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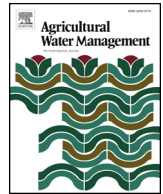
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# Too big to handle, too important to abandon: Reforming Sudan's Gezira scheme

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## ABSTRACT

Participatory irrigation management (PIM) has been broadly promoted by public administrators and donor organizations. The reasons for this push include performance failures of state-controlled irrigation schemes and the need to improve irrigation productivity for meeting rising food demands. A popular reform for increasing participation and ownership is represented by Irrigation Management Transfers (IMTs). IMTs mean replacing the government with the civil society (farmers) in irrigation management, and they go beyond working with the public sector as in PIM. These widely implemented reforms produced mixed experiences. Besides, the evaluation of IMT cases is reliant on scarce quantitative data. IMTs are also difficult to replicate due to methodological issues. However, qualitative research can engage with stakeholders' perceptions and narratives, especially the most relevant target group, namely farmers. We provide in this study stakeholders' opinions and attitudes towards several waves of IMT reforms in the Gezira scheme in Sudan. This mega-scheme is of high developmental and socio-cultural importance for the country ever since the independence from the British Empire. Using a perception survey and in-depth interviews with key informants, we illustrate the failure legacies to reform the Gezira scheme by enhancing farmers' participation through Water User Associations (WUAs). While both farmers and experts have suggested a poor implementation, inadequate farmers' involvement and unclear objectives of the reforms, the reforms' recurrent failures are explained within complex historic and political contexts. There are long-standing legacies of development missteps of the Gezira scheme, with no clear and ultimate triggers of performance deterioration. Besides, splits in professional cultures, power imbalances, political instrumentalization (of farmers) and the lack of farmers' awareness or capacities are salient factors for understanding the poor state of the Gezira scheme. It is difficult for stand-alone irrigation management reforms to be successful. Such reforms need to be embedded within a comprehensive policy package that prioritizes irrigation governance and proposes sound regulations based on clear roles, consensus-making and prior consultation.

## 1. Introduction

Irrigation is seen as a solution to meet rising food demands across the world. About 20 % of cultivated land under irrigation produce 40 % of the global food output (UNESCO, 2009). With irrigation, crop yields per hectare and profitability are estimated to be higher than in rain-fed agriculture (Darré et al., 2019; Garces-Restrepo et al., 2007; Lobell et al., 2009; Vico and Porporato, 2011). Irrigation is found to contribute to poverty alleviation, as it makes food more available and affordable for the poor, due to higher productivity and lower risk of crop failure (Hussain and Hanjra, 2004). The development of irrigation schemes was greatly expanded after the Second World War as governmental and international (donor) investments peaked in the 1970s. According to

Seibert et al. (2013), on a global level, more than 300 million hectares are today equipped for irrigation (69 % in Asia, 17 % in America, 8 % in Europe, 4 % in Africa, 2 % in Oceania), with the majority (62 %) irrigated with surface water. By consuming a 70 % share of all freshwater withdrawn globally and up to 95 % in developing countries, agriculture is the largest water use sector Seibert et al. (2013). Almost half of irrigated agriculture is practiced in only three countries, China, India and Pakistan (FAO, 2011). Other areas of high irrigation density can be found in the US and along the Nile River in Egypt and Sudan.

While food demand will increase by 50 % globally by 2050 (and 100 % in developing countries), today's agricultural demand for water resources is largely unsustainable due to the depletion of aquifers, reduction of river flows, degradation of ecosystems and the salinization of

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irrigated soil (WWAP, 2015). In order to secure a world free from hunger and malnutrition, agriculture needs to become more sustainable and resources use more efficient. Unwanted side effects of irrigation, such as environmental damage and soil erosion need to be minimized. At the same time, extensive investment in irrigation infrastructure, as seen around the world in the second half of the 20th century, has proved to be insufficient. In fact, governments and international donors realized that there are serious management problems that inhibit the realization of irrigation schemes' full potential. In response, management reforms were promoted in the guise of Irrigation Management Transfers (IMTs). IMT implies transferring the irrigation responsibility and authority from the public hands into civil societal actors, such as the Water User Associations (WUAs), or into private sector entities (Garces-Restrepo et al., 2007; Senanayake et al., 2015). If irrigation management reforms involve merely working with (and not replacing) the government, the term Participatory Irrigation Management (PIM) is used (Vermillion and Sagardoy, 1999). This irrigation subsector reform (IMT) was heralded (e.g. by donors) as a recipe to reduce or even eliminate government expenditure for the operation and maintenance of irrigation infrastructure, improve scheme efficiency and productivity as well as increase the income of farmers (Cambaza et al., 2020; Playán et al., 2018). In the second half of the 20th century, it has been promoted in tens of countries, but with mixed results (Garces-Restrepo et al., 2007).

Given the urgency to improve irrigated agriculture, understanding if and how IMT can live up to the expectations is highly important. Irrigation management is a key factor for water use efficiency and agricultural productivity alongside other factors such as infrastructure, operation and maintenance (O&M), land and water resources or cropping practices (WWAP, 2015). There have been numerous case studies that evaluated the impact of IMTs on irrigation and water use performance. These studies include relatively successful IMT cases from India (Mishra et al., 2011), Mexico (Rap and Wester, 2013) and Korea (Choi et al., 2016). Other cases reported IMT failures on substantial issues such as irrigation scheme performance, maintenance of infrastructure, institutional set-up of WUAs or the collection of fees. While the reasons and reform missteps vary across case study, IMT difficulties are reported from across the developing world, e.g. in Pakistan (Bell et al., 2013; Wegerich and Hussain, 2016), Central Asia (Yakubov, 2012), India (Bassi and Kumar, 2011), Indonesia (Suhardiman, 2013), or Ghana (Kakuta, 2019).

The impact direction of IMTs has also not been consistent. For example, in Turkey, irrigation associations improved collection of fees but not water use efficiency (Kibaroglu, 2020). In Central Asian countries such as Uzbekistan and Kazakhstan, IMT implementation was not consequent in the different periods after the collapse of the Soviet Union, while the involvement of state remained high (Zinzani, 2016, 2015). In fact, fifty years after IMT became a global trend, evidence-based research and the literature on post-reform scheme performance are largely quantitative using performance key indicators (KPIs), and less through qualitative analysis via farmers' perceptions. This poses several methodological difficulties to isolate and measure the impact of IMT on scheme performance, and shortcomings regarding the representativeness of the analyses (Senanayake et al., 2015). There is little focus on farmers' opinions and the perception of involved stakeholders, which can vary greatly from one case to another (Senanayake et al., 2015). In fact, farmers, as the irrigation water users, are at the center of any IMT process, especially when responsibility is handed over to WUAs. Thus, it is important to understand their perceptions, motivation, capacity and needs. Furthermore, the motivation behind IMTs is not studied thoroughly, since the reduction of government expenditures is often cited as the main objective for introducing such reforms (Merrey et al., 2007; Vermillion, 1997). The relevance of studying stakeholders' perception of IMT is arguably high due to their key role in IMT implementation, or more specifically the role of farmers in WUAs.

