

## **Original Research Article**

### Impact Assessment of Small-scale Irrigation Investment on Poverty Reduction: A Case Study of the Municipality of Dabaga in Niger

#### **Abstract**

Niger is one of the poorest countries in the world, where more than 80% of the population live in rural areas and depend on agriculture. Agricultural production in Niger depends on rainfall which is irregularly distributed in place and time; thus, causing food deficit or food insecurity. To deal with these constraints and find a remedy to the precariousness of food insecurity, the focus is on irrigated agriculture where the purpose of the study is entitled "contribution of small-scale irrigation to reduce poverty". The main objective of this study was to analyse the economic and social impact of small-scale irrigation investment in the reduction of poverty. The municipality of Dabaga in Niger was selected as a case study. The specific objectives were to characterize the cropping systems practised by the farmers; calculate the gross margin of agricultural production (for the main crops grown); draw up the cereal balance sheet and the farm producers' operating account. Thus, surveys were conducted in the study area where 174 farmers were randomly selected. After that, the farmers were classified into two categories according to the main cultivated culture. Descriptive statistics and econometric correlation tests (Pearson method) were used for data analysis.

It emerges from this study that this irrigated agriculture, which is of semi-intensive type, is dominated by the practice of polyculture. It involves the entire surveyed population, which had a negative cereal balance sheet but provides, for 82.18% of the farmers, a satisfactory net monetary income, above the country's monetary poverty line.

**Keywords:** Irrigated agriculture, cereal balance, agricultural income, Dabaga

## 1 Introduction

Niger is a Sahelian country located between 11° 37' and 23° 33' north latitude and 0° 06' and 16° 00' east longitude. It is bordered to the east by Chad, to the north by Libya and Algeria, to the west by Mali and Burkina Faso and the south by Nigeria and Benin. It covers an area of 1 267 000 km<sup>2</sup> (or 126 700 000 ha), two-thirds of which is desert. The area of cultivated land covers 15 000 000 ha in 2011, **which** is 12% of the country's area. Irrigable land is estimated as 270 000 ha (1). The population of Niger was estimated in 2020 at 24 206 636 inhabitants (2), more than 80% live in rural areas and their income **depends** on agriculture (3). According to a study carried out by the National Institute of Statistics (in French Institut National de la Statistique which is abbreviated INS) in 2011, 48.2% of the population is poor, including 17.9% poor in urban areas and 54.6% poor in rural areas. However, the **favourable** economic outlook helped reduce the poverty rate from 48.2% in 2011 to 41.2% in 2020 (4).

On the other hand, Niger is one of the poorest countries in the world where agriculture **is** the main economic **activity** of the country. Currently, rain-fed agriculture provides almost all the country's cereal production. Despite the important contribution of the agricultural sector to the national economy up to 40% of GDP (4), agro-pastoral production is strongly influenced by climate variability (5). The volume and distribution of rains, which is especially important for most agricultural activities, are irregular and poorly distributed in time and space. Since Niger's agriculture depends on rainfall, the poor distribution of rainfall affects agricultural production, thus causing food deficit or food insecurity (6).

To deal with these constraints and remedy the precariousness of insecurity food, the government, and non-governmental organizations (NGOs) have oriented their agricultural policies towards the promotion of irrigated agriculture. To this end, irrigation is seen as a way of intensifying agriculture. It contributes to **increase** productivity while securing the farmers against the climate change effects like drought. Irrigation is seen as an instrument **which** could eradicate the poverty and hunger in sub-Saharan Africa and particularly in West Africa.

