Theoretical framework for applied climate education: 2. Training development and delivery for building knowledge and skills to apply seasonal climate forecasts in agriculture

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ABSTRACT

Workshops were held in Australia, India, Indonesia and Zimbabwe between January 1999 to September 2002 to enhance understanding of climate variability, ENSO and seasonal forecasts, particularly as they impact on agriculture systems in these countries. These workshops were delivered to a range of participants including agriculture department staff, farmers, researchers, bureau of meteorology staff and food security personnel.

A range of resource materials were customised in Australia for these other countries and adapted for workshops. During previous visits to these countries, there were meetings with researchers, extension officers, farmers, meteorologists, policy makers and other project members and as a result, a set of workshop aims and criteria for participants attending the workshops was developed. Educational course-ware has been developed for a range of stakeholders including secondary schools, vocational and tertiary education, formal and informal materials for workshops. This material has been developed not only in booklet format but also multimedia format so as to appeal to the changing face of education and learning styles of students. A structured program for workshops were proposed but had to in-build flexibility so as to cope with different needs of participants. The workshops consisted of sessions on the climate of their country, tools to assist forecasting, application of forecasts, communication, evaluation and future work.

The workshops improved the knowledge and skills of participants. Although the workshops also increased awareness of climate and agricultural issues, the feedback provided by participants shows clearly that further training is needed before they can confidently, independently and proficiently use these technologies to train others or issue advice to decision makers and farmers. A more comprehensive and advanced training program as identified by the skills audit would be ideal.

Climate variability creates enormous problems with agricultural production and in natural resource management. A better understanding of this variable climate and what drives these systems plus the use of seasonal climate forecasting can help to improve this situation. Professional development training has shown the major benefits of this work to be improved knowledge and skills, enhanced decision-making, and reduced climate risk exposure.

1 INTRODUCTION

Workshops were held in Australia, India, Indonesia and Zimbabwe (see Figure 1) between January 1999 to September 2002 to enhance understanding of climate variability, ENSO and seasonal forecasts, particularly as they impact on agriculture systems in these countries. These workshops were delivered to a range of participants including agriculture department staff, farmers, researchers, bureau of meteorology staff and food security personnel. A range of resource materials were customised in Australia for these other countries and adapted for workshops. These materials were used in hands-on activities throughout the workshops with participants working on local examples and developing solutions to local problems. The resource materials included software packages (RAINMAN INTERNATIONAL, StreamFlow), handout notes (including exercises), copies of *Will it Rain?* This paper intends to present results of this work and also highlight the approach and advantages of building knowledge and skills to apply seasonal climate forecasts in agriculture.

2 AIMS OF WORKSHOPS

2.1 Workshop aims

During previous visits to these countries, there were meetings with researchers, extension officers, farmers, meteorologists, policy makers and other project members and as a result, a set of workshop aims and criteria for participants attending the workshops was developed.

The aims of the 'train the trainer' workshops are to improve the knowledge and skills of participants. As a result of participating in this workshop, it is expected participants would be better able to:

- Investigate 'What makes it rain' in your location.
- Read and interpret weather maps
- Examine and investigate the impact of climate variability and ENSO on agriculture
- View and discuss climatic data for your location, (including averages, median, deciles, probabilities and statistical skill)
- Complete an enterprise decision making exercise using RAINMAN
- Identify key decision points in the agricultural system where seasonal climate forecasts may be useful
- Review climatic information sources and references
- Complete a 'climate related' skills audit for agricultural management
- Observe and discuss current short and long-term forecasts.

