RISK MANAGEMENT IN AGRICULTURAL WATER USE

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Summary

Water availability for agricultural activities will decrease in the twenty-first century. As a consequence, agricultural water management will have to improve in order to meet two challenges: satisfy the needs of an increasing world population; and alleviate the climate change impacts.

One way to improve agricultural water management consists of including the 'risk' notion as much as possible at the different decision levels of: farmers, farmer corporations and states or associations of states. These three decision levels will be analysed both for rainfed and irrigated agriculture. The poorest countries are those most subject to climate risks, the main risks in developing countries, because they too rarely possess the means to combat excesses or shortages of water during the plant growing period (irrigation schemes) and they cannot rely on crop insurance or other kinds of support to maintain their income in bad years. Consequently, in order to ensure a minimum level of income, farmers will prefer low input practices that provide a low but stable production without involving too much investment or cash. Where possible they will diversify their production.

This paper first defines hazard, vulnerability and risk in the particular context of drought assessment and prediction. It then presents some strategies to reduce water risk in three major categories: (1) more irrigated agricultural land in an efficient manner; (2) increased and better managed pasture and forest areas to benefit from otherwise lost water by evaporation process, increasing animal productivity; (3) well water managed dryland agriculture. In dryland agriculture, some additional public measures are necessary, mainly drought risk insurance and early warning systems, in order to promote investment in drought-prone environments and to provide tools for decision-making.

The adoption of an efficient water use management of rainfall and irrigation will ensure food security, contribute to poverty alleviation, and free water for non-agricultural uses.

The paper presents some new promising techniques and approaches. Finally, it discusses the sharing of risk between the different decision levels and launches some ideas to serve as discussion points in the electronic conference.

Key issues

1. The risk notion is linked to uncertainty principles that are not easy to integrate into classical farmer crop management. How can this be done in practice?
2. What are the present and future means for reducing, mitigating or removing risk in agricultural water use at the farm and state scales respectively?
3. What are the links between poverty and risk management in agricultural water use?
4. Drought risk can be drastically reduced by material investments in improving water supply to crops (irrigation). Thus, a natural risk is replaced by an economic one, which can sometimes be much higher and much more difficult to endure. What process can reduce the risk level when such a transfer of risk happens?

Introduction

Both water security and food security face high risks, due to the dual pressure of increasing population needs and decreasing available water resources. Food security in developing countries relies mostly on rainfed agriculture characterized by low and unstable productivity. Some 60 percent of the world's food is supplied by rainfed agriculture that covers 83 percent of the cultivated lands (FAO, 2002). Irrigation has been introduced as a way of reducing dependency on climate and increasing productivity. It now uses a major portion of all collected water resources. According to some FAO studies (Roche, 2001) a 30-percent increase in irrigation appears indispensable to satisfying increasing food needs in the next 30 years. This may well lead to major water withdrawals. Moreover, the agriculture sector will have to cede part of this water for the benefit of domestic needs, placing a higher risk on food security. Shiklomanov (1999) forecast an increase of 9 percent (1 900 km^3/year) in water demand in the agriculture sector for 2025, compared with 27 percent (950 km^3/year) for the industry sector and 100 percent (700 km^3/year) for household use. These estimates do not allow for the climate change impacts that appear evident in some regions of the world. For example, in Morocco the amount of rainfall and its distribution within the season have become very erratic. The frequency of droughts has increased from 5 seasons out of 40 in the 1940-1979 period, to 6 out of 16 in 1980-1995, and 4 out of 7 in 1996-2002.

Definitions

The hazard is defined as the "probability of occurrence of a damaging event in a given period of time".

The vulnerability expresses the foreseeable consequences of a damaging event on stakes that can be human life or health, wealth, or the environment (Ozer, 2001). In the particular context of early warnings for food security, FEWS (1994) defines vulnerability as a measure of the susceptibility of some groups of persons or regions to have food insecurity. The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as "the extent to which climate may damage or harm a system. It depends not only on a system's sensitivity but also on its ability to adapt to new climatic conditions" (IPCC, 1995).

The risk is the product of the hazard and the vulnerability. It increases with the increasing occurrence of damaging events and with the vulnerability of a population or wealth (a crop in this case). In theory, the same risk can be observed when the environment is very vulnerable but subject to very low occurrence probability of a damaging event as when the environment is not sensitive but very often confronted by damaging events.

