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ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC
UNITED STATES NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
and
USAID OFFICE OF FOREIGN DISASTER ASSISTANCE

Seminar on Agro-climatic Models for the Assessment of Drought-related Food Shortages in South and South-East Asia
24-27 January 1984
Bangkok

REPORT OF THE SEMINAR

This document has been issued without formal editing.

ORGANIZATION OF THE MEETING

1. The ESCAP/NOAA/USAID Seminar on Agro-climatic Models for the Assessment of Drought-related Food Shortages in South and South-East Asia was held at Bangkok from 24 to 27 January 1984.

Attendance and Opening Statements

2. The Seminar was attended by 28 representatives of the following member countries of ESCAP: Bangladesh, India, Indonesia, Nepal, Malaysia, Pakistan, Philippines, Sri Lanka and Thailand. Observers attended from the ASEAN Agricultural Development Planning Centre, Bangkok, the Asian Regional Remote Sensing Training Centre of the Asian Institute of Technology, Bangkok, and the Remote Sensing Division of the National Research Council, Bangkok. The World Food Programme and the World Meteorological Organization also attended as observers.

3. The Seminar was opened by the Executive Secretary of ESCAP, who indicated that the Seminar marked a begining of a new technical assistance programme aimed to improve food security through enhancing capabilities for assessing drought-related food shortages. He welcomed the association of the USAID Office of Foreign Disaster Assistance and the United States National Oceanic and Atmospheric Administration in this joint venture.

4. The Executive Secretary noted that drought is particularly serious in the South Asian countries where drought affects four times the area affected by floods, posing a major limitation for agriculture. Attention was focused on the savage Australian drought of 1982 which was reflected across the region culminating in a debilitating 8 per cent fall in overall food grain production, excluding China. Because of the dominance of the role of the agricultural sector in many Asian countries, these shortfalls tend to produce strong impacts on the economic growth performance of the affected countries. Although average gains in food production have slightly exceeded population growth for the past decade, three major tasks still lie before the member countries of ESCAP. These were the alleviation of widespread malnutrition, the reduction of mounting cereal imports for the region, and the decrease of dependence on rain-fed farming. It was noted that the preponderance of rain-fed cultivation will remain with us for many years to come due to the lack of land with suitable terrene for irrigation development.

5. In this context, reliable advanced drought impact assessment could enable policy planners and other decision-makers to take effective and timely corrective action to minimize drought-related food shortages. NOAA's pioneering role in the development of these technologies was recognized as a major step in building such capability in receptive member countries. Stress was laid on the fact that these assessment techniques relied on data already at the disposal of most governments and that the system had been tested thoroughly and proven to be timely, reliable and cost effective.

6. ESCAP's commitment and involvement in the pursuit of food security was described. ESCAP was concerned to play a positive catalytic role in promoting regional food security as a concrete activity to mitigate the problems of hunger and malnutrition.

7. In closing, the Executive Secretary expressed the hope that full advantage would be taken of this opportunity to acquire capabilities offered by the new programme on drought impact assessment.

8. Dr. John H. McElroy, Assistant Administrator for National Environmental Satellite, Data and Information Service (NESDIS) of the U.S. National Oceanic and Atmospheric Administration (NOAA), expressed pleasure at his opportunity to participate in the Seminar and in the introduction of climate impact methodologies to the ESCAP region. He stated that the Seminar was designed to help improve food security programmes and socio-economic decision-making by integrating the NOAA/NESDIS climate impact assessment methodology into established USAID drought/disaster early warning programmes.

9. The Seminar was informed that the methodology was a proven information management system designed to assist decision-makers in their policy formulation process, not through the prediction of weather conditions but through the projection of agricultural, eocnomic and social impacts arising as a result of current and measurable meteorological conditions. The methodology was to be presented for the considered evaluation of participating countries. Its successful adoption would help pave the way towards operational national programmes in the near future.

10. It was stressed that the attractiveness of the assessment methodology was both its possibilities for immediate enhancement of national and regional food and economic security, and its potential for the expansion of its

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applications by the introduction of new tools such as remote sensing satellite data. In this context, the capabilities of current civil remote sensing satellite systems operated by several nations and regional organizations were reviewed. The mutually beneficial interdependence achieved through international cooperation in satellite data collection and applications was highlighted. The attendance of the distinguished delegates, all accomplished and recognized in their respective fields, insured the success of the Seminar and would help catalyze the evolution of dynamic climate impact assessment system programmes for use in the nations of South and Southeast Asia.

11. Mr. Paul F. Krumpe, Programme Officer and Science Adviser of the United States Office of U.S. Foreign Disaster Assistance, Agency for International Development stated that he wished on behalf of his Director to welcome each participating country to the Seminar. The Seminar was a major milestone in the ESCAP/NOAA/USAID commitment to transfer an appropriate technology to South and Southeast Asia. The technology was believed to advance national food security planning, and leads to the mitigation of the impacts of disasterous weather/climate conditions on food production. It was noted that disaster assistance to developing countries to alleviate the impacts of disasters and increase their capability to deal effectively with disaster-causing events must be viewed as part of the development process and not simply as a humanitarian relief response to isolated events. The active participation of the delegations was welcomed in planning a regional strategy to implement operational, co-operative, and co-ordinated weather impact assessment activities for national and regional food shortages and disaster preparedness planning.

Election of officers

12. Mr. B.S. Sarao (India) and Dr. Jesus C. Alix (Philippines) were respectively elected as Chairman and Vice Chairman of the Seminar. Mr. S.M. Hasanuzzaman (Bangladesh) was elected as Rapporteur.

Agenda

13. The Agenda of the Seminar was as follows:

1. Opening of the Seminar
2. Election of officers

3. Presentation of Seminar goals

4. Discussion on how drought assessments improve disaster management and food security programmes

5. Discussion of the NOAA programme

6. Discussion of the assessment model and its utility

7. Country presentations on experiences with agro-climatic assessment models

8. Discussion on new applications of drought impact assessment programmes

9. Presentation and discussion of the technical assistance programme for agro-climatic impact assessment for 1984

10. Adoption of the Seminar report

II. OBJECTIVES OF THE SEMINAR

Dr. John H. McElroy, Assistant Administrator for National Environmental Satellite, Data and Information Service (NESDIS) of the U.S. National Oceanic and Atmospheric Administration (NOAA), reviewed the development and objectives of the Seminar, stating that its ultimate goal was to enhance existing USAID drought/disaster early warning and preparedness programmes by making available to South and Southeast Asian countries operationally proven agro-climatic modelling and impact assessment technology developed and verified by NOAA/NESDIS. The evolution of this goal has proceeded in four programatic phases, first beginning with the successful development of a simple climatic impact assessment methodology (1979-1982). This system was based on crop index models and operational rainfall data, providing timely, reliable, yet inexpensive assessments of major crop losses and potential food shortage conditions due to drought by about 30 days before crop harvesting begins. Verification studies have shown that such assessments can represent a three to six month lead time in which to develop disaster mitigation strategies.

During phase II of programme development -- ranging in time between June 1982 and April 1983 -- the climatic impact assessment technology was first made available to countries in the ASEAN region. NOAA/NESDIS conducted several six-week agro-climatic orientation training programmes in late 1982. These were followed by the "ASEAN Workshop on Climatic Impact Assessment for

/Agriculture.

Agriculture: Applications and Methods" in April 1983 (conducted in Bangkok for AID by NOAA/NESDIS and the University of Missouri). Director-Generals and programme scientists from the meteorological services and the ministries of agriculture of ASEAN who attended the 1983 workshop endorsed the need for assessment technologies in their countries; agreed to begin test assessments during the 1983 crop season; requested technical assistance; and recommended that follow-up activities include the active participation of drought/food security managers so as to facilitate assessment technology implementation and the establishment of routine, interagency co-ordination.

In phase III, extending to the date of the present Seminar, NOAA/NESDIS and USAID continued implementation activities in the participating ASEAN countries, expanded the availability of the methodology to the South Asian region, and culminated these activities with the gathering of delegates and observers from nine ESCAP member countries at this Seminar. In May 1983, ESCAP introduced the assessment technology to government policy makers attending the UN/FAO Workshop on National Preparedness for Acute, Large-Scale Food Shortages in Asia and the Pacific (Bangkok). Indonesia, the Philippines and Thailand began testing regional drought and agro-climatic/crop condition assessments during June-October 1983. In September and October of 1983 NOAA/NESDIS conducted a one-day special workshop for government officials and representatives of oil palm and rubber industries in Malaysia. Finally, NOAA/NESDIS and the University of Missouri provided technical assistance on assessment preparation, computer software development, and case study analysis for the present Seminar.

Phase IV will be accomplished during 1984. Phase IV will focus on the implementation by participating countries of assessment programmes, based on formal individual country plans developed at the January 1984 Seminar, as well as technical assistance in the form of training, equipment, international programme coordination, and individual technical assistance missions. Phase IV will conclude with a follow-on evaluation seminar, scheduled for January 1985, where senior policymakers will report on the results of assessment methodology application.

Dr. McElroy briefly illustrated currently available remote sensing satellite data products, notably Vegetation Index imagery derived from NOAA's polar orbiting environmental satellite and Coastal Zone Color Scanner imagery

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produced from NASA's NIMBUS satellite. New applications of these satellite data relevant to impact assessment are being investigated, and the production of this information is nearing an operational stage within NOAA/NESDIS. Future use of these satellite data, through integration into the assessment methodology, will be within the capability of participating countries, and should be considered as an example of the methodology's ability to expand in utility and importance.

III. DEVELOPMENT OF AGRO-CLIMATIC ASSESSMENT TECHNOLOGY FOR FOOD SECURITY PLANNING

The NOAA/NESDIS and AID/OFDA Programme for Disaster Early Warning and Technical Assistance on the Developing World was presented to the Seminar by the NOAA/NESDIS team of experts on the subject which was composed of Ms. Margaret E. Courain, Deputy Assistant Administrator for Information Services, Dr. Joan C. Hock, Director, Assessment and Information Services Centre (AISC), Mr. Russell A. Ambroziak, Chief, Climatic Impact Assessment Division, AISC and Dr. Louis T. Steyaert, Programme Manager, AISC, Mr. Paul E. Krumpe, Programme Officer and Science Adviser, the AID Office of U.S. Foreign Disaster Assistance, also described the role of AID/OFDA and its commitment to drought disaster early warning preparedness in the region. The following is a summary of these presentations.

