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Transforming Arid and Semi-Arid Areas to be Food Secure: The Role of Small-Scale Irrigation Projects

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Abstract

The primary aim of this research was to evaluate the contribution of irrigation-based initiatives towards ensuring food security. The specific objectives encompassed assessing the role of labor within small-holder irrigation projects in bolstering food security, analyzing the impact of external donor assistance on food security outcomes within these projects, and appraising the extent of governmental backing for small-holder irrigation endeavors in the pursuit of food security goals. The study was conducted within various small-holder irrigation projects using a descriptive survey methodology. The research population comprised 1303 members affiliated with the irrigation schemes and 12 agricultural officers. Utilizing a simple random sampling technique, two agricultural extension officers were selected from the irrigation schemes, while a stratified sampling approach identified 66 irrigation scheme members for participation in the study. Data collection primarily relied on the administration of questionnaires. Findings revealed that most farmers predominantly relied on their labor or that of family members, with minimal utilization of hired labor observed in small-scale irrigation ventures. Consequently, labor scarcity emerged as a notable challenge within these projects. Furthermore, the study highlighted that many small-holder irrigation initiatives benefited from external donor support. To address labor shortages, the research suggested incentivizing specialized labor while recommending collaborative efforts among farmers to engage specialists in crop management, thereby enhancing crop productivity within the schemes.

Keywords: Arid and Semi-Arid Areas; Food Security; Irrigation Projects

A. INTRODUCTION

Agriculture is Africa's primary economic driver and numerous developing nations worldwide. Consequently, fostering agricultural growth presents an opportunity for countries to mitigate the risks associated with food shortages, thus transforming agriculture into a viable economic pursuit (Lyne et al., 2009). A study by (Birchi (2018) highlights that food security has emerged as a significant global challenge, particularly in Africa, where it has contributed to numerous conflicts resulting in loss of lives among citizens. To alleviate inter-community tensions, ensuring food security becomes imperative. Not only does food security promote stability, but it also facilitates cross-border trade and elevates living standards. Emphasizing small-holder irrigation emerges as a crucial strategy for achieving food security, particularly in regions like Kenya, where land ownership typically involves plots of less than two acres per household. Enhancing the productivity of these small-scale irrigation projects holds the key to safeguarding the nation's food supply.

(Obadire et al, 2010) observed that in South Africa, the issue of food security does not solely stem from agricultural production inadequacies at the national level; rather, it represents a multifaceted challenge revolving around households' inability to access an ample food supply consistently. The nexus between food insecurity and poverty perpetuates a detrimental cycle wherein poverty serves as the primary catalyst for food insecurity, while food insecurity exacerbates the persistence of poverty. Numerous studies have investigated household food insecurity within the semi-arid regions of Southern Africa, revealing a myriad of factors influencing food security, including but not limited to irrigation practices, land quality, household incomes, family size, farmers' wealth, and landholding sizes.

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Food insecurity poses significant security risks in developing countries, as highlighted by (Oni et al., 2011). Large tracts of land remain unproductive without irrigation, particularly in semi-arid regions, intensifying this challenge. However, water scarcity persists in these zones, necessitating the adoption of highly efficient irrigation methods to maximize water usage. Irrigation emerges as crucial for regional development due to its pivotal role in sustaining populations. However, small-holder irrigation projects, predominantly subsistence-oriented, present a notable obstacle to irrigation effectiveness in ensuring food security, underscoring the need for a transition to a more commercial model.

(Carruthers et al., 2007) underscore the pivotal role of irrigated land globally in bolstering food security despite facing formidable challenges rooted in prevalent societal myths. These misconceptions include the belief that food security can be maintained without reliance on irrigation and the misconception that withdrawing water from inefficient irrigation practices will not affect food security. Moreover, the notion that irrigation investment may harm the environment without impacting food security persists, hindering widespread recognition of irrigation's importance in advancing food security agendas.

In response to the exponential global population growth, (Dabour, 2019) contends that increasing agricultural production to meet escalating food demands amplifies the need for irrigation water. However, water scarcity necessitates enhancing irrigation water efficiency. (Karogo, 2003) notes the heavy reliance on rain-fed agriculture to achieve food security, which has become precarious due to climate change impacts. This dependence has led to a surge in demand for irrigation to ensure household sustenance, particularly in arid and semi-arid regions. Despite increased yields attributed to irrigation, the non-commercial nature of many irrigation projects focused on enhancing household food security has led to suboptimal outputs and, in some cases, project collapses. While considerable research has been conducted on the role of large-scale irrigation projects in bolstering food security, limited attention has been given to the contribution of small-holder irrigation initiatives. The availability of labor represents a crucial factor in enhancing food security, prompting this study to explore labor availability and the technical aspects that contribute to heightened productivity in small-holder irrigation projects. Successful irrigation projects necessitate support from either donors or government entities. Consequently, this study aims to evaluate the support provided by donors and governments to small-holder irrigation ventures, thereby ensuring food security for Kenyan citizens. The overarching purpose of this study is to bridge the existing research gap regarding the role of small-holder irrigation schemes in advancing food security objectives.

