Impact of Agricultural Water Management Activities on Rural Poverty Alleviation with Reference to *Gash* Scheme, Sudan (2013)

Hysum Ibrahim Mohammed[1]
Ali Adeeb Mohamed[2]

Abstract

Poverty alleviation is an essential issue for development process, and it considered as one of UN Millennium Development Goals (MDGs), there is worldwide agreement on the role of poverty alleviation as target of development policies and strategies, particularly for country like Sudan, which has high poverty incidence in rural and urban areas. This study aimed at investigating the impact of agricultural water management activities on alleviate rural poverty in Sudan: with reference to *Gash* scheme, Kassala State. The research depended on primary data collected by means of a questionnaire, which is distributed to a sample contained 240 respondents in the study area, half of them are members of Water User Associations (WUAs) and the other half are not members (control group). Also the study measured the level of income and expenditure poverty and the differences between means for some variables among the two groups of the study. The logistic regression model has been adopted for predicting either some of the respondents can escape poverty line according to some basic characteristics or not. The results suggested that the income and expenditure poverty indices have declined among the members of WUAs than non-members. The results revealed that there is significant differences between means of the two groups of study in favor of WUAs members, in term of household income, total revenues of the farm, household educational years and the total costs of the farming. The results of binary logistic regression model showed that households headed by member of water user associations are 3.8 times more likely to be above the poverty line than those headed by non members of theses associations and the household headed by literate persons are 1.3 more likely have a chance to escape poverty line than those households headed by illiterate persons.

[1] Assistant professor. Dept. of Rural Development, Faculty of Economics and Rural Development, University of Gezira. Email: hytham.ibrahim@yahoo.com
[2] Professor. Institute of Water Management and Irrigation, University of Gezira

أثر نشاطات إدارة المياه على التخفيف من وطأة الفقر الريفي
في مشروع القاش, السودان (2013م)

المستخلص

التخفيف من وطأة الفقر قضية مهمة لعملية التنمية، ويعتبر أحد أهداف الأمم المتحدة التنموية للألفية. هنالك اتفاق عالمي عن دور التخفيف من الفقر كهدف لسياسات واستراتيجيات التنمية, بصورة خاصة في دولة كالسودان, التي لديها معدلات فقر مرتفعة في المناطق الريفية والحضرية. هذه الدراسة هدفت إلى تقصي أثر نشاطات إدارة المياه الزراعية في التخفيف من الفقر الريفي في السودان: بالرجوع إلي مشروع القاش بولاية كسلا. اعتمدت الدراسة على بيانات أولية جمعت عن طريق الاستبيان, وزع على عينة مكونة من 240 مبحوثاً في منطقة الدراسة, نصفهم أعضاء في روابط مستخدمي المياه والنصف الأخر غير أعضاء (مجموعة ضابطة). تقصّت الدراسة كلاً من مستوى فقر الدخل والإنفاق والفروق في المتوسطات لبعض المتغيرات في أوساط مجموعتي الدراسة. تم تبني نموذج الانحدار اللوجستي الثنائي للتنبؤ بالأسر التي يمكنها تجاوز خط الفقر وفق بعض الخصائص. أوضحت نتائج الدراسة أن مؤشرات فقر الدخل والإنفاق قد انخفضت في أوساط أعضاء روابط مستخدمي المياه أكثر منه عند غير الأعضاء، كما أكدت النتائج أن هناك فروقاً معنوية في المتوسطات لمجموعتي الدراسة لصالح أعضاء روابط مستخدمي المياه, فيما يتعلق بإنفاق الأسرة, العائدات الكلية للمزرعة, أعوام تعليم الأسرة والتكاليف الكلية للزراعة. أوضحت نتائج الانحدار اللوجستي أن فرص أعضاء روابط مستخدمي المياه في تجاوز الفقر تكبر(3.8) مرة عن فرص غير الأعضاء. واعتماداً على المستوى التعليمي، فقد أوضحت النتائج أن فرص الأسر التي أربابها من المتعلمين في تجاوز الفقر(1.3) مرة أكبر من غير المتعلمين.

