

## Impacts of Agricultural Land Cover Changes on the Environmental Quality at Bakolori Irrigation Scheme, Talata Mafara, Zamfara State

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### ABSTRACT

*The study identified changes in land cover interns of crop cultivated at the Bakolori Irrigation Scheme, due some natural and pathogenic factors. Crops designated to be cultivated in some sectors of the scheme are no more cultivated, or cultivated at very low rate due to usurpation of its land by other crop (s), thereby changing the cropping pattern of the Scheme. Data collected through questionnaire administration, in-depth interview and focus group discussion were analysed using descriptive and inferential statistics. The frontier factors of land cover changes in the scheme were examined and the result shows that, poor water management, land tenure, market value, extension services, storage etc. were the main factors responsible for the changes in land cover systems in the scheme. The study reveals that, rice cultivation has over taken a significant land of about 7,190ha (93%) from 3,530ha (its initial land coverage), living only 530 (7%) to other crops, hence, becoming the dominant land cover in the scheme. Correlation analysis at 0.5% significant level show a significant relationship of 0.653 between the correlated variables. This changes has leads to many unprecedented environmental damages in the scheme, the situation that need to be arrested before the worst was done. The study therefore recommend the provision of necessary institutional support, secure land tenure, provision of services and facilities such as improved transportation, adequate storage, extension services etc to enable farmers reverse to the status quo, for improve food security, productivity and environmental quality. This can be done through government policies, extension services and enlightenment campaign on the danger of this changes on the environment.*

**Keywords:** Agricultural Land Cover, Changes, Environmental Quality, Irrigation Scheme

### 1. INTRODUCTION

Agricultural land use is practiced by clearing a patch of vegetation, growing assorted varieties of crops in the cleared land for one or two seasons and then moving to another plot is a major characteristic of this land-use system. Although this extensive land-use system was environmentally suitable in the past when population pressure on land was minimum, but presently has caused adverse impact on the environment with the gradual increase in population and migration of people (Gafur, 2001; HARS, 2000; Knudsen & Khan, 2002). Declining forest cover and inappropriate land cover changes have led to severe soil erosion (Shoib, Mostafa, & Rahman, 1998).

This, combined with reduced fallow periods due to increased population pressure have led to diminishing soil fertility and crop yields, thereby threatening the livelihood of many communities. Hence, agricultural land cover changes is no longer suitable from both environmental and economic perspectives (DANIDA, 2000; Knudsen & Khan, 2002). Scholars have offered different explanations for variations in land use and land cover. In the early 19th century, von Thuenen, considered agricultural land use as a function of distance to market centers and transport cost. According to him, agricultural intensity decreases with increasing distance to market centers (Visser, 1980). This explanation is a foundation upon which theories and explanations of

land use are built, though it overlooks several other biophysical, socio-economic and institutional factors influencing the land use/land cover. For example, where irrigated crops are grown land cover intensity is determined by the availability of water, rather than the distance to the market (Blaikie, 1971). Furthermore, some considered population pressure and resultant land scarcity as a driving force of change in land cover. Although the thesis was supported by many scholars, it provides a valuable framework to understand factors influencing land cover changes, but Stone, (2001) considered it as too simple to explain the intricate process of land change. Moreover, the assumption that land use undergoes a process of systematic change from extensive to intensive corresponding to the pace of population growth, gives an impression that the change would happen automatically. According to Geertz (1963), if population growth is not accompanied with right policy and technology it may lead to 'involution' of the land-use system rather than progression to the higher order. Cultural ecologists see agricultural change as a function of constraints imposed by the physical environment, and human abilities to influence those constraints (Ali, 1995). Institutional innovation theory pioneered by economists, Hayami and Ruttan, (1971) and Schultz, (1964), on the other hand, argues that physical constraints could be compensated by technology, knowledge and institutional innovations by improving human capabilities. Schultz (1964), pioneer among them, argues that farmers' skills, knowledge and technological progress—what he called 'productive art'—play an important role in agricultural development. Binswanger, (1987) and Lipton, (1989), however, argue that knowledge and skill are necessary for agricultural improvement, but these are not enough to facilitate the change. Despite having knowledge and skill, poor farmers cannot use improved seeds, chemical fertilizers, and irrigation because of structural constraints imposed by institutions. Institutions not only govern the processes by which scientific and technical knowledge is created, but also facilitate the introduction and use of new technology in agricultural production (Hayami and Ruttan, 1971). Savadogo, (2001) and other researchers have emphasized an equally important role of infrastructure, including transportation facilities, and access to market centers as they broaden the scope of new crops and technologies facilitating land-use changes. Other scholars like Feder, Onchan and Chalamwong, (1988), Li *et al.*, (1998) and Thapa, (1998) have laid emphasis on tenurial security as important factor influencing land use decision. To move from one type to crop to another, farmers need to make investment of substantial amounts of financial and labor resources. Insecure land tenure not only constraints such investments,

