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POOR FARMERS AND IRRIGATION:

ALTERNATIVE METHODS FOR MEASURING THE DRIVERS AND THE BENEFITS OF THE PARTICIPATORY IRRIGATION MANAGEMENT IN A DEVELOPING COUNTRY

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TARTALOMJEGYZÉK

1. RESEARCH BACKGROUND AND OBJECTIVES

Growing global challenges related to the malnutrition and the food insecurity required new approaches in the agricultural production by the beginning of the mid-20th century (Hamada and Samad 2011; Ameen and Raza 2018). In response to such challenges, the leading organizations initiated Green Revolution in developing countries to significantly increase the productivity of agriculture through a set of technology transfers, including irrigation development. The new technologies achieved considerable results in many regions, thus contributed to the poverty reduction and food security (Cleaver 1972; Masters et al. 1998; Falcon 1970). Despite the considerable impact in Asia and partially in Latin-America, the merits fell short of their potential in Africa (Mosley 2020, Dawson 2016; Evenson és Gollin 2003; Denning et al. 2009). Likewise, the irrigation expansion remained far below its potential. Depending on the approach of global inventory, it is estimated that only 5-7 percent of the cultivated lands is under agricultural water management in Sub-Saharan Africa, as of today (FAO, 2011). Adding to the hurdle, the current irrigation schemes are still underperforming in delivering reliable, adequate and equitable water services, thus resulting a setback for the already achieved objectives of irrigation development (ElShaikh 2018; Svendsen et al. 2009; Alcon et al. 2014; Woodhouse et al. 2016). It is well understood that irrigation development is the cornerstone of food security, economic growth, and climate change adaptation. Adequate irrigation management substantially contributes to multiple Sustainable Development Goals (SDG) then, most importantly to SDG1 – eradicating extreme poverty, SDG2 – ending hunger and achieving food security, SDG6 – clean water and sanitation, SDG13 – combatting climate change and its impacts.

From the 80ths, decision-makers committed to shifting the traditional management mechanisms to a more integrated community-based design to increase the efficiency and productivity. Management transfer (alternatively called Participatory Irrigation Management – PIM or Irrigation Management Transfer – IMT), therefore, grew into a key strategy. It aimed at relaxing the budgetary burden of state-financed irrigation systems and improve the engagement of farmers in irrigation management (Wong 2012; Khadra et al. 2017; Playán et al. 2018; Vermillion és Sagardoy 1999; Agrawal, 2003; Ricks, 2015). As a first necessary step, the establishment of farmer-centered Water User Associations (WUA) spread worldwide to enable the management of public irrigation schemes directly by farmers. However, the policy implementation and the actual participation of farmers remain poor and incomplete in most of the countries (Ghazouani et al., 2012; Ricks 2015; Huang, 2010; Yami, 2013; Moss és Hamidov, 2016; Wang és Wu, 2018, Vandersypen et al. 2008). More than 60 countries have already introduced the management transfer, expecting to generate benefits for both the state and farmers (FAO 2007). Notwithstanding its envisaged gains for farmers, such as efficiency increase, engagement and long-term profit, there is a surprisingly little scientific evidence that management transfer programmes have been attaining a significant impact on farmers. One of the major drawbacks of the impact assessments is the fact that the varying conditions of implementation are not well-explored. Consequently, the willingness of farmers to engage in such programmes are not addressed (Vandersypen 2008, Gany et al. 2018, Senanayake et al. 2015). The impact assessments, furthermore, neglect the importance of high-rigor methodologies. It has been widely argued that water resource is key factor in agriculture, and climate change will restrict its availability. The further development of impact assessment methodologies,

therefore, is of urgent need (Rosegrant et al. 2009; FAO 2011; Qadir et al 2003; Pimentel et al. 1997). There should be a strong emphasis on irrigation development with a stronger focus on people-centered approaches, such as Participatory Irrigation Management (PIM). The magnitude of the impacts of irrigation development programmes is further amplified in developing countries, whereas agriculture plays a strategic role in poverty reduction (Giordano et al. 2019; Hussain és Hanjra 2003; Hussain 2007; Lipton et al. 2003; Chitale 1994; Lipton 2007; FAO 1999; Smith 2007; IWMI 2005).

