How to Achieve The Required Food Producion To Meet The Growing Demand?

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Abstract

We now face the challenge of feeding 8 billion people by the end of the first quarter of the twenty-first century. More than 80% of these people will live in developing countries that are those suffering the most from severe water scarcity, notable shortage in food production and increasing hunger and poverty. The challenge is: how to achieve the required food production to meet the growing demand?

To feed the increasingly growing population, on the one hand, balanced, broad-based pro-poor growth-oriented programs are generally required to increase food production, agricultural productivity and rural income and, on the other hand, special targeted programs are necessary to alleviate hunger. Success mostly depends on having conducive policies, adequate institutions, improved market infrastructure, social safety nets and primarily peace and stability, all on a sustainable basis.

In this paper, our attempt is to outline the key issues that allow shifting our priority attention from a common understanding of the major causes behind the problems to concrete actions that must be implemented, in view of fighting hunger and achieving food safety, water security and environment sustainability.

Keywords: water management, environment sustainability, food safety.

Résumé

Le défi auquel nous sommes confrontés est de nourrir une population mondiale qui atteindra les 8 milliards à l'horizon 2025. Plus de 80% de cette population sera concentrée dans les pays en développement qui souffrent le plus de la rareté de l'eau, d'un déficit important de production alimentaire et d'une condition de famine et pauvreté croissante. Le défi est le suivant: comment réaliser la production alimentaire nécessaire pour satisfaire la demande croissante?

Pour nourrir une population qui augmente sans cesse, d'une part il est nécessaire d'envisager des programmes de croissance équilibrés, à large assise et en faveur des pauvres, axés sur l'augmentation de la production alimentaire, la productivité agricole et le revenu agricole, en général, et d'autre part des programmes ciblés et spécifiques de lutte contre la faim. Le succès dépend surtout de la mise en place de politiques appropriées, d'institutions adéquates, d'infrastructures de marché renforcées, de réseaux sociaux accessibles et surtout de paix et stabilité, sur une base de durabilité.

L'objectif de ce travail est donc d'illustrer les questions-clés permettant de focaliser l'attention non seulement sur les causes principales des problèmes abordés, mais aussi sur les actions concrètes à réaliser, afin de lutter contre la faim et atteindre la sécurité alimentaire, la sécurité des ressources en eau et la durabilité de l'environnement.

Mots clés: *gestion de l'eau, durabilité de l'environnement, sécurité alimentaire.*

1. Introduction

The availability of freshwater is one of the great issues the human kind is currently facing, in some ways it is the greatest issue, because problems associated with it affect the living conditions of many millions of people. In the next 50 years, problems associated with the lack of water or the pollution of water bodies will virtually affect everyone on the planet. Water shortages and needs are increasing, and the competition for water among urban, industrial, and agricultural sectors, as well as other resource users, is more intensively growing.

At present, water shortages have led most of arid and semi-arid countries to increase food imports because the local agriculture sector is not able to produce sufficient food to fill the existing food gaps. The increasing food gaps is posing serious challenges beyond the economic and political capacity required for the necessary adjustments concerning the allocation and the use of water in all sectors, particularly in the agricultural one.

The agricultural sector is by far the largest user of water in the world. On a consumptive use basis, 80 to 90 percent of all water is consumed in agriculture. Unfortunately, the water use efficiency in this sector is very poor, not exceeding 45% with more than 50% of water losses. The growing water scarcity and the misuse and improper management of the available water resources are nowadays major threats to sustainable development with drastic increase in the food production gap that most developing countries are facing.

Today, in most countries suffering form water shortages, the heart of the problem is based on the understanding whether a water crisis can be averted or whether water can be made productive. Increasing the productivity of water is central to produce food, fight against poverty, decrease competition for water and ensure there is enough water for the nature. The more we produce with less water and/or with the same amount of water, the less the need for infrastructure development, the weaker the conflicts among the sectoral water uses, the greater the local food safety and the higher the water availability for agricultural, household and industrial uses, and the higher its availability for the nature.

