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The essentials of deficit irrigation for crop and water productivity in Ethiopia: A review

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Abstract

Improving irrigation water control and augmenting crop and water productivity (WP) are essential to report future water scarcity in Ethiopia. Increasing WP via revealing the crop to an effective stage of water stress the usage of deficit irrigation (DI) is taken into consideration a promising strategy. To espouse deficit irrigation schemes, a shared of complete proof regarding deficit irrigation for distinctive crops is mandatory. The objective of this critical assessment is to collect good enough facts approximately the indicators on the essential of DI to crop and water productivity. Just a revision on the role of deficit irrigation shows recover crop yield and water use efficiency or water productivity. The end result confirmed that DI appreciably improved WP in comparison to complete irrigation. The study was additionally observed that yield declining can be minor in comparison to the advantages won through diverting the kept water to irrigate additional arable area. The advantages of water-saving methods which include deficit irrigation techniques want to be traveled to make sure meals safety for the ever-growing populace in the context of decreasing accessibility of irrigation water. Consequently, reviewer concluded that deficit irrigation is doubtlessly essential to enhance supportable crop and water productiveness in Ethiopian agriculture.

Keywords: Deficit Irrigation, Water Productivity and Crop Productivity

1. Introduction

The Ethiopian agriculture is the foundation of the country's economy. About 82% of the Ethiopian population are existing in rural areas and involved in farming for their livelihood (Bank 2014). Agriculture also accounts for 40% of Agriculture additionally accounts for 40% of the gross domestic product (GDP) of Ethiopia(Awulachew et al. 2010). However, most Ethiopian farmers rely on low productiveness rain-fed small-holder agricultures, despite the fact that rainfall could be very inconsistent, drought happens very frequently Rain-fed agriculture produces almost all of the country's food crops. This shows that the country's water potential is underutilized, and that emerging and effectively consuming this natural resource will enable the country to become food self-sufficient in a short period of time.

During dry developing intervals whilst there's not sufficient rainfall to catch up on soil moisture losses through evapotranspiration, utility of irrigation water with the aid of using synthetic manner is required to keep right crop growing and productivity. Refining irrigation water controlling and increasing water productivity (WP)is essential to report future water shortage with inside the sub-Saharan region. Through the growing water shortage in developing countries, improving agricultural water managing approaches is of paramount significance to minimize diet insecurity (Giordano et al 2016).

The adoption of techniques for saving irrigation water and preserving appropriate yields may also make contributions to the upkeep of this ever greater limited resource(Topçu et al. 2007).This lengthy-time period use of water in irrigated agricultural systems, with an emphasis on decreasing water use, calls for careful making plans and management. In regions of water scarcity and lengthy summer time season droughts, maximizing water productiveness can be extra useful to the farmer than maximizing crop yield according to given unit of land. One of the irrigation control practices which should bring about water-saving is deficit irrigation(Eck et al. 1987). Deficit irrigation (DI) is a water-saving method below which plants are uncovered to a positive stage of water strain both all through a particular developmental stage or all through the complete developing season (Pereira et al. 2002). DI can be taken into consideration as a manner of maximizing water use efficiency (WUE) through making use of a discounted quantity of irrigation water, which has no considerable effect on yield (Akele 2019a).According to Fereres and Soriano (2007), the level of irrigation supply should be 60-100% of full crop evapotranspiration (ET_c) requests in most cases to improve water productivity. The DI may be taken into consideration as a manner of maximizing WUE via way of means of making use of a discounted quantity of irrigation water, which has no tremendous effect on yield(Akele 2019b).

Even though irrigation practices is an old stage exercise in Ethiopia, WP has been recognized As very low(Erkossa et al. 2011; Hordofa 2006). Advanced, to emphasis on strive which could increase water productivity in irrigated agriculture; comprehensive proof and good enough understanding regarding deficit irrigation outcome on water productivity and crop produce are necessary. Nevertheless there are numerous area attempt on deficit irrigation, there isa lack of complete assessment research approximately DI outcomes on water and crop productivity which may be used as a position for students and other users in each Ethiopian and Sub-Saharan states. This assessment paper, therefore, pursuits to bridge this understanding hole and offer good enough statistics approximately the effect of DI techniques on distinctive crop yield and water productivity, that is beneficial for growers, researchers, planners, and decision-makers