Global Monitoring Systems in Support of United States International Disaster Assistance

The Seminar was provided by Mr. Paul F. Krumpe, USAID/OFDA with an overview of the United States international disaster assistance programme and the application of new technologies for disaster monitoring, preparedness and early warning by the Office of U.S. Foreign Disaster Assistance (OFDA) of the Agency for International Development (AID). Since 1977 OFDA has actively pursued new satellite-based and related technologies for global surveillance of disaster-causing natural phenomena. OFDA has long recognized the need to seek out incipient and potential disaster situations rather than waiting, as had traditionally been the case, to react to disasters after they occurred.

State-of-the-art disaster early warning technology currently available and suitable for operational implementation worldwide remains relatively new to many scientists and decision-makers in the Third World.

/Technical

Technical personnel in the developing countries are often fully capable to understand and utilize results and data obtained from relatively sophisticated environmental monitoring systems. OFDA expects to make a significant contribution toward mitigating disasters and saving lives in the 1980s through the transfer of prevention and early warning technology.

OFDA's disaster monitoring and early warning activities represent a major contribution toward effectively reducing the impact of foreign disasters. In advancing U.S. technologies in the developing countries, OFDA has significantly increased the warning lead-time prior to the occurrence of disasters, thereby stimulating disaster-prone country officials to mitigate, prevent or otherwise avoid the severe consequences of natural events. Hazards-threat definition and event detection combined with delineation of vulnerability and risk, form the basis for both early warning and responsible avoidance actions.

How Drought/Early Warning Assessment Improve Disaster Management and Food Security

The Seminar was informed by Margaret E. Courain, NOAA/NESDIS, on how disaster managers and other government officials can use operational weather information to forecast drought caused food shortages, increase disaster preparedness and improve national food security. This can be accomplished by using daily weather reports and existing historical climatic data to develop, implement and operate a National Drought Early Warning Program. This management information system will provide decision makers with timely, reliable, yet inexpensive assessments of weather impacts on the agricultural sector including food crops. The system will detect drought and assess drought caused crop production losses by as much as 30 to 60 days before harvesting begins. This usually represents a 3 to 6 month early warning before food security becomes strained due to potential food shortages. Food security managers can use this early warning capability to improve drought disaster preparedness plans. The assessment information and food shortage forecast lead-time can also be used to develop strategies which will help mitigate or even avert potential socio-economic losses due to drought.

Unlike typhoons and earthquakes, drought is a "creeping" natural disaster: the economic and social impacts may not occur until much later. For example, undetected drought which causes large-scale crop failure can lead to unstable markets, increased prices, economic losses and in extreme cases disastrous food shortages, famine and resultant political problems.

/Drought

Drought compounds other problems in national economies which sometimes in the 1980's have suffered mounting external debt, large trade imbalances and slow growth records. It has become increasingly recognized that natural disasters such as drought slow down economic development, e.g., long-term plans leading to food self-sufficiency.

Although these characteristics paint a somewhat bleak picture about drought impacts, this is not to suggest that food security is not improving and that vulnerability to food shortages is not decreasing. Significant gains have been made in recent years. For example, "Green Revolution" technology, particularly expanded irrigation and introduction of new varieties, has improved food security in South and Southeast Asia. Also, countries have established large food stock and reserve programmes.

A National Drought Early Warning System identifies drought, problems, determines the regional extent and magnitude of potential drought impacts and provides an early warning alert. This enables the disaster manager to develop strategies and take actions to mitigate potential impacts such as food shortages which lead to malnutrition, starvation, population migration and other socio-economic disruptions. A National Drought Early Warning System can reliably do the following:

1. Continuously monitor, assess and report weather impacts on the agricultural sector; this identifies potential weather-related problems.

2. Assess significant crop production losses due to drought by about 30-60 days before crop harvesting begins; this represents a 3-6 month early warning prediction of severe economic losses and/or potential food shortage conditions.

3. Provide indications at harvest of potential "bumper" crops due to favorable growing season weather; this helps determine import/export requirements.

4. Track and report weather impacts in areas where ongoing disaster relief operations are in effect.

The methodology of the drought early warning programme is simple and it is based on existing data and technology. The meteorologist begins by processing historic data so that current weather can be put into perspective.

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The result is a routine, inexpensive assessment that gives qualitative impacts of weather on crop yields. Because weather is not the only controlling factor of production, the meteorologist can take the report no further. It is then up to the agricultural statistician to turn this qualitative climate impact report into a quantitative agricultural production estimate. Area planted, yield, fertilizer applications, pests, disease, etc. are data collected and analyzed by the statistician. It is the combination of these data with the climate assessment that leads to the crop production estimate. The economist must evaluate the economic implications of this estimate and produce policy recommendations.

To be effective, disaster food assistance must be made available to the potential victim before food shortages occurs. An early warning system can help answer important questions such as, can the potential food shortage problem be improved by moving food within the country from food surplus to deficit areas or does the food have to be imported. Assessments of current crop conditions can be used to determine if expected food production coupled with existing food reserves are adequate. Information on expected production surpluses can help determine how to relocate and distribute existing stocks. If food must be imported to meet expected needs, the system provides information on import requirements and a sufficient lead-time to plan purchases and shipment of food in a cost-effective way. Early warning information can be used to penetrate international markets on more favorable economic terms, thereby conserving scarce foreign exchange. This lead-time also improves the development of plans to distribute food (e.g., procurement, transportation and handling).

Economists can use the early warning assessment to adjust economic policy involving marketing strategy, price supports, producer incentives, etc. They can anticipate market instability and large commodity price swings leading to sharp increases in the price of domestic foods. For example, urban and rural populations are vulnerable to price instability, particularly in rural areas where purchasing power is quite low. The government can also use the assessments to determine how weather may be affecting food crop procurements or reduced farmer incentives.

A National Drought Early Warning Assessment System also helps the government maintain public confidence in the government's ability to correctly

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define the problem and develop appropriate measures to relieve the severity of the food shortage condition. This reduces the potential for rumors, panic, hoarding, speculative buying and political problems.

A drought early warning system based on climatic impact assessment technology is not just agro-climatic data and models. It is also people who can interpret the data and models and then prepare concise, clearly written impact assessments which are understandable and useful for the manager. The people, or assessors, represent several disciplines, e.g., meteorology, statistics and economics. Disaster managers and policy-makers can use the system as a "Stand-alone" technology; however, it works best when assessments are used to complement and supplement analysis from other information sources. These may include agricultural production surveys (crop cutting, objective area and yield measurements, field reports, etc.), food price monitoring systems, or nutritional surveys.

The Role of NOAA/NESDIS Assessment and Information Services Center

The Seminar was informed by Dr. Joan C. Hock, Director, NOAA/NESDIS Assessment and Information Services Centre (AISC) about the types of studies performed in the Center. It was stated that both economists and meteorologists agree that weather does impact the economy, but the fundamental questions that remain are by how much, when, the costs and what to do about such impacts. It was noted that the mission of AISC is to quantify the impact of weather and give an early warning to policymakers for planning. AISC case studies were used to illustrate the message that linking meteorological data and economic models will allow each country to develop a similar capability and help policymakers answer important questions.

The required resources are minimal--an economist, a meteorologist, and limited computer technology. It was stated that AISC has all of these resources and then the Center's early work in this area was outlined. The 1980 drought and current activities concerning El Nino were used to illustrate the need for an economic assessment capability. Specifically, that industry and the public need to know the impact of weather as soon as possible to reduce costs of operation and minimize hardships.

For example in 1980, the press and the public needed to know the impact of the summer heat wave and drought in the United States. The principal

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questions were: How much would consumers have to pay for food if corn and soybean production was reduced 20 per cent and how much more would they have to pay for energy with temperatures much above normal?

During the summer of 1980 AISC only had a retrospective or historical assessment capability. Using reports and government statistics, the Center's staff summarized the impact of the 1980 drought 2 months after the event. The results, subsequently verified more than 6 months later, showed that the drought cost the economy $US 18 billion. Eighty-five per cent of the impact occurred in the agricultural sector while energy was the second major sector impacted by the drought.

The Center is now able to give estimates of impact in some areas like energy 30-60 days before the event. In the tropics, AISC is able to get an early picture of weather impacts 30-90 days before price increases and 3-6 months prior to actual food shortage conditions.

Many ask, how can assessments be made with limited weather forecasting capabilities and are such forecasts really accurate enough to provide the basis for economic projections? To these questions it was noted that such forecasts are not required in assessment work. However, when reliable forecasts become routinely available, one would still need impact assessments to interpret them.

In contrast to climate forecasting, the usefulness of diagnostic studies was outlined. An example of this can be seen in NOAA's El Nino analysis for 1982-1983. In this instance, the National Weather Service of NOAA detected the first signs of an El Nino in the southern Pacific where sea surface temperatures were abnormally high. Following this rise in sea surface temperatures, anomalous weather was reported in South America (e.g., Ecuador and Peru), the Caribbean, Southern Africa and in South and Southeast Asia (e.g., the Philippines and Indonesia).

Policy makers wanted to know what the economic impact of this event was at home and abroad. To answer this question, the U.S. National Weather Service designated areas that scientists felt were impacted by the El Nino. Second, AISC tracked the impact of drought conditions using meteorological and weather satellite data. This allowed AISC to assess impacts on crops and economic activities. Third, AISC used precipitation data and compared current conditions with historic climatologies for selected regions. This

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provided information for an index of crop stress in selected countries. Fourth, AISC compared normal yield and normal precipitation to the perturbed case due to El Nino impacts. Bar charts and computer graphics allowed the Center to depict the severity of the drought to policy-makers. AISC's early results were then compared to regional press coverage and embassy reports. Fifth, the results were tabulated and a joint National Weather Service and NESDIS/AISC press release was issued. Information was simultaneously provided to the Department of State, Department of Agriculture, and the public.

To illustrate lead-times for this type of assessment, AISC's results were issued approximately 6 months before major financial institutions (the International Monetary Fund and the World Bank) requested briefings on the economic impact of El Nino. Such information was needed by loan officers receiving loan applications from countries affected by the El Nino.

Internationally, the technology transfer programme is an attempt to repeat the simple lessons learned while developing the U.S. Assessment and operating the Drought/Food Shortage Early Warning Programme for USAID. The programme has expanded to include economic assessments by many countries in the tropics. The drought early warning capability and the reliable lead times on price changes and other economic factors has demonstrated application in the developing world. As a consequence, some countries (e.g. Peru and Ecuador) have developed major projects with USAID to use the impact assessment technology to improve food security.

In summary, it was stated that the resource commitment is small: an economist, a meteorologist, and a small expenditure for computer time and training. It was suggested that such a programme will generate its own market and provide government agencies with visibility in decision-making and a role in the national policy-making process.