The study was conducted to examine various aspects pertinent to enhancing food security within small-holder irrigation projects. Firstly, it sought to investigate the significance of labor in contributing to food security within these projects. Secondly, the study aimed to assess the level of support donors provided to achieve food security within small-holder irrigation initiatives. Lastly, it aimed to evaluate the extent of governmental support allocated to small-holder irrigation schemes to advance food security objectives. Through these objectives, the research aimed to provide valuable insights into the multifaceted nature of promoting food security within small-holder irrigation projects.

Theoretical Review

The research was grounded in the classical contingency theory, as proposed by (Pinto & Slevin, 1987). According to this theory, collaboration among various project components increases resource productivity and establishes the necessary conditions for community-driven development. Food security represents a paramount challenge confronting communities in the developing world. Therefore, it becomes imperative to foster collaboration among available labor, donor assistance, and government support for small-holder irrigation projects to achieve optimal productivity and enhance Kenya's food security status. At the grassroots level, small-holder farmers are expected to take the lead in implementing and managing small-holder irrigation projects. However, they also require support from private institutions or donors

possessing the requisite knowledge and entrepreneurial skills. Furthermore, government support is crucial to facilitate resource utilization and the sustainable management of natural resources for long-term development. Each stakeholder contributes uniquely to bolstering the overall productivity of small-holder irrigation farms.

Labour Availability in Irrigation-based Farming and Food Security

(Devi et al., 2013) delved into labor dynamics within the agricultural sector, noting a marked decrease in employment elasticity across Asian agricultural settings. Factors such as adopting bio-chemical technologies, mechanization, shifts in cropping patterns, and waning interest among youth in agricultural employment were identified as contributors to this decline. They stressed the necessity of scrutinizing labor dynamics intricately to understand the sector's complexities. Similarly, (Narayanamoorthy and Deshpande, 2003) underscored the significance of real wages in shaping labor demand and availability within agriculture, highlighting that regions with higher real wages tended to exhibit more elastic labor supplies. Meanwhile, a (Masya, 2016) study on irrigation project viability in Kenya emphasized the critical role of labor possessing expertise and technological knowledge. Effective project management, informed by labor legitimacy, governance, and accountability, emerged as pivotal factors in optimizing irrigation project outcomes.

(Muraya and Ruigu, 2017) shed light on labor's macro determinants within agriculture, noting an association between agricultural productivity and labor force increase in regions with reasonable wages. Conversely, Ngenoh et al.'s (2015) examination of irrigation schemes in Kenya highlighted challenges impeding their success, including concerns over labor quality and the overwhelming demand for casual labor, rendering many government-run projects unviable. This preference for permanent employment overshadowed the schemes' role in enhancing food security. Despite these hurdles, privately managed schemes thrived due to effective project management, underscoring the importance of labor dynamics in irrigation project sustainability.

The Role of Donors in Enhancing Success of Irrigation Schemes in Kenya

(Kabanda, 2011) illuminated the enduring impoverishment citizens face, particularly those in regions with scarce goods and insufficient services. Donor interventions strive to break this cycle of poverty by empowering communities through capacity building, enabling them to tackle challenges independently. This approach fosters self-reliance within communities and emphasizes the importance of political and social commitment to sustainable development (Hope, 2009; Blewitt, 2008).

(Ngenoh et al., 2015) examined the heavy reliance of Kenyan irrigation projects on donor funding and technical expertise. The government oversees major projects, but donor intervention, including economic stimulus packages, has spurred small-scale community-managed initiatives. Donors continue to support these projects, facilitating a transition from government-run to community-managed irrigation endeavors.

(Muraya & Ruigu, 2017) underscored Kenya's vast irrigation potential and donors' significant role in supporting small-scale projects. Donors employ various capacity-building strategies, such as the Training and Visits model and farmers' field schools, to promote irrigation adoption. However, challenges persist, including low adoption rates among farmers and limited government support for small-holder irrigation initiatives amidst recent reforms in the water sector (Muthama, 2015).