3. METHODS

Development of materials

Educational course-ware has been developed for a range of stakeholders including secondary schools, vocational and tertiary education, formal and informal materials for workshops. This material has been developed not only in booklet format but also multimedia format so as to appeal to the changing face of education and learning styles of students. The list of materials includes:

- Tutorials in Rainman (Clewett *et al*. 1999)
- Tutorials in StreamFlow (Clarkson *et. al.* 2001)
- Workshop books for Australia, Indonesia, Zimbabwe and India (George 2003a, George 2003b, Unganai and George 2003, Selvaraju and George 2003).
- Climate and Agriculture web site at: http://www.schools.ash.org.au/paa/cwabook (George 2001)

An accredited vocational education course for ***Developing climate risk management strategies (AG5215BM)*** has also been achieved through the Australian National Training Authority (ANTA). Although specific resource materials have not yet been developed, accreditation of an applied climate course has advantages for putting in place life-long learning pathways from secondary to vocational and tertiary educational providers if desired by the student. It also puts in place a complementary applied climate curricular that intends to build knowledge and skills. Partnerships with secondary, vocational and tertiary education providers are a necessary requirement if this outcome is desired.

Delivery of education and training

Workshops and training have been undertaken in Australia, Indonesia, Zimbabwe and India. The numbers of participants and industries represented at these workshops are shown in Table 1 below.

Table 1. Industries represented in workshops and training in Australia, India, Indonesia and Zimbabwe.

Country	**Industries represented**
Australia* (workshops concentrated on farmers and QDPI staff concentrating on workshops at Emerald [10], Gatton [8] and Mareeba [8].)	Extension officers comprising staff from cropping, livestock horticulture, fisheries, entomology; teachers/educators, farmers (George and Paull 2002, p.9)
Indonesia** (first workshop series in July 2000 with 120 people approximately concentrated on a range of university and government officers at Mataram [34], Praya [39] and Selong [39], on Lombok. The second series of workshops concentrated on University staff, Bureau of Meteorology staff and public works and irrigation staff at Bogor[40], Yogyakarta [17]and Mataram [22] in July 2002)	University lecturers, students, Bureau of Meteorology, extension officers, agriculture officers, public works, BAPPEDA, irrigation officers, farmers, water users association, animal husbandry officers (Clewett 2001, George 2002)
Zimbabwe*** (Workshops at Harare [26], and Bulawayo [15]) drawing in people from 11 towns and 11 organisations.	Policy, cropping (maize), cattle producers, irrigation and field crops, vegetables, vines and nuts, climate scientists and educators (Cobon 2001 p.3).
India**** (this work concentrated on 8 villages and 240 farmers with multiple workshops	Farmers [Arasur, Kodangipalayam, Onnipalayam, Natchipalayam,

presented during the duration of the project).	Vellamadai, Naratripuram, Virugalpatti, Ramanathapuram and Agriculture Department staff] (Clewett 2001 p.19)

** Full report of AFFS workshops are in George and Paull (2002) with other Australian workshops in ACIAR Review Document Report (2001)*
*** Full report of Indonesian workshops up to September 2001 are in ACIAR Review Document Report (2001) with July 2002 workshops presented in George 2002.*
**** Full report of Zimbabwean workshops up to September 2001 are in ACIAR Review Document Report (2001)*
***** Full report of Indian workshops up to September 2001 are in ACIAR Review Document Report (2001), with a summary of all workshops presented in Selvaraju and George. 2003.*

A structured program for workshops were proposed but had to in-build flexibility so as to cope with different needs of participants. An example of a typical workshop program, planned for the first workshop series in extension staff awareness training is described below. Please note there were slightly different programs for Indonesia, India and Zimbabwe workshops according to the agreed learning outcomes.

Collaborators from the designated other country Institutes, and other key staff, were contacted to arrange convenient dates and a satisfactory program for the workshops. Workshops were conducted at the locations described in the table above. A flexible workshop program was developed following discussion on their needs and our expected outcomes. The program covered the topics as described in the aims. Workshops were delivered according to what was agreed in discussions. Evaluations were based on the agreed learning outcomes.

The workshops consisted of sessions on the climate of their country, tools to assist forecasting (RAINMAN V4), application of forecasts, communication, evaluation and future work.

