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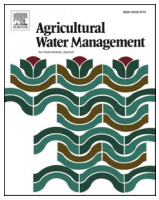

Review

Farmer-led irrigation development in Kenya: Characteristics and opportunities

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ABSTRACT

Farmer-led irrigation development (FLID) is not a new phenomenon and has been happening throughout the centuries in all countries where irrigation is practised. Despite this, planners, policy makers, funders, including engineers have generally taken the perception that irrigation development occurs mainly in "irrigation schemes". Although farmer-led irrigation happens in formal irrigation schemes, there is a substantive amount of irrigation development implemented quietly by self-motivated individual farmers on their own initiatives. Such irrigation remains unrecognized, un-recorded and thus ignored in the realm of the irrigation sector decision-makers. The term FLID was coined just recently in 2017, and through it, there is emerging a wealth of knowledge on the technologies, practices, economic, marketing, financing and social components regarding how this sub-sector operates. Indeed FLID is not tacitly captured in Kenya's policies, statutes and development plans. Its extent is largely unknown since it has not been targeted in any mapping exercise. Yet, as irrigation transitions more from public to private investment, FLID is the next big thing pushing the growth of irrigation in Kenya. This paper therefore highlights some of the salient features of FLID, a sub-sector of interest towards enhancing irrigation development and food security in Kenya.

1. Introduction

There is renewed impetus to expand and promote irrigation development in Kenya over the next decade and beyond. According to the National Water Master Plan 2030 (GoK, 2013), irrigation potential in Kenya without water storage is estimated at 1.2 million ha, but this differs slightly with the potential of 1.342 million ha as per FAO, (2018). But the Kenya vision 2030 (GoK, 2007) goes further and points out that additionally, there are some 9.2 million hectares in arid and semi-arid lands (ASALs) which have the potential for crop production if irrigated. This is a powerful statement that gets omitted in most planning and policy documents including the current National Irrigation Policy (GoK, 2017). It therefore means that the irrigation potential is underestimated and much greater than listed in most reports. Generally, only 15% of potential irrigable area of Kenya has been developed (NIA, 2019). Indeed the future growth and development of the agricultural sector in Kenya will rely on developing the 83% of land that is ASAL, as well as intensifying production in the other arable areas through irrigation.

Irrigation development is a viable option for increasing agricultural production through resource mobilization, improved water productivity as well as food security. However, investments in irrigation go beyond food security, as they can be used to address poverty alleviation, wealth and employment creation in the country. Yet, "poverty reduction through irrigation" is not very evident as a policy objective in Kenya, despite the fact that farmers who have access to irrigation are likely to attain better crop productivity and higher incomes. Furthermore, the importance of irrigation is becoming critical with emerging climate change and climate variability, which render rain-fed farming risky. These considerations mean that there should be greater policy support, funding, capacity development and promotion of FLID as an important irrigation sub-sector.

2. Irrigation as defined in Kenya's laws and policies

Irrigation in Kenya is viewed in terms of "irrigation schemes". Indeed the former Irrigation Act CAP 347 (Republic of Kenya, 1966) defined *"scheme"* as *"any area designated to be a national irrigation scheme under Section 14 of the Act"*. The idea that irrigation only happens in schemes seems to have permeated across the decades to the present time. Even contemporary policies, laws and guidelines have this connotation. For instance, the current Irrigation Act-2019 (Republic of Kenya, 2019)

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defines "*irrigation scheme"* as *"a systematic and orderly irrigation system covering a defined area of land regardless of the type or system of irrigation employed*". The same Irrigation Act-2019 further defines *"irrigation"* as "*any process, other than by natural precipitation, which supplies water to crops or any other cultivated plants, livestock, aquaculture and desired forest trees"*. As a technical definition, this is fine but does not introduce the fact that irrigation in Kenya exists in the absence of a "scheme". Inherently an individual irrigator is construed to be a "scheme". This is still not accommodating of individual irrigators when tallying the areas under irrigation and thus, policy support.

