AGRICULTURAL DEVELOPMENT
AND
DISASTER PREPAREDNESS

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Pacific Islands Development Program for the
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Suva, Fiji
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Pacific Islands Development Program
East-West Center
AGRICULTURAL DEVELOPMENT AND DISASTER PREPAREDNESS

A preliminary outline of information needs, options and methods for reducing agricultural vulnerability in the Pacific Region.

John Campbell
Fred Cuny

1. Introduction

With only few exceptions, agriculture is the predominant economic activity in the Pacific region. It provides most of the food consumed domestically and comprises the bulk of national export production. Despite recent and rapid urbanization throughout the Pacific the great majority of people still live in rural areas. Following natural disasters, the considerable attention given to the high costs of damage and destruction often focuses upon the expenses of providing food relief and home reconstruction. Most frequently, these forms of assistance are directed to rural communities, acknowledging the contemporary vulnerability of farmers who are likely not only to lose their sources of food, but also of cash income, the latter often for several years and at a time when it is most needed.

While the costs of food relief and reconstruction are very high, they are often greatly exceeded by the costs of lost cash crop production. These costs include reduced export earnings, increased food imports and higher prices (initiated by shortages) in the domestic food market. In addition, agricultural development projects may be set back several years with considerable losses in capital investments, time, effort, and enthusiasm. Whereas the impacts of disasters in large countries are cushioned by the fact that most areas are likely to escape damage, this is usually not so in the Pacific where proportionately large areas of small
nations are regularly affected by single events such as droughts and hurricanes. Consequently, national agricultural production can be crippled.

The impacts of disasters upon agriculture and associated costs appear to be increasing throughout the region. This is reflected in food relief programs which are designed to assist larger and larger numbers of people and for longer periods. At the same time national economies are being disrupted with increasing frequency. It is evident that there is a growing need to address the problem of agricultural vulnerability in the region.

In the following sections, a preliminary indication of some of the methods and options for redressing this situation is presented. We are, however, at a stage where our knowledge about the ways in which agricultural vulnerability can be reduced is only partial. Little is understood about the factors which contribute to agricultural vulnerability in most countries and territories within the region, and in many instances, even less is known about the feasibility of schemes to improve the stability of agriculture in the event of natural disasters. In organizing a national program to reduce the vulnerability of agriculture, these deficiencies need to be accounted for. It would thus seem best to begin by analysing the reasons for vulnerability—the natural events themselves and the characteristics of contemporary agricultural systems which are most vulnerable to their effects (Section 2). In this way, the major patterns may be identified and other options, including a broad range of mitigation, preparedness, and rehabilitation measures may be investigated and evaluated as alternatives (Section 3). These activities would help ensure that the necessary information bases are established, upon which programs for reducing agricultural vulnerability may be built (Section 4).
2. Evaluation of Vulnerability

The two most significant sets of factors influencing the vulnerability of agriculture are the characteristics of the disaster(s) which may affect it and the characteristics of agricultural systems likely to be exposed to the disaster(s). Information, at several levels, about these sets of factors is necessary for successful counter-disaster planning.

a) Characteristics of Disasters

Most countries within the region are exposed to a broad range of disaster types and a checklist such as that given in Table 1 may be useful in identifying the disasters which may be experienced. Defining the disasters in terms of their damage causing characteristics, or agents of disruption, helps to clarify the physical processes which affect agriculture and often indicates the types of damage or destruction which is likely to occur.