To reach better understanding of the measured effects, a systematic review is conducted to investigate the quality of existing literatures on impact evaluation and draw conclusions from their findings. The involvement criteria of the investigated literature are the following; i./ impacts measured directly on farmers, ii./ geographical focus on developing countries; iii./ case-study based approach; iv./ involved scientific methodologies; v./ peer-reviewed study. From 42 studies, 148 performance indicators in 5 impacts scopes (productivity, efficiency and performance, sustainability of the resources, cost of irrigation and profitability) are analyzed and the major shortcomings of PIM evaluation are identified, namely i./ the lack of complex and multidisciplinary assessments of irrigation conditions, ii./ the poor diversification of irrigation scheme size, iii./ the geographical imbalance amongst case studies, and the underrepresentation of the studies in Africa, iv./ misdirected performance indicators overlooking the benefits of farmers and v./ the low-rigor of applied methodologies. To better understand the positive impacts of the management transfer, these research gaps are in the research framework. The overall goal of the dissertation is to introduce robust methods for measuring the impacts of participatory management from the poor farmers' perspective. The research is built on case-study approach, focusing

on Mubuku irrigation scheme in Uganda. The complex research objective requires the following specific goals:

G1: Qualitative assessment of the farmers' engagement in PIM and the adoption of co-joint management by farmers;

G2: Identification of the motivation pattern in participatory irrigation management, and definition of enabling factors of the participation applying semiparametric and semi non parametric methods;

G3: Characterization of farmers' groups by the participation in irrigation managemen through cluster analysist;

G4 Evaluation of the effects of participatory irrigation management on farming outcomes through alternative methods (difference in means, regression adjustment, propensity score matching and entropy balancing).

The novel approach enables the estimation of the real-term impacts of the management transfer in small-scale irrigation schemes. The objective of the stepwise approach is to take due account of the farmers' varying conditions, thus scaling the assessment at individual level. In first step, the management activities in Mubuku pilot irrigation scheme are explored, and the degree of farmers' engagement in management is estimated on the basis of the individual participation in such activities. The first part of the dissertation provides a multidisciplinary, descriptive analysis of the irrigation scheme. Such analysis provides an all-encompassing performance assessment from agricultural, hydrological, management and engineering point of view. The applied methodologies, model specifications and variables are defined in the second step. Addressing the first research goal, a qualitative assessment is conducted to understand the level and status of the management transfer in Mubuku. The second research goal is set to estimate the motivation factors

enhancing farmers' engagement in management transfer. Afterwards, the farmers are categorized in homogenous groups as per their participation in management activities. Finally, the impact of participatory management is assessed via four alternative methods. The impact assessment introduces a set of impact indicators that are linked to the abovementioned global challenges of poverty reduction and food security.

2. MATERIALS AND METHODS

2.1. The data and command area

The research is conducted in Mubuku settlement scheme in Uganda. According to the National Water Policy, the management responsibility, as well as the ownership of an irrigation infrastructure should be gradually transferred to farmers. Such transfer is recently incomplete in Mubuku, notwithstanding that the scheme has been operating for more than a half of century. (Government of Uganda 2017, Wanyama et al. 2017). Mubuku is a former settlement scheme established by Goverment of Uganda to improve rural livelihood. From the original 2 000 ha designated area, only 540 ha is under production in Mubuku, shared by 167 farmers. The cropping pattern is in line with the national food security strategy, as it is almost exclusively limited to maize, rice and onion production. Maize production can be considered as a part of the national food security strategy, therefore, maize-growing farmers are entitled to receive governmental subsidies. The sales points are limited to local and informal markets. The analysis of the agricultural production concluded that farmers are risk-averse. They prefer the low-profit maize production over other crops due to its guaranteed trigger price (Bettili et al. 2019). The field observation proved that the scheme faces severe hardships to deliver good irrigation services. The rudimentary, gravity-fed system reduces the overall conveyance efficiency and results in inequal water distribution. To conduct a comprehensive performance assessment, Rapid Appraisal Procedure was implemented. Such methodology allowed, on one hand, the performance assessment, and the identification of management activities on the other hand. Altogether, 14 transferable management activities were identified to form a basis for the participatory irrigation model. These activities are grouped into three categories: management including operation,