Workshop participants were selected by certain criteria.. Emphasis was on the people who will have lasting impacts in our area of work. For example, those who already teach or conduct research and extension on agro-climatology, and possibly staff who provide advice on applied climate and agriculture policy. Some level of computer literacy was specified, and a moderate level of English. We really wanted those who were keen. Invitations were then to be sent to leaders of organisations who were asked to nominate participants that would represent leaders in the following groups or disciplines:

- higher education and university staff
- public works
- Agriculture Department
- Bureau of Meteorology staff

In addition, participants should ideally be computer literate with access to computing facilities, and have potential existing projects with on-farm contact (crops and livestock) or have acurrent network of contact with extension officers and / or farmers.

The purpose of this selection of people was to not only broaden the geographical distribution of participants but to improve the chances of getting those with direct and regular contact with farmers, and put in place long term skills that could indirectly get to farmers, through education and training.

Evaluation

At the end of the workshops, prior to completing the formal qualitative and quantitative evaluation, participants were asked to discuss what was most important about the day(s) and perhaps, *what next*? Generally it would follow the ORID process of discussion on individuals '*observation, reflection, interpretation and decision – making*'. Participants were asked:

- What are some words they could recall?
- Where were they excited or frustrated?
- What are the areas you consider most important for you and your work?
- What are some things you can apply to your work situation?

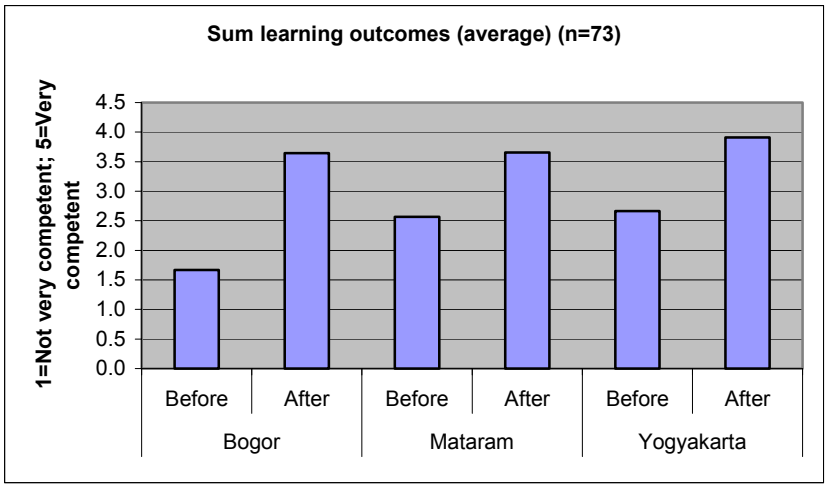
The more formal qualitative and quantitative evaluation was a 3 page survey to help evaluate the overall utility of the workshop. For the presenters, participants were asked about presentation quality, relevance, and usefulness so they could improve their presentation process and content. To measure skills and knowledge changes, we examined the degree to which the workshop outcomes were achieved (Figures 1-2. Tables 2-11) and whether they had improved understanding and capacity to implement these technologies. An exercise to assess participant's skills was used to determine future training requirements.

Following is a summary of that evaluation process.

4. RESULTS

If the average of all learning outcomes are calculated, it demonstrates skills levels at all three locations in Indonesia in July 2002 improved in the learning outcomes developed and delivered (Figure 1). Before the workshop the majority of participants were not very competent at these skills, but after the workshop, the majority were between moderately competent and very competent in these skills.

Figure 1. Average competence level before and after the workshops in Indonesia in July 2002 of all Learning Outcomes



Knowledge and skills were also shown to improve with participants in Australia (George et. al 2000), with individual farmers in India (Clewett 2001 p. 19), and in the Zimbabwe workshops (Cobon 2001 p. 6).

Figure 2 shows a summary from the average of all the skills from work in Indonesia in July 2002. Approximately 63% of participants ranked these climate skills as *essential* with approximately 33% considering it *useful* in their work, with only approximately 9% of participants ranking themselves at being *very good* and approximately 43% being *good* at that skill. Professional QDPI staff also emphasised how essential or useful climate skills are, and their general inadequacy level of these skills (George and Paull 2002). Case studies from India (Clewett 2001 p.19), describes how individual farmers skills have improved in incorporating seasonal climate forecasting in decision making.

