DETERMINANTS OF ARABLE CROP PRODUCTIVITY UNDER THE GORONYO IRRIGATION PROJECT, NORTH-WEST NIGERIA

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ABSTRACT

The study evaluated the determinants of arable crop productivity under the Goronyo irrigation project located in North-Western Nigeria. Multi-stage sampling technique was used to select 246 farmers from whom data were collected with the aid of an interview schedule. Descriptive statistics such as mean, frequency tables and percentages were used to describe the socioeconomic characteristics of the farmers. Data envelopment analysis (DEA) approach was used to obtain the productivity indices for the major arable crop, and ordinary least squares regression model was used in evaluating the factors that determined productivity. The results revealed mean age, formal schooling and irrigation experience of 43, 2.5 and 7 years, respectively. The mean household size was five persons. Furthermore, mean farm size in hectares of the irrigation farmers was highest in rice (0.91) compared to 0.76, 0.62 and 0.45 for tomato, cowpea and maize, respectively. Productivity was positively and significantly influenced by household size, extension contact, non-farm income, location of farm in relation to source of irrigation water and scale of operation. Based on the results, it was concluded that opportunities exist in the area for increasing productivity of resources by increasing contact of farmers with extension workers and other conventional inputs. The scale efficiency analysis result confirmed increasing return to scale and therefore more output will be produced if additional improved conventional inputs are used.

KEYWORDS: Irrigation, arable crops, productivity indices, data envelopment analysis

INTRODUCTION

Nigeria's population grows at about 2.8% per annum while food production growth rate is about 2.0% (NBS, 2010 and Mohammed and Abdulquadri, 2012). Due to the high population growth rate, food demand has been increasing at a very high rate (more than 3.5% per annum) resulting in domestic food supply deficit (Ali, 2010). Over the years, Nigeria's agricultural sector has not adequately responded to this serious food security challenge owing mainly to the low productivity that characterises crop and livestock production in the country (Ahungwa *et al.*, 2014). Agricultural production is dominated by smallholders who rely mainly on traditional agricultural technologies and inputs whose capacities to generate high yields of crops and livestock are intrinsically limited (Eroarome, 2009). The situation is worsened by underinvestment in irrigated agriculture and over reliance on rain-fed production.

Irrigated agriculture is however, known for its capacity for increasing crop yields, increasing the size of the total farm business, providing fuller employment of resources, ensuring stability in the supply of farm products and lessening the danger of crop failure and fluctuation in yields (Baba, 2010). Therefore, irrigation, if properly harnessed could make major contribution toward reducing domestic food supply deficit in Nigeria. The critical role of irrigation in Nigeria's agriculture is further underpinned by the climate change challenge. It has been observed that climate change is causing declining precipitation and increased weather variability (Janneh, 2008). The potential of irrigated agriculture in reducing food supply deficit seems to have long been recognised in Nigeria. Thus dating back to the colonial era and post-independence, Nigerian governments established small and large-scale irrigation schemes in various parts of the country but especially in the north where annual rainfall duration is short (sometimes less than five months) and the annual amount is low (less than 500 mm per annum in some places). The river basin development approach was introduced in 1973 and today, there are 12 river basin development authorities (RBDAs). The RBDAs have established many large-scale irrigation schemes, including the Goronyo Irrigation Project in Sokoto State. The development of the full irrigation potentials of the country will therefore, contribute immensely to bridging the food supply-demand gap. It will also contribute to the current effort by government to diversify the economy and reduce its food import bill particularly in view of the dwindling foreign exchange occasioned by the recent collapse in the international prices of crude oil from which the country earns most of its foreign exchange. While irrigation development may hold some promise for Nigeria's agriculture and economy, however, it must be pursued in such a manner that the potentials are realised. One of the aspects through which irrigation development is expected to make an impact on smallholder agriculture, is productivity increase because irrigated lands are supposed to be more production friendly and produce higher crop yields per unit area than rainfed agriculture (Fagade and Nguyen, 2001). It is therefore, important to examine crop productivity in existing irrigation projects in Nigeria as a way of ascertaining the extent to which the potentials of irrigation are being met. Furthermore, analysing productivity meaningfully, would involve identifying its socioeconomic and institutional determinants. Knowing these determinants would suggest possible ways by which they could be harnessed through appropriate policy instruments, to increase productivity. This study therefore, estimated productivities for the major arable crops produced under the Goronyo Irrigation Project, in North-Western Nigeria using the data envelopment (DEA) approach data envelopment analysis (DEA), and determined the factors influencing productivity.

