

Project title: Development of a meteorological network to aid the use of HRI prediction models (ADEM and PEST-MAN)

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Project leader: Dr Angela Berrie, HRI East Malling

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Report for the APRC

**DEVELOPMENT OF A METEOROLOGICAL NETWORK TO AID THE USE OF HRI
PREDICTION MODELS (ADEM AND PESTMAN) - SP 111**

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Year of experiment:

Year three of three

Period covered:

April 1997 - March 1998

Abstract

The foundation for a meteorological network for fruit growers was established. Several weather stations were linked via modem to a central computer such that downloading, running of pest and disease forecasting programmes and sending of faxes can all take place automatically.

A prototype fax has been designed, this , and the further development of the network needs more input taking into account the needs of the industry. The future of the network and recommendations to the development of the network are discussed.

A leaflet providing information with regards to all the available weather stations in the UK has been produced, this should serve as a guide to growers when choosing a weather station.

Introduction

In 1995 and 1996, considerable progress was made in evaluating the performance of ADEM under commercial conditions (see reports to the APRC for 1995 & 1996). The work carried out showed that, when applied to a conventional spray programme on farms with sufficient management skills and flexibility of spray equipment, financial savings could be made and the standard of disease control enhanced while ensuring minimal impact on the orchard environment. The work also highlighted practical and management attitude aspects which are currently hampering the wider uptake of this aid to disease control.

There are few individual growers that are using the disease and pest forecasting models developed by HRI East Malling at present, the only output from these models is either generated by advisers to their individual clients or through the fruit advisory leaflets produced at a regular bases by both ADAS and FAST. To increase the reach of the warnings put out by the models it was envisaged that a network of weather station linked by modem to a central computer would serve this purpose. Growers would not have to have their own weather station on site but would be able to subscribe to this 'network' and receive a fax or e-mail on a regular bases.

This project is the initial stage of setting up such a network, sorting out problems with connecting weather station by modem to a central computer and producing material which will make the project assessable to a wider audience.

Objectives

- [1] Conversion and upgrading of existing Metos weather stations to allow automatic downloading of met data to a central computer at HRI East Malling. Automation of outputs to both growers, by fax, and advisers e.i. ADAS and FAST, by electronic mail. The total number of machines to which this will apply will depend on the expenditure needed to upgrade individual weather stations but the money available should be sufficient to upgrade at least 7. Most weather stations will be located in Kent, but it is envisaged that at least one will be located in East Anglia.
- [2] Production of advisory material about the use and benefits of the network, with information on interpretation of outputs, choice of weather stations and cost/benefit analyses.
- [3] Advisory visits to individual growers to try to persuade them to join the meteorological network. Priority will be given to those who already own a weather station. Two regional growers meetings will be held (one in Kent and one in East Anglia) to inform a wider grower audience on the benefits of the network.

Achievements

[1] Conversion and upgrading of existing Metos weather stations

Table 1 Sites and status of weather stations suitable to be incorporated into a meteorological network for fruit growers.

Location	Grower	Weather station	Status
Rainham	Holt	Metos ¹	linked
Sittingbourne	Doubleday	Metos ¹	not linked
Teynham	Redsell	Metos ³	not linked
Faversham	Dawes	Metos ³	linked
Ash	Chandler	Metos ²	linked
Matfield	Charington	Metos ²	not linked
Marden	Jenner	Metos ¹ Smaartlog ⁴	not linked not linked
Linton	Firmin	Metos ³	linked
East Malling	HRI-main HRI-Rocks	Metos ² Metos ²	not linked not linked

Station owned by:

- ¹ ADAS
- ² HRI
- ³ Grower
- ⁴ On loan

At the start of this project it was envisaged that we would be able to link approximately 7 weather stations to the central computer. The cost of upgrading and providing modems has however been much greater than expected and in 1997 only 4 weather stations could be linked of which two modems were provided by the growers themselves (Dawes and Firmin).

In theory it should be relatively easy to link existing weather stations via modem to the central computer. In practice several problems cropped up such as reception at location of weather station, configuration of modems, upgrading of 'old' weather stations and obtaining the correct cables. Mr. Graham Amos of Agrichandlers, agent for METOS has been helping to sort out the hardware problems.

Ideally weather stations should be connected to mains electricity, at present the majority still use batteries which are very unreliable. If the weather station is remotely downloaded frequently this will drain the batteries faster than when downloaded manually once per week.

