III.2.1.(c) The Selection of Actual Preparedness Strategies for Dealing with Climate as Adopted in Monocropping

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Climate variability creates enormous problems with agricultural production and in natural resource management. Preparedness is needed. Climate forecast information could help farmers to stabilize yield through management of agroclimatic resources as well as other inputs (Gommes 1997). However, effectiveness of climate related preparations for enhanced agricultural production and protection can be improved through close collaboration among the relevant agencies and organizations, National Extension Services, National Agrometeorological Services and farming communities (Weiss et al. 2000). Although there may be other constraints before a forecast can be factored into decision-making, it is often these stakeholders that need additional information to offset risk as much as possible (Ziervogel and Downing 2004). Many farmers involved in participatory decision making processes have shown interest in using climate information and try to implement their own management practices. Farmers have built a strong knowledge base from practical experiences (Balasubramanian et al. 1998) gained over generations and this knowledge has to be valued for potential gain in farming. Stigter et al. (2005) stressed the use of traditional methods and indigenous technologies for coping with climate variability.

Crop production in industrialized societies is primarily monoculture. These monocultures are input-intensive, depending on agrochemicals (fertilizer and pesticides) for high productivity. Plants in this system feed at the same level in the soil and draw the same nutrients. Pests associated with the crop tend to build up with favorable climatic conditions, necessitating the intensive use of pesticides to manage them. Biomass accumulation in monocultures is exponential in pattern. This pattern is modified by plant density.

Hansen (2002) argued that agricultural decision makers would realize the potential benefits of climate information only if farmers are prepared for viable decision options. Effective forecast applications impose intensive demands on coping skills, as they are implemented through adjustments of possibly many interrelated

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decisions. Coping decisions that are realistic and adoptable by farmers need to be investigated for associated risks (Ingram et al. 2002). Ideally, to get optimal preparations, farmers and researchers exchange information, most often through intermediaries, that is useful for each other in a participatory co-learning approach to properly understand decision options through discussions supported by economic analyses.

Farmers in general, and specifically dry-land farmers, take cropping decisions mainly influenced by the input costs and perceived risks of economic loss, because of crop failures resulting from climate variability. Although farmers possess good understanding about their crops and give primary importance to economic returns, risk aversion is their boon to achieve higher production, even during a good rainfall season. Seasonal rainfall forecasts are required to take technical decisions on options like (a) choice of cropping system: single or double crop, (b) crop maturity type, (c) optimum plant population, (d) when to sow a first crop or a second crop, (e) decisions on application of fertilizers and their quantity and (f) taking into account the likely effect of seasonal climate on crop yields. The following paragraphs and boxes list some preparedness strategies for dealing with climatic variability as adopted in agricultural production. The specific examples come from India (Box III.2.3), Australia (Box III.2.4) and the USA (Box III.2.5).

Box III.2.3

In the Anantapur region of Andhra Pradesh, India, cost of seed is a large fraction of the cost of cultivation of rainfed groundnut, ranging from 20 to 35% depending on the seed rate used. Hence, it is important to determine the seed rate for the climate variability of the region. The seed rate used by the farmers is about half the recommended rate. On the basis of a survey of six districts around the Anantapur region, scientists have suggested that a major contributory factor to the low yield is lower plant density practised by the farmers (Singh and Nageswara Rao 2004). However, Singh's (1997) synthesis of field experiments at seven locations in different parts of India showed that increasing plant density from 15 to 30 per square meter generally increased average yields only between 3 and 10%. It is therefore necessary to determine the change in yield with change in plant density for the different types of rainfall patterns that occur over the region. It was found that in about 38% of the years, the yield at the higher plant density is higher by over $150\,\mathrm{kg/ha}^{-1}$, which is about the level required to compensate for the additional cost of seed. Such an enhancement of yield with enhanced plant density only occurs for years with good rainfall and hence good levels of yield. Hence, only if skillful prediction of good rainfall years was possible, it appears appropriate to prepare for enhanced seed rate beyond what the farmers now use.