but deprives farmers from formal credit, inputs and other institutional services required for improved farming practices. Practical experiences from different parts of the world suggest that no single factor alone lead to change in agricultural land use. Rather, several biophysical, socioeconomic and institutional factors interact and interplay to facilitate the change. As mention, one critical underlying factor driving Agricultural Land Use Changes (ALUC) is the issue of land tenure insecurity, beside the other factors. In Nigeria, the Land Use Act of 1978 vested the control and management of all lands to the State and Local Governments. The state governors issued the statutory right of occupancy and customary right of occupancy by local governments for land users. However, majority of the land in Nigeria, especially agricultural lands, are still unregistered with a proof of right of occupancy (Eberechukwu, *et al.*, 2021). Consequently, majority of the farmers still suffer from tenure insecurity. It was found that, government seems to be taking advantage of this to disposes farmers of their lands through infrastructural development. Indeed, majority of farmers are socially in secured, financially excluded, and lack the financial capacity to secure their croplands or obtain Certificate of Occupancy for their lands (Eberechukwu, *et al.*, 2021) and this has great impact on land decisions.

At Bakolori Irrigation Scheme Talata Mafara, farmers have largely abandoned the cultivation of crops other than Rice. Experiences from early days of the project shows, that a large number of farmers' previous agricultural knowledge, quality of land resources, availability of water, proximity to markets, market value and level of support received, had played important role in maintaining the status quo of the agricultural land use in the scheme. But presently, changes in farming activities in the scheme were observed and believed to be caused by a number of factors, among which are; market value of the crop, ready market for the crops, storage facilities, cost of cultivation, water management, yield and insecurity of land tenure and property right. Therefore, the research intend to examine the various factor responsible for land cover changes on agricultural land use with particular reference to Bakolori Irrigation Scheme Talata Mafara. In this paper, land use change refers to more than simply the pattern of different land covers in space. Rather, it includes any changes in arrangements, activities, and inputs that people undertake in a certain land cover type.

## 2. STUDY AREA

Bakolori Dam is located in the North Western part of Nigeria (see Figure 1), Zamfara State, in Maradun Local Government. It lies between long.11° and 13° E and lat.4° and 6° N. In terms of climate and vegetation, Bakolori Irrigation Scheme is within the

Sudan Savannah. The rainfall (wet-season) starts between April and June and ends around October when the dry season sets in. Given the abundant water resources in the country and its potential for increasing agricultural production in Nigeria, the Federal Government established the River Basin Development Authority (RBDA). The scheme became necessary because of the persistent too short rainy season in many northern states of the federation. It was against this background that the Bakolori Irrigation Project was commissioned in 1975. The climatic condition of the area, explains the need for irrigation particularly for their cereal and vegetable dominant farming system. Farming is undoubtedly, the major occupation/economic activity in the study area. Though, there are some that are engaged in trading, public service, livestock farming, rearing etc.