Local and National Government Role in Small Holder Irrigation Projects

The government plays a vital role in ensuring the success of development projects by mobilizing resources and safeguarding public interests. This includes maintaining functional irrigation systems crucial

for sustainable national development and promoting agricultural extension programs to enhance productivity and rural development. Despite initial challenges with approaches like the "training and visits" model, governments have adapted to more demand-driven extension strategies advocated by organizations like the World Bank, focusing on poverty reduction and agricultural development initiatives. Agricultural extension programs are crucial in supporting food security by empowering farmers with knowledge and skills to adapt to climate change challenges and make informed decisions regarding crop and livestock diversification options.

Education and training are essential for human development, focusing on acquiring knowledge and intelligence and training targeting specific skill transfer. Improving pre-service education for extension workers is necessary to meet the evolving needs of agricultural education. Agricultural institutions face significant challenges, including institutional disconnects between teaching, research, and extension services, hindering effective knowledge transfer and policy implementation. Bridging these gaps requires innovative leadership, institutional reforms, and functional mechanisms to integrate education, research, and extension efforts and address common challenges in agricultural development.

Based on the explanation above, a research framework was formulated, as presented in Figure 1.

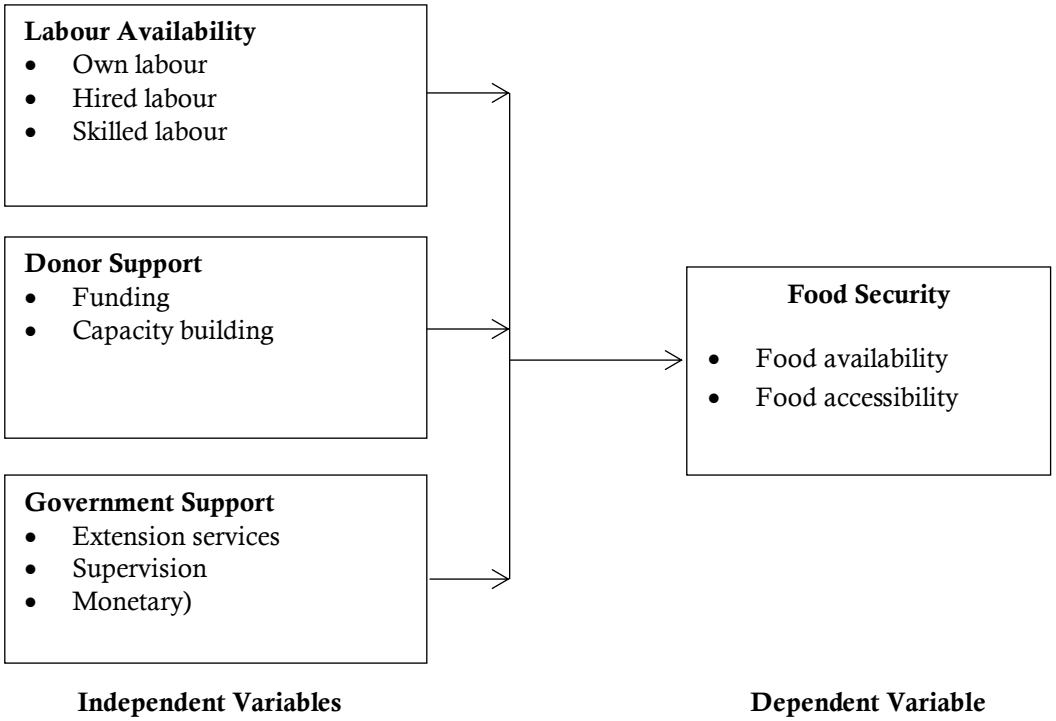

Figure 1. Conceptual Framework

B. RESEARCH METHOD

The study utilized a descriptive survey design to collect qualitative and quantitative data to assess irrigation-based projects' role in achieving food security. It involved 1303 participants from six irrigation schemes in Kenya, jointly funded by the government and donors like GTZ, with members contributing 50% of the project cost. The schemes cultivated crops such as bananas, horticulture crops, livestock fodder feeds, and maize. Sampling adhered to the (Gay & Arasian, 2003) principle, randomly selecting 66 scheme members (5.07% of the population) and two agricultural extension officers, while farmers from each scheme were chosen through stratified sampling. Data collection relied on questionnaires and interviews

administered physically by trained research assistants and the researcher. The analysis involved categorizing, coding, and summarizing data using descriptive statistics and the Statistical Package for Social Sciences (SPSS), alongside thematic summarization of qualitative data.

