



The Impact of Irrigated Agriculture on Child Nutrition Outcomes in Southern Ghana

Charles Y. Okyere and Muhammed A. Usman

November 2023 / No.817

Abstract

In this study, we investigated whether irrigated agriculture results in improved child nutrition outcomes among farm households in southern Ghana. Using panel data collected between 2014 and 2015, the results from the inverse probability weighted regression adjustment (IPWRA) estimator suggest that children living with irrigating households have, on average, higher weight-for-age and weight-for-height than children residing with non-irrigating households. Males and under-five children gained substantial improvements. Disaggregating irrigation by type, the results indicated that households planting on riverbeds or

riverbanks had improved child nutrition. Additionally, children living with households lifting water from water sources had higher height-for-age and weight-for-age. Further analysis of the underlying pathways suggests that an increase in health care financing and improvement in environmental quality rather than decreases in illness incidence may be the crucial channels. Altogether, the findings showed the importance of investments in agricultural development, particularly in small-scale irrigated agriculture technologies, to reduce childhood undernutrition.

Introduction

In many low and middle-income countries (LMICs), reducing undernutrition remains a primary public health goal. This is more evident in the Sustainable Development Goals (SDGs), where 12 of the 17 (about 70%) goals are related to nutrition (Scaling-Up Nutrition, 2017). Globally, undernutrition accounts for about 45% of deaths of children under five years old (Black *et al.*, 2013). Despite several nutrition-sensitive interventions, undernutrition remains disproportionately higher in LMICs. The health effects of child undernutrition are often irreversible and have long-term consequences. Many empirical studies show that undernutrition can impair cognitive and physical development, school performance and labour productivity in later years (see, e.g., Humphrey, 2009; Almond and Currie, 2011). In Ghana, about 19% of children under 5 years old are stunted (low height-for-age z-scores), and 11% of children are underweight (low weight-for-age z-scores) (GSS *et al.*, 2015). The prevalence of child undernutrition is higher in rural areas than in urban areas. This could be attributed to several factors, including limited infrastructure investment and high poverty levels in rural areas compared to urban areas.

Investments in agriculture are essential to enhance food and nutrition security. Agriculture employs about 38% of the labour force despite Ghana's population being increasingly urbanized, and the gross domestic product (GDP) shares of the agriculture sector declined sharply over the last decade (GSS, 2019). Public investments can improve agricultural yield and productivity through knowledge transfer and infrastructure expansion (Dercon *et al.*, 2009). In Africa, expanding irrigation technology is one of the agrarian policy goals, and is emphasized in the 2018 Malabo Montpellier Panel report (Malabo Montpellier Panel, 2018). However, public investments in agriculture remain low in many African countries. In Ghana, for example, public agricultural expenditure (% GDP) averaged about 3.3% from 2001 to 2015, significantly lower than the 10% target of the Comprehensive Africa Agriculture Development Programme (CAADP) commitment (Benin, 2019).

Previous studies have shown that irrigation technology increases production and household income. For example, by expanding irrigation technologies households can extend the growing season (produce more than once annually) and reduce

dependence on rainfed agriculture by making crop production possible in marginal land where rainfall is inadequate (Lipton *et al.*, 2003). Irrigation also increases land productivity using an appropriate input mix, thereby generating higher farm incomes. In addition, small-scale irrigation (SSI) using tube wells in Nigeria increased per hectare returns from 65% to 500% (Burney and Naylor, 2012), and treadle pump irrigation increased income per hectare by over 500% in Malawi (Mangisoni, 2008). Balana *et al.* (2020) showed that, although access to SSI can significantly increase net returns in northern Ghana, the use of diesel-powered irrigation schemes generates more net income than other types of irrigation. The cost–benefit analysis, however, shows that the use of watering-cans generates higher returns per capital investment, indicating potential differential impacts of irrigation technologies. Altogether, the literature suggests that SSI schemes generate the highest economic payoffs and are more sustainable (You *et al.*, 2011; Xie *et al.*, 2014). The main objective of our study was to examine the impact of irrigated agriculture on child health and nutrition outcomes in southern Ghana using four rounds of panel data collected between 2014 and 2015.