The Gezira Scheme received a lot of attention from researchers and international organizations. There are several studies on the development of the scheme and possible reasons for its poor performance (Al Zayed et al., 2016, 2015; Elshaikh et al., 2018; Plusquellec, 1990; Salman, 2010; Wallach, 1988; World Bank, 2000). Yet, these studies have not yet gauged farmers' and stakeholders' opinions and attitudes towards several waves of IMT and institutional reforms. The objective of this study is to make a contribution to the wider discussion concerning if and how irrigation management transfer can lead to better irrigation management, and ultimately greater food security, environmental sustainability and poverty reduction. This paper represents a reform outlook study that stresses the importance of soft issues such as addressing developmental legacies, involvement of farmers, the management of reform expectations, awareness raising or good irrigation governance. More specifically, it looks at the perceptions of farmer groups and on-site stakeholders of IMT with the aim of exploring their understanding and lived experiences of the management reforms. The paper also contextualizes irrigation management reforms of the Gezira scheme within historic eras of state involvement in irrigation management in Sudan and within international experiences of IMT. As such, the study does not evaluate the success of the reforms. The failure of the reforms is widely accepted as evident in the pullback of reforms package. Besides, the paper does not evaluate Gezira's scheme performance and the impact of IMT as it is quite difficult to satisfactorily link IMT reforms to the performance deterioration of the scheme, although such detailed efforts exist (e.g. Elshaikh et al., 2018).

## 2. Case study: Gezira irrigation scheme

### 2.1. Gezira's key characteristics and reform timeline

With a net command area of approximately 2.1 million feddan, which corresponds to 882,000 ha, the Gezira Scheme is one of the world's largest, probably the largest, irrigation scheme under one management. It is located on the Blue Nile, where the Nile water is stored by the Sennar Dam and supplied to the field through an extensive network of canals, consisting of two main canals (194 km), major canals (2300 km), minor canals (8000 km) that feed tertiary canals (locally called Abu XX) and then field ditches (Abu VI). The plain fields are evenly and slightly sloped towards the northeast and allow for gravity irrigation. Fig. 1 provides the key characteristics of the scheme.

The scheme was inaugurated with the construction of the Sennar Dam by the British in 1925. The initial objective was cotton production for Britain's textile industry. The scheme reached today's size with the Managil Extension through the construction of the Roseiries Dam in the early 1960s. Beyond the canalization network, the scheme's infrastructure includes machinery, equipment, staff housing, roads and vehicles. The value of the infrastructure is roughly estimated to amount to eight billion USD and is an important asset of the government, while around 12,000 farming families and thousands of state administrators usually live there (Eldaw, 2004). During the first years after independence in 1956, cotton remained the main crop for export and sorghum the second as a staple food crop for the tenants. In the mid-1970s, agriculture was intensified and diversified by adding groundnuts, vegetables and wheat. Impressive numbers materialized, such as the Gezira scheme representing less than 11 % of Sudan's cultivated area, yet producing 60 % of cotton, 75 % of wheat, 35 % of groundnuts (Verhoeven, 2015). Nation-wide, large-scale irrigation was promoted and peaked at the end of the 1970s. The price for the expansion of the area under irrigation was a reduction in agricultural efficiency. In the Gezira scheme, the intensification and expansion have produced an impressive output in the short-term, but it contributed to the deterioration of the system in the long-term. This trend was reflected in the titles of early publications about the scheme. Arthur Gaitskell's book from 1959 was called "Gezira: A Story of Development in Sudan". Not even twenty years later Anthony Barrett (1977) published "The Gezira

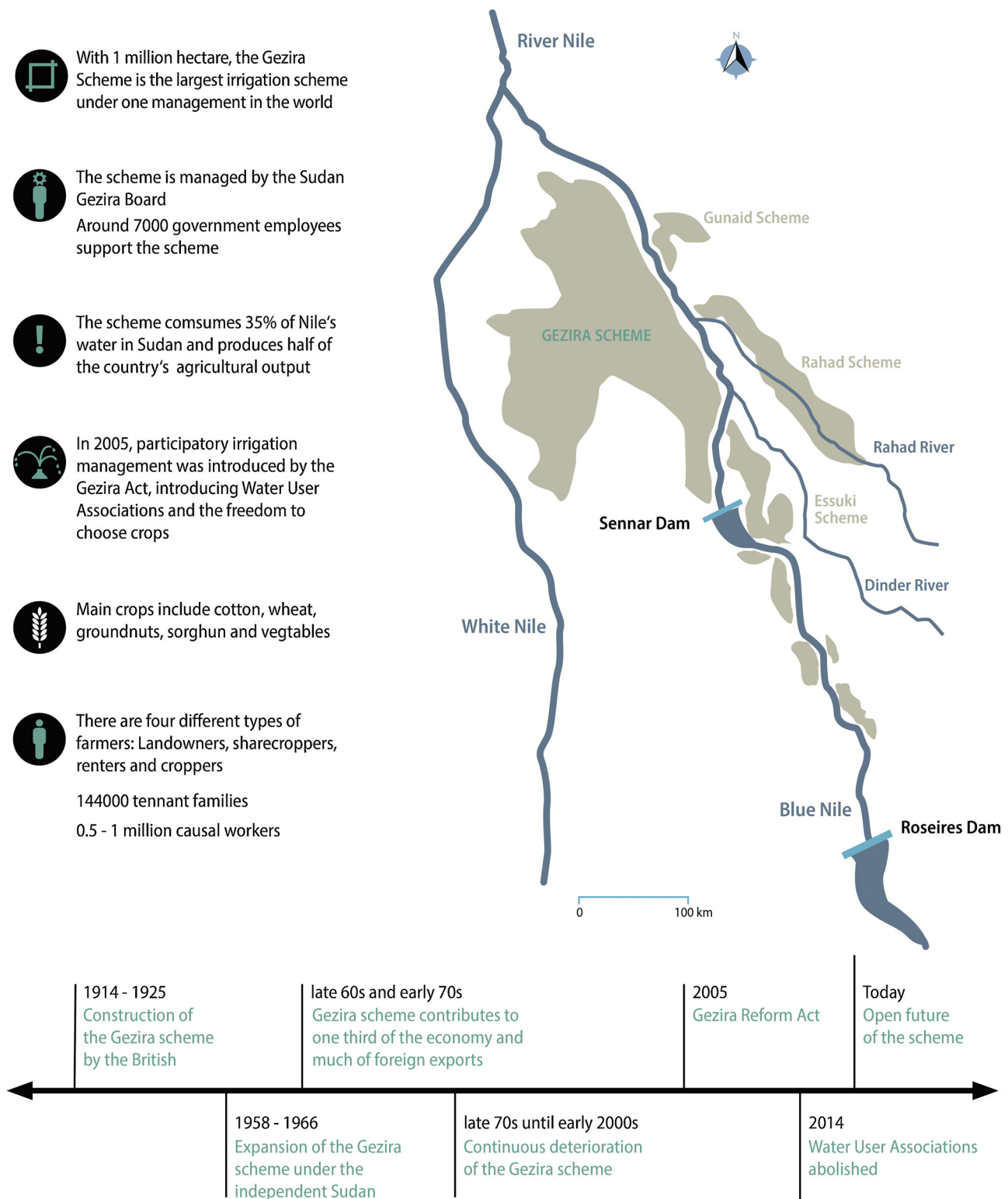


Fig. 1. Location map of the Gezira Scheme in Sudan. Source: Government Statistics.