According to Gommes (1999), the risk is also defined more simply as a loss due to a damaging event. The advantage of this last definition is that it can easily be materialized and measured (e.g. loss of agricultural production or income).

An acceptable risk is one that individuals, businesses or governments are willing to accept in return for perceived benefits. The level of acceptable risk is usually defined by local governments, taking into account information on drought hazards and combining it with economic, social and political factors specific to the area threatened.

Drought risk management strategies

Drought is the major climate threat to agricultural production, much greater than cyclones, floods and storms, which are very rare in comparison to drought events (Gommes, 1999). Drought represents one of the most important natural triggers for malnutrition and famine.

Other risks, linked for example to war, geostrategic policies (for countries which are dependent on their neighbours for water resources, such as Egypt, Syria and Israel) and fluctuations in world markets (increased food prices or energy costs), could have a great influence on water for food security. This paper discusses only drought risk management, which is by far the most important problem that can be managed at country level.

Drought events can be faced at the parcel level by several management decisions, at the watershed level or at the country level. Parcel-level decisions lie with farmers or farmer associations whereas decisions at watershed and country level must be taken by the governments or state agencies.

Farmer and farmer association drought risk management

Crop practices and field management provide several means of coping with soil water management (Gommes, 1999; Debaeke, 2002). Strategies in rainfed agriculture are based on producing more food per rainfall unit in a durable manner. They can be categorized as: (i) collecting the maximum rainfall (water harvesting, runoff reduction, early planting, fallow, use of recycled water from other sectors, etc.); (ii) minimizing water loss (evaporation reduction by mulching or rapid crop cover, windshields, minimum tillage, weeding, etc.); and (iii) using water efficiently (low water consuming crop species, fertilization adapted to the water available, disease and pest control, optimal planting and seeding, selection of varieties able to accomplish their cycle within the length of the climate growing period, etc.). The above strategies allow a better use of the available water at the parcel level. Moreover, traditional farming aims at a stable production rather than a maximum income. Farmers achieve this objective by a diversification of their production and by following low input practices that do not involve too much investment or cash. Forming associations of farmers, for example at the village scale, or farmer corporations will further reduce the risk of low production.

Irrigation is the best way to escape from the constraints of climate variability. However, the high cost of irrigation techniques may explain why about 95 percent of cropland remains as rainfed agriculture in the Sahel region. The economic risk associated with such heavy investments in these arid countries often appears unbearable. The real cost of irrigated food production is far from clear as it is one of the most subsidized activities in the world (FAO, 2002). Irrigation will continue to expand in the coming years but particular attention should be paid to its water efficiency. Certainly, more land can be irrigated, more productivity can be obtained, and more water can be available for domestic and industrial uses if water is saved and used more efficiently, reducing dependency on climate.

State or state agency drought risk management

Irrigation development

State agencies play a major role in reducing the risk of drought effects as they sustain agricultural production in various ways.

They invest considerably in irrigation development: building dams and irrigation schemes. They seek to maximize water storage capacity, extending the life of dams by controlling erosion in watersheds, redistribute water to more needy regions, promote efficient irrigation systems, improve water management in order to take crop water requirements more fully into account.

Education and training of farmers

States can also promote different ways of combating drought: education and training programs. A better knowledge of climate conditions and their evolution can help adjust farmers' decisions to climate potentialities. New techniques or improvements to traditional methods of combating drought events can also be taught to farmers or farmer advisers.

Early warning systems

Most of the time, also in regions suffering from frequent climate disturbances, early warning systems alert governments to possible drought events. Thanks to this advance information, they can take appropriate measures in good time and safeguard their populations against famine or exceptional income decreases. Garavani (1997) provides several definitions of early warning systems. Such systems are also available at international level (GIEWS, FEWS, etc.) and regional level (AGRHYMET–EWS). According to data available, each country develops its own system. These systems are often based on the philosophy developed by FAO (Gommes, 1997) that tries to optimize the combination of several kinds of data: punctual (meteorological data) or continuous (satellite data), historical or in-time data, seeking for the best yield forecasting. Crop models play a key role in these systems. However, such monitoring systems are almost never available at the farm level. The information acquired at national or international level is seldom transmitted to farmers for their personal use. Enhanced collaboration between national and international agencies could help improve these systems.

