

Irrigation Management in Times of Shortage, Constraints, Strategies and Adaptive Measures for Irrigators in Falki and Gadouram (Mirriah-Zinder-Niger)

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Abstract

Original Research Article

Abstract : Climate change in Niger in general and in the study area in particular has led to a socio-environmental change. The main consequence of this situation was a drop in yields in a context where food needs are increased. Today, we are increasingly seeing the promotion of irrigated agriculture which increasingly makes up for the deficits recorded by rain-fed production. The present study conducted in the rural commune of Mirriah aims to carry out an investigation into the analysis of irrigation management in periods of shortage, strategies and local adaptive measures used by farmers at the market gardening sites of Falki and Gadouram. The methodology consisted of visiting these sites to speak with producers in order to get to grips with the problem relating to irrigation water in times of shortage. Thus, a survey was conducted among 230 producers from the 2 study sites, or 13.2% of all irrigators. The results of the study show that the mode of access to land is among others: 67.91% inheritance, 25.5% purchase, 5.3% loans and 1.25% rental. The chi-square test showed that the strategies and adaptive measures used by irrigators to deal with multiple and untimely shortages do not vary significantly depending on the market gardening sites ($P=0.464$). The results of this study reveal a range of strategies developed and measures taken by operators. The strategies include: the construction of traditional cesspools (23%); the use of connected motor pumps (24.8%); irrigation during the night or very early in the morning (27%); the cleaning and deepening of wells or sumps (7.8%); the choice of early or resistant varieties, the reduction in cultivated area and 6% of producers took no adaptation measures, due to a lack of technical and financial resources. In order to increase water retention capacity and improve irrigation management, the State must build irrigation canals in concrete or reinforced concrete from the Timballa dam to the Falki pond in order to reduce water loss through infiltration and evaporation.

Keywords: Changement Climatique, Falki Et Gadouram, Mesures Adaptatives, Irrigation, Producteurs.

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2. INTRODUCTION

In a context of scarcity and the risks of climate change, the management of water resources has become a major concern worldwide (Naceur M *et al.*, 2019). West Africa, one of the poorest regions in the world and also one of the most vulnerable to climate hazards, as illustrated by the magnitude of the impacts of climate variability over the last three to four decades. The drop in average rainfall before and after 1970, a pivotal year from the point of view of the recent evolution of the Sahelian climate, varies from around 15% to more than 30% depending on the area (Madiodio Niassa, 2007).

In Niger, with a contribution of 40% to the national GDP, agriculture constitutes one of the main activities of the country and is faced with a certain number of constraints such as: insufficient rainfall, decline in soil fertility, the reduction of arable land... (Gonda, 2018 and Benjamin. S, 2013).

Furthermore, climate change with its negative impacts on onion production will lead to a reduction in available water resources and accentuate drought at medium altitudes and in the low-altitude semi-arid zone. Thus, hundreds of millions of people will be exposed to increased water stress (IPCC, 2007) affecting several areas such as: agriculture, forestry, natural spaces, etc.

Faced with climate change, policies must therefore be implemented to strengthen resilience in all areas concerned.

For all crops, a shortage throughout the cycle is much more detrimental than occasional shortages. The periods of flowering and product formation are periods very sensitive to rationing and conversely yields are very little affected by a shortage during the ripening phase. (Doorenbos *et. Pruitt* 1987)

For several decades we have been witnessing situations of insufficient rainfall, resulting in a reduction in surface and groundwater, making agricultural production difficult. Farmers are constantly fighting to overcome this scourge by adopting adaptive strategies and measures for climate resilience.

The general objective of this study is to analyze irrigation management in periods of shortage and adaptive measures taken by irrigators with the aim of improving management and making production more economical.

3. MATERIALS AND METHODS

3.1 Study Areas

The study areas are the ponds of Falki (800ha) and Gadouram (300ha) with two (2) market gardening sites. These areas belong to the rural commune of Mirriah, Zinder region (west of the country). The map below illustrates the administrative map of the municipality of Mirriah.