3. Water scarcity in the face of irrigation expansion

The available policies and statutes do not classify irrigation according to water use (big or small users) or types of use in Kenya e.g. full control irrigation, supplemental irrigation and other scales of water use. A clear understanding of these scales is necessary in terms of water allocation and supplies, which are core components of irrigation development and management. This is because water use and users have been increasing rapidly. This is associated with demand for fresh produce due to increasing urbanization, leading to expansion of irrigated areas. In addition, there is higher per capita water usage from domestic, commercial and industrial sectors all of which utilize more water. An assessment conducted by World Bank's Water Resources Group-2030 (WRG, 2016) revealed that Kenya faces absolute water scarcity with respect to availability of renewable freshwater. Driven by population growth, Kenya's renewable internal freshwater per capita has decreased by an average of 2.6% annually from 556 cubic meters in 2007–461 cubic meters in 2014. Over the same period, annual freshwater withdrawals per capita have increased by 2.0% annually from 62 to 72 cubic meters. Given the growing water scarcity, there is need for interventions that support the uptake of water-efficient irrigation technologies, as well as developing unconventional sources water e.g. rainfall-runoff harvesting and storage. FLID is quietly taking up this space, but there is little data as evidence due to invisibility of the sub-sector.

4. Characterization of irrigation schemes by ownership and management

Irrigated areas in Kenya are classified according to the size of a scheme, as defined in Irrigation Act-2019 (Republic of Kenya, 2019), and expounded by the Irrigation Guidelines (MWSandI, 2020a). The Guidelines further categorize irrigation schemes by ownership and management, namely: Public and national, Community-based, and Private owned. These are described as follows:

a) **Public and National Irrigation Schemes**: These are schemes developed on public land and managed by public institutions. More specifically, these schemes are developed and managed by the National Irrigation Authority (NIA), Regional Development Authorities (RDAs), the Agricultural Development Corporation, the National Youth Service, the Prisons, Universities, Colleges and other State entities. The size of public scheme range from 40 to 12,000 ha in area. Altogether, public schemes cover 22,028 ha in area, which is about 10.9% of all irrigated lands (Table 1). Examples of public irrigation schemes include: Mwea, Bura, Hola, Perkerra, Ahero and West Kano, which are managed by NIA as settlement schemes. Generally, there are shared mandates for the management of these schemes through Irrigation Water Users Associations (IWUAs). NIA provides advisory services, operation and maintenance while the farmers pay irrigation service fees through their respective IWUAs.

b) **Community-Based Irrigation Schemes**: Are schemes owned by individual farmers or groups sharing an irrigation facility, e.g. a canal, pipeline or pump. These schemes are managed through IWUAs, cooperatives or self-help groups. The Irrigation Regulations-2020 (MWSandI, 2020b) require that self-help groups should transit into IWUAs. There are over 3600 community-based irrigation schemes in Kenya covering over 99,964 ha of land, equivalent to 49.5% of the country's developed irrigable area. Community-based schemes produce the bulk of horticultural produce for domestic and export markets. Other crops grown include: grain staples and tubers. These schemes provide economic empowerment of rural communities and farmers, as it becomes possible to bridge rainfall deficits by irrigating niche crops. Community-based schemes have lower overhead construction and management costs and are relatively sustainable.

c) **Private Irrigation Schemes:** Are developed by private companies or individuals and tend to be large scale in area and/or highly commercialized. They cover over 79,970 ha accounting for 39.6% of irrigated land. Most private schemes utilize high technology and produce high-value crops for the local and export market, especially flowers, fruits and vegetables. They offer employment to local people and also support small scale irrigators by sub-contracting them as out-growers for some of their produce.

Table 1
Extent of Irrigation in Kenya by Scheme Sizes.

Category of Irrigation	Holding size (ha)	Irrigated Area (ha)	Percentage of total
Public and national schemes	40–12,000	22,028	10.9%
Community-based schemes	< 40	99,964	49.5%
Private commercial farms		79,970	39.6%
Total Irrigated area		**201,962**	**100%**
Total irrigation potential & percentage of total land irrigated	All	**1342,000**	**15.0%**

Data source: Irrigation Guidelines (MWSandI, 2020a)

5. Classification of irrigation schemes by scale of holding size

Generally, irrigation in Kenya is typified by size of land holding under fully managed water systems. According to the Irrigation Act-2019 (Republic of Kenya, 2019), Kenya's irrigation sector is classified as into three types by area of schemes, i.e. large, medium or small-scale viz:

(i) *Large scale irrigation scheme:* A scheme which acreage size covers over 1200 ha, and is developed and managed by NIA, and is established for national strategic purposes, or such schemes as implemented by the private sector.

(ii) *Medium scale irrigation scheme:* A scheme which in acreage size covers over 40–1200 ha, and is implemented by NIA, or another state agency in collaboration with county government, or such schemes as implemented by a private entity.