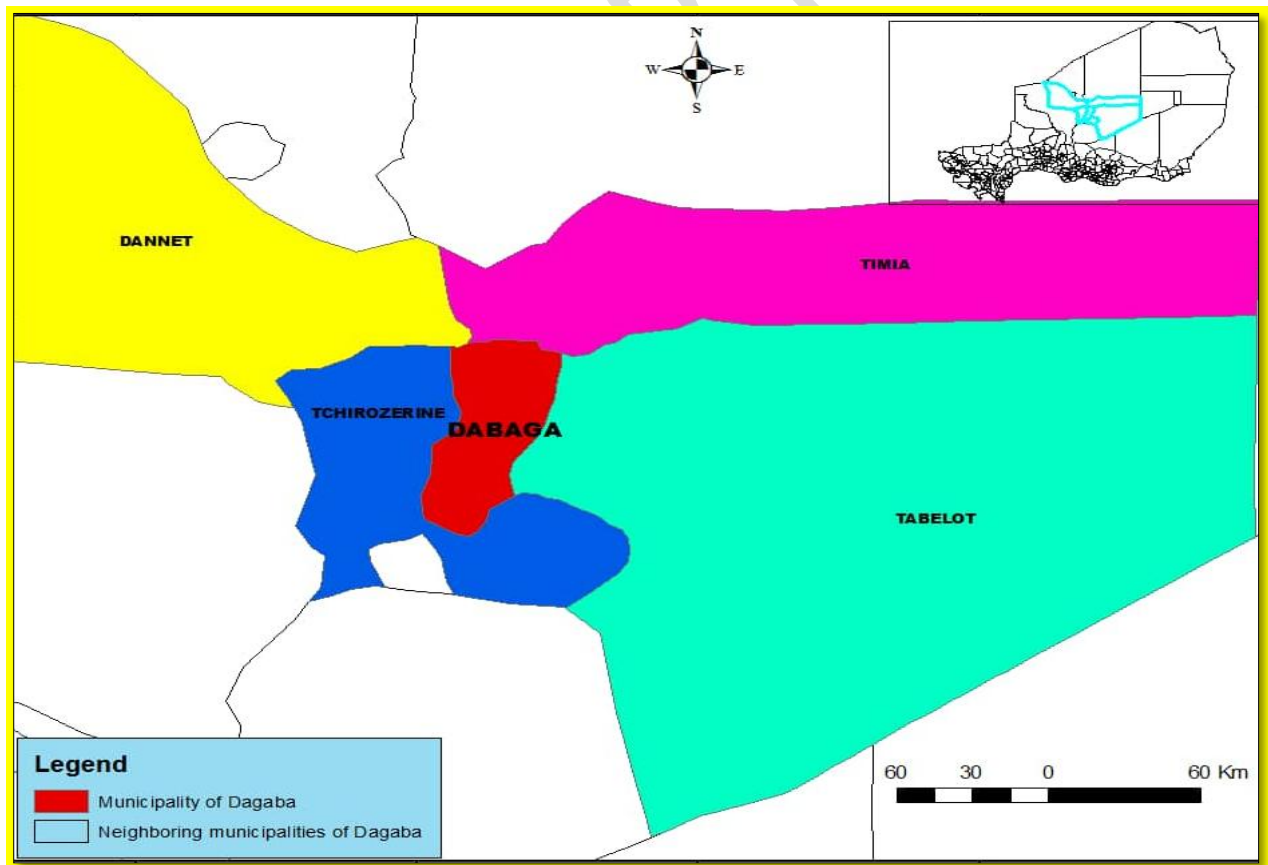
To appreciate more the role of irrigated agriculture it is important to know their contributions in improving the living conditions of farmers. It is in this context that this study was conducted on the theme "Impact Assessment of Small-scale Irrigation Investment on Poverty Reduction in the municipality of Dabaga, in Niger". The general objective of this study is to **analyse** the economic

and social impact of small-scale irrigation on poverty and food security. The specific objectives are as follows: characterize the cropping systems practised in the parcels; establish the gross margin of agricultural production; draw up the cereal balance sheet and the operating account of agricultural producers. Thus, to properly conduct this study and achieve the objectives assigned to it, it would be appropriate to adopt a methodological plan which includes the description of the study area, sampling and data collection methods and techniques. The collected data is then processed, analysed, and discussed in the results and discussion section.

## 2. Methodology

### 2.1 Study Area Description

The municipality of Dabaga is in Tchirozérine province of the Agadez region and it extends between 8 °00 and 8 °32 East Longitude and 17 °05 and 17 °58 of North Latitude (Fig. 1).



**Fig. 1.** Map of Niger Republic (on the upright side), showing a zoomed-in image of the municipality of Dabaga (on the left)

The area of the municipality is estimated at approximately 3232 km<sup>2</sup>. In 2017, the population of this municipality was estimated at 27 844 inhabitants including 14 262 men and 13 582 women distributed in around sixty villages. The average household size is 5.4 people (3).

The lowest average temperatures are recorded in January (6.7 °C) and the maximum temperatures are recorded in mid-June (42 °C). According to the Köppen-Geiger classification, Dagabas' climate is of desert type (BWh). Rainfall's average is 282 mm and varies in time and space. There are two seasons in Dabaga:

- ✓ The dry season consists of a cold dry season and a hot dry season,
- ✓ The rainy season is commonly called wintering.

Agriculture is the main activity of the inhabitants of the municipality of Dabaga and is practiced in irrigated agriculture form. Although Dabaga is an arid region, the inhabitants who live there have managed to develop irrigated agriculture through the exploitation of groundwater. Irrigated agriculture is practiced in the irrigated fields during the rainy season before the withdrawal of groundwater.

According to a study conducted by NGOs AcSSA-Afrique Verte Niger and Economic interest group (in french Groupement d'intérêt économique GIE) GIE Tagazt in 2010, there are 5 five irrigated sites in Dabaga municipality (7). The irrigated site or irrigated perimeter is an agricultural area divided into collective or individual fields or parcels where irrigated agriculture is practised. The parcels are made up of small planks of 4 to 6 square meters of surface in which the irrigated crops are sown.