A few studies have investigated the relationship between irrigation and consumption/nutrition outcomes. Alaofe *et al.* (2016) reported that households with irrigation increase yield and consumption of fruits and vegetables, spend more on food and healthcare services than households without irrigation. This suggests that increased income from irrigation leads to investment in productive expenditures/assets. Other studies that explore the relationship between irrigation and dietary diversity found that irrigation is positively and significantly associated with household dietary diversity and production diversity (Bhagowalia *et al.*, 2012; Benson, 2015; Passarelli *et al.*, 2018; Akudugu *et al.* 2016). Although investment in irrigation is supported to ensure food and livelihood security (e.g., Domenech, 2015), there is an ongoing debate over which types of irrigation technologies could be more nutrition sensitive.

Irrigation technology is a key strategy to improve yield and productivity and thereby to ensure food and nutrition security among smallholders. To that end, various types of SSI technologies have been promoted in many LMICs. The impacts of irrigation on household nutrition and health outcomes greatly depend on the scale and types of irrigation schemes. For example, homestead irrigation, typically owned by women, is used to grow vegetables for their own consumption and/or for local markets. However, in large-scale irrigation schemes farmers produce mainly cash crops and women often do not have much control over the income (see, for example, Theis, 2016; Bryan and El Didi, 2019; Bryan and Garner, 2022).

Studies assessing the impact of irrigated agriculture on child nutrition using anthropometric measurements are few (e.g., Benson, 2015; Usman and Gerber, 2020). To the best of our knowledge, evidence on the impacts of irrigated agriculture by its type on child nutrition is also scarce and no previous study has examined the gender-differentiated impact of irrigated agriculture on child nutrition outcomes. A strong

evidence base should be built for policy makers and development practitioners to guide on the design of successful programmes and facilitate the adoption of irrigation technologies. This study attempted to fill these gaps.

With the growing interest in expanding SSI in Ghana, this is an important and policy-relevant topic. With the implementation challenges encountered with the so-called “One Village: One Dam” programme, the results from this study could shed additional light by providing evidence on the nutritional benefits of SSI. Furthermore, the implementation challenges of the government’s current irrigation programme make it a critical issue in terms of agricultural policy. Therefore, studying the impact of irrigated agriculture on child nutritional outcomes is a topical issue in Ghana due to the slow pace of implementation of this flagship programme and the reported complaints about the quality of completed dams (GhanaWeb, 2019). Furthermore, policy decisions require information on the types of irrigation technologies that are nutrition-sensitive and quick implementation of the programme.

This study contributes to the literature in many ways. First, the study focuses on the effect of irrigated agriculture on child nutrition using anthropometric indicators. Previous studies (e.g., Passarelli *et al.*, 2018; Mekonnen *et al.*, 2019) mostly relied on food consumption diversity. Second, this study uses panel data allowing to control for time dimension in the analysis. Other studies (e.g., Kiroge *et al.*, 2007; Benson, 2015; Gerber *et al.*, 2019; Usman and Gerber, 2020) have relied on cross-sectional data affected by endogeneity issues. Third, and most important, the study disaggregates the impacts based on irrigation types and gender of children and discusses the potential pathways through which irrigated agriculture could impact child nutrition outcomes. Using four rounds of panel data collected between 2014 and 2015 in southern Ghana and employing the inverse probability weighted regression adjustment (IPWRA) estimator, the findings were that children living in irrigating households had, on average, higher weight-for-age, and weight-for-height than children residing in non-irrigating households. The results are robust to various model specifications and alternative estimation approaches.