Figure 2. Assessment of average of all skills from Indonesian workshops in July 2002

Feedback on issues and potential applications of this work

The evaluation sheet provided the opportunity for participants to give feedback on specific issues and applications of this work that were raised during the workshop. A summary of the results follows below.

Responses to the question: What actions could you undertake as a result of this session? Are presented in Table 2.

Table 2. Response to the question 10: What actions could you undertake as a result of this session?

Some Indonesia 2002 participant responses (George 2002 pp. 26-27):
• To exploit material for teaching, 2. to exploit for develop crops pattern
• Build my knowledge about how the climate phenomenon have it impact in fisheries
• Explaining to student about SOI and weather forecast

• I can give information about climate, forecast and useful of it to fisheries application
In Indonesia in 2000 Clewett (2000 pp.158-159), reported farmers will use this information for selecting crop choice and in water use scheduling.
In India (Clewett 2001 p. 19), farmers will use this information for selecting crop choice, water use scheduling and integrating production with market prices to make the best decision for the season.
In Zimbabwe (Cobon 2001), material from this project will be used by agricultural extension staff for training and writing of a 'fact sheet' for farmers to better interpret and integrate seasonal climate forecasts in their decision making; and in providing better agronomic advice
In Australia (George and Paull 2002 p.4), this work will lead to more focussed (and accurate) regional and temporal forecasts; incorporation into participatory action learning groups and integrated into pest, weed and horticultural research

Responses to the question: Are there other suggestions you wish to make about the session? are presented in Table 3.

Table 3. Response to Q 11: Are there other suggestions you wish to make about the session?

Some Indonesia 2002 participants responses (George 2002 pp. 27-28): • Adding time and material particularly climate changes and forestry • C/W other information where climate have it direct impact • Explain clearly about software and data interpreting • I want training which more intensive
Generally the consensus was the information was good, but to make the sessions more valuable it would be necessary to make more time available, more resources for people to take away and use, and more workshops with increased size of the participants. This was reinforced in Zimbabwe (Cobon 2001 p.20) and in Indonesia in 2000 (Clewett 2000 p. 156).

Responses to the question: Will it be of benefit to you in your work to have a copy of Will it Rain? If yes, how? are presented in Table 4.

Table 4. Response to Q 12: Will it be of benefit to you in your work to have a copy of Will it Rain? If yes, how?

Some Indonesia 2002 participants responses (George 2002 pp. 28-30): • At least it can [help] predict the production of forage crops/pasture, then finally I can estimate the carrying capacity of livestock • I will distributed in my location (South Kalimantan) and I want to teach about it • I'd be confident for me • Sure, this book can give us information about rain and anything else and I can use it to teach the students • To have a copy of Will It Rain, I can be able to explain to my students when the rainfall in it effect, clearly (I hope) • to increase my ability to [better understand] climate and weather

100% of Zimbabwe participants wanted the resource book for Zimbabwe (Cobon 2001). The earlier workshops in Indonesia also recognised the value of having the WIR? as a resource (Clewett 2000 p.157) and as a teaching resource (George 2002 pp.28-30)

Responses to the question: Will it be of benefit to you in your work to have a copy of Rainman? If yes, how? are presented in Table 5.

Table 5. Response to Q 13: Will it be of benefit to you in your work to have a copy of Rainman? If yes, how?

Some Indonesia 2002 participants responses (George 2002 pp. 30-31): • As the basic to develop the RAINMAN by applying with fisheries information system • At least it can predict the production of forage crops/pasture, then finally I can estimate the carrying capacity of livestock • continuous learning • I will investigate and teaching the causes and effects ENSO: SOI and SST in my location • Sure, I need it • to be more confident if I forecast my location In summary, participants believed there were significant benefits to having Rainman and were generally disappointed they were not able to get a copy during the workshops.
In Zimbabwe, 100% of participants believed having a copy of Rainman would be a benefit to their work.
[for clarification] In Australia, QDPI have access to Rainman and there are networked versions available in BoM, numerous universities and most other state departments of agriculture. In particular, NSW Agriculture and PISA use Rainman in staff training.

