Rain-fed agriculture improvement: Water management is the key challenge

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Abstract

In arid and semi-arid regions water management is the key challenge for improving food production in rain-fed agriculture due to the extreme variability of rainfall, long dry season and recurrent droughts, floods and dry spells. Water management should be directed towards the reduction of water-related risks posed by high rainfall variability rather than coping with an absolute lack of water.

To reduce these rainfall-related risks a new era of water investments and policy is required. Investments are needed in soil, crop and farm management in small holders' rain-fed farming systems, those to improve water productivity to add new freshwater with valuable water saving through local management of rainfall and runoff.

For upgrading rain-fed agriculture there is an urgent need for widening policy scope to include new strategies for water management in rain-fed agriculture and to provide the required investments to implement the management options to build knowledge and to reform and develop institutions.

Introduction

For most countries facing an acute food gap, the potential for increasing water withdrawals for expanding irrigated area is quite limited. Increasing food production to fulfil the food gap is fundamentally depending on increasing crop water productivity to produce more biomass per unit of water. This confirms that the greatest potential increase in yields are in rain-fed areas where many of the world's poorest rural people live and where managing water is the key to such increase. Foreseeable future world food will be very difficult to achieve unless further efforts are directed to improve rain-fed agriculture from the perspective of water productivity and the water management spectrum to upgrade rain-fed farming system.

The crucial question which is still seeking a reasonable answer is: *how rain-fed crops can be improved?* The answer can be found through using innovative and appropriate water resources management techniques and small scale harvesting of water in combination with protective irrigation.

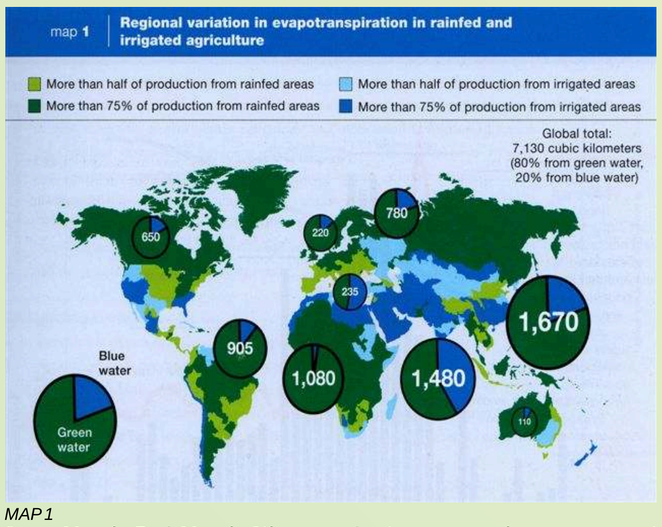
The way of thinking about water by water professionals and policy-makers should be changed realizing the need to improve the use not only of blue water in lakes, rivers and aquifers but, also, that of green water, the soil moisture under rain-fed agriculture which is still poorly managed.

Water use in rain-fed and irrigated agriculture

The main source of water is rainfall falling on the earth's land surface (110,000 cubic kilometres) (Fig.1).

It is estimated that out of the total annual amount of precipitation (110 km3), about 40,000 km3 is converted into surface runoff and aquifer recharge (Blue Water) and an estimated 70,000 km3 is stored in the soil and later returns to the atmosphere through evaporation and plant transpiration (Green Water).

A schematic of the hydrologic cycle components (Fig.2) illustrates where and how renewable annual water flows move through the hydrological cycle.



MAP 1
Source: Water for Food, Water for Life: a comprehensive assessment of water management in agriculture. (Earthcan, 2007).

Upgrading rainfed agriculture- the needs:

Changes in land, water and crop management under rain-fed agriculture.
Investments to build knowledge and to reform and develop institutions.
A combination of investments, policy and research approaches.

Experiences proved that lack of commitment and targeted investment, insufficient human capacity, infective institutions and poor governance are the major obstacles behind the low adoption rates of improved technologies as well as in not materializing rain-fed yield improvements.