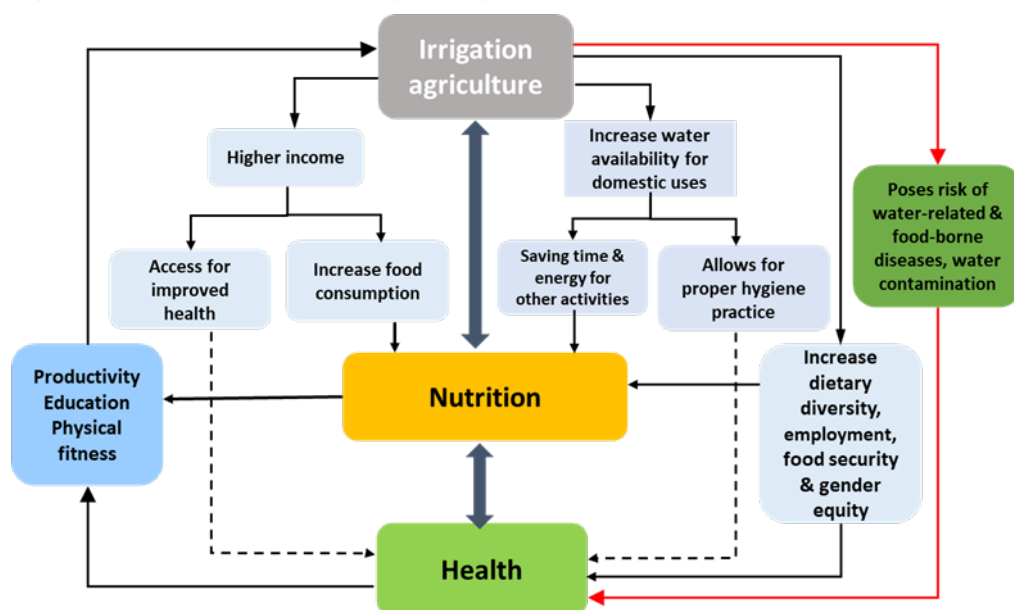
Conceptual framework

Irrigation can affect health and nutrition outcomes through several pathways (see Figure 1). Interestingly, the adoption of different types of irrigation could affect children's nutrition outcomes in diverse ways. Irrigation can cause adverse impacts on the environment and human health if it is poorly planned or designed. Irrigated agriculture influences health negatively through increased water-related diseases and domestic water contamination (Gerber *et al.*, 2019; Usman and Gerber, 2019; Usman *et al.*, 2019). Domestic water quality and quantity may also be affected by irrigation practices. Interestingly, irrigation schemes increase the availability of water for domestic purposes where multiple-use water systems are common (van

der Hoek *et al.* 2001; van der Hoek *et al.* 2002). Moreover, irrigation systems can exacerbate the incidence of waterborne diseases by creating suitable conditions for the propagation of disease vectors, such as mosquitoes (Asayehegn, 2012; Asenso-Okyere *et al.*, 2012). Irrigated agriculture could also increase productivity, production diversity and improves food availability that allows households to improve their nutrition and household income (von Braun *et al.*, 1989; Passarelli *et al.*, 2018; Adela *et al.*, 2019; Nonvide, 2018). Moreover, the increased income associated with irrigated agriculture can allow a given household to access improved healthcare services and, in turn, improve the health and nutrition outcomes of household members.

Irrigation water also serves as a source of drinking water in many developing countries where access to improved drinking water sources is inadequate (van Der Hoek *et al.*, 2001; van der Hoek *et al.* 2002; Usman *et al.*, 2018). Increasing water availability for domestic purposes helps households meet basic hygiene needs, improving health outcomes associated with water quantity (van Der Hoek *et al.*, 2001). Moreover, where access to improved drinking water supply is inadequate, increasing water availability reduces the burden of water collection time, which is often disproportionately borne by women and girls, and can save time and energy for other income-generating activities, such as agricultural production, social activities, child-caring (Sorenson *et al.*, 2011), with direct and indirect health consequences. A review by Domenech and Ringler (2013) synthesized the available evidence on the impacts of irrigation on health, nutrition, and women empowerment in sub-Saharan Africa.

