Water Resource Management and Crop Production in General and in Ethiopian Scenario

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Abstract
Water was considered a free commodity in the past, which meant that its quality was unregulated and it was available whenever it was needed. However, as a result of increased population and urbanization, diversification, and a rapid increase in resource demands, water resources are becoming limited and of lower quality. Only 13-18% of the water used by irrigated crops worldwide is used in the form of transpiration, which is correlated with yield and production. Small-scale irrigation development would result from a lack of quality and quantity of water supply for growing crops, as well as increased social, economic, and environmental costs associated with developing large-scale irrigation schemes. This type of development has an impact on the use of rain-fed water for irrigation efficiency. Whereas rain-fed agriculture produces more irrigation products in developing countries' semi-arid regions, accounting for up to 90% in some cases. The primary option would be to increase crop production in these areas by increasing rain-fed agriculture, which ensures that freshwater supply is not stressed in irrigated agriculture. Ethiopia also has a significant amount of available water resources. Despite the country's remarkable water resource potential, river basin development is rarely carried out. Water is critical to the development of the country. Furthermore, Ethiopia's abundant natural water resource endowment, rapidly growing economy, and ambitious government agenda present significant opportunities. It is critical to recognize and capitalize on these opportunities. Water resource management in Ethiopia is hampered by a lack of knowledge about resource conditions, patterns of use, and change drivers, as well as a lack of capacity and capacity within organizations to manage water distribution, determine impacts and trade-offs, and ensure 'climate-smart' planning.
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1. Water resource and crop production

Though water is more yet a scarcer resource compared to land, it is difficult to understand how it can be used in a more productive, efficient, and fair manner. Conventionally, farm productivity is a significant measure of the production of irrigated agricultural land, expressed as the ratio of grain yield to a harvested unit area (kg/ha) (Bastiaanssen et al. 1999). In areas of water-scarce overall production is improved by rising crop water productivity (CWP). Higher CWP, as reported by Zwart & Bastiaanssen (2004), is either a result of the use of fewer water resources for the same production or the use of the same water resource for higher production. The amount of crop ET has a direct relation to crop yield. To achieve more crop yield to its physical limit, it is possible only if more water is provided for crop evapotranspiration. Sometimes increasing crop water productivity (i.e., increasing the productivity of water consumed by ET) also suggested one way of alternatives to enrich crop yield.

The productivity of water is expressed as the ratio between the mass of production/economic value and crop evapotranspiration or the ratio between the mass of production/economic value and supply/depletion of water, i.e., the productivity of water is defined as the tangible value (kg) or economic value ($).On the other side, the amount of water quantities can either be consumed or supplied (m3). Proportionally low and high in sub-Saharan Africa and developed countries, respectively (Cai & Rosegrant 2003). Several studies have shown that there is an improvement in CWP to save water (Cai & Rosegrant 2003; Zwart & Bastiaanssen 2004). Such improvements can be accomplished by increasing the mass of production per hectare of land (grain yield) by enhancing crop varieties and practicing greater agronomy (Erkossa 2011; Sadras et al. 2012), as well as by improving water management and the development of related materials. For instance, the use of fertilizer at the farm level and allocating available world water resources between and within irrigated & rain-feed agriculture to make the land use more efficient (Nangia et al. 2008). Moreover, Sadras et al. (2012) address the behavior between agronomy and breeding, usually apart from over-edged.

Furthermore, the majority of grain crop water productivity is increased by enhancing long-term yield potential without any significant change in the absorption of crop water (Sadras et al. 2012), raise the fertility of the soil by increasing photosynthesis through increasing canopy size, nutrient, and water absorption through the development of root growth (Erkossa 2011). Various factors affect the productivity of the water resource compared to the land resource. These include water management and availability in the well, canal management, soil salinity, farm water management, agronomic practice, water table depth, and crop varieties (Bastiaanssen et al. 1999). They argued that CWP is more homogenous than land production (kg/ha). Water productivity can also be influenced by other factors, such as size, amount, timing, and season of rainfall events, and nitrogen deficit (Sadras et al., 2012).

Both agricultural water and the agricultural land use area will increase rapidly from 301 million ha in 2009 to 318 million ha in 2050. Depending on the availability of data, the agricultural withdrawal will further increase from 2900 km3/yr to 3000 km3/yr by 2050. It means that by 2050, the water withdrawal from agriculture will be 10% higher than it is now (FAO 2011). Zwart and Bastiaanssen (2004) depict that, on the global scale, crop water productivity for irrigated maize (Zea mays L.) varies between 1.1 and 2.7 kg m-3. They concluded that the achievement of the maximum yield of maize using a wise irrigation system in the water-scarce region contributes to the achievement of CWP under favorable conditions. This is attributable to the sowing of maize on the bottom (tape) of the irrigation of the furrow (Ibrahim and Atta 2014).