Natural disasters can be described or measured in a number of ways (Burton, Kates, and White, 1978). One of the most useful of these is magnitude which involves numerous factors such as intensity (e.g., wind speeds, rainfall, flood heights, Richter scale for earthquakes), the extent of area covered by the effects of a disaster and the duration of its influence (e.g., length of a dry spell). However, for planning purposes the frequency of occurrence, that is, the long-term average likelihood of a disaster of a given magnitude, and the areas most likely to be affected by such disasters are the key measures.
<table>
<thead>
<tr>
<th>Natural Extreme</th>
<th>Agents of Disruption</th>
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<tbody>
<tr>
<td>1. Drought</td>
<td>Long periods without rain</td>
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<td></td>
<td>Low soil moisture levels</td>
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<td>2. Earthquake</td>
<td>Landslides</td>
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<td>3. Erosion</td>
<td>Loss of soil</td>
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<td></td>
<td>Downstream silting and increased flood risk</td>
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<td>4. Flood</td>
<td>Inundation of agricultural land</td>
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<td></td>
<td>- Erosion</td>
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<td></td>
<td>- Silting</td>
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<td></td>
<td>- Ponding and standing water</td>
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<td></td>
<td>- Waterlogging</td>
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<tr>
<td>5. Frosts</td>
<td>Temperatures below crop tolerance levels</td>
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<tr>
<td>6. Hurricane</td>
<td>High winds</td>
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<td></td>
<td>Heavy rains</td>
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<td>- Flooding</td>
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<td></td>
<td>- Erosion</td>
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<td>- Landslides</td>
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<tr>
<td></td>
<td>Storm surge and storm waves</td>
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<td></td>
<td>- Coastal inundation</td>
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<td>- Salinization</td>
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<td></td>
<td>- Coastal erosion</td>
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<tr>
<td>7. Landslide</td>
<td>Loss of agricultural land</td>
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<td>- Denudation</td>
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<td></td>
<td>- Deposition</td>
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<tr>
<td></td>
<td>Stream diversion</td>
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<tr>
<td></td>
<td>- Flooding</td>
</tr>
<tr>
<td>8. Tsunami</td>
<td>Inundation of coastal areas</td>
</tr>
<tr>
<td>9. Volcanic Eruption</td>
<td>Ash falls</td>
</tr>
</tbody>
</table>

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Unfortunately, detailed records of the characteristics of disasters are rarely, if at all, available in the time depth necessary to compute accurate probabilities of disaster frequencies or areal preferences. Nevertheless, considerable information is available which, if combined with a basic knowledge of the physical processes involved, can be applied to indicate broad trends which are useful for disaster planning. Historical records such as newspapers, annual reports of government departments (e.g., "Colonial", Public Works and Agriculture department reports), and published works (e.g., Kerr, 1976; McLean, 1977; Revell, 1981; Visher, 1925) may be used alongside environmental data sources such as climatological and hydrological records where available. In addition, the expertise of personnel in specialized government departments (e.g., Meteorological Services, Geological Surveys, and Public Works departments) may be tapped.

This information, when gathered, could be used to indicate the location of "priority areas", where there is a high frequency of large magnitude events. Indications such as these are very important for counter-disaster planning although there is a danger that the information may be misinterpreted. It is stressed that this procedure is not intended to indicate the only areas vulnerable to disasters but those which are likely to be most vulnerable over the long-run. For some types of disasters, most notably hurricanes, it is probable that in most countries and territories all areas have the same characteristics of storm magnitude and frequency of occurrence. Other important information concerning the vulnerability of certain types of locations should a disaster occur are valuable in this context. For example, during hurricanes low-lying coastal lands are particularly vulnerable to inundation by salt water as a result of storm surge (the raising of the sea-level under very low pressure systems) and
storm waves. In comparison, inland areas adjacent to rivers, especially on large islands, are often subjected to flooding and in steeply sloped locations, landslides may occur. Thus, in planning for the occurrence of just one type of disaster, a variety of mitigation, preparedness and rehabilitation strategies need to be considered. The identification of the location of these "priority zones", particularly within the "priority areas", would be a very valuable tool in disaster planning. Again, it is stressed that the intention is to indicate those zones most likely to be most vulnerable should the area in which they are located be struck by disaster.