maintenance and finance. The sample size involved 122 from 167 farmers, who responded to the registered surveys. The surveys involved two blocks: the demographic, agricultural and performance features of farmers, and the binary responses to the participation in the 14 management activities.

2.2. Applied methodologies

The methodologies are presented as per the structure of the research goals. The first research goal defined a qualitative assessment to understand the very recent status and performance of the management transfer via Rapid Appraisal Procedure (RAP) and the Design Principles of self-managing irrigation schemes by Ostrom (Ostrom 1992; Saunders 2014). The performance assessment was supported by RAP questionnaires, through which interviews with farmers and state delegation were conducted. In order to measure the degree of farmers' participation in irrigation management, farmers were asked to indicate those management measures, which they regularly pursue. The Farmers Participation Index established under the binary responses to participation divided farmers into two groups: participating (treated) and non-participating (control) groups. As a result, FPI is the proxy of farmers' active role in PIM. This critical step of introducing FPI enables the investigation of the impacts of PIM directly at farmers' level. The aggregated results of impacts on individuals, then, give a more accurate estimate of the success of management transfer

Comparison of participating and non-participating groups Source: own calculation

Irrigation management domain	Identified management activities	Standard. weights	Participating	Non-participating	All farmers
Management (including operation)	Water discharge measurement	0.1	0.05	0.0016	0.0033
	Visiting other schemes	0.02	0.008	0.0074	0.0075
	Cooperation with other farmers to re-distribute water	0.2	0.193	0.1613	0.1170
	Regular participation in irrigation training	0.05	0.039	0.0331	0.0361
	Other water-management techniques	0.05	0.003	0.000	0.0016
	Attending meeting in irrigation turn planning	0.05	0.039	0.0331	0.0361
	Regular participation in extension service related to irrigation practices	0.03	0.020	0.0097	0.0145
	Adjustment of water supply to observed crop demand	0.2	0.127	0.0065	0.0656
	Regular payment of water fee	0.01	0.005	0.0027	0.0037

Continuing

Maintenance	Weeding, bushing, profiling tertiary and quaternary canals	0.1	0.090	0.0677	0.0787
	Regular manual work on the irrigation infrastructure	0.1	0.077	0.0177	0.0467
	Consultation with WUA officers about maintenance	0.03	0.022	0.0121	0.0170
	Private investment on the irrigation infrastructure	0.05	0.028	0.0258	0.0266
Financing	Contribution (in-kind or cash) to canal maintenance	0.01	0.005	0.0021	0.0035

In the second research goal, the farmers' motivation to participate in irrigation management is investigated. Given the number of nominal and ordinal explanatory variables, semi-nonparametric (SNP) of Gallant and Nyhcka (1987) and semiparametric maximum likelihood approach (SML) of Klein and Spady (1993) are applied (Gallant and Nyhcka, 1987; Klein and Spady, 1993). The following variables are used as explanatory variables: education, gender, age, produced crops, number of household members and land size. The causal effect of explanatory variable is measured on three binary outcome variables: farmers' participatory index (FPI), attendance in irrigation training and access to information. The outputs showing consistent similarities between the two models are analyzed and concluded in the results of the research. In order to identify the similarities in farmers' participation pattern,