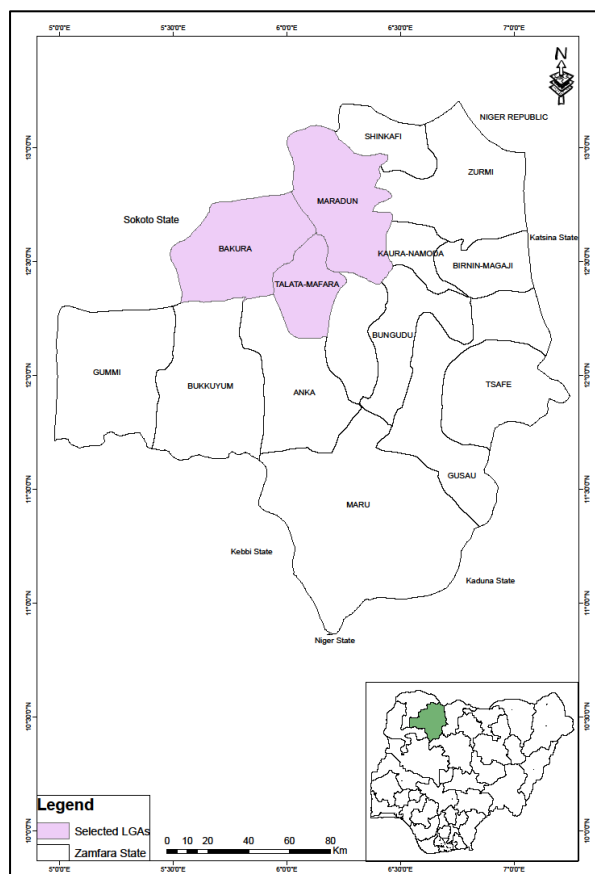


Figure 1: Map of the Study Area

### 3. MATERIAL AND METHODS

In conducting this research, a total number of 380 farmers were selected as sample size from farmers' total population of 30,000 in the scheme, using Cretchy and Morgan Table. Both quantitative and qualitative data sources were used. Descriptive statistics (Tables and Percentages (%)) were employed to present the data using formula for computing percentage i.e.,  $\frac{x}{\text{total population}} \times 100$ . Where X, represents the number of respondents for a particular variable, to show the approved crops to be

cultivated, changes and environmental problems in each sector. To corroborate the information from the questionnaire administered, in-depth interview and focus group discussion (FGD) were also used. Inferentially, correlation analysis was used to examine the relationship between the land cover changes and environmental quality using some selected variables in the study area.

### 4. RESULT AND DISCUSSIONS

Table 1. shows the various crop approved to be cultivated in the scheme, which was divided in to Two (2); Area demarcated for Rice cultivation only (Rice Surface Irrigation, [RSI]) and that for the cultivation of Wheat, Vegetables and Tubers (Surface Irrigation, [SI]). Each irrigation type is having six (6) intakes with a total of 3530 and 4190 hectares of land respectively. Sectorally, Bakura has six (6), Talata Mafara has five (5) intakes and Maradun has one (1).

Table 1: Approved Crops to be Cultivated in Each Sector of the Scheme

Sector	Intakes	Hectare	Units	Crop	Type of Irrigation
BKA	GRA	680	34	RICE	RSI
BKA	GRB	190	9.5	RICE	RSI
MRD	LR 10	160	8	RICE	RSI
BKA	LR 20	220	11	RICE	RSI
BKA	MRICE	900	45	RICE	RSI
BKA	NRICE	1,3	69	RICE	RSI
<b>SUB TOTAL</b>		<b>3,530</b>	<b>176.5</b>		
TMA	E-LEFT	950	47.5	MIX	SI
TMA	A-LEFT	400	20	MIX	SI
TMA	A-RIGHT	200	10	MIX	SI
TMA	C	580	29	MIX	SI
TMA	E-RIGHT DOWN	960	48	MIX	SI
BKA	E-RIGHT UP 1&2	1,100	55	MIX	SI
<b>SUB-TOTAL</b>		<b>4,190</b>	<b>209.5</b>		
<b>GRAND TOTAL</b>		<b>7,720</b>	<b>386</b>		

**RSI**= Rice Surface Irrigation, **SI** = Surface Irrigation **Mix**= Wheat, Maize, Tubers, Sugar cane, Spices and Vegetables

**Source:** SRRBDA (2022), Author's Field Work (2023)

Table 2 reveals a lot of changes in the farming activities (crops cultivated) in the scheme which was triggered by different factors in the area, among which are insecurity of tenure system and property rights are the main actors. Presently, out of 3,530ha reserved for rice cultivation in the scheme (RI), Rice is grown in 3,330ha while other crops like sugar cane are cultivated in the remaining balance of 200ha. In SI, out of 4,190ha reserved for the cultivation of Wheat, Vegetables and Tubers, 3,860ha were converted to rice cultivation, living only 330ha for the initial crops. On the aggregate, rice cultivation has taken a total of 7,180ha against 4,190ha. On the other hand, a total change in the study area reaches 4,040 ha. This has a lot of implication in the scheme, it resulted into many environmental and economic problems by reducing the quantity of yield from other crops and increase in water shortages in some area due to high water need of Rice.