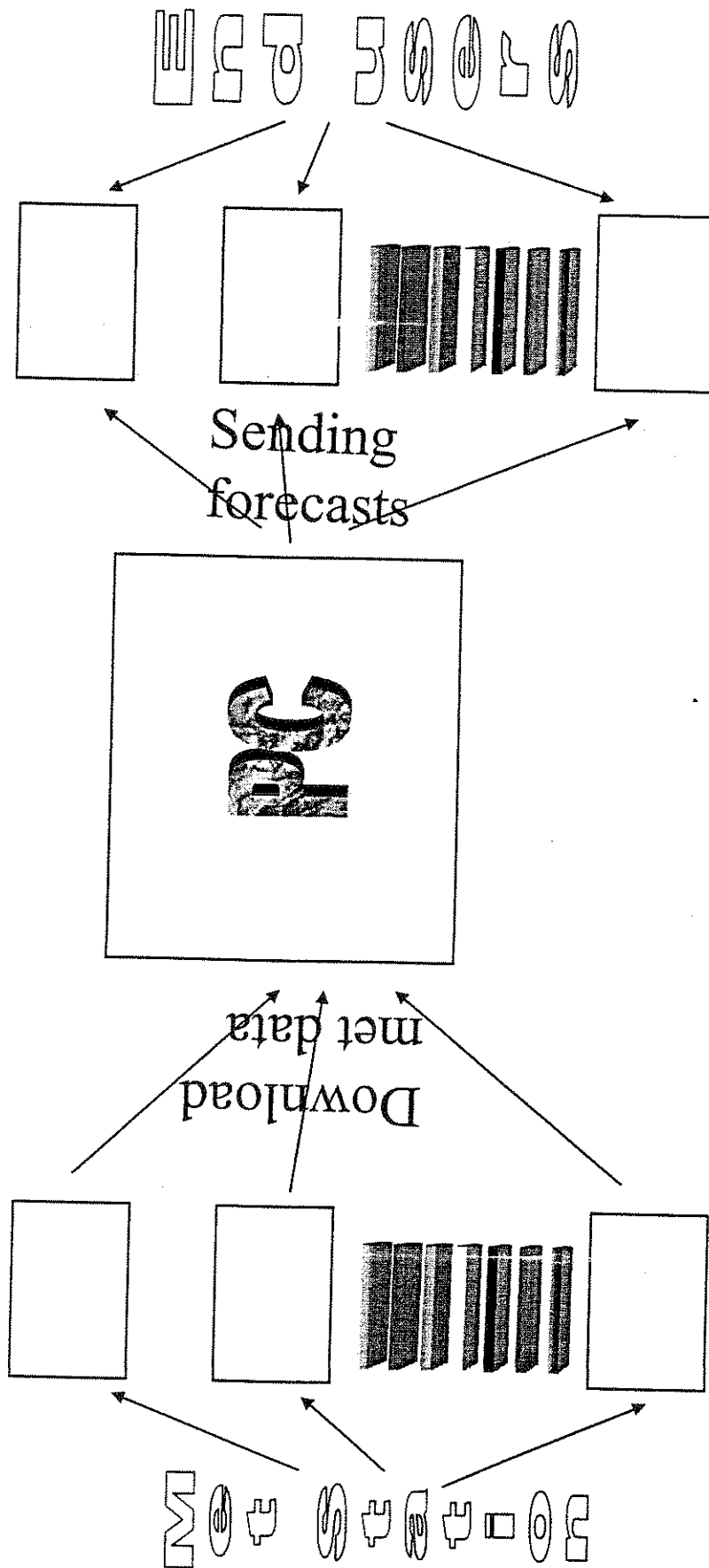
Instead of connecting the weather station via a modem to the central computer they can also be connected through a telephone landline, the cost of this is even greater and the weather station cannot be moved.

The automated process of downloading the weather stations remotely was developed by Xiangming Xu, HRI East Mailing. A window-based script programme has been written to automatically:

- download data from all loggers
- start ADEM, which can run models using data from all loggers automatically
- start a fax programme which can send multiple faxes automatically

