

The Problems, Opportunities and Implications of Small Scale Irrigation for Livelihood Improvement in Ethiopia–A Review

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Abstract

This paper has reviewed the Ethiopian small scale irrigation on the basis of its importance, problems and opportunities, future development perspectives, and its implications to livelihood. Small-scale irrigation may have a considerable potential in improving rural livelihoods through employing different mechanisms into account. In Ethiopia, today small-scale irrigation is being promoted through giving highest priority for capacity-building in the study, design, and implementation of irrigation projects because of the associated benefits with it. Accordingly, the future opportunity is also bright in the country. However, small-scale irrigation is associated with certain problems of development that range from individual household's biased attitudes to institutional arrangements. Therefore, redesigning of institutions, especially appropriate cost recovery mechanisms which contributes to the sustainable management of the irrigation scheme is compulsory work.

Keywords: Livelihood; Small Scale Irrigation; Sustainable Management, Review, Ethiopia

1. Introduction

Water is an imperative input in production in most economic sectors; hence it is an engine of economic development. The availability of sufficient water resources for humans and natural environment are paramount significant (Omondi, 2014). However, the problem of water scarcity is getting worse as cities and populations grow, and the demand for water increases in agriculture, industry, and households, if not valued (Tolera *et al.*, 2017).

Ethiopia has abundant water resources, including more than 10 river basins and 22 natural and artificial lakes, hence known as the water tower of Africa (ADF, 2005). The country has more than 10 river basins with an annual runoff volume of 122 billion m³ of surface water and an estimated 2.6 billion m³ of ground water potential, which makes an average of 1557.5 m³ water available per person per year. This is a relatively large volume of water. Of the more than ten major river basins of the country the largest four river basins namely Abay, Baro-Akobo, Tekeze and Omo-Ghibe account for 80%-90% of the country's water resource. However, according to Seleshi (2010), the country has about 5.3 million hectare (Mha) potential irrigable land. Yet, only about 640,000 ha are irrigated, of which about 241,000 ha from small scale, 315,000 ha from medium scale and 84,000 ha from large scale schemes.

Frequent dry spells and droughts exacerbate the incidence of crop failure and hence food insecurity and poverty. Given the amount of water available, even while passing through the semi-arid, arid, and desert areas, it is evident that the promotion of water development technologies, especially irrigation, at both small and large-scales, can provide an opportunity to improve the productivity of land and labor and increase production volumes (Awulachew *et al.*, 2007).

Irrigated farming is recognized as central point in increasing land productivity, enhancing food security, earning higher and more stable incomes and increasing prospects for multiple cropping and crop diversification (Hussain *et al.*, 2001). An increase productivity of labor, reduce reliance on rainfall and increase exports are also among the other few benefits of developing irrigation potential of the country (Awulachew *et al.*, 2010). It was also claimed that Ethiopia cannot assure food security for its population with rain-fed agriculture alone without a substantive contribution of irrigation (Van Den Berg and Ruben, 2006). Therefore, irrigated agriculture is important in stimulating sustainable economic growth and rural employment, and it is the cornerstone for food security and poverty reduction. Accordingly, the national Irrigation Development Program (IDP) establishes the objective of increasing food production, leading to improvements in nutritional status and economic well-being among the people so as to achieve the overall goal of sustainable development (MoWR, 2002). Therefore, to promote multiple cropping and better cope with climate variability and ensure food security, GTP aims to enhance the uses of the country's water resources to maintaining agriculture as a major source of economic growth (NPC, 2016). In this line, expansion of small-scale irrigation was given attention to the extent possible opportunities (MoFED, 2010).

Although Ethiopia has abundant rainfall and water resources, its agricultural system does not yet fully benefit from the technologies of water management and irrigation (Awulachew *et al.*, 2010). Besides, different scale irrigation schemes the country is implementing to the huge level schemes are poorly designed and planned that undermines efforts to improve livelihoods and exposes people and environment to risks. Moreover, some of the irrigation schemes may cause different negative impacts that hinder the livelihood, health, employment and food security levels of farm households (Asayehegn, 2012). Therefore, as water development for agriculture is a

priority area to meet the demand of the ever increasing population in Ethiopia, this paper intended to review some challenges, opportunities and the implications of small-scale irrigation sector on the livelihood, which helps the policy makers and implementing bodies to consider and incorporate for different mitigations for the future developmental plans.