THE NOAA/NESDIS/AISC AND AID/OFDA PROGRAMME FOR DISASTER EARLY WARNING AND TECHNICAL ASSISTANCE IN THE DEVELOPING WORLD

The Seminar was informed by Dr. Joan C. Hock, Director, AISC and Dr. Louis T. Steyaert, Programme Manager, AISC, about the NOAA/NESDIS/AISC and AID/OFDA Disaster Early Warning and Technical Assistance Programmes in the developing world. It was noted that the NOAA/NESDIS Assessment and Information Services Center (AISC) had developed a reliable and cost-effective

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programme to support disaster early warning and technical assistance objectives of the Agency for International Development, Office of U.S. Foreign Disaster Assistance (USAID/OFDA). AISC's operational climatic impact assessments provide disaster managers in USAID and American Embassies with continuous information on weather/crop conditions and in particular a 3-6 month alert on drought caused food shortages in the developing world. Recent verification on "ground-truth" data demonstrated that the system accurately assessed major droughts in the last four years within 72 operationally assessed countries. The result is a cost-effective increase in the lead time for planning of disaster relief operations, food assistance strategies and mitigation measures to reduce the adverse impact of climate. Because the assessments have been successful, AISC has been asked by USAID to help developing countries use weather information in a similar way. AISC and USAID/OFDA are now working to improve disaster preparedness programmes in 26 countries. Operational drought impact assessments are being implemented by a combination of U.S. based short-term training, workshops for interagency decision makers and seminars for senior policymakers involved with food security management. As a side benefit, a very strong positive feedback between AISC's operational assessments and the technical Assistance programme has been created.

AISC began issuing biweekly assessments of climatic impact on the food security of developing countries in the Caribbean Basin, Africa, South and Southeast Asia during 1979. More recently the programme was expanded to Central America and the Andes countries of South America. The AISC assessment cables are provided to American Embassies, USAID Missions, USAID/OFDA, USAID/Food for Peace, Peace Corps, USDA, UN/FAO, UN/Disaster Relief Organization, WMO and others through NOAA communication facilities.

In addition, AISC prepares special assessment reports for USAID (OFDA, Food for Peace, etc.), e.g., the 1981/82 drought impact in Bangladesh, Sri Lanka, Malaysia, Tanzania, Botswana and more recently the 1982/1983 drought problems in Nepal, Philippines, Ethiopia, Somalia, Uganda, Sudan, the Sahel countries, Southern Africa, South Pacific, Haiti, Northeast Brazil and others. These reports were used to estimate the magnitude of drought impact, potential for shortage deficits or disaster assistance needs.

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The Disaster Early Warning Programme is based on weekly rainfall/weather analysis and climatic impact assessment models for more than 350 agroclimatic regions. Regional rainfall estimates are determined from ground station reports received through the WMO's communications network. Satellite cloud data are used to improve the accuracy of precipitation estimates, particularly in those regions where weather data are sparse and unreliable. Weather data are then interpreted by regional agroclimatic indices which indicate potential crop production in relative terms. Finally, climatic impact and the potential for abnormal food shortages are identified from these indices.

Agroclimatic/crop condition indices are based on derived climatic variables (e.g., soil moisture, plant water deficit, moisture stress, etc.) which directly determine the plant's reponse to environmental conditions, hence productivity. The selection of the regionally appropriate indices is in part determined through the use of episodic data. For example, candidate indices are qualitatively compared to the historic occurrences of crop failure, food shortages, drought, flooding and other anomalous weather/non-weather events as determined from reports, newspapers and computerized data bases. Episodic data are also used to "calibrate" the index by establishing a critical threshold which is associated with crop failure and/or drought-related food shortages.

The success the programme has enjoyed so far has led to an active dialogue between AISC and the U.S. Missions. This feedback has helped tailor products, guide development and identify host-country data sets that were not previously known. This has become a most valuable tool in continuing AISC support to AID Missions.

Documented food shortages determined by in-country field inspections and reported by the UN/FAO and American Embassies during 1979-1983 (Africa, South and Southeast Asia and the Caribbean Basin) confirmed that AISC assessments consistently provide a 3-6 month alert on potential food shortage situations. Typically, the initial AISC assessment on drought/food shortage conditions was issued 30-60 days before the beginning of the crop harvest. Actual indications of food shortage conditions were not evident until 2-4 months after harvest.

AISC has also been working with AID to assist development countries use weather information for policymaking and economic analysis. The focus has been on implementing operational drought impact assessments to improve disaster early warning and preparedness programmes. To date, AISC and the University of Missouri have programmes in Latin America, Southeast Asia and Africa. The technology transfer is accomplished by conducting technical training courses, sponsoring workshops and seminars for managers and providing in-country technical assistance, e.g., test assessment programmes.

AISC is seeking to improve disaster preparedness and early warning programmes by simultaneously expanding and upgrading the current climatic impact assessment programme and increasing the technical assistance to the developing world in support of AID agriculture and rural development objectives.

Agroclimatic/potential food shortage assessments will be developed for drought-prone countries of Equatorial West Africa, the Middle East, the South Pacific, Mexico and South America (NE Brazil, Paraguay and Urugay). This will complete the model development phase of AISC's work for AID/OFDA.

The timeliness, reliability and quantification of AISC assessments will be upgraded by introducing meteorological satellite technology, global climatic analysis and economic modeling applications. Automated processing of daily satellite data will be used for: (1) improving the assessment of daily rainfall, particularly in remote data sparse regions or at locations with unreliable and incomplete rainfall reporting and (2) monitoring crop conditions for evidence of moisture stress and standing water reserves potentially available for irrigation (applications being developed primarily through AISC/UMC AGRISTARS staff support). A second type of independent drought/potential food shortage index will be developed from ongoing AISC climatic research programmes on tropical circulation patterns and their association with drought. Econoclimatic models will be developed for semi-arid regions in the Sahel, Eastern Africa and Southeast Asia. These can be used to provide USAID Missions with recommended management strategies for the potential mitigation of ongoing climatic impact.

In summary it was noted that climatic impact assessment technology developed by the NOAA/NESDIS Assessment and Information Services Center and the Agency for International Development is contributing to improved drought/disaster early warning programmes in the developing world. This can lead to increased food security and agricultural economic stability.

/CLIMATIC

CLIMATIC IMPACT ASSESSMENTS

The Seminar was informed about climatic impact assessments by the NOAA/AISC Early Warning Programme Manager, Dr. Louis T. Steyaert. It was stated that climatic impact assessment technology represents a management information system to support economic decision making. The impact of weather and climate on various economic sectors could be systematically reported. For example, simple agro-climatic/crop index models, mainly based on historical and operational rainfall data, can be used to assess impacts on agriculture. In this context, the technology helps to define weather problems and quantify their impacts in economic terms. These economic forecasts allows for mitigation of problems and improves food security.

It is useful to define assessments in terms of "what they are" versus "what they are not". Assessments are based on observed weather data and are in no way dependent on weather forecasts or climatic prediction. Because assessments provided to decision makers must be reliable to ensure credibility, simple models are preferred to complex models which produce erratic results. A model must have a good "track record" before it is used in operational assessments. Specifically, it was suggested that agro-climatic/crop index models based on simple cumulative rainfall over the crop season are vastly superior to most statistical/climate crop yield models based on linear correlation and regression analysis. Participants were encouraged to thoroughly test regression models before operational use. Agro-climatic assessments work best for rain-fed agriculture. Drought is much more reliably assessed than flooding.

The impact assessment report usually has at least four statements: impact, perspective, model output and weather analysis. The impact statement defines the weather-related problem in economic, not meteorological terms. Qualitative impacts could be statements such as "delayed planting", "reduced yields", "well below normal yields", "corp failure" and "potential food shortages". In contrast, examples of quantitative impact statements include "yield will be down by 40 per cent", "forecast yield is 3 metric tons/hectare", or "the potential food deficit is 50,000 metric tons". The perspective statement informs decision-makers on "how large is the problem". For example, is the problem regional or national, i.e., is the problem a major national problem, the worst case on record or just a minor problem. The model output statement provides the results of the agro-climatic model (e.g., the maize index is at the tenth percentile). Finally, the weather analysis statement describes the weather events that caused the impact (i.e., July and August rainfall was only 40 per cent of normal).

/Assessments

Assessments can be made on a weekly, ten day (decadal) or monthly basis. Sometimes the type of historical data base determines the frequency of the assessment report. Because historical data must be used to make good assessments, monthly assessments using readily available monthly rainfall data bases are preferred to weekly or decadal assessment periods if adequate historical data are not available.

The NOAA/NESDIS Drought Impact Early Warning Programme for the tropics is largely based on monthly rainfall data. In fact, rainfall is the primary meteorological element which determines year-to-year variations in yield. This is true because the variance of monthly and seasonal rainfall is 500-1,000 times larger than the variance of other meteorological elements. It was noted that all meteorological elements combine to determine potential yield due to the local climate.

In South and Southeast Asia, NOAA uses two types of agro-climatic/crop condition indices. Both indices require 20-30 years of historical, monthly rainfall data which are used to interpret current index values in terms of past values. The first is a monsoon index, usually June-September for the southwest monsoon and October-January for the northeast monsoon in the northern latitudes with adjustments for Indonesia. The second index is for specific crops and is calculated according to crop calendars and crop water requirements. Both indices described in NOAA/AISC technical reports, were discussed at the Seminar.

It was noted that a climatic impact assessment programme represents a management information system. It helps managers monitor activities, measure performance, identify problems, develop strategies and make decisions. The assessment process in this context is multi-disciplinary and inter-agency. Organizationally, it involves technical staff, mid-level managers and high-level policy makers. It was suggested that there are at least two organizational approaches for implementing operational assessment programmes. The first approach involves forming a joint institute involving meteorology and agriculture. Although this approach can be very effective, it may not be appropriate due to management considerations and inter-agency questions. In the second and easier approach a determination is made of the involved agencies and their roles are defined. Activities are coordinated through a regular system of monthly reports. Specifically, agencies communicate by regular assessment reports which reflect the agencies mission and respect the mission of other agencies.

/Successful

Successful programmes have some common characteristics. First, they produce good results without a lot of delay. Generally these programmes are based on simple models that work. It certainly helps if the programme is inexpensive to develop and operate. Decision-makers must be involved and user needs clearly determined. Finally, it is always necessary to thoroughly test a programme before it is made operational.

NEW APPLICATIONS AND OPPORTUNITIES

The Seminar was informed about new applications and opportunities by Mr. Russel A. Ambroziak, Chief, Climatic Impact Assessment Division, NOAA/NESDIS/AISC. It was noted that before any improvements can be made to a climatic impact assessment programme there must be a programme in existence. After establishing the programme there were two ways to improve it, both of which could by pursued simultaneously. Product improvement and expansion was the logical first step and it was this process which guided technological improvements, the second avenue for programme improvement.