INTRODUCTION

Poverty as a socio-economic phenomenon is still widespread worldwide, particularly in developing countries with very high concentration on rural areas, where people depend in their livelihood on agricultural activities. World Bank (2008) addressed that, in the 21st century agricultural sector continues to be a major instrument for poverty reduction and sustainable development, where the governments and NGOs in developing courtiers working to realize the Millennium Development Goal (MDG) of reducing poverty and hunger to half by the end of 2015 and continuing reducing poverty and hunger for many decades after. For Sudan case, widespread and mass poverty affecting the majority of the Sudanese people, particularly those who live in rural areas and work in traditional agricultural sector (United Nations Development Program, 1990). According to Narmara (2010) water is critically important to the livelihoods of about 1 billion people living on less than US$1 a day, particularly for the 850 million rural poor engaged in agriculture. In many developing countries, water is a major factor constraining agriculture production and hence income of the rural poor. Improved agricultural water management can contribute to poverty reduction through several ways: improving accessibility to water increasing production and productivity, creating employment opportunities and increasing income and consumption. Water is essential for human well-being. Water used in both productive and consumptive activities and contributes to rural and urban livelihoods in myriad ways. Adequate access to water is a prerequisite for realization of development. Water resource development can address poverty, improve well-being, and enhance people's freedoms and opportunities, to accumulate assets that make people have dignified live. According (1999) poverty remains a major feature of many developing countries, despite over a century of debate and action and over forty years of international aid to improve the livelihoods of the poor. There is evidence that for many developing countries increasing agricultural productivity is essential for poverty reduction. High economic growth, increased incomes and improved nutrition have been associated to improvements in rural development in many countries in Asia, but several countries in Africa experienced real declines in agricultural growth and also showed the lowest growth in national GNP and an increase in poverty from 1970s-1990s. Irrigated agriculture provides 40% of world food production on only 17% of total cultivated land.

The World Food Summit in 1996 estimated that 60% of the extra food required to sustain the world in the future must come from irrigated agriculture. Much of this increase must come from improvements in existing schemes, as new sites for development are scarce.

The declaration of 2005- 2015 as decade of water for life has been made in Johannesburg (2002) argued that the political commitment is only poorly translated into concerted sustainable actions on the ground. Also water hardly figures in many poverty reduction strategies. Water management in many countries is stagnant or falling. The effective poverty targeting in water management, an issue discussed in more depth in may international meetings (UNEP,2005). According to Cornwall (2008) water management would be instrument for narrowing the focus on water supply and population growth. Irrigation Management (PIM) and Irrigation Management Transfer (IMT) emerged in a neo-liberal context, when most of developing countries have adopted the structural adjustment policies, which is stemmed from the idea that water has to be managed exclusively by the state and its institutions with participation of water users in groups and organizations they could take over specific responsibilities and tasks in water management that the state was no longer capable of or willing to finance. These new participatory policies ranged from increasing users involvement in irrigation management as a supplement to state management (PIM) to transferring full

responsibility and control over resources to organized users (IMT). Initially, these policies were inspired by the idea that it is possible to replicate in public schemes the kind of local self-governance commonly observed in communal irrigation systems. Many donors and governments supported the transfer of management responsibilities to farmer as target groups and their organizations, with the aim for improving the accountability and responsibility of the irrigation to service farmers, make this service more cost-effective, motivate farmers to invest more in maintaining irrigation systems and, ultimately, make irrigation systems more productive and sustainable (Carces, 2007). Water User Associations have been formulated of farmers in Gezira and *Gash* Schemes in 2005, which were formulated to be participated in of some of decisions related to irrigation management, the Government official institutions based on the participatory approaches, they transferred the responsibilities of managing, maintaining and collecting irrigation costs to farmers associations in each irrigation area. According to IFAD (2001) Sudan as one of the developing counties does not has shortage in water resource but the important issue is the managing of available water resources to accelerate economic growth and alleviating rural poverty, Many previous studies conducted in Sudan in different aspects of poverty alleviation but none of them studied the contribution of natural resources management to alleviate poverty, which is essential for Sudan as a country has tremendous natural resources such as water, land, animals and mineral resources. This study investigated the impact of agricultural water management as engine on alleviating rural poverty in Sudan with reference to *Gash* Scheme, Kassala States in the Year 2013.