2. History of irrigation in Ethiopia

The Ethiopian agriculture is the leading movement to tolerate the agricultural community's lifestyles and essential to people's fundamental requirements(Tesfaw 2018; Tilahun et al. 2011). Irrigation is presently taken into consideration as a way by which agricultural productiveness may be stepped forward to meet the developing food call for in Ethiopia (Awulachew et al. 2005). Furthermore, to conquer the trouble of insufficient rainfall irrigation improvement is the fine technique and has been given tremendous interest in Ethiopia cited by Daniel G. Eshete(Ayele 2011; Hagos et al. 2009; Haile and Kasa 2015). Irrigation improvement has been recognized as an essential device to actuate financial increase and rural improvement to enhance family diet safety and indigence discount in Ethiopia (Garbero and Songsermsawas 2018; Hagos et al. 2009).Ethiopia has been began out traditional irrigation exercise during that historical time for the intention of subsistence nutrition production(Awulachew et al. 2007). Bekele et al. (2012) reported that in Ethiopia, old-style irrigation changed into skillful earlier than centuries. Furthermore, with inside the uplands of Ethiopia, irrigational exercise have lengthy been in use subsequently earliest times for producing survival diet crops (Awulachew et al. 2007;

Bacha et al. 2011). Different authors like; Awulachew et al. (2007); Makombe et al. (2007);Bacha et al. (2011)concerned that supplementary irrigation has been expert through smallholder farmers of Ethiopia for periods to explain their livelihood contests.

Ethiopian agricultural practices traditionally used spat irrigation system predominantly in Southern Tigray and in some semi-arid regions which has been used for water collecting from greater areas at upper streams (Mehari et al. 2011). These conventional irrigation structures have been advanced and controlled via making a water user's association for capabilities of building, water distribution, setup and upkeep and have been controlled through persons(Belay and Bewket 2013). However, current irrigation was happening in the initial 1950's by the bilateral settlement among the government of Ethiopia and the Dutch company together known as HVA-Ethiopia sugar cane plantation (Bekele et al. 2012).Modern irrigation in Ethiopia starts under Rift Valley especially in the Awash River Basin at which adoption of pump-irrigation begins(Gebremedhin 2015).

Similarly Awulachew et al. (2007)defined as irrigated agriculture has begun out in Ethiopia with inside the higher Awash Valley with the goal of making commercial plants as sugarcane, cotton and horticultural crops on a large-scale basis, defined in an amazing appearance of irrigation improvement and established order of agro manufacturing centers. This turned into because of taking the benefit of the development of Koka dam estimated as a reservoir irrigation water supply, flood manage and hydropower generation.

2.1. Concepts of Deficit Irrigation

Currently and extra with inside the coming, irrigated agriculture will be afflicted by irrigation water scarcity, specifically with inside the regions with excessive evaporative request, short and abnormal rain, and recurrent drought period(Brouwer et al. 1989).Increasing demand and competition for irrigation water need leads to changes in irrigation management to improve crop water use and saving the scarce available water for agriculture. Now a days, deficit irrigation (DI) is extensively considered as one of the water-saving options (Pereira et al. 2002). It is critical for reducing irrigation water use and increasing water production in a variety of field crops(Fereres and Soriano 2007). The aim of DI is to enhance crop water use efficiency (WUE) by minimizing the amount of water applied or by decreasing the number of irrigation events (Kirda 2002). Geerts and Raes (2009)also reported as DI is an optimization method in which irrigation is practical during drought-sensitive growth stages of the crop.

DI is one of the talented irrigation plans to maintain acceptable yield in the situation of water shortage and efficient tools to optimize water use efficiencyDemelash (2013) and Tejero et al. (2011) defined as DI in numerous crops has often proved to be an effective tool to increase water-use efficiency. It goals at steadying yields and at attaining extreme crop water productivity rather than extreme yields (Geerts and Raes 2009). In DI, plants are exposed to certain levels of water stress during precise growth stages or during the whole growing period, without a significant decrease in yields (Kirda 2002).

