Water management from source to plot in the ~~at the level of the~~ Aneker hydro-agricultural development within~~in~~ dysfunction and proposed solutions(Niger/ Africa).

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1. Abstract

Located in West Africa, Niger is a Sahelian country ~~located in West Africa~~, where only 12% of its population practices agriculture. Besides, ~~I~~it is a country characterized by the most unfavorable climatic conditions, with low rainfall and very subject to continuous degradation. The combination of all these phenomena makes Niger a chronically deficit country from a food point of view despite the efforts made by the various governments. To this end, the state considered in the 1970s the creation of hydro-agricultural developments, some of which are currently in very poor condition. It is in this context that this study was carried out in the Anekerarea.

~~Its objective~~the aim of this paper is to make an exhaustive diagnosis of the irrigation and drainage networks. The methodology consisted of going through a certain number of hydraulic works such as irrigation and drainage canals, to carry out our diagnosis in relation to the latter. Furthermore, this study was supplemented by an interview on the one hand with irrigators and on the other hand with ONAHA technicians and those responsible for irrigation water management in the study area. The study shows that 68% of plots do not receive sufficient water for irrigation. Still according to the results obtained, 91% of producers abandoned their plots due to lack of water due to the severely degraded state of the irrigation water distribution channels.The severely degraded state (37%) of the irrigation network leads to a huge loss in the transport of water to the plots. Also, in addition to non-compliance with the water flow, the irrigator is no longer able to have the water supply required to satisfy water needs. Which requires long hours of irrigation (more than 12 hours).

So that the Aneker perimeter can be operational in an effective and sustainable manner, it would be interesting to rehabilitate all that remains of the hydraulic works. To also build the capacity of irrigators in the maintenance of these infrastructures and in water management.

Key words : Diagnosis, Aneker, irrigated perimeter, irrigation network, drainage network.

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2. Introduction

A West African country, Niger is characterized by low rainfall and, above all, poorly distributed in time and space (INS, 2012). The country is marked by extremely adverse climatic conditions, featuring low and frequently poorly distributed rainfall both temporally and spatially. Furthermore, the soils are deficient and prone to ongoing degradation~~It is a country characterized by the most unfavorable climatic conditions, with low rainfall and very often poorly distributed in time and space. In addition, the soils are poor and subject to continuous degradation~~(Ouakhir et El Ghachi 2023; Ouakhir et al 2023; Ennaji et al., 2022). The combination of all these phenomena makes Niger a chronically deficit country from a food point of view.

To fight against the famines that populations frequently face, the authorities of Niger have highlighted the development of irrigated crops in regions where water and land potential exist. This political will was manifested through the development of several types of irrigation systems, namely hydro-agricultural developments with total water control, off-season perimeters, private irrigation, collection of water from runoff, large and medium commercial irrigation (World Bank, 2008)1. In the area of total water control, this policy materialized through the development of approximately 13939.75 ha including 8408.05 ha of rice fields and 4696.75 ha of mixed farming (ONAHA, 2010). These areas are distributed between 67 perimeters distributed between the regions of Tillabéry, Dosso, Tahoua, Maradi, Zinder, Agadez, Diffa as well as the urban community of Niamey. Hydro-agricultural developments built before the 1980s were subject to two types of ~~management :~~management; state management characterized by the omnipresence of the State and then peasant management in which operators were made responsible for taking into account manage all development activities (Mossi, 2009; Ennaji et al., 2024).