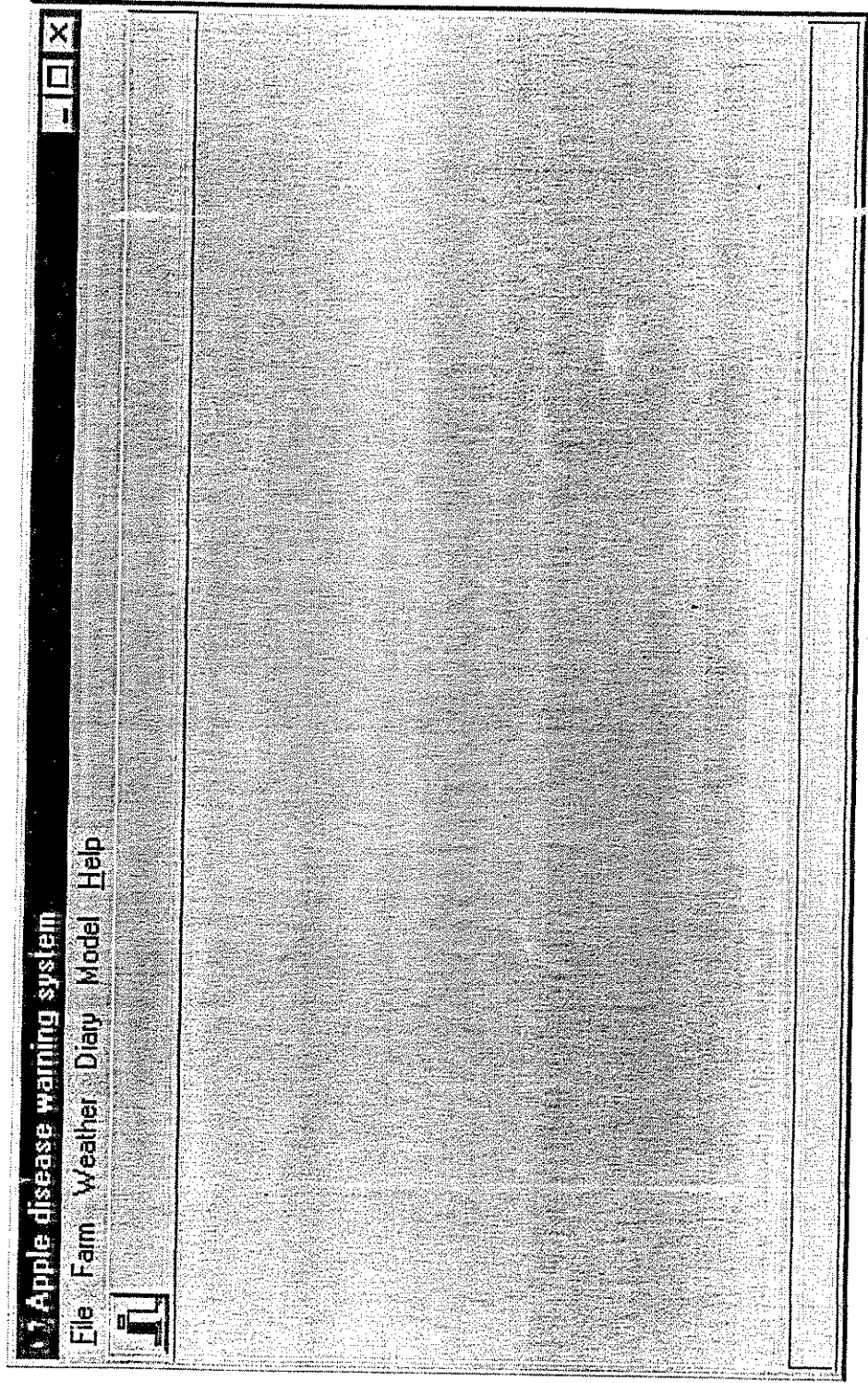
The following pages provide a brief summary of the automated process.

Met Network



Adem™ system

This screen capture show the main window of Window Adem™ system



Define loggers in Adem™

This screen capture shows the form to set up data loggers

The screenshot shows a dialog box titled "Define weather data logger" with the following fields and controls:

- Logger name:** jerry
- Logger site:** XU
- Logger path:** c:\mystuff\models\delp
- Logger latitude:** 52
- Automation:** To include for automation
- Navigation/Action buttons:** Back, Forward, Home, End, Cancel, OK, Close

Annotations with arrows point to the following elements:

- An arrow points to the "Logger name" field with the text: "Logger name used for data and forecast files, and faxing purpose".
- An arrow points to the "To include for automation" checkbox with the text: "Indicate whether to automatically run models using data from this logger".
- An arrow points to the navigation and action buttons with the text: "Tools to add or remove loggers".