Improving products means expanding the assessment to answer more questions. Crop production forecasts can be produced from index and analyses. Subsequently, the technology can be expanded to include crop weather advisories for farmers and eventually land use studies based in part on climate can increase farm income.

To make these product improvements there must be improvements in technology. Many of these advances are available now with more being done every day. Crop models, micro-computers, and satellite imagery are three areas in which technology exists now.

Crop models can provide more tailored information than indexes, but they require more resources to build and operate. They come in basic varieties. The regression models, which require good historical yield data, and are fairly expensive to run, are the most common. The plant process/physiologic models represent the "state of the art"; they are still under development and are extremely expensive to use.

To develop and test good statistical regression models, it is useful to have computer software which helps choose the climate parameters to use as predictors. Furthermore, monthly climatic data are not only autocorrelated, they are usually enough to over-specify any relationship. To illustrate, monthly temperature and rainfall data for the 12 months up to harvest represent 24 variables which can use all degress of freedom in

/a 25-year

a 25-year data set. Moreover, temperature and rainfall are usually very negatively correlated to each other, producing autocorrelation problems in computing and interpreting the equations. One simple solution to all of these hazards is to use a correlation coefficient triangle which shows the correlation between any continuous grouping of months for a climate parameter and crop yield or production. This triangle also serves to screen for bad data and to evaluate crop calendars.

Plant process models are being designed to mathematically duplicate the plant's growth and development. The process is far too complex for complete specification and some degree of parameterization is necessary. These models require at least daily data to operate and some need hourly data. Complete synoptic observations plus other parameters are usually required such as net radiation, soil moisture, etc.

The major operational use of plant process models is currently phenology forecasting, which they do quite well. Knowing the stage of a plant is key to determining the impact of the climate on the plant. Combining the stage of growth with currently available climatic data can greatly increase assessment accuracy.

Although yield and production estimates are not operationally possible from these physiological models, they do offer a framework for learning about climate crop interactions. If resources are available to operate a plant process model, it is certainly a worthwhile venture.

Micro-computers are rapidly becoming more portable and more powerful. Currently, the Apple II plus is being used as the heart of a portable climate impact assessment programme. Some software is already available with documentation and user manuals. Other software is being developed and existing software is being improved. Within three years AISC hopes to transfer software to an even more portable, battery-powered, briefcase computer with as much (or more) computational power as the Apple II Plus.

Most drought indexes and regression crop models require relatively small data based and a microcomputer is more than large enough to do the job. Scientists, with the help of these computers, can build models, run them, and help in the analysis. Data base management problems are easily handled on a microcomputer as well as other project administrative chores. If all members of a project are using compatible hardware, diskettes can be exchanged to greatly improve communication.

/The

The most technically difficult problem, satellite applications, is now nearing solution. Many countries already have receiving and processing equipment that could be used for this task. The advantage of satellite data is that it covers large regions frequently with uniform data. Satellites can be used to estimate rainfall as well as monitor the condition of the crops. Satellites, however, cannot be used alone. Atmospheric interference makes quantification nearly impossible and without ground reference points the usefulness of the relative satellite data is lost. When combined with the other parts of an assessment system, satellites enhance the value of the other data and provide a powerful assessment tool.

To illustrate Vegetative Indexes can be calculated from meteorological polar-orbiting satellite data for any number of areas on the ground. These indexes can be plotted as a time series and compared from year to year to get a measure of relative crop vigor.

Colour images can be produced to see the distribution of droughts or floods. These images give an overall picture of what is going on at a single time. A trained analyst can use these images to produce interpolated index maps with very accurate isoline placement.

IV. COUNTRY EXPERIENCES IN USING AGRO-CLIMATIC IMPACT ASSESSMENT METHODS

The participating countries were invited to report on the current use of agro-climatic assessment methods in their country. The following is a summary of the country reports.

BANGLADESH

Drought, flood and salinity adversely affect crop production of Bangladesh. Major food crops are rice, wheat, millets, oil seeds, legumes, vegetables, fruits and sugarcane. Approximately 17 million tons of cereals are needed but the production varies from 15.5 to 16.5 million tons. Reduction in cereal production depends on various constraints of which amount and distribution of rainfall are major factors.

Officially, production estimates are done by the Bangladesh Bureau of Statistics (BBS). However, to supplement the effort of BBS, the Ministries of Agriculture and Food also collect estimates of food production.

From 1980, the Food Planning and Monitoring Unit (FPMU) of the Planning Commission has attempted to develop crop assessment models based

/on

on weather parameters. Expatriates from the United States and the World Food Centre of Amsterdam are assisted FPMU to develop working models. The models developed at FPMU were claimed to be reliable models to start with. However, further research was considered necessary to refine them.

In this context Bangladesh needs assistance to train local scientists, economists and meteorologists to work in an integrated way so that simple and effective production assessment models can be developed on specific crop areas and other parameters.

INDIA

India has been divided into 35 homogeneous meteorological subdivisions. The India Meteorological Department has developed regression models for predicting yield of rice for 26 meteorological subdivisions and for wheat for 20 subdivisions where these crops are grown. The predictors are meteorological parameters including a drought index and technical factors such as fertilizers and pesticides. The forecast is given to the Ministry of Agriculture. Independent assessments are also made by crop-cutting experiments and agricultural surveys. Based on these information sources a final prediction is given.

To establish regression models, crop-weather relationships have been established. Also water requirements of crops, critical phases of water requirements and irrigation parameters have been and are being obtained by evapotranspiration measurements from a network of 35 stations through Lysimetric observations.

For land use planning in rain-fed agriculture a package of practices has been developed by agro-climatic classification of the dry farming tract of the country by weekly analysis of agro-climatic data. This determines the growing period and the water-stress period for each region. Plant breeders develop suitable varieties accordingly.

Drought is monitored every week by a distribution of Aridity Index. Its intensity and spread is examined and a qualitative assessment of drought impact on yield is made.

Farmers are advised how to pursue their specific operations. Long-range forecasts for seasonal rainfall and a monthly forecast of rainfall are made for each region. Depending on past, present and anticipated weather and, based on the stage of crops, specific bulletins are prepared jointly by meteorologists and agricultural scientists so that farming communities can be advised as to what to do.

A crop weather watch group has been established at the National level. Here every week meteorologists, agricultural scientists and decision-makers meet and draw-up and implement contingency plans depending upon the situation. Once the final assessment of crop production has been made, budgeting for the food situation is made for every region. Accordingly, decisions are taken and implemented about the reserve, transfer of food from one region to the other, import and exports and so forth.

INDONESIA

An Assessment of Climate Impact on Agriculture is produced for Indonesia by the Climate Impact Assessment Service which is a joint effort of the Meteorological and Geophysical Agency, Directorate General of Food Crop Production, National Logistics Agency, and the Central Bureau of Statistics. This report summarizes the significant weather events and their impact on agriculture in various parts of the country under the period covered by the report. It involves the collection, analysis, and interpretation of simultaneous weather and agricultural data by a Working Group with representatives primarily from the above four agencies. Three types of information devices are used to present information in the report as given below:

Tables

Self-explanatory tables concerning weather-induced agricultural damages are given by province. General corrective farm actions to minimize further damage and/or harness good weather are suggested where appropriate.

Maps

Two types of maps are given in the report. The actual and normal (or long term mean) decade rainfall are shown for Java-Madura and also for the Outer Islands and a map entitled "Weather-Induced Problems" shows damaging weather which occurred until the present 10-day period at delineated areas.

Several types of indices and maps are also given in the report. These include the Generalized Moisture Index (GMI) map, the Current Yield Moisture Index (YMI) map, the Current YMI map for maize, the Current YMI map for soybean, and the Current YMI map for groundnuts.

/Graphs

Graphs

Graphs are also shown in the report. Actual rainfall until the current decade and that equalled or exceeded at 70 per cent probability based on the incomplete gamma function for the rest of the year for every representative station as well as the value of 80 per cent of actual open pan evaporation (average for the rest of the year) are shown for each major island. The average soil moisture status at the top 30 cm of the soil in rainfed areas is also shown. The areas planted and flowering for each major crop (rice, maize, soybean, and peanut) are shown next as these stages of crop growth are very sensitive to water extremes. Finally the actual and normal cumulative per cent area harvested since January, which gives, some indication on how well this crop year is relative to the normal, are presented in the report.

MALAYSIA

Paddy is the principal food crop in Malaysia, being the staple food for the population. Out of approximately 400 000 ha of paddy land, about 148,000 ha have irrigation facilities and are therefore double cropped.

No specific agro-climatic model has been developed for the paddy crop. Estimates of yield has been established through statistical returns of area planted by the Department of Agriculture. These estimates are combined with crop-cutting tests on established grids in major paddy growing states at harvest time by the Department of Statistics. Estimate corrections are made by crop surveillence reports or pests and diseases by the Department of Agriculture. Acreages affected by droughts/shortage of irrigation water are made by the Drainage and Irrigation Department. Estimates of production are also made by use of other derived data through other agencies such as the National Rice and Padi Board and the Ministry of Agriculture.

The non-development of specific agro-climatic models for Malaysia is due to several constraints such as the lack of an appropriate methodology, the lack of sequential time series data of sufficient duration, lack of trained personnel and equipment, as well as funds to develop such models.

Malsysia is keen to develop an appropriate agro-climatic model for its paddy crop. To this end, of late the Malaysian Meteorological Service has turned its attention to adapting its data in general weather forecasting for agricultural purposes by creating a section to analyse and develop appropriate agrometeorology techniques for Malaysia.

/Towards

Towards achieving this end, a specific proposal has been submitted for the creation of a working team for the development of agro-climatic models for Malaysia under the Ministry of Agriculture, incorporating an agronomist from the Department of Agriculture, a meteorologist from the Meteorological Service Ministry of Science and Technology, and an agricultural economist from the Ministry of Agriculture. Appropriate linkages between these agencies are to be established.

Malaysia also recognizes the development needs of training a core team to activate and implement the agro-climatic programme and to establish basic micro-computer facilities for this purpose.

NEPAL

Since 1983, the Nepal Meteorological Service (NMS) of the Department of Irrigation, Hydrology and Meteorology and the Agricultural Statistics Division (ASD) of the Department of Food and Agricultural Marketing Services started a joint programme to monitor the crop situation in Nepal. A primary objective of this programme was to provide early warning and forecasting of crop situations in order to help anticipate the food situation throughout Nepal. Collection of weather data and the analysis of weather data are the responsibilities of the Nepal Meteorological Service. Similarly, the Agricultural Statistics Division has the responsibility to collect information on crop area, crop condition, crop stage (including planting and harvesting progress and crop damage from insect and disease attacks as well as damage from adverse weather conditions). Estimation of crop production is to be issued to the concerned Ministries and other related agencies to aid in policy making and planning of exports and imports and to assist the operations of the Nepal Food Cooperation.