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However, to achieve such goals, major improvements are still required in water resources use and irrigation technology and management. Meeting such challenges will require a much greater effort and more significant changes in *how is water managed? What does need to be changed? What are the improvements required*? to achieve food safety despite the increased water scarcity.

2. Water And Food Production

For a long time, agriculture has accounted for the greatest part of human water use and currently claims nearly 70 per cent of the world's water withdrawals. Agriculture may claim more than 90 per cent of water in arid developing countries.

Learning from experience, we know that nowadays our planet could feed over six billion people basically thanks to the enhanced production resulting from the «Green Revolution». According to Pretty and Hine (2001), between the early 1960s and mid-1990s, average cereal/yields grew from 1.2 t/ha to 2.52 t/ha in developing countries, while total cereal production passed from 420 to 1.176 million tons per year.

The world agriculture is now facing the challenge of feeding almost 10 billion people by the year 2050 while alleviating the pressure on agro-ecosystems. Further challenges are put by those who highlight the need for a new «food systems paradigm» (it is not sufficient to produce food enough, but the quality of nutrition must be taken into account as well: e.g. Welch and Graham (1999): 'those who want to ban the use of all synthetic fertilizers and pesticides; those against the radiation of foods; those against the reuse of treated urban wastewaters for irrigation or against irrigation altogether; those against genetically modified organisms'. A second Green Revolution is expected, a «more green» revolution, reconciling intensification and sustainability (Sherwood and Uphoff, 2000; Horne and McDermott, 2002).

The International Food Policy Research Institute (IFPRI) currently estimates that demand for cereals in developing countries will increase by nearly 50 per cent from 1997 to 2020, rising to nearly 1.7 billion metric tons. Excluding China and India, developing countries are expected to account for about 50% of this increased demand that is nearly three times greater than the ones of the developed countries.

In this regard, irrigation can play an important role in satisfying the increased cereal demands. IFPRI expects the irrigated cereal area to increase from the 1997 total of 218 million hectares to 248 million hectares by 2020 with an additional one million hectares in developed countries and 29 million hectares in developing ones.

3. Sustainable Food Production System: the Barriers

Many of the key components of a more sustainable food production system depend on the environmental policy and the overcoming of barriers. In most of the developing countries, more attention is now given to the development of rural areas through broad programs and well-defined approaches and strategies to increase food production, alleviate poverty, increasing farmers' income and decrease the relatively high urbanization rate. However, in spite of the major efforts already carried out on both international and national levels, the implementation of the outlined plans and programs is still facing several constraints and barriers that produce limited positive impacts on the beneficiaries, the rural poor. Some of those barriers are:

• *Lack of integrated land and water resources management approach*

Land and water management institutions tend to be centralized, technically-oriented agencies that support limited and specific aspects of management. Indeed, the single-sector approach to land and water resources often leads to short-term economic gains. In the meantime, such approach can result in long-term environmental degradation because it fails to account for the complex linkages among various components of the ecosystem. In addition, this approach tends to heavily rely on technical and engineering solutions, making little or no attempt to address related policies and institutional issues. Both are fundamental issues to be carefully considered as far as we are seeking the sustainability of rural development programs.

• *Lack of land tenure and water rights*

Many farmers lack secure land tenure, which greatly increases the risk of investing in land and water conservation or other improvements. Land tenure is a particularly important issue for women farmers. In some developing countries, one third of rural households are headed by women, yet less than 2 percent of all land is owned by women. Partly, as a consequence, women have less access to credit and inputs and receive only 5 percent of agricultural extension services worldwide.

The establishment and strengthening of the regulatory and institutional framework for land tenure and land market development is a priority. This calls for comparative studies and innovative research in land policy analysis, formulation and implementation, involving, whenever possible, community and co-operative action for land (and water) management.

In addition to the land tenure and gender issues, other obstacles aggravating this problem include (Abu-Zeid and Hamdy, 2004):

- the lack of access to affordable technologies for small farmers accounting for 80 percent or more of the farm population;

high costs of the equipment with prices not at all affordable for small and poor rural farmers;

- poor transportation and marketing facilities.