(iii) *Small scale irrigation scheme:* A scheme which in acreage size covers less than 40 ha and is implemented by a county government, or by the national government through Authority in case of trans boundary or inter county schemes or strategic schemes or such schemes as implemented by a private entity.

From the foregoing, it is apparent that FLID has not been tacitly factored in the Irrigation Act (2019).

6. Small-scale farming vs smallholder irrigation

A small-scale farm under rainfed agriculture is different from the scales under irrigated systems. The Agriculture Sector Development Strategy (ASDS) (GoK, 2010) described small-scale farming as "*production carried out on farms averaging 0.2–3 ha mainly in the high-potential areas"*. Neither the Agriculture, Fisheries and Food Authority Act-AFFA (Republic of Kenya, 2013), nor the Agricultural Transformation and Growth Strategy-ASTGS (2019–2029) provide a

definition for smallholder irrigated agriculture. But the closest the ASTGS gets to define small scale farmers is clustering them under small/medium enterprise (SME), defined as: *"both formal and informal businesses concentrated in urban and peri-urban areas"*. Kenyan SMEs have 10–100 employees, and an annual turnover of less than US$5000–50, 000 (in 2019) per year. There is, therefore, need for a clear understanding of what constitutes a small-scale farmer under rainfed agriculture as compared to that under irrigated agriculture.

The Irrigation Act (Republic of Kenya, 2019), defines *smallholder irrigation and drainage scheme* as: "*An irrigation scheme that is developed, owned and managed by communities as irrigation water user groups or individual farmers*." The Act did not allocate the command area for this sub-sector. Thus, "*Smallholder Irrigation"* is inherently presumed to be small scale in size. The word "scheme" runs through and "Individual irrigators" are presumed to be "schemes". But therein lies the disconnect because there exists large numbers of small scale individual irrigators who may not belong to a "scheme" and are thus not adequately accommodated by being defined as a scheme.

7. Small-scale irrigation has been increasing

There is ample evidence to show that small-scale irrigation (SSI) has been increasing, despite the lack of clarity on the exact areas irrigated, or the number of farmers benefitting. A study by Hornum and Bolwig (2020) documented that SSI was steadily growing, overtaking both large public schemes and commercial schemes, to cover about 110,000 ha. Data from the Ministry of Water, Sanitation and Irrigation showed that SSI commands 54% of irrigated land in Kenya (MWSandI, 2020c). Meanwhile, other organizations and farmers themselves have been developing irrigation. This is referred to as farmer-led-irrigation development (FLID). The extra irrigation expansion under FLID has not been mapped nor quantified. Thus, the overall irrigated area, crops produced, number of farmers engaged and activities outside of formal irrigation schemes are generally unknown and are expected to be higher than what is quoted in government reports.

8. Farmer-led irrigation development (FLID) defined

Farmer-led irrigation development (FLID) has been defined (Wiggins and Lankford, 2019), as "*when farmers drive the establishment, improvement, and/or expansion of irrigated agriculture - and influence the location, purpose, and design of irrigation development through small-scale, on-farm, locally relevant, and market-oriented solutions.*" The term FLID was coined in 2017, and described as " a process *where farmers, alone or as a collective, take the driving seat to improve irrigation development by acquiring technologies for agricultural water use and by developing associated input and output linkages"* (Woodhouse et al., 2017). Yet a clearer definition has been proffered by the African Union, (2020), which describes FLID *as "a process where farmers assume a driving role in improving their water use for agriculture by bringing about changes in knowledge production, technology use, investment patterns and market linkages, and the governance of land and water"*. FLID does not include highly commercial farms – *some of which are small in size* e.g. *flower farms, as those are already clustered under "private schemes"*. All these definitions agree that FLID relates to irrigation developed by farmer(s) for the farmer(s), through mostly individual or collective initiatives and investments.

9. Characteristics of FLID

FLID initiatives cut across existing irrigation types in terms of scale, technologies, crops and governance arrangements. Farmers bring in or develop new ideas and technologies, change investment patterns, and create new knowledge – inevitably involving other actors (such as local communities, government, or private sector). They are also widely diverse in their scale, technology applications and farming methods. The operation and management decisions and actions under FLID are fully controlled by farmers. Typically, farmer-led irrigation enterprises have the following characteristics (World Bank, 2021):

1. Typically grow high-value crops for urban, peri-urban and in some cases, export markets.
2. Is small-scale (<40 ha) and typically irrigate small fields of 0.5–2 ha.
3. Includes both individual initiatives and group schemes.
4. Is self-funded (mostly) and largely managed by farmers.
5. Tends to adopt multiple cropping
6. Usually adopts market-oriented crop enterprises
7. Often, but not necessarily, use pumped systems (manual, small petrol, or solar pumps).
8. High reliance on shallow wells in the case of individual irrigation systems, water harvesting storages or direct river pumping.
9. Farmers grow mainly horticultural or high value crops.
10. Family labor on smaller plots and use of employed/paid labor on larger farms.