Responses to the question: What do you think are the key decision points in the agricultural system where seasonal climate forecasts may be useful? Are presented in Table 6.

Table 6. Response to Q 14: What do you think are the key decision points in the agricultural system where seasonal climate forecasts may be useful?

Some Indonesia 2002 participants responses (George 2002 pp. 31-32): • 1. Planting in Agricultural/Forestry in wet season 2. Post harvest in dry season 3. Time schedule of activity of agricultural and forestry could predict • Cropping and land maintenance • Decision point: 1. When we should plant? 2. What crop? 3. How much makes deficit or surplus water etc • I think it will be useful to avoid breaking paddy harvest • I think it's very useful in agricultural cause we can make planning to planting In the year 2000 responses from Indonesia, they believed crop choice, water scheduling and fertiliser application times (and rates) can all be helped with seasonal climate

forecast information (Clewett 2000 p.157). With analysis of daily data, monsoon onset and crop planting times were also critical in Indonesia (George 2002 pp. 45-46).
Indian farmers (dryland and irrigated) believe crop choice, water scheduling and fertiliser application times (and rates) can all be helped with seasonal climate forecast information (Clewett 2001 pp.18-19).
The above points were reiterated with the Australian workshops. In addition, working with horticulturalists in Australia, they believed with additional research on rainfall and temperature, there could be even greater benefits for agricultural sustainability (George and Paull 2002 pp.4-6)
In Zimbabwe, the type of variety of crop to plant and planting date with the analysis of daily data were key decisions (Cobon 2001 p.9).

Response to the question: Do you now have a better knowledge and understanding of ENSO, climate variability and alternative forecast methods? are presented in Table 7.

Table 7. Response to Q 15: Do you now have a better knowledge and understanding of ENSO, climate variability and alternative forecast methods?

Some Indonesia 2002 participants responses (George 2002 p.33): • Climate just part of our competent but most important • I can find locations which influence ENSO • I more learn about physical process of ENSO • I used to be only understand some terms of weather forecast such as (rainfall, minimum/max temp, wind speed/wind direction). Now I have more knowledge on weather/climate forecast; how El Nino happens, what SOI, ENSO. Altogether, 95% of participants said they have a better knowledge and understanding of ENSO, climate variability and alternative forecast methods (George 2002 p.33). The 2000 workshops explained the information is useful for arranging crop patterns, knowledge of onset of the monsoon, and in terms of helping to better arrange water for irrigation (Clewett 2000 p.157).
In Zimbabwe, 100% of participants had a better knowledge and understanding of ENSO, climate variability and alternative forecast methods (Cobon 2001 p.6).
In Indian case studies, it was revealed increased understanding will lead to more informed decisions for agriculture and resource management (Clewett 2001 pp.18-19)

Response to the question: Are you now better able (with development and tools like Rainman) to provide improved services to farmers, businesses and government? are presented in Table 8. Approximately 90% of participants in Indonesia in 2002, agreed they could provide improved services.

Table 8. Response to Q 16: Are you now better able (with development and tools like Rainman) to provide improved services to farmers, businesses and government?

Some Indonesia 2002 participants responses (from George 2002 p.34): • At least we have knowledge and could give some suggestion especially in agriculture systems

• I think I should get more training units, RAINMAN tools • now, I be able to provide improved advices to my students and government This was also evident from the previous workshops with feedback responses (Clewett 2000 p.156).
In Zimbabwe, 77% of participants believed they are now better able (with development and tools like Rainman) to provide improved services to farmers, businesses and government (Cobon 2001 p.6)
Indian work (Clewett 2001 pp.18-19) indicated there was a need for clearer articulation of seasonal climate forecast information to farmers due to possible misinterpretation of probability based forecasts.