**Table 2: Changes in Crops Cultivation (land cover) in the Scheme**

Sector	Intake (RSI)	Hectare	Change Unit	per	Current Proportion of Rice Cultivation	Other Crops	Level of Changes
BKA	GRA	680	32/2		640	40	40
BKA	GRB	190	9.5/0		190	0	0
BKA	LR10	160	8/0		160	0	0
MRD	LR 20	220	10/1		200	20	20
BKA	MRICE	900	42/3		840	60	60
BKA	NRICE	1,380	65/4		1,300	80	80
<b>Sub Total</b>		<b>3,530</b>	<b>165.5/11</b>		<b>3,330</b>	<b>200</b>	<b>200</b>
<b>Intake (SI)</b>							
TMA	E-Left	950	44/3.5		880	70	880
TMA	A-Left	400	19/1		380	20	380
TMA	A-Right	200	9/1		180	20	180
TMA	C	580	27/2		540	40	540
TMA	E-Right Down	960	44/4		880	80	880
BKR	E-Right up 1&2	1,100	50/5		1,000	100	1,000
<b>Sub Total</b>		<b>4,190</b>	<b>193/16.5</b>		<b>3,860</b>	<b>330</b>	<b>3,860</b>
<b>Grand Total</b>		<b>7,720</b>	<b>358.5/27.5</b>		<b>7,190</b>	<b>530</b>	<b>4,040</b>

**Source:** SRRBDA (2022), *Author's Field Work* (2023)

#### 4.1 Market Value

As one of the factors that contribute to changes in the farming practices in the study area, market value has a total of 17% of respondents as indicated on table 3. Market value of any commodity plays significant role in its continued supply or otherwise as always the demand determines the supply. Therefore, with the coming of time, demand for rice production increased and having easy market and being more profitable above others in the scheme, farmers started to change from what supposed to be grown in some sectors to rice with little or no

thought of what could be the result in the future. This is one of the factors that led to the conversion of most areas not designed in the scheme for rice cultivation to rice cultivation. This change has not gone without any predicaments to people and environment as well; such as water logging and water shortages in some parts of the scheme and extinction of some use-to-be cultivated crop in most parts of the scheme such as Tubers, Vegetables, and other spices. Therefore, this affects the economic gain (positively or negatively) of farmers whose areas were affected.

#### 4.2 Cost of cultivation

A Total of 31 (8%) respondents from the total opt for cost of cultivation as the reason for changes in farming activities in the scheme. To corroborate this opinion, it was gathered during FGD and in-depth interviews that, the cost of cultivating some crops and difficulties incurred are more than that of rice and with less yield.

Besides, some stated that, gradual cultivation of rice in a wheat site has added to the burden and fast tract the changes as well, because excess water from rice farms, neighbouring other farms with different crops need extra cost to be truncated, which if not, damages the neighbouring crops such as wheat and other less water requiring crops. Therefore, these necessitated farmers to change for rice cultivation as any failure in demarcating water will cause a catastrophic to damages to neighbouring farms.

#### 4.3 Fragmentation of farmlands

As revealed on Table 3, access to land has a total of 8 (2%) respondents out of the total respondents in the study area. This is mostly as a result of inheritance, whereby the successors subdivide a unit of land left to them by the deceased. Therefore, each member will be an authority on his portion of land i.e, can cultivate whatever he so wishes, with the contribution of other factors and the limited land, farmers opt for a more marketable and profitable crop that can earn them more, to take good care of their family and as source of income for another round of cultivation. This finding is in line with conclusions of Tesfaye and Seifu's, (2016), that a relatively small farm size and fragmented land