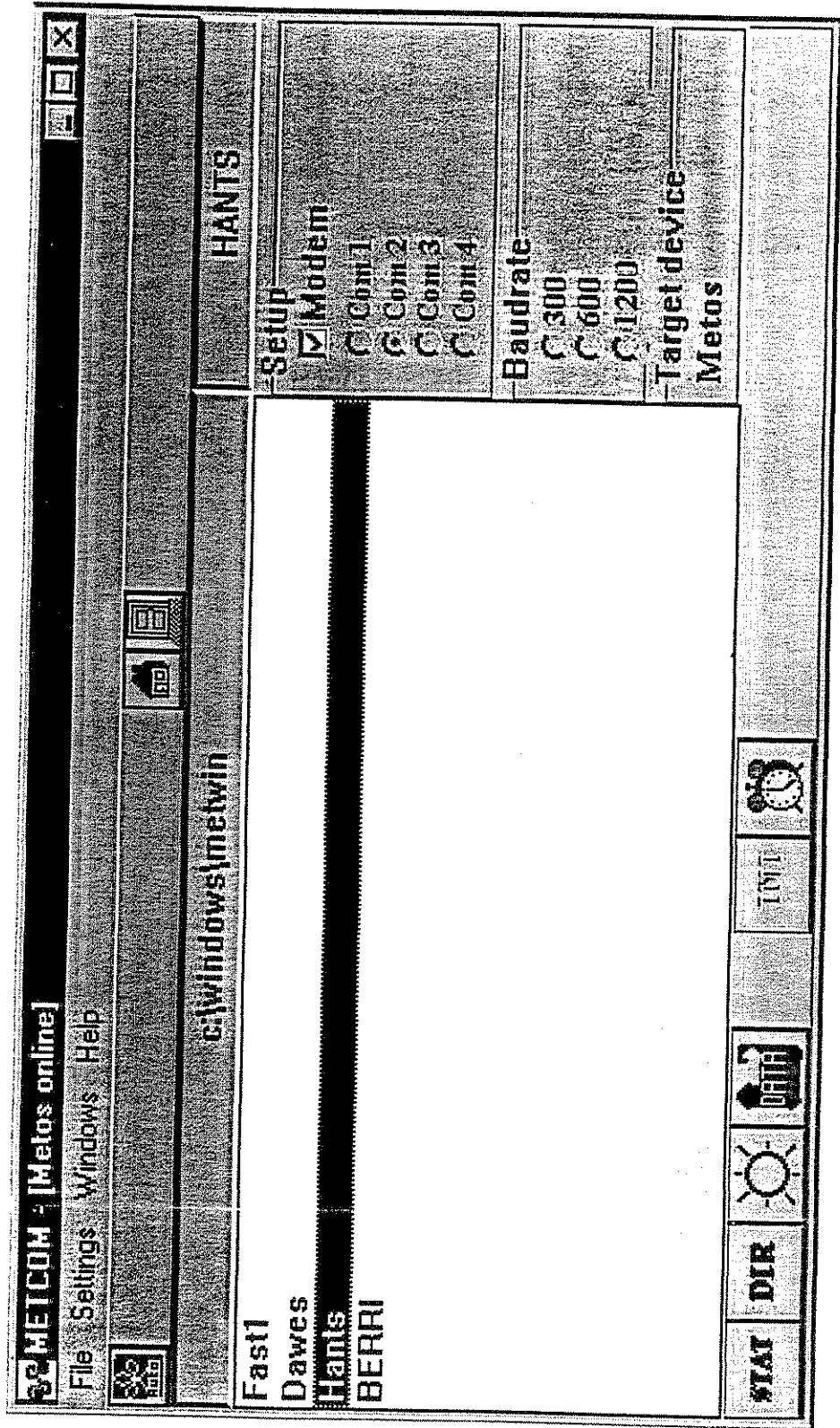
Sending fax

This screen capture shows the AutoFax software displays the fax status

Fax Status	
Phone number:	
Fax file name:	
Cover file name:	
Total pages:	0
Dial attempt:	1
Current page:	<cover page>
Page length:	0
Remote ID:	0
Connect BPS:	standard
Resolution:	1728
Width:	off
Error control:	
Bytes transferred:	0
Elapsed time:	00:00
Status: Initializing modem for fax processing	
Page progress:	
<input type="button" value="Cancel"/>	

Downloading data

This screen capture shows the data communication form



Modifying fax recipients

This screen capture shows the form to add or remove fax recipients for each data logger in the AutoFax software

Name	Number	LoggerName	Automat
Xiangming Xu	849067	Beiri	True
Jerry	849067	Jerry	True