a data clustering is performed under the third research goal (Omran et al. 2007; Elmore és Richman 2001; Rencher és Christensen 2012). Regarding the characteristics, the analysis involves the same variables described in the previous research methodology, but it applies two further explanatory variables, namely the profit and revenue. To understand whether the obtained clusters are significantly different on any of the variables, Kruskal-Wallis test is applied. As per the research objective, the effect of participatory irrigation management is measured on three farming outcomes under the last research goal. The following four alternative econometric methods are used to estimate the average treatment effect (ATE) of PIM in the order of degree of rigor: difference in means, ordinary least square, propensity score matching (PSM) and entropy balancing (Schweizer et al 2017; Heckman et al., 1999; Cox 1958; Wordofa és Sassi 2018 Rosenbaum és Rubin 1938; Becker és Ichino 2020; Wells et al 2013; Erlander 1977; Baborska et al. 2018; Hainmueller 2011). The FPI is applied as binary treatment indicator, and the following treatment independents are included in the model: education, gender, age, household number, attendance in irrigation training, frequent experience of water shortage or waterlogging, frequent experience of failing production and access to information system. The treatment indicators, namely revenue, profit and productivity are selected to address the link between the research and pro-poor objectives. The PSM applies nearest-neighbor matching algorithm, and balancing test is conducted to ensure the robustness of results.

3. RESULTS

The qualitative assessment provided an evidence that the current implementation stage of the participatory management is somehow derailed by disconnecting farmers from the elementary management functions. The current two-tier management between WUA and farmers leaves a considerable gap in efficient management and leads to a decrease of performance. One of the symptoms of such performance decrease is the critically poor field irrigation efficiency, as low as 15 percent (Salman et al. 2019). Another evident problem is the inequal water distribution amongst farmers, which lead to massive over-irrigation in upstream parts and water stress in downstream areas. The conflict resolution remains an issue to be addressed, as the responsibility sharing between local Abasaija Kweyamba Mubuku Farming Cooperative incorporating the WUA functions and farmers is unclear. The analysis and findings on the asymmetric and incomplete participation in management confirms the concerns of the literature and proves that farmers' role becomes overly limited if WUAs are established merely by governmental intentions.

The second research objective explored the motivation pattern of farmers' engagement in management. Three factors are identified as motivating factors: education, members of household and land size.

Results of SNP and SML models, Source: own calculation

	Farmers Participatory Index		**Attending irrigation training**		**Access to information**	
	SNP	SML	SNP	SML	SNP	SML
Education	0.93***	5.65***	0.25	1.24***	2.65***	5.32***
Gender	-0.29	1.15***	0.60	3.25***	-0.41	0.52
Age	0.67***	-0.89***	-0.11	-0.13	0.53***	0.37
Land size	-2.15**	-4.71***	-1.94***	-2.44***	-0.91	-5.99**
Household size	0.10*	4.05***	0.11**	0.30***	0.02	-0.32***
Produced crops	-0.48	0.8***	1.97***	2.69***	-0.72**	-3.30***

*p<0.1; **p<0.05; *** p<0.01

As per the three participation indicators (FPI, attending irrigation training and access to information), the cluster analysis resulted four homogenous and statistically different groups. The clustering confirmed the results of the investigation of motivation pattern in the case of two variables: education and land size. Furthermore, the clusters are statistically different on two additional variables: revenue and profit.

