Title

Necessity of linking irrigation systems typology and performance indicators analyzing and validation

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The benchmarking method is focused on definition and comparison of irrigation systems according to performance indicators.

First, to compare irrigation systems from the point of view of their performances is a very complex task, cause the different skills are very linked to technical, economical and social context of the farmers. Second, the result analysis depends on the irrigation system objectives, for example food security, social equity, etc.

Otherwise, the decisional level for the farmer is the irrigation system first including the irrigated plot seen as a production unit among others. To analyze performance indicators cannot be done without taking into account the typology of the irrigation system dealing both with the two levels (the plot and the irrigation system).

Irrigation systems typology is until now an important key question taking into consideration its great complexity and its high range for the proposal of irrigation systems management models.

According to different actors, there are in sub-Saharan Africa several proposals for typologies of irrigation systems. Face to the diversity of the typologies it is very doubtful to compare the performance indicators results.

The challenge is to build an innovating typological method witch can help to better analyze irrigation systems performances.

Of course, according to the region irrigation system typology is based on the mixing of many criteria and real or sham cases can be generated.

The aim of this paper is to discuss the link between irrigation systems typology and performance indicators usage through a conceptual approach and examples.

Key words: irrigation systems - indicator – performance –typology

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Titre

Nécessité de la prise en compte de la typologie des périmètres irrigués dans l'interprétation et la validation des indicateurs de performance.

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Résumé

La démarche de parangonnage est centrée sur la définition et la comparaison d'indicateurs de performance entre périmètres irrigués.

Cette dernière est une opération complexe car d'une part, les niveaux obtenus sont très liés aux contextes technique, économique et social auxquels sont soumis les agriculteurs et d'autre part, l'interprétation du résultat dépend de l'objectif fixé pour l'aménagement qui peut être par exemple la sécurité alimentaire, l'équité sociale ou autre.

De plus, le niveau décisionnel de l'agriculteur est d'abord celui de l'exploitation agricole dont la parcelle irriguée n'est qu'un atelier de production parmi d'autres. Raisonner autour d'indicateurs ne peut se faire sans prendre en compte cette dimension que seule une typologie intégrant les deux niveaux (périmètre et exploitation) peut résoudre.

La typologie des périmètres irrigues, demeure donc une question très centrale de par sa grande complexité et sa haute portée dans la proposition des modèles de gestion des aménagements.

En Afrique subsaharienne, il existe selon les acteurs plusieurs propositions de typologies des périmètres irrigués rendant la comparaison des résultats liés à des indicateurs de performance très délicate.

Le défi qui se pose est d'arriver à définir une démarche typologique qui permette de mieux interpréter les performances des systèmes irrigues.

La typologie des aménagements reposant sur le croisement de multiples critères, on est souvent conduit à générer une grille complexe de cas réels et fictifs selon la zone d'intervention considérée.

L'ambition poursuivie par ce travail, à travers une approche conceptuelle et des exemples, est de mettre en évidence la relation entre la typologie des périmètres irrigués et l'exploitation des indicateurs de performance.

Mots clés : indicateurs - performance – périmètres irrigues – typologie

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Introduction

At all times irrigated agriculture constituted one of the essential supports of the humanity great civilizations.Before any consideration, the major stake of irrigated agriculture is better to ensure the requirements in food for the communities, food self-sufficiency and safety while guaranteeing the protection and the conservation of the environment. Because it strongly depends on the natural resources, agriculture was not always respectful of the sustainable use of the natural resources. In addition, irrigated agriculture requires important capital for its setting up and which it is necessary to put in value. Otherwise, the maintenance of the infrastructures faces to organizational and financial problems which are not often easy to solve. Also, the agricultural production drawn from the irrigation schemes can be sometimes under the expected levels or be confronted with the market uncertainties. In short, irrigated agriculture is in the center of great concerns. To contribute to the control of these concerns, it is necessary to define and benchmark the major performances of the irrigation schemes in order to improve them using appropriate methods, tools and actions. It is an essential way to reach both a high level of competitiveness and a good efficiency of use of the resources. However, being given, on the one hand, that the aims of each irrigation system differ and, on the other hand, that the definite objectives flash back on the typology of the systems themselves, it appears a problem of coherence as for the comparison of the performances. Thus, the overall management of irrigation schemes for decision-making and planning faces to a real difficulty of standardization.

Objectives of the study

The objectives of the study are:

- To define a typological method allowing to better analyze the performances of irrigation systems;

- To highlight the relation between irrigation systems typology and performance indicators usage through a conceptual approach and examples;

- to show how benchmarking influenced the decisions of management or planning

Irrigation schemes typology

Irrigation schemes typology is based on multiple criteria such as the scale of the scheme, the crops, the type of the irrigation network (gravity, pressurized or mixed system), the operating mode of the irrigation network, the irrigation method, the water resource used and its mobilization, the degree of water control (irrigation and drainage), the mode of management, the climate, etc.