FLID encompasses beyond just a technology, e.g. small pumps. It is about a dynamic and unfolding development process. Recognition of this *"process"* requires a reflexive approach that first aims to understand local diversity, strengths and weaknesses of the system, then identifies opportunities and interventions that may catalyse positive change (World Bank, 2021). Granted that highly commercial, privately owned irrigated farms (e.g. flower farms) are developed through farmers' initiatives, but these are already recognized as private irrigation schemes in Kenya and thus, are not considered to be FLID.

10. Basic typologies of FLID

Generally, two typologies of FLID are distinguished (African Union, 2020) as follows:

(i) **Individual (private) irrigation for high-value crops** – These are farmers who assume a driving role in improving their water use for agriculture, in particular, irrigation. They are characterized by their independent entrepreneurial nature, private financing, and ability to take risk, thus amenable to try new initiatives.

(ii) **Small-scale community-based irrigation schemes -** These are small-group schemes, quite often developed through integrated rural development, natural resources management, community-driven development (CDD), self-help groups or social fund projects.

Regardless of typology, farmer-led irrigation initiatives cut across diverse scales, technologies, crops, management and governance arrangements. FLID is not limited to a defined range of farm sizes, but typically involves farmers on less than 10 ha of land, but a majority cultivate less than 2 ha. The main focus of FLID is smallholders because they are generally less equipped – financially, technically and in their access to knowledge – to overcome the constraints posed by unfavorable operating environments. This does not mean that FLID has a small impact. On the contrary, while individual farms are usually small, FLID is spread throughout the country to the extent that collectively, its impacts on food production, the economy and livelihoods is substantive. However, the extent of FLID in Kenya has not been unmapped and thus, remains unknown.

11. Opportunities in farmer-led irrigation development

The rapid growth and entrepreneurial nature of FLID offers inherent opportunities for developing the infrastructure, technologies, water, markets and commercialization of irrigated agriculture. Within Africa, FLID has gained traction in recent years and is identified as the dominant

process driving agricultural water expansion in the continent (African Union, 2020). At the farm level, water availability within or close to farmlands usually facilitates adoption of irrigation, with or without external support. FLID thus provides opportunity for farmers to invest in their own irrigation systems, as simple and affordable irrigation methods to be used. Otherwise, uptake of irrigation technologies is sometimes limited by high initial capital investment and operating costs, as is common in large-scale public irrigation schemes. FLID is relatively sustainable as it is free from undue pressures that slow down decision making in large public schemes.

FLID farmers are normally innovative and ready to take risks, through own-funded initiatives. They sometimes use funds from other sources to try new ideas and technologies and are able to overcome various challenges faced in smallholder irrigation and increase the profitability of their crops. In addition, the inherent unregulated character of farmer-led irrigation means that they operate with minimal government interference and decision making is at an individual level. That way, technology adoption is more rapid and the farmer adapts to changing circumstances easily. Within Africa, there is growing evidence that FLID has recorded better success rates and fewer failures than schemes under public sector management. In essence, FLID systems take up the largest share of irrigated land in many countries in sub-Saharan Africa, accounting for at least 83% of irrigation development over the last 20 years (World Bank, 2021).

12. Drivers of FLID

Kenya is urbanizing rapidly with migration of mainly youth from rural to urban areas. This is driven by limited rural income opportunities that are compounded by low labor productivity due to low-intensity farming. Urbanization is associated with higher incomes and changing lifestyles, which leads to shifts in food preferences; mainly increased demand for high value products such as meat, dairy, fruit and vegetables. The changes in food preferences leads to increased markets for crops from irrigated agriculture, which in turn require commanded water for production. The pull-factor of urbanization thus accelerates irrigation uptake and presents opportunity for introduction of new irrigation technologies, such as energy-efficient solar pumps, or improved water application systems associated with peri-urban farming. This demand is mostly met by smallholder, market-oriented producers; typically farming horticultural crops through irrigation. These market-oriented, entrepreneurial small-scale farmers have been at the forefront of irrigation expansion across Africa over the last two decades (Woodhouse et al., 2017). The main drivers of FLID include:

1. Availability of appropriate irrigation technologies (including water supplies, control and efficient application methods);
2. Land tenure and water security;
3. Access to finance, credit and investment opportunities usually through appropriate business models for farmers operating at different scales;
4. Affordable irrigation equipment to generate greater economic returns;
5. Input market value-chains making it easier to access input markets for technology buyers, spares, fertilizers, seeds and irrigation equipment;
6. Easy access to output markets and favorable farm-gate pricing of irrigated produce;
7. Information and knowledge flows through opportunities such as the internet, radio, TV, mobile phones, print media and farmer-to-farmer visits;
8. Highly developed mobile money transfer (e.g. M-Pesa) enabling remote farming, financial transactions and knowledge flows more versatile and practical; and
9. A relatively well educated farming clientele willing to invest funds from other sources (e.g. employment, retirement benefits, other businesses) in irrigated agriculture.

13. Main challenges facing FLID in Kenya

One of the major challenges facing FLID is its lack of recognition in the policies and institutions responsible for irrigated agriculture in Kenya. Although FLID is not new, having been practiced over many years, the sub-sector got recognition at the international level just recently (Woodhouse et al., 2017). Within Kenya, the equating of irrigation development to infer "irrigation scheme" has meant that FLID misses out on policy support, resource allocation, as well as planning alongside other sectors. Although apex policies e.g. Kenya Vision 2030 support small-scale irrigation and private enterprise, but FLID had not been defined at the time of its formulation. The Water Act-2016 (Republic of Kenya, 2016) heavily dwells on drinking water, including environmental flows, but completely omits irrigation. The Agricultural Sector Transformation for Growth Strategy (GoK, 2019b) tends to favor large scale irrigation at the expense of SSI and FLID. Even then, a number of statutes articulate small-scale irrigation (SSI) e.g. Irrigation Act 2019 (Republic of Kenya, 2019), but it is silent on FLID. Despite this, the largest cluster of small-scale irrigators are individual farmers. FLID is almost invisible in Kenya's policies, legal, regulatory and planning instruments and thus misses out on development support. Meanwhile, non-governmental organizations (NGOs) and various private sector actors e.g. banks, microfinance institutions, equipment supplier, off-takers and other value chain actors support or interact with FLID directly and indirectly. However, it is not clear who is doing what, where, as a census of the key actors in FLID has not been conducted. Despite the challenges, FLID has continued to grow with minimal policy support, e.g. the benefits accorded to SSI in publicly developed irrigation schemes do not reach individual irrigators. Institutional support e.g. capacity building, subsidies, access to information and other incentives are not always availed to FLID. Most individual farmers do not belong to groups, hence have no means to express their problems or gain from group marketing or extension services. Generally, FLID doesn't feature when irrigation is being enumerated. The contribution of FLID to irrigation largely remains unknown (yet it is huge and growing), and thus, not adequately accounted for or factored in development planning. Individual farmers engaged in FLID operate almost their own.

14. Guidelines for irrigation design and development

Irrigation development in Kenya is guided by the Irrigation (General) Regulations-2020 (MWSandI, 2020b), which are in turn pegged on the broader Water Resources Regulations (GoK, 2020). On their part, the Irrigation Regulations outline modalities for irrigation development, licensing, management and financing. Alongside these Regulations, the Government also developed the Irrigation Guidelines (MoWS&I, 2020a) which guide the promotion, development and management of irrigation schemes in Kenya. Both the Regulations and Guidelines clearly articulate who can initiate an irrigation scheme or investment and how. They allow that an individual, a developer, a community, county or national government can initiate an irrigation scheme. Also, an owner, developer or any other person intending to construct an irrigation scheme is supposed to submit to the supervising entity, the following (MoWSI, 2020a);.

a) Pre-feasibility study report or initial project identification concept note showing viability;
b) Minutes of resolutions of stakeholders' meetings endorsing or requesting for development of the irrigation scheme where applicable;
c) Feasibility study report;
d) Irrigation project design report;

e) An authorization for construction from the Water Resources Authority;
f) Land use authorization from the County or national ministry responsible for land and physical planning; and
g) An environmental impact assessment license from National Environmental Management Authority;
h) Evidence of relevant easements from relevant agencies and entities;
i) In respect to irrigation within private and community-based smallholder schemes, provide proof of land ownership, which may consist of a certified copy of title deed or lease agreement; and
j) For community-based smallholder irrigation schemes, evidence of existence of an irrigation water users' association.