Results of cluster analysis, Source: own calculation

	1	2	3	4	Kruskal-Wallis
Participation variables					
Irrigation training attendance	0.3	0	1	1	0.00***
Access to information	0	1	0.91	1	0.00***
Participation/FPI	0.5	0.38	0	1	0.00***
Farmers characteristics					
Gender	0.85	0.65	0.70	0.74	0.49
Education	1	1.45	1.20	1.61	0.01***
Age	4.5	4.52	4.65	4.61	0.62
Land size	1	1	1	0.79	0.01***
Household number	7.9	7.03	7.61	9.02	0.30
Profit	14.09	13.80	13.63	14.17	0.00***
Revenue	14.91	14.89	14.87	15.02	0.05**
Number of observations	20	29	34	39	

*p<0.1; **p<0.05; *** p<0.01

In order to rigorously measure the Average Treatment Effect (ATE) of participation on farming outcomes, four alternative methods used. The research establishes counterfactual analysis by replicating the characteristic of the treated (participating) for control (non-participating) group. The impact is estimated on three indicators (profit, revenue and yield of maize). Balancing test is performed to investigate and confirm whether the treatment independents are balanced in the matched sample.

Results of balancing test, Source: own calculation

	Mean		% decrease	t-test	
Variable	**Treated**	**Control**	**%bias**	**t**	**p>t**
Education level	1.37	1.44	-10.0	-0.54	0.59
Gender	0.74	0.67	16.5	0.84	0.40
Age	4.59	4.42	22.9	1.03	0.30
Irrigation training attendance	0.72	0.74	-3.9	-0.22	0.83
Frequent experience of water shortage or waterlogging	0.33	0.29	7.6	0.41	0.68
Household number	8.11	7.61	13.5	0.91	0.36
Access to information system	0.81	0.83	-4.7	-0.25	0.80

The positive and significant results of ATE shows that the participating group achieves better results in terms of profit, revenue, and yield.

Results of alternative methods, Source: own calculation

	Mean difference	**Regression adjustment**	**Propensity score matching nn (1)**	**Entropy balancing**
Average yield of maize production	0.29***	0.39***	0.33***	0.37***
standard error	0.12	0.14	0.17	0.15
t stat	2.49	2.76	1.99	2.39
Average revenue per acre	474***	437.63***	584.29***	408.75***
standard. error	126.75	140.43	179.25	148.73
t stat	3.74	3.12	3.26	2.75
Average profit per acre	453.95***	523.74***	427.47***	463.01***
standard. error	103.53	112.92	150.99	120.02
t stat	4.38	4.64	2.83	3.86

4. CONCLUSIONS AND RECOMMENDATIONS

The dissertation introduces a novel approach of the comprehensive assessment of participatory management. The systematic review concluded that the literature does not provide a compelling evidence of the positive impacts of PIM on poor farmers. It was found that researchers give preference to countries with more developed irrigation sector over Africa. The arising global challenges prompt the involvement of the currently neglected countries, as they are in the most immense need of irrigation development. The literature review also revealed the poor presentation of small-scale irrigation schemes and smallholders, even though, the small-scale production has an even greater role in future development strategies. Although the objective of the participatory management is to increase the farmers' satisfaction and improve the efficiency, most of the impact assessments are conducted at system level and neglected the impact indicators targeting farmers. The reviewed literature has limitations in their research methodologies, as many of them are based solely on "before-after" comparison, and they do not take due account of external and internal factors that can influence the outcome of management transfers. This research, therefore, applies a novel approach and methodology, which can address the beforementioned issues. Thus, the research substantially contributes to the literature of the impact assessments of management transfer. The conclusions and recommendations are built around the research results and presented in the order of the research goals.

The performance assessment of Mubuku irrigation scheme was conducted through the application of the Rapid Appraisal Procedure, a multidisciplinary assessment of the system performance. The descriptive analysis showed that the proper implementation and assessment of the management transfer