One other characteristic of disasters which has particular relevance to agriculture is temporal spacing of events. In particular, disasters associated with climatic extremes are often characterized by seasonal patterns in their occurrence. Given the seasonality of agricultural activities, the timing of disasters in relation to stages in crop maturity are often critical. Information concerning such patterns may have some important ramifications for agricultural development planning.

b) Characteristics of Agricultural Systems

There is ample evidence that traditional agricultural systems were much more finely tuned to the environment of which they were part than the forms of agriculture presently found in the region. Numerous strategies and skills were practiced by traditional agriculturalists in the Pacific region which enabled them, much more often than not, to cope with the same sets of disasters, at the same magnitudes and frequencies presently experienced. In later sections of this report we point out the value of numerous traditional disaster mitigation, preparedness and rehabilitation strategies. However, in most parts of the region traditional agricultural
systems have undergone numerous changes. New crops, both for subsistence and cash farming, have been adopted, sometimes grafted onto traditional management systems for which they are inappropriate. In many instances agricultural practices have changed, agricultural land has been put to new uses and land formerly reserved for other purposes has been put to agriculture. What have been the effects of these changes upon the vulnerability of agriculture?

There is considerable variation in the types of agriculture found not only in the region, but within many of the countries and territories themselves. It is highly likely that different agricultural systems have different degrees of vulnerability to prevailing hazards and in this light, it may be best to study the vulnerability of agriculture at this level. Numerous criteria may be employed to identify agricultural systems including the types of crops grown both for food and for commercial purposes, the diversity of crops, and agricultural practices including fallow systems, environmental modifications such as irrigation, drainage, terracing, mounding and the like.

Most of these features have a degree of vulnerability to a given type of disaster, although as mentioned above, many traditional agricultural practices often served to mitigate disasters (e.g. irrigation for drought, mounding for frosts, etc.). Identifying the most vulnerable features within agricultural systems is one of the most essential requirements for disaster planning in agriculture. Although very little has been published in connection with this topic there is undoubtedly a considerable body of pertinent information in each of the countries in the region amongst members of agricultural departmental staffs and the disaster victims themselves. Unpublished damage reports of disasters often contain useful
information and there is clearly a need for the compilation and analysis of these data. At the central location of a severe disaster the destruction of crops may well be very nearly complete but as the degree of damage decreases away from that central point or zone it often does so at different rates for different crops. Table 2, compiled from the reports of post-disaster inspections in the Lau group in eastern Fiji following Hurricane Meli in which the center passed almost directly over Nayau, illustrates such a pattern. Much further research is, however, necessary to determine the vulnerability of different crops to the various types of disasters to which they are likely to be exposed. The areas in which the most beneficial results may be obtained include the analysis of vulnerability to high winds, moisture requirements including minimum and maximum thresholds, tolerance to salt water, ash falls or frosts and variations in these characteristics through the life cycle.

While our knowledge of crop responses to environmental extremes is limited, we are even less aware of the degrees of vulnerability of various agricultural practices. Site selection for some agricultural activities may, for example, render them more vulnerable, but often there are trade-offs to be taken into account, the relationship between flood plain fertility and risk of flooding being but one example. The reduction of land under forests and of the planting and utilization of species grown under tree cover may also serve to increase vulnerability to high winds. Agricultural activities which involve deforestation may contribute towards increasing slope instability and foster the possibility of landslides.

1 The establishment of guidelines for disaster inspection teams in the future may be a very simple and valuable way to collect much of the information we need while at the same time ensuring the right kinds of data for relief and rehabilitation measures are also obtained.
Table 2: Percentage Crop Losses in the Lau Group (Eastern Fiji) Due To 'Meli'