Scheme: An Illusion of Development”.

## 2.2. Overview of management change and reforms

The Gezira scheme has a unique land tenure arrangement. After the establishment of the scheme, the government either bought land or forced private owners to lease the land to the government for 40 years. The basically dispossessed landowners became tenants. Land allotments

were limited to the size of 15–30 feddan (feddan equals around 0.4 ha). After the expiration of the 1927 Land Ordinance, no new system was arranged, which still causes problems today. Ever since, the management of the Gezira Scheme has been highly centralized in the hands of the Sudan Gezira Board (SGB). The SGB determined the crop rotation plan, including fallow period and was responsible for land management (including levelling necessary to allow gravity flow, which has been neglected since 1970s due to lack of resources), and water management

## INFRASTRUCTURE



Increased sedimentation in the canals is a major problem

### Reasons why:

- Increased erosion in the Blue Nile catchment in Ethiopia
- Use of water during the rainy season (July - August)
- Diversion of too much water
- Reduced trapping of the Roseires and Sennar reservoirs

### Result:

The quantity of silt removed from the canals has been declining since the mid 1990s

## PROCESS

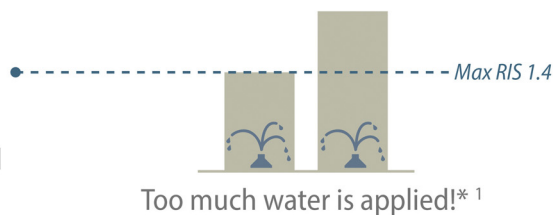


### Relative Irrigation Supply (RIS)

1.4 is the highest level in surface irrigation allowed

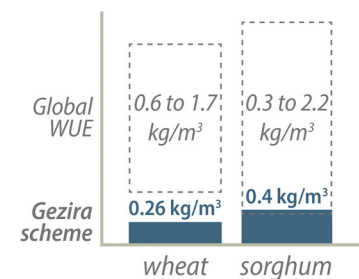
Between 1970 and 1994, the RIS in Gezira was 1.4

Between 1994 and 2010 the RIS was 2.23



<sup>\*</sup>The same for Relative Water Supply (how much water altogether, irrigation and precipitation is allocated to the crops) (RWS) has deteriorated from 1.7 to 2.6 in the same

Water Use Efficiency (WUE) is much less than the global average <sup>2</sup>

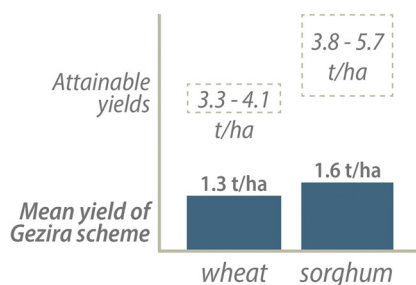


## OUTPUT



### Land productivity

The average yield of main crops Gezira is much less than the attainable yield internationally <sup>3</sup>



### Productivity of Cotton

The productivity of cotton at country level is no exception. It is only... <sup>4</sup>

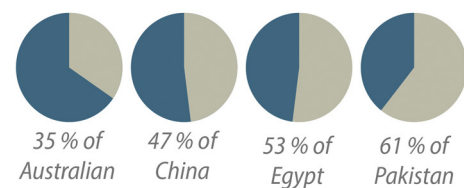


Fig. 2. Performance categories and indicators for the Gezira Scheme. Sources: <sup>1,2,3</sup> from (Al Zayed et al., 2015); <sup>4</sup> from (Bushara and Barakat, 2010).

from minor to field canal. The upper system was managed by the Ministry of Water and Irrigation. Administratively, the scheme was divided into 18 groups, composed of five to seven blocks (114 in total) headed by a block inspector. The blocks were divided into a unit called number/nimra (90 feddan) which consisted of up to 18 Hawashas (farm/tenant plot) (Hussein et al., 2002). In modern-day Sudan, the Gezira scheme witnessed different phases of relative prosperity (after

independence till the 1970s), decline due to intensification, increased water use and silt accumulation after the construction of the Mangail extension in 1966 (since the late 1970s), liberalization (during the 1990s), and institutional reforms (since early 2000s). Fig. 1 provides a short historic trajectory. The economic liberalization of the 1990s did not lead to the desired effect of increasing agricultural productivity based on a new incentive structure for farmers. The government

disengaged from the scheme, but the private sector did not fill the gaps. The scheme continued to deteriorate at an alarming rate. In order to illustrate the major performance problems of the Gezira scheme, we summarize in the infographics in Fig. 2 key performance categories of the scheme and introduce selected performance indicators using data from secondary literature.

According to a 2000 World Bank report, the Gezira scheme had become the “least efficient schemes in world” and needed to be institutionally reorganized (Salman, 2010). Mostly based on the World Bank’s recommendation, the Gezira Scheme Act was issued in 2005 and more than 1500 WUAs (one for each minor canal) were established in 2007. This act represented the IMT in the Gezira scheme. According to this act, farm irrigation and management including collection of fees and weed cleaning were now the responsibilities of the WUAs. Through the control of the minor canals and field canals, the reform transferred the responsibility of field irrigation from the government to the farmers. In the Gezira scheme, irrigation water reaches the field via the main canal, major canals, minor canals and eventually the field canals through gated field outlets pipes (FOPs). The field canals (Abu XX) irrigate 90 feddan through 9 small field ditches (Abu VI), which means that that one Abu VI irrigates 10 feddan. Before 2005, block inspectors from the SGB were responsible for the minor canals and engineers from the Ministry of Water for the outlets from the major canals. The 2005 Gezira Act replaced the 1984 Act (adopted after the last great rehabilitation project in 1983) and the 1927 Gezira Land Ordinance, which had forced private landowners to lease their land to the government. However, already in 2009, the Ministry of Agriculture and Forestry admitted in a report that these reforms has been “a total failure” since the disposition of scheme’s assets, the crop choice freedom and the establishment of WUAs lacking needed capacities have resulted in “irrecoverable damage” to the scheme (Salman, 2010). Table 1 provides a mapping of stakeholders as well as their roles and interests before and after the Gezira Act.