requires a complex analysis that involves agricultural, engineering and management sciences. The appraisal proved that the field irrigation efficiency is critically low, and the water distribution amongst farmers are inequal due to the unclear responsibility share amongst management layers. The analysis confirmed that the overall assessment of irrigation performance is the necessary first step to identify the potential consequences of poor management and its spillover effects. When framed into the context of poor farmers, the importance of the research is even more amplified by their extreme vulnerability. The investigation of first research goal highlighted the concerns on the top-down organization of WUAs. If WUAs are established by centralized and high-level mechanisms, the objectives and authorities of the farmers and WUAs become distinct. Moreover, farmers' roles in the management remains limited. This process results the very opposite of the theory and definition of WUAs, which advocates the all-inclusive involvement of farmers through management transfer. This analysis, also, endorsed the concept that promotes the impact assessment right at farmer-level. Such farmer-level analysis starts with the introduction of FPI, a measure to differentiate farmer groups through the estimation of individual participation in management activities. The overall objective of participatory management can be achieved only if farmers are keen to engage in such programmes.

The second goal is the immediate result of the first research goal, as it confirmed that Mubuku is a sterling example of farmers' varying participation in management activities. Both the literature review and the descriptive analysis proved that farmers' diverse conditions eventually influence the degree of their participation. This conclusion has an outstanding meaning in development policies because there is no "one-size-fits" mechanism for the

implementation of strategies such as participatory management. Ultimately, it is desirable to explore the motivation factors of engagement and participation. The results of semiparametric and semi nonparametric models showed that these factors are the education, number of household members and land size in the case of Mubuku. Education is identified as a potential link between the state-initiated PIM process and the engagement. The research shows that the process of "learning-by-doing" should not be considered as a feasible process to make farmers active members of the management. The household size has a particular potential in farming because it allows the experience sharing and enhances the sustainability of irrigation development. The negative relationship between land size and participation raises a paradox turn. The interviews underpinned the fact that farmers with larger farm size hire daily labor. Due to the hired labor to carry-out the daily works, the landowners are disconnected from the day-to-day activities, such as the irrigation, and eventually become neutral in issues related to the irrigation development. The outcomes show that the participatory management can meet its objectives if farmers are directly involved in the irrigation management without intermediary actors.

The third research objective is directly linked to the previous research question. It classifies farmers on the basis of their participation. The clustering reinforces the results of the assessment of engagement drivers through showing statistically significant differences in the education and farm size variables. Furthermore, the four clusters are statistically different on two additional characteristics: profit and revenue. Based on the results, these variables seemingly correlate with the FPI. Hence, clustering is a critical step to delineate the characteristics pattern per farmers group and to denote the most suitable performance indicators of management transfer. As Mubuku

incorporate partially subsistence-based, poor farmers, the livelihood of farmers almost entirely depends on the success of the production.

The fourth research goal involves the impact assessment of management transfer through four alternative methods (difference in means, regression adjustment, propensity score matching and entropy balancing) and directly responds to the research objective. Given the particularity of the pilot area, notably the remote location, the lack of historical data, the cost of the research and the changing environment, a counterfactual analysis was applied in the framework of the quasi-experimental research method. The literature review raised the concern on the explanatory power of applied methodologies. Most of these methodologies conducted a before-after analysis and attributed the estimated impacts to the management transfer. These methodologies involve uncertainties due to two reasons. Many policy-related programmes have been integrated in system rehabilitation or modernization projects. If PIM/IMT is part of an investment project, the measured increase can be also credited to the improved engineering conditions. On the other hand, the changing production conditions can also influence the results, thus distorting the impact of management transfer. The novel approach is introduced to estimate the direct gains of participatory management through the treatment variable of FPI. Three outcome indicators are investigated to estimate the impacts: revenue, profit and yield. These indicators directly reflect on the objectives of poor farmers, namely the livelihood and income generation. In doing so, the impacts of participatory management are measured from farmers' perspectives and targeted to farmers' benefits. Each method results positive and significant effects of management transfer on the indicators. The research proved that PIM can be an effective tool to support the cross-cutting objectives of programmes related to livelihood development of vulnerable farmers.

Finally, the research proved that participatory irrigation management has direct contribution to poverty reduction and the objectives integrated water resource management.