Dabaga irrigated sites take their names from the different villages such as Tebagaw, Dabaga (here Dabaga is the chief town of the Dagabas' municipality), Béital, Indoudou and Boughoul. Thus, each village has an irrigated site organized as a cooperative which is constituted of fields/parcels where all the farmers of that village work. These five irrigated sites are composed in total number by 1826 fields/parcels. Among these parcels, 1131 of them are cultivated, which correspond to 61.94% of the total number of farms. It is noted that each farmer has only one field. So, the number of parcels corresponds to the number of farmers among whom the sampling was done. Since some agricultural lands are not accessible during the rainy season after the permanent runoff of rivers, sampling has focused only on 869 farmers whose agricultural lands are accessible (Table 1)

**Table 1** Number of Active Farms and their Area by Irrigated Site

Municipality	Irrigated Sites	Number of Active Farms by Site	Irrigated Sites' Areas in Ha	Area Sown by Irrigated Site in Ha
<b>Dabaga</b>	Tebagaw	179	191.53	184.53
	Dabaga	271	501.35	460.95
	Béital	65	52	45.61
	Indoudou	218	324.82	196.41
	Boughoul	136	187.68	100.64
<b>Total</b>		<b>869</b>	<b>1257.38</b>	<b>988.14</b>

Source: GIE-Air, 2009 (13)

Mainly cereals are planted in the parcels or farms, depending on the seasons, the producers' means and strategies. For cereal crops, wheat, barley, and corn are generally sown and are mainly produced for self-consumption. The cereal crop is currently in decline in favour of other crops which are mainly produced for sale including fresh onion, tomato, pepper, potato, coriander, etc.

It is so important to mention that onion is the most important and intensively cultivated crop in the town because currently, it is the most profitable in terms of agricultural income (8).

Furthermore, in Niger, onion is the most cultivated irrigated crop. Approximately 24% of irrigated land was sown by onion in 2011 (1). Onion and corn occupy a large area respectively 59% and 22% of the cultivated area in Dabaga. Table 2 shows the areas occupied by the main crops grown in the locality of the study. On the other hand, livestock is the second activity in order of economic importance. There were 1263 of 4338 households (which corresponded to 29.11% of total households) living exclusively on livestock (9).

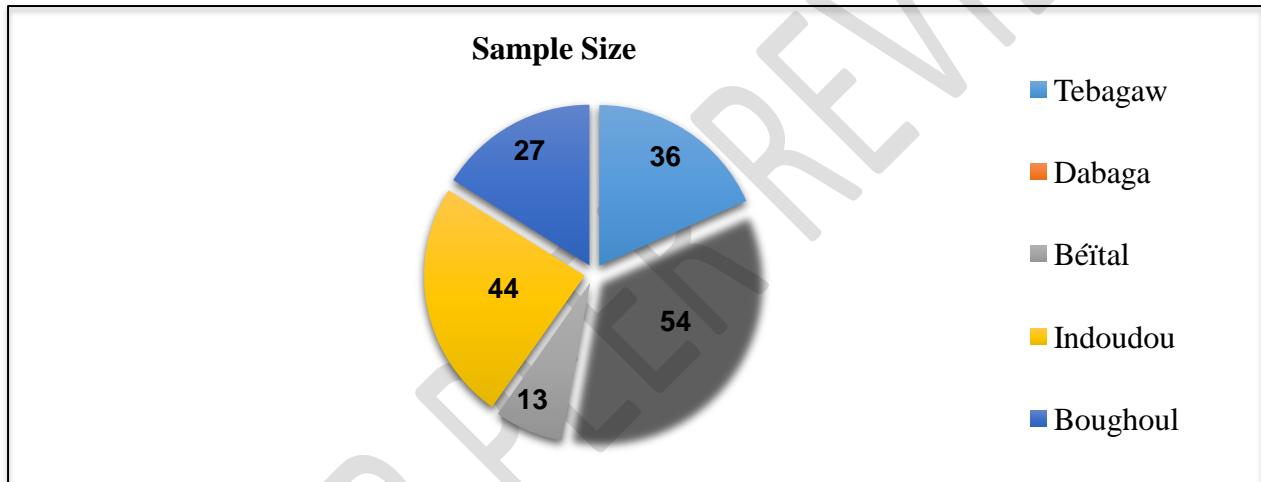
**Table 2** Area Sown According to Main Crops (ha)

Municipality	Irrigated Sites	Area Sown in Ha According to Irrigated Crops							Total Area Sown in Ha
		Onion	Corn	Chilli Pepper	Cabbage	Squash	Tomato	Potato	
<b>Dabaga</b>	Tebagaw	85.92	55.49	14.32			0.16	28.64	184.53
	Dabaga	308.94	132.79		18.97	0.25			460.95
	Béital	31.2		7.15			0.11	7.15	45.61
	Indoudou	117.72	26.16		6.54		0.21	45.78	196.41
	Boughoul	42.16		24.48		20.4	13.6		100.64
<b>Total</b>		585.94	214.44	45.95	25.51	20.65	14.08	81.57	988.14
<b>Percentage (%)</b>		<b>59</b>	<b>22</b>	<b>5</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>8</b>	<b>100</b>

Source: GIE-Air, 2009

## 2.2 Sampling technique and data collection

The surveys were conducted in two steps. The first step was a visit to the study area and the second step was to do a focus group and individual interviews. To do individual interviews, sampling was done. Thus, 20% of 869 farms (174 farmers randomly selected) were surveyed. In other words, on each irrigated site (Tébagaw, Dabaga, Béïtal, Indoudou and Boughoul sites), 20% of the farmers were randomly chosen. Thus, the size and distribution of the sample are given in fig. 2.