Box III.2.4

(I) In a case study in Australia, Carberry et al. (2000) demonstrated that using the SOI in preparedness contributed some skill to improving management decisions over a 2 year rotation. By changing cropping based on the Southern Oscillation Index (SOI) phase in the August–September period preceding the next two summers, average gross margin for the 2 year period increased by 14% over a standard fallow-cotton rotation, and cash flow improved in many years because an extra crop was sown. The SOI-based strategy did however increase the risk of economic loss from 5% of years for the standard fallow-cotton rotation to 9%, but this risk was considerably less than the 15% for sorghum-cotton and 19% for cotton-cotton rotations. (II) Also in Australia, particularly in the northern part of the grain belt, wheat is grown in an extremely variable climate. The wheat crop manager in this region is faced with complex preparedness decisions on choice of planting time, varietal development pattern and fertilizer strategy. A skillful seasonal forecast would provide an opportunity for the manager to tailor crop management decisions more appropriately to the season.

Hammer et al. (1996) examined the decisions on nitrogen (N) fertilizer and cultivar maturity using simulation analyses of specific production scenarios at a representative location (Goondiwindi) using long-term daily weather data. The average profit and risk of making a loss were calculated for the possible range of fixed (i.e. the same every year) and tactical (i.e. varying depending on seasonal forecast) strategies. Significant increase in profit (up to 20%) and/or reduction in risk (up to 35%) were associated with tactical adjustment of crop management of N fertilizer or cultivar maturity. Those years with SOI phase IV in January and February had decreased probability of late frosts. Consequently, in those years, chance of frost would be reduced for any given maturity type. Alternatively, in those years it would be possible to plant earlier maturity types (than those suggested by the fixed strategy) without an increase in chance of frost damage. The opposite occurred with SOI phase V years, as the probability of late frosts increased in those years. Hence, it would be necessary to plant later maturing types to avoid an increase in chance of frost damage. Tactical adjustment of cultivar maturity resulted in increased average profit and reduced risk of making a loss.

Box III.2.5

To illustrate preparations with the potential application of information about ENSO impacts on crops, Hansen et al. (2001) identified optimum management of maize and winter wheat in Georgia, USA, for a set of all years for each ENSO phase from 1923 to 1997. The management variables optimized included planting date, the amount of N applied at planting, and the amount and date of a second N application. The optimal strategies identified for wheat included later planting, less total N fertilizer, and a higher proportion of N applied at planting in La Nina years and earlier planting in El Nino years relative to all years. The optimal strategy for neutral years was similar to the strategy optimized for all years. Reduced precipitation during grain fill and enhanced rainfall near harvest (May) tend to reduce wheat yields, thereby reducing optimal N amounts. In contrast to wheat, the optimal strategy for maize following La Nina events included earlier planting. The optimal planting date for El Nino years fell between the optimal values for La Nina and neutral years, and matched the optimal values identified for all years. The earlier planting date for maize following La Nina events can be explained by enhanced precipitation from May to July, and reduced precipitation in August. The optimal planting dates result in tasseling in mid-June for the La Nina phase and early to mid-July for the other groups of years. Differences among ENSO phases in optimal N amounts were small for maize.

In high rainfall areas where there are a series of wet and dry spells, rainfall can be harvested in either farm ponds or in village tanks and can be recycled as lifesaving irrigation during a prolonged dry spell (Das 2003). The remaining water can also be used to provide irrigation for a second crop with a lower water requirement. However, no one strategy can be adopted universally (Das 2005). In fact, all such preparation strategies are location, time, crop, crop stage and (to some extent) socio-economic condition specific. Developing such strategies for each specific factor can help make agriculture sustainable.

There is need to have a Drought Watch System at district and state levels, which should be developed, implemented, and managed by experts in meteorology, agriculture, irrigation, public health, food supplies etc. (Das 2000). The pre-requisites for the operation of such a preparative drought watch system are:

(i) a network of rainfall stations, with reliable records of good quality, that are homogeneous and extend over a period of at least 20 and preferably more than 50 years;
(ii) weekly/monthly rainfall records that are in computer compatible form;
(iii) weekly/monthly rainfall totals that are available at the drought watch center within 2 or 3 days at the end of the week/month; and,
(iv) the drought watch centers should have the capability of issuing weekly/monthly drought watch statements whenever the rainfall situation demands.

In general, important information can be provided with a short time horizon for tactical applications concerning early warning (i.e. short cycle varieties, choice of alternative cultural systems, real time seed distribution, irrigation management etc.), and with a long time horizon for agro-economic planning with benefits at national and international scale.

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