Deficit irrigational practices is different from traditional water supplying system(Kirda 2002). Prior to implementing the DI program, it is essential to know the crop yield reply to water deficit, either through the particular growth periods or throughout the whole growing season (Kirda et al. 1999). The crop yield reduction may be insignificant likened with the advantage gained through the diverted saved water to irrigate extra cropland (Kirda 2002; Patel and Rajput 2013). Deficit irrigation strategies, when used correctly, can result in significant savings in irrigation water allocation (Kirda 2002). The water saved from deficit irrigation application of one piece of land might be important to irrigate additional cropland (Bekele and Tilahun 2007; English 1990; Kirda 2002).

a) Essential of deficit irrigation for crop production

The reaction of crops to water shortage depends on the extent and rate of water loss and its timing and duration (Tura and Tolossa 2020). Many investigations had been carried out to gain experience in the irrigation of crops to increase the performance, profitability, and efficiency. Yet, examinations in water-saving irrigation still are sustained. Mostly full irrigation is used by farmers in unlimited or even water-limited areas. Under this technique, crops receive full crop water requirements to outcome the higher crop yield. Currently, full irrigation is considered as an extra use of water that can be minimized with negligible or no effect on gainful yield (Kang and Zhang 2004). But, the degree of irrigation decrease is crop-dependent, and most irrigation reductions are escorted by no or slight yield loss, which rises water productivity(Ahmadi et al. 2010). Different researches have been conducted on the effects of deficit irrigation on crop in different agro-climatic conditions such as(Bekele and Tilahun 2007; Biswas et al. 2017; El-Sherif and Ali 2015; Tezera Bizuneh 2019).

According to Tezera Bizuneh (2019), the effects of soil moisture stress on onion crop production in the central rift valley of Ethiopia, the result of the study directed that different soil moisture stress levels influenced the growth and the yield of the onion crop. The best marketable bulb yield was recorded at 100% ETc but it was statistically similar with 75% ETc, the lowest marketable yield was obtained under 40% ETc. The studies ofLeskovar et al. (2010) showed that DI at 50% ETc decreased most growth components and reduce marketable onion yield by 27% and 19% in both the cropping seasons, while DI at 75% ETc reduce yield by 8% and 13% by saving 25% irrigation water in both growing seasons compared with a 100% ETc irrigation application. Generally, they conclude that onion yield can be affected by the volume of irrigation water application.

According to (Meskelu et al. 2017), the request of 85% and 70% of ETc DI techniques didn't show a significant wheat yield minimize. Deficit irrigation includes locating the best stability among water use and crop yield. Under deficit irrigation, crop producers agree the crop to enjoy certain water stress, however the water saved have to permit rise with inside the irrigable land, or it may be placed to greater productive use. DI is comparatively inexpensive to stabilize crop yield with limited water (Heng et al. 2009).ICARDA has proven that a 50% discount in irrigation water implemented reduced yields with the aid of using 10 to 15%, and general farm productiveness extended by 38% whilst the water saved turned into used on the extra land(Pereira et al. 2002).Narayanan and Seid (2015)reported as the uppermost grain yield of 8.4 tons per ha was gained from conventional furrow irrigation at 100% of crop water application and had no significant change with 85% of crop water application. This indicates that 15 percent saved water can be used to irrigate additional crop lands which will be enhancing the crop yield.

2.2. Concept of water productivity

Eshete et al. (2020) reported as the well-organized use of Sub-Saharan Africa's water resources would considerably rise the production of food and export of high value crops. The main challenge of irrigated agriculture is how to improve water productivity and crop production from limited water supply (Igbadun et al. 2012). For the sustainability of irrigated agriculture, water productivity is used to identify the management strategies by which the yield per unit of water can be maximized (Mubarak and Hamdan 2018). Water productivity is the ratio of the net benefits from the crop, and forestry agricultural system to the amount of water used (Molden et al. 2010). Water productivity may be defined in terms of physical or economical productivity. Physical water productivity is defined as the ratio of yield of the crop to the amount of water used or applied. Crop water productivity means raising crop yields per unit of water consumed or applied (Kijne et al. 2003a). enhancing crop water productivity is a significant pathway for poverty reduction and is appropriate in the area where water is scarce and computation

for water is high (Geerts and Raes 2009). In the past, crop irrigation requirements did not consider the limitations of the available water supplies. Improving water productiveness is at once wanted in water-scarce areas. To reduce input cost and environmental damage, farmers will likely produce crops with less irrigation water in the future (Aguilar et al. 2007). With this in mind, crop water productivity (CWP) is a basic term in the evaluation of deficit irrigation schemes. Water productivity with dimensions of $kg/_{m}^{3}$ is defined as the ratio of the mass of marketable yield (Ya) to the volume of water spent by the crop (ETa) or CWP is clear as the physical or economic output per part of water application(Fereres and Soriano 2007; Kijne et al. 2003b; Molden et al. 2007). These can also determine as:

$$CWP = \frac{Ya}{ETa} \quad \text{..... (1)}$$

Where, CWP is crop water productivity (kg/m^3), Ya is a marketable crop yield (kg/ha) and ETa is the volume of water consumed by the crop throughout the growing period of the crop (m^3/ha).