Tools to modify the list

Recipient name

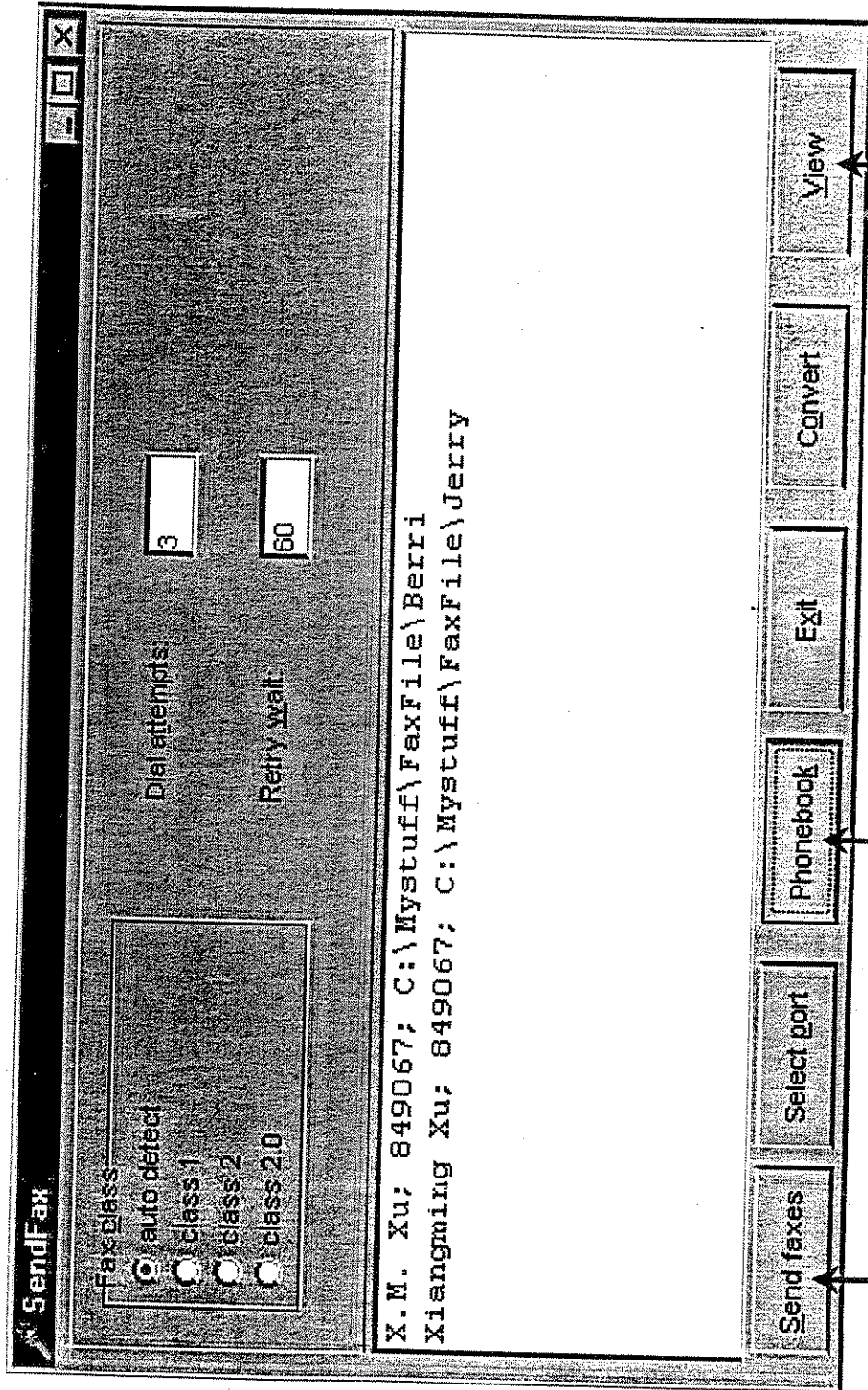
Fax number

Indicate forecast from which logger (logger name: the same as that in Adem™)

Indicate whether to send fax automatically

Appending fax

This screen form shows faxes to be sent



[2] Production of advisory material

A leaflet with information on weather stations available in the UK, was produced with help from a large number of firms producing or marketing weather stations (Appendix III). In total 8 types of weather station are included which all record the various parameters required for running ADEM and Pestman. The output from the weather stations varies, output is either in ASCII, which can be converted to the correct format for the programmes, or the output is already compatible with the programmes.

Not included in this publication are the various ways of powering the weather station, either by mains, batteries or solar power. The method used has a great influence on costs and will be up to the individual farmer to decide the best method for his/her circumstances e.i. location on the farm etc. Also not included is the method of down loading, ideally if the weather station is going to be used in the network the weather station will be linked by modem to the main computer.

Leaflets will be available through the APRC offices, a mention of this will have to be made in the next APRC newsletter.

[3] Information to growers directly

It was apparent directly from the start of the project that with the limited funds available it would take a long time to set up a network that growers could actually join, while the network is still in it's infancy it was decided that it would be premature to hold growers meetings. To promote the network to growers the network was demonstrated at Fruit Focus, 23rd of July '97 at HRI East Malling.

Growers could witness the automated process of downloading a remote Metos weather station and receive a fax with scab warnings. A leaflet with the aims of the network (Appendix I) and a prototype fax (Appendix II) was handed out to interested growers.

Discussion

The work carried out under this project has shown that it is possible to have an automated system for downloading weather stations and sending out faxes to and from a central computer. The data received from the weather station can automatically be used to run the disease and pest forecasting models ADEM and Pestman. The output from these models can be send to growers by fax.

The network itself has not been fully developed yet, several questions need to be answered before this can be done.

- **Which organisation is going to co-ordinate the network?**

General opinion is that this should be done by an independent grower's body such as the APRC. At present there are a number of advisory services active in this field, all developing their own system. In the author's opinion this does not benefit the fruit industry, ideally all advisors and researchers should be put under one umbrella with regards to collection of data and sending out information. Each individual organisation can then decide if they want to follow this up with their personal advice on interpretation of the output, or to run other programmes on the data set.