Upgrading rain-fed agriculture: required water investments

Increasing the crop water productivity in rain-fed agriculture is the solely effective pathway towards attaining food security. A key to success is to invest in the often untapped potential of upgrading rain-fed agriculture through integrated water investments. The key challenge is to reduce water related risks posed by high rainfall variability but this cannot be achieved in the absence of the needed investments in water management as they are the entry point to unlock the potential in rain-fed agriculture.

The temporal and spatial variability of climate, especially rainfall, is a major constraint to yield improvements, competitiveness and commercialisation of rain-fed crops, tree crops as well as livestock systems in most of the tropics. This is why investment in soil, crop and water management is crucial for upgrading rain-fed agriculture.

Improving rainwater management

Globally, only a small fraction of rainfall, generally, less than 30%, is used as productive green water flow (plant transpiration) supporting plant growth. Rainfall partitioning in the semi-arid tropics indicating rainfall losses from the farm scale is given in (Fig. 4).

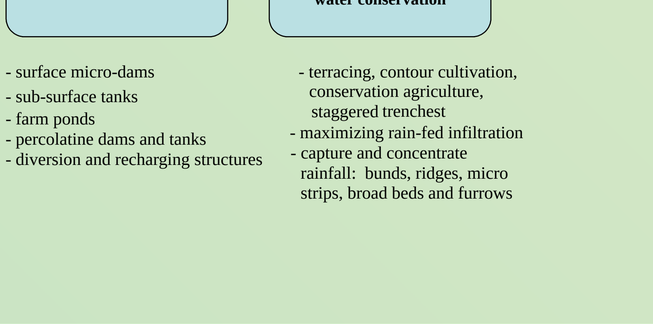


Fig. 4 : Rainfall partitioning in the semiarid tropics. Source: Water for Life, Water for Food: a comprehensive assessment of water management in agriculture (2007) (ed) D. Molden.

Rainwater management strategies and options

Blue and Green Water

Blue water: is the freshwater that sustains aquatic ecosystem in rivers and lacks. It is used for drinking or domestic purposes, to industry and hydropower and to irrigated agriculture. Blue water withdrawals are about 9% of the total blue water sources (43,800 km3) with 70% of withdrawals going to irrigation (2,700 km3). Irrigation uses in addition to blue water the green water, where as rain-fed agriculture uses only green water.

Globally, about 80% of agricultural evapotranspiration is directly from green water with the rest from blue water sources (Map. 1)

Upgrading rain-fed agriculture and future food demands

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 rain-fed or irrigated agriculture. In the past many countries focused their water attention and resources on irrigation development to fulfil both present as well as future food production gaps, but it should be clearly understood that most of the world's food production does not rely on freshwater withdrawals and that the bulk of the world's agriculture production is rain-fed not irrigated.

The potential of rain-fed agriculture is large enough to meet present and future food demand through increased productivity, through better water, soil and land management practices and through the following diverse options (Fig. 3):