In situations of water constraint, deficit irrigation (DI), and water application systems in furrow irrigation are significant anxieties for increasing water productivity (Narayanan and Seid 2015).

a) Essential of deficit irrigation on water productivity

Deficit irrigation and water Appling method in furrow irrigation are significant occupation to develop water productivity in surround of water shortage(Narayanan and Seid 2015).The application of deficit irrigation as much as 30% of crop evapotranspiration can save a substantial amount of irrigation water without considerable yield reduction (Gebremariam et al. 2018). For a moist weather in which the soil is dominated with the aid of using clay and water is a liming factor, the alternate furrow irrigation approach with the suitable irrigation interval is taken into reflection as a suitable irrigation technique(Eba 2018).In areas where water resources are limiting it can be more gainful for producers of farmers to improve crop water productivity rather than maximizing the yield per unit land. The saved water may be used for further purposes or to irrigate extra units of irrigable land. It is usually assumed that increasing agricultural water productivity is the most effective way to mitigate water shortage, and environmental problems in arid, and semi-arid areas. In dry areas, water is the maximum restricting useful resource for enhancing agricultural production. Maximization of yield for each unit of water (WP), and not yield per unit of land (land productivity), is, consequently, a better approach for dry farming systems (English 1990). So, the improvement of WP in irrigated agriculture is actual important.

The adoption of DI suggests suitable knowledge of crop ET, crop responses to water shortages counting the identification of critical crop growth periods, and the economic impacts of yield decrease approaches. Zhang and Oweis (1999) stated that when techniques for deficit irrigation are resulting from multi-factorial field attempt, the optimum irrigation schedules are frequently based on the notion of water productivity (WP) or, as frequently called, water use efficiency (WUE).WP is a term used in the crop production system to describe the relationship between the amounts of water utilized in crop production, represented as crop production per unit volume of water.

Yihun (2015) reported as the quick growth in population requires adequate management of Ethiopia's land and water resources. Rising agricultural water productivity permitting families to generate better revenue, growing their resilience in addition to changing their livelihoods stands out as the most pressing program now and for the approaching many years in Ethiopia (Mengistie and Kidane 2016). Hence, enhancing agricultural water control is essential and might be of social, cultural, and economic significance to the beneficiaries(Molden et al. 2010).

According to (Bekele 2017),Implementation of alternative furrow irrigation kept 45 % of the water to be applied for additional irrigable land as

likened to conventional furrow irrigation, Furthermore, application of 75 % ETc level saves 25 % of water without a significant effect on fruit yield of tomato.(Admasu et al. 2019)documented that in areas where water shortage is high, 35 to 75% ETc application appears to be promising to be contingent on the availability of water resources with minor trade-off in grain yield and water use efficiency.

According to (Meskelu et al. 2017),the decreasing of water from 100 to 30% ETc led to the levitation of WP by 72%. DI has been widely investigated as a valuable and maintainable production approach in dry areas(Pereira et al. 2002). DI is successful in enhancing water productivity for many crops without generating substantial yield decreases, according to different research findings. In agriculture, one is interested to produce more with less water because water is a restrictive factor in many parts of the world. In this case, WP can be used in the evaluation of DI Water Resource Scarcity.

In northern Ethiopia, in which water is restrictive rather than labor, each furrow-scientific scheduling can be an option (Mintesinot et al. 2004). Well crop water use efficiency and irrigation water use efficiency were gained in the AFI while the applied water in AFI was minimized by 50% of the CFI. So, it can be decided that enhanced water saving and related water productivity can be accomplished without significant decrease of yield in AFI with 100% ETc of irrigation level and this saved water should be of significant value in everywhere to irrigate additional land it considered by (Mebrahtu et al. 2018) as a suitable method. The adoption of deficit irrigation techniques in which a 50% decrease of crop evapotranspiration restored is carried out for the whole growing period or portion of it could be recommended in processing tomato, to save water improving water use efficiency, reducing fruit losses and upholding high fruit quality levels(Patanè et al. 2011).