PAKISTAN

Agriculture in Pakistan is the most important activity; on it hinges the welfare of 72 per cent of its rural population.

Of the total geographical area of 80 million hectares, 20 million hectares are presently under cultivation. The area depending upon rains is around 4.5 million hectares. The remaining area is served by an efficient irrigation system encompassing about 3 million hectares by deep tubewells and the rest by canal flows. The important food crops are wheat, rice and maize.

/Compilation

Compilation of area and crop production estimates is the responsibility of the provincial agriculture departments. Crop area figures are issued by the Revenue Department which has officials in the field maintaining map and measurement records for every 3-5 villages. The Revenue Department officials conduct crop inspections bi-annually to record crops planted in a field. The yields of the crops are determined by the agriculture departments using both subjective and objective methods. Area figures from the Revenue Department become available much after the harvest of the crops. Thus both objective and subjective methods are employed by agriculture departments to estimate both area and yield. The delay in compilation of these estimates results in uncertainties, particularly in poor harvest years. Efforts are, therefore, being made to further improve the system. In this respect Pakistan has already signed a technical assistance programme with FAO and a consultant is expected to arrive shortly to advise on the implementation of the Early Warning System Programme. For implementation of this programme, Pakistan will need further assistance in the form of training and equipment.

PHILIPPINES

PHILIPPINE ADMINISTRATIVE SYSTEM FOR FOOD PRODUCTION ASSESSMENTS/FORECAST

In the Philippines, several agencies are involved in the assessments and forecasts of food production. The major ones are the National Economic and Development Authority (NEDA), the Ministry of Agriculture (M.A.), the National Food Authority (NFA), the National Food and Agriculture Council (NFAC), and the Bureau of Agricultural Economic (BAEcon).

NEDA is mandated to prepare the long-term plan (Five-Year Development Plan) in co-ordination with the different ministries of the Government. The Plan sets the national goals, thrusts and strategies which serve as the broad planning and policy guidelines for the line ministries. M.A., in co-ordination with NFAC, is the lead ministry in the implementation of programmes and projects on food production. NFA's major role is in the procurement, maintenance and distribution of food and to stabilize both supply and prices.

An inter-agency committee, composed of the technical staff of the Ministry of Agriculture, NEDA, NFA and the Ministry of Trade and Industry (M.T.I.) makes periodic assessment of food to determine domestic supply

/sufficiency.

sufficiency. The inter-agency committee enhances the strong and active linkages among the different agencies involved in food programmes.

The data requirements for food production assessments and forecasts are provided by the National Census and Statistics Office (NCSO) and the Bureau of Agricultural Economics of the Ministry of Agriculture.

The statistics generated by BAEcon are mostly the results of surveys and field reports produced/gathered by BAEcon independently or in co-operation with other agencies. The monthly estimates of rice and corn stocks are produced from the monthly surveys of households and commercial dealers conducted jointly by BAEcon and NFA, while the Government stocks are actually monitored by NFA on a daily basis. Quarterly surveys on consumption are also undertaken. Production and area estimates, costs and returns and prices are generated entirely by the BAEcon Data system. Livestock statistics are obtained by BAEcon with the assistance of the Bureau of Animal Industry and the National Meat Inspection Commission.

AGRO-CLIMATIC ASSESSMENT FOR CROPS IN THE PHILIPPINES

The Philippines country paper presented at the Seminar was the output of a study on agro-climatic impact assessment and was conceived during the workshop held in Bangkok, Thailand last April 1983, with the main objective of demonstrating the feasibility of making operational a simple and an inexpensive agro-climatic assessment system. Subsequently, the Philippine Atmospheric, Geophysical and Astronomical Service Administration (PAGASA) and the Bureau of Agricultural Economics, Ministry of Agriculture, (BAEcon, M.A.) jointly came up with a model, which reflects the following assessments:

(a) Monthly agro-climatic crop assessment describing the conditions of crops relative to the prevailing weather, supplemented by field reports; and

(b) Quarterly yield and area assessment based on forecasting models, which attempt to quantify crop production.

The assessments indicate the likely direction of change of crop productivity and production, thus allowing concerned government agencies sufficient lead time to plan and implement measures to mitigate the impact of crop changes.

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The forecasting models make use of traditional regression technique and the initial models developed for the 12 regions in the country were based on the following:

(a) Harvest areas and yields are assumed to be functions of monthly rainfall from planting to harvesting as well as technology and

(b) Time was used as dummy variable to reflect into the model the effect of technology.

The models developed were categorized into three sets depending upon their goodness of fit, while most of the models indicated respectable goodness of fit showing 0.60 to 0.85 R squares, the remaining models are either of exceptionally good fit (R square above 0.85) or of poor fit (R square less than 0.60).

In assessing the applicability of the forecasting models, comparison with the actual situation was undertaken indicating some favourable results. Investigations made by PAGASA and BAEcon indicate that the assessment system is feasible. Furthermore these investigations and assessments made apparent the need for further research in the improvement of the models which require additional weather statistics, such as information on typhoons, temperature and radiation.

The work programme for 1984 will focus on the above refinements needed to make the agro-climatic assessment model fully operational.

SRI LANKA

Sri Lanka is divided into three main climatic zones of wet, intermediate and dry respectively. Rainfall over the island follows a distinctly bi-model pattern. The high frequency of dry spells in the dry zone is a major constraint for rainfed crop production. Monthly histogrames of rainfall probability have been prepared for 425 stations and a rainfall probability map for agricultural purposes has been prepared.

Rice production under major irrigation systems are fairly stable and show little year to year variation. Rainfed upland crops in the dry zone show a high year to year variation in production. By a study of the rainfall confidence limits for the different agro-ecological regions and with a knowledge of the water consumption patterns of crops together with the moisture holding characteristics of soils, the optimum sowing dates as well as the sowing-to-harvest duration of crops have been specified. Studies in crop modelling have been recently initiated by the Research Division of the Department of Agriculture.

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The Ministry of Agricultural Development and Research, and the Ministry of Food and Co-operatives are the two main agencies responsible for food production assessments. The Department of Meteorology provides the Development Division of the Ministry of Agriculture a weekly crop weather situation report. The Food Commission's Department links closely with other agencies with a view to keeping a balance between the supply and demand situation of food studies. It maintains a buffer stock equivalent to a two-month national consumption requirement. Effective methodology has yet to be worked out in order to assess the quantitative effects of adverse drought conditions on domestic food production during the course of the season.

Sri Lanka's long-term available data awaits more stringent analysis with a view to establishing critical threshold levels which are associated with drought related food shortages. The Department of Meteorology has the capacity to utilize weather satellite information is assessing the impact of predictable drought trends on domestic food production.

THAILAND

Thailand is an agricultural product exporting country. Crop forecasting has played an important role in informing the Government about the supply conditions for specific crops. These forecasts allow the Government to set export levels for the various crops. The crop forecasting estimates also allow the Government to plan its domestic price programmes.

There are two basic models used by the Government for forecasting purposes, the acreage and the yield model. The acreage model is specified as a linear function of lagged price of the product concerned (P_{t-1}), lagged price of the competing product (PO_{t-1}), the amount of rainfall in the planting season (R_t), the distribution of rain ($\sigma^2 R_t$), and the planted area lagged one year (A_{t-1}). A dummy variable is also included as an independent variable to obtain the interval estimate of area planted. The specific functional form can be written as:

$$A_t = a_0 + a_1 A_{t-1} + a_2 P_{t-1} + a_3 PO_{t-1} + a_4 P_t + a_5 \sigma^2 R_t + a_6 \text{Dummy} + e_t \quad \ldots\ldots\ldots\ldots (1)$$

During the crop planting season month-by-month forecasts are prepared using accumulated rainfall and rainfall distribution data in the model as it becomes available.

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The second model used by the Government is the yield forecasting model. This model is specified as a function of amount of rainfall (R_t) Usually, the crop growth period is from early June to the end of October. In general, the linear function form is assumed and can be written as:

$$Y_t = b_o + b_1 R_t + b_2 6R^2_t + e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Rice production estimates are prepared by two agencies of the Ministry of Agriculture and Co-operatives (MOAC), the Office of Agricultural Economics (OAE) and the Department of Agricultural Extension (DAE). The methodology and precedures used by the two agencies are as follows:

(1) The DAE bases its estimates on subjective reports from its extension workers who are stationed in every district in the country. The extension workers report on the progress of planting and harvesting and an observed crop conditions. DAE does not have any forecasting activity but does compile a season total estimate of area and production.

(2) The OAE is the agency authorized to produce official agricultural statistics for the country. During the growing season, OAE uses forecast models described above to prepare monthly forecasts of planted area and yield for the entire season. OAE uses sample surveys to prepare the official estimates of area and production at the end of the season.

Copies of the report of the district officers of DAE are sent to OAE for compiling and analysis in order to evaluate crop conditions during the growing season and in order to check the results of its own sample surveys after the season is over.

Each month, after the forecast of the final estimate has been made by OAE, it is submitted for consideration and approval to the Agricultural Development and Planning for Agriculture and Co-operatives Board. Upon approval the forecast is used by the MOAC for policy decisions concerning crops to be grown during the dry season. For example, this year the wet season forecast was very favourable and the MOAC decided to encourage the production of soybeans as a substitute for dry season rice. The information is sent to the Ministry of Commerce and the Economic Ministers Council. The Ministry of Commerce uses the information for setting export targets. The Economic Ministers Council use the information for making price decisions and other policies so that export targets can be met.

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V. THE PROPOSED 1984 AGRO-CLIMATIC ASSESSMENT TECHNICAL ASSISTANCE PROGRAMME

In general, the proposed technical assistance programme for 1984 focuses on extending to participating countries the experience of NOAA in establishing a reliable and cost-effective management information system that provides the decision-maker with timely information needed to respond to drought disaster situations. For this purpose it uses climatic impact assessment technology developed by NOAA for AID. The technology is composed of agro-climatic indices which are simple, implementable and easy to understand. The system relies for effective functioning on co-ordinated interagency co-operation within participating countries at least to the extent that data and assessment reports are exchanged. Support for the proposed technical assistance will be provided by USAID/OFDA through NOAA/AID agreements in conjunction with NOAA agreements with ESCAP and the University Missouri Columbia (UMC).

The proposed technical assistance programme is composed of five separate but integrated activities.

1. Training

A 2 week training course on preparing and using agro-climatic impact assessments will be held for 3 technicians nominated by each participating country. These could include a meteorologist, agronomist/statistician and agricultural economist. The training course is tentatively planned to be held in May 1984.