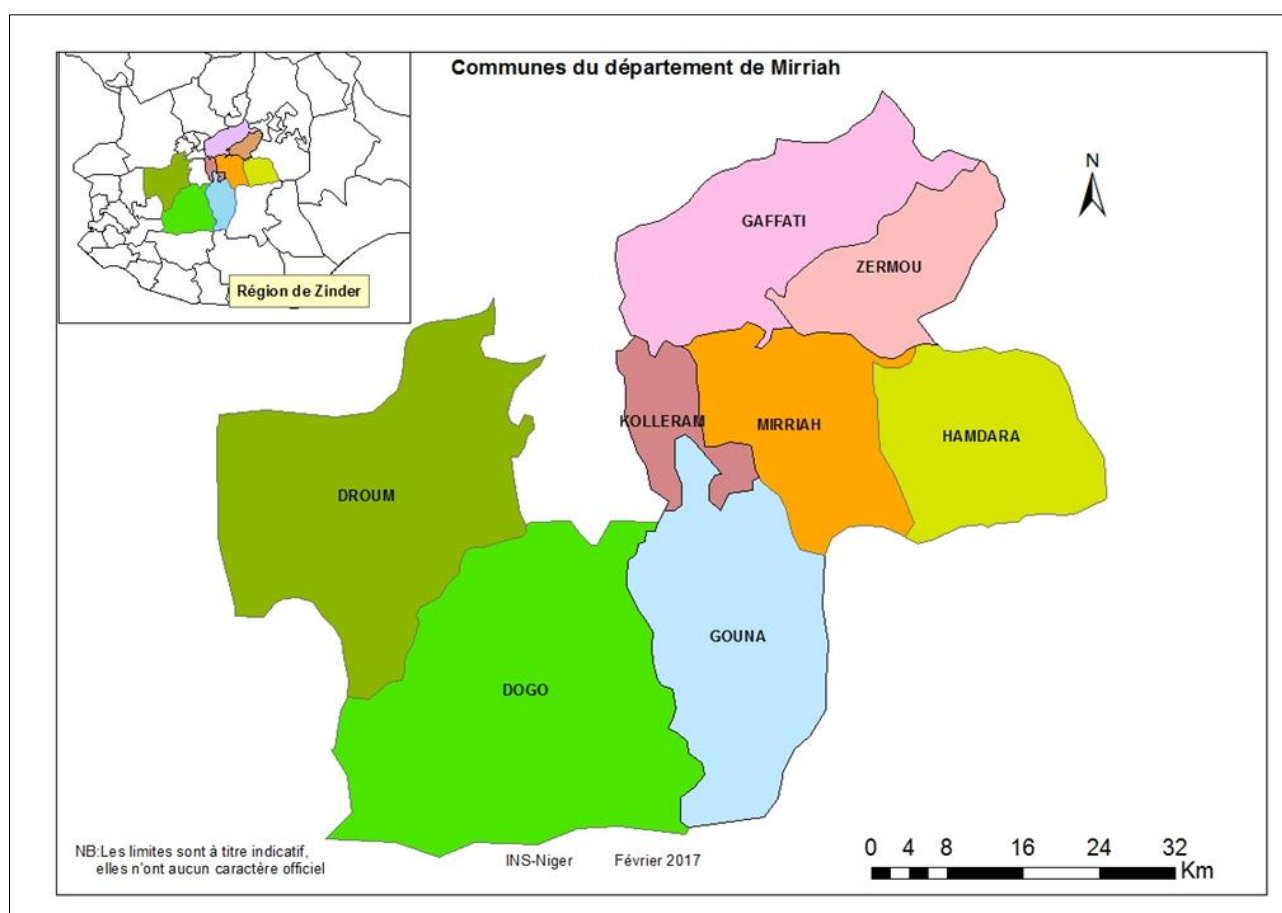


Figure 1: Administrative map of the commune of Mirriah (Zinder-Niger)

For sampling, interviews were carried out with producers who practice market gardening. Given the large number of producers (Falki market gardening site) and the unavailability of producers busy with their field work, the sampling involved 200 producers on the Falki site and 30 producers on the Gadouram site with a total of 230, i.e. a sample of 13.2% of the irrigators surveyed.