3. Challenges and Opportunities of adapting deficit irrigation in Ethiopia

3.1 Challenges

In Ethiopia adoption of deficit irrigation is affected by different factors. These challenges are the knowledge gap about D. If the applications of water are taken to avoid salinization, deficit irrigation can only be effective. By using deficit irrigation techniques, over-irrigation rarely occurs. Consequently, the leaching of salts from the root area is inferior beneath deficit irrigation than in full water application(Hsiao et al. 2007). This is typically located in arid and semi-arid regions wherein water is limited joined with warm temperatures(Fereres and Soriano 2007), which may disturb the sustainability of irrigation projects.

As said byZwart and Bastiaanssen (2004), the main obstacles that affect the use of deficit irrigation could be summarized as, technical challenges, lack of knowledge under well and varied irrigation agronomic applies, inadequate baseline data and information about the improvement of water resources, insufficient enjoy in design, construction and management of fineness irrigation projects, deprived performance of current irrigation schemes, lack of community involvement through scheduling, construction and use of irrigation growth, and lack of capital for irrigation substructure development are some of them to mention.

3.2 Opportunities

The main advantage of deficit irrigation is the development of water productivity and rises in the overall yield of all crops due to going up the irrigable lands, by applying the saved water. It can also create minimized humid circumstances around the crop in comparison with full irrigation, decreasing the effect of fungal diseases. Although deficit irrigation results in some yield declines per hectare, the quality of the product is similarly to be equal or even higher than under full irrigation water application in addition to this minimizing

irrigation water depth over the crop cycle will also decrease agrochemical and nutrient losses through leaching from the root zone, decrease the fertilizer wants of the crop, and recovers groundwater quality(Kirda et al. 2005; Moser et al. 2006). Moreover, in Ethiopian standard deficit irrigation is required to control water logging and minimize the total labor costs through growing season.

4. Conclusion

Deficit irrigation techniques have confirmed the option of achieving optimal crop yields by permitting a definite level of yield reduces for each hectare however, advanced returns obtained from irrigating additional irrigable areas by the saved water. Since there is a reasonable growth in the price of agricultural production, good attention is required to enhance water productivity (WP).By following the rising of water shortage and mounting rivalry for water, there will be more extensive adoption of DI, particularly in arid and semi-arid regions. Whereas there are huge outlying to approve DI, it has been passed through numerous problems for instance shortage of information, practical difficulties, inappropriate water controlling approaches, and additional hazard of soil salinity. This review could contribute to the advancement of improving the water productivity of crops under high water rivalry by as long as yield consequence, general yield upsurge by cultivating additional land using the saved water, increment of water productivity, and water saved documentation due to deficit irrigation techniques. As a general conclusion, in areas where water sufficiency and soil moisture is the restricting issue for crop production besides sufficient arable land is available, the utility of deficit irrigation is essential.

References

Admasu, R., A. W. Michael & T. Hordofa, 2019. Effect of moisture stress on maize (Zea Mays L.) yield and water productivity. Int J Environ Sci Nat Res 16(4):555945.

Aguilar, M., F. B. Muñoz & M. Espinosa, 2007. Agronomic response of maize to limited levels of water under furrow irrigation in southern Spain. Spanish Journal of Agricultural Research(4):587-592.

Ahmadi, S. H., M. N. Andersen, F. Plauborg, R. T. Poulsen, C. R. Jensen, A. R. Sepaskhah & S. Hansen, 2010. Effects of irrigation strategies and soils on field grown potatoes: Yield and water productivity. Agricultural Water Management 97(11):1923-1930.

Akele, Z., 2019a. Evaluation of alternate, fixed and conventional furrow irrigation systems with different water application level on onion yield in Dubti. Afar, Ethiopia.

Akele, Z., 2019b. Evaluation of Alternate, Fixed and Conventional Furrow Irrigation Systems with Different Water Application Level on Onion Yield in Dubti, Afar, Ethiopia. Evaluation 9(5).