**Fig. 2.** Size and Distribution of the Sample on Irrigated Sites

Thus, of the 174 farmers surveyed, the respondents were classified into two categories according to the main crops grown in the parcels:

- ✓ Category 1 corresponds to farmers who grow onions as the main crop,
- ✓ Category 2 corresponds to farmers who grow onion and corn as main crops at the same time and in the same parcels.

In total 74 farmers (43% of surveyed farmers) were classified in category 1 and 100 farmers (57% of surveyed farmers) were classified in category 2. It is also important to indicate that the farmers cultivated other crops on small areas of land (see table 3).

**Table 3** Classification of Farmers According to Irrigated Sites and Categories

Categories of farmers	Irrigated Sites										Irrigated sites	
	Betail		Boughoul		Indoudou		Tebagaw		Dabaga		Nbr	%
	Nbr	%	Nbr	%	Nbr	%	Nbr	%	Nbr	%		
<b>1</b>	11	85	23	85	23	52	2	6	15	28	<b>74</b>	43
<b>2</b>	2	15	4	15	21	48	34	94	39	72	<b>100</b>	57
<b>Total</b>	13	100	27	100	44	100	36	100	54	100	<b>174</b>	100

Collective survey sheets (for focus group), individual survey sheets and a GPS for the measurement of areas were used as materials to conduct this study.

After collecting data in the field, the next step was the data entry and processing by using software such as Excel and SPSS. Indeed, it is necessary to define some parameters which are used in the context of the analysis of the results as well as their calculation methods.

### 2.3 Empirical method

The income calculation method used is the gross margins. The gross margin of an activity is defined as the difference between the products of this activity and the charges that can be allocated to this activity. Thus, the overall gross margin is the difference between the gross product and operational expenses. The later expenses increase or decrease with the production from which they come. They vary while the structural charges are fixed charges. All these expenses constitute the farm operating expenses (10).

As for the net gross margin or net farm income, it is the difference between the overall gross margin and structural charges. To this end, the "operating account" table includes data into two parts which are the operating expenses and the revenues (products). The operating account is only an encrypted indicator but does not give details on the success of the activity. Thus, an econometric correlation tests (Pearson method) was carried out to determine the factors that

influence much the farm's income. The correlation rate and the degree of significance of each variable (which is used in the production process) were determined in relation to the net farm income which is the "dependent variable".

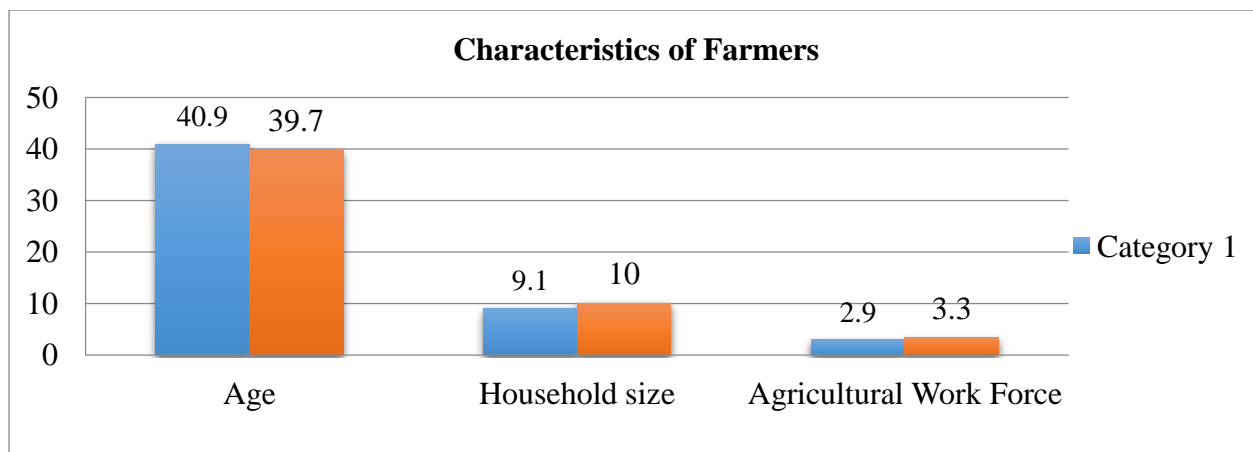
Otherwise, since cereals are the basis of food in Niger, a cereal balance sheet has been established to determine if the food balance of the household is reached. This cereal balance is obtained, by establishing the balance between the human cereal consumption needs which are 239 kg of cereals per person per year (for rural areas) and the products available in cereals.