In the years after the 2005 reforms, the performance of the Gezira scheme did not pick up, which led to the 2014 Gezira Act Amendment. This amendment replaced the WUAs with agricultural cooperatives (Farmer Unions), while the scheme’s maintenance and management of the irrigation (including water allocation) was transferred to the Ministry of Agriculture and Irrigation. The government was to finance

the scheme through water charges and to appoint a scheme’s Governor by the Republic’s President (instead of the elected General Manager of the scheme). Here, the Ministry of Water Resources was not mentioned in the reform since, in 2011, Irrigation was moved to the Ministry of Agriculture (from the Ministry of Water), while Electricity was given to the Ministry of Water Resources (and Electricity) in the same year. In 2015, water management was given back to the now-called Ministry of Water Resources, Irrigation and Electricity, transferred from the now called the Ministry of Agriculture and Forestry. The reforms of 2014 met a strong opposition from farmers since it increased the role of the Governor and pushed farmers into producers’ associations. According to a University of Khartoum Professor, this decision was made because “the government is betting on the weakness of the financial, administrative and logistical capabilities of the associations – and their failure in the end, to be given to the affiliates of the National Congress Party” (cited in Radio Dabanga, 2015a). In September 2015, the Farmer Unions (known as WUAs prior to the 2014 reforms) were dissolved through the Constitutional Decree 32, which effectively meant a solidification of responsibilities for water management of the scheme under the Ministry of Water Resources, Irrigation and Energy while decision-making systems and the organizational structure of the scheme become unresolved (Hydraulic Research Center, 2016).

### 3. Method and data

In order to gauge the perception of the stakeholders’ on the different episodes of the IMT reforms in the Gezira scheme, this study largely relies on qualitative data using key informants’ interviews, a farmers’ survey and a mapping of stakeholders and their declared attitudes. Ten expert interviews (semi-structured) were conducted with the leadership and a staff from the Gezira Board (2), the Ministry of Water Resources Irrigation and Electricity (1), the Hydraulics Research Center (4), the Agricultural Research Center (1) and independent experts (2). These are mostly stakeholders located in the Gezira scheme area, and work almost exclusively on this scheme. These experts have been identified during a first visit to the study area in December 2015. The final number and selection of experts was a result of their availability and willingness to contribute to this study during a second field visit in March 2016. Interview protocols served as documentation. The experts did not

**Table 1**  
Overview of stakeholders, roles before and after 2005 Gezira Act, interests and position.

Stakeholders (names as of 2010)	Role before 2005	Role after 2005	Interests & Position on Gezira Act 2005
Ministry of Irrigation and Water Resources (MIWR)	historically responsible for (overseeing) irrigation management, provision of water, operation of the Sennar Dam	no role under new the Act with the transfer of responsibility to an irrigation unit within Gezira scheme	interest mainly in maintaining role, status, jobs; largely opposed to reforms; non-cooperative in implementation
Ministry of Agriculture and Forestry (MAF)	Minister of Agriculture chaired the Board of Directors of the Gezira Scheme (the Board)	absence of a specific role in the new Act; represented in the Board as “relevant ministry”	initially no opposition to the act, but concerns about rushed WUA introduction; later very critical of implementation
Ministry of Finance and National Economy (MFNE)	owner of assets, source of financial support	owner of assets; to provide funding for maintenance in return for water charges; approval of budget; represented as “relevant ministry”	no opposition to the Act; opinion that SGB should be a financially independent entity and costs to be covered by government of Gezira State
Sudan Gezira Board (SGB)	running the scheme; authority and finances decreased with the decline in cotton production and introduction of individual accounting systems; 10,000 staff (mid-1980s)	converted into an agricultural research institution; continues to play a major role through Board of Directors of the scheme; full-time chairman appointed by the President, 85 contracted employees (2010)	unclear; tremendous loss of staff and authority, but little evidence on reform opposition
Gezira Farmers Union (GFU)	executive committee involved in managerial, financial and technical matters	at least 40 % (6 out of 14) of the Board member are representatives of the GFU	influential active supporter of the institutional reforms; spearheading development of the 2005 Act
Landowners and Tenants	compulsory lease of land to the government since 1927; no new deal after expiration of the lease contract in 1967; no collection of rent due to loss of value	the Act meant a repeal and replacement of Gezira Land Ordinance 1927	demanding back rent or compensation; solution pending
World Bank	–	–	supporter of the Act; facilitator and funder of missions and workshops

necessarily represent the organizations they are working for, but rather their personal perception. Further, since the paper is primarily concerned with farmers' involvement and their perception of the irrigation management reform, a structured survey with multiple-choice and open-ended questions was conducted in 2016. The survey aimed at gathering information on farmers' experience and perception of changes in operational, maintenance, economic and managerial performance of the scheme before and after 2005. Particularly, the survey assesses qualitative variables such as farmers' knowledge and level of trust regarding the initiated reforms. The survey borrows from IWMI methodology to assess IMTs (Samad and Vermillion, 1999). Out of the total 50 interviewed farmers, 15 were interviewed over phone in order to get voices from other areas of the vast Gezira scheme and not only from around Wad Medani. Farmers were sampled based on recommendations from local research institutions on representative farmers' villages to visit based on prior research experiences. Several small groups of farmers were instructed about the survey and asked to fill in the survey individually. They were supervised by a helper from a research institution in Wad Madni, Sudan, who addressed farmers' questions. The translated survey can be found in Annex 1.

## 4. Results

### 4.1. Stakeholders' perception on Gezira's past performance and reforms

#### 4.1.1. Technical issues and ultimate triggers of performance deterioration

There seems to be a consensus in the perception of key informants that the performance of the Gezira scheme has deteriorated, although identifying the start and the reasons of this process is not simple. In fact, such a deterioration might have occurred in three to four waves. First, in the mid-1970s, the scheme witnessed a period of "unattended irrigation" when farmers started to do what they wanted, young people moved away, elderly tenants were not able to run the farm alone, and sharecroppers were hired to do the farming. It was the end of family-based agriculture since "share-croppers had no connection to the land, came from rain-fed agriculture, did not know the Gezira system, and worked only in the morning to open the FOP [Field Outlet Pipe] and let it run" (expert interview 2, March 2016). With increased crop diversity, the balance of the gravity flow system in Gezira was disturbed (expert interview 6, March 2015). Further, since the 1970s, irrigation started during rainy season, which led to cost explosion and a drastic increase of sediments (times four) (expert interview 4, March 2016). However, it is difficult to exactly determine the deterioration time point and reasons, since there is limited to no time series data for performance indicators. However, a common perception of deterioration since late 60s or and 70s is strongly held among experts. Second, with the switch from the Joint to the Individual Account System in 1981 (i.e. instead of flat taxes compensating the government for water and land services, a tenant needs to pay incurred input costs from his individual account), problems of inadequate maintenance and deficient cost recovery started (expert interview 9, March 2016). However, other interviewed experts did not share this view.