• *Urbanization and inter-sectoral water allocation*

By the year 2025, the urban population numbers can double from 2.5 billion today to 5 billion. We can expect a fur-

ther imbalance between population size and water availability and food sufficiency in many more countries. Attention needs to be paid to this change, particularly in the rural economies of the developing world that has switched to urban-oriented economies and societies. Rapid urbanization is turning the rural majority into a minority, even in Africa that is the least urbanized region on the planet. Beyond these statistics, challenges lie in promoting sustainable practices. Already in some water-deficient countries, there is inevitable competition between expanding urban and rural populations on one side and agricultural, household and industrial users of water on the other side.

• *Valuation of water and its trade-off*

The Dublin Conference in 1992 advocated water as an economic good. Since then, many decision-makers have come to adhere to this principle. However, the popularity of this notion tends to overlook the social, cultural and environmental aspects of water.

On an economic basis, it has been shown that water use by subsistence farmers and grain crop producers has a lower economic value. On the other hand, industrial and municipal usage of water brings in a higher return. At the extreme end, water is to be diverted towards the users of recreation and tourism. If water allocation is based on this «economic good» principle, it then jeopardizes access to water and food for millions of people on the planet. Furthermore, such a principle could have negative consequences for the cultural and social fabric, as we know it; not to mention disastrous changes to the environmental ecosystem. Therefore, market forces alone should not be the dictating factor in these social decisions.

Indeed, in many developing countries, water is mostly subsidized by governments; hence water is kept at low prices. However, such low priced water does not provide sufficient revenues to operate and maintain water systems, to invest in new infrastructures or to research new technologies. Low water pricing and its subsidy also have slowed the reduction of water saving and reduced the incentives of farmers to invest in efficiency. Similarly, energy subsidies in many countries have artificially reduced the cost of groundwater pumping and encouraged farmers to overuse this vital drinking water resource.

Such prevailing conditions in many developing countries have resulted in the misuse of water with notable losses that could be saved and utilized in expanding the irrigated area and raising the food production to meet the increasing food demand (Hamdy, 2002 and Abu-Zeid, 2001).

• *Poor institutional capacity building*

Institutional capacity plays a central role in any decentralization process. Failure of local governments to take advantage of the opportunities provided by decentralization because of lack of capacity will result in poor outcomes. Local governments and other institutions that cannot adequately administer and account for grants or effectively mobilize local resources will find those powers swiftly taken back. Non-Governmental Organizations (NGOs) and Community Base Organizations (CBOs) that lack managerial capacity or, alternatively, focus on furthering their organization's own ends at the expense of broader community will undermine successful outcomes.

However, improved capacity will not on its own solve all the shortcomings. Capacity building efforts that are carried out in highly centralized systems soon run into limits related to central constraints. Capacity enhancement and devolution of functions must be pursued together and paced to complement each other.

To be stressed here that the success and/or failure of rural development programs is not only a matter of decentralization. Decentralization without explicit efforts to strengthen rural institutions and enhance participation of rural poor people carries a high danger of urban-bias and prolonged rural incapacitation. This is one of the major reasons behind the well observed decline in food production.

• *Rural data assessment*

There are considerable data problems not only with the quality and reliability of rural data in many developing countries, but also with the non-existence of vital data.

Improved monitoring of rural development will require a significant effort in data collection on a long-term basis. Comprehensive household surveys and extended coverage of the agricultural consensus are needed, focusing on family status, access to services, economic activities, production practices, expenditures and social activities. Those are the fundamental issues to be carefully considered regarding any strategic plan to increase food production and alleviating poverty and hunger.

4. The Challenges

We now face the challenge of feeding 8 billion people by the end of the first quarter of the twenty-first century.

The United Nations medium growth projection will expand from present 6 billion to nearly 8 billion in the 2025. More than 80% of these people will live in developing countries. This implies that, nearly with the same water and land resources base, we must grow food for 2 billion more people as well as supplying expanding domestic and industrial water use.