### **3. Results and discussion**

Data analysis focuses on the frequency and average of the parameters which include characteristics of farms, agricultural production (consumption and marketing of agricultural products), agricultural income of farmers, etc. These results collected and analysed are the result of the activities of one agricultural campaign while some farmers make two campaigns in the year. The agricultural production season during this study took place is the most important agricultural season because it is the one that corresponds to the rainy season and the moment during which the groundwater is saturated with water. It is exactly the period (June-December) of agricultural activities.

#### **3.1 Characteristics of Farmers**

Of the 174 farmers surveyed, only one woman is declared to be the household head all the rest of the respondents were men. According to figure 3, the average age is 40.9 years for farmers of category 1 and 39.7 years for those of category 2. Household average size is 9.1 people for category 1 farmers and 10 people for category 2 farmers. Regarding the number of agricultural workers, the average is 2.9 for category 1 farmers and 3.3 for category 2 farmers (Fig. 3).



**Fig. 3.** Demographic characteristics of farmers

It is important to note that the respondents are members of farmers' organizations, and they were helped by some NGOs by giving food (cereal) and training.

According to Table 4, it emerges that onions are cultivated on 92% of parcel areas by category 1 farmers and on 64% of parcels areas by category 2 farmers. As for corn, it is cultivated in 21% of parcel areas by category 2 farmers (Table 4).

Otherwise almost (74.71%) of farmers live exclusively on agriculture, only a few of them have occasionally secondary activities. It can be said that agriculture is the only and main source of income for most of the respondents.

**Table 4** Different Cultures and their Occupied Areas (ha)

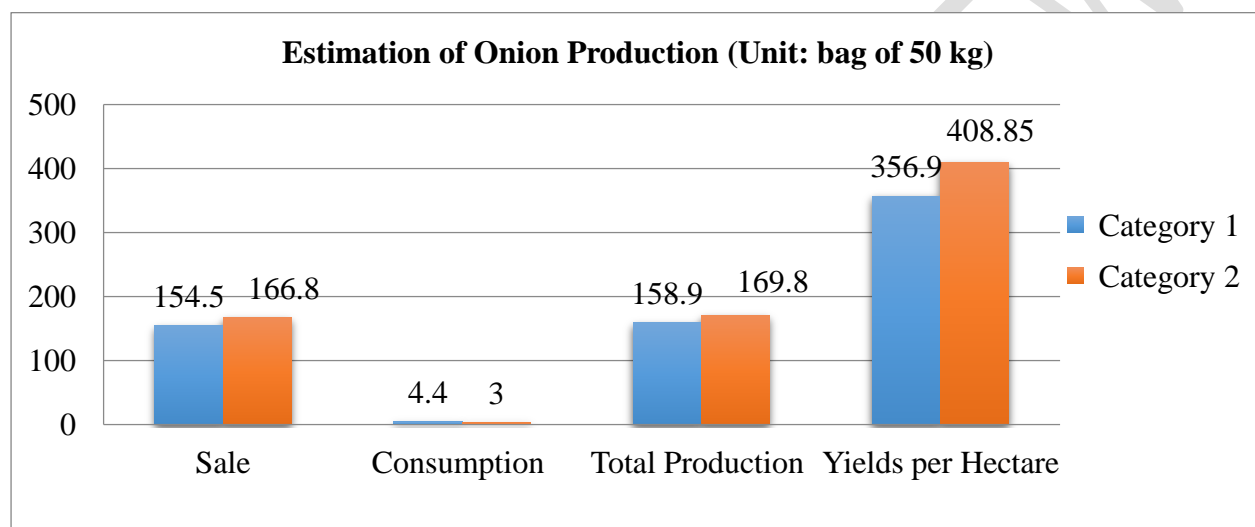
Cultures	Category 1		Category 2	
	Mean	%	Mean	%
Onion area (Hectare)	0.72	92	0.56	64
Corn area (Hectare)			0.18	21
Area of other crops (Hectare)	0.06	8	0.13	15
Farm area (Hectare)	0.78	100	0.87	100

Thus, to appreciate the role that irrigated agriculture plays in improving the living conditions of the farmers, it was evaluated on its agricultural production, its impact on agricultural employment, food balance and farm income.

## 3.2. Agricultural Production

### 3.2.1 Onion production

According to the observation of fig. 4 the category 2 farmers obtained the highest yield with an average 408.85 bags of 50 kg equivalent to 26.67 tons/ha against 356.90 bags of 50 kg or 22.50 tons/ha for category 1 farmers.



**Fig. 4.** Estimation of Onion Production (Unit: bag of 50 kg)

Indeed, more than 97% of the onion production was sold. This means that the onion is a cash crop. Onion was not sold at the same time; it was sold as farmers were harvesting their agricultural products. Consequently, the price of a bag of onions ranged from 9000 to 18 000 FCFA.