Response to the question: Are you now better able to examine forecasts for your own location? are presented in Table 9. Approximately 90% of participants in Indonesia in July 2002 agreed they could (from George 2002 p.35).

Table 9. Response to Q 17: Are you now better able to examine forecasts for your own location?

Some Indonesia 2002 participants responses (from George 2002 p.35): • I have simple and small set up equipment in my location, gather with data from BMG. It will be helpful to plan our schools • RAINMAN 4.1 is new version which must be more developing by me • Data available can be analysed directly • I have almost 80% of data needed • My capability increased • The analysis method given by this program can be used to support probability analysis method which has been used recently However in Clewett (2000 p.160) there was an indication from professionals suggesting their understanding of the forecast may be allright, but there may be a difficulty with farmers and ultimately misinterpretation.
In India, possibilities of forecast misinterpretation also became evident with problem ramifications (Clewett 2001 pp.18-19)
In Zimbabwe 77% of participants believed they are now better able to examine forecasts for their own location (Cobon 2001 pp.6-7).

Response to the question: Do you have better access to multi-media information on climate variability, impacts of ENSO and seasonal climate forecasting with the development and availability of these tools? are presented in Table 10. Approximately 80% of participants in Indonesia in July 2002 agreed they did (from George 2002 p.36).

Table 10. Response to Q 18: Do you have better access to multi-media information on climate variability, impacts of ENSO and seasonal climate forecasting with the development and availability of these tools?

Some Indonesia 2002 participants responses (from George 2002 p.36): • I used to access on these information from FAO sites but I can access from the right

and more proper sites. • The program helps to manage data available • The program is enough and easy to applied In the previous Indonesian workshops (Clewett 2000 p.160), there was greater ease of obtaining increased information of the seasonal climate forecast
In Zimbabwe, 77% of participants agreed they have better access to multi-media information on climate variability, impacts of ENSO and seasonal climate forecasting with the development and availability of these tools (Cobon 2001 p.7).

Response to the question: Do you think that further extending the application of climate variability and forecasting for rainfall and streamflow would be useful? are presented in Table 11. Over 80% of participants in Indonesia in July 2002 agreed that it would be useful (from George 2002 p.37).

Table 11. Response to Q 19: Do you think that further extending the application of climate variability and forecasting for rainfall and streamflow would be useful?

Some Indonesia 2002 participants responses (from George 2002 p.37): • relevance with water resources management • Especially in planting time, irrigation and draining policy There was a demand for this information at regional and village level from the previous Indonesian workshops (Clewett 2000 p.159)
In Zimbabwe 96% of participants agreed that further extending the application of climate variability and forecasting for rainfall and streamflow would be useful (Cobon 2001 p.7)
Australian professional staff also saw the value of this work for possible collaborative future projects (George and Paull 2002 p.4-5)

5. DISCUSSION

A considerable amount of information was collected during the workshops and in the formal and informal evaluation process that was included. Although these numerous issues are very closely related, I have summarised the major findings into the areas I consider equally important, and I would like to discuss the findings of the results in the following categories:

Education

- Improvements in knowledge and skills
- Workshop process and content
- Future training opportunities identified by the skills audit

Technical areas of climate and agriculture

- Data and software
- Key decision points in the agriculture cycle where Seasonal Climate Forecasts may be useful

Process issues

- How to get important climate and agriculture information to farmers and key stakeholders in Indonesia?

Opportunities for future work

5.1 Education

Improvements in knowledge and skills

The workshops improved the knowledge and skills of participants. Although the workshops also increased awareness of climate and agricultural issues, the feedback provided by participants shows clearly that further training is needed before they can confidently, independently and proficiently use these technologies to train others or issue advice to decision makers and farmers (Tables 2-11). Building on the progress made with the existing participant pool to produce some climate extension 'champions' is most likely to have the greatest impacts in terms of potential capacity to train others and increase application of technologies on-farm.