In the worldwide, only 13-18% of the water is used by irrigated crops in the form of transpiration, which is correlated with yield and production. Limited quality and quantity of water supply for growing crops, increased social, economic, and environmental costs for developing large-scale irrigation schemes would lead to small-scale irrigation development. Such development affects the use of rain-fed water for irrigation efficiency (Wallace and Gregory 2002). Whereas rain-fed agriculture in the semi-arid regions of developing countries produces more irrigation products, accounting for around 90% in some countries. The primary option would be to increase crop production in these regions by increasing rain-fed agriculture, which ensures that the freshwater supply will not be under strain in irrigated agriculture (Wallace 2000). In the initial analysis for water stress, Falkenmark (1997) supposed that the annual per capita of freshwater demand from irrigated agriculture in the semi-arid area is around 785m3. Of which 50% from the estimated total annual per capita of water requirement and the remaining 50% of food is found from rain-fed agriculture. In both rain-fed and irrigated agriculture areas, water from the given area has been losing through surface runoff; these are due to high rainfall amount, less soil infiltration rate, and steeper slope of the land. Fallis (2013) and Shiklomanov (1998) estimated global water withdrawal by their demand in the three major sectors agriculture, industries, and municipal (domestic). Irrigated agriculture uses the most considerable portion of the world's annual freshwater resource (Shiklomanov 1998; FAO 2011; SDSN 2013; Fallis 2013). This accounts for 69% of annual water withdrawals worldwide(The United Nations 2016). This affects the daily life of human beings in different ways, both indirectly and directly.

Falkenmark (1997) has obtained annually per capita availability of freshwater in 21 different regions of the world for the current and the year 2050. Using Falkenmark data Wallace (2000) reveals that currently, around 7% of the world's population lives in areas where there is some degree of water stress. When the same annual renewable freshwater resources are shared among the world population estimated for 2050, it is expected that about one in six of the world's population will have insufficient water to meet their basic requirements (> 2,000 m3). Presently, the availability of per capita water in North Africa is less than 1,000 cubic meters, which appears to be the countries with the most extreme water scarcity in the region; there is also some water scarcity in southern Africa and the Middle East. This condition would spread to large regions of Africa and the Middle East. The annual availability of water in Ethiopia is also approximately 1,220 m3 per capita, showing water-stress circumstances. It has also been distinguished that two of the twelve river basins in the country are water surpluses (Abbay and Baro-Akobo), of which eight are water deficits at various levels (Tekeze, Mereb, Awash, Afar-Denakil, Omo Gibe, Rift Valley, Wabi Shebele and Genale Dawa) and the remaining two are dry (Ogaden and Aysha). There are always issues related to water in dry and deficit basins that have an impact on the community's growth and livelihoods activities (Adeba et al. 2016). Most regions of the world, with already enough water, would face some degree of water scarcity, such as India, the Far East, and parts of China. In order to estimate water stress globally and regionally, it is imperative to combine the estimates of the UN population and the estimated amount of annual renewable freshwater resources with the amount of water needed to grow basic per capita food requirements (Wallace 2000).

2. Water resources in Ethiopia

Ethiopia has a significant amount of available water resources (Berhanu et al. 2014; FAO 2016). Even though the potential for water resources in the country is remarkable, river basin developments are rarely carried out. The water resource is essential to the country's development. In addition, water-based production is the key to the country's growth and transformation. The country's Growth and Transformation Plan (GTP) also recognizes and aims to improve the use of the country's water resources (Berhanu et al. 2014). The country is estimated to have a total volume of 112 BCM of surface water and some 2.6 BCM of groundwater. The western half of the country receives a sufficient amount of precipitation and has many seasonal rivers and streams, while the precipitation is negligible in the eastern half of the country. As a result of the rapid land loss that is taking place at present, the amount of water entering the land taken away from it must have risen more than ever before. The amount of water available on the spot was therefore reduced, especially in the eastern half of the country. The country's river's primary source is the highlands of Ethiopia, which flow towards the West and the Southwest. Such rivers are Abbay, Baro-Akobo, Tekeze, Mereb, Awash, and Omo (Paulos 2002).

3. Water resource management

Water balance is the basis for policy-making and management on several critical issues related to water resource management, such as flood forecasting, water supply systems design, management of water ecosystem, use and allocation of water, virtual water management, wastewater and storm water management in urban areas and water trading (Ghandhari and Alavi Moghaddam 2011). In all of these fields, the basin's policymakers and managers require excerpt information on demand for water, change in storage, and water resource volume in the basin. The definition of water balance has acquired significant popularity among hydrologists, geologists, meteorologists, geographers, climatologists, and other disciplines primarily concerned with water problems. Therefore, it is beneficial to research the water balance and apply this principle in the study of an agricultural area to achieve better and efficient planning, management, and rational conservation of water resources in the cropland. Water balance may be defined as the income of water from precipitation and other sources and the loss or outflow of water by means of evapotranspiration. Moreover, water balance is important in arid and semi-arid regions as it can be used to assess the hydrology of the area. It also allows an evaluation of the quality of the data and the identification of inconsistencies. The measurement of the water balance can be carried out for both small and large areas of the basin. The water balance analysis in the catchment can be as short as one second and as long as many years.