The experience leads us to the fact that to feed 2 billion people water supplies used in agriculture will have to be augmented by an additional 15 to 20% over the next 25 years, meaning an additional 0.6% to 0.7% of water supply per year.

This will lead us to get a better understanding of the options and tools to be implemented to reasonably meet our future water and food needs.

For sustainable use of water resources in irrigated agriculture to take up the challenge it is now facing, and the future difficult ones, and in order to survive the consequences of water scarcity, approaches to be undertaken by professionals are as follows:

- strictly manage the demand for those precious resources, preserve and increase the supply or more preferably combine the previous two options in an integrated management plan ultimately aiming at the sustainable development;
- set up effective water saving programs and strategies in all water uses sectors and, particularly, the agricultural one;
- increase water productivity;
- re-use and recycle non-conventional water sources as additional ones.

5. Growing Food Demand and How To Meet It

5.1. Water planning and management: the need for a new approach

The experience gained and the lessons learned clearly emphasize that the fragmented approach we are still using in managing water resources in the agricultural sector resulting in enormous water loss will never provide the countries suffering from water shortages with both water and food safety. In the majority of arid and semi-arid countries, the increase in water demand faced with limited water supply, on one hand, and the arising water scarcity problems, on the other hand, are steadily mounting; the response to such acute water shortages requires immediate actions and plans with appropriate changes in the way those countries are using and managing the water resources. Indeed, there are two main approaches that follow:

The first: the traditional hardware approach

Traditionally, solutions were fully focusing on the supply side, relying on an ever-larger number of dams, reservoirs, and aqueducts to capture and store ever-larger fractions of freshwater run-off. Such approach is now criticized for environmental, economic and social reasons. Basic human needs for water still remain unmet and it is becoming harder and harder to find new water resources, or even to maintain the existing ones to supply croplands.

Under such traditional approach, water-planning efforts usually did not include a detailed analysis of how water is actually used. Equally, there was no clear identification of the common goals for water development to seek agreement on principles to resolve conflicts over water. In addition, little attention has been paid to protecting natural ecosystems from which water supplies have been withdrawn. Those could be some of the driving forces, beside others including high costs of construction, tight budgets, and deep environmental concerns, changing the way we are following in planning and managing our water resources.

The second: the new soft path approach

This approach implies developing new methods to meet the demand of a growing population without requiring major new constructions or new large-scale water transfer from one region to another.

The focus is to explore the possibility for efficiency improvements, to implement options for managing demand and reallocate water among users to reduce projected gaps and meet future needs, particularly those regarding food (Gleick, 2002, 2003 and RMI, 2002).

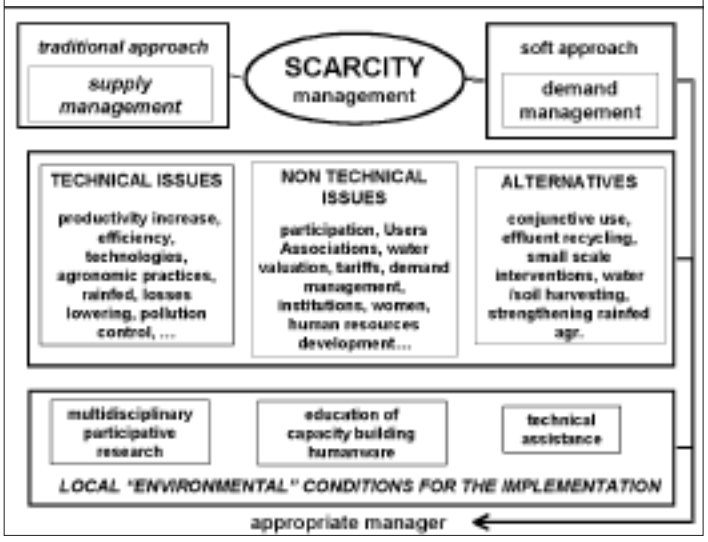
In this regard, two approaches should be followed: the first, by increasing the efficiency with which current needs are met, and the second by increasing the efficiency at which water is allocated among different users in particular in the irrigation sector.