Figure 1: Linkage between irrigated agriculture, and health and nutrition



Source: Usman (2017).

Data source

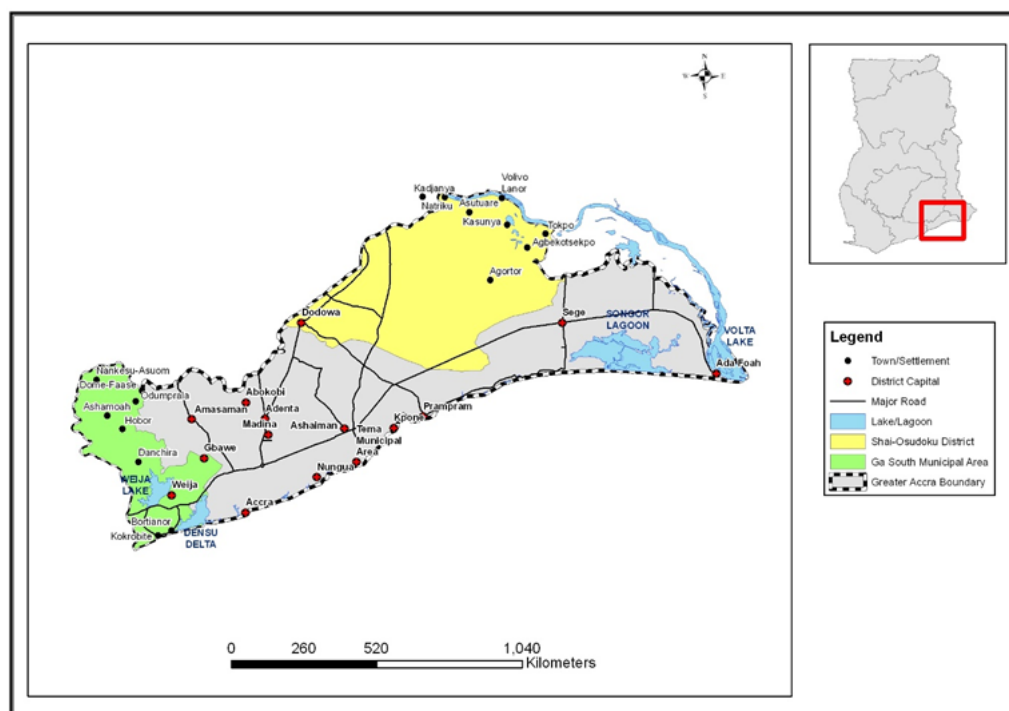
This study relied on four rounds of geographic-specific surveys collected from April 2014 to June 2015. The sample households were selected using a stratified cluster sample design (for detailed information, see Okyere, 2018). Informed consent was obtained for participating households. The survey instruments for the baseline survey data (April/May 2014) collected height and weight measurements for children under eight years of age, detailed information on agricultural activities, irrigated agriculture, productive assets, income, healthcare expenses, household consumption expenditures and other socio-economic characteristics. This survey instrument was repeated for the end line survey in May/June 2015. The other two survey waves (i.e., first follow-up (November/December 2014) and second follow-up (January/February 2015)) used an abridged version of the baseline survey instrument with anthropometric measures, information on income, healthcare expenses, irrigated agriculture, and other agricultural activities, but without the detailed consumption expenses and productive assets information.

Having child-level anthropometric measures together with irrigated agriculture activities and detailed household socio-economic characteristics presents the opportunity to examine the potential mechanisms. According to Kirk *et al.* (2018), the short time duration between the survey waves allows controlling for time-constant child characteristics, which could not be addressed using cross-sectional data.