2. Small-Scale Irrigation for Livelihood Improvement in Ethiopia.

2.1. Economic Importance of Irrigation Development

According to Nata *et al.* (2008), water is mankind's most vital and versatile natural resource. Molden (2007) described that in countries and regions that rely on agriculture for a large part of their GDP (such as most of Sub Saharan Africa), raising agricultural productivity may require large water storage facilities, further irrigation development, and changes in the operation of existing schemes. Therefore, this is the most possible option for reducing poverty, to keep up with global demand for agricultural products and adapt to changing food preferences and public demands, to adapt to the effect of urbanization in many developing countries shifting demand from staple crops to fruits, vegetables, and livestock products, and to respond to climate change.

The development of new irrigation schemes and improvement on existing schemes increase agricultural productivity. The increment in productivity stimulates input suppliers and agro processing industries, which in turn stimulate employment in urban areas; higher farm incomes mean more household expenditures, which stimulate retail trade: wholesale expanded; manufacturing industries encouraged; service industries like transportation get more business; import and export market stimulated; and so on. Thus, improving the performance of existing systems and adding new irrigation can reduce poverty by increasing farmer incomes, providing employment for the landless, reducing staple food prices, and contributing to overall economic growth by inducing secondary benefits, such as boosting agro industry (MoA, 2010).

The stimulated agro-industries in urban areas reduce pressure on urban employment and increase the real wage of urban laborers and hence, it extends the benefit to urban dwellers beyond the rural poor. It also involves land distribution and promotes both seasonal and permanent settlement of landless families to newly irrigated area. However, the success of irrigation has also often come at the environment's expense, degrading ecosystems and reducing water supplies to wetlands (Svendsen and Turrall, 2007).

Belay and Bewket, (2013) explained that irrigation water is critical to poverty alleviation through increased production in rural areas so as to improve food security and rural livelihoods. Smallholder irrigation has recently received significant focus from local governments to enable farmers to cultivate crops twice or more per year. The impact of small-scale irrigation on household poverty in central Ethiopia is reported Bacha *et al.* (2011) that land productivity, asset ownership, credit utilization, extension support, resilience to poverty, mean off-farm income, and mean food consumption and expenditure on food and non-food assets were significantly higher for irrigators than non-irrigators. Accordingly, the Five Years Growth and Transformation Plan (FYGTP) put 8% annual increase in irrigated arable land until 2020 by planning to invest more 3 billion USD (MoA, 2010).

2.2. The Problems of Small Scale Irrigation

According to the MoWIE (2013) and MoA (2011), the main challenges of irrigation development in Ethiopia especially of small scale irrigation are identified as inadequate awareness of irrigation water management as in irrigation scheduling techniques, water saving irrigation technologies, water measurement techniques, operation and maintenance of irrigation facilities.; inadequate knowledge on improved and diversified irrigation agronomic practices; shortage of basic technical knowledge on irrigation pumps, drip irrigation system, sprinkler irrigations, surface and spate irrigation methods; scheme based approach rather than area/catchments based approach for the development of SSI schemes; inadequate baseline data and information on the development of water resources; lack of experience in design, construction and supervision of quality irrigation project; low productivity of existing irrigation schemes; inadequate community involvement and consultation in scheme planning, construction and implementation of irrigation development, and poor economic background of users for irrigation infrastructure development, to access irrigation technologies and agricultural inputs, where the price increment is not affordable to farmers.

Despite Small-scale irrigation has immense potential to improve the incomes of poor rural households in developing countries like Ethiopia, it is never free from problems. These problems of small-scale irrigation technology development range from individual household's biased attitudes to institutional arrangements. Accordingly, the major problems encountered in small-scale irrigation are problems related to cost, institutional problems, the policy environment, design issues, cultural factors and environmental problems (Getaneh, 2011). As study by (Gebrehiwot *et al.*, 2015) also revealed that the problems of small-scale irrigation are problems related to lack of water, problem in the distribution of water, pests and diseases, thief and other animals eat the irrigation products, lack of supply inputs specially late supplying means no supplying in time. Other factors like design issues, cultural factors, environmental problems are also there. In the same manner to the above mentioned, (CTA, 2003) generally characterize Small-scale irrigation schemes in Ethiopia as there are low

efficiency, lack of finance, inadequate marketing, weak extension services.