In both approaches, efficiency is the key element towards producing more with less water in order to meet the increasingly stronger food demand.

5.2. Managing water scarcity: major policy issues

Policy issues here refer to various technical and non-technical issues in managing irrigation water. The list of such issues is long. In this part, emphasis will be placed on the highly relevant ones (Fig. 1).

Figure 1 – *Managing water scarcity: major issues (Hamdy et al., 2002A).*



5.2.1. Technical issues: water use efficiency improvements

Among the technical issues to be ranked as a priority in the region, there is the non-structural water development with its several techniques leading to the increase in crop water productivity, i.e. producing more with less water, reducing water losses and thereby lowering the water demand in the agricultural activities, and automatically increasing the foreseen water supply needed to increase the rate of irrigated agriculture without the need for any further irrigation infrastructure. This could be achieved through improvements in water use efficiency.

From a purely technical point of view, important water savings are possible, if one thinks that under realistic conditions water efficiency can vary from about 25% to 75% depending

on the cases, the modes and the equipment, understanding that moving from the former to the latter value means not only to triple the irrigated surface but also the food production at equal water volumes. Furthermore, this also will address some of the countries major environmental problems of waterlogging and salinity, declining groundwater tables, and shrinking lakes. There is great potential for improving the water efficiency in producing food, by changing cropping patterns towards less water-demanding crops, by reducing wasteful applications of water, by cutting field-to-plate losses, and by alternating diets and functioning of international markets (Hamdy and Trisorio-Liuzzi, 2004 and 2005). Small-scale irrigation and conjunctive use and re-use of non-conventional water resources are further alternative approaches recommended (Hamdy and Sardo, 2002).

5.2.2. Increasing water productivity

Improving water productivity in agriculture is the immediate answer to the question: *are we able to produce enough food to feed the arid and semi-arid burgeoning population and get it to where it is needed?*

Evidently, achieving greater productivity to resolve the water crisis will not happen automatically. An intensive work is needed to modernize irrigated agriculture, through technological upgrading, changes in attitude, as well as sufficient targeted investments in infrastructure modernization, institutional restructuring and upgrading of the technical capacities of farmers and water managers.

The key principles for improving water productivity at field, farm and basin level, which apply regardless of whether the crop is grown under rainfed or irrigated conditions, are: (i) increasing the marketable yield of the crop per each unit of water transpired; (ii) reducing all outflows (e.g. drainage, seepage and percolation), including evaporative outflows other than the crop stomata transpiration; and (iii) increasing the effective use of rainfall, stored water and water of marginal quality.

World Water Vision (2000) lists a range of technical and management options to improve productivity, including:

- developing new crop varieties with higher yields per unit of water - for example, crops with comparable yields but shorter growth periods;
- switching to crops that consume less water or use water more efficiently;
- improving soil management, fertilization and pest and weed control;
- improving the reliability of water supplies at critical crop growth periods; this would encourage farmers to invest more in other inputs and lead to higher output per unit of water;
- promoting deficit irrigation, which can increase productivity per unit of water by providing less-than-full irrigation requirements; and supplemental irrigation, which uses limited irrigation at critical periods to supplement rainfall.

Improving the productivity of water in agriculture does not fall into the domain of one group of specialists, but, rather requires the integrated efforts of breeders, natural resource management specialists, physical scientists, sociologists and above all the synergistic efforts of farmers and water resources managers.

5.2.3. Improvement of irrigation systems

Globally, for most countries, the major physical and technical problems and constraints in irrigation systems are: inefficient water use, shortage of water supply at the source, poor canal regulation, water-logging and salinity, poor operation and maintenance, small-scale programs and scarce water resources. Such problems and constraints require a set of common supporting actions, namely the development of adequate data bases, adaptive research, institutional strengthening, human resource development, improvements in socio-economic analysis, environmental protection, technology transfer and infra-structure development.

In many cases, technology-related problems have been accumulating for long time and their adverse impact on system performance is increasing because solutions have not been found or proven effective, and maintenance has been neglected.