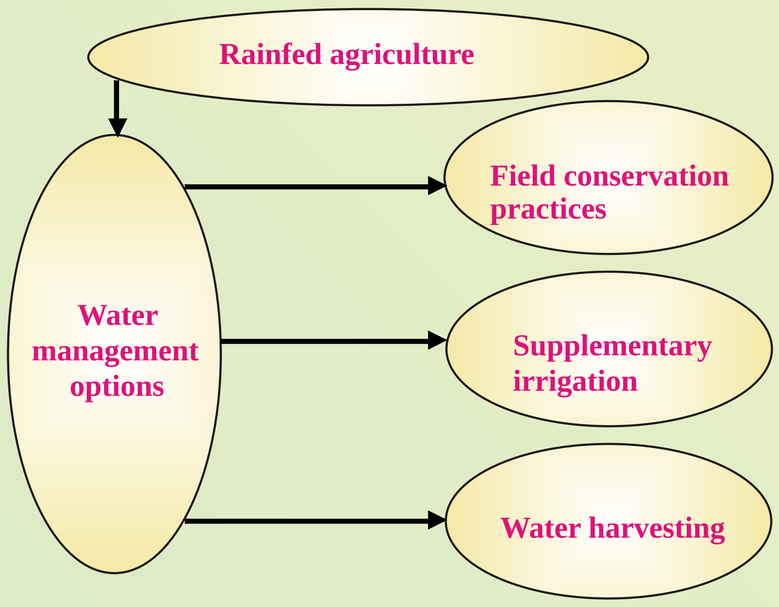


Fig. 3 Diverse options for water management in rain-fed conditions

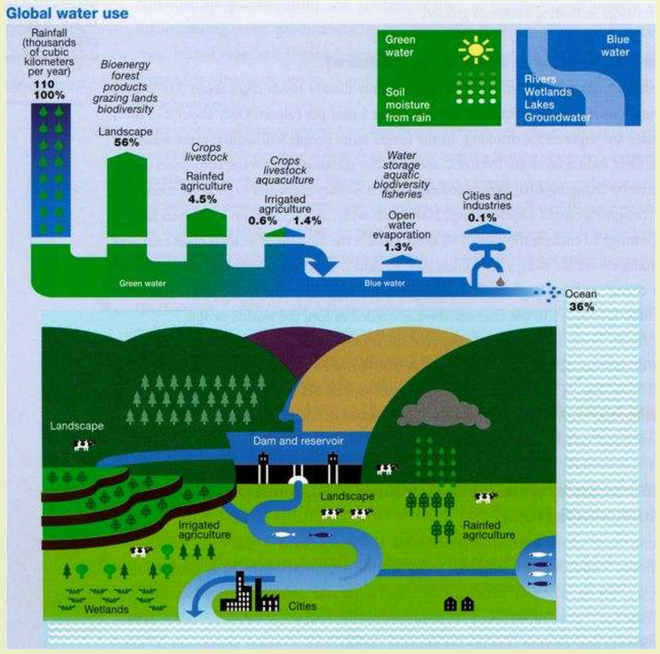


Fig. 1 Water use in rain-fed and irrigated agriculture. Source: Comprehensive assessment of water management in agriculture. 2007, Water for Food, Water for Life - (eds) D. Molden

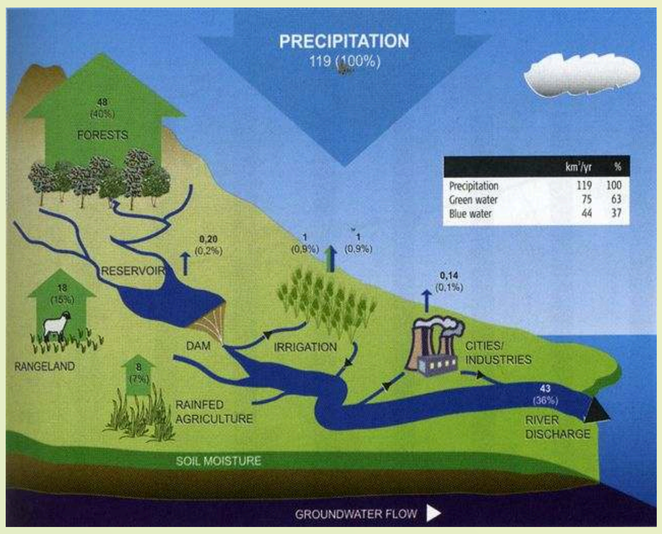


Fig. 2 Blue and Green Water. In: Water a Shared Responsibility. The United Nations :World Water Development Report (2) 2006. FAO, IFAD.

The presented data show that losses in rainfall through drainage, surface runoff and non-productive evaporation is extremely high (70 up to 85 percent), where as the part of the rainfall used productively, to produce food is of minimum values lying between 15% up 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.