METHODOLOGY

Study area

The study covered the Goronyo irrigation project area. The project is located in Sokoto State in North-Western Nigeria. The irrigation project covers a total land area of 17,080 hectares on both sides of the Rima River between Goronyo dam near the village of Katsire to the North East, and about 5 km downstream of the village of Shinaka to the South East and is located within latitudes $13^0 25'$- $13^0 31'$N and longitudes $5^0 5'$ - $5^0 39'$E (MRVI, 2001). While some inhabitants of Sokoto State are also engaged in livestock rearing, trading and public service, farming is the most important occupation and livelihood activity (Yahaya, 2002). The major tribes in the project area are Hausa and Fulani. The vegetation is sudano-sahel savannah type. Annual rainfall ranges from 579 – 674 mm and lasts for four to five months (June to October) while average monthly temperature ranges from 24^0C-33^0C (Okereke *et al*., 2007). Without irrigation, most agricultural resources are idle for three-quarters of the year. Although rainfed production takes place in the short rainy season, crops grown are typically limited to the drought-tolerant and/or early-maturing varieties of millet, cowpea and sorghum, in the upland areas, and rice in the *fadama* (lowland) areas. Yields of these rainfed crops are usually low mainly due to moisture deficit (Anderson *et al*., 2016). The establishment of the Goronyo irrigation project in the area was expected to bring about a major boost in agricultural production in the area by enabling full (all-year-round) employment of resources, increasing the range of crops produced and substantially raising crop productivity. Crops produced under irrigation in the area include rice, tomato, maize, cowpea, pepper, onion, garlic, cassava and wheat.

Sampling technique

The irrigation project was selected for study given its significance (considering the agricultural environment in which it is situated) and the fact that no research has been conducted to evaluate productivity of resources used in crop production under the project. Multi-stage sampling technique was used to select farmers for the study. The first stage involved random selection of 12 out of the 23 farming communities identified within the project area. A list obtained from the Agricultural Extension Office of Sokoto Rima River Basin Development Authority (SRRBDA) attached to the irrigation project, showed that 640 farming households in the sampled villages used the Goronyo dam irrigation infrastructure during the 2012/2013 cropping season. In order to arrive at appropriate sample size, equation for sample size determination as reported by Eboh (2009) was used to select 246 household heads for the study. The equation used for calculating the sample size is specified as:

$$n = \frac{N}{1+N(e2)} \qquad \ldots\ldots 1$$

Where n is the sample size, N is the population size and e is the level of precision which is 5% in this study.

Data collection

The limited cost-route approach was used to collect data on a fortnightly basis from the sampled farmers throughout the 2012/2013 irrigation season. This method was adopted to minimise undue reliance on farmers' memory recall as it is usually the case with single-visit data collection at the end of the season. Input data collected include sizes of farm lands (ha), quantities of planting materials (kg), fertilizer input (kg), herbicides (litres), labour (including family and hired) in man-days, tractor hiring expenses (N) and expenses on animal traction (N). Output data on all the cereals, legumes and vegetables harvested from each farm were collected at the time of harvest. The prevailing prices of inputs and outputs were also obtained from the farmers. Further data were collected on the farmers' socio-economic variables such as age, years of schooling, household size, number of contacts with extension agents during the year and membership of farmers' organizations.

Data analysis

Data were analyzed using descriptive statistics, data envelopment analysis (DEA) approach and a multiple regression model. The DEA technique is a non-parametric approach to the measurement of performance of decision making units. Unlike the parametric approach, it does not require specification of a functional form and the frontier is calculated on the basis of the sample observations. The input-oriented DEA determines how much the input combination for an enterprise would have to change to achieve the output level that coincides with the best practice frontier (Ojo *et al*., 2013). The model distinguishes between pure and scale efficiency, identifying if increasing, decreasing, or constant returns to scale are present in the data set. The variable return to scale (VRS) DEA model envelops data in tighter way than constant return to scale (CRS) DEA model (Cesaro *et al*., 2009). Therefore, the VRS technical efficiency score is equal to or greater than CRS or overall technical efficiency score. This relationship is used to measure scale efficiency (SE) of the farms under consideration as presented in equation 1:

SE = TEcrs/TEvrs 1

SE = 1 implies that the farm is scale efficient while SE > 1 indicate scale inefficiency that could be due to the existence of either increasing or decreasing returns to scale. The scale efficiency scores generated this way were then used as proxy measures of farm productivity (Cesaro *et al*., 2009). Ordinary least squares regression (OLS) method was used to estimate factors affecting productivity (Nkonya *et al*., 2010). The general empirical OLS model is as presented in equation 2:

Y = f(X, Z, M) 2

Where:

Y = Productivity indices

X = a vector of household socioeconomic characteristics.