The APRC can commission an organisation or a person to deal with the day to day running of the network but should ideally stay in control of the administration of such a network.

- **How many weather stations should be part of the network?**

This is an extremely difficult question, ideally there will be a weather station in every orchard, or at least at every holding. This, however will never be a possibility. Disease and pest forecasts from several sites near a holding should give some indication for the local disease and pest risk, though. To increase the area for which we can run the network it is highly advisable that either new weather stations are purchased for strategic locations or use is made from other weather data sets collected by weather stations set up for other purposes, such as suggested for the link proposal put forward by CSL.

- **What information will the output fax provide?**

At present the automated system can provide the outputs from the scab model within ADEM. In future this needs to be expanded to cover other diseases and pests such that the output becomes more valuable to growers. Often growers really appreciate a summary of the weather for their area. This will help them with regards to frost and/or rainfall.

- **How will the network be financed?**

The initial setting up needs to be done by a grant, either from MAFF (link) or another source. High investment costs are required to provide enough weather stations to make the outputs reliable.

Once the network has been set up farmers can subscribe by paying an annual subscription for which they receive fax outputs at a regular bases during the growing season. If a grower is the owner of the weather station then there should be some incentive for this grower such that the network can access data from his/her weather station.

Income received from the subscription should cover maintenance of the weather stations and day to day running of the network.

- **Other user groups.**

At present HRI are working on the development of other pest and disease forecasting models which can be used in other areas of fruit growing such as for strawberries. It is envisaged that the network can expand to the soft fruit industry, giving it a much broader base to work on, especially since many growers both have top and soft fruit on their holdings.

In summary, there are still a lot of questions that need answering but they need to be answered by the industry as a whole, fragmentation of networks will not serve anybody.

Conclusions & recommendations

- 1 - An automated system for downloading weather station to a central computer and sending out faxes with pest and disease forecasts was developed. Several weather stations were linked to form the basis of a meteorological network for fruit growers.
- 2 - The development of a meteorological network for fruit growers needs a lot more input than provided for this project. To make a functional network the number of weather stations need to be increased, especially to areas outside Kent.
- 3 - Investments in new weather stations is highly recommended, high costs have been occurred in this project because old machines needed to be converted to be able to accept new technology. Ideally, new machines are used all round.
- 4 - Input of weather data from other sources is a priority, currently the number of weather stations available to the partners in this project, but also on holdings of other top fruit growers, is far too small to serve a reliable network. Collaboration with CSL might be an option.
- 5 - At present only FAST, HRI East Malling and ADAS are active participants in the 'network', other advisory services should be included in the 'network'.
- 6 - The financial side of running a network needs to be evaluated before it can be set up as a commercial enterprise - the APRC needs to play an active role in this such that all fruit growers will benefit.
- 7 - Once the foundation of the network has been formed, growers can then be invited to participate. A good structure needs to be set up, and broadcasting of information needs to be extremely reliable.
- 8 - Further work is needed to pull together all fruit industry partners that have a vested interest in this type of network.

ADAS

FAST

HRI

APRC

METEOROLOGICAL NETWORK for FRUIT GROWERS

- With APRC funding, FAST, HRI and ADAS are examining the feasibility of setting up a network of meteorological stations for top fruit growers. Such a meteorological network could initially provide information on:

Weather data

Disease warnings on scab and mildew generated by ADEM

Pest warnings generated by Pestman

- Basic weather data would be collected from a weather station situated either on the farm or in the vicinity. The nearer the weather station is to the holding the more accurate the information provided will be.
- The weather station would be downloaded automatically to a central computer based at East-Malling where the models will be run using the basic weather data.
- The output from the models could be sent by fax or e-mail to growers and advisors twice weekly, or accessed via the Rural Business Network. The information should be used in conjunction with field observations to enable appropriate spray decisions to be made.
- It is envisaged that the network would be run by an independent grower body with inputs from FAST, HRI and ADAS. Similar to the subscription weather fax, growers would have to pay a subscription to receive this information.
- The network is still in the development stages, but we will keep you informed on progress.

If you would like more information please contact :

Irene Koomen (ADAS, Wye; project co-ordinator) 01233-812761

Graham Moore (FAST) 01795-533225

Angeia Berrie or Xiangming Xu (HRI) 01732-843833

Appendix II - Prototype fax

ADEM-MET-FAX

ADAS
FAST
HRI

To : A.N. Grower
Metos site : Fruit Farm, Kent
Period : 16/6 - 22/6 1997

* Scab

Date	Low susceptible variety			Moderate susceptible variety			High susceptible variety		
	L	M	H	L	M	H	L	M	H
16/6/97									
17/6/97									
18/6/97	√	√	√	√	√	√	√	√	√
19/6/97		√	√	√	√	√	√	√	√
20/6/97									
21/6/97						√		√	√
22/6/97			√	√	√	√	√	√	√