3.2 Field Data Collection

The data was collected following an individual survey and a focus group with producers from the study sites. Two types of data were collected: qualitative and quantitative data. Figure 2 illustrates one of the focuses carried out with a group of irrigators on the Falki site.



Figure 2: Meeting with Mirriah irrigators for a focus group on the Falki site

3.3 Analysis of Qualitative Variables (Chi-Square Test): Water Source, Drainage System and Irrigation Method

A chi-square test was carried out in order to find out if the source of irrigation water is statistically linked according to the cultivation site. This analysis has a probability $P = 0.287$, which indicates that the source of irrigation water does not vary significantly depending on the site. The water source is almost 100% the pond for both sites with very few producers supplementing irrigation using well water. However, water availability is a key factor in this market gardening activity. This is why many producers want to remove sand and deepen the pond to increase its retention capacity.

In addition, we analyzed the means of draining irrigation water. Analysis of the results shows a probability $P=0.105$, therefore implying that there is no statistical difference between the means of drainage and the site. There are two types of drainage means, namely the motor pump and manual drainage using a calabash or

other containers. Thus, a chi-square test revealed that using an irrigation method remains far from being significantly influenced by the site ($P=0.051$).

Two irrigation methods are practiced on the study sites: gravity irrigation and manual water distribution. We note that the percentage of manual distribution is very low. This is explained by the fact that even producers who do not have the capacity to buy a motor pump lend it to their neighbors and the latter benefit in return from the rest of the fuel not consumed.

Table 1 gives us an analysis of qualitative variables such as the water source, the means of drainage and the method of irrigation at the Falki and Gadouram sites. Thus, whether it is the Falki or Gadouram site, the irrigators use the pond, the motor pump and gravity irrigation as respectively the source of water, the means of drainage and the method of irrigation on these two sites.

Table 1: Analyzes of qualitative variables: water source, drainage system and irrigation method at the Falki and Gadouram sites

Variable	Modality	Marketen Garden Site of		P-Value
		Falki	Gadouram	
Water source	Pool+ Well	8,5% _a	3,3% _a	0,287
	Pool	91,5% _a	96,7% _a	
Means of dewatering	Direct debit	5,5% _a	13,3% _a	0,105
	Motor pump	94,5% _a	86,7% _a	
Irrigation method	Gravity irrigation	95,5% _a	86,7% _a	0,051
	Manual water distribution	4,5% _a	n<5 _a	

Figures 3 and 4 illustrate the means of dewatering used by operators at the Gadouram site.



Figure 3 : Dewatering with the motor pump

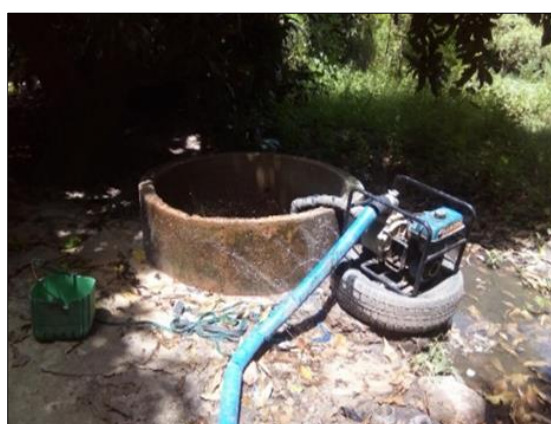


Figure 4: Dewatering with the motor pump in the case of a well in Gadouram

3.4 Analysis of Variance Using the ANOVA test: Area and Frequency of Irrigation

In the study area, the analysis of variances in relation to the sown area shows that there is no significant difference for the study sites with a probability $P = 0.002$ (table 2). On the other hand, with

regard to the number of years of irrigation practices and irrigation frequency, there is no significant difference for the study sites with respectively probabilities $P = 0.0168$ and 0.839 and a standard deviation of 0.63 in both cases (Table 2).