MATERIALS AND METHODOLOGY

Kassala State is one of the 18 states of the Sudan, covers an area of 42,330 square kilometers. It bordered by Eritrea to the east, the Red Sea state to the north, Nahral-Neel and Khartoum State to the west, and Gadarif state to the southwest. The state's water resources are represented in the seasonal Atbara and Gash Rivers, besides seasonal rains and a number of streams and valleys. The state produces banana, fruits and onion. It has famous agricultural schemes such as New Halfa Sugar Scheme and Gash Agricultural Scheme. The Gash Delta is approximately 280,000 hectares of land, 180,000 of which is allotted to the Gash Agricultural Scheme. About 100,000 hectares are irrigated land, representing the Gash Irrigation Scheme, which is supplied primarily by the Gash River. The study depended on primary data collected from random sample of 240 farmers in *Gash* Scheme in Kassala State, Sudan, which represented target groups (members of water user associations) and control group (non members of water user associations). The questionnaire has used as means of data collection. The research selected three agricultural areas in *Gash* Scheme, namely, Kassala, Malaki and Degain. The collected data have been analyzed through Statistical Package for Social Science (SPSS) and Microsoft Excel programs. The sample has been selected according to the following formula of Cochrane (1979):

$$n = Z_{\alpha}^{2} \frac{\pi(1-\pi)}{d^{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where:

Z_{α} : the standardized variable that corresponds to the 95% confidence level.

π : proportion of the rural poor in the study area, which is determined according to poverty incidence in some studies, notably Sayied (2006).

d : the desired marginal error (or precision). applying the above equation, we have:

$$n = (1.96)^2 \frac{(0.95)(0.05)}{(0.05)^2} = 80$$

Eighty respondents of households in each of the three agricultural areas in *Gash* Scheme have been selected, Thus, the total sample is equal to 240 households.

Poverty Measurements:

Based on the poverty line estimates, three standard poverty indices were calculated based on the more general formulas suggested by Foster et al (1984) given by:

$$P_\alpha = \frac{1}{n}\sum_{i=1}^{q}\frac{(z-y_i)^\alpha}{z}, \alpha \geq 0 \quad \text{.....(2)}$$

where:

P_α : poverty measure , q: number of the poor, Z : the poverty line, yi: income or expenditure of poor individual i. and n: total population.

When α = 0, we obtain the head-count index (p_0), which is used commonly for measuring poverty, this index is defined as the proportion of the number of households with income level that falls below the poverty line in the total population. This is simply obtained by counting the number of the poor whose incomes fall below the poverty line and calculating their percentage in the total population. It measures the poverty incidence, which is given by the following formula:

$$P_0 = \frac{q}{n} \quad \text{.....(3)}$$

Where q is the number of the poor, and n is the total population. This index measured the extent of the spread of poverty in the society.

When α = 1, we obtain the poverty gap index (P_1), measuring the depth of poverty, which is given by:

$$P_1 = \frac{1}{n}\sum_{i=1}^{q}\frac{(z-y_i)}{z} \quad \text{.....(4)}$$

Finally when α = 2, we obtain the squared poverty gap index (P_2) which is given by:

$$P_2 = \frac{1}{n}\sum_{i=1}^{q}\frac{(z-y_i)^2}{z} \quad \text{.....(5)}$$

Student's t-statistic to test

The student's t-statistic have been used for measuring the difference between the means of some variables, such as households expenditure, total revenues of the farm, total costs of farming, distance of farm from irrigation source and family education years for the sample of members of water user associations and that of the control group. The standard Trapezium formula for the t-test is given by:

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\hat{\sigma}\sqrt{\frac{1}{T_1} + \frac{1}{T_2}}} \quad \text{.....(6)}$$

Which follows the t-distribution with v = (T_1+ T_2 – 2) degree of freedom, where T_i and $\overline{X}_i$ are the size an mean of sample i (i = 1, 2), respectively.

Also the research has adopted the binary logistic regression model of rural poverty to predict the households who can escape poverty line according to certain characteristics, which is defined as a line that separates between the poor and non-poor. Based on this, the study can argues that poverty is a binary variable in its nature that a household is either poor or not poor. In this variable can take the value 1 with a probability of success equals, or the value 0 with probability of failure equals 1-. The model is given by:

$$\theta(x)=\frac{1}{1+\exp[-(\alpha+\beta_1 x_1+\beta_2 x_2+...+\beta_k x_k)]} \quad \text{.....(7)}$$

where α is the constant term and βx is the coefficient of the predictor variable x, and θ is the probability that a certain event (or choice) occurs (is made) given knowledge of the xi variables (Scott, 1995).