<table>
<thead>
<tr>
<th>Island</th>
<th>Distance From Nayau (km)</th>
<th>Root Crops</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Tree Crops</th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Cassava</td>
<td>Via</td>
<td>Kumala</td>
<td>Dalo</td>
<td>Dalo ni Thna</td>
<td>Yam</td>
<td>Kawai</td>
<td>Voivoi</td>
<td>Banana</td>
<td>Coconut</td>
</tr>
<tr>
<td>Nayau</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>80</td>
<td>100</td>
<td>97</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Cicla</td>
<td>30</td>
<td>100</td>
<td>100</td>
<td>80</td>
<td>96</td>
<td>56</td>
<td>54</td>
<td>65</td>
<td>59</td>
<td>100</td>
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<td>Lakeba</td>
<td>30</td>
<td>94</td>
<td>88</td>
<td>87</td>
<td>55</td>
<td>28</td>
<td>48</td>
<td>20</td>
<td>20</td>
<td>75</td>
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<td>Vuniavatu</td>
<td>45</td>
<td>75</td>
<td>50</td>
<td>75</td>
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<td>25</td>
<td>20</td>
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<td>75</td>
<td>60</td>
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<td>60</td>
<td>50</td>
<td>10</td>
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<td>10</td>
<td>20</td>
<td>20</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Kono</td>
<td>86</td>
<td>60</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>20</td>
<td>20</td>
<td>50</td>
<td>40</td>
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<tr>
<td>Koe</td>
<td>88</td>
<td>60</td>
<td>10</td>
<td>10</td>
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<td>10</td>
<td>20</td>
<td>20</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Namuka</td>
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<td>50</td>
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<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>4</td>
<td>40</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Kabasa</td>
<td>99</td>
<td>60</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>40</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Pulasa</td>
<td>129</td>
<td>50</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>4</td>
<td>40</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Oyoa</td>
<td>142</td>
<td>50</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>4</td>
<td>40</td>
<td>10</td>
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</tbody>
</table>
occurring. Perhaps one of the most important factors is a trend away from crop diversity towards monoculture, a trend which is encouraged by the adoption of and growing dependence upon cash cropping and which removes the opportunities to take advantage of differential crop vulnerability.

There are a number of secondary factors which also need to be taken into consideration in assessing the vulnerability of agricultural systems. Livestock may be lost and structural features such as irrigation, drainage, and terracing systems may break down as a result of disaster. We are therefore confronted with numerous factors for consideration in identifying vulnerable aspects of agricultural systems. Research into the significance of these factors would appear to be essential and the development of guidelines for assessing the vulnerability of agricultural systems a significant step forward in improving the disaster planning process.

One of the most important considerations in reducing agricultural vulnerability is that of costs of mitigation, preparedness, and rehabilitation programs. By identifying those agricultural systems with the greatest degree of vulnerability which are located within the "priority areas/zones" attention would be focused on the areas in which the need to reduce agricultural vulnerability is greatest. Further special attention may be given to those areas where there is a large population dependent upon agriculture.

3. Options for Reducing Vulnerability

It is one thing to pinpoint the problems relating to agricultural vulnerability and entirely another to find their solutions. Certainly, there are no easy answers. Any alternatives to those features presently characterizing a vulnerable agricultural system need to be evaluated carefully in a number of contexts. First of all, they must be technically
sound with a high likelihood of success. For example, encouraging the planting of a crop or crop variety with an improved resistance to drought but much less resistant to high winds would be a poor investment in an area where both hazards occur. Initiating a change in agricultural management practices which does not prove successful when the next disaster strikes may jeopardize the chances that farmers will adopt other projects.

Plans to reduce vulnerability should also be culturally appropriate. Alternative strategies which are likely to upset the social order may precipitate disasters of much greater magnitude than the natural ones which they are intended to reduce. Cultural preferences also need to be considered—for example, encouraging a crop, the taste of which is not preferred, is likely to meet with considerable resistance. From this perspective, it would appear that fostering the reinstatement of traditional alternatives may have the best chances of success.

Projects, especially those with the objective of modifying the environment to reduce the impact of disasters, such as flood protection or river control schemes, need to be environmentally sound. Considerable harm can result from schemes designed to avert relatively infrequent extreme events but which also alter ongoing, day-to-day physical processes. The construction of sea walls, for example, may initiate long-term processes which result in the coastal erosion of otherwise stable areas nearby.

The economic viability of schemes to reduce disaster vulnerability is extremely important. Alternative cash crops, whether encouraged as a long-term alternative or a quick recovery income source, must have a realistic chance of being marketable at reasonable returns. Similarly, subsistence alternatives need to promise yields at levels which will encourage their adoption.
Finally, any programs designed to reduce agricultural vulnerability have to be set against the availability of technical, human, and financial resources of the country involved. This may indeed be a beneficial factor, for the most realistic options for improving the resistance of agricultural systems in terms of the preceding provisos would appear to be those in which small scale modifications and adjustments rather than wholesale alterations are made.