Third, after 1992, private banks got involved in agricultural finance in the scheme (replacing the Bank of Sudan's interest-rate free loans), and some experts see this as a negative moment due to expensive loans, deterioration of services and a delay of the irrigation season (expert interviews 3 & 4, March 2016). Finally, while there is some evidence that the Gezira scheme started to deteriorate prior to the 2005 Gezira Act, this Act did not stop this process (Elshaikh et al., 2018). Moreover, some experts indicated several problems resulting from the Act which was intended to reduce governmental expenditures. There are many problems mentioned by the interviewed stakeholders (expert interviews 1, 3, 5, 9, March 2016). Stakeholders mention that there has been an infrastructure damage due to a lack of know-how of the WUAs (e.g. over-digging leading to the destruction of the gravity system of the scheme, failure to collect fees, no cleaning of weed or inadequate water

use for different crop types). Furthermore, there was a deterioration of infrastructure inspection and maintenance after the government sold vehicles to employees who were not willing to use them anymore. Considering these technical problems, some interviewed experts argued that these issues would have been solvable if the wider political and economic contexts were suitable, and they pointed out to larger issues such as the withdrawal of government funding or demographic changes, e.g. young people moving to the cities and ending farming as a family business. It has also been difficult to attract foreign investors (e.g. from China or the Gulf States) to the Gezira scheme due to its complicated reality with many powerful farmers and vague institutional and management set-ups as well as unclear land use rights (expert interview 9, March 2016).

#### 4.1.2. Wider issues and splits in professional cultures

Another contextual issue more specific to the management of the Gezira scheme is that of the professional and cultural split between (water) "engineers" and "agriculturalists", which has become evident in the wake of the exchange of irrigation responsibilities between ministries. When the responsibility for irrigation was moved from the Ministry of Water to the Ministry of Agriculture, irrigation engineers, preferably with experience in the Gezira scheme, were needed at the latter ministry to continue their job of maintaining the outlets from the major canals. However, "engineers refused to move to the Ministry of Agriculture. It was a question of dignity. The minister of agriculture discussed face-to-face with the 30 top engineers, but all refused, he found some people among the more junior engineers" (expert interview 9, March 2016). This was confirmed by other experts saying that those engineers refused to work with the Gezira Board. It was not about salary, but about social status. According to them, when you are specialized in irrigation, you cannot work for agriculturalists. Therefore, the Gezira Board did not have an adequate number of engineers. "This effected the output of the whole things and resulted in a low productivity" (expert interview 4, March 2016). Many of the interviewed engineers regarded negatively the transfer of the irrigation tasks to the Ministry of Agriculture in the wake of the Gezira Act, and subsequent reforms – this decision was reversed only in 2015. Their perception is that Gezira's problems are not merely institutional but rather an institutional-technical challenge. In fact, the Water Ministry has been alienated by the original 2005 reforms, and even further by the 2010 decree transferring all irrigation responsibilities to the SGB.

#### 4.1.3. Farmers' power

The Gezira reform empowering WUAs was a "long, slow and controversial" process, with the irrigation management transfer to farmers barely taking place because of the lack of funding for canal rehabilitation that was a pre-requisite for handover (Salman, 2010). Indeed, the farmers themselves were a powerful group, but had little trust in public institutions and the SGB. In fact, prior to the 2005 reforms, farmers have been criticizing the SGB for being overstaffed, inefficient or incompetent while they demanded WUAs to be in charge (expert interview 10, March 2016). Particularly in 2003, mistrust grew as rain-fed mechanized farmers endured a crop loss due to a shortage in rainfall in the northern parts. Some farmers perceived the government's withdrawal from the scheme as a sort of escape from due compensation for rain-fed based farmers who were then asked "to work like other farmers", but looking back "it was a trap" (expert interview 2, March 2016).

While farmer unions were supporting the 2005 reforms, some experts questioned the representativeness of these unions. There are about 140,000 farmers in the Gezira Scheme with different backgrounds, while the unions have been criticized for being pro-government, not inclusive or seeking more influence in the scheme. In fact, in March 2015, the relationship between the government and the unions reached a low point, as some news outlets reported the farmer unions of the Gezira Scheme to have planned an election boycott in coordination

with opposition forces. Accordingly, the unions were using visits to villages, speeches in public markets, cars fitted with loudspeakers and tours to remote areas to advocate for an election boycott (Sudan Tribune, 2015). Six months later, in September 2015, the unions were dissolved which provoked an outcry and was considered as “an attempt to break-up the unity of farmers” (Radio Dabanga, 2015b) and a prediction that Gezira farmers “will now be replaced by figures loyal to the ruling National Congress Party” (Radio Dabanga, 2015a). These developments might have had wider implications. Gezira farmers are residents of the “Hamdi Triangle” – whose support is/was considered vital for the regime. This is interesting to consider in the wake of the 2019 revolution. At the level of the Gezira scheme, it can be said that the negative relations and the lack of cooperation among stakeholders have impeded reforms from addressing any managerial and technical problems.

## 4.2. Farmer's perception

### 4.2.1. Survey results

The perception survey gauged the views of selected farmers on the performance of the irrigation scheme after the 2005 reforms, the objectives of these reforms as well as their general perception of the post-reform period. On the scheme's performance (Tables 2 and 3), the responses indicate that there is generally a perceived deterioration of the scheme after the 2005 reforms. At the same time, the overall deterioration tendency is not significant with some issues (e.g. conflicts among farmers) indicated to be slightly less. Further, the level of participation of farmers is perceived to not have changed significantly because of the reforms. Here, the reforms brought crop choice and irrigation freedom for the farmers, which might have reduced the occurrence of conflicts on the operational level without changing the perception of the farmers regarding the participation requirement in the management of the scheme. One needs to note that, when disaggregating the responses based on the educational background, the deterioration of the operational performance (adequacy and timing of water delivery and fairness of water distribution) is overwhelmingly perceived by less educated farmers. However, due to the small sample size, it is not possible to judge that this trend will hold for the whole scheme. Some interviewed experts mentioned that better educated and wealthier farmers could have benefited more from the reforms. They explained that more affluent farmers could afford pumps and equipment to exploit the freedoms associated with the reforms. As mentioned earlier, the transfer of irrigation responsibility was limited in scale since it was not much practiced. Here, richer farmers were more able to organize, update their systems and thus manage irrigation tasks themselves. Other farmers did not participate because the required rehabilitation could not be undertaken. Furthermore, farmers perceive the costs to have remained the same or increased slightly and this can be explained by the ineffectiveness of the WUAs with regard to fees collection. With regard to the farmers' post-reform perception of the

**Table 3**

Perception on participation extent before and after the reforms.

	Before 2005		After 2005	
Low	40 %	Low	44 %	
Moderate	24 %	Moderate	22 %	
High	36 %	High	32 %	

reforms' objectives, personal impacts and the management of the scheme, results from relevant survey questions are in Table 4.

### 4.2.2. Discussion of survey insights

First, it seems rather contradictory that most farmers saw their personal situation become better despite the perceived deterioration of the schemes' performance. In the same line, the farmers reported that the costs became either higher or the same, but apparently did not affect their personal situation. This contradiction can be explained by the ineffectiveness of the fees collection system of the scheme or by the existence of multiple factors that can affect the farmers' income. Second, on the reforms' objectives, it is surprising that a significant number of farmers thought that the reform objective was to destroy them, although this answer was not given as an option. This might be explained by the timing of the survey, which took place after the farmers' unions were dissolved. Third, farmers did not indicate any predominant factors for the performance deterioration of the scheme. They seem to regard the bad shape of the scheme as a result of legacies of bad management, missing economization, the deterioration of infrastructure and missing finances. In this overall context, single issues such as training and the choice of technology are not seen the most relevant problems. The WUAs did not contribute to improving the development perspective of the scheme since they failed to offer an alternative institutional set-up for the scheme's management or to contribute to its long-term financial sustainability through higher collection rates of water fees.