C. RESULTS AND ANALYSIS

Response Rate

The study had a sample of 66 respondents who were surveyed using a structured questionnaire. A response rate of 92.4% (61 respondents) was achieved, and the data was used for analysis. This, therefore, makes the study appropriate to make conclusions and recommendations since, according to (Creswell, 2014), a response rate of 30-60% in a study is adequate for making conclusions and recommendations. The response rate is shown in Table 1.

Table 1: Response Rate

Category	Frequency	Percentage
Sampled Population	66	100%
Responses	61	92.4%
Non-Responses	5	7.6%

Source: Research data, 2023

Labour Availability in Irrigation-based Farming and Food Security

This research aimed to evaluate the labor components crucial for enhancing food security within small-holder irrigation projects. Respondents were tasked with indicating their level of agreement or disagreement with key statements about this objective, and the summarized findings are presented in Table 2. The results indicate a prevalent disagreement among most respondents with the statements, suggesting inadequate labor availability for promoting food security in irrigation-based agriculture. Government officials highlighted an influx of young individuals reluctant to engage in farming due to comparatively lower wages than those offered in non-agricultural sectors. These findings align with (Narayanamoorthy & Deshpande, 2003) observation that self-labor predominated in small-scale irrigation projects due to the modest size of plots. Mechanization remained limited in many schemes, typically relying on donations of mechanized equipment from donors and the government to alleviate farmers' burdens.

Similarly, (Masya, 2016) emphasized the significance of labor availability as a major concern in small-scale irrigation endeavors. Furthermore, the research identified challenges in managing labor time efficiently, reflecting societal dynamics where individuals seek to minimize effort while maximizing daily wages. Notably, the lack of specialized labor hindered the significant contribution of small-holder irrigation projects to regional food security. However, the study revealed that farmers in small-holder irrigation schemes primarily cultivated crops for the market, enhancing food security in Kenya. These findings corroborate (Ngenoh et al., 2015) assertion that large-scale and small-holder irrigation schemes significantly contribute to food security in Africa by effectively utilizing otherwise underutilized lands.

Table 2: Labour Availability in Irrigation-based Farming and Food Security

Statement	Mean	Std. Dev.
I apply my human labor on my land	2.19	0.99
It is difficult to get good, dependable labor for my land under the irrigation scheme	2.46	1.03
The human labor receives wages daily from me	2.85	1.19
The labor has complained of low wages paid	1.59	0.63
some laborers keep away, citing low wages	1.74	0.48
Finding specialized human labor in my project is challenging	2.12	0.72
The human labor works to my satisfaction	2.15	0.91
Given Specialized labor, my productivity in terms of quality and quantity would significantly change	3.27	1.20
I produce more for the market than my consumption	1.88	0.59

Source: Research data, 2023

Role of Donors in Enhancing Success of Irrigation Schemes in Kenya

This research aimed to assess the extent of donor support in facilitating the success of small-holder irrigation projects in Kenya. A key objective was to gauge respondents' perspectives on donor support through a Likert scale-based assessment of key statements related to this objective. The summarized results in Table 3 indicate a disagreement among respondents regarding the extent of donor support received by their irrigation schemes. This suggests that the majority of small-holder irrigation projects lack significant donor backing. These findings align with (Burnside and Dollar, 2000), who observed that many projects in developing economies relied on government funding or external donor assistance. Additionally, (Ngenoh et al., 2015) highlighted the country's heavy reliance on donor funding and technical expertise for irrigation projects. The study further concluded that a substantial proportion of small-holder irrigation projects benefited from the training provided by donors, consistent with (Blewitt's, 2008) assertion that donors often offer capacity-building services to projects they support. Such support may encompass various activities, including training sessions, provision of necessary materials, and fostering community engagement through conferences and public participation initiatives.

Table 3: The Role of Donors in Enhancing Success of Irrigation Schemes in Kenya

Statement	Mean	Std. Dev.
This project has received support from non-government organization	1.66	0.65
We receive training on project sustainability from NGO technical staff	2.00	0.89
Members receive training on efficient resource utilization from NGO-paid staff	2.24	1.07
We constantly receive training from NGO staff	2.13	0.94
The NGO assists us in looking for a market for our products	2.24	0.95
We receive material support (insecticides, seeds, weedicide) from the NGO	2.10	0.86
We have increased our production directly attributed to support from the NGO	2.86	1.34

Source: Research data, 2023

Role of Government in Enhancing Success of Irrigation Schemes in Kenya

The research aimed to evaluate the extent of government support provided to small-holder irrigation schemes to achieve food security. Using a Likert scale, respondents were tasked with expressing their agreement or disagreement with specific statements about this objective. The summarized outcomes are presented in Table 4. The results indicated minimal government support extended to the irrigation schemes, with most participants expressing disagreement regarding assistance from government agencies such as WARMA. This suggests that most small-holder irrigation projects did not benefit from governmental aid.