Z = conditioning factors beyond the household that affect productivity, e.g. distance to major roads and markets.

M = production technologies used

The relationship is specified in explicit form in equation 3:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + e \quad \ldots\ldots\ldots\ldots3$$

Where:

Y = Scale efficiency score (productivity index) generated using the DEA approach for each of the arable crops under consideration.

β_0 = Constant

X_1 = Household size (number)

X_2 = Number of years spent in school

X_3 = Irrigation farming experience (years)

X_4 = Extension contact (number)

X_5 = Non- farm income (Naira)

X_6 = Location of farm (dummy: 1 if close to source of water, 0 otherwise)

X_7 = Age of the farmer (years)

X_8 = Scale of operation of the farmer (dummy: 1 if small scale, 0 otherwise)

X_9 = Distance to the market (kilometers)

$\beta_1 - \beta_9$ parameters estimated

e = Error term

This model was estimated separately for rice, maize, cowpea and tomato which were the major crops produced under the irrigation project. Thereafter, a combined analysis including the four crops was made, using grain equivalent table.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Irrigation Farmers in the Study Area

Information on irrigation farmers' socioeconomic characteristics in Table 1 shows that almost 68% of them were aged 30-49 years and the mean age was 43 years. The age distribution of the respondents implies that they were in their economically active age. Irrigation farming under the Goronyo project is highly labour-intensive as most of the farming operations are accomplished manually. And age, to a large extent, determines the level of labour input by the farmer (Oluyole *et al*, 2013). Results further show that 99% of the farmers were male. This could be attributed to the cultural practice of *purdah* (seclusion), which limits the daytime outdoor activities of women in the area. This result is consistent with that of the study on the estimation of technical efficiency of irrigated rice farmers in Niger State of Nigeria (Ahmadu and Alufohai, 2012).

The level of formal education as showed in Table 1, was low, with only 12 percent of the farmers attaining primary, secondary or tertiary education. Low level of formal education among farmers has been reported in studies in northern Nigeria (Olayide *et al*., 2009 and Ayoola *et al*., 2011) and elsewhere in Africa (Al-hassan, 2008). However, farmers in the present study could not be considered as illiterate since many of them had attended adult literacy classes. This could be exploited by agricultural extension agents in the area to omote technology adoption. Another favourable factor for technology adoption is long ars of farming experience (Akinola and Owombo, 2012). The results showed that the rmers had an average of seven years' experience in irrigation farming. Therefore, they em to have enough experience to increase productivity by adopting best practices quired through the years.

he average duration of formal schooling was 2.5 years. Furthermore, more than 93% of e irrigation farmers had household sizes ranging from one to ten persons while the mean as five persons per household. The results further showed that most farmers had usehold sizes of 10 persons or less. This result agrees with the pattern reported in a study small-scale farmers in some states in northern Nigeria (Ojo, 2013). Nonetheless, further alysis of the results shows that about 35% of the farmers had household sizes of six ersons or more. The large household sizes could be attributed to the widespread practice of olygamy in the area. Large household sizes could make family labour easily available for e labour-intensive irrigation farming operations in the area.

able 1: Socioeconomic characteristics of farmers using Goronyo Irrigation Project

Variable	Frequency	Percent
Age (years)		
20 – 29	14	5.70
30 – 39	63	25.60
40 – 49	104	42.30
50 – 59	43	17.50
60 – 69	17	6.90
> 69	5	2.00
Total	246 (43)*	100.00
Gender		
Male	243	98.80
Female	3	1.20
Total	246	100.00
Education		
Primary	4	1.63
Secondary	16	6.50
Tertiary	10	4.07
Adult education	162	65.85
No education	54	21.95
Total	246	100.00
Irrigation experience (years)		
1 – 2	2	0.80
3 – 4	45	18.30
5 – 6	56	22.80
7 – 8	54	22.00
9 – 10	89	36.20
Total	246 (7)	100.00
Household size		
1 – 5	161	65.40
6 – 10	68	27.60
11 – 15	16	6.50
16 – 20	1	0.40
Total	246 (5)	100.00