Finally, the results indicate that the reforms' objectives were not clearly transmitted to the farmers. On the responsibility for irrigation management in the scheme, nobody mentioned the Ministry of Agriculture, although this was given as an option. This ministry overtook the irrigation resort in 2011, and the scheme's irrigation responsibility in 2014, but lost both responsibilities to the Water Ministry in 2015. The farmers' response indicate that they do not favour the idea of the irrigation being under the Ministry of Agriculture. At the same time, they see this responsibility to be under the SGB or the Water Ministry. Here, it is quite interesting that the farmers do not see this responsibility to be primarily theirs (as the 2005 Act envisioned), while the opinion of a small minority reflect the status-quo, i.e. irrigation as a shared responsibility between SGB and the Water Ministry. The farmers' were also asked about their overarching attitudes on whether they regard the reform as a mistake, welcome the idea of WUAs and require more trainings, technical support or funds. Opinions were

**Table 2**

Perception of water management practices after and before the 2005 reforms (Gezira Act).

	Better with WUAs	Worse with WUAs	About the same	Don't know
Adequacy of water supply	42 %	48 %	8 %	2 %
Fairness of water distribution	40 %	52 %	4 %	4 %
Timing of water delivery	38 %	44 %	16 %	2 %
	More conflicts with WUAs	Less conflicts with WUAs	About the same	Don't know
Occurrence of farmers' conflicts	34 %	44 %	14 %	8 %
Conditions/ functionality of canals	40 %	42 %	12 %	6 %
	lower costs with WUAs	Higher costs with WUAs	About the same	Don't know
Water costs (fees)	14 %	32 %	50 %	4 %

**Table 4**  
Farmers' perception of the reforms and the post-reform period.

Who should be responsible for irrigation management in the Gezira Scheme?		What was the objective of the Gezira Act 2005?	
Gezira Board	38 %	Increasing participation of farmers	8 %
Ministry of Water	26 %	Decreasing participation of farmers	4 %
Farmers	10 %	Improving Operation & Maintenance	8 %
Ministry of Water and Farmers	10 %	Improving agricultural productivity	24 %
Ministry of Water & SGB	2 %	Reducing government expenditure	20 %
SGB and farmers	2 %	Increasing government expenditure	0%
altogether	6 %	Don't know	12 %
don't know	6 %	Other: "destroying the scheme" or "destroy us"	24 %

What has been the biggest problem in the past 10 years? (number of farmers while multiple answers chosen by some farmers)		Did your situation change with the 2005 Gezira Act?	
Inadequate water supply	12	My situation improved	50 %
Lack of training	1	My situation become worse	36 %
Lack of funds for operation and maintenance	12	The scheme improved but not my farm	2 %
Lack of technology	2	Nothing changed, it was just politics	6 %
Lack of marketing	20	Don't know	6 %
Poor management	18		
Others (1 farmer said that the biggest problem is that farmers have freedom to choose crop)	1		

consistently spilt on all of these propositions, which might indicate that participatory irrigation or irrigation responsibility transfer is not a unique or predominant concern of farmers.

## 5. Reform outlook and directions

### 5.1. Impediments and reform details

The IMT experience in Sudan can be characterized as a recent experiment that needs to be understood by considering some unique features and conditions of the scheme. In this section, we introduce some of the specific conditions that might have led to reform details and failures. We also discuss some alternatives and solutions and refer to IMT experiences elsewhere. First, the scope and timing of the IMT reforms in the Gezira scheme indicate that reforms might have been sudden and little prepared. Many of the stakeholders regard the reforms as a (late) trial to save an already deteriorating scheme. Furthermore, the reforms represented a sweeping change without adequately piloting ideas such as WUAs or other forms of farmers' participation. Another important point is that, in the Gezira case, the size of this scheme is quite large and therefore the farmers' financial and governance capabilities differ widely. Similar to other experiences from developing countries, the objectives and expectations from the Gezira IMT reforms might have been overambitious. Therefore, the post-reform period has witnessed setbacks and many reversal, leading to halting the reforms and dissolving any farmers' participation altogether. In this context, a gradual reform pathway can allow for experimentation of approaches and appropriate participation designs in large schemes. IMTs reforms are one alternative, which, if designed right, can help bring out benefits for irrigation governance, and as a result, better irrigation performance. While there are other alternatives such as management contracts or water markets (Zekri and Easter, 2007), such alternatives need to be tested and deliberated in terms of advantages and disadvantages. At the same time, common property based solutions can be made refitted and better, e.g. through material incentives for farmers to allow participation, increasing empowerment of farmers or strengthening social relationships (Ostrom, 2015). Such incentives were largely absent in the IMT reforms in the Gezira scheme.

Second, one can postulate a lack of a conducive environment for the IMT reforms. This is mainly due to the political and developmental context of the scheme. The scheme has witnessed decades of negligence, poor management and performance deteriorations. While IMTs can result in larger irrigated areas, increased crop yields and increased farm income in other cases (Chaudhry, 2018; Choi et al., 2016; Garcés-

Restrepo et al., 2007), such general conclusions on performance have not been confirmed in the Gezira case study (Elshaikh et al., 2018). In the Gezira scheme, the challenges might have been unique, and it is difficult to transmit some failure factors to the Gezira Act failure. For example, the reliance on donors or the lack of power delegation to WUAs (e.g. heavy state involvement or unwillingness to delegate power) can hinder the success of reforms (Bassi and Kumar, 2011; Cambaza et al., 2020; Yakubov, 2012; Zinzani, 2015). On the one hand, variables such as reform opposition by some actors or donor-led reforms can be confirmed for the Gezira scheme. However, neither reform opposition nor the overreliance on donors have been explicitly given as overriding reasons for failure, and especially not for the initial period of the reforms. Further, (national) state interferences were arguably low since many interviewees perceive the reform as a way to abandon the scheme due to its financial costs. In fact, the common reasons in the responses of our interviewees relate mostly to the lack of capacities of farmers as well as the difficult developmental legacies of Gezira scheme, i.e. a highly politicized and complex mega-scheme under a longstanding deterioration trend undergoing selective and half-hearted reforms.