**Table 3.0: Factors that Contribute to Changes in Crops Cultivation in the Scheme**

Factors	TMA	%	BKA	%	MRD	%	TOTAL	%
Market Value	65	43	0	0	0	0	65	17
Cost of cultivation	31	20	0	0	0	0	31	8
Access to Land (Fragmentation of Farm Land)	8	5	0	0	0	0	8	2
Population Growth	11	7	0	0	0	0	11	3
Poor Water Management	27	18	0	0	0	0	27	7
Insecurity of Tenure and Rights	10	7	0	0	0	0	10	3
Water Shortage	0	0	217	100	11	100	228	60
<b>TOTAL</b>	<b>152</b>	<b>100</b>	<b>217</b>	<b>100</b>	<b>11</b>	<b>100</b>	<b>380</b>	<b>100</b>

Source: Author's Field Survey, (2023).

system, and severe population pressure are the constraints to wheat production in Ethiopia's eastern areas.

#### 4.4 Population growth

Population growth has a total of about 11(3%) respondents as shown on Table 3.0. there is a tremendous increase in the population of people in the study area, after the construction of Bakolori Dam due to increase in Birth rate and migration of people to the area. The population of the Three (3) Local Government Areas were the Bakolori Irrigation Scheme was located has increase from 612, 356 people to 1,126,078 in 2023 at growth rate of 3.7 (NPC, 2023). This shows an increase of about 43%. The implication here is in the need of more land for the cultivation of food for the teeming population. Swindell, (1986) affirmed that the case of Rima Basin appeared to confirm the Boserupian theory that population growth fundamentally serves as the factor of agricultural expansion and intensification which could lead to many changes in cropping and farming techniques. He, however, affirmed that there is not necessarily a linear development from food gathering, through fallow, to agricultural intensification and that population density alone cannot sufficiently explain agricultural expansion and intensification but that historical evolution of the population increase together with the production relations support the population need to be understood. Most of the causes of changes are directly connected to human population growth (Ghosh *et al.*, 2012). The Boserupian theory of land use and land cover changes, was anchored on population growth as the main factor of agricultural expansion and intensification (Reenberg, *et al.*, 2008). Keita and Zhang, (2010) also agreed that Land use changes develop on a long time scale under different environmental, economic, social, political

and demographic conditions. In their analysis of land use change in Siby, Mali. Keita, *et al.*, (2010) noticed that expansion occurs in the rural areas while intensification is associated with population growth and urbanization. Furthermore, Reenberg, *et al.*, (2008), in their attempt to conceptualize land use and land cover changes using two cases in Senegal, argued that although population growth is the most plausibly linked factor to agricultural changes, but it looks too simplistic in explaining agricultural land use expansion and intensification. They concluded that, choice of land use resides with individual's decision shaped by factors such as land tenure rules, legal protection, local/national/global economic policies, etc. In their study, Stephenne and Lambin, (2001) also identified changes in human and animal population which increase consumption and demand for food crops and forage, and inter-annual rainfall variability which modifies land productivity as factors of agricultural land use changes in the arid and semi-arid region of Africa.

#### 4.5 Poor water management

Different crops were earmarked for different areas (intakes) in the scheme, and it was based on that, water distribution canals were designed and constructed for the provision of adequate and effective supply of required water quantity. It was also based on this categorization, that the requirement of water for each area was determined. These crops include Rice, Wheat, Maize, Tubers, and Vegetables etc. As one of the factors with 27 (7%) of the total responses in the study samples as shown on table 3.0, poor water management is one of key factors that led to the changes in farming activities in the scheme.

With all the canal arrangements for smooth flow of water in the scheme to various farmlands, a lot of distortion and changes were made in the scheme,