*Values in parentheses are means

Source: Field Survey, 2013

Resource Use and Crop Yield

Table 2 reveals that rice was the most important crop both in terms of the total land area (224.7 ha or 65% of total area cultivated) devoted to it and the proportion of sampled farmers engaged in its cultivation. In fact, all the sampled farmers practiced rice cultivation. The average farm size under rice (0.91 ha) was also higher than that of any other crop. Rice was followed in importance by maize, cowpea and tomato in that order. There were other irrigated crops such as cassava, hot pepper, onion, garlic and wheat, but these were cultivated by only few farmers. The table also shows an average fertilizer input of about 376.18 kg/ha by rice farmers compared to 235.43kg/ha for maize and 161.58 kg/ha for tomato. Furthermore, herbicides were used at an average rate of 5.68, 5.48 and 4.31 litres/ha by rice, maize and cowpea farmers, respectively. Rice farmers obtained an average paddy yield of 3,473.89 kg/ha while maize farmers realized 2,229.83 kg/ha. Farmers producing cowpea obtained a grain yield of 1,187.50 kg/ha on the average and the mean fruit yield of tomato was 5,648.96 kg/ha. The irrigation farmers at the Goronyo project devoted most (65%) of their land to rice production. This is probably because it serves as a major cash and food crop for the farmers. Although irrigated maize is also produced, relatively smaller plots are devoted to it. Maize is not an important cash crop in the area. Even as a food crop, it has close substitutes in sorghum and millet which are produced rainfed. In fact, the latter two crops are more prominent in the diets of the households in the area. Maize is therefore, not a priority as either food or cash crop in the study area. Both cowpea and tomato are grown mainly as cash crops. The results also show that irrigation farmers under the project operated on a small scale cultivating less than one hectare, on the average. Most of the farmers, however, used improved inputs such as inorganic fertilizer and herbicides.

The rate of fertilizer use was highest in rice production, followed by maize and then tomato. Fertilizer was not used on cowpea. The average fertilizer input by the rice farmers compares well with the rate of 375 kg/ha recommended for lowland rice production in Nigeria (NCRI, 2008; Ahmadu and Alufohai, 2012). However, maize farmers' fertilizer use (235.43 kg/ha) is far short of the recommended 500-600 kg/ha for the savanna zone of Nigeria ((USAID, 2016). Similarly, fertilizer use in tomato was low (131.52kg/ha) when compared to the 250-280 kg/ha reported as efficient for total fruit yield in the northern guinea savanna of Nigeria (Isah *et al.*, 2014). Furthermore, herbicide rates recorded in this study for the various crops range from 4.31 to 5.68 litres/ha. These rates appear to be at the lower limit of a range of 3-11.5 litres/ha recommended for rice production in northern Nigeria. Probably due to the inadequate application of herbicides, most farmers at the irrigation site were compelled to undertake supplementary hand (or hoe) weeding. Low use of fertilizer and herbicides could be attributed to their high cost and (in the case of fertilizer) scarcity in the area.

Crop yields obtained by the irrigation farmers in this study were generally low. For instance, the rice yield of 3,474 kg/ha (3.47 t/ha) is lower than 3.7 t/ha Nigerian irrigated rice average (Onyekwena, 2016) or even the sub-Saharan Africa average of 3.5 t/ha (Fagade and Nguyen 2001). It is also, far short of the potential yield of 6-7 t/ha in Nigeria

(Cadoni and Angelucci, 2013). The yield is however, higher than yields obtained under rainfed rice production system in Nigeria (Onyekwena, 2016). The yield of maize among the farmers is comparable to the average reported under irrigation in a previous study in northern Nigeria though far lower than the world average (Ammani, 2015). Cowpea is normally produced rainfed thus its production under irrigation in the area is an exception rather than the rule.

The cowpea yield obtained by the farmers is much higher than the rainfed yield reported in Nigeria, but lower than the potential (FAO, 2012). Similarly, yield performance of tomato was poor compared to the national average (Isah *et al.*, 2014 and FAO, 2012).