Rainwater management is truly poor generating excessive runoff, causing soil erosion and poor yields due to a shortage of soil moisture. Investments in this area will not only maximize rainfall infiltration and the water-holding capacity of the soils, but, in the meantime, will minimize land degradation as well as increasing the water available in the soil for crop growth. Investments to meliorate rainwater management in rain-fed agriculture will result not only in achieving significant and sustainable increase in food production, but, equally, in improving environmental sustainability.

Today required investments should be directed to increase human and institutional capacity and improve management and infrastructure. Investments should be more strategic, planned within the overall national framework regarding the rain-fed agriculture upgrading.

Water management to upgrade rain-fed agriculture

Water management to upgrade rain-fed agriculture encompasses a wide spectrum from water conservation practices for improving rainwater management on the farmers' field to managing runoff water (surface and sub-surfaces) for supplying supplemental irrigation water to rain-fed food production.

Improving water management in rain-fed agriculture is a long term process and requires learning by doing using an adaptive approach that should be:
responsive to the variability within systems as well as to the long term and slow ones changes;
carefully consider the increasing rainfall variability and frequency of extreme events such as drought, floods and hurricanes due to the emerging climatic changes.

Upgrading rain-fed agriculture: the constraints

Why water management investments in rain-fed agriculture have been neglected over the past 50 years due to several reasons, among them:

in this period all the efforts were directed to the development and management of the blue water with a major focus on developing and allocation of such water particularly to large scale irrigation;
large investments have historically tended to go to high potential irrigated areas, keeping most rain-fed areas with very poor infrastructure facilities;
the complete failure in establishing the enabling conditions needed to promote and upgrade rain-fed water management;
the limited capacity of local institutions engaged in agriculture development and extension beside the very weak existing information systems;
investments needed for turning the knowledge for better management of rainwater into innovations in governance, policy, institutions, practices and technologies are very limited and, in many cases, are completely absent.

Upgrading rain-fed agriculture: water management perspectives

On the globe, the evidence of rain-fed agriculture conveys two key messages: ***the first***, emphasizes the major important role rain-fed agriculture could play in global food security and sustainable economic growth; ***the second*** message is that there are large opportunities for gains from new investments in water management. Investments in rain-fed agriculture have large payoffs in yield improvements and poverty alleviation through income generation and environmental sustainability.

Some views are considering the rain-fed agriculture as a risky business with current yield production generally less than half of those in irrigated systems. This is mainly due to insufficient policy and institutional support for improving water management for production. The focus on blue water has led to week policies for water management investments in rain-fed agriculture.

What is needed to be done

Important efforts have been made for improving green water productivity and increasing food production, but what has been achieved is very limited with respect to what is planned and desired. What to be stressed hare is that we have the knowledge for improving water management in rain-fed agriculture to increase yield production, but there is a gap in the dissemination and use of this knowledge among the stakeholders from policy makers to the users, the small scale farmers.

It is needed to overcome the existing constraints including technical, socio-economic and policy factors and, above all, the inadequate investments in knowledge sharing and scaling-up of best practices. Unlocking potential in rain-fed requires large new investments in human capacity building, supporting research and institutional development as well as specific technologies.

Upgrading rain-fed agriculture requires integrated approaches to social and ecological management. The integrated approach to rainwater management must address links between investments and risk reduction and between rainwater management and land and crops management. Equally, there is a need for innovations in management of water that requires novel technologies and practices.

It is time for governments, development organizations and donors agencies to cancel completely the notion that rain-fed farming is a marginal activity and, instead, raise the awareness, promote investments to upgrade rain-fed agriculture to abandon the sectoral divide between irrigated and rain-fed agriculture and to place water resources management and planning more centrally in the policy domain of agriculture at large. Unlocking the potential of rain-fed agriculture is a long way and complex process, but we have to start even where water poses a particular challenge and to invest in tapping the potential that lies in the availability of adequate but erratic resource provided by rainfall.