RESULTS AND DISCUSSION

The results showed that all respondents are males. This may be due to cultural factors reducing the sharing of women in agricultural activities, for this reason the researcher did not meet any woman as a head of household during the survey. the researcher observed from direct interviews during the survey that most of farmers mentioned that they faced a problem of weeds (Mesquite), also they mentioned that the continuing extension of the residual sector tend to cut parts of their agricultural land and this presented one of serious problems for them, which restricted their agricultural lands. Also the researcher noticed that most of the respondents depended on their family members as agricultural labor force in the study area.

Income and expenditure poverty measurements

For measuring the poverty firstly the study in need to poverty lines for both groups members water user associations and non members using the household income. For this purpose the results showed that the subjective poverty lines for the members and non members are counted to about SDGs 2657 and 1956, respectively, based on this cut off point between poor and non poor the researcher calculated three well-known poverty indices namely poverty incidence, depth and severity as in Table (1):

As shown in Table (1) the results of poverty measurement when the research used the income as welfare indicator showed that the poverty incidence of members of water user associations is 70 percent compared to 78 percent of non members. For the depth and severity of poverty the results revealed that for the members of water user associations the depth of poverty is 60 percent and the severity of poverty is 21 percent, whereas for non members the poverty depth is 67 percent and the severity of poverty is 38 percent. When the study used the household expenditure as welfare indicator the results reported that for the members of water users associations the incidence of poverty is 79 compared to 84 for non members. The poverty depth of the members of water user associations is 60 percent whereas for non members is 78 percent. The severity of poverty for the members of water user associations is 32 percent while for non members is 42 percent. From these results the researcher could abstract that the membership of water users associations has reduced slightly the poverty. Also he noticed that when he used the household expenditure as welfare indicator he found that the incidence, depth and severity of poverty are high than when he used the household income as welfare indicator this may indicated that the household expenditure as a wellbeing indicator is better than household income.

Table (1): Poverty indices

Using income as welfare indicator		
Poverty indices	Members	Non members
P	70	78
P1	60	67
P2	21	38
Using expenditure as welfare indicator		
P0	79	84
P1	60	78
P2	32	42

Source: own calculations based on the survey data.

Testing the Difference between Means:

Based on survey the researcher used standard formula to calculate the arithmetic means of family expenditure, total revenues of farm, total cost of farm, distance of farm from irrigation source and family education years for the beneficiaries and non-beneficiaries in both study areas. the Student's t-test is conducted on the standard formula outlined in the methodology.

Student's Statistical t-test.

From these results, the study observed that the mean family expenditure of the members is greater than that of non members. the t-statistic for the difference between means of family expenditure is statistically significant at (0.00). This means that membership of water user associations has led to a significant improvement in at least some of family expenditure of the members, if not all of them. As the study used expenditure as one of the welfare indicators, the researcher can argued that membership of water user associations led to improvements in the welfare of the members and then can reduce rural poverty in the study area. The results revealed that for the mean of total farm revenues of members is greater than that of non members, at significant level (0.02), this means that the membership of water user associations has improved the farm revues among members, this may increase farmer income and reduce poverty.

For the variable total cost of farm the result confirmed that mean of the variable among the members is less than that of non members at significant level (0.01), this indicated that membership of water user associations can reduce the total cost of agricultural activities. Also the study confirmed that mean of distance of farm from irrigation source for member of association is less than for non members at significant level (0.03), this means that the members of water use associations have a merits to be near the irrigation source than those who are not members. Finally the results suggested that the means of family educational years is greater of members than that of non members at significant level (0.01), this indicates that the membership of water user associations has improved the educational level among the members family members, thus can increase their productivity and incomes hence it may reduce rural poverty.