Integrated management of water resources

Basin agencies are in charge of managing the available water and using it for different sectors of activity at the basin scale. These organizations normally have at their disposal large amounts of data (long-term time series) available for scenario simulations. By also taking global warming into account, scenarios of the evolution of the future water needs in each different sector will enable national authorities to prepare policies to face the future.
Landscape management also plays an important role in the water balance. For example, uncontrolled deforestation exposes the bare soil to direct contact with the raindrops and the splashing effects increases runoff. In addition, in the long term, erosion will reduce the water storage capacity of these soils, a situation which will ultimately lead to increased vulnerability. Reforestation with forest trees and fruit trees adapted to the climate conditions (e.g. olive trees in Andalusia, Spain) keeps the soil covered and may modify microclimates.

New means of combating drought

Seasonal climate forecasting

The recent understanding of the processes involved in and the impacts of the El Nino Southern Oscillation phenomenon on climate conditions in different regions of the world, has resulted in progress in forecasting, with a certain confidence level, the seasonal rainfall pattern for a crop growing season. In order to be useful to the agricultural community, this recent improvement requires a shift from a passive acceptance of climate variability and its associated impacts to an active response to a climate forecast (Hammer and Nichols, 1996). However, realizing these opportunities is not straightforward as forecasting skills are imperfect and approaches to applying the existing expertise to management issues have not been developed and tested extensively (Hammer *et al*., 2001). A farm-level survey in Zimbabwe (Hammer *et al*., 2001), showed the gap between a given statistical forecast and the interpretation of it by the farmers. Notions of risk and probability are often misunderstood. Moreover, until skill levels and confidence in the forecasts improved improve significantly, they will not be used for adapting crop management strategies. Seasonal forecasting looks promising but for the time being it remains in the research field.

Crop insurance

The IPCC's Third Assessment Report (IPCC, 2002) highlights insurance and other components of the financial services sector. Such elements constitute a risk-spreading mechanism through which the cost of weather-related events are distributed among other sectors and throughout society. Drought impacts are expected to be higher in developing countries but these are the regions with only limited access to insurance, the consequence of a long history of instability with fluctuating insurance costs that are prohibitive when compared to agricultural prices. This situation makes these regions more vulnerable and impairs their ability to adapt. Because of the lack of insurance, disaster relief is the major input for disaster recovery in many developing countries. In the event of drought, the government generally provides assistance first. Governments often act as the insurer for uninsured damages in these cases. A World Bank-UNDP workshop reports that "disaster mitigation is evolving from the phase of relief and contingency planning to a phase in which there is greater emphasis on reducing social and economic vulnerabilities and investing in the long term mitigation activities". Even in developed countries, when private insurers do not accept specific disaster risk, governments often play the role of insurer. Some countries define the government role explicitly as paying for "uninsurable damage".

Conclusions

Several strategies at the farm and state levels can reduce or mitigate the impact of drought on the population. However, adaptation to climate risk will vary considerably among countries. Key factors affecting the adaptive capacity of a region or a country include: economic resources, technology, information and skills, infrastructure, and institutions. Developing countries have to face higher risks with fewer means than do developed countries. With the technical means presented above, socio-economical support will also contribute (and probably more significantly) to improving risk management in agricultural water use. Water risk management is also an international concern as drought is, at least partially, an expression of disturbances in global systems. The electronic conference should discuss the involvement of the international community in this matter.

Questions for the electronic conference

1. How can we define the risk associated with each crop management system?
2. Each region has its own vulnerability to a climate risk. How could we optimize the crop system in order to be adapted to this particular vulnerability?
3. Material investment to combat natural disasters (drought, inundation, etc.) can lead to other types of risks (debts, bankruptcy, etc.) that are even greater than the original danger. How could we counsel farmers facing such a problem?
4. Would the inclusion of a better awareness of risk all agricultural management systems allow an improvement in the status of the poorest countries?
5. Who should be responsible for managing water-related risks in agriculture?

6. How should the risk alleviation mechanisms be organized and managed?
7. What is the role and impact of early warning systems?
8. What are the respective roles for government, farmer associations and the private sector?
9. What policies can be developed to strengthen the resilience of farming communities in times of disaster?
10. How should the international community be involved in water risk management?

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