The household survey was conducted in Ga South Municipal (urban) and Shai-Osudoku (rural) districts in the Greater Accra Region. From the urban district, only rural and peri-urban communities (which are like those in the rural district) were targeted in the sample selection. The focus of this study was children living in agricultural households. However, children from non-agricultural households were included due to the relatively smaller sample size for the study. We restricted the analysis to children with anthropometric measures in the baseline survey or to those born after the baseline survey (see Kremer *et al.*, 2011). The final analysis comprised 1,317 child observations across the 4 survey waves: 318, 331, 392 and 276 child observations in April/May 2014, November/December 2014, January/February 2015, and May/June 2015 respectively. Of these, 41.6% in all the 4 surveys, 32.6% in 3 survey waves, 16.9% in any 2 survey waves and 9% in only 1 survey wave were observed. Figure 2 depicts a map of the study areas. Finally, the sample was representative neither at the national nor at the district level. The study sites were selected purposely based on ex ante information. Therefore, the results may not be generalized to the whole population. While we acknowledge that the sample size was small, alternative panel data sets are lacking for Ghana (to the best of our knowledge) containing anthropometrics with representative samples for children in both irrigated agriculture and non-irrigated agriculture households. In Ghana, access to irrigation

is extremely low. For example, the Africa RISING baseline evaluation survey (ARBES) report, a nationally representative survey in Ghana, showed that 3% of the sampled households reported irrigating their land (Tinonin *et al.*, 2016). Similarly, various types of irrigation technologies exist in the country but less than 2% of arable lands are under irrigation (Mendes *et al.*, 2014). These include human-powered, rope and treadle pumps to liquid fuel engine-driven systems and solar-powered pumps as well as gravity and river diversion methods (Akrofi *et al.*, 2019).

Figure 2: Map of the study areas



Source: Okyere (2018)

This study used unbalanced panel data, where some of the children not measured in all the survey rounds. Accordingly, the results may suffer from attrition bias. Although we controlled for survey round fixed effects in the analyses, the attrition rate, if systematic and affects one group more than the other, could lead to potential upward estimation bias. We undertook an analysis of the attrition rate and found it similar for both irrigators and non-irrigators. For example, we analysed the level of attrition rate based on children with only one observation and older than 12 months of age in the baseline data, following Kirk *et al.* (2018). The attrition rate was unaffected by the adoption of irrigated agriculture. Furthermore, the results did not change by defining attrition either to mean children with 1 or 2 observations and older than 12 months of age in the baseline data or to mean children with only 1 or 2 observations in the data.

Conclusion and Policy Implications

Agricultural development, primarily irrigated agriculture, has the potential of reducing undernutrition in LMICs. Despite its large potential benefits, investments in agriculture are low in many sub-Saharan African countries. In this study, we examined whether households engaged in irrigated agriculture have improved child nutrition outcomes. Using a panel household survey data and a doubly robust estimator, we found that irrigated agriculture led to large improvements in child nutrition outcomes, with considerable gains for males and children under five years old. For example, a child living with an irrigating household gained 0.23 units of SD in WAZ and 0.27 units of SD in WHZ during the study period. The findings on male children indicate the biases in intra-household resource allocation toward this group, which concurs with earlier findings (e.g., Pal, 1999). The estimated results are robust to alternative model specifications and estimation techniques.

Disaggregating irrigation by types, the results show that the presence of irrigated fields in the community, planting on riverbeds, and lifting water from water sources have larger impacts on child nutrition than overhead and other irrigation types. While there is a broad consensus on the importance of investments in irrigation as a policy towards the reduction of undernutrition, there is still debate on the types of irrigation that could deliver these nutritional benefits. Our findings also suggest that some of the irrigation types, such as planting on riverbeds and drawing water from water sources, generate higher nutrition benefits than overhead irrigation. Moreover, the presence of irrigated fields in the community generates improved nutrition outcomes. This implies that irrigated agriculture generates community-level benefits aside from the benefits accrued to an individual or household. The results suggest that investment in low-cost SSI generates nutrition benefits in the study context.