### 3.2.2 Corn Production

Following table 5, more than 68% of the total corn production is intended for family consumption.

**Table 5** Estimation of Corn Production (by kg)

Corn Production	Category 2	
	Kg	Proportion (%)
Sale	105	22.11
Consumption	325	68.42
Other <sup>1</sup>	45	9.47
Total Quantity Produced	475	100
Yield per Hectare	3851.7	

Corn is a food crop for all farmers who cultivate it. However, farmers were selling a small quantity of corn production to provide for other needs. The price of a bag of corn ranged from 11 000 to 20 000 FCFA (The CFA Franc which means “Franc of the French Community of Africa”).

### 3.2 Socio-economic impact of small-scale irrigation

This section focuses on the evaluation of the contribution of small-scale irrigation to improve the living conditions of farm households both economically and socially.

#### 3.2.1 Impact Irrigated Agriculture on Employment

In terms of employment, irrigation involves the entire respondents (men and women) and affects young people, adults as well as the elderly. It helps keep young people in place while preventing them from migrating in search of employment.

Indeed, of the 174 surveyed farmers, only three reported one family member had migrated. Agriculture creates jobs for the unemployed through the agricultural labour. Thirty-four agricultural workers were hired on fixed-term contracts by category 1 farmers and thirty workers were hired by those of category 2. A total of sixty-four agricultural workers were hired by the respondents. Average wages were 156 967 FCFA per agricultural worker (for category 1 farmers) and 168 100 FCFA per agricultural worker (for those of category 2). The food, accommodation and other necessities of agricultural workers were provided by the farmers who hired them. The income level of agricultural workers is well above the threshold of income poverty in Niger

<sup>1</sup> Other means the payment in type of hand work pay.

which is 110 348 FCFA per person per year in rural areas (11). This makes it possible to classify agricultural workers among the non-poor population.

### 3.2.2 Impact of Irrigated Agriculture on Food Balance

To know if the food balance is reached, the cereal balance which consisted in establishing the balance between the quantity of food available in cereals and the food needs of households was calculated. Thus, to calculate the cereal balance, at first it was estimated the food needs per household and per year, cereal production, purchases, and loans of cereals as well as the quantities of foods received from the NGOs as food aid (Table 6). Otherwise, household food needs are estimated by multiplying the size of households by human consumption norm which is estimated at 239 kg per person per year (12).

The results of Table 6 show that the cereal balance sheet is negative for the two categories of producers.

**Table 6** Cereal Balance Sheet by Category of Farmers (kg/household/year)

<b>Variables (Kg)</b>	<b>Category 1</b>	<b>Category 2</b>
Food Requirements (1)	<b>1 888.25</b>	<b>2 075.00</b>
Cereal Production (2)	-	326.25
Cereal Purchase (3)	1 035	803.5
Cereal Loans (4)	107	121
Humanitarian aid (5)	250	250
Quantity of Available Cereals (6) = (2)+(3)+(4)+(5)	<b>1 392</b>	<b>1 500.75</b>
<b>Cereal Balance Sheet (7) = (6) – (1)</b>	<b>-496.25</b>	<b>-574.25</b>

The study area is essentially an area for irrigated crops (cash crops) where food production is very insufficient to cover the food needs of the population. In other words, the farmers are more interested in cash crops, particularly crops with high added value. To this end, purchases of

cereals constitute the most important source of food supply for all the respondents. Thus, to fill the food deficit, farmers buy food with farm income.

### 3.2.3 Impact of Irrigated Agriculture on Household Income

To calculate the agricultural income, it was estimated the value of the agricultural products sold and operating expenses which is composed of operational expenses and structural expenses (Refer Table 7).

All these variables were calculated one by one for each farmer to determine their farm income. The calculated farm income is then divided by the household size of each farmer to find the farm income per person. It is to indicate that farm income includes all income from irrigated agriculture, rain-fed agriculture and animal husbandry and it was calculated according to the currency of Niger which is the CFA Franc which means “Franc of the French Community of Africa”.

According to Table 7, it emerges that overall, the farm incomes obtained by category 1 farmers (5280.53 USD) were better than those of Category 2 farmers (3267.86 USD). This could be explained by the fact that category 1 farmers produce cash crops with high added value on larger areas.