Table 2: Analyzes of quantitative variables: sown area, experience in irrigation and frequency of irrigation at the Falki and Gadouram sites

Market gardening sites	Sown areas	Frequency	P – Value
Falki	2,25+ -1,314a	F=10,055	0,002
Gadouram	1,47+ - 0,819b		
Number of years of irrigation experience			
Falki	19,62 + - 12,930a	F=1,909	0,168
Gadouram			
Irrigation frequency			
Falki	1,58 + - 0,630a	F=0,041	0,839
Gadouram	1,60 + - 0,621a		

3.5 Degrees and Constraints Linked to Water Scarcity

A statistical analysis was carried out to see if the degree and constraints linked to water scarcity are statistically significant depending on the site.

The chi-square test indicates a probability $P = 0.005$ therefore implying a significant variation in the

degree of water shortage depending on the market gardening site (Table 3). Indeed, the multiple comparison of the proportions shows that the low degree of water shortage is significantly less important on the Falki site, while it is higher on the Falki site compared to Gadouram.

However, we see that there is no significant difference in the average degree of water scarcity. In the study area, especially on the Falki site, we are witnessing a gradual increase in producers who are initiated into this activity while the volume of the pond reservoir decreases over time following the silting of the ponds. This gradually increases the demand for irrigation water.

Thus, the chi-square test was carried out to actually see if there is a link between the constraints

linked to the shortage and the sites. This analysis of variance indicates a probability $P = 0.034$ showing that there is no significant difference from one site to another considering the constraint variable linked to water shortage. The most encountered constraints are, among others: crop failure due to insufficient or no water in full cultivation, low yield, conflict of use, slows down activity.

Table 3: Degree and constraints linked to water shortage at the Falki and Gadouram sites

Variables	Modalities	Market garden site		
		Falki	Gadouram	P-Value
Degree of water scarcity	Low shortage	8,5% _a	27,6% _b	0,005
	Average	16,4% _a	20,7% _a	
	High degree of shortage	75,1% _a	51,7% _b	
Constraints linked to water shortage	The cultivated area is very small	47,3% _a	65,5% _a	0,034
	Culture failure	18,4% _a	20,7% _a	
	Prevents cultivation	22,4% _a		
	Usage conflict	4,0% _a		
	Leads to crop failure	8,0% _a	13,8% _a	

Other Constraints at the Timballa Dam and Its Contribution to Supplying the Falki Pond

Built in 2005, over an area of 75ha, the Timballa dam has an initial reservoir capacity of two million cubic meters (2,000,000 m³). This dam supplies the Falki pond twice a year over a distance of 40km separating the dam from the pond. In fact, the first water release takes place at the beginning of December and the second at the end of February. These two releases allow Falki producers to better continue their activities.

However, the supply line was not guaranteed, as the water passes through its path (Koris) along the distance. So there is strong infiltration and evaporation of water. This is why this water takes a long time (14 to 20 days) before arriving at the pond. Thus, on the path of this water, some farmers block the passage in order to satisfy their needs (watering, direct collection, etc.).

3.6 Stratégies Et Mesures Adaptatives Des Producteurs

Strategies common to all producers

After the first market gardening campaign, all producers were obliged to take the following measures:

- The cultivated area is reduced considerably during periods of shortage;
- Water supply from the Timballa dam. This last point only concerns the Falki site;
- Change of crops (the least demanding in water) such as: lettuce, watermelon, pepper, sorrel, cassava...etc. Mesures adaptatives des producteurs face à la pénurie d'eau

We carried out a chi-square test to see if there is a significant link between the measures adapted by the irrigators and the market gardening site.