The potential pathways that irrigation has an impact on child nutrition could be increased demand for environmental quality and healthcare financing rather than decreases in illness incidence. This is not surprising as the results show that irrigated agriculture does not lead to investments in preventive health care (e.g., bed nets), leading to a high incidence of self-reported fever cases. Although the results are not statistically significant, incidence of diarrhoea was consistently lower. Finally, the study identified several areas for future research on the impacts of irrigation on child nutrition outcomes. The sample for the study was relatively small and due to the complexity of the linkages between irrigated agriculture and nutrition, future studies based on nationally representative data could shed additional light on these linkages. Furthermore, although we attempted to reduce selection problems to the extent possible using various econometric techniques, causal interpretation of the results may be biased. This is because treatment effects models and panel regressions may be unable to address all issues related to endogeneity and therefore, the causal interpretation of empirical findings may be viewed with some caution. For example, unobserved child or household characteristics can still bias the true coefficient of the impacts of irrigation on child nutrition outcome. Despite these limitations, the results obtained from this study are robust to various model specifications and are relevant for policy makers and researchers on the nutrition impacts of irrigation in LMICs, including Ghana.

References

- Abdulai, A., V. Owusu, V. and J.-E.A. Bakang. 2011. "Adoption of Safer Irrigation Technologies and Cropping patterns: Evidence from southern Ghana". *Ecological Economics*, 70: 1415–23.
- Adela, F. A., Aurbacher, J., and Abebe, G. K. 2019. "Small-scale irrigation scheme governance - poverty nexus: evidence from Ethiopia". *Food Security*, 11(4), 897-913. doi:10.1007/s12571-019-00953-8
- Akrofi, N., D. Sarpong, H. Somuah and Y. Osei-Owusu. 2019. "Paying for privately installed irrigation services in northern Ghana: The case of the smallholder Bhungroo Irrigation Technology". *Agricultural Water Management*, 216: 284–93.
- Akudugu, MA., Nyamadi, B. V., & Dittoh, S. 2016. Transforming smallholder agriculture in Africa through irrigation: an assessment of irrigation impact pathways in Ghana. Conference paper presented at the 5th International Conference of the African Association of Agricultural Economists (AAAE), Addis Ababa, Ethiopia.
- Asenso-Okyere, K., F.A. Asante, J. Tarekegn and K.S. Andam. 2012. "Addressing the links among agriculture, malaria, and development in Africa". In F. Shenggen and R. Pandya-Lorch, eds., *Reshaping Agriculture for Nutrition and Health*. Washington, D.C.: International Food Policy Research Institute (IFPRI).
- Balana, B.B., J.-C. Bizimana, J.W. Richardson, N. Lefore, Z. Adimassu and B.K. Herbst. 2020. "Economic and food security effects of small-scale irrigation technologies in northern Ghana". *Water Resources and Economics*, 29: 100141. <https://doi.org/10.1016/j.wre.2019.03.001>
- Benson, T. 2015. "Association between irrigated farming and improved nutrition in farm households in Malawi". *Agrekon*, 54(3): 62–86.
- Black, R. E., C. G. Victora, S. P. Walker, Z. A. Bhutta, P. Christian, . de Onis, M. Ezzati, S. Grantham-McGregor, J. Katz, R. Martorell, R. Uauy; Maternal and Child Nutrition Study Group. 2013. "Maternal and child undernutrition and overweight in low-income and middle-income countries". *The Lancet*, 382(9890): 427–51. doi:10.1016/S0140-6736(13)60937-X
- Bryan, E. and H. El Didi. 2019. Considering gender in irrigation: Meeting the challenges women farmers face in technology adoption. IFPRI Blog: Research Post. At <https://www.ifpri.org/blog/considering-gender-irrigation-meeting-challenges-women-farmers-face-technology-adoption> (accessed on 5 September 2022).
- Bryan, E. and E. Garner. 2022. "Understanding the pathways to women's empowerment in northern Ghana and the relationship with small-scale irrigation". *Agriculture and Human Values*, 39: 905–20. <https://doi.org/10.1007/s10460-021-10291-1>
- Domenech, L. and C. Ringler. 2013. "The impact of irrigation on nutrition, health, and gender: A review paper with insights for Africa south of the Sahara". IFPRI Discussion Paper 01259. International Food Policy Research Institute (IFPRI), Washington, D.C. At <http://ssrn.com/abstract=2249812>.
- Filipski, M., D. Manning J.E. Taylor, X.D.A. Pradesha and A. Pradesha,. 2013. "Evaluating the local economywide impacts of irrigation projects: Feed the future in Tanzania". IFPRI Discussion Paper 01247. International Food Policy Research Institute (IFPRI), Washington, D.C.