2. Provision of Equipment

Each participating country will be given a micro-computer with the capability needed to facilitate calculations for the agro-climatic models and indices described in the training course. The technical specifications of the CPU is 64K with 2 disk drives a green monitor printer, and associated software.

3. Co-ordination

Special emphasis will be given to co-ordination of the technical assistance programme on agro-climatic impact assessment with programmes for early warning and food relief implemented by other international organizations, namely FAO, WFP and WMO.

4. Technical Assistance In-country

Technical assistance missions will be provided to the participating countries at the end of the 1984 Monsoon season. In addition to additional training, the mission will evaluate the progress which each participating country had achieved in monitoring the 1984 Monsoon. It will also evaluate each country's future development needs in this area. Missions will be conducted by representatives of ESCAP, NOAA and the University of Missouri, Columbia.

5. Evaluation Seminar

An ESCAP/NOAA/USAID Seminar is planned to be held in early 1985 to evaluate progress made and discuss follow-up activities. Donor agencies will be invited to attend the seminar.

It was noted that the technical assistance programme, to function properly, requires several inter-related activities to be accomplished in participating countries during the course of programme implementation. Of particular importance to successful programme functioning was the development of interagency linkages to assure a timely and routine flow of information from the field to the impact assessment technician to decision-makers. In this regard it was suggested that a monthly routine reporting system on agro-climatic impacts on food shortages should be established. The participating countries should also be prepared to report at a Seminar in early 1985 on assessing the impact of the 1984 monsoon on food supply.

All the nine participating countries at the Seminar expressed their willingness to participate in the proposed 1984 technical assistance programme. Country plans were developed by each participating country which specified (a) the government agencies to be involved in programme implementation, (b) channels for the flow of assessment information, (c) trainees, (d) scheduling of technical services and (e) estimated country input into the programme. The country plans are presented in Annex I. A summary of the country plans are presented in Table 1. It was felt by the representatives of Bangladesh, Nepal and Malaysia that provision should be made for the supply of two micro-computers for the proposed technical assistance programme to ensure its full and immediate implementation.

ADOPTION OF REPORT

The report of the Seminar was adopted on 27 January 1984.

/Table 1.

TABLE 1. SUMMARY COUNTRY PLANS FOR THE 1984 TECHNICAL ASSISTANCE PROGRAMME ON AGRO-CLIMATIC ASSESSMENT

Country	Govt. Agencies Involved	Channels for Assessment Information Flow to Decision Maker	Trainees	Preferred Schedule of Technical Back-up Service	Estimated Country Input
Bangladesh	Bangladesh Agricultural Research Council (BARC) to coordinate multi-disciplinary team from 1. Meteorological Department 2. Bureau of Statistics 3. Food Planning and Monitoring Unit of Planning Commission 4. Ministry of Agriculture	Team of Technologists submit data to BARC Project Director who adds assessment and submits to Ministry of Agriculture, Ministry of Food and Ministry of Planning	Four technologists (meteorologist, statistician agronomist and economist) selected for training from the cooperating agencies	October 1984	1. Participating Technicians, Building space Tools and equipment cannot be supplied.

Country	Govt. Agencies Involved	Channels for Assessment Information Flow to Decision Maker	Trainees	Preferred Schedule of Technical Back-up Service	Estimated Country Input
India	1. Ministry of Agriculture at Centre & States 2. India Meteorological Department	Combined responsibility by India Meteorological Department, Ministry of Agriculture, Indian Council of Agriculture Research, Ministries of Food and Finance and the Planning Commission	Three technicians one each from the Indian Meteorological Department (Meteorologist), Ministry of Agriculture (Agriculturist) & Ministry of Food and Civil Supplies (Economist), at the Master's Degree level	Last quarter of 1984	Man-power, facilities and further training

Country	Govt. Agencies Involved	Channels for Assessment Information Flow to Decision Maker	Trainees	Preferred Schedule of Technical Back-up Service	Estimated Country Input
Indonesia	1. Meteorological and Geophysical Agency (BMG) 2. Directorate General of Food Crop Production (DITJENTAN) 3. Central Bureau of Statistics (BPS) 4. National Logistics Agency (BULOG)	Each data from DITJENTAN, BPS, BULOG compiled with climate data from BMG used to compile assessment reports. Submitted to "concerned" agencies for decision.	Four in number with one each from: 1. BMG (Agro-meteorology) 2. Director General of Food Crop Production (Agronomy) 3. Central Bureau of Statistics (Statistics) 4. National logistics Agency (Agricultural Economist)	July 1984 (Computer) delivery August 1984 (Indices for irrigated areas) November-December 1984 (Roving Seminar)	Considerable staff from BMG, DITJENTAN BPS, BULOG compute systems and communication systems.

Country	Govt. Agencies Involved	Channels for Assessment Information Flow to Decision Maker	Trainees	Preferred Schedule of Technical Back-up Service	Estimated Country Input
Malaysia	1. Department of Agriculture (DOA) 2. Meteorological Service (MS) 3. Ministry of Agriculture (MS)	Data from DOA and MS analysed and evaluated by the Ministry of Agriculture for consideration by 1. National Paddy and Rice Authority 2. Economic Planning Unit 3. Ministry of Agriculture (Planners) 4. Other agencies and private sector	Three trainees consisting of: 1. Ministry of Agriculture (Economist) 2. Department of Agriculture (Agronomist) 3. Meteorologist Service (Meteorologist) Followed by Advanced study later by select team member on tree crops	Requested at mutually agreed future date with evaluation following training at an appropriate interval.	1. Utilization of existing network of Meteorological and Agrometeorological Stations 2. Manpower support from MS and DOA 3. Special Technical Team for compilation and analysis of data.

Country	Govt. Agencies Involved	Channels for Assessment Information Flow to Decision Maker	Trainees	Preferred Schedule of Technical Back-up Service	Estimated Country Input
Nepal	1. Nepal Meteorological Service, Ministry of Water Resources 2. Agricultural Statistics Division Ministry of Agriculture 3. Ministry of Supply	Nepal Meteorological Service submits data to Agricultural Statistic Division which submit it to Ministry of Agriculture and Ministry of Supply	1. Meteorologist 2. Agricultural Statistician 3. Agricultural economist	September-October 1984	Three staff each from Nepal Meteorological Service and Agricultural Statistics Division and two staff from the Ministry of pply

Country	Govt. Agencies Involved	Channels for Assessment Information Flow to Decision Maker	Trainees	Preferred Schedule of Technical Back-up Service	Estimated Country Input
Pakistan	1. Meteorological Department 2. Provincial Agricultural Department 3. Food Department 4. Federal Ministry of Food and Agriculture (Coordinator) 5. Federal Bureau of Statistics	Data on crop conditions from the Agriculture Department would be combined with rainfall data from Meteorological Departments for analysis by the Ministry of Agriculture. The Food Departments would plan grain movements	Three trainees: 1. Agronomist 2. Meteorologist 3. Economist	To be mutually agreed at a later date	Utilization of existing facilities through organizational arrangements

Country	Govt. Agencies Involved	Channels for Assessment Information Flow to Decision Maker	Trainees	Preferred Schedule of Technical Back-up Service	Estimated Country Input
Philippines	1. Philippine Atmospheric, Geophysical and Astronomical Service Administration (PAGASA) 2. National Economic and Development Authority (NEDA) 3. National Food Authority (NFA) 4. Bureau by Agricultural Economics, Ministry of Agriculture (BAEcon, MA)	The assessment will flow from a coordinated effort by PAGASA and BAEcon to an Inter-agency Committee composed of NFA, NEDA, BAEcon, the National Food and Agriculture Council and the Office of the Minister. The Inter-agency Committee passes the assessment to Ministry of Agriculture and the NFA, thence to the President of the Philippines	1. Economist (NFA) 2. Meteorologist (PAGASA) 3. Statistician-economist (BAEcon)	October 1984	Five researchers and computer facilities.

Country	Govt. Agencies Involved	Channels for Assessment Information Flow to Decision Maker	Trainees	Preferred Schedule of Technical Back-up Service	Estimated Country Input
Sri Lanka	1. Ministry of Agricultural Development and Research 2. Ministry of Food and Co-operatives 3. Meteorological Department 4. Agricultural Research and Training Institute	Divisional agencies and district organization feed data to heads of departments. Monitoring and assessment to be compiled by two lead ministries i.e. Agricultural Development and Ministry of Food and Cooperatives. National Food Committee will take decisions.	1. Agricultural Research and Training Institute (economist) 2. Meteorological Department (M.Sc. level officer) 3. Ministry of Agriculture (agro-economist)	September to November 1984	One officer with one agronomist and economist with supporting staff from the Meteorological Department.

Country	Govt. Agencies Involved	Channels for Assessment Information Flow to Decision Maker	Trainees	Preferred Schedule of Technical Back-up Service	Estimated Country Input
Thailand	1. Soil and Water Conservation & Land Management Div., Land Development Department 2. The Royal Rain-Making Research & Development Institute 3. Agriculture Relations Div., Department of Agricultural Extension 4. Office of Agricultural Economics 5. Office of the Under-Secretary of State 6. Department of Agriculture 7. Meteorological Department	The Meteorological Dept. to provide relevant data which is passed to the Office of Agricultural Economics for production estimates which are reviewed by the Agricultural Development and Planning Unit. Decisions are taken by the Economic Ministers' Council	Three trainees to include: 1. meteorologist 2. agronomist 3. economist	The appropriate time for technical back-up services is September 1984	1. Manpower: 8 officers in Meteorological Office 2. Facilities: Computer IMB/34 3. Further training: two week course in Feb.-March 1984 for working group staff of Meteorological Department.

ANNEX I

TENTATIVE COUNTRY PLANS FOR ESCAP/NOAA/USAID TECHNICAL ASSISTANCE PROGRAMME ON AGRO-CLIMATIC IMPACT ASSESSMENT FOR 1984

I. BANGLADESH

1. Government agencies involved

In order to develop an effective working team with multi-disciplinary organizations like:

(a) Bangladesh Meteorological Department

(b) Bangladesh Bureau of Statistics

(c) Food Planning & Monitoring Unit of Planning Commission

(d) Ministry of Agriculture

there shall be a co-ordinating agency which will integrate the functions of these bodies. This co-ordinating body may be the Bangladesh Agriculture Research Councils (BARC).

Each of these above-mentioned project performing agencies will select 3 to 4 of their scientists who will work exclusively on agro-climatic models for crop assessment. A separate project on this will have to be developed by BARC and be approved by the Planning Commission and the National Economic Council (NEC). This project will then take care of financing and administration of the project activities.

2. Channels for assessment information flow

These project planning agencies with their respective units are collecting data on relevant factors that are necessary for food assessment and forecasting. The data thus collected will be submitted to the Project Director who will use them for project performance.