Awulachew, S. B., T. Erkossa & R. E. Namara, 2010. Irrigation potential in Ethiopia. Constraints and Opportunities for Enhancing the System; International Water Management Institute: Addis Ababa, Ethiopia.

Awulachew, S. B., D. Merrey, A. Kamara, B. Van Koppen, F. Penning de Vries & E. Boelee, 2005. Experiences and opportunities for promoting small-scale/micro irrigation and rainwater harvesting for food security in Ethiopia, vol 98. IWMI.

Awulachew, S. B., A. D. Yilma, M. Loulseged, W. Loiskandl, M. Ayana & T. Alamirew, 2007. Water resources and irrigation development in Ethiopia, vol 123. Iwmi.

Ayele, G. K., 2011. The impact of selected small-scale irrigation schemes on household income and the likelihood of poverty in the Lake Tana Basin of Ethiopia. Cornell University Ithaca.

Bacha, D., R. Namara, A. Bogale & A. Tesfaye, 2011. Impact of small-scale irrigation on household poverty: empirical evidence from the Ambo district in Ethiopia. Irrigation and Drainage 60(1):1-10.

Bank, W., 2014. World development report 2015: Mind, society, and behavior. The World Bank.

Bekele, S., 2017. Response of Tomato to Deficit Irrigation at Ambo, Ethiopia. Journal of Natural Sciences Research 7(23).

Bekele, S. & K. Tilahun, 2007. Regulated deficit irrigation scheduling of onion in a semiarid region of Ethiopia. Agricultural water management 89(1-2):148-152.

Bekele, Y., N. Tadesse & B. Konka, 2012. Preliminary study on the impact of water quality and irrigation practices on soil salinity and crop production, Gergera Watershed, Atsbi-Wonberta, Tigray, Northern Ethiopia. Momona Ethiopian Journal of Science 4(1):29-46.

Belay, M. & W. Bewket, 2013. Traditional irrigation and water management practices in highland Ethiopia: Case study in Dangila woreda. Irrigation and Drainage 62(4):435-448.

Biswas, S., D. Roy, K. Sarkar, A. Milla, K. Murad & M. Anower, 2017. Effects of Deficit Irrigation and Mulching on Seed Yield and Water Use of Onion (Allium cepa L.). International Journal of Plant & Soil Science:1-10.

Brouwer, C., K. Prins & M. Heibloem, 1989. Irrigation water management: irrigation scheduling, Training manual No. 4. Natural Resources Management and Environment Dept, Food and Agriculture Organization (FAO) of the United Nations.

Demelash, N., 2013. Deficit irrigation scheduling for potato production in North Gondar, Ethiopia. African J Agric Res 8(11):1144-1154.

Eba, A. T., 2018. The impact of alternate furrow irrigation on water productivity and yield of potato at small scale irrigation, Ejere District, West Shoa, Ethiopia. Journal of Plant Sciences and Agricultural Research 2(2):16.

Eck, H., A. Mathers & J. Musick, 1987. Plant water stress at various growth stages and growth and yield of soybeans. Field Crops Research 17(1):1-16.

El-Sherif, A. M. & M. M. Ali, 2015. Effect of deficit irrigation and soybean/maize intercropping on yield and water use efficiency. Int J Curr Microbiol App Sci 4(12):777-794.

English, M., 1990. Deficit irrigation. I: Analytical framework. Journal of irrigation and drainage engineering 116(3):399-412.

Erkossa, T., S. B. Awulachew & D. Aster, 2011. Soil fertility effect on water productivity of maize in the upper Blue Nile basin, Ethiopia. Agricultural Sciences 2(03):238.

Eshete, D. G., B. G. Sinshaw & K. G. Legese, 2020. Critical review on improving irrigation water use efficiency: Advances, challenges, and opportunities in the Ethiopia context. Water-Energy Nexus 3:143-154.

Fereres, E. & M. A. Soriano, 2007. Deficit irrigation for reducing agricultural water use. Journal of experimental botany 58(2):147-159.

Garbero, A. & T. Songsermsawas, 2018. Impact of modern irrigation on household production and welfare outcomes: Evidence from the Participatory Small-Scale Irrigation Development Programme (PASIDP) project in Ethiopia. IFAD Research Series(31):1-47.