Generally, according to the regulations, all small scale, County public and County initiated irrigation schemes should be supervised by the County Irrigation Development Units (CIDUs) while all other schemes are supervised by the National Irrigation Authority. However, this is more in theory than in practice. There are many instances where irrigation is developed through individual or community initiatives with little or no involvement of NIA or county Government. Generally, most FLID is un-supervised at construction and largely un-regulated at operational level. The result is water abstractions that are unknown or not accounted for. Many irrigated areas in eastern and central Kenya are faced with water shortages as a result. This underscores the need to accord FLID some recognition, both to support the sub-sector as well as to streamline its operations, including water allocation, marketing and capacity growth.

15. Conclusions

FLID like other modes of irrigation, requires proper design, development, operation and management. Design and respective reviews are made during planning of the irrigation system. This task is supposed to be the responsibility of qualified (preferably certified) engineers, working with agronomists, hydrologists and other professionals. They are expected to check the functionality of infrastructure, water supplies and distribution systems, water storage, control structures, measuring devices, on-farm irrigation works and drainage. Designs are expected to be made along with cost estimates. In addition, water allocation and availability should be determined (IFAD and IFC, 2022). In addition, water supply rates should match crop water requirements as embedded in the irrigation design for system efficiency.

Infrastructure development involves construction works that prepare land and bring the water for irrigation. The main activities include development of water sources, conveyance infrastructure e.g. canals, pipe layouts, as well as field levelling, laying field pipe networks, and drainage works. It also includes selection of water application equipment e.g. sprinklers, drip lines and their accessories. The construction and operation of irrigation system should factor all hydrological processes so as to ensure environmental flows are retained in water-courses, but this is sometimes overlooked under FLID.

Irrigation design may also involve water harvesting and storage infrastructure, as well as construction and rehabilitation of community small dams, water pans and auxiliary infrastructure. It is usually necessary to support establishment of farmer groups which in turn take over the operation, management and maintenance of schemes.

The expansion of FLID is premised on the realization that it has grown into a vibrant and expanding sub-sector that can attract investments with good returns. Moreover, opportunities are emerging to expand irrigation in peri-urban farming and asset management is better assured under FLID than conventional public schemes.

16. Recommendations

There is need to support farmer-led irrigation development, given the growing evidence that FLID has recorded better success rates and fewer failures than schemes under public sector management. This sub-sector comprises individuals and small groups who make their own investments to advance irrigation. In addition, FLID has unique entrepreneurial, self-financing, and market-oriented niche, seeking interventions which are relatively low-cost as compared to large scale irrigation schemes. The scope for irrigation expansion using private finance is huge through FLID. Within Kenya, the extent of FLID has not been mapped in ways that accommodate individual irrigation. For this reason, FLID sub-sector requires targeted assessment including mapping to explore its extent, impacts and opportunities for upscaling.

It was noted that FLID misses out on various subsidies, incentives and opportunities accorded publicly funded irrigation schemes in Kenya due to its being invisible as a specific irrigation typology. It is therefore necessary to deliberately channel resources to support FLID through projects, subsidies, incentives, capacity building, and access to information for FLID farmers.

There is need to adopt water-efficient irrigation systems - In the past, irrigation schemes were designed with little concern for water wastage or losses. But in modern times, as water scarcity becomes more acute, there is need to improve the water productivity of crops and the overall efficiency of irrigation, especially under FLID. There are many options to achieve this, such as efficient new designs, rehabilitation of old water conveyance and application systems, e.g. lining canals or using piped conveyance. Others include; converting water application methods from basin to furrow, or from sprinkler to drip irrigation. Water saving practices such as choice of crop variety, agronomic management, prevention of excessive evaporation losses e.g. use of mulches and shade nets, wind breaks or use of sunken beds/planting basins to concentrate soil moisture absorption, among other techniques.

FLID requires institutional support across all fronts. This could be in the design water pans, wells, gravity diversion works, efficient water application methods such as drip systems, energy for water pumping such as solar powered pumps, improving water productivity and ultimately economic returns from FLID. Data and information is scanty on FLID as research has not been focused on the sub-sector. There is need for research on FLID across all its components to advice policy and other actors in the irrigated agriculture space.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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