These workshops have begun training in climate technologies for key personnel in major agricultural training and education organisations in Indonesia, India and Zimbabwe as well as Australia. The impact of this activity will escalate provided further training and resource materials are provided. Participants have indicated a willingness to show these climate technologies to others. For example, when asked the question about what actions they could do as a result of this workshop (Table 2), responses included extending research, modelling, teaching, and use in diverse areas like fisheries and forestry across broader areas of Indonesia and Australia.

Copies of Rainman were identified as being useful for continued application of this work (Table 5). It is believed that by not being able to release Rainman during the workshops, was a major barrier to achieving a more successful outcome from this work.

Will it Rain? was considered to be a valuable resource and teaching aid (Table 3) for local, regional and a national perspective. The books versatility in being in English and Bahasa Indonesian means it will be a valuable reference for lecturers and students in Indonesia.

Workshop process and content

The workshop process and content seemed to be satisfactory overall (Figures 1-2. Tables 7-11). Materials developed will be in the International version of Rainman which are expected to be published later this year – 2002 or early 2003.

Future training

A more comprehensive and advanced training program as identified by the skills audit would be ideal (Figures 1,2). In addition, a thorough educational curriculum and syllabus needs to be developed that is useful for secondary, tertiary and vocational students.

5.2 Technical areas of climate and agriculture

Data and software

Having monthly data for many stations was very useful, however the data sets could be improved (in Indonesia in particular) if a person was dedicated to that task. Longer records with patched data for the month and daily data sets would provide more information about climate variability and give greater confidence for forecasts. The limited streamflow data sets also raised a lot of interest with hydrologists and fisheries personnel (Table 8-11). The evidence to support resourcing this area of work is identified in Table 8, where potential for this work to assist farmers, business and government was highlighted.

At this stage, the availability of the resource materials we used in these workshops is limiting in Indonesia and Zimbabwe. For participants to use these packages they not only need further training, but access to the resource materials needs to be improved (see Tables 3-4). Feedback from the sessions included *..you won't master RAINMAN in one day and a half session, that comes with practice….*

Because we provide a probabilistic forecast it is important that extension officers and farmers in Indonesia understand what the forecasts mean. Our experience in Australia demonstrates that many of our clients misinterpret our forecasts and training is an important prerequisite for many advisers and farmers. The ability to show tables and graphs in Rainman, were seen by the participants to be very useful tools to help with training about probabilities in Indonesia.

Understanding probabilities is an important component in communicating the correct messages to farmers, however the avenues of communicating to farmers is a further challenge this project attempted in previous workshops (see Indonesia Trip Report with farmer workshops – July 2000 in Clewett 2000), but remains as substantial future work that requires strategic and tactical planning at local, regional and national levels.

Key decision points in the agriculture cycle where seasonal climate forecasts may be useful

A key use of this technology in Indonesia, India and Zimbabwe is to help decisions regarding type and variety of crop to plant and planting date (Tables 2,6,9,10,11). Analysis of daily rainfall data is needed to perform these forecasts and for best results the historical record should be around 80-100 years. Currently a major limitation is the low number of long-term daily data sets in Indonesia that have been quality checked and formatted for use in RAINMAN.

Onset date of the monsoon and crop variety selection:

One question discussed during the Indonesian workshops was-Are there a number of varieties of rice that could be planted in season 1, if we expect the season to be normal, wetter than normal or drier than normal? For example, this is an El Niño year, would farmers (and also agribusiness / extension officers recommend) consider planting a faster maturing rice variety because of a possible expected late start to the wet season and possible drier than normal season with less water available?

There are really two problems. One is the accuracy and belief in a forecast. The second is, what are the actual choices available for a farmer even if they do or don't believe in a forecast anyway.

Farmers in Indonesia are driven by 'habit', market price and availability is true (Dr Dewi *pers. comm*.). The point is, if farmers in the market place had more power to select what would be a more suitable variety for a location and a season, then that choice would perhaps be an advantage for farmers that would minimise their risk (of a potential failed crop or reduced yield due to reduced variety selection) and help in terms of making better decisions with the variable climate.