This method of management employed by farmers is referred to as peasant self-management. The aim of this initiative is to enhance farmers' income by optimizing water usage, hence fostering a conducive environment for irrigated crops through improved water management in irrigated regions. The Anekar irrigated perimeter was established in 2018 through the PMERSA project and is situated in the Tahouaarea.~~This approach to management by farmers is called peasant self-management. The objective of this achievement is to secure farmers' income through production through better use of water, by creating a favorable environment for irrigated crops through better water management on irrigated areas. Thus the Anekar irrigated perimeter was created in 2018 by the PMERSA project, and is located in the Tahoua region.~~

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The principal objective of this study is to examine water management, from the source to the field, in the ineffective irrigated region of Aneker and to suggest options for operationalizing the newly developed hydro-agricultural development. The study specifically examines: (i) the current management of irrigation water in this region, and (ii) the identification and proposal of alternatives to overcome the problems hindering effective water management.~~The general objective of this work is to analyze water management from source to plot on the dysfunctional irrigated area of Aneker and propose solutions to make the newly created hydro agricultural development operational. .~~

~~This is specifically:~~

~~(i) To know how irrigation water is managed within this irrigated area ;~~

~~(ii.) and to propose solutions to the problems that hinder this water management.~~

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3.1 Material

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The materials that we used as part of this study are the study site, the data collection tools in the field and finally the tools for analyzing and processing this data.

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3.2Methods

Development of data collection tools

This stage concerns the design of tools allowing us to meet the objectives of the study. This is an interview sheet which will be carried out with the Association of Irrigation Water Users (AUEI) and ONAHA technicians at the study area ; To achieve the objectives set, the methodology chosen is to identify the location of the perimeter before being on the ground.So we had interviews with ONAHA service agents to gain knowledge on the study theme. During this phase also we had to make contact with the producers and with the bodies of the Aneker cooperative on the conduct of the study at the perimeter level.A ground truth mission was carried out to not only make contact with the operators on the one hand and on the other

hand to see the few hydraulic works one by one. This will make it possible to identify as much data as possible relating to the state of these structures.

For data collection, a survey was conducted in a formal, cross-sectional manner and in a single round.

Management of irrigation water on the perimeter

A focus group interview was conducted with farmers to find out how water is managed from source to plot and how irrigation is carried out during periods of abundance and shortage in the Aneker irrigated area.

Subsequently, an interview was conducted with the main irrigation water management structure in the area, which is the Association of Irrigation Water Users (AUEI). Also the opinions of ONAHA technicians on water management were collected.

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Results and Discussion

3. 1 Results

3.1.1 Water source ~~management :~~management:Aneker dam

Improving the performance of irrigated areas. To better understand it, the diagnosis and analysis of irrigation ~~at the level of~~in the study area focused on the following aspects : the management of the water source (the dam), and the management of irrigation in the perimeter. The interview with technicians from Rural Engineering and ONAHA made it possible to obtain technical information on the capacity of the dam which is 6 million cubic meters (m3). According to the field investigation, it appears that the AUEI does not have any formal tool for monitoring the capacity of the dam at the head. Such a situation often leads to an error in assessing the available water resource and the uses envisaged, especially in the conduct of irrigation in the dry season (SS).

3.1..2 Analysis of irrigation management in the Aneker irrigation perimeter

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The AUEI of the Aneker perimeter lacks a systematic mechanism for monitoring the dam's capacity at the head, as previously noted. This indicates poor irrigation water management, particularly in a publicly irrigated region (Amraoui et al., 2023). Nonetheless, the comprehensive topographic survey conducted by DAO on the dam basin facilitated the creation of the volume-height curves (H-V) and the surface-height curve (H-S) accessible to the water manager. Throughout our internship focused on the construction of Aneker, we monitored the progression of water supplies at the dam, including its filling, until it commenced spilling at the conclusion of the rainy season.~~As highlighted in the previous paragraph, the AUEI of the Aneker perimeter does not have any formal tool for monitoring the capacity of the dam at the head. This is a bad sign for irrigation water management, especially in a public irrigated area. However, the detailed topographic survey carried out by DAO on the dam basin made it possible to develop the volume height curves (H-V) and the surface height curve (H-S) available to the water manager. During our internship on the development of Aneker, we followed the evolution of water supplies at the level of the dam and even its filling until the moment when it began to spill towards the end of the rainy season~~.