According to IWMI (2004), the key constraints in effectively implementing the technologies of small scale irrigation in Ethiopia are lack of or inadequacy of baseline studies, data and information on potentials of different areas for the development of water resources; poor technology choice - difficult to manage by farmers on their own; low yields - significantly above rain fed system, soils/agronomic problems; property rights - land use rights, land ownership and water rights not clear, and hence difficult access and conflicts; too small landholdings - land holdings small; continued land fragmentation hence problems of diversification into high value crops; conflicts in water use and use rights - conflicts between traditional irrigators and those in modern systems; marketing and market access - limited knowledge of target marketing, need for market assessment, and market information; dependency syndrome - some see aid or donation has become a part of rural life; anticipate to aid as one of the various livelihood options; less effort for successful farming because of fear that they will lose out on aid; institutional arrangements and instability - gaps, overlaps and conflicts of mandates of regional federal institutions; beneficiaries not adequately involve (farmers); lack of training to handle technologies; lack of extension services; lack of start-up capital or access to credit to initiate venture, and poor linkage between research and extension in the area of irrigation water management.

2.3. Opportunities of Small Scale Irrigation

According to the MoWIE (2013) and MoA (2011), the main opportunities for the development of irrigation in Ethiopia are identified as emphasis and priorities are given to irrigation in the growth and transformation plan of the country; indigenous knowledge and introduction of promising household water harvesting and micro-irrigation technologies; government's strong political commitment and encouragement to private sector and public enterprises involvement in irrigation development; abundant water resources, climate and land suitability; availability of inexpensive labor, and availability of suitable lands for irrigation developments especially at arid areas of the country.

Small-scale irrigation is being promoted because of the associated benefits with it. It requires much lower investment costs, and in a majority of cases these costs are borne by the community; it do not involve dams or storage reservoirs, hence no population displacement is involved; less demanding in terms of management, operation and maintenance; no land tenure or resettlement implications; it has no serious adverse environmental impact; it allow a wider diffusion of irrigation benefits and permit farmers to learn irrigation techniques at their own pace and in their own way (CTA, 2003; MoWR, 2002).

2.4. Future Opportunities

The Ethiopian Irrigation Development Plan (IDP) emphasizes the development of small-scale irrigation systems through giving highest priority for capacity-building in the study, design, and implementation of irrigation projects. Increasing emphasis will also be given to the development of large and medium-scale irrigation schemes. Ethiopia has designed a Water Sector Development Programme (MoWR, 2002). Accordingly, high water potential (Makombe *et al.*, 2011; MoA, 2011); high commitment of the Ethiopia government, donors and NGOs to support irrigation management and development activity; opportunity for implementing multiple use water systems (MUS), with regions coordinating sub-activities; effective utilization of scheme infrastructure through diversification of uses to meet various needs for water such as domestic, irrigation, livestock and hygiene is the most important; opportunities for improving knowledge of policy makers, planners, and designers, contractors and development agencies through education, training, dialogues and participation; opportunities for more gender-equitable investments, targeting poor women are key future opportunities in effectively implementing the technologies of small scale irrigation in Ethiopia are (IWMI, 2004).

2.5. Implications of Small Scale Irrigation on the livelihood improvement

Irrigation can bring about increased agricultural production thereby improve the economic and social wellbeing of the farmers. For meeting the growing demand for food in the short run and long run food security, small scale irrigation has immense contribution in achieving the objective. It is one of the options which increase yield, facilitate diversification, reduce rainfall risk, and create employment opportunities. In addition, the role of irrigation development is increasing food sufficiency level of households (helps to produce sufficient amount of food consumption), increasing income level, asset building such as house construction for rent, saving account and creation of employment opportunity. Thus it is an important indicator of economic development and brings sustainable agriculture development (Tesfa, 2011).