Table 2: Crop enterprises, inputs use and yields under the Goronyo Irrigation Project

Crop	% of farmers	Land area (ha)	Mean farm size (ha)	Mean fertilizer input (kg/ha)	Mean chemical input (ltrs/ha)	Mean yield (kg/ha)
Rice	100.00	224.70	0.91	376.18	5.68	3473.89
Maize	75.61	59.76	0.32	235.43	5.48	2229.83
Cowpea	52.03	40.26	0.31	-	4.31	1187.50
Tomato	33.74	23.60	0.28	161.58	-	5648.96

Source: Field Survey, 2013

Crop Productivity Indices from Data Envelopment Analysis

The productivity indices for the various irrigated crops derived from the application of the DEA analysis are shown in Table 3. The average productivity index was 0.91, 0.45, 0.62 and 0.76 for rice, maize, cowpea and tomato farms, respectively. Table 4 shows the distribution of the farmers according to scale efficiency. It can be seen that only 23.17, 6.99, 10.16 and 13.25 percent of rice, maize, cowpea and tomato farms, respectively, were scale efficient, that mean they are operating optimally. The remaining farmers' experienced increasing returns to scale, which suggest need for increasing use of inputs to produce more output. The crop yields presented show the productivity with respect to land. On the other hand, the productivity indices obtained from the data envelopment analysis are with respect to all factors used in production and could vary between zero and one. The rice farms had the highest average productivity index while maize farms had the lowest. It implies that the inputs were most productive when used in rice cultivation. Farmers were therefore, right in devoting most of their resources to the production of the crop. Although the productivity of tomato farms was also fairly high, the crop is the least popular probably because of the marketing problems associated with it in the area

Cowpea farms had moderate productivity while the productivity index of 0.45 shows that maize farms were less than 50% productive. The results further show that only few farms were operating at optimal scale. For each of the crops, most farmers were in stage one of production with increasing returns to scale. This implies that if all the inputs or factors under the control of such farmers were increased by one percent, their output would increase by more than one percent. Therefore, farmers could increase their productivity by using production factors beyond the current levels.

Table 3: Productivity indices for farms under the Goronyo Irrigation Project

	Crops			
Statistic	Rice	Maize	Cowpea	Tomato
Mean	0.91	0.45	0.62	0.76
Minimum	0.48	0.02	0.14	0.08
Maximum	1.00	1.00	1.00	1.00
Standard deviation	0.12	0.25	0.22	0.19

Source: Field Survey, 2013

Table 4: Distribution of the Goronyo Irrigation Project farmers according to scale efficiency

Arable crop	Scale efficient		Increasing returns to scale		Decreasing returns to scale	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Rice	57	23.17	189	76.83	-	-
Maize	13	6.99	173	93.01	-	-
Cowpea	13	10.16	115	89.84	-	-
Tomato	11	13.25	72	86.75	-	-
All crops	12	4.89	224	91.06	7	2.85

Source: Field Survey, 2013

Determinants of Productivity in Arable Crop Production

The result of the analysis of the multiple regression model on socioeconomic and institutional variables influencing productivity as shown in Table 5 reveals that household size had positive and significant effect on productivity of cowpea and tomato farms. Furthermore, extension contact and level of non-farm income were significant only for rice farms. Location of the farm with respect to water source had a positive and significant relationship with productivity of maize farms but was not significant for the other crops. The table further shows that scale of operation had positive and significant influence on productivity of all the crop farms except maize. However, years spent in school, irrigation farming experience, age and distance to market were not significantly related with productivity for any of the crop farms. With all the crops combined, the results reveal that household size, extension contact, non-farm income and farm location all had significant positive effect on productivity while scale of operation had a negative and significant effect. The results on determinants of productivity which showed a positive relationship between household size and productivity of cowpea and tomato farms imply that an increase in household size would increase productivity. Similar results have been reported in some

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other developing countries (Hafiz, 2009 and Thapa, 2007). It appears that large household sizes increase productivity by making more family labour available for effective crop production operations. Furthermore, the direct and significant relationship between the number of extension contacts and productivity of rice farmers is expected. Frequent contact with extension agents will likely enhance adoption of improved technologies and thereby increase productivity. This agrees with the findings of a similar study on rice farmers in Bangladesh (Haq, 2011). In addition, the positive influence of non-farm income on rice productivity underscores the significance of access to alternative income sources in promoting crop production by smallholder farmers. It has been observed that non-farm income has a significant positive influence on farm productivity through its effect on agricultural capital investment (Ye *et al*., 2011).