Gebremariam, H. L., K. Welde & K. D. Kahsay, 2018. Optimizing yield and water use efficiency of furrow-irrigated potato under different depth of irrigation water levels. Sustainable Water Resources Management 4(4):1043-1049.

Gebremedhin, G. H., 2015. Irrigation in Ethiopia, a review. Journal of Environment and Earth Science 5(15):141-147.

Geerts, S. & D. Raes, 2009. Deficit irrigation as an on-farm strategy to maximize crop water productivity in dry areas. Agricultural water management 96(9):1275-1284.

Hagos, F., G. Makombe, R. E. Namara & S. B. Awulachew, 2009. Importance of irrigated agriculture to the Ethiopian economy: Capturing the direct net benefits of irrigation, vol 128. IWMI.

Haile, G. G. & A. K. Kasa, 2015. Irrigation in Ethiopia: A review. Academia journal of agricultural research 3(10):264-269.

Heng, L. K., T. Hsiao, S. Evett, T. Howell & P. Steduto, 2009. Validating the FAO AquaCrop model for irrigated and water deficient field maize. Agronomy journal 101(3):488-498.

Hordofa, T., Achievement and prospect of irrigation research for Central Rift Valley of Ethiopia. In: Achievements and Priorities in Irrigation Water Management Research in Ethiopia with Particular Reference to Amhara Region Amhara Region Agricultural Research Institute,, Bahir Dar (Ethiopia), 5-7 Dec 2005, 2006. Amhara Region Agricultural Research Institute, Bahir Dar (Ethiopia).

Hsiao, T. C., P. Steduto & E. Fereres, 2007. A systematic and quantitative approach to improve water use efficiency in agriculture. Irrigation science 25(3):209-231.

Igbadun, H. E., A. Ramalan & E. Oiganji, 2012. Effects of regulated deficit irrigation and mulch on yield, water use and crop water productivity of onion in Samaru, Nigeria. Agricultural water management 109:162-169.

Kang, S. & J. Zhang, 2004. Controlled alternate partial root-zone irrigation: its physiological consequences and impact on water use efficiency. Journal of experimental botany 55(407):2437-2446.

Kijne, J. W., R. Barker & D. Molden, 2003a. Improving water productivity in agriculture: editors' overview. Water productivity in agriculture: Limits and opportunities for improvement:xi-xix.

Kijne, J. W., R. Barker & D. J. Molden, 2003b. Water productivity in agriculture: limits and opportunities for improvement, vol 1. Cabi.

Kirda, C., 2002. Deficit irrigation scheduling based on plant growth stages showing water stress tolerance. Food and Agricultural Organization of the United Nations, Deficit Irrigation Practices, Water Reports 22(102).

Kirda, C., P. Moutonnet, C. Hera & D. Nielsen, 1999. Crop yield response to deficit irrigation: report of an FAO/IAEA co-ordinated research program by using nuclear techniques: executed by the Soil and Water Management & Crop Nutrition Section of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, vol 84. Springer Science & Business Media.

Kirda, C., S. Topcu, H. Kaman, A. Ulger, A. Yazici, M. Çetin & M. R. Derici, 2005. Grain yield response and N-fertiliser recovery of maize under deficit irrigation. Field Crops Research 93(2-3):132-141.

Leskovar, D., S. Agehara, K. Yoo & N. Pascual-Seva, Deficit irrigation and plant density impact on growth, yield, quality and quercetin of short-day onion. In: XXVIII International Horticultural Congress on Science and Horticulture for People (IHC2010): International Symposium on 936, 2010. p 219-226.

Makombe, G., D. Kelemework & D. Aredo, 2007. A comparative analysis of rainfed and irrigated agricultural production in Ethiopia. Irrigation and Drainage Systems 21(1):35-44.

Mebrahtu, Y., A. Woldemichael & S. Habtu, 2018. Response of onion (Allium cepa l.) to deficit irrigation under different furrow irrigation water management techniques in Raya Valley, Northern Ethiopia. African Journal of Plant Science 12(5):105-113.

Mehari, A., F. Van Steenbergen & B. Schultz, 2011. Modernization of spate irrigated agriculture: A new approach. Irrigation and drainage 60(2):163-173.

Mengistie, D. & D. Kidane, 2016. Assessment of the impact of small-scale irrigation on household livelihood improvement at Gubalafto District, North Wollo, Ethiopia. Agriculture 6(3):27.