A study by IFAD (2005) states that in Ethiopia, the construction of small-scale irrigation schemes has resulted in increased production, income and diet diversification in the Oromia and Southern Nation and Nationalities People (SNNP) regions. According to this study, the cash generated from selling vegetables and other produce is commonly used to buy food to cover the household food demand during the food deficit months. The same study further added that the hungry months reduced from 6 to 2 months (July and August) because of

the use of small scale irrigation. Moreover, the increase in diversity of crops across the schemes and the shift from cereal livestock system to cereal-vegetable-livestock system is starting to improve the diversity of household nutrition through making vegetables part of the daily diet.

Incomes are determinants of food security in Africa mainly because of rural farm households are net purchaser of food. Thus improvement in rural as well as urban household incomes will be result in significant reduction in food security. With limited off-farm sources of income, incomes from irrigated vegetables are important for food security in household that undertake irrigation (Dittoh *et al.*, 2013).

Small scale irrigation schemes in the poverty reduction and livelihood enhancement discourse especially in recent times when the rainfall pattern is increasingly becoming erratic are very important in enhancing food security, because agricultural related activities became all year round with dry season gardening providing the necessary ingredients (vegetables) to complement staple foods produced during the rainy season. Small scale irrigation scheme has significantly reduced migration of the youth from rural to town; this time around, they stayed back and earn extra income from sale of fresh vegetables. Small scale irrigation farming is negatively impeding the cultural cohesion of the locality because the only leisure time frame meant for social activities which enhanced their cultural heritage is waning off (less leisure time now) because farmers now stay on farms and earning high income throughout the year (Bagson *et al.*, 2013).

Farming income is more important to irrigating households than to non-irrigating households, while off-farm income is negatively related with access to irrigation. The mean income of irrigators is significantly higher than that of rain-fed farmers. Irrigating households' average income is above the regional average, while non-irrigating households' average income is 50 percent less than the average income of irrigating households. There is also a difference in total household consumption expenditure between the two groups (Gebrehaweria and Regassa, 2007).

Small-scale irrigation schemes as compared with other irrigation strategies used in Africa, if properly implemented with appropriate technologies, may have a considerable potential in improving rural livelihoods. However, the viability of such systems becomes questionable when the financial responsibility rests entirely on the community in the absence of institutional support services that enhance market orientation (Kamara *et al.*, 2002). According to Haile (2008), there are four interrelated mechanisms by which irrigated agriculture can reduce poverty, through: (i) increasing production and income, and reduction of food prices, that helps very poor households meet the basic needs and associated with improvements in household overall economic welfare, (ii) protecting against risks of crop loss due to erratic, unreliable or insufficient rainwater supplies, (iii) promoting greater use of yield enhancing farm inputs and (iv) creation of additional employment, which together enables people to move out of the poverty cycle. Hussain and Hanjira (2004) confirmed a strong direct and indirect linkage between irrigation and poverty. Direct linkages operate through localized and household level effects, whereas indirect linkages operate through aggregate or sub-national and national level impacts. Irrigation benefits the poor through higher production, higher yields, lower risk of crop failure, and higher and year-round farm and non-farm employment. Irrigation enables smallholders to adopt more diversified cropping patterns, and to switch from low-value staple production to high-value market-oriented production. Increased production makes food available and affordable for the poor (Asayehegn *et al.*, 2011).

Food insecurity and famine in Ethiopia is the result of erratic and low rainfall (Awulachew *et al.*, 2005). Ethiopia faced three large-scale drought-induced food shortages and famines in recent history, i.e. in 1972/73, 1983/84, 2002/03, which costed many lives (Awulachew *et al.*, 2005). In 2002/03 about 15 million people (over 20% of the population) received food aid. The net farm income is the most watched indicator of farm sector well-being, as it captures and reflects the entirety of economic activity across the range of production processes, input expenses, and marketing conditions that have persisted during a specific time period. In this regard, those farmers who are producing more through small scale irrigation are increasing their income from the sale of agricultural products and this will lead them to increase their revenue and thereby improve their livelihood. Some of the major results identified in relation to the contribution of small scale irrigation to livelihood improvement include increased agricultural production and better food security, getting additional income, access to improved nutritional values (vegetables and fruits), improved feeding habit, improved access of water for drinking livestock development and sanitation, purchase of oxen and cows, pay credit and save money, purchase of household goods, building of houses in towns, cover educational cost for children and the likes. These all indicates that small scale irrigation activities are improving their living condition of their families and promoting the livelihood of the farmers (Nahusenay and P.Madhu S., 2015).