- GSS (Ghana Statistical Service), GHS (Ghana Health Service) and ICF International. 2015. *Demographic and Health Survey 2014*. Rockville, Maryland, USA: GSS, GHS and ICF International.
- GhanaWeb. 2019. One Village, One Dam not solving irrigation problems – Bongo residents complain. At <https://www.ghanaweb.com/GhanaHomePage/NewsArchive/One-Village-One-Dam-not-solving-irrigation-problems-Bongo-residents-complain-730881>. (Accessed on 4 Oct 2019)
- Ijumba, J. and S. Lindsay. 2001. “Impact of irrigation on malaria in Africa: paddies paradox”. *Medical and Veterinary Entomology*, 15(1): 1–11.
- Ijumba, J., F. Shenton, S. Clarke, F. Mosha and S. Lindsay. 2002. “Irrigated crop production is associated with less malaria than traditional agricultural practices in Tanzania”. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 96(5): 476–80.
- Lipton, M., J. Litchfield and J.M. Faurès. 2003. “The effects of irrigation on poverty: A framework for analysis”. *Water Policy*, 5: 413–27.
- Malabo Montpellier Panel (2018). *Water-Wise: Smart Irrigation Strategies for Africa*. Dakar, December.
- Mendes, M., L. Paglietti, D. Jackson and G. Altozano. 2014. “Ghana: Irrigation market brief”. In: Rome: FAO and IFC.
- Mangisoni, J.H. 2008. “Impact of treadle pump irrigation technology on smallholder poverty and food security in Malawi: a case study of Blantyre and Mchinji districts”. *International Journal of Agricultural Sustainability*, 6(4): 248–66. doi:10.3763/ijas.2008.0306
- Mangyo, E. 2008. “The effect of water accessibility on child health in China”. *Journal of Health Economics*, 27: 1343–56.
- Mekonnen, D.K., J. Choufani, E. Bryan, A.R. Abizari, C. Ringler and J. Amikuzuno. 2019. Irrigation–nutrition linkages: Evidence from northern Ghana. IFPRI Discussion Paper 01887. International Food Policy Research Institute (IFPRI), Washington, D.C. At <https://doi.org/10.2499/p15738coll2.133515>
- Okyere, C.Y. and Ahene-Codjoe, A.A. 2021. Irrigated Agriculture and Welfare: Panel Data Evidence from Southern Ghana. *The European Journal of Development Research*. Available online at: <https://doi.org/10.1057/s41287-021-00384-2>
- Pal, S. 1999. “An analysis of childhood malnutrition in rural India: Role of gender, income and other household characteristics”. *World Development*, 27(7): 1151–71.
- Passarelli, S., D. Mekonnen, E. Bryan and C. Ringler. 2018. “Evaluating the pathways from small-scale irrigation to dietary diversity: evidence from Ethiopia and Tanzania”. *Food Security*, 10(4): 981–97.
- Scaling-Up Nutrition. 2017. Nutrition at the Heart of the SDGs. At www.scalingupnutrition.org (accessed on 5 July 2017).
- Tanko, M. and S. Ismaila 2021. “How culture and religion influence the agriculture technology gap in northern Ghana”. *World Development Perspectives*, 22: 100301.
- Theis S. 2016. Investigating gender dynamics in irrigation. At <https://www.ifpri.org/blog/investigating-gender-dynamics-irrigation>. (accessed on 5 September 2022).
- Tinonin, C., C. Azzarri, B. Haile, M. Comanescu, C. Roberts and S. Signorelli. 2016. Africa RISING baseline evaluation survey (ARBES) report for Ghana. International Food Policy Research Institute (IFPRI), Washington, D.C: At <http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/130390>