What is generally required is improved maintenance, better linkages to seasonal production requirements to individual crops, more responsiveness to farmers and stepped up management, training and supervision.

6. Increasing food production: promising approaches

6.1. Available irrigation technologies and management techniques

A broad range of irrigation technologies now available can increase water productivity. For example, drip irrigation, which uses a network of perforated plastic tubes that deliver water directly to the roots of plants, can cut water use by 30-70 percent and increase crop yields by 20-90 percent.

There is also a variety of management techniques that can improve irrigation efficiency. These include improving irrigation timing, improving canal operations for more efficient deliveries, applying water only at crucial periods, using water-conserving tillage and field preparation methods, improving canal maintenance, and recycling drainage and tail water.

In addition, there is a wide array of small-scale irrigation strategies for areas with scarce water supplies. For example, check dams built across gullies can trap large amounts of runoff, which can be channelled to fields or stored for later use.

6.2. Appropriate water subsidies

Reducing water subsidies will help promote more efficient water use. The World Water Vision (2000) recommends that consumers be charged the full cost of providing water services, including the cost of obtaining the water and of collecting, treating and disposing of wastewater. Full-cost pricing will make water suppliers accountable to users, reduce water withdrawals from ecosystems, and provide the

revenue needed to cover operation and maintenance costs. Such policies must be accompanied by targeted, transparent subsidies to low-income communities and individuals.

Indeed, irrigation efficiency concepts need to be adapted in meaningful and easy to understand principles. Equating a unit of consumers' food per units of water needed for its production should be easily understood by the public which could then bring about changes in the pattern of food consumption that is not water efficient (Shady, 1999).

6.3. Increasing community participation: irrigation management transfer and the emerging role of the private sector

Historically, many irrigation regimes have been financed, managed and operated by governments, public sector or parastatal cooperation. In the last two decades, the trend has been to adopt the management transfer from the public sector to its users. More than 25 governments are now in the process of transferring responsibility for irrigation systems to local farmers' groups or other private organizations.

The case of Irrigation Management Transfer (IMT) is very relevant in Mexico. Management of more than 85 percent of the nations' irrigated lands has been turned off to Water Users Associations (WUAs). Water fees have been increased to cover costs, and the irrigation districts are about 80% financially self-sufficient (Kemper and Douglas, 2000).

Water Users Associations are an effective way to improve efficiency, productivity, accountability, and responsiveness to farmers. They give users the authority to operate and maintain water systems, collect fees, hire professionals and manage water rights (Hamdy, 2005). Through IMT running programs, rehabilitation and improvement of existing irrigation systems had resulted in bringing new life to potentially highly productive land as well as in correcting operation and management of wrongly planned irrigation systems, which are not producing and having such effective improvement in food production.

Regarding the private sector and its involvement in the water sector, it is advisable that before the privatization of public services can fully occur, the role of the public sector needs to be fully redefined. As it stands today, without private sector financing and input, it would become increasingly difficult to create new infrastructures or rehabilitate and expand existing ones. The question then becomes how to mobilize the private sector, so that it would assume the risk of financing, operating and managing this costly infrastructure. *What kind of environment is needed to stimulate their participation?* The few successful case studies of this should be examined. The telecommunications industry could be held up as a sterling example.

In this scenario of increasing privatization and management transfer, the areas of regulatory functions identified to protect the public interest should occur through legislation, regulations and the endorsement of standards of practice, and through a dispute settlement mechanism. Financing of research and development, education and partnerships should ideally remain in the domain of the public sector (Hamdy, 2003A; 2005A and B).

6.4. Agricultural research and technological progress

To date, agricultural research in developing countries has been mostly concentrated on production in relatively high potential environments and on traditional export and the main staple food commodities. Partial shift is now needed in research strategies to include the development of technologies for indigenous food crops and non-traditional export commodities.

Low cost, simple technology packages emphasizing improved cultivation practices could increase smallholder's food production and, consequently, their consumption in a comparatively short time. However, if smallholder programs have to realize this potential, a higher degree of political priority and administrative support should be provided than what programs for larger farms normally do.