In the remainder of this section, a wide variety of options or alternatives are discussed. In many instances, they may appear inappropriate for one or a number of the reasons given above. However, they do indicate the range of possibilities available for reducing vulnerability and avenues for research to achieve that end. The options listed here are presented in a general sense but in the disaster planning process would be considered against the vulnerability of a given agricultural system. Thus in the division of options into two types of measures—"traditional" and "others"—the latter may include strategies which are considered traditional elsewhere in the region, even within the country concerned, in addition to measures which have been applied successfully outside of the region or developed from research.

a) Mitigation Options

Mitigation measures are those which reduce the amount of damage and destruction caused by disasters and short of disaster prevention offer us some of the best means with which to reduce agricultural vulnerability.

Traditional mitigation strategies in most, if not all parts of the region, incorporated numerous measures for reducing the impact of disasters into regular agricultural activities. A number of these are outlined by Thaman, Meleisea and Makasiale (1979), and are mentioned in the writing of

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early travelers to the region and in numerous parts of the region some of
these strategies, often highly modified, still exist. Traditional
strategies for mitigating the effects of disasters included:

1) Resistant staple crops. Most traditional staples; taro, yams,
and in some areas, sweet potato are less vulnerable to
disasters than, for example, cassava.

2) Staple crop diversification. The benefits of crop
diversification have been mentioned. The increasing reliance
on one or two crops, in particular, cassava, and also upon cash
cropping monocultures has been a significant factor in reducing
agricultural self-sufficiency at times of disaster.

3) Disaster resistant varieties and "famine foods" were often
grown as supplements to the regular staples with the major
purpose being that of disaster mitigation. In large areas of
the region, this practice is no longer continued.

4) Utilizing uncultivated resources. Wild foods, especially those
found in the natural forests, including various nuts and fruits
as well as wild yams were a significant part of the traditional
diet in most parts of the region. Their importance following
disasters was often critical but their role today is almost
minimal in many places.

Research aimed at identifying these strategies, the species involved, and
the management practices associated with them would be particularly useful.

Alternative mitigation strategies tend to focus on two types of
measures—those concerned with the crops themselves and structural or
environmental modification. Research and studies of other areas prone to
similar disasters may provide some useful information regarding:
1) Alternative crops,
2) alternative varieties, and
3) alternative crop diversification strategies.

Unlike the traditional measures, many of these "externally" derived measures may be more difficult to implement and it is possible that they may be most applicable to the commercial side of agricultural operations. Alternatives which involve considerable environmental modifications are mostly "engineering" types of schemes, although not necessarily at a large scale. Economic and environmental criteria must be carefully applied in evaluating such options which include:

1) Flood control including terraces, stop backs, contouring and drainage and irrigation improvements.
2) Coastal protection including seawalls, embankments, and raised roads.
3) Wind protection which may be achieved through establishing natural windbreaks.
4) Watershed management schemes which include a wide range of possibilities such as afforestation, stream or river diversions, dams, etc.

b) Preparedness Options

Preparedness refers to those measures which are aimed at improving the means of coping with disasters once it is apparent that such an event will occur. Preparedness implies that a disaster is expected and preparedness strategies are based on two levels of this expectation. First, awareness of disaster frequency enables long-term preparedness measures to be incorporated into agricultural activities such as storing food during the hurricane season or at all times. Second, preparedness measures may be
developed to deal with the imminent onset of a disaster and would require accurate warning systems to be effective.

Traditional preparedness is most evident in relation to food storage where techniques for preserving and storing most types of food were developed. In most areas, these skills are rapidly becoming lost as rice, for example, provides a non-traditional replacement for the need to preserve food, not only for times of shortage, but for day-to-day use. In addition, it is clear that traditional warning systems existed in the past although we do not know the degree of accuracy, or time lag before the event, of such measures. Similarly, there is little information available regarding traditional agricultural practices (e.g., pruning or cutting back crops) employed immediately before a disaster occurs.

Alternative preparedness measures include the improvement of warning and information systems as well as developing an accurate data base regarding disaster magnitudes and frequencies as outlined previously. This information provides the necessary basis upon which numerous preparedness options, such as the following, may be based:

1) Seeds and planting materials for rapid replanting may be stockpiled.