Despite, irrigation reduces poverty significantly, the antipoverty impacts of irrigation vary across and within irrigation systems and depend on a number of factors, which include: a) condition of the irrigation infrastructure and its management, b) irrigation water allocation and distribution procedures and practices, c) irrigation and production technologies/methods, cropping patterns and crop diversification, d) support measures, e.g., information, input and output marketing, and e) structure of land distribution—(in) equity in land distribution—and land quality. As a result, irrigation investments, whether in the development of irrigation or in the

performance improvement of existing systems, should not always be assumed to be poverty-reducing and that irrigation can be strongly pro-poor, neutral or even anti-poor depending on the these and the other related conditions (Intizar, 2004). Similarly, for irrigation to play a more important role in poverty reduction, creating enabling institutional and economic environments is a major prerequisite (Bacha *et al.*, 2009).

2.7. Empirical Reviews

Because small-scale irrigation increases mean annual household income, irrigating households have lower probability of being poor than non-irrigating households. Irrigation development has a profound impact in alleviating poverty. A much higher proportion of those who are poor are non-irrigating rather than irrigating households. Thus, the poverty prevalence in non-irrigating households is by far greater than in irrigating households. Though small-scale irrigation has those mentioned roles, the study also identified many problems in irrigation development such as: lack of access to surface water, loss of water through seepage, problem of irrigation water distribution, lack of spare parts for water pumps, high cost of fuel for water pumps, lack of market transparency and marketing facilities, crop disease, and the perceived high cost of inputs (Getaneh, 2011).

Irrigation user households are in a better position when compared to those that are non users. For example, users have high crop income, higher level of education of the household head, large size of livestock holding, better labor man-day equivalent and all these contributed significantly to high total income for users than non-users. Accordingly, access to small scale irrigation can significantly improve (about three fold) income level of beneficiary households. This implies, in addition to surface water, the use of ground water for small-scale irrigation is likely to be valuable for future economic growth and development. As a result, access to irrigation increases the opportunity for crop intensity and diversification which increase cropping income. Therefore, in order to increase the rural households' income expansion of small scale irrigation by using available water resource is a crucial factor. Therefore, access to irrigation has got a significant and positive contribution to income (Hamda, 2014). However, (Asayehegn, 2012) argued that irrigation and irrigation dams have negative impact in animal production through reduction of grazing land throughout the year and lack of free communal land for movement. It also reduces crop production as a result of pest infestation, lack of aeration, water logging and percolation that leads to swamps. Moreover, it affects public health through infestation of malaria and other water born diseases. Hence, the negative and positive impacts of irrigation should be equally considered while planning of similar irrigation schemes. Therefore, it is advisable the provision of infrastructural services before implementation of irrigation schemes to reduce the less profitability and perish ability of the irrigation sector. Similarly, farm households should diversify their product temporally and spatially for better profitability in addition to implementation of processing industries in cooperation. Animal forage should be given equal treatment with the crop production be it as hedgerows or intercropped with the food crops. Canals and schemes should be cemented for the prevention of water logging, percolation, changing farmland to swamps and proper aeration of soils.

Irrigation and irrigation dams have both positive consequences on food security, asset ownership and income of households. Increased in agricultural production through diversification and intensification of crops grown, increased household income because of on/off/non-farm employment, source of animal feed, improving human health due to balanced diet and easy access and utilization for medication, soil and ecology degradation prevention and asset ownership are contributions of irrigation. The ratio of mean income of irrigation users to non-users exceeds by 37.03% and nutritional status and standard of living of the users also increased by the same factor as income. After construction of the dams on-farm income 16 of 90.77% of the irrigation user households is increased after irrigation utilization despite of the figure difference. Moreover, irrigation utilization greatly supports the livelihood of the non-users through employment opportunity (Asayehegn, 2012).