A still very open field is that of biotechnology. *What are the prospects of it being used to address the needs of the poor and enhance food security*? *What role can the National and International Agricultural Research systems play in this respect? Conversely, what are the risks of polarization of production in developed countries on the rural poor and rural agriculture?*

In rural areas, specific work has to be done to establish accessibility to communication media and information and the way to enhance the promotion of Agricultural Information Systems by the National Agricultural Research Centres (NARS).

6.5. Access to capital and micro-credit initiatives

Access to capital is the other major factor for improving the material conditions of small farmers and other rural poor. Greater access to credit by the rural poor would entail improvements in a whole range of financial services. This is also the case with the micro-credit initiatives.

Improved credit arrangements can result in high returns to smallholders in the short term. Better credit facilities, emphasizing improvement of loan administration, will be a key element in any package of smallholder assistance. Providing small loans for small land holders and tenant farmers is a promising new approach to increase food production as it gives the opportunity to about half of the world's hunger people to grow their own food.

For the developing countries, it is necessary to move from general knowledge to the analysis of specific implementation mechanisms, facilitating awareness of the most effective practical modalities of micro-credit for food security.

6.6. Upgrading rainfed agriculture

According to the FAO (2005) projections, food demand in 2030 is expected to be 55 percent higher than 1998. To meet this demand, global food production should increase at an annual rate of 1.4 percent.

At present, 55% of the gross value of food is produced under rain-fed conditions on nearly 72% of the world's harvested

crop land. The subject receiving intense debate is the future food demands whether it will be provided by rainfed or irrigated agriculture. Indeed, in the past many countries focused their water attention and resources on irrigation development to fulfil both present and future food production gaps. However, what should be clearly understood is that most of the world's food production does not rely on freshwater withdrawals at all and does not necessarily accelerate the naturally occurring rates of evapotranspiration. This evidently means that the bulk of the world's agriculture production is rainfed and not irrigated.

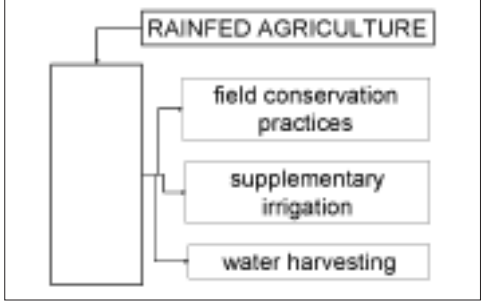
Evidence from water balance analyses on farmers fields around the world shows that only a small fraction of rainfall, generally less than 30%, is used as productive green water flow (plant transpiration) supporting plant growth (Rockstrom, 2003).

Losses in rainfall through drainage, surface runoff and non-productive evaporation is extremely high (70 up to 85 percent), whereas the part of the rainfall used productively, to produce food is minimum between 15% and to 30%. In arid areas, only as little as 10% of rainfall is consumed as productive green water flow with most of the remainder going to non-productive evaporation flow (Oweis and Hachum, 2003).

At the global level, it is well recognized that the potential of rainfed agriculture is large enough to meet present and future food demand through increased productivity. In this regard, an important option is to upgrade rainfed agriculture through better water, soil and land management practices. This can be done through several ways, including the following diverse options (Fig. 2):

- increasing productivity in rainfed areas through enhanced management of soil moisture and supplemental irrigation where small water storage is feasible;
- improving soil fertility management including the reversal of land degradation, and expanding cropped areas.

Figure 2 – *Diverse options for water management in rainfed conditions (Trisorio -Liuzzi and Hamdy, 2008).*



In the global analysis of more than 100 agricultural development projects, Pretty and Hine (2001) found that in projects that focused on improving rainfed agriculture, yields doubled on average and often increased of several hundreds percent. This clearly demonstrates and emphasizes again the large potential for investments in upgrading rainfed agriculture.

However, what to be stressed here is identifying the investments required today. Investments should be more strategic, planned within the overall national framework regarding the rainfed agriculture upgrading. A combination of investments, policy and research approaches will clearly be needed, in order to overcome the lack of commitment and targeted investment, insufficient human capacity, infective institutions and poor governance.