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Documentary research with the technical services in charge of water did not make it possible to find the perimeter design document. Furthermore, during our visit, the perimeter was not functional because it had been flooded. However, a verification of the sizing of the system was carried out on the basis of the sections of the existing structures, the water needs of the cultivated crops and the climatic parameters. This exercise aimed to verify the capacity of the existing network to support water needs and the adequacy of current irrigation practices with meeting water needs. The crops cultivated are: onion, cabbage 4 ha, cowpea, corn, etc. The most water-restrictive crop is the onion. The exploited area is 12 ha.

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- The number of irrigation hours per day is 12 hours, or from 6 a.m. to 6 p.m., which means that many producers do not work within this area and therefore leave. There is a water tower that is not well organized and is often not respected. One of the consequences of the permanent presence of water in this area following the floods, we did not witness the irrigation being carried out during our stays in Aneker. But even so, we were content to ask the technicians responsible for the distribution and management of irrigation water at the level of this development, the producers themselves and the ONAHA technicians. Thus, irrigation management at the Aneker

perimeter is as follow:During the period of abundance of irrigation water (cold season and wet season)

- Irrigation is done once or twice a week during the cold season and during the wet season, it is only done when it is a few days without recording any rain (supplemental irrigation).
- And during the period of irrigation water shortage (dry season). Irrigation is done according to the day when the hydraulic districts are affected by the water turn in the week with a strict restriction generally leading to a reduction in the size of the plots so that the water is satisfactory ;
- It emerges from the analysis of irrigation water management that the operator irrigates according to its availability on the day when its hydraulic district is affected by the water tower.

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Inside the hydraulic districts, when a secondary canal is filled with water, all the tertiary canals concerned are also filled and the plots are irrigated according to their proximity to the tertiary canal concerned.

The deficit in water resources observed in this area could be compensated by the construction of market gardening wells. This practice must be in progress on the perimeter for the creation of market garden wells. Note in this regard that in-depth hydrogeological studies must be carried out to determine the hydrodynamic parameters of the soil and the capacity of the wells to be produced.

3.1.3 Water management on the plot

As we did not have the chance to follow the irrigation system, here too we simply asked the producers. According to the analysis of their statements, it appears that 68% of the plots do not receive sufficient water for irrigation. The only explanation we have had from these producers is the poor condition of the canals (main canal, secondary or even tertiary canals) in this area is one of the causes of the water shortage. According to these technicians and irrigators, water is very poorly managed at the plot level. Figure 1 below illustrates the level of irrigation water allocation at this study facility.

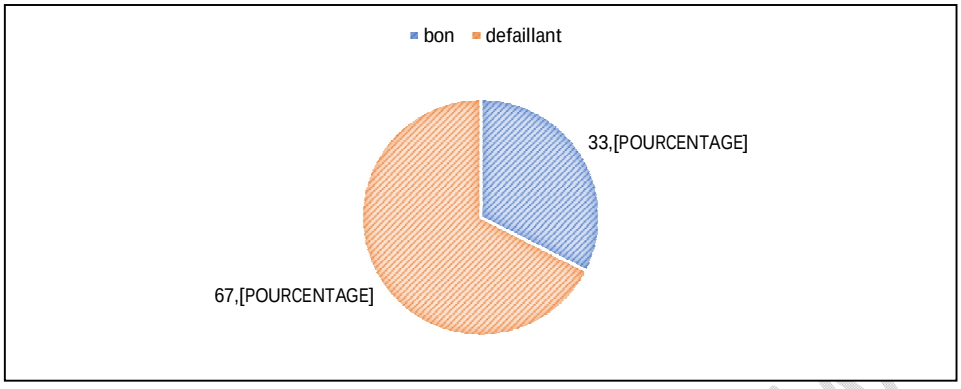

Figure 1 : Allocation of irrigation water at the Aneker irrigated perimeter (Source :YERIMA 2023)

According to the statistics, 91% of producers deserted their plots due to water scarcity caused by the significantly deteriorated condition of the irrigation water delivery systems.