**Table 7 Farm Income from Irrigated Agriculture (FCFA)**

Farm Operating Results (FCFA)	Category of Farmers	
	Category 1	Category 2
<b>Sale of Production</b>		
Fresh Onion	2 910 380.95	2 599 128.21
Corn		110 300.00
Other crops	1 053 333.33	
<b>Total gross product (1)</b>	<b>3 963 714.28</b>	<b>2 709 428.21</b>
<b>Operational Expenses</b>		
Cost of Small Agricultural Equipment	15 761.9	26 384.62
Cost of Temporary Labor	196 690.48	159 740.38
Cost of Irrigation	167 881.67	150 391.79
Cost of Agricultural Inputs	172 547.62	142 506.41
Cost for Packaging and Routing	210 695.24	246 478.21
<b>Total Operational Expenses (2)</b>	<b>763 576.91</b>	<b>725 501.41</b>
<b>Gross Margin (3) = (1) - (2)</b>	<b>3 200 137.37</b>	<b>1 983 926.80</b>

<b>Structural Expenses</b>		
Cost of Permanent Salaried Labor	263 523.81	163 794.87
Amortization of Agricultural Equipment and Infrastructure	4766.67	3397.06
Farmer's organization fees	2963.16	3705.88
<b>Total Structural Expenses (4)</b>	<b>271 253.64</b>	<b>170 897.81</b>
<b>Farm Income = (5) = (3) - (4)</b>	<b>2 928 883.73</b>	<b>1 813 028.99</b>
	<b>(5280.53 USD)</b>	<b>(3267.86 USD)</b>

It is necessary to identify the factors that influence irrigated agricultural income. To do this, it was calculated the correlation coefficients between farm income (dependent variable) and the different variables involved in the production process called independent variables which are: the area cultivated, total production, the quantity of onion produced, yield, operational expenses, structural expenses, and household size (Table 8). Thus, the Pearson correlation test is the method of calculation chosen.

By convention, the correlation (noted by "r") between agricultural income and the different variables is perfect if  $r = 1$ ; very strong if  $r > 0.8$ ; strong if  $r$  is between 0.5 and 0.8; average intensity if  $r$  is between 0.2 and 0.5; low if  $r$  is between 0 and 0.2 and if  $r = 0$ , there is no correlation.

The results of the correlation test (Table 8) show that there is a strong correlation between agricultural income and yield, the value of production, onion production and agricultural products transport cost. This means that these variables positively and significantly influence farm income. However, the variable "corn production" negatively influences the farm income to which it is moderately correlated. This means that if the farmers produce more corn, farm income would decrease; this can be explained by the fact that corn is a subsistence crop for the respondents.

The variable "area cultivated" negatively impact farm income. This means that more cultivated area is large, less farm income is important. The farmers who have cultivated small parcels make more profit because they could efficiently exploit it while exploiting large parcels requires much more resources. Thus, small-scale irrigation could be more beneficial to farmers in a low-income country like Niger.

The variable "age" has a negative and weak influence on agricultural income. Indeed, the agricultural techniques used were traditional. All agricultural work was done by hand. Therefore, the more the farmer gets older less he could not efficiently work.

In other words, the labour force of farmers decreases as they get older. Therefore, the variable "age" negatively impacts farm income. As for the variable "agricultural workforce", it positively influences agricultural incomes, especially those of category 2 farmers who had more agricultural workers.

**Table 8** Correlation of the Farm Income with the Variables of Production

Dependent Variables	Correlation	Category 1	Category 2
Age	Correlation coefficient	-0.289	-0.034
	Degree of significance	0.230	0.899
Agricultural Work Force	Correlation coefficient	0.007	0.316
	Degree of significance	0.977	0.050
Irrigated Sites/Villages	Correlation coefficient	0.181	0.145
	Degree of significance	0.283	0.315
Area exploited	Correlation coefficient	-0.059	-0.244
	Degree of significance	0.801	0.13
Yield	Correlation coefficient	0.477*	0.627**
	Degree of significance	0.029	0
Total production value	Correlation coefficient	0.548*	0.650**
	Degree of significance	0.01	0
Fresh Onion's Production	Correlation coefficient	0.447*	0.654**
	Degree of significance	0.042	0
Corn's Production	Correlation coefficient		-0.254
	Degree of significance		0.113
Operational Expenses	Correlation coefficient	0.128	0.356*
	Degree of significance	0.58	0.024
Structural Expenses	Correlation coefficient	-0.077	-0.086
	Degree of significance	0.739	0.596
Household Size	Correlation coefficient	-0.015	0.119
	Degree of significance	0.947	0.465
Input Cost	Correlation coefficient	0.07	0.05
	Degree of significance	0.77	0.77
Irrigation Cost	Correlation coefficient	-0.04	0.1
	Degree of significance	0.86	0.56
Labor Cost	Correlation coefficient	0.12	-0.11
	Degree of significance	0.59	0.51
Transport Cost	Correlation coefficient	0.2	0.638**
	Degree of significance	0.38	0

In addition to irrigated agriculture, respondents practised animal husbandry in their homes and sometimes in their parcels after the harvest of agricultural products and breed more sheep and

goats that they often sell when necessary. The sale of livestock is also a source of income for farmers.

Concerning non-agricultural income, they are the transfer of money done by the emigrants to their families and employee salary. Thus, the total income of respondents was calculated by summing the annual average of revenues from irrigated agriculture, livestock selling, transfer of money and employee salary. Thus, irrigated agriculture constitutes the main source of income for farmers.