The chi-square test indicates a probability $P = 0.249$ showing that the strategies adapted by irrigators do not vary significantly depending on the market gardening site. The strategies adapted by irrigators are diverse in the study area and are summarized in Table 4.

Table 4: Analysis of adaptive measures used by producers at the Falki and Gadouram sites

Variable	Terms and conditions	Market gardening site		P-Value
		Site de Falki	Gadouram website	
Strategies Adapted	Creation of traditional cesspools	21,9% _a	31,0% _a	0,249
	Use of connected motor pumps	26,4% _a	13,8% _a	
	Irrigation during night/early morning	25,4% _a	37,9% _a	
	Cleaning and deepening of wells/sumps	8,5% _a	3,4% _a	
	Choice of early or resistant varieties	11,9% _a	13,8% _a	
	No measurement	6,0% _a		

3.7 DISCUSSION

The results of this study made it possible to highlight the hydraulic and agronomic constraints due to

the untimely shortages observed at the market gardening sites of Falki and Gadouram in the Mirriah department, Zinder region. Indeed, the analysis of the results showed

in terms of area sown for market gardening, the average area in Falki is 2.25 ha with a standard deviation plus or minus 1.314 while in Gadouram the average is 1.47 with a standard deviation plus or minus 0.819. This difference can be explained by the fact that the Gadouram site is located around the city while that of Falki is located approximately 5 km away.

In relation to the constraints, strategies and adaptive measures identified on the study sites. Our results of the different types of strategies adapted by producers in times of water shortage have common and specific points with those of other studies in North Africa (Berahmani *et al.*, 2012; Grami and Ben Rejeb, 2015; Frija *et al.*, 2016), in Asia and the Middle East (Molle *et al.*, 2010; Venot *et al.*, 2010; Ghazouani *et al.*, 2014; Alam, 2015), Europe (Iglesias and Garroteb, 2015) and Australia (Wheeler *et al.*, 2013) which reveal that people are aware of climate variability and take subsequent actions to respond to the variability climate: the deepening and cleaning of new wells, the diversification of irrigation sources and the increase in the irrigated area through the rental of land richer in water, diversification of crops, adjustments to the agricultural calendar, change in the cultivation system and conservation of irrigation water (water saving) at the farm scale, reduction in the irrigated area.

These individual actions and strategies show both commonalities and specificities compared to other adaptation strategies put forward by other works. These specificities could be due to a financial problem and a lack of training which could allow producers to cope with the water shortage. But it could also be due to the fact that on our study sites, almost 100% of producers make do with pond water.

The statistical analysis demonstrated that the strategies adapted by producers do not vary significantly according to the age of the producers rather with experience. This result is consistent with that of Maddison (2007) who states that it is better to consider the experience of farmers than their ages.

3.8 CONCLUSION

This study was carried out with the aim of analyzing irrigation management in periods of shortage, constraints, strategies and adaptive measures used by irrigators at the market gardening sites of Falki and Gadouram in the Mirriah department.

The study demonstrated that irrigation methods and strategies adapted in times of water shortage are traditional and therefore powerless to allow Nigerien producers to better respond to climate variability. The role of this activity no longer needs to be demonstrated today given its contribution to the dietary diversification of populations and the income it provides to the most vulnerable populations. However, water, the main key element which is essential to agricultural production

(market gardening) is rare and limited and its management seems unsparing because there is too much waste in its management apart from its variation over time. and in space; the quantity of water that infiltrates and that which evaporates during the passage from the water source to the irrigated field are far from being neglected. These problems are mainly organizational, technical and financial.

However, the construction of infrastructure and the provision of technical and financial support to producers could improve water and irrigation management at the Falki and Gadouram sites.

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