5. NEW SCIENTIFIC RESULTS

The following new scientific results are defined:

1. The dissertation highlighted the importance of approaching participatory irrigation management from a multidisciplinary aspect. A well-established irrigation performance assessment tool, the MASSCOTE-RAP was applied to delineate the distinguished management measures amongst multiple institutional layers: state, WUA and farmers. The results showed that although understanding the system performance is crucial to set-up hydrological and administrative boundaries of irrigation management, a successful management transfer goes beyond the flaws of engineering design.
2. The research showed that farmers in relatively homogenous communities do not engage in participatory irrigation management at the same degree. The results showed that education and household number play vital role in participatory management, as they have positive and significant impacts on active participation in management. In contrary, land size has negative and significant impact on it. This result proves that management responsibilities are less likely to be successfully transferred without proper knowledge or sufficiently large household. The negative effect of land size highlighted the fact that farmers without direct experience and daily work in irrigation are rather reluctant to take role in management. Hence, participatory management requires farmers' personal commitment.
3. The research introduced a novel research approach to measure the level of engagement in irrigation management. Farmers participatory index was computed to measure the impact in "with-or-without" context. The dissertation, then, overcame the major obstacles of previous literatures to establish robust research method, namely: time and geographical

constraints, varying conditions over the implementation period and diverse backgrounds of farmers.

4. Through the process of understanding the drivers of management transfer, the dissertation identified performance indicators to measure the farmers' benefits. Instead of the widely used performance indicators of system efficiency and cost recovery, the dissertation narrowed the set of indicators to the ones directly contributing to the farmers' livelihood. This feature is considered crucial in a developing country context.
5. The dissertation introduced a counter-factual analysis to measure the impact of PIM. The research approach was proved to be suitable for the estimation of the PIM benefits at individual basis. Measuring the benefits in disaggregated manner and through quantitative methods provided a fresh perspective for impact assessment in complex development programmes such as the management transfer. The research proved that PIM has positive impact on poor farmers, thus supporting the viability of management transfer in development programmes.

6. PUBLICATIONS RELATED TO THE DISSERTATION TOPIC

Books

Salman, M.; Pek, E.; Giusti, S., Lebdi, F.; Almerei, A.; Shrestha, N.; El-Desouky, I.; Zaki, S.; Darwesh, R.; Lamaddalena, N.; Raes, D. (2020). On-farm Irrigation Development Project in the Old Lands (OFIDO). Technical assessment, Food and Agriculture Organization, ISBN 978-92-5-133119-4, Rome, Italy, https://doi.org/10.4060/cb0484en

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Salman, M.; Fertő, I.; Alobid, M.; Pek, E. (2020): Farmers can substantially deploy irrigation potential through improved management environment: Enabling factors of farmers' involvement into resource-efficient irrigation management, Irrigation and Drainage Journal, Special Issue Article, https://doi.org/10.1002/ird.2538

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Full papers in conference proceedings, posters and conference presentations

Food and Agriculture Organization and Agricultural Water in Africa: Strengthening agricultural water efficiency and productivity at African and global level workshop, Rome, Italy, 12-13.12.2019: National Agricultural Water Policy Sector in Uganda

International Commission on Irrigation and Drainage (ICID): Third World Irrigation Forum (WIF3), Asset management systems for sustainable water, food and nutrition security with a focus on irrigation infrastructure in a competitive environment side event, Bali, Indonesia, 01-04.09.2019: Experiences with asset management in selected irrigation schemes

International Commission on Irrigation and Drainage (ICID): International Conference, Data-driven improvement of water use efficiency in small-scale irrigation side event, Saskatoon, Canada, 12-17.08.2018: Improving water-efficient irrigation: Prospects and difficulties of innovative technologies and practices in agricultural water management

Food and Agriculture Organization and CIHEAM Bari: Emerging Practices from Agricultural Water Management in Africa and the Near East thematic workshop, Bari, Italy, 28-31.08.2017

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