2	1

3. Specifically, which topics do you feel you will be able to apply?

4. Please make any additional comments you would like to about this workshop.