Position of farm relative to source of irrigation water also had a positive influence on productivity of maize. In other words, the closer the maize farm is to the water source, the higher its productivity. This is expected because water is likely to be more readily available for farms located close to the water source than those that are farther away.

The implication of the direct and significant relationship between scale of operation (based on size of farm holding) and productivity is that as scale increases, productivity also increases. However, some studies have suggested an inverse relationship between scale of operation and productivity (Elibariki *et al*., 2008 and Unal, 2008). It is argued that small farms have more cropping intensity than large farms which translates to higher productivity. But as the results of the present study have shown, most of the farms were producing in stage one which implies that they were operating below the optimum (scale efficient) size. Therefore, farms that are larger are likely to be closer to the scale efficient farm than smaller ones. In that sense, the larger farms are expected to have higher productivity.

Table 5: Determinants of productivity of arable crop production under Goronyo Irrigation Project

Variable	Coefficients				
	Rice	Maize	Cowpea	Tomato	All arable crops
Constant	0.11(2.03)**	0.37 (3.38)***	0.73(5.52)***	0.99(8.06)***	0.033(0.12)
Household size	-0.003 (-1.07)	0.0014 (0.20)	0.01(1.72)*	0.62 (2.21)**	0.086 (2.91)***
Years Spent in School	0.002 (0.83)	0.0042 (0.83)	0.007(1.22)	0.0039 (0.71)	-0.011 (-0.61)
Irrigation experience	-0.001 (-0.26)	0.0041 (0.61)	-0.006(-0.49)	-0.012(-1.04)	-0.0062 (-0.15)
Extension Contact	0.011 (1.99)*	0.023 (1.19)	-0.013(0.61)	0.017(0.87)	0.063 (2.01)**
Non-Farm income	7.22 -07 (1.93)*	-2.89e-08 (-0.03)	1.19e-06(1.24)	-2.44 e -06 (1.53)	0.011 (2.10)**
Location	0.03 (0.99)	0.23(6.25)***	0.044 (1.07)	0.04(1.40)	0.21(5.57)***
Age	-0.006(-0.76)	-0.02 (-0.90)	-0.0031(-1.45)	-0.0043(-1.40	-.017(-0.25)
Scale of operation	0.04 (2.14)**	-0.18(-2.23)**	0.30(2.60)***	0.27 (2.30)**	-0.12(-3.65)***
Distance to market	-0.004(-0.43)	0.002 (1.04)	-0.003(-1.04)	-0.0032(-1.33)	-0.0039(-0.18)
R^2	0.26	0.23	0.14	0.21	0. 22
F-value	7.55***	5.77***	2.05**	2.09**	7.24***

*Significant at 10 percent, **Significant at 5 percent, ***Significant at 1 percent

Source: Field Survey, 2013.

CONCLUSIONS AND RECOMMENDATIONS

Rice was the major crop grown in the area and it was also the most productive. But opportunities exist in the area for increasing productivity of resources used in producing each of the crops given the observed productivity gaps. The major determinants of productivity were farmer's household size, number of contacts with extension worker, amount of non-farm income earned and scale of operation.

The results of the study show in part that productivity of resources in arable crop production under the irrigation project could be increased by promoting more interaction between extension agents and farmers. More effective interaction between the farmers and the extension workers thus could promote appropriate utilization of the inputs and other production technologies and increase crop yields which are currently below potentials. However, for such a policy to work, the improved inputs have to be made readily available at affordable prices to the farmers. Furthermore, the positive effect of non-farm income on productivity suggests that farmers could increase productivity if they have access to additional income other than what is earned from their own farms. In addition, since livestock rearing is already part of the culture of the people in the area, it could be targeted for development as an important alternative income source. Efforts should also be made to promote non-farm employment by establishing industries, particularly those based on processing of farm products such as tomato and rice, in the area.

Finally, since the study finding have shown that farmers were operating in stage one of production and that scale of operation positively influenced productivity, the farmers could increase their productivity and income by increasing their farm sizes. Farmers cultivate small farms under the scheme probably because of paucity of suitable land. This has restricted not just the number of farmers who could participate, but also the sizes of land per participant. Bringing all the planned area for the irrigation project into cultivation as suggested earlier could alleviate this problem.

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