6.7. Adoption of deficit irrigation

Deficit irrigation is an optimising strategy under which crops are deliberately allowed to sustain some degree of water deficit and yield reduction (English *et al.,*1990).

From the practical point of view, there are different ways to manage deficit irrigation. The irrigator can reduce the irrigation depth, refilling only part of the root-zone soil water capacity, or reduce the irrigation frequency by increasing the time interval between successive irrigations. In surface irrigation, wetting furrows alternatively or placing them further part is one way to implement deficit irrigation.

Experiences gained in many parts around the world, clearly indicate that whatever the approach to be followed for managing deficit irrigation, the gaining benefits in optimising water use and improving water productivity is a function of different important management factors including the selection of crop variety, the crop rotation, sowing dates, crop density, soil fertility management and weed, pests and diseases control.

7. Discussions and concluding remarks

Insufficient food production to meet the increasing food demand is a major problem causing food insecurity in most developing countries.

The point to be asked is «*how did we get here and what are the major causes behind food insufficiency and increasing hunger in many countries around the world*»?

The reasons to such unbalanced food supply to meet the food demand are numerous, among them we would like to highlight the following, (Fig. 3):

Figure 3 – *Inadequate food supply: most common causes.*

The foundation of success lies in two major areas. *The first* is investment in agricultural productivity growth and *the second* is investment in human resources development.

Clearly, urgent actions are required (Fig. 4). In trying to list priorities for actions and design policies, therefore, it is much more important to focus on the questions «how» and at «what» cost.

Figure 4 – *Increasing food production: required actions.*

7.1. Different pillars within the agricultural sector

One of the first pillars to work on is the market at national, regional and even global levels. We know that for most developing countries, their markets are incomplete. They are poorly endowed with infrastructure, information, market intelligence and are suffering from difficulties in accessing to global markets. We have to start developing our national and regional markets.

If we have markets functioning well, the second pillar is water and how to use and manage it in the agricultural sector to reduce losses and improve its on-farm use efficiency and productivity.

The third pillar is land. There are not only soil fertility and productivity issues, but also serious issues of security of land tenure.

Next is science and technology. What kinds of technologies are we going to develop for the next generation of farmers? What are the land conservation and water saving technologies to be implemented to meet the increasing gap in food production? We have to think about these questions and decide on the technology to be implemented by farmers.

7.2. Key priorities for action: needed tools and strategies

To achieve the required food production to meet the growing demand, the priority actions should be focused on four areas:

- agricultural productivity;
- fostering pro-poor economic growth through improved markets, better infrastructure and greater trade competitiveness;
- building institutional and human capacity;
- strengthening governance.

If we want to seriously and correctly identify food and nutrition problems and accurately assess the economic and agronomic programs associated with them, we must set up a lasting system of observation, information and analysis. We need to think about a partnership between research, concerned administrations and professional organizations. This implies a long-term commitment of these stakeholders in human and institutional capacity building.

To meet the increasing food demand, agriculture must be intensified. The developing countries cannot continue relying on rainfed agriculture coupled with application of inappropriate technologies. It needs to explore all avenues for transforming agriculture, including irrigation.

Partnerships for food and nutrition security should be established on three levels: the national level, the regional level and the pan-continental level. An effective, fruitful partnership means that each partner has something to offer. The skills and know-how required for the partnerships should be forged at national level. Without this, it will be impossible for partnership to develop at the other two broader levels.

Setting up appropriate strategies for food and nutrition security that can be implemented. If strategies cannot be implemented, they are not sound. But, if implementation without a sound strategy is attempted, that is also not satisfactory. Successful implementation must happen at local level. Communities are the key to achieving food and nutrition security. We need effective decentralized management for public investment. But we also need sound public administration, wise public investment and adequate resource allocation.

There is no progress in food production without research. Agronomic research should be firstly considered. Whatever technical path is envisaged to improve food production, research must continue. Research institutions must also become more involved in partnerships with producer organizations, public services and private operators.

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