Irrigation improved household income and contributed to poverty reduction. However, the enhanced poverty impact of irrigation was constrained due to unsatisfactory performance and imperfect market. Thus, enhancing the capacity of water user associations through provision of training, market linkage and finance are a necessary step to improve irrigation performance towards poverty reduction. Irrigation use has a positive impact on households earning from crop, and livestock. And, remunerative off farm income sources like cart and trade were the results of irrigated agriculture whereas inferior livelihood activities like fire wood and charcoal selling, and casual work were dominated by non irrigators (Eneyew *et al.*, 2013).

In general, the above reviewed empirical studies revealed that, small scale irrigation system is an important tools for the improvement the households' livelihood, both in the form of liquid and tangible asset. This is also a best mechanism that leads to the use resources more efficiently. However, few of them have tried to study the management of irrigation water to increase the future opportunities of small scale irrigation.

3. Summary and Conclusion

This work has thoroughly reviewed the Ethiopian small scale irrigation on the basis of its role, its implications to livelihood, challenges and opportunities, and future development perspectives. There is strong direct and indirect

linkage between irrigation and poverty that lead to improve households' livelihood especially in recent times when the rainfall pattern is increasingly becoming erratic. Direct linkages operate through localized and household level effects, whereas indirect linkages operate through aggregate or sub-national and national level impacts. Therefore, small-scale irrigation schemes as compared with other irrigation strategies if properly implemented with appropriate technologies, may have a considerable potential in improving rural livelihoods through: (i) increasing production and income, and reduction of food prices, that helps very poor households meet the basic needs and associated with improvements in household overall economic welfare, (ii) protecting against risks of crop loss due to erratic, unreliable or insufficient rainwater supplies, (iii) promoting greater use of yield enhancing farm inputs and (iv) creation of additional employment, which together enables people to move out of the poverty cycle.

Small-scale irrigation is being promoted in Ethiopia through giving highest priority for capacity-building in the study, design, and implementation of irrigation projects because of the associated benefits with it. The future opportunity is also wide in the country. Accordingly, to promote multiple cropping and better cope with climate variability and ensure food security, GTP will enhance the uses of the country's water resources to maintaining agriculture as a major source of economic growth as priority was given for expansion of irrigation. However, small-scale irrigation is never free from problems as many constraints it has got. These problems of small-scale irrigation technology development range from individual household's biased attitudes to institutional arrangements. These are lack of or inadequacy of baseline studies, data and information on potentials of different areas for the development of water resources; poor technology choice; low yields; property rights; too small landholdings; conflicts in water use and use rights; marketing and market access; dependency syndrome; institutional arrangements and instability; lack of training to handle technologies; lack of extension services; lack of start-up capital or access to credit to initiate venture; poor linkage between research and extension in the area of irrigation water management. Therefore, redesigning of institutions which contributes to the sustainable management of the irrigation scheme is necessary. Accordingly, Ethiopia has also focused for the management of irrigation by designing policy to develop the appropriate cost recovery systems and mechanisms for all irrigation schemes.