Third, IMT reforms have led to institutional fuzziness and insecurities. Using qualitative data from interviews with farmers and key experts, we showed that the IMT in the Gezira scheme has been poorly implemented while it was perceived rather negatively. This is true even for farmers who were the target group, which the irrigation transfer was supposed to be benefit. In addition, there have been a lack of clarity about roles and responsibilities of the WUAs and conflicts among ministries or even professional groups (engineers vs. agriculturalists). These factors led to power struggles that de facto hindered the implementation of the reforms. Besides, the awareness among farmers on the objectives and merits of the IMT reforms can be seen as low. This is similar to the study by Bell et al. (2013) who concluded for Pakistan that the perception of stakeholders on their roles in the IMT reforms differed from the designed organizational structure. In fact, inconsequent and adverse reform experiences are commonplace in water management, while consensus building and peace-making among institutions can help mitigate opposition and reform failure (Al-Saidi, 2017). At the same time, the system of free crop choice and irrigation transfer requires discipline and coordination. Both are difficult without improving the capacities of farmers to administer such responsibilities while addressing infrastructure deterioration first. Here, it is important to explore ways that can empower farmers and ease opposition and interferences. For example, states can accompany IMT reforms with bureaucratic reforms (Suhardiman, 2013), or empower coordinating

public water authorities to make IMT work through technological interventions and a network of support (Rap and Wester, 2013). Another study suggest that farmers' empowerment can take place within irrigation bureaucracies through elections, larger representation and creating responsive institutions (Wegerich and Hussain, 2016).

## 5.2. Contextualization and overall challenges

Sudan or the Gezira Scheme is a quiet recent example of IMTs reforms that have been implemented across the world since the 1960s. Although it is still difficult to evaluate the implementation and outcomes of IMTs due to the lack of consistent frameworks (Khadra et al., 2018, 2017), IMT case studies have produced a range of factors influencing the success of these reforms. Thus, IMTs have resulted in mixed experiences and a long list of success and failure factors (Cambaza et al., 2020; Playán et al., 2018). In this section, we highlight the importance of embedding IMT reforms in more comprehensive frameworks in order to increase success. First, IMT reforms need to be seen as a part of larger efforts of investments in irrigation management. The reform experience of the Gezira scheme highlights the importance of the wider context of scheme management and irrigation governance. In fact, the lack of consistent empirical evidence for the supposed superior performance of WUAs is partly due to methodological issues (i.e. methods and data used for linking performance changes to institutional reforms) (Senanayake et al., 2015). However, IMTs might be more successful if embedded within a larger effort of sound irrigation governance and regulation. The developmental legacies of the Gezira scheme show that this scheme has been trapped in a low-performance state in which yield is low, farmers lack markets and growth opportunities and the scheme's financial sustainability is threatened. Fig. 3 illustrate this trap of a low scheme performance leading to livelihood, financial and infrastructure deteriorations which, in turn, reinforce bad performance. Here, IMT reforms need to be seen as a part of a larger package of governance remedies to address the low performance malaise in irrigation schemes. Often, stakeholders and farmers mention how the lack of modernization (investments, technology transfer and maintenance) has hindered any performance improvement in the scheme. In fact, alongside farmers' perception, the state of the infrastructure has been confirmed as an important factor for IMT reforms in other cases (Bell et al., 2013; Choi et al., 2016; Garces-Restrepo et al., 2007; Playán et al., 2018). Here, good governance and adequate regulations can break the low performance trap of irrigation schemes. Major reviews of IMT experiences often state factors for hindering IMT success such as the lack of legal institutionalization of farmers' participation, clear water rights, supporting infrastructure, markets, incentives and adequate accountability measures, coordination mechanisms, or transparency (Cambaza et al., 2020; Merrey et al., 2007; Playán et al., 2018). However, such issues go beyond IMT reform actions, and relate the way we allocate resources and develop the irrigation sector. A key aspect for successful IMT reforms is related to the government's capacity to support farmers, delegate power, set-up institutional framework and prevent the creation of a vacuum regarding maintenance of roads or major canals (K'akumu et al., 2016; Kakuta, 2019). In the Gezira scheme, alongside the development of markets, infrastructure and investments, prioritizing irrigation management through a participatory, transparent and equitable governance (some features of a good irrigation governance) is highly demanded by farmers and stakeholders.

Second, the participation and the formation of irrigators (organizational set-up for farmers' participation) need to be designed carefully and to consider soft issues such as trust and ownership of the reforms. The idea to get farmers involved in management was in response to the realization that the huge infrastructure investments done in the 1950s and 1960s did not pay off (Meinzen-Dick, 2014). Further reasons for the promotion of IMT included the need to reduce governmental expenditure and several assumptions about the superior economic

performance by farmers. Accordingly, WUAs have more commitment, ownership, accountability and ability to achieve a better productivity, cost-efficient operation and maintenance of irrigation infrastructure (Garces-Restrepo et al., 2007; Samad and Vermillion, 1999; Senanayake et al., 2015). However, these assumptions need to be tested on a case-study basis and they need to consider the organization of farmers' communities in the irrigation scheme. In the Gezira scheme, farmers seem to not appreciate the motivation of the reforms in terms of reducing the public financial burden. Instead, the reforms have been partly perceived as an act to abandon the scheme and to punish farmers. Such a mistrust is highly relevant as it undermines the reform ownership. Furthermore, there is little evidence that the capacities of the farmers to organize and execute the operations of the WUAs were available prior to the reform act. The farmers were given little support during and after the reform. Until the reform was abandoned almost ten years after its initiation, trust and support of the reform were decreasing. As a result, the theoretical assumptions about the superior performance of farmer-based organizations did not materialize. In fact, they were not appropriately tested since there is little evidence of the WUAs appreciating and carrying out their designated tasks.

## 6. Conclusions

Since the beginning of the 20th century, irrigation schemes have mostly been in public hands with irrigation services provided by government agencies. The argument in favour of IMTs cite that state-run schemes often performed weakly due to the lack of capacity, poor incentives and the limited ability to respond to demand changes. Further, if governments did not have the resources to maintain and repair irrigation systems, water users will not be willing to pay, leading to uncollected/ uncovered bills. In response, IMT was heralded as the answer to these problems. WUAs have been formed in many countries as recipients of irrigation management functions transferred to them from the government. They were assumed to show more commitment, ownership and efficiency in carrying out irrigation functions. However, the evidence of IMT success is mixed and a plethora of success and failure factors was put forward in academic literature. This paper looked at the IMT reforms in the Gezira scheme as one of the largest irrigation schemes in the world. We highlighted the importance of considering longstanding development legacies, the perception of key stakeholders such as farmers and the overall political-economic context of the reforms.

The Gezira IMT case is documented as a retracted and failed reform experience that evidently did not improve the scheme performance. Our qualitative analysis provides nuanced narratives of this experience suggesting a poor implementation and an uncondusive environment for the reforms. Farmers' knowledge, capacities and involvement are key for IMT reforms, but we found no evidence of these in our study. On the one hand, it is not surprising that IMT reforms will fail if the target group is not adequately educated and empowered. Instead of merely pulling back from the scheme management, the state needs to provide more support in terms of awareness raising, clear institutional rules and an active role in rehabilitating infrastructure including roads and main canals. The IMT reforms represented an abrupt transfer of authority in a quite large scheme where farmers' financial and organizational capacities vary from one area to another. There is no evidence of a prior experimentation with different participation approaches of farmers or a gradual move to strengthen farming communities. Instead, we documented how distrust and the lack of reform ownership led to farmers and experts perceiving the reforms as an effort to abandon the scheme.