which led to shortages of water and water logging in some places, hence, necessitating changes in the farming practices. This is more pronounced in Talata Mafara Sector which comprises Five (5) Intakes; A Left, A Right, E Left, E Right down, and C. Within these Five (5) intakes, Two have presently change completely to rainy season cultivation for Millet, Guinea corn, Beans etc due to damages done to canal and Pumping Machines. These intakes were initially for the cultivation of Maize, Tubers and Vegetables, but due to the market value of rice and other factors at play, it was changed mostly to rice cultivation later, and as a known fact, water requirements for rice cultivation is far more in quantity from that of initial crops (Maize etc). As a result, farmers started experiencing water shortages, and machines started grounding as they are over worked and gradually collapse. All these resulted from changes in the approved crops to be cultivated as mentioned above to rice cultivation. For the remaining three (3) sectors, the changes are also caused by the gradual movement of farmers from cultivation of Wheat, Vegetable, Maize and Tubers to rice cultivation, due to its market value and other contributing factors also. These changes that took place, resulted in some places to get dried (out of conventional irrigation at all), as irrigation water does not reach those sites anymore; as the areas were not earmarked for that purpose (i.e., rice cultivation). as a result, water supply to the area cannot cope with the changes, and soil type does not retain water easily, therefore need additional quantity which is at the expense of others, creating artificial shortages to some farmland that are far from the source. Thus, it can be deduced that, these changes in water management had contributed immensely to land cover changes and environmental degradation in the Scheme.

#### 4.6 Insecurity of land tenure and property right

Having 3% of the total sampled population as indicated on table 3.0, insecurity contributes greatly towards changes in farming activities in the study area, due to the fear of eviction by farmers in the scheme. More specifically those who rent farmland, due to short duration of right they experienced. As most farmers cultivate crops for food and economic gain they always vote for crops that can serve such purposes. This notion of farmers and fear of eviction by the tenants had strengthened the change in cropping pattern, for them (tenants) to get best out of little investment they make within the duration of their right. Therefore, they opt to cultivate crops that are easier in its cultivation or that can be cultivated more than once before the expiration of their duration of right. For the owners also who cultivate their farms, they are skewed more to crops that favoured their investment. These contribute to changes in land cover within the land use in the scheme, and the finding was corroborated by a study conducted by Baslyd, (2022) in Ghana. Insecurity of tenure and right experienced by irrigators has a

damaging contribution in the output, total productivity and environmental quality in the scheme, as put forward by Feder and Noronha, (1987) that, the absence of land tenure security has the effect of increasing uncertainty and reducing expectations of gains enjoyed by the producers. This follows a reduction in investment incentives, which leads to low productivity levels. Furthermore, the existing ambiguities in terms of land rights lower the impetus of farmers to undertake environmental improvements and to adopt new technologies that would as a result be likely to increase their productivity (Harrison, 1987). These findings and that of the study are consistent with recent research by Nigus, *et al.*, (2022), which revealed that low land productivity and limited access to land were identified as important constraints for 92.9 and 90.4% of smallholder farmers in East- and West-Hararge respectively.

Correlation analysis was used to test if there is relationship between the level of land cover changes and environmental quality in the study area. The finding on table 4.0 reveals that, there exists positive relationship of 0.653 at 0.05 significant levels when compared with P value of 0.000. This indicates that, the more un coordinated land cover changes the more the environmental problems in the study area and vice versa. From the above therefore, it reveals tthat, relationship exists between the level of land cover changes and environmental quality in the study area. This agrees with the finding of Tsue, *et al.*, (2014) in their study at North-Central Nigeria.

**Table 4: Correlations (Pearson) Analysis on the Relationship Between Land Cover Changes and Environmental Quality in the Study Area**

Variables	Statistics	Environmental Quality
Factors of Land Use Changes	Pearson Correlation, 0.653	
	Sig. (2tailed) 1 0.000	
	N 380 380	

*Source: Author's Field Survey, (2023)*

#### 5. CONCLUSION:

Land cover changes are changes in crop cultivation within the agricultural land use. Though has its advantages and caused by different factors, including physical, social and economic, it also caused a lot of damages to the environment. Hence, the study outline and discussed the various causes and effects of land cover changes on the environment in the study area, indicating the overall changes in the scheme and between the crop. It clearly shows that, a substantial percentage of farmers have change to rice cultivation, without any recourse to the environmental problems it might caused in the Scheme. The analysis revealed a positive correlation between the quality of environment and land cover changes at Bakolori

Irrigation Scheme Talata Mafara. The study therefore recommend the provision of necessary institutional support, secure land tenure, provision of services and facilities such as improved transportation, adequate storage, extension services etc to enable farmers reverse to the status quo, for improve food security, productivity and environmental quality. This can be done through government policies, extension services and enlightenment campaign on the danger of this changes on the environment.

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