The other point to remember I suppose is the cycle of poverty that many farmers may well be locked into. I think many farmers are living on what could well be described as borderline poverty with poor education and a 'hand to mouth' existence. Their rice plants are grown from the seed they harvested in the previous season. Unless there had been a major problem in the previous season and a seed shortfall occurred, they would not even consider buying seed of different varieties, but rather use seed from their own storage. If this is true for most of the area we had contact with, then this is a research area that could be developed - that is; Given the variable climate and forecast, does selection of more suitable rice varieties yield better returns? If we are certain that answer is yes, then the next (two - maybe more...) problems are:

(a) how to get that result adopted by farmers? (and that becomes an extension / socialisation challenge or opportunity), and;
(b) how do farmers have increased choice in their seed / variety selection given the variable climate, and also given the fact that (i) the marketplace may offer very little (appropriate) choice and/ or (ii) the socio-economic status of farmers means most farmers are unable to have choice even if it was available (that is they do not have the cash to buy seed of more varieties - or even change the ratio of the varieties they may normally plant, that may well be more suited to the current forecast)?.

Water use efficiency for farms, and irrigation scheduling and water releases by Irrigation agencies are other areas identified where seasonal climate forecasts may be useful. Forestry decisions on planting and watering activities were also highlighted (Tables 2, 6, 8-11).

5.3 Process issues

How to get important climate and agriculture information to farmers and key stakeholders in Indonesia?

As stated previously, building on the progress made with the existing participant pool to produce some climate extension 'champions' is most likely to have the greatest impacts in terms of potential capacity to train others and increase application of technologies on-farm. This will require resourcing and support.

5.4 Opportunities for future work

Some possible areas for future work in Indonesia for Sumatra, Kalimantan (which could also be relevant to targeted research in other parts of Zimbabwe, India and Australia) and other areas are:

- Given the variable climate and forecast, does selection of more suitable rice varieties yield better returns? Research and extension activity.
- Climate variability impacts on forestry. Research and extension activity.
- Climate variability impacts on aquaculture. Research and extension activity.
- Climate variability impacts on farm pests and diseases. Research and extension activity.
- Climate forecasting and agriculture applications (including streamflow and irrigation) in different regions of Indonesia. Research and extension activity.

There is a potential for continued development of an educational program for climate and agriculture. This could be supported by continued research and extension activities.

6. CONCLUSION

Climate variability creates enormous problems with agricultural production and in natural resource management. A better understanding of this variable climate and what drives these systems plus the use of seasonal climate forecasting can help to improve this situation. Professional development training has shown the major benefits of this work to be:

- ***Improved knowledge and skills to better cope with the variable climate***. Participants have demonstrated a better knowledge of ENSO and climate variability. Enhanced resources have been developed for teaching others about climate variability and impacts of ENSO through the Rainman International software, books like *Will it Rain?* and the workshop material.
- ***Enhanced decisions*** by applying information on climate variability and seasonal climate forecasts. This is particularly useful for helping in planting decisions like when to plant, what crop to plant and what ratio of crops to plant. It is also evident in predicting water availability for irrigation.
- ***Reducing climate risk exposure.*** By using Rainman International, participants are able to see what is the extent and severity of areas affected by ENSO at local and regional scales and over what period of time this impact extends. This

more accurate information of the impacts of ENSO, can be used to reduce climate risk exposure in business, agriculture and resource management. The Rainman software and resource books of *Will it Rain?,* and the workshop material can make positive contributions to reducing climate risk exposure.

Improvements in the communication component of this research project could be enhanced by a greater number of workshops with more key people in strategic locations. This methodology to improve knowledge and skills has made some positive contributions to the countries involved. This same methodology could be emulated on a larger scale if similar results are desired. QCCA could continue to contribute to ongoing learning's to capture the benefits of seasonal climate forecasts in agricultural management. These results are preliminary and to assess the impacts of this work, there would be a need for a follow-up evaluation to measure post workshop 'end result' and 'practice change'.

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