The irrigation network's substantially damaged condition (37%) results in significant water transport losses to the plots. Furthermore, in addition to non-compliance with the water flow, the irrigator can no longer secure the necessary water supply to meet irrigation demands. Which necessitates extended periods of irrigation (exceeding 12 hours).~~Still according to the results obtained, 91% of producers abandoned their plots due to lack of water due to the severely degraded state of the irrigation water distribution channels.~~

~~The severely degraded state (37%) of the irrigation network leads to a huge loss in the transport of water to the plots. Also, in addition to non-compliance with the water flow, the irrigator is no longer able to have the water supply required to satisfy water needs. Which requires long hours of irrigation (more than 12 hours)~~.

This is why a restructuring of the layout of the plots is necessary.

3.2 Proposals for improving the performance of the Aneker irrigated area

- Following the successive floods from 2019 to 2021, the perimeter suffered a lot of damage on all networks which led to the dysfunction of the said development until today. To operate the perimeter effectively and sustainably, the following proposals must be taken into account. These are :
- Completely take over certain hydraulic infrastructures which suffer from a design problem;
- Proceed with the separation of the production function and that of infrastructure maintenance by signing a management contract with GMP ; Even if this study at its

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conclusion proposes the separation of production and maintenance functions, for better management of the scope;

- Carry out regular monitoring of the water resource, thus, we propose that the volume height curve (H-V) be made available to the structure in charge of the management of the perimeter (AUEI) to better assess the programming of the areas to be exploit according to the maximum level of the reservoir at the end of the rainy season ;
- This will allow crop needs to be adapted as much as possible according to the available water resource;
- Make judicious use of available water resources;
- Given the insufficient water resources to cover the two seasons (SS and SH) adequately, it would be more interesting for the water intake to be repositioned on the south side because water is available at the dam to be able to exploit part of the water portion of this water mobilization work;
- Consider mitigating the phenomenon of siltation, ONAHA, which officially deals with hydro-agricultural developments, must undertake and encourage actions to protect the banks of the dam to mitigate siltation;
- Set up an irrigation schedule (water tower) each year based on the actual estimate of crop water needs. This involves the establishment of a technical team (hydraulicians and agronomists) to help the irrigation water management structure (AUEI) of the perimeter to better program the irrigation calendars by campaign with tours of water which will be strictly respected ;
- Carry out a suitable plot, in effect an internal redevelopment of the plot in the new development proposal such that each plot has the possibility of being irrigated directly from a tertiary canal ;
- Carry out the maintenance and repair of infrastructure, thus raising awareness among irrigators to constantly carry out these activities for the proper functioning of the perimeter;
- Inform the irrigation water management team in time in the event of a leak as soon as possible to avoid possible problems on the canal or linked to the distribution of irrigation water;
- Immediate repair of any work in a situation with a minimal problem so as not to aggravate said constraint can cause numerous disasters;

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– Increase the hydraulic fee, in terms of maintenance and renewal of works, we suggest a gradual increase in this fee per unit of net production value, taking into account the socio-economic realities of operators.

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3.3 Discussion

In relation to water management, the perimeter since its construction in 2018, almost every year, it is flooded and every year the dam fills to the point of overflowing. According to the farmers, the results of our work show that 65% of them stressed that the very degraded state of the irrigation canals and the very defective state of many hydraulic structures do not allow good management of water at the level of water mobilization works and leads to enormous water losses there as well as at the level of these canals.