Table (2): Student's t-test for the difference between means

Variable in (SDGs)	Group Means		t-ratio	Significance Level
	Members	Non members		
family expenditure	2159 (12.34)	1742 (12.34)	21.0	0.00
total revenues of farm	3785 (32.06)	2920 (27.24)	14.4	0.02
total cost of farm	2010 (12.70)	2660 (24.87)	16.07	0.01
Variable in(meters)	**Members**	**Non members**		
distance of farm from irrigation source	1102 (13.19)	1788 (25.59)	12.2	0.03
Variable in(years)	**Members**	**Non members**		
family educational years	28.28 (20.95)	23.14 (13.23)	22.1	0.01

Source: own calculations based on the survey

Logistic Regression Results:

Logistic regression has been used to predict the dependent variable (poor/not poor) based on the basis of four independent variables, namely membership of water user associations (member/ not member), educational level of head of household (literate/ illiterate), whether the household have toilet in their houses or not (having /not having) and the a availability of electricity in household house (available/not available). Subjective poverty lines have been used to classify the dependent variable into (poor/not poor). These poverty lines are calculated on the basis of household income and household expenditure as welfare indicators. In what follows the researcher reports the logistic regression results corresponding to respondents in *Gash* Scheme, Kassala state. The study classified the dependent variable (poor/ not poor) based on the poverty line calculated on the basis of income as a welfare indicator. Using SPSS software and the data collected from the survey, the researcher has estimated the binary logistic regression model. This binary logistic regression results are reported in Table (3) below. The first column shows the tested variables, the seconded one shows how these variables are binary in nature, the third column shows the values of chi square test and the forth column showed the significant levels of chi square test. The results revealed that there are some independent variables that reported to be statistically highly significant in influencing the dependent variable. These variables are the membership of water user associations (member/not member), educational level of head of household (literate/ illiterate), whether the household has toilet in their house or not (having/ not having) and the viability of electricity services in household house (available /not available). These results showed as follows:

Table (3) Logistic Regression Results

Variables	Binary nature	Chi square value	P value
WUAs	Member / non member	17.54	(0.000
Educational level	literate / illiterate	14.33	(0.020)
Having toilet	Having /not having	18.32	(0.002)
Having electricity	available /not available	16.25	(0.0200

Source: own calculations based on the survey data.

For interpreting the results logistic regression model the study in need to calculate the odds ratio, namely Exp (β) the odds for the statistically significant variables are reported in table (4).

As shown in Table (4) below and based on income as a welfare indicator, the results suggest that households headed by members of water use associations are more likely to escape poverty than those headed by non members of water user associations. Precisely these results suggest that households headed by member of water user associations are 3.8 times more likely to be better than those headed by non members of theses associations. Furthermore these results indicated that members of water user associations have a better chance to escape poverty relative to those who are not members of these associations. The results confirm that the household headed by literate persons are 1.3 more likely have a chance to escape poverty line than those household headed by illiterate persons, this indicated that the education can reduce poverty among the rural producers. The results confirmed that households have toilets in their houses are 3.4 more likely to escape poverty than those who have no toilets in their houses, this means that the availability of toilet inside the houses may improve the health status among the farmers then help them to increase their productivity and escape poverty. Also the results suggested that households that have electricity services in houses are 2.03 more likely to escape poverty line than those who have no electricity in their houses.

Table (4) The Odds Ratios for Significant Variables

Characteristics of Heads of Households	Odds Ratios [Exp (β)]
Member/non member	3.8
literate/ illiterate	1.3
having toilet/ not having toilet	3.4
having electricity / not having electricity	2.03

Source: own calculations based on the survey data.

CONCLUSION

The study concluded that the water user associations as water management activity has reduced slightly the income and expenditure poverty in the study area. The study revealed that the membership of WUAs has increased the family expenditure, total revenues of the farm, educational year of household and reducing the distance of farm from irrigation source and total costs of farming. Furthermore the results indicated that members of water user associations have a better chance to escape poverty relative to those who are not members of these associations. Also the results indicated that the education can reduce poverty among the rural producers. Finely the study confirmed that the availability of toilet inside the houses may improve the health status among the farmers hence help them to increase their productivity and escape poverty.

The study recommended the following:

1. The policy makers may expand the participation of farmers in all agricultural activities, which is encroaching them to work hard for escaping poverty line.
2. The Government of Kassala state may support the educational processes for helping rural households to enhanced their education and then alleviate poverty.
3. The local governments may raise the awareness of rural people about the availability of toilets in their houses, which is improving their health status increase and productivity.

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