The results will then be submitted to the following Ministries:

(a) Ministry of Agriculture

(b) Ministry of Food

(c) Ministry of Planning

so that they can used to appraise the cabinet for final decision.

3. Training needs

The scientists and technicians involved in this project will need training to make them professionally efficient. It will be better if expatriates come to Bangladesh and train 20 to 25 scientists and assist them initially to develop the work plan and the working models.

Selected scientists from this group can be sent abroad for advanced training. The timing can be determined by the project director and the expatriates.

4. Preferred scheduling of technical services

Technical back up services will be needed to make the project effective. Technical assistance for a short period will be needed for programme verification, monitoring and evaluation.

5. Estimated country input to the programme

The project will consist of 20 to 25 core scientists and technicians. An additional manpower requirement will depend on the performance of the project and expansion of the programme. A functional lab building (20 to 25 thousand sq.ft.) will be needed along with required tools and equipment.

The training component has been outlined in section 3. There will be very little local inputs in term of tools and equipment.

Immediate requirement: Two computers with facilities of achieving an analysis of meteorological data. The computers will be located at Meteorological Department and will form a part of the project under consideration.

/II.

II. INDIA

1. Government agencies involved

   (a) Ministry of Agriculture at the Centre and in the States

   (b) India Meteorological Department

   (c) Ministries of Food and Finance

2. Channels for assessment information flow

   Combined responsibility of Indian Meteorological

   Department, Ministry of Agriculture, Indian Council of Agriculture Research, Ministries of Food and Finance and the Planning Commission

3. Training needs

   Three technicians, one each from:

   (a) Indian Meteorological Department (Meteorologist),

   (b) Ministry of Agriculture (Agricultural Scientist),

   (c) Ministry of Food & Civil Supplies (Economist), (at the Master's Degree Level)

4. Preferred scheduling of technical services

   Last quarter of 1984.

5. Estimated country input to the Programme

   Man-power, facilities and further training

III. INDONESIA

Indonesia has been fortunate to participate from the start of this Climate Impact Assessment Technology Transfer Programme which was initially sponsored by NOAA, USAID, and the University of Missouri Columbia (UMC) and which now includes ESCAP. We are grateful to the sponsors for kindly involving us actively in the programme.

As reported earlier, Indonesia shall implement a combined Indonesian/NOAA/NESDIS/UMC system for its climate impact assessment programme. The analysis shall be on a decadal basis.

At present, the Generalized Monsoon Index (GMI) and Yield Moisture Index (YMI) computer programmes (on monthly basis) for the NOAA/NESDIS/UMC approach are running in the Meteorological and Geophysical Agency (BMG) computer system. We hope to get some technical assistance from ESCAP/NOAA/USAID in converting the programme from monthly to decadal analysis, including the 64K CPU computer with 2 disk drives, a green monitor and printer.

BMG shall interpret the impact on food production of the climate analysis results using the corresponding crop data coming from the Department of Agriculture, Central Bureau of Statistics, and National Logistics Agency. Details of the channel for information flow from the technical staff to the decision-makers are given in section 2 of this paper.

In view of the fact that four agencies are involved in the assessment of climate impact on food production in Indonesia, the government would like to request the training of one technician each from these agencies. These trainees would be specialists in agrometeorology, agronomy, statistics and agricultural economics.

In addition to the conversion of the GMI and YMI programmes from monthly to decadal analysis as well as the training of four (4) technicians, the government is interested in some technical assistance for the development of agro-climatic indices for irrigated areas because most of the rice is produced in irrigated areas.

The Government of Indonesia is prepared to provide appropriate inputs (manpower, facilities, etc.) to get the technical assistance and climate impact assessment programme going. More details are given in section 5.

For the benefit of participants in the various seminars and other interested parties, it would be very useful for ESCAP/NOAA/USAID to distribute the proceedings or abridged reports on the previous, present and future seminars on climate impact assessment.

1. Government Agencies Involved:

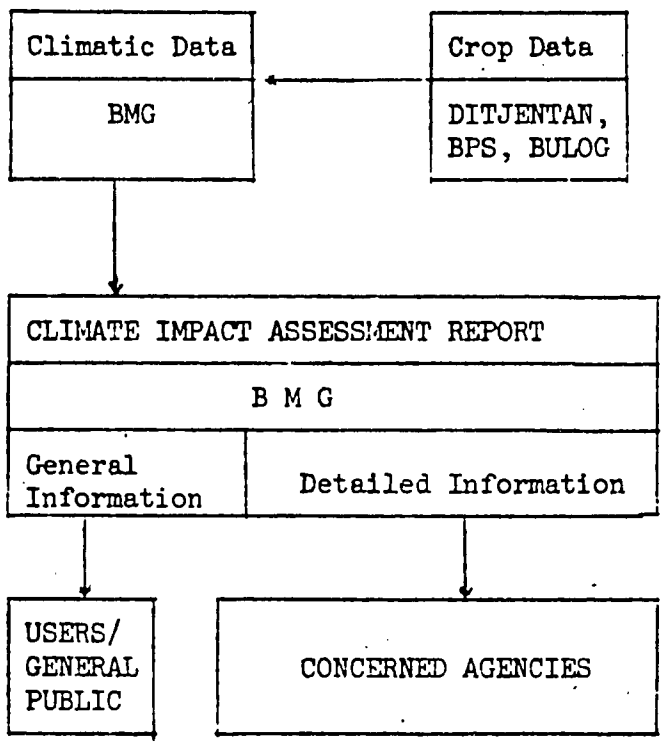
   (a) Meteorological and Geophysical Agency (BMG)

   (b) Directorate General of Food Crop Production (DITJENTAN)

   (c) Central Bureau of Statistics (BPS)

   (d) National Logistics Agency (BULOG).

2. Channel for Assessment Information Flow



3. Training needs

   One trainee from each of the following agencies:

   (a) BMG

   (b) Dit. Gen. of Food Crop Production

   (c) Central Bureau of Statistics

   (d) National Logistics Agency

4. Preferred scheduling of technical back-up services

	Services	Date
(a)	Delivery of computers	July 1984
(b)	Development of Agro-climatic indices for irrigated areas	August 1984
(c)	Roving seminar	Nov.-Dec. 1984

5. Estimated Country Inputs to the Programme

Input	B M G	DITJENTAN	B P S	BULOG
(a) Manpower	- Agrometeorologists - Climatologists - Computer Programmers Agrometeorological Field Observers - Telecommunications Personnel - Clerical Support Personnel	- Agricultural Specialists - Crop Data Suppliers	- Statisticians - Field Observers in Kecamatan	Agricultural Economists - Field Surveyor - Statisticians
(b) Facilities	- Computer System - Telecommunication System	- Limited Telecommunication System	- Limited Telecommunication System - Computer System	- Telecommunication System - Computer System
(c) Roving Seminar	Lecturer	Lecturer	Lecturer	Lecturer

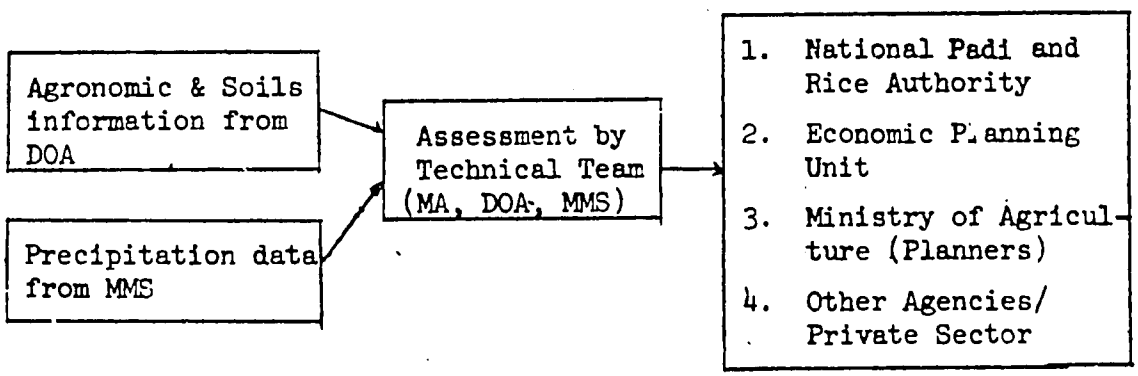
IV. MALAYSIA

1. Government Agencies Involved

The agencies involved will be the Department of Agriculture (DOA), Malaysian Meterological Services (MMS) and the Ministry of Agriculture (MA). The in-country co-ordination for the implementation of the programme will be provided by the Ministry of Agriculture, which will also participate in the Technical Team for data assessment.

2. Channel for Assessment Information Flows

Specific functions of agencies involved has been identified and work flow established as follows:



Information Flow

3. Trainees

Malaysia is prepared to participate in a 2 week training course by sending three participants. The participants will consist of an economist from the Ministry of Agriculture, an agronomist from the Department of Agriculture and a meteorologist from the Malaysian Meteorological Service.

Further in-depth training at a future date in the form of fellowships for officials assigned to the team are essential to study refinements and extensions of agro-climatic models to include other economic tree crops.

4. Technical Services

Back-up technical services and support by an ESCAP/NOAA mission will be necessary. The time for the team to visit Malaysia in this respect is to be arranged on a mutually agreed date.

It will be necessary for Malaysia to participate in the ESCAP/NOAA/USAID Seminar to be held in early 1985 to evaluate the progress made and discuss future needs for three participants making up the team to activate the agro-climatic assessment procedures in Malaysia.

/5.

5. Estimated Country Input to the Programme

Malaysia's input to the programme will include:

(a) Utilization of existing network of Meteorological and Agrometeorological Stations,

(b) Manpower support of Technicians taking observations by the MMS and other related agencies, and

(c) The Technical Team responsible for the analysis and compilation of data.

6. Provision of Equipment

The offer of a computer with technical specifications of the CPU of 64K with two disk drives, a green monitor and printer with the capability needed to facilitate calculations for the agro-climatic models and indices is gratefully accepted by Malaysia. However, it is felt that there is need for two micro-computers to enable full and immediate implementation of the programme in Malaysia. The Meteorological Service has need of a micro-computer to help it compile, store and retrieve agrometerological data, while the Ministry of Agriculture needs the other unit to analyse data and prepare the output reports.

/V.

V. NEPAL

1. Government agencies involved

   (a) Nepal Meteorological Service, Department of Irrigation, Hydrology and Meteorology, (Ministry of Water Resources)

   (b) Agricultural Statistics Division, Department of Food and Agricultural Marketing Services (Ministry of Agriculture)

   (c) Ministry of Supply

2. Channels for assessment information flow

Weather data (National Meteorological Service)	------→ Crop reports (Agricultural Statistics Division)	←------→ Ministry of Agriculture Ministry of Supply, etc.