2) Fertilizers and pesticides to encourage rapid recovery may be stockpiled.

3) Equipment and materials for flood fighting may be prepositioned in high risk locations.

4) Equipment for post-disaster clearing of debris from agricultural land or irrigation/drainage channels and pumps for drainage may be prepositioned in high risk locations.

5) Alternative storage techniques may be developed.
Some of these preparedness measures may incur considerable costs which have to be balanced against disaster frequency and the probable costs of relief measures. In addition to costs, some preparedness alternatives are likely to place considerable demands upon manpower and equipment which even at the best of times are often in restricted supply. There would thus appear to be a need for establishing priority areas based on estimates of the number of people likely to be affected, the nature of their losses, and the costs of economic recovery.

c) Agricultural Recovery and Rehabilitation Options

Agricultural recovery includes four major factors including the salvage and storage of damaged crops, land restoration, replanting of short-term quick recovery crops, and crops for long-term re-establishment of normal agricultural activities. An important but often overlooked consideration is that the post-disaster period provides an opportunity for making adjustments or modifications to vulnerable agricultural systems which would enhance the mitigation of future disaster effects.

Traditional recovery practices in the region involved many varied activities ranging from immediate replanting, inter-island or inter-community exchange of food and planting materials and salvaging of damaged crops. In many parts of the region, yam production in particular has decreased yet in many instances, this appears to be one of the most salvageable crops and it is easily stored. Most of the staples, however, perish relatively quickly after sustaining damage and were subjected to various preservation techniques such as fermentation or drying so as not to be wasted. Today, following disasters, most crops often rot in the ground.

Alternative recovery measures include the introduction of quick maturing food and cash crops which serve to fill the otherwise
non-productive period during which the usual staples and cash crops are rehabilitated. A number of factors have to be considered here including maturing speed and yields and in the case of rapidly maturing cash crops adequate returns for the investment would seem a pre-requisite. Unfortunately, there is a great possibility, especially when quick crops for domestic market consumption are encouraged, that a glut may develop. The costs of support systems such as fertilizer, pesticides, storage facilities and other investments such as treatment plants are often very high. A further consideration is the likely impact of quick recovery crops on regular agricultural activities and in particular the progress of rehabilitation itself. Schemes involving quick return crops are often developed only after a disaster occurs and thus, often under conditions of considerable urgency. The development of such schemes in advance, as contingency plans, for example, would reduce considerable pressure on decision-makers following the event and lead to more efficient post-disaster recovery.

Land restoration schemes can enable agricultural rehabilitation to be achieved much more rapidly than would otherwise be the case. Examples of such measures are drainage of flooded lands, and desalinization of land inundated by the sea. Possibilities for improving the means of salvaging and storing damaged crops need also to be explored. This latter factor is of great importance for when most of the staple plants are damaged during disasters, the edible portions, especially in mature or near mature plants, are often not destroyed. Rather, they perish later as a result of damage to the plant or because of prolonged exposure to unsuitable conditions such as waterlogged or salt affected soils.
This list of options is by no means exhaustive but it does give an indication of the considerable number, and broad range, of possibilities. The potential that any one or combination of these alternatives may have for reducing vulnerability is in many instances not known or poorly understood. Numerous types of these options have already been tried in the region and sharing of experience developed from various schemes could prove very valuable. Research directed towards identifying further options and the technical evaluation of their likely efficiency in reducing vulnerability as well as the development of guidelines and/or techniques for evaluation at the national or local level appears to be necessary. The results of such research would provide valuable information upon which agricultural/disaster planners could base their decisions and develop programs for reducing vulnerability.

4. Programs to Reduce Agricultural Vulnerability

Figure 1 illustrates in very general terms some of the key elements which may be incorporated into a national program for reducing agricultural vulnerability. While research can help pinpoint some of the technical aspects of both disaster vulnerability and the means of mitigation, preparedness, and recovery, the actions ultimately to be taken must also be in accord with national or territorial social and economic objectives. Statements of policy and objectives are important in this regard for they provide the bounds within which decisions for reducing vulnerability can be made.