L = low inoculum M = moderate inoculum H = high inoculum
√ = scab period recorded

* Mildew forecast: current risk is de-creasing

* Weather data

Date	Min T (°C)	Mean T (°C)	Max T (°C)	Rainfall (ml)	RH	hours leafwetness
16/6/97	8.9	12.9	18.3	0	76%	3h 24m
17/6/97	3.3	11.6	19.7	0.2	73%	24h
18/6/97	11.1	15.7	23.0	0	65%	24h
19/6/97	7.8	12.2	18.6	0.6	79%	24h
20/6/97	10.7	12.6	16.0	9.4	85%	14h 36m
21/6/97	9.9	13.8	19.0	1	74%	5h 24m
22/6/97	9.3	12.6	17.3	18.0	86%	16h 48m

The long term weather forecast can be obtained through weather fax. Please contact your local advisor to assist with interpretation of this fax. A.N. Advisor Tel 01234-123456.

APPENDIX III

LIST OF WEATHER STATIONS CURRENTLY AVAILABLE IN THE UK

an aid to help top fruit growers choose the right weather station for their needs

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All information supplied by manufacturers or agents; the author cannot be held responsible for the information provided in this document, before purchasing a weather station it is strongly advised to contact the various companies directly and discuss the final choice with your advisor.

This work was funded by the APRC, project SP 111.

INTRODUCTION

This information is compiled to aid growers in making an informed choice with regards to purchasing a weather station.

The APRC has during recent years funded the development of computer based disease and pest forecasting models (ADEM and Pestman, HRI East Malling). These models need the input from an automated weather station, originally developed with METOS, there is now a large choice of weather stations on the market. Not all weather stations are directly compatible with the programmes but this can, however, be overcome with additional programming.

The ADEM programme, which provides forecasts for scab, mildew, canker in store and fireblight on apples has the following requirements with regards to weather data collected by weather stations:

1. Rainfall - as mm per sensor scan interval
2. Screen temperature - as °C
3. Relative humidity - as 0-100%
4. Surface wetness - as 1 = wet surface, 0 = dry surface

Weather stations are available at a widely differing price range, prices quoted here should be taken as a guideline since they might change and they are also dependant on accessories required for running the station. Additional solar panels, cables and software might be required for an individual set-up. For most effective use a PC with or without modem is required most models.

Irene Koomen
ADAS FRUIT TEAM
01732-521520
July 1998

WEATHER STATION: Campbell Scientific

COMPANY: Campbell Scientific Ltd.,
Campbell Park,
80, Hathern Road,
Shepshed,
Leicestershire LE 12 9RP

PHONE: 01509-601141

FAX: 01509-601091

SPECIFICATIONS:

module & panel	CR10X
Batteries	PS12EALK
Enclosure	ENC12/14
Mounting for enclosure	ENC-MOUNT
Tripod	CM10/3
T & RH probe	HMP35AC
Radiation shield	URS-1
Rain gauge	ARG100
Wetness sensor	237
Connector fitting	03C

COMPATIBILITY WITH ADEM: ASCII

APPROX. PRICE for ADEM SET-UP: £2,280

WEATHER STATION: Delta-T

COMPANY: Delta-T Devices Ltd.,
128, Low Road,
Burwell,
Cambridge,
CB5 0EJ

PHONE: 01638-742922

FAX: 01638-743155

SPECIFICATIONS:

Delta-T logger	DL2e
Mast	M2
Rain gauge	RG1
Levelling base plate for RG1	RGB1
RH and air T sensor	RHA1
Surface wetness sensor	SWS

The weather station is based on the rugged , weatherproof Delta-T logger type DL2e. The DL2e provides independent control over each sensor to define reading units and the frequency with which readings are taken. If required, the logger memory can be expanded from the basic 64k of readings to 128k readings. The number of sensor inputs can also be increased - for example to add soil moisture or solar radiation. The DL2e logger as supplied will have 11 spare analogue channels and one spare counter channel.

COMPATIBILITY WITH ADEM: ASCII output

APPROX. PRICE for ADEM SET-UP: £1912.34 + VAT

WEATHER STATION: Hardi Metpole

COMPANY: Hardi Ltd.,
4-5, Watling Close,
Sketchley Meadows Ind. Estate,
Hinckley,
Leicestershire LE10 3EX

PHONE: 01455-233811

FAX: 01455-233815

SPECIFICATIONS:

Hardi Metpole with integral sensors for wind velocity, surface wetness, global radiation, air temperature, relative humidity, rainfall, soil temperature and soil water content.