Farmers are classified according to their farm income levels into poor and non-poor (Table 9). This classification is done according to the level of farm income of a household member is higher or lower than the country's monetary poverty line (Niger) which is 110 348 FCFA/year (which corresponds to 199.056 USD/year) in rural areas (13).

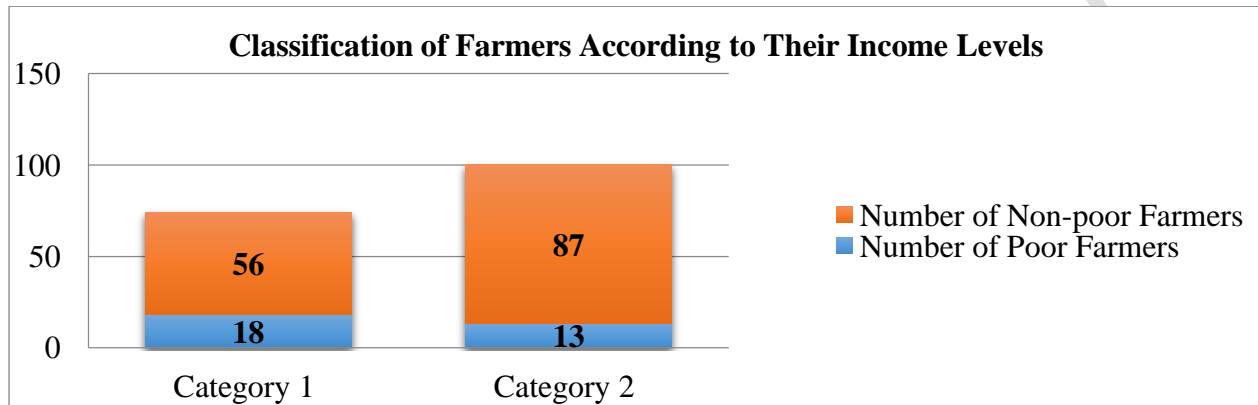
**Table 9** Farmers Income According to the Monetary Poverty Line (FCFA)

Farmers Income (FCFA)	Category of Farmers			
	Category 1		Category 2	
	Non-poor	Poor	Non-poor	Poor
Irrigated Agriculture	3 410 091.00	414 365.00	2 460 741.00	149 642.00
Livestock Selling	72 825.00	41 629.86	124 275.00	50 759.00
Salary (Employee)	36 250.00	0.00	0.00	0.00
Money Transfer (Exodus)	0.00	324 324.32	0.00	307 500.00
Total Farmers Income	3 482 916.00	780 319.19	2 585 016.00	507 901.00
Income per Capita	429 166.59 <b>(773.69 USD)</b>	109 904.11 <b>(198.11 USD)</b>	331 412.31 <b>(597.35 USD)</b>	108 064.04 <b>(194.79 USD)</b>

Thus, a farmer is said vulnerable (poor) if his agricultural income is below the poverty line, he is said to be at ease (non-poor), if his income is higher than the poverty line. Thus, **Figure 5** shows the percentages of poor respondents according to their income levels.

It emerges from the observation of **figure 5** that more than 75% of category 1 farmers and 87% of those of category 2 are classified as wealthy farmers. Of the total of respondents, 82.18% are

non-poor. Overall, the respondents' agricultural incomes (farm income per person per year) are like that indicated by a study conducted by the National Statistics Institute in 2013 which is 200 000 FCFA which is equivalent to 360.627 USD. Although this study is focused on only the two main cultivated crops, these poverty rates obtained are like those indicated by the National Statistics Institute in 2014 which stipulate that 90.3% of the population of Agadez's region live above the country's monetary poverty line.



**Fig. 5.** Classification of Farmers According to their Income levels

#### 4. Conclusion

It emerges from this study entitled "Impact Assessment of Small-scale Irrigation on Poverty Reduction" that irrigated agriculture constitutes the main activity of the municipality in general and the irrigated sites surveyed. It is the main source of income to satisfy the vital needs of the populations. Moreover, according to the results obtained on agricultural income, 82.18% of respondents can be classified as non-poor. Compared to national results, the population of this area is less exposed to food insecurity and poverty. Indeed, while the national poverty rate is 41.2% (2), the study case rate is 17.82%. Furthermore, irrigated agriculture could also keep young people in place while preventing them from migrating in search of employment. This means that irrigated agriculture creates jobs for the unemployed (64 agriculture workers were hired on fixed-term contracts by the respondents) through the agricultural labour.

Despite the important contribution of this agriculture to improving the income of the population, the cereal balance sheets recorded were negative. Thus, with farm income obtained, the deficit could be made up by purchasing food. Ultimately in the regions such as Niger where agriculture

depends heavily on rain, irrigated agriculture could be, then, considered as a real tool to combat food insecurity, poverty and mitigating ecological risks in the context of climate change.

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