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References

- ADF (African Development Fund). 2005. Rural water supply and sanitation program in Ethiopia: Appraisal Report, Infrastructure Department North East and South Onin.
- Asayehegn K. 2012. Irrigation versus Rain-fed Agriculture: Driving for Households' Income Disparity, A Study from Central Tigray, Ethiopia. *Journal of Agricultural Science Research*. 2(1): 20-29.
- Asayehegn, K., Chilot, Y. and Sundar, R. 2011. Effect of small-scale irrigation on the income of rural farm households: the case of Laelay Maichew district, Central Tigray, Ethiopia. *Journal of Stored Products and Postharvest Research*. 2(10): 208 – 215.
- Awulachew, B.S., Erkossa, T. and Namara, R. E. 2010. Irrigation potential in Ethiopia; Constraints and opportunities for enhancing the system; International water management institute (IWMI).
- Awulachew, B.S., Yilma, A. D., Loulseged, M., Loiskandl, W., Ayana, M., Alamirew, T. 2007. Water Resources and Irrigation Development in Ethiopia, International Water Management Institute, Working Paper 123.
- Awulachew, S. B., Merry, J., Kamara, A. B., Van Koppen, B., Penning de Vries F., Boelee E. and Makombe G. 2005. Experiences and opportunities for promoting small-scale/micro irrigation and rainwater harvesting for food security in Ethiopia. Colombo, Sri Lanka: *International Water Management Institute (IWMI)*. pp. 91.
- Bacha, D., Regassa, N., Bogale, A. and Tesfaye, A. 2009. Impact of Small-Scale Irrigation on Household Poverty: Empirical Evidence from the Ambo District in Ethiopia. *Irrigation and Drainage*. 60: 1–10.
- Bacha, D., Regasa, N., Ayalneh, B. and Abonesh T. 2011. Impact of Small-Scale Irrigation on Household Poverty: Empirical Evidence from the Ambo District In Ethiopia. *Irrigation and Drainage*. 60: 1–10.
- Bagson Ernest and Conrad-J.Wuleka Kuuder. 2013. Assessment of a Smallscale Irrigation Scheme on Household Food Security and Leisure in Kokoligu; Ghana. *Research on Humanities and Social Sciences*. 3(1), 2013: 168–184.
- Belay, M. and Bewket, W. 2013. Traditional Irrigation and Water Management Practices in Highland, Ethiopia: Case Study in Dangila Woreda. *Irrigation and Drainage*. 62: 435-448.
- CTA (Center for Technical Agriculture). 2003. Small-scale irrigation for food security in sub-Saharan Africa. Organised by CTA with the support of Tigray Water Resources Development Bureau, Ethiopia.
- Dittoh Saa, Madhusudan Bhattarai and Margaret Atosina Makuriba. 2013. Micro irrigation- based vegetable