COMPATIBILITY WITH ADEM: ASCII

APPROX. PRICE for ADEM SET-UP : £2160 + VAT
receiver required for transmission of data : £1565 + VAT

WEATHER STATION: Lufft - HP100

COMPANY: Carrington Marketing (agent),
497, Leeds Road,
Idle,
Bradford,
BD10 8LD

PHONE: 01274-617961

FAX: 01274-427375

E-Mail: sales@carrington-mktg.demon.co.uk

SPECIFICATIONS:

HP-100 on base plus sensor unit

The LUFFT HP100 Orchard Advisory System is a sophisticated weather monitoring and recording unit. By taking automatic readings, every 12 minutes, of temperature, humidity, rainfall, brightness/darkness, as well as leaf wetness, the HP100's powerful built-in software (based on established scientific knowledge) provides the grower with detailed information warning when critical conditions have been reached for apple scab infection.

COMPATIBILITY WITH ADEM: Software for the conversion of data already exists

APPROX. PRICE for ADEM SET-UP: HP-100 £2,995.00

WEATHER STATION: Mini-METOS M600 or METOS Compact

COMPANY: Agrichandlers (agent),
Hartlet Witney,
Hook,
Hants,
RG27 8DH

PHONE: 01252-843205
FAX: 01252-843205
E-MAIL: agrichandlers@msn.com

SPECIFICATIONS:

Mini-METOS M600 RH/Air temperature sensors, leaf wetness sensors, rain gauge 0.2 mm resolution.

METOS Compact C906 RH/Air temperature sensors, 2leaf wetness sensors, rain gauge 0.2mm resolution

Mini-METOS provides all the facilities most top fruit growers require. Single weatherproof construction, can be sited at various heights, easy to self-maintain and move. Option include solar panel, soil temperature sensor and irrigation controller.

METOS Compact available in small or large format in it's own weatherproof box. Optional additional sensors will yield data for all farming and crop needs. Ideal as the major base station on large farms where mini-METOS are used as satellite outstations.

COMPATIBILITY WITH ADEM: fully compatible

APPROX. PRICE for ADEM SET-UP: Mini-METOS £1530
METOS Compact £2498

WEATHER STATION: MiniMet

COMPANY: Skye Instruments Ltd.,
Unit 32,
Ddole Industrial Estate,
Llandrindod Wells,
Powys LD1 6DF

PHONE: 01597-824811

FAX: 01597-824812

EMAIL: skyemail@skyeinstruments.com

WEB PAGE: <http://www.skyeinstruments.com>

SPECIFICATIONS:

Skye 4-channel MiniMet (includes RH and T probe)	SDL5160
Rain gauge	ARG100/I
Surface wetness sensor	SKLW 1900/I
Levelling plate for ARG100/I	RGB1
Mount for SKLW	SKM 226
Radiation screen & mount	SKRS 080S

COMPATIBILITY WITH ADEM: Compatible

APPROX. PRICE for ADEM SET-UP: £1,098

WEATHER STATION: SMAARTLOG

COMPANY: Aardware Design,
Russell House,
Molesey Road,
Walton-on-Thames,
Surrey KT12 3PL

PHONE: 01932-269258

FAX: 01932-269288

E-MAIL: AARDVARK_TECHNICAL_SERVICES@COMPUSERVE.COM

SPECIFICATIONS:

Logger module	SMA-LOG
Air T sensor	SMA-1TA
RH sensor	SMA-1H
Leaf wetness sensor	SMA-1LW
Rain gauge	SMA-1RHS
Sensor Screen	

Designed and manufactured in the UK the SMAARTLOG is a competitively priced, easy to use and flexible weather station specifically designed for the horticultural market. As a result of its modular design the SMAARTLOG offers options from a simple stand-alone entry level to full remote SMAARTLOG networks. For expansion SMAARTLOG is easily upgraded with additional sensors (up to 17).

COMPATIBILITY WITH ADEM: Compatible

APPROX. PRICE for ADEM SET-UP: £1200

WEATHER STATION: EM

COMPANY: Environmental Measurements Ltd.,
Business & Innovation Centre
Sunderland Enterprise Park (East)
Wearfield
Sunderland SR5 2TA

PHONE: 0191- 5010064
FAX: 0191- 5010065
E-Mail: sales@em-ltd.demon.co.uk

SPECIFICATIONS:

Modular Weather Station - data logger, aerodynamic rain gauge, temperature & humidity probe in sensor shield, surface wetness probe and mast

EML manufacture a range of weather stations utilising up to 6 sensors (4 analogue & 2 digital) including rainfall, temperature, relative humidity, surface wetness, net and solar radiation, barometric pressure, wind speed and wind direction.

COMPATIBILITY WITH ADEM: ASCII

APPROX. PRICE for ADEM SET-UP: £1550 +VAT

The soft ware to run ADEM and Pestman can be obtained from the APRC offices :

The APRC
Bradbourne House Stable Block
East Malling Research Station
West Malling
Kent ME19 6DZ