The classification criteria which the sensitivity is variable according to actors divide into socio-economic, organisational, technical arguments (agronomic, hydrological, and hydraulic).

In the principle, the crossing of the criteria makes it possible to produce a matrix of typologies generating real or sham cases; it is thus necessary to carry out adjustments according to the concrete contexts of each irrigated system considered.

By way of example one could quote for typology the proposals for criteria mentioned in table 1 hereafter.

Table 1: Irrigation schemes matrix of typology elements

Climate	Moderate climate	
	Equatorial climate	
	Tropical Climate	
	Sahelian climate	
Type of network	Gravity network	
	Pressurized network	
	Pressurized and gravity network	
Type of regulation	Upstream regulation	
	Downstream regulation	
	Mixed regulation	
Degree of water control	Total water control	
	Partial water control	
Source of irrigation water	Surface water	Irrigation schemes downstream dams and lakes
		Irrigation schemes upstream dams and lakes
		Irrigation schemes with gravity intake from a river
		Irrigation schemes with pumping in river
		Rising spreading irrigation schemes
	Ground water	Irrigation schemes supplied with boreholes
		Irrigation schemes supplied with wells
		Irrigation schemes supplied with sources
	Waste water	Cleaned waste water
		Non cleaned wasted water
	Mixed water	Surface water + ground water
		Waste water + Surface water
		Waste water + ground water
Irrigation methods	Surface Irrigation	Graded system : border or furrow irrigation
		Level system : basin irrigation
		Mixed (graded and level system)
	Sprinkler	Sprinkler system
		Irrigation machines systems
	Micro irrigation	Trickle irrigation
		Micro sprinkler system
Irrigation scheme scale	Family irrigation schemes	
	Small scale irrigation schemes	
	Medium scale irrigation schemes	
	Large scale irrigation schemes	
Mode of management	Small irrigation systems	
	Collective irrigation schemes	
	Private irrigation schemes	
	Industrial irrigation schemes	
Crops	Rice irrigation schemes	
	Vegetable irrigation schemes	
	mixed-farming irrigation schemes	
	Fruits irrigation schemes	
	Sugar cane irrigation schemes	

The multiplication of the criteria involves a very fast increase in the number of the types often without justification with reality.
Considering the example of Burkina Faso, Gordio (2005) carried out a typology intended for the Geographical Institute of Burkina and retained only three criteria of definition of typology which are the scale of the irrigation scheme, the source of the irrigation water, the degree of water control. The types below have been obtained:

Table 2: Typologies obtained on the basis of 3 criteria (size of the scheme, the source of the irrigation water, the degree of water control)

Types	***Description***
A	- Small scale schemes - Surface water - Total water control
B	- Medium scale schemes - Surface water - Total water control
C	- Large scale schemes - Surface water - Total water control
D	- Small scale schemes - Surface water - Partial water control
E	- Medium scale schemes - Surface water - Partial water control
F	- Large scale schemes - Surface water - Partial water control
G	- Small scale schemes - Ground water - Total water control
H	- Medium scale schemes - Ground water - Total water control
I	- Large scale schemes - Ground water - Total water control

Types	***Description***
J	- Small scale schemes - Ground water - Partial water control
K	- Medium scale schemes - Ground water - Partial water control
L	- Large scale schemes - Ground water - Partial water control
M	- Small scale schemes - Waste water - Total water control
N	- Medium scale schemes - Waste water - Total water control
O	- Large scale schemes - Waste water - Total water control
P	- Small scale schemes - Waste water - Partial water control
Q	- Medium scale schemes - Waste water - Partial water control
R	- Large scale schemes - Waste water - Partial water control

By applying it to a sample of 200 irrigation schemes, there has been got the distribution hereafter (table 3).

Table 3: Distribution of the irrigation schemes sampled in the matrix of the categories.

Irrigation schemes type	A	B	C	D	E	F	G	H to R
Number per type	172	16	7	0	1	2	2	0
Percentage (%)	86	8.0	3.5	0.0	0.5	1.0	1.0	0.0

If it is considered that a type is representative when the number of irrigation schemes which belong to it reached at least 2%, one finds that only 4 categories can be retained (table 4).