Evaluating vulnerability both in terms of locational and systematic factors provides the basic information on needs. The problems of identification and evaluation of options are likely to be significantly improved by the formulation of a problem statement outlining the location
Figure 1: Components of a Program to Reduce Agricultural Vulnerability

- TERMS OF REFERENCE
  - Policy
  - Objectives

- EVALUATE ALTERNATIVES
  - Mitigation
  - Preparedness
  - Rehabilitation

- ESTABLISH PROJECTS
  - Priorities
  - Procedures
  - Pilot Projects
  - Expansion

- PROBLEM STATEMENT & PRIORITIES

- EVALUATE VULNERABILITY
  - Areas
  - Zones
  - Agricultural Systems

- FOLLOW-UP
of priority areas and zones, the features of agricultural systems which are most vulnerable and the type(s) of hazards to which they are frequently subjected and the scale of the problem such as the population numbers likely to be affected, the magnitude of losses or extent of destruction and the probable costs in terms of relief and rehabilitation should another disaster occur. The information obtained in the problem statements would also guide the final stage in which decisions are made about where and what kinds of projects may be established.

A comprehensive national program for reducing agricultural vulnerability may include a number of features. The implementation of mitigation projects or the incorporation of mitigation measures into ongoing and future agricultural schemes may include actions ranging from relatively large scale engineering projects to educational or public awareness programs encouraging relatively minor adjustments in agricultural practices. In addition, disaster preparedness, emergency response, and rehabilitation plans may be formulated in anticipation of future events. Procedures for the implementation of projects or plans may include pilot projects which can be used to identify possible improvements and refinements. Moreover, follow-up evaluations of project progress provide information not only upon which ongoing projects can be adjusted but also for the improvement of similar projects which may be undertaken elsewhere or in the future. The development of post-disaster assessment guidelines which provide this type of information would be a useful inclusion in a vulnerability reduction program. As projects proceed or further disasters occur, new and useful information will undoubtedly surface. It is important that national programs to reduce agricultural vulnerability have
the flexibility to respond to newly identified needs and/or technical improvements as they arise.

5. Conclusion

Traditional Pacific island agriculturalists appear to have mastered numerous techniques and strategies for coping with the impact of environmental extremes. Over a century of European contact and colonial administration has seen the erosion of many of these skills as agriculture has adjusted to a different economic and social order. When disasters strike in the Pacific region today, agriculture is often the most vulnerable sector. In this report, a tentative outline of procedures for reducing this vulnerability has been presented. While it appears there are numerous options available for achieving this end, we are presently limited to providing only general indications. Research and the compilation of presently available knowledge including traditional wisdom and the experience of contemporary agricultural staff would appear to be necessary before a successful program to reduce agricultural vulnerability can be achieved.
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The East-West Center is a public, nonprofit educational institution with an international board of governors. Some 2,000 research fellows, graduate students, and professionals in business and government each year work with the Center's international staff in cooperative study, training, and research. They examine major issues related to population, resources and development, the environment, culture, and communication in Asia, the Pacific, and the United States. The Center was established in 1960 by the United States Congress, which provides principal funding. Support also comes from more than 20 Asian and Pacific governments, as well as private agencies and corporations.

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The Pacific Islands Development Program (PIDP) at the East-West Center helps meet the special development needs of the Pacific islands region through cooperative research, education, and training. PIDP also serves as the Secretariat for the Pacific Islands Conference, a heads of government organization involving leaders from throughout the Pacific region, and for the Pacific Islands Conference Standing Committee, which was established to ensure follow-up on development problems discussed at the 1980 Conference.

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A major objective of the program has been to provide quality in-depth analytical studies on specific priority issues as identified by the Pacific island leaders and people. The aim is to provide leaders with detailed information and alternative strategies on policy issues. Each island country will make its own decision based on national goals and objectives. Since 1980, PIDP has been given the task of research in eight project areas: energy, disaster preparedness, aquaculture, government and administrative systems, nuclear waste disposal, business ventures development and management, roles of multinational corporations, and regional cooperation.