This permanent situation of flooding and poor condition of a significant number of hydraulic infrastructures undoubtedly hinders the development of plots at the Aneker development level. In addition, the degradation and disappearance of certain irrigation canals remain the greatest hydraulic constraints in the Aneker perimeter. This constraint hinders the development of crops leading to allocation restrictions. As for the question of irrigation at the Aneker perimeter, insufficient water for irrigation is the second constraint forcing producers to reduce the cultivated space. These results are contrary to those obtained by Mossi et al., (2009) at the level of the irrigated area of Galmi.In fact, these authors showed that the dam in the said perimeter only filled every other year (2) or even more. Due to the bowl not being filled, there were restrictions on water allocation. Water is truly a limiting factor for cultivated plots. In Burkina Faso, the results of research carried out on the Bogandé irrigated area by Alexis (2016) are close to our results. According to the author, the technical malfunction (cracks, breaks and grass cover, etc.) that he observed during his investigation of this area has enormous consequences on water management. These consequences include, among other things, difficulty transporting water in grassy canals, considerable losses in water volume and irrigation time leading to water dissatisfaction for the plots.

Compared to the management of irrigation at the plot level, the results of our study reveal that the irrigation system used is gravity and does not save water and requires adequate leveling of the plots and waste. significant amount of water. Thus, 87% of producers in the Aneker area explain that they have an irrigation problem due to the poor leveling of their plots, even leading to producers abandoning the development. The main constraint listed by this author is

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that the distribution and irrigation works are poorly dimensioned and the existence of a counter slope at the level of the dividers.

On the other hand, for most of the irrigators in the Aneker area, the main dysfunction of this development since the impoundment is a purely technical problem relating to the design. According to the author, the main causes of the dysfunction of this newly created development are inadequacies noted in the design and implementation of the said irrigated area which lead to poor irrigation management. This situation has led to poor distribution and even dissatisfaction of irrigators with regard to water.These results are contrary to the work of the irrigation management project in Burkina Faso (PMI-BF., IIMI., 1997) on the irrigated perimeter of Dakiri and in Niger on the perimeter of Karma (Ibrahim., 2009) A study carried out in Burkina showed a strong heterogeneity in the satisfaction of irrigation water needs between producers. It also notes, on this development, irrigation difficulties on 35.9% of the developed areas. Compared to the Karma rice growing area, in fact, from the pumped volumes and the irrigation water needs of the Karma area, the value of the satisfaction rate of irrigation water needs obtained is 174%.

This difference can be explained by the water source (river for Karma perimeter and dam for Aneker) and the experience of irrigators in water and irrigation management. Indeed, the scope of Karma, which was commissioned in 1972 (52 years of experience) and for Aneker, in 2019.

In the Aneker perimeter, the tertiary canals in general are in a very advanced state of degradation due to problems such as damaged valves, water leaks in places, defective parcel intake leading to a huge loss of water, water to a drainage problem or even flooding of plots and water stagnation. These results corroborate the work of Rutabara (2017) who showed that the lack of maintenance of drains leads to flooding of crop plots and waste deposits lead to water stagnation, such is the case for the area in question.

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Conclusion

This study focused on water management from the resource to the plot or even irrigation management on the irrigated area of Aneker. Thus, it emerges from the study that the unsatisfaction of the water needs of the perimeter due to an insufficiency and poor management of the water resource and the floods from 2019 to 2021. The filling of the dam during each season of rains coupled with the very disastrous state of many hydraulic infrastructures further complicates this management of water from the Aneker dam to the

plots. Regarding the management of irrigation water, the water resource is available in the dam but no longer allows two campaigns (wet and dry season) to be carried out on the entire 250ha of the developed area. According to the producers of the Aneker perimeter, the water resource is partly insufficient to ensure the two agricultural seasons on the perimeter (The supply ends from the month of February). But on the one hand, this is due to the fact that the hydraulic infrastructures suffer from a design and implementation problem worsened by the floods of previous years. This has the major consequence of poor irrigation management over time. We are witnessing a notorious poor distribution of irrigation water in the Aneker area at the level of the irrigation networks and even the plots. Thus, there is no crop calendar based on the actual estimate of water needs in order to respect the water flow designed for this irrigated development.

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