Meskelu, E., A. Woldemichael & T. Hordofa, 2017. Effect of Moisture Stress on Yield and Water Use Efficiency of Irrigated Wheat (Triticum aestivum L.) at Melkassa, Ethiopia. Acad Res J Agri Sci Res 5(2):90-97.

Mintesinot, B., H. Verplancke, E. Van Ranst & H. Mitiku, 2004. Examining traditional irrigation methods, irrigation scheduling and alternate furrows irrigation on vertisols in northern Ethiopia. Agricultural Water Management 64(1):17-27.

Molden, D., T. Oweis, P. Steduto, P. Bindraban, M. A. Hanjra & J. Kijne, 2010. Improving agricultural water productivity: Between optimism and caution. Agricultural water management 97(4):528-535.

Molden, D., T. Y. Oweis, S. Pasquale, J. W. Kijne, M. A. Hanjra, P. S. Bindraban, B. A. Bouman, S. Cook, O. Erenstein & H. Farahani, 2007. Pathways for increasing agricultural water productivity.

Moser, S. B., B. Feil, S. Jampatong & P. Stamp, 2006. Effects of pre-anthesis drought, nitrogen fertilizer rate, and variety on grain yield, yield components, and harvest index of tropical maize. Agricultural Water Management 81(1-2):41-58.

Mubarak, I. & A. Hamdan, 2018. Onion crop response to different irrigation and N-fertilizer levels in dry Mediterranean region. Advances in Horticultural Science 32(4):495-501.

Narayanan, K. & M. M. Seid, 2015. Effect of deficit irrigation on maize under conventional, fixed and alternate furrow irrigation systems at Melkassa, Ethiopia. International Journal of Engineering Research & Technology (IJERT).

Patanè, C., S. Tringali & O. Sortino, 2011. Effects of deficit irrigation on biomass, yield, water productivity and fruit quality of processing tomato under semi-arid Mediterranean climate conditions. Scientia Horticulturae 129(4):590-596.

Patel, N. & T. Rajput, 2013. Effect of deficit irrigation on crop growth, yield and quality of onion in subsurface drip irrigation. International Journal of Plant Production 7(3):417-436.

Pereira, L. S., T. Oweis & A. Zairi, 2002. Irrigation management under water scarcity. Agricultural water management 57(3):175-206.

Tejero, I. G., V. H. D. Zuazo, J. A. J. Bocanegra & J. L. M. Fernández, 2011. Improved water-use efficiency by deficit-irrigation programmes: Implications for saving water in citrus orchards. Scientia Horticulturae 128(3):274-282.

Tesfaw, M., 2018. Small scale irrigation development. Irrigation Drainage Syst Eng.

Tezera Bizuneh, K., 2019. Effect of soil moisture stress on onion (allium cepa l) production and water productivity at Melkassa in the central rift valley of Ethiopia. HAWASSA UNIVERSITY.

Tilahun, H., E. Teklu, M. Michael, H. Fitsum & S. B. Awulachew, 2011. Comparative performance of irrigated and rainfed agriculture in Ethiopia. World Applied Sciences Journal 14(2):235-244.

Topçu, S., C. Kirda, Y. Dasgan, H. Kaman, M. Çetin, A. Yazici & M. Bacon, 2007. Yield response and N-fertiliser recovery of tomato grown under deficit irrigation. European Journal of Agronomy 26(1):64-70.

Tura, L. E. & T. T. Tolossa, 2020. Systematic review: Effect of Irrigation Water Quality and Deficit Irrigation on Crop Yield and Water Use efficiency. Turkish Journal of Agriculture-Food Science and Technology 8(5):1201-1210.

Yihun, Y. M., 2015. Agricultural water productivity optimization for irrigated Teff (Eragrostic Tef) in water scarce semi-arid region of EthiopiaAgricultural water productivity optimization for irrigated Teff (Eragrostic Tef) in water scarce semi-arid region of Ethiopia. Wageningen University and Research.

Zhang, H. & T. Oweis, 1999. Water–yield relations and optimal irrigation scheduling of wheat in the Mediterranean region. Agricultural Water Management 38(3):195-211.

Zwart, S. J. & W. G. Bastiaanssen, 2004. Review of measured crop water productivity values for irrigated wheat, rice, cotton and maize. Agricultural water management 69(2):115-133.

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