Table 4: Categorization of the sampled irrigation schemes

Categories	***Description***	***Surface area per category (ha)***	***Percentage (%)***
I	- Small scale schemes - Surface water - Total water control	2600	13
II	- Medium scale schemes - Surface water - Total water control	3990	20
III	- Large scale schemes - Surface water - Total water control	10315	51
IV	Others	3275	16
Total		20180	100

Indicators of performances and typology of the irrigation schemes

The performance of an irrigation system gives the degree of satisfaction of the objectives which are assigned to him and shows the efficiency with which the resources (natural, human and material) available are used to carry out the results. To appreciate the performance of an irrigation system, one uses objectively defined performance indicators witch must be measurable and whose measurement is reproducible. Thus, many indicators can be defined: the yield, the productivity of irrigation water, the relative water supply, the farming intensity, the income, the value of the working day, the profitability of the irrigated plot, the efficiency of infrastructure, etc.

In their own principle, the background information of the performance of the irrigation schemes is closely related to the typology of these systems. Indeed, according to the type of each irrigation schemes the recommended objectives will be different and rather specific the expected performances. Under these conditions, can the benchmarking of the performances of the irrigation systems be indifferent to their typologies?

Relation between the benchmarking irrigation schemes performances and typology

According to the logic and the objectives of each actor and the socio-economic context, such or such criterion can be put in priority for the purpose of modelling typologies which meet completely different needs. When for example a social objective is assigned to an irrigation system, its performances could not be rigorously compared with those of an irrigation system witch objective is rather economic, industrial or other.
By considering a criterion such as the scale for example, one can have from one area to another or country to another a divergent classification which undoubtedly has an impact on the benchmarking of the performances in the sense that any comparison between the irrigated systems would miss coherence and of relevance. The examples of typologies of irrigation schemes in Burkina and Madagascar presented in the tables hereafter give an illustration of it. Indeed, being given the difference very marked in the scale of values how could it be possible to compare the performances of the irrigation systems between them without making a distortion?

Table 5: Typology of the irrigation schemes in Madagascar according to the scale

Nomenclature	Size (ha)	Management arrangement	Surface area equipped (ha)
Large scale irrigation schemes (LIS)	> 3 000	Government	120000
Small scale irrigation schemes (SIS)	100 - 3 000	Government + Users	167000
Micro scale irrigation schemes (MIS)	10 -100	Users	500000
Family irrigation schemes (FIS)	< 10	Users	300000
Total			1 087 000

Source: www.fao.org

Table 6: Typology of the irrigation schemes in Burkina according to the scale

Nomenclature	Size (ha)	Management arrangement	Surface area equipped (ha)
Large scale irrigation schemes (LIS)	> 500	Government + Users	12058
Medium scale irrigation schemes (MdIS)	100 - 500	Users	3000
Small scale irrigation schemes (SIS)	< 100	Users	8200
Small irrigation systems (SISy)		Users	10000
Inland valleys (IV)		Users	7200
Total			40 458

Source: Direction générale de l'hydraulique agricole du Burkina - politique sectorielle d'hydraulique agricole

For 11 rice irrigation schemes (cf appendix), work of the project « identification et diffusion de bonnes pratiques sur les périmètres irrigués en Afrique de l'ouest » (identification and dissemination good irrigation practices in West Africa) make it possible to establish the need for the taking into account of the typology of the irrigation schemes in the interpretation and the validation of the indicators of performance.

According to the major characteristics (the scale, the source of the irrigation water and its pumping out) of the 11 irrigation schemes monitored by the project « bonnes pratiques » (good practices), there have been arbitrarily defined 3 groups of irrigation schemes whose performances are analyzed (table 7):

- Irrigation scheme witch size ≤ 100 ha
- Irrigation scheme witch size is between 100 ha and 500 ha;
- Irrigation scheme witch size > 500 ha

Table 7: Synthesis of some performance indicators on the studied irrigation schemes

Performance indicators	Irrigation schemes scales		
	S ≤ 100 ha	100 < S ≤ 500 ha	S > 500 ha
Paddy yield (t/ha)	3.5 ≤ Y ≤ 5.5 in RS*	4.5 ≤ Y ≤ 5.3 in RS 4.5 ≤ Y ≤ 5.6 in DS**	4.5 ≤ Y ≤ 5.3 in RS
Pumped water volume (km^3/ha)	9.3 ≤ Vp ≤ 13.2 in RS	13 ≤ Vp ≤ 18 in RS 18.5 ≤ Vp ≤ 19.6 in DS	12 ≤ Vp ≤ 13 in RS
Water productivity (kg/m^3)	0.34 ≤ Pw ≤ 0.53 in RS	0.30 ≤ Pw ≤ 0.38 in RS	0.38 ≤ Pw ≤ 0.41 in RS
Family income (kF CFA)	102 ≤ Fin ≤ 383 in RS	105 ≤ Fin ≤ 252 in RS 104 ≤ Fin ≤ 228 in DS	320 ≤ Fin ≤ 372 in RS

(*): RH = rainy season (**): DS = dry season

The results of table 7 show that it is important to consider the typology of the irrigation system in the interpretation of the results of the performances and in the comparison between irrigation schemes. Indeed, in this case, one notes for each indicator:

- A range of results of variable amplitude according to the category and the reduction of this amplitude with the increase in size of the irrigation scheme;
- A better productivity of the irrigation water for the small irrigation schemes.