3. Training needs

   (a) Meteorologists, National Meteorological Service (NMS)

   (b) Agricultural Statistician, Agricultural Statistics Division (ASD)

   (c) Agricultural Economists (Ministry of Supply)

4. Preferred schedule of technical services

   During Sept. to Oct. 1984.

5. Estimated country input to the programme

   Staff, directly:

   (a) Three staff (NMS)

   (b) Three staff (ASD)

   (c) Two staff (Ministry of Supply)

   Staff, indirectly:

   Many staff will collect the crop data and weather data.

6. Special features

   (a) Nepal is interested in obtaining detailed descriptions of different methods already applied in other Asian countries.

   (b) Nepal is interested in the installation of two microcomputers and provision of appropriate software, one each for NMS and ASD.

   (c) Nepal is interested in working out arrangements for regular reception and colour processing of images from the weather satellite covering Nepal.

/VI.

VI. PAKISTAN

1. Government agencies

Pakistan is keen to participate in the plans for the agro-climatic assessments. This programme can be implemented with the active co-operation of five agencies, viz. the Meteorological Department, the Provincial Agriculture Department, Food Department, the Federal Ministry of Food and Agriculture and the Federal Bureau of Statistics. The Federal Ministry of Food and Agriculture will co-ordinate the work at the national level.

2. Channels for assessment

The tentative channels for assessment information flow from technician to the decision maker would be that signals on crop conditions would flow from the Agriculture Department to the Ministry of Agriculture directly. The warnings on weather behaviour will emanate from the Meteorological Department. The Food Department will be responsible for drawing up plans for grain movements.

3. Training

Training facilities will be needed in agronomy, meteorology and economics.

4. Technical back-up services schedule

The schedule will be developed after taking into account the facilities available with the agencies concerned.

5. Country inputs

Country inputs will be provided through re-arrangements of existing facilities and in-service training.

/VII.

VII. PHILIPPINES

1. Agencies involved:

   (a) Philippine Atmospheric, Geophysical and Astronomical Service Administration (PAGASA)

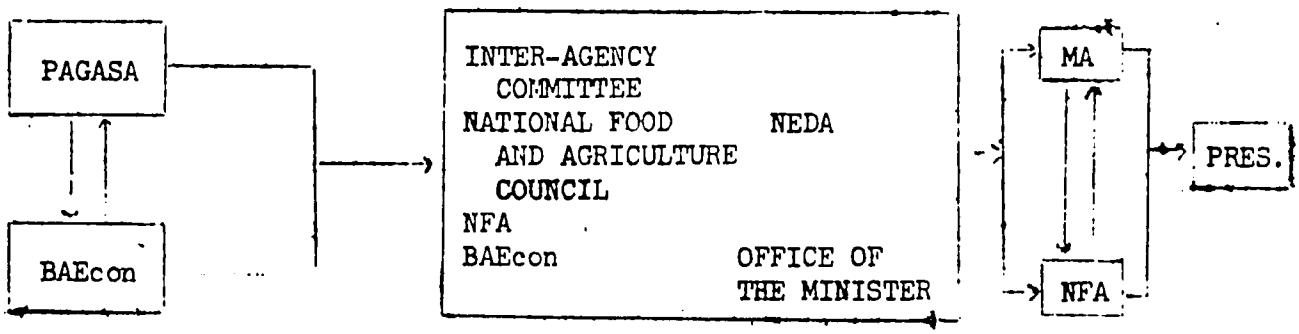
   (b) National Economic and Development Authority (NEDA)

   (c) National Food Authority (NFA)

   (d) Bureau of Agricultural Economics, Ministry of Agriculture (BAEcon, MA)

2. Channel for assessment information flow:

The channel for assessment and information flow is indicated in the following chart:



3. Training requirements:

   (a) 1 Economist from National Food Authority

   (b) 1 Meteorologist from Philippine Atmospheric, Geophysical and Astronomical Service Administration

   (c) 1 Statistician-economist from Bureau of Agricultural Economics

4. Technical back-up services and equipment requirements:

   - Expert in agro-climatic assessment and modeling to be made available during April and October.

   Equipment: 1 Computer and 1 heavy duty plain paper copier

5. Country input in the programme:

The following are needed to make the assessment fully operational: Five man research staff composed of 2 at PAGASA, 2 at BAEcon and 1 at NFA

/VIII.

VIII. SRI LANKA

1. Government agencies

Government agencies involved will be: (a) Meteorological Department, (b) Agricultural Research and Training Institute, (c) Ministry of Agricultural Development and Research and (d) Ministry of Food and Co-operatives.

2. Channels for assessment

Channels for assessment information flow date from Meteorological stations at the periphery to the headquarters.

Divisional agencies and district organizations of the respective government departments involved will provide feed back to the heads of department. Monitoring and assessment is to be done at the Ministry level, co-ordinated by the senior officials of the two key ministries -- Agricultural Development and Research and the Ministry of Food and Co-operatives. The National Food Committee will decide on the National Food Policy.

3. Trainees

One trainee from the Meteorological Department of the M.Sc. level and who is directly involved in the area of work.

One economist from the Agricultural Research and Training Institute; one trainee from the Ministry of Agriculture who would be an Agronomist.

4. Technical back-up schedule

1984 - September to November period would be most suitable.

5. Country inputs

Services of an officer from the Meteorological Department, one agronomist and an economist with supporting staff will be provided.

Arrangements will be made, to have the equipment given to be stationed at the Meteorological Department Head Office in Colombo.

Internal travel and stationery with office equipment will be made available. Further training will depend on the return of the three technician to be trained by ESCAP for two weeks.

/IX.

IX. THAILAND

1. Government agencies involved

   (a) Soil and Water Conservation and Land Management Division, Land Development Department.

   (b) The Royal Rain-Making Research and Development Institute.

   (c) Agriculture Relations Division, Department of Agricultural Extension.

   (d) Office of Agricultural Economics.

   (e) Office of the Under-Secretary of State.

   (f) Department of Agriculture.

   (g) Meteorological Department.

2. Channels for assessment information flow from technician to decision-maker on food security

(see page 54)

3. Trainees

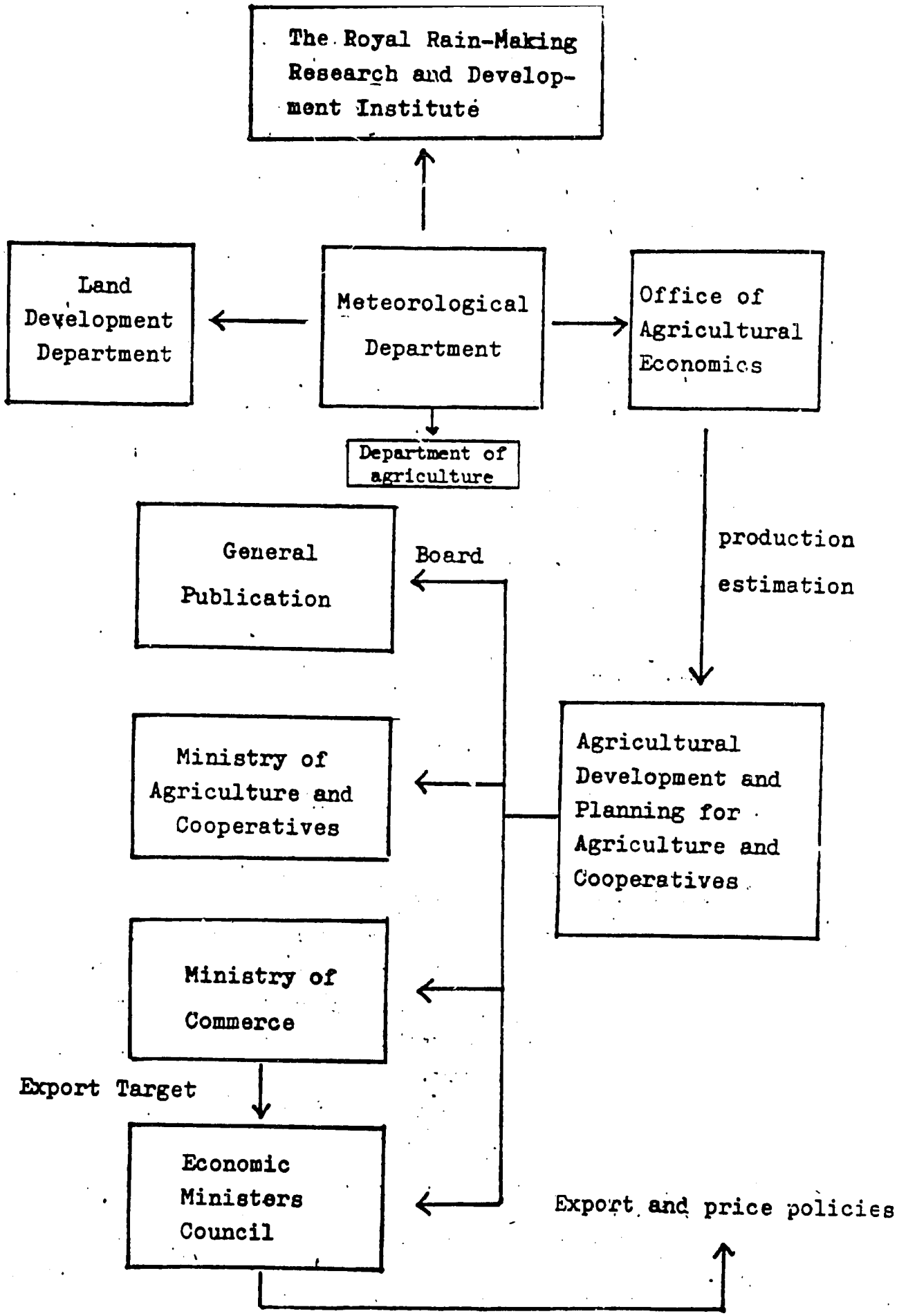
   (a) meteorologist
   (b) agronomist
   (c) economist

4. Preferred scheduling of technical back-up services

   - Approximately by the end of September 1984

5. Estimated country input to the programme

   (a) manpower - 8 officers in Meteorological Department
   (b) facilities - computer IBM/34
   (c) further training } - two-week training course (27 Feb.-9 March 1984) for the staff in the working group in Meteorological Department.


The Royal Rain-Making Research and Development Institute
Land Development Department
Meteorological Department
Office of Agricultural Economics
Department of agriculture
production estimation
General Publication
Board
Ministry of Agriculture and Cooperatives
Agricultural Development and Planning for Agriculture and Cooperatives
Ministry of Commerce
Export Target
Economic Ministers Council
Export and price policies