On the other hand, we elaborated on the complex cultural, political, developmental and performance-related legacies of the Gezira megascheme. These legacies are reflected in the longstanding performance deterioration, clashes of professions, instrumentalization of farmer unions by the state and a politicization of the reforms. These factors constituted an unfavourable environment for the reforms. The reforms

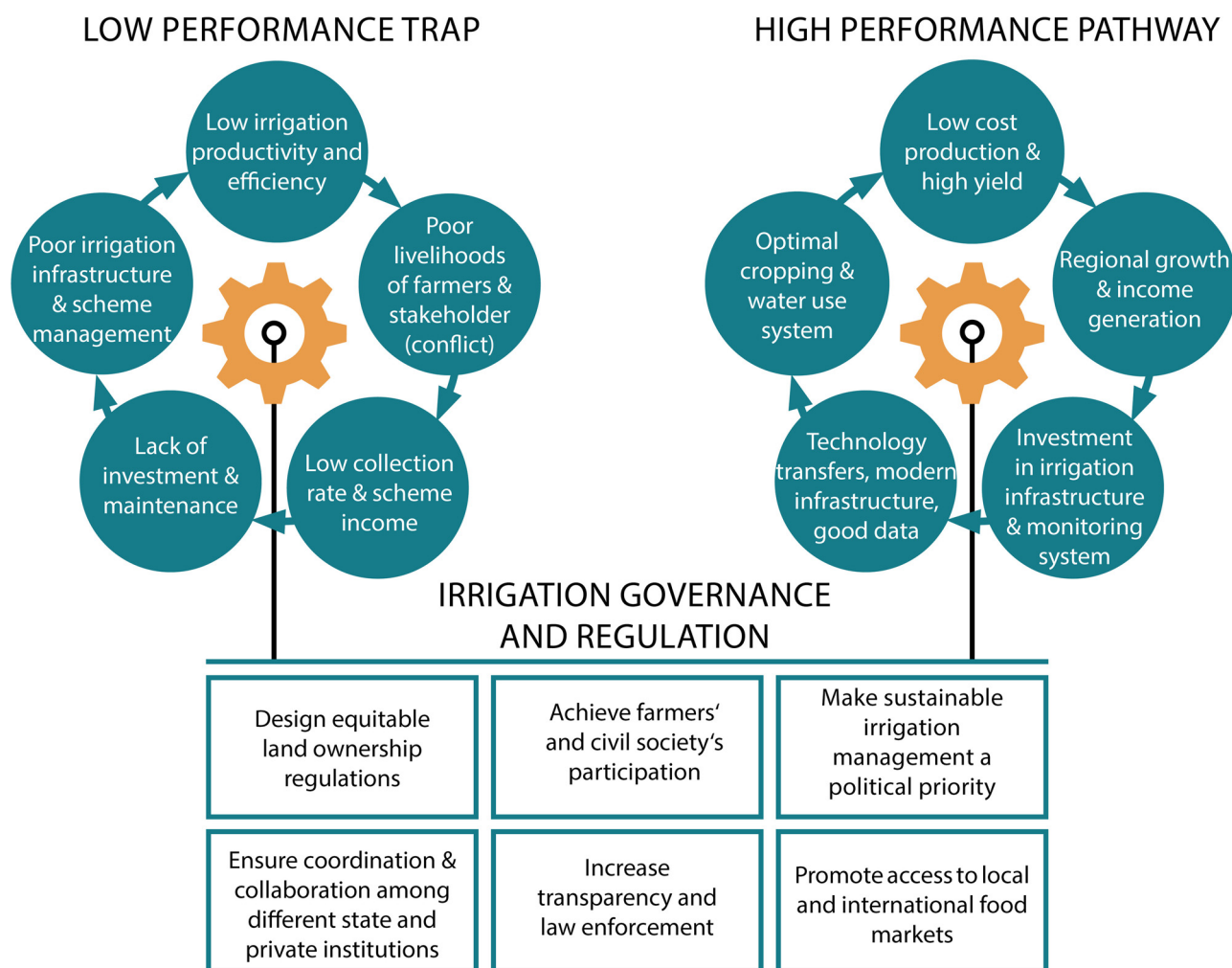


Fig. 3. Performance trap and the governance of irrigation schemes.

have led to a state of institutional fuzziness and insecurity in which the farmers did not carry out envisioned tasks. The awareness about the reform benefits was low while farmers were not adequately incentivized to participate in the WUAs operations. Furthermore, the ensuing conflicts over roles and responsibilities were not mitigated through adequate responses, e.g. mediation or institutional peace-making. Here, the government did not take an active role in managing conflicts or delivering on some of its tasks such as canal rehabilitations. At the same time, farmers had little trust in governmental institutions and farmers' unions suffered from a lack of representativeness and a susceptibility for political interferences.

Addressing the schemes future needs to be reconstructed within a larger context of breaking the low performance trap through a revaluation of good irrigation governance as a holistic concept. Such a governance can involve, among others, property right based solutions, ownerships, economic regulation and an honest dialogue about the steps ahead. Successful IMT cases show that the capacity of the government to advocate for the reforms and lead in facilitating their implementation is important. Building coalitions and alliances among key stakeholder organizations in favour of IMTs or different forms of participatory irrigation management can help promote the reforms. Above all, a good irrigation governance prioritizes irrigation management as a key function that can put the scheme on a high performance pathway. The financial sustainability of the scheme needs to be improved through a multi-level approach that can include improving fees collection, encouraging investments, public private partnerships and piloting technologies or exemplary farms. These ideas have been put forward by

stakeholders who stress that public policies have a major role to play in promoting the scheme. At the same time, soft issues are equally important. They include empowering farmers and civil society to participate in the schemes management, improving marketization of products and designing equitable, transparent and enforceable regulations. Despite the modest success, many of the interviewed experts still regard the idea of WUAs as conceptually interesting for the Gezira scheme although they see the recovery of the scheme as a government's responsibility that requires political prioritization. This is especially true after the loss of much of the oil revenues in the wake of the separation of South Sudan in 2011. Further, after the completion of the construction of the Ethiopian Grand Renaissance Dam, fewer sediments are expected at the Gezira scheme. The Sudanese revolution which uttered a new political era since 2019 has also raised hopes of economic improvements (e.g. lifting the sanctions) and a better governance of the country's resources, including Sudan's huge potential for agricultural development. These recent developments provide an opportunity to improve the infrastructure and to explore new institutional arrangements. There are many possible directions for future reforms that are suggested by experts to be explored in future participatory and transparent reform processes, e.g. restoring crop rotation, division of the scheme into smaller units, piloting WUAs before upscaling, and increasing capacities and trust of farmers.

#### Declaration of Competing Interest

The authors declare that there is no conflict of interest.

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## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.agwat.2020.106396>.

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