The state of water resource for quantitative understanding is used for safe water management. Properly managing water resources is an essential component of growth, equity and poverty reduction, social and economic development, and sustainable environmental services (UNESCO 2009). The availability of sufficient and reliable data is required for monitoring, sound policy, participation, and research (Awad et al. 2009). Compromised validity of information due to an insufficiency of reliable and sufficient data is used for subsequent decision making and assessment purposes (UNESCO 2009). Economically secure and equitable water resources with integrated water resource management (IWRM) in the river basin are considered viable options to safeguard environmentally sustainable growth. IWRM is a mechanism that promotes integrated land, water, and associated resource management and development. It starts with a comprehensive collection of basin data, such as physical and socio-economic data, and the development of physical systems models such as hydrology, hydrogeology, and hydraulics (Ako et al. 2010).

Water is considered as a free commodity in the past, i.e., unregulated in quality and available as needed. However, a resulting increase in population and urbanization, diversification, and a rapid increase in resource demands are becoming limited and lower quality water resources. Diversification comprises irrigation water, industrial process, municipality, conservation of aquatic ecosystems, generation of hydropower, and fisheries (Mensah 2010). For example, various information is required to allocate freshwater for agricultural irrigation and other purposes and gain the best possible outcomes. These include consumption of water by vegetation and crops, availability of water and streamflow, and related crop production (Albek et al. 2004; Young 2006; Awad et al. 2009). Having said that, locating this information in any area is difficult. Globally, for instance, due to unreliable and incomplete data on water quality and quantity, adequate management of water resources is given by the water observation network; however, these networks are in danger of potential declines (UNESCO 2009). In addition, recorded streamflow data are not available globally in different river basins due to the degeneration of the gauging station. FAO (2003) reported that, out of a total of 7782 streamflow gauging stations in the Mediterranean region, only 1868 have more than 30 years of time-series records.

4. Water resource management in Ethiopia

Ethiopia has a generous endowment of water, but this water is distributed unevenly in space and time. Unmitigated hydrological variability, compounded by climate change, has been estimated to cost the country roughly one-third of its growth potential (World Bank 2006). Today, the production of water resources to promote' green growth' and poverty reduction is a key plank of government policy as the country aims to achieve middle-income status by 2025. Ethiopia's Growth and Transformation Plan (GTP) sets ambitious goals for a six-fold increase in irrigated land and a quadrupling hydropower generation capacity between 2015 and 2020 (NPC 2016).

Water has played a major role in Ethiopian society; it is almost a source of input for all forms of output and a force for destruction. There has been a struggle across society to increase productivity and reduce the negative effects of productivity in the country. This challenge has increased over the last century as the population has grown rapidly. The increase in population requires effective management of the country's land and water resources. Today, Ethiopia's development is critically constrained by a complicated legacy of water resources and a lack of access to and management of these water resources(World Bank 2006).

Ethiopia’s rich natural water resource endowment, its rapidly growing economy, and its ambitious government agenda offer significant opportunities. It is essential to understand what these opportunities are and capitalize on them. For example, the formulation of the second GTP (GTP-2) can provide an entry point to reinforce the links between WRM and land resource management and set aside funding to establish stakeholder collaboration and data sharing mechanisms' at all levels. WRM in Ethiopia is hampered by a lack of knowledge of resource conditions, patterns of use and drivers of change, and a lack of capacity and capacity within organizations to manage the distribution of water, determine impacts and trade-offs, and ensure ' climate-smart ' planning.

5. Conclusion

Though water is a more valuable and scarce resource than land, it is difficult to see how it can be used in a more productive, efficient, and equitable manner. Furthermore, the majority of grain crop water productivity is increased by increasing long-term yield potential without any significant change in crop water absorption. Increase soil fertility by increasing photosynthesis through increased canopy size, nutrient, and water absorption through root growth development. Several factors influence the productivity of the water resource in comparison to the productivity of the land resource. Other factors that influence water productivity include the size, amount, timing, and season of rainfall events, as well as nitrogen deficiency. Ethiopia has a plentiful supply of water, but it is distributed unevenly in space and time. It has been estimated that unabated hydrological variability, compounded by climate change, will cost the country roughly one-third of its growth potential. Water has played a significant role in Ethiopian society; it is almost a source of input for all forms of output as well as a destructive force.

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