- farming for income employment and food security in West Africa: Tamale, Ghana.
- Eneyew, A., Dananto, M., Alemu, E., Ayana, M. and Bekelle. 2013. Environmental Impacts of Small Scale Irrigation Schemes: Evidence from Ethiopian Rift Valley Lake Basins. *Environmental Research, Engineering and Management*. 1(63): 17-29.
- Gebreaweria Gebregziabher and Regassa Namara. 2007. Investment in irrigation as a poverty reduction strategy: Analysis of smallscale irrigation impact on poverty in Tigray, Ethiopia.
- Gebrehiwot, A., Adera, A. and Tilahun, M. 2015. The Impact of Small – Scale Irrigation on Income of Rural Farm Households: Evidence from Ahferom Woreda in Tigray, Ethiopia. *International Journal of Business and Economics Research*. 4(4): 217-228.
- Getaneh Kebede. 2011. The Impact of Selected Small-Scale Irrigation Schemes on Household Income and the Likelihood of Poverty in the Lake Tana Basin of Ethiopia: A Project Paper Presented to the Faculty of the Graduate School of Cornell University in Partial Fulfillment of the Requirements for the Degree of Master of Professional Studies
- Haile Tesfaye. 2008. Impact of irrigation development on poverty reduction in Northern. PhD thesis, Ethiopia.
- Hamda Tulu. 2014. The Effects of Small Scale Irrigation on Rural Households' Income: The Case of Adami Tulu Jido Kombolcha District, Oromia National Regional State. A M.Sc. thesis Submitted to Department of Agricultural Economics School of Graduate Studies Haramaya University (HU).
- Hussain, I. and Hanjra, M. 2004. Irrigation poverty alleviation: review of the empirical evidence. *International Water Management Institute, Colombo, Sri Lanka*.
- Hussain, I., Marikar, F. and Thrikawala, S. 2001. Impact of irrigation infrastructure development on poverty alleviation in Sri Lanka and Pakistan. *Journal of Development Studies*. 21(2): 29- 31.
- IFAD (International Fund for Agricultural Development). 2005. Special country program phase II (SCP II) interim evaluation report number 1643-ET. Ethiopia.
- Intizar Hussain. 2004. Assessing Impacts of Irrigation on Poverty: Approaches, Methods, Case Studies and Lessons. *Paper prepared for presentation at the workshop on IWMI-BOKU-Siebersdorf-EARO-Arbamintch University collaborative study on the impact of irrigation development on poverty and environment, 26- 30 April, 2004, Ethiopia*.
- IWMI (International Water Management Institute). 2004. Assessment of Experience and Opportunities in Small Scale Irrigation, Rain Water Harvesting in Ethiopia. Unpublished report.
- Kamara, A. B., Van Koppen, B. and Magingxa, L. 2002. Economic Viability of Small Scale Irrigation Systems in the Context of State Withdrawal. The Arabie Scheme in the Northern Province of South Africa. *Physics and Chemistry of the Earth*. 27: 815-823.
- Makombe, G., Namara, R., Hagos, F., Awulachew, S. B., Ayana, M. and Bossio D. 2011. A comparative analysis of the technical efficiency of rain-fed and smallholder irrigation in Ethiopia. *Colombo, Sri Lanka: International Water Management Institute*. pp. 37.
- MoA (Ministry of Agriculture). 2010. Ethiopia's agricultural sector policy and investment framework (PIF) 2010-2020. Draft final report, Addis Ababa.
- MoA (Ministry of Agriculture). 2011. Natural Resources Management Directorates. Small-Scale Irrigation Situation Analysis and Capacity Needs Assessment, Addis Ababa, Ethiopia.
- MoFED (Ministry of Finance and Economic Development), 2010. Growth and transformation plan (2010/11-2014/15), draft report, September 2010, Addis Ababa.
- Molden, D. 2007. Water for food, water for life: a comprehensive assessment of water management in agriculture. London: Earthscan, and Colombo: International Water Management Institute. 40p.
- MoWIE (Ministry of Water, Irrigation and Energy). 2013. Water Resources of Ethiopia; The National and International Perspective, Awareness creation Program prepared for Public Relation officials, Addis Ababa, Ethiopia.
- MoWR, 2002. Water Sector Development Programme 2002–2016. Irrigation Development Program, Main report. MoWR, Addis Ababa, Ethiopia. pp. 142.
- Nahusenay , T. and P.Madhu S. 2015. Opportunities and Challenges of Small-Scale Irrigation and Its Implications for Livelihood Improvement: The Case Of Tigray Regional State, Northern Ethiopia. Addis Ababa, Ethiopia.
- Nata, T., Asmelash, B., Bheemalingeswara K. 2008. Initiatives, Opportunities and Challenges in Shallow Groundwater Utilization: a Case Study from Debrekidane Watershed, Hawzien Woreda, Tigray Region, Northern Ethiopia, *Agricultural Engineering International. The CIGR Ejournal*. 08 (008): 22.
- NPC (National Planning Commission). 2016. Growth and transformation plan II (2015/16-2019/20), Volume I: Main text. Addis Ababa, Ethiopia.
- Omondi, S. 2014. Economic valuation of irrigation water in Ahero irrigation scheme in Nyando District, Kenya. A Thesis submitted in partial fulfillment of the requirements for the Degree of Master of Science in Agricultural and Applied Economics, University of Nairobi, Kenya.

- Seleshi Bekele. 2010. Irrigation potential in Ethiopia: constraints and opportunities for enhancing the system. Colombo, Sri Lanka: International Water Management Institute. 59p.
- Svendsen, M., and H. Turrall. 2007. *Reinventing irrigation*. Colombo, Sri Lanka: International Water Management Institute.
- Tesfa Worku. 2011. Impact of Small Scale Irrigation on Socio-Economic Development in Dewa Cheffa Woreda, Oromia Zone of the Amhara National Regional States. A M.Sc. thesis Submitted to Addis Ababa University in Partial Fulfillment for the Degree of Master in Water and Development Studies (Water Resource Planning And Management) June 2011 Addis Ababa, Ethiopia.
- Tolera T., Legesse B., Aman M. and Etensa T. 2017. Economic Valuation of Improved Irrigation Water Use: The Case of Woliso District, South West Shoa Zone, Oromiya National Regional State, Ethiopia, *Journal of Economics and Sustainable Development*, 8(13):58-64
- Van Den Burg, M. and Ruben R. 2006. Small-Scale Irrigation and Income Distribution in Ethiopia. *Journal of Developmental Studies*. 42(5): 868-880.