Furthermore, respondents largely disagreed with the assertion that government officials visited their irrigation projects, indicating a lack of direct involvement from governmental bodies. The study revealed a notable absence of government assistance in small-holder community irrigation projects within the region. Additionally, it highlighted inadequate extension services provided to members of small-holder irrigation projects. These findings diverge from (Tuffour and Armah's, 2008) assertion that the government offered farmer training and visitation programs to enhance production. Similarly, they contrast with (Collett and Gale, 2009) view that the government's role in small-holder irrigation includes training farmers on sustainable agricultural practices.

Table 4: Government in Enhancing Success of Irrigation Schemes in Kenya

Statement	Mean	Std. Dev.
Our project has received support from government agencies (WARMA, NIB)	2.70	1.13
The government officers constantly visit us to check on the project's progress	2.66	1.19
The government sends a technical team to assist us in the project	2.58	1.18
The extension officers train members on crop management	2.78	1.11
The government assists us in looking for a market for our products	2.69	1.18
We receive material support (insecticides, seeds, weedicide) from the government	2.64	1.19
We have increased our production directly attributed to support from the government	2.85	1.09

Source: Research data, 2023

The Influence of Labour Quality, Donor Support, and Government Support on the Productivity and Food Security in Small Holder Irrigation Projects

The study aimed to highlight the impact of independent variables on the dependent variable. The analysis of responses is synthesized in Table 5. According to the findings, most farmers acknowledged that timely access to labor would enhance farm productivity. However, the study revealed that small-holder irrigation projects encounter challenges securing timely labor. Moreover, most respondents agreed that the availability of specialized labor could bolster farm productivity. The study concluded that labor accessibility and quality significantly influenced production in small-holder irrigation farms, aligning with (Narayanamoorthy and Deshpande, 2003) observation on the influence of labor availability on farm productivity.

Furthermore, most small-holder farmers agreed that increased donor support would enhance their productivity. The study indicated that donor support was crucial in boosting productivity in small-holder irrigation projects, consequently impacting food security in the country. These findings corroborate the (Hope, 2009) assertion regarding the influence of donors on project production volume. Respondents also concurred that government support, through technical advice and input assistance, would elevate production on their land parcels. The findings underscored the necessity of government support in enhancing the role of small-holder irrigation projects in advancing food security in Kenya. This observation aligns with the perspectives of (Christoplos, 2008; Benor and Baxter, 2004), as well as (Collett and Gale, 2009) on the pivotal role of government in improving productivity in small-holder irrigation farming.

Table 5: Influence of Labour, Donor Support and Government Support on Feed Security in Small-holder Irrigation Schemes in Kenya

Statement	Mean	Std. Dev.
If I had access to adequate labor in real time, I would increase my production to the current volume	3.48	0.56
Specialized labor would increase the unit production of my irrigated land	3.70	0.61
Increased donor funding would harness more productivity in small-holder irrigation land	3.96	0.69
An increase in the frequency of technical advice would increase my production proportionately	3.69	0.58
Government support in the form of technical and input would increase my productivity	3.62	0.56
The government should increase agricultural extension services to assist us in increasing our production	3.67	0.63

Source: Research data, 2023

D. CONCLUSION

The study findings revealed a significant scarcity of labor, especially specialized labor, within small-holder irrigation projects, which could substantially enhance unit production. Concurrently, the research aimed to gauge donor support in bolstering food security within small-scale irrigation initiatives. It was discerned that most of these projects benefitted from donor assistance, encompassing technical guidance and input provisions, resulting in tangible productivity enhancements. However, a notable dearth of government support for small-holder irrigation schemes in achieving food security was also underscored, with minimal technical guidance and farming inputs. Consequently, the study proposes several recommendations based on these findings. Firstly, farmers are urged to incentivize the recruitment of specialized labor, potentially pooling resources to engage specialists in crop management. Secondly, NGOs are encouraged to intensify their capacity-building endeavors, particularly focusing on technical aspects for farmers. Lastly, the county government's agriculture department is urged to prioritize offering technical support to small-holder irrigation projects, including scheduled visits and training sessions to enhance crop management practices.

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