Impact of the benchmarking irrigation performance on management decisions and planning

The performance indicators are not only tools of diagnosis and management, but also for planning. These characteristics are reinforced through the benchmarking irrigation performances method. To implement the participatory diagnosis, the comparative diagnosis, the restitutions with the actors concerned, the solutions recommended and the evaluations within the framework of the benchmarking of the performances produces a strong impact on the decisions of management and planning. On the matter, the experiments of the PMIBF (projet management de l'irrigation au Burkina Faso), of the PSI-CORAF (pôle régional de recherche sur les systèmes irrigués soudano-sahéliens), of the PCPS (projet centre de prestation de services), of the project « identification et diffusion de bonnes pratiques sur les périmètres irrigués en Afrique de l'ouest », of the project APPIA (amélioration des performances des périmètres irrigués en Afrique) can be quoted even if they did not cover an integral approach of benchmarking. The effects of the diagnoses and the innovations introduced by these projects induced a greater awakening in the actors, gave them a sense of responsibility in acquisition and usage of data, provided them tools of assistance to the decision-making, instigated their organizational frameworks, brought them progress as regards professionalization. In real terms, there have been improvements in the management of the target systems in term of application of the technical recommendations, of the water distribution programs, the maintenance implementation and the use of financial standards. The findings and the learned lessons were used somewhat for better specifying the planning of new systems or the rehabilitation of existing systems.

Conclusion

The benchmarking of the performances as a method of research and development makes it possible to introduce innovations in the management of the irrigation systems. However, it cannot be applied in a general way without real taking into account of the studied systems typology. It is through the integration of the irrigation schemes typology in the benchmarking approach that an objective comparison is possible and that improvements can be better identified.

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APPENDIX

SOME PERFORMANCE INDICATORS ESTABLISHED ON 11 IRRIGATION SCHEMES IN WEST AFRICA

Part a

IRRIGATION SCHEMES					
	Nakhlet	Kotaka	Diantakaye	Débé I	Dieuck
Characteristics					
Country	Mauritania	Mali	Mali	Burkina	Mauritania
Climate	Sahelian	Sahelian	Sahelian	North soudanian	Sahelian
Surface area (ha)	27.5	34	40	47	52
Water resource	River	River	River	River	River
Water pumping	Yes	Yes	Yes	Yes	Yes
Performances indicators					
Yields (1999 et 2000)	5.5 in RS*	4.9 in RS	5 in RS	4.3 in RS 4 in DS**	3.5 in RS
Family income	383 000	102 000	140 000	147 000 in RS 104 000 in DS	193 000
Pumped water volume (m^3/ha)	13 200 in RS	9 300 in RS	10 000 in RS	6 800 in RS 14 500 in DS	10 300 in RS
Water productivity (kg/m^3)	0.42	0.53	0.50	0.63 in RS 0.28 in DS	0.34

(*): RS = rainy season (**): DS = dry season

Partie b

IRRIGATION SCHEMES						
	Toula	Lata	Pont Gendarme	Débé II	PPGII	Boudoum
Characteristics						
Country	Niger	Niger	Senegal	Burkina	Mauritania	Senegal
Climate	Sahelian	Sahelian	Sahelian	North soudanian	Sahelian	Sahelian
Surface area (ha)	256	260	260	500	1188	3080
Water resource	River	River	River	River	River	River
Water pumping	Yes	Yes	Yes	Yes	Yes	Yes
Performances indicators						
Yields (1999 et 2000)	5 in RS* 5.4 in DS **	5.3 in RS 5.6 in DS	5.1 in RS 4.7 in DS	4.5 in RS 4.5 in DS	4.5 in RS	5.3 in RS
Family income	105 000 in RS 128 000 in DS	112 000 in RS 104 000 en SS	252 000 in RS 228 000 in DS	126 000 in RS 125 000 in DS	320 000	372 000
Pumped water volume (m^3/ha)	13 000 in RS - en SS	18 000 in RS - en SS	- in RS 19 600 in DS	14 000 in RS 18 500 en SS	12 000	13010
Water productivity (kg/m^3)	0.38 in RS - in DS	0.29 in RS - in DS	- in RS 0.24 in DS	0.32 in RS 0.24 in DS	0.38	0.41

(*): RS = rainy season (**): DS = dry season

Source : Projet « identification et diffusion de bonnes pratiques sur les périmètres irrigués en Afrique de l'ouest »