- Usman, M.A., and N. Gerber. 2020. "Irrigation, drinking water quality, and child nutritional status in northern Ethiopia". *Journal of Water, Sanitation & Hygiene for Development*, 10(3): 425–34. doi:10.2166/washdev.2020.045
- Usman, M.A. and N. Gerber. 2019. "Assessing the effect of irrigation on household water quality and health: A case study in rural Ethiopia". *International Journal of Environmental Health Research*, 31(4): 433–52. doi:10.1080/09603123.2019.1668544
- Van Den Berg, M., and R. Ruben. 2006. "Small-scale irrigation and income distribution in Ethiopia". *The Journal of Development Studies*, 42(5): 868–80. doi:10.1080/00220380600742142
- van der Hoek, W., Feenstra, SG., & Konradsen, F. (2002). Availability of irrigation water for domestic use in Pakistan: Its impact on prevalence of diarrhoea and nutritional status of children. *Journal of Health Population and Nutrition*, 20(1), 77–84.
- van der Hoek, W., F. Konradsen, J.H.J. Ensink, M. Mudasser and P.K. Jensen. 2001. "Irrigation water as a source of drinking water: is safe use possible? *Tropical Medicine & International Health*, 6(1): 46–54. doi: 10.1046/j.1365-3156.2001.00671.x
- Wolf, J., A. Prüss-Ustün, O. Cumming, J. Bartram, S. Bonjour, S. Cairncross, T. Clasen, J. M. Colford Jr, V. Curtis, J. De France, L. Fewtrell, M. C. Freeman, B. Gordon, P. R. Hunter, A. Jeandron, R. B. Johnston, D. Mäusezahl, C. Mathers, M. Neira, and J. P. T. Higgins. 2014. "Systematic review: assessing the impact of drinking water and sanitation on diarrhoeal disease in low-and middle-income settings: systematic review and meta-regression". *Tropical Medicine & International Health*, 19(8): 928–42.
- Zeweld, W., G.V. Huylenbroeck, A. Hidgot, M.G. Chandrakanth and S. Speelman. 2015. "Adoption of small-scale irrigation and its livelihood impacts in northern Ethiopia". *Irrigation and Drainage*, 64(5): 655–68. doi:10.1002/ird.1938
- Zhang, J. 2012. "The impact of water quality on health: Evidence from the drinking water infrastructure program in rural China". *Journal of Health Economics*, 31: 122–34.



Mission

To strengthen local capacity for conducting independent, rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

The mission rests on two basic premises: that development is more likely to occur where there is sustained sound management of the economy, and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

Bringing Rigour and Evidence to Economic Policy Making in Africa

- Improve quality.
- Ensure Sustainability.
- Expand influence.

www.aercafrica.org

Learn More



www.facebook.com/aercafrica



www.instagram.com/aercafrica_official/



twitter.com/aercafrica



www.linkedin.com/school/aercafrica/

Contact Us

African Economic Research Consortium
Consortium pour la Recherche Economique en Afrique
Middle East Bank Towers,
3rd Floor, Jakaya Kikwete Road
Nairobi 00200, Kenya
Tel: +254 (0) 20 273 4150
communications@ercafrica.org