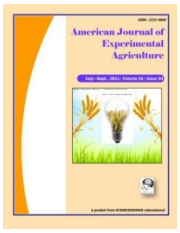

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Socio-economic Effects of Schistosomiasis on Irrigation Rice Growers in Morogoro, Tanzania

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Research Article

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ABSTRACT

Aims: To assess Socio-economic effects of schistosomiasis on irrigation rice farmers in Modern, Improved traditional and Traditional irrigation schemes in Morogoro Region.
Study Design: Cross-sectional study.
Place and Duration of Study: Mkindo (improved traditional) in Mvomero district, and Mwega (Modern) and Chabi (Traditional) in Kilosa District, between March and April 2010.
Methodology: In each scheme we used 40 farmers practicing irrigation rice farming. Between-scheme differences for infected farmers were tested using one way-ANOVA, and t-test for differences between infected and non-infected farmers within and irrespective of schemes.
Results: Over 60% of all farmers surveyed reported to have had suffered from schistosomiasis, with traditional scheme exhibiting the highest number. Differences in financial expenditures on treatment and care were detected between improved traditional and traditional ($P<0.001$), and improved traditional and modern ($p=0.014$). Similarly, hours spent on treatment and care differed between improved traditional and traditional ($p=0.001$) and between traditional and modern ($p=0.028$). Additionally, net working hours per month differed between traditional and improved traditional ($p=0.002$) and between traditional and modern ($p=0.056$). Contrary, only net working hours per month differed between infected and non-infected farmers within traditional ($p=0.003$) and modern ($p=0.001$) before and after converting hours spent on caring of oneself/other family members into monetary cost. The same variable exhibited significant difference all schemes pooled together ($p<0.001$). Results of this study contravene the hypothesis that farmers in the modern scheme would have high income balance compared to farmers in traditional and improved traditional.

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Conclusion: Four key conclusions were reached:

1) Contrary to our expectation, net income balance remained highest in the improved traditional scheme both before and after conversion of time spent on treatment and care into monetary cost, but remained smallest amount in the traditional scheme.
2) Failure of expenditures related to treatment and care to trigger significant difference in net income balance between infected and non-infected farmers, both between and within schemes caused the proposed hypothesis not to be accepted.
3) Apparently, the family that replaces the labour of a family that fails to indulge in production process due to schistosomiasis illness is likely to undergo an economic cost as they will have abandoned their own production activities. But then, the tendency of ignoring such cost is deep rooted in many African traditions including rice farmers in Morogoro schemes thus causing underestimation of the actual Socio-economic cost of schistosomiasis in Sub-Sahara Africa.
4) Occurrence of higher expenditures on treatment and care in traditional than in modern and improved traditional schemes justify the need for improvement of traditional irrigation infrastructures and cleanliness as well as training on water management and cropping calendar that would "cut" the pathways of schistosomiasis transmission.

Keywords: Irrigated agriculture; schistosomiasis; socio-economic effects; Morogoro; Tanzania.

1. INTRODUCTION

Schistosomiasis is an important fatal water-borne tropical disease that is increasing in the tropics as a result of landscape changes associated with the building of dams and the expansion of irrigation (Patz et al., 2000). The disease burdens and reduces the quality of life of those people infected (Stephenson et al., 1989). It is considered as a disease of poverty because it persists in rural marginalized areas of Sub-Saharan Africa whose people are often subsistence farmers living on meager incomes and with no education (Watts, 2008). Regardless of the burden it causes, the disease often receives little attention by healthcare providers, national governments and international agencies compared to malaria, HIV/AIDS and tuberculosis, childhood diseases and diarrhea, simply because not every individual infected becomes immediately ill (Michaud et al., 2003). In Africa alone, about 192 million cases of schistosomiasis have been reported, with Nigeria ranking the highest (15% of the cases) followed by the United Republic of Tanzania (about 10% of the cases) and the Democratic Republic of Congo and Ghana with 7.8% of the cases each (Hotez et al., 2009). About 200,000 deaths per annum occur as a result of this pandemic, mainly through bladder cancer and renal failure driven by urinary schistosomiasis and liver fibrosis due to intestinal schistosomiasis.

Schistosomiasis has substantially reduced labour productivity in Egypt, Sudan and Tanzania. In Egypt, for example, labour output dropped as much as 35% among infected groups (Guy, 1991) whereas, in Nigeria, the disease reduced worker productivity, cash income, rates of land clearing and farm size (Umeh et al., 2004). Similarly, studies on sugar plantations in Tanzania and Sudan showed that infected workers produced 10 to 15% less than non-infected workers (Guy, 1991).

Schistosome worms known as Cercariae live in water and they infect irrigation rice growers by penetrating their skins as they work in the rice fields. Although a clear understanding of schistosomiasis and its effect on the socio-economy of farming communities is vital, such knowledge is scanty in Tanzania**.** Existing information is based on morbidity of individuals infected by the disease only for modern irrigation schemes (F.S. Kisanga, University of Dar es Salaam, Tanzania, Unpublished results; Kiwelu et al., 1991). With regard to prevalence, the existing information is biased towards school children (Ndyomugyenyi and Minjas, 2001; Brooker et al., 2001; Booth et al., 1998; Lengeler et al., 1991; Hatz et al., 1998; Lwambo, 1988). Therefore, this study compares the effects of the disease on the socio-economy of rice growers of three different irrigation schemes (modern, improved traditional and traditional) in Morogoro Region. The study hypothesizes that irrigation farmers in the modern scheme will have a high income balance compared to farmers in traditional and improved traditional schemes. The study predicts that expenditure related to treatment and care of oneself/other family members as a result of schistosomiasis will underlie the difference in net income balance between the schemes. In order to have a good knowledge of the interaction between irrigation farming communities and schistosomiasis, this study deems it important to understand the demographic attributes of the farmers studied.

2. MATERIALS AND METHODS

2.1 Study Areas

Three types of irrigation schemes differing in terms of their designs – i.e. Mkindo, Mwega and Chabi – were selected in Morogoro Region, Tanzania. Mkindo is considered as an 'improved traditional scheme' because its intake, division structures and part of the main canal is constructed using concrete materials while the rest of the infrastructures are earth lined. Mkindo scheme was initiated in 1982 and uses the Mkindo River, which originates from the Nguru South forest reserve as a source of water for irrigation (PEMA, 2003). Mwega is a 'modern scheme' since its intake, main canal, secondary canals, drop and division structures are concrete lined. However, Chabi is categorized as a 'traditional irrigation scheme' because its intake, main and secondary canals and other infrastructures are earth lined/constructed using natural materials. These schemes were chosen because they have not received in-depth research attention of the kind presented here before.

Mkindo scheme is located in Mvomero district between 8 - 10º S and 28 – 37º E (Mboera et al., 2007) while Mwega and Chabi schemes are located in Kilosa district, 06º42'S and 37º02'E (www.agriculture.go.tz/Organization structure/ARD/eastern zone.html). Mvomero district has a land area of 7,325 km^2 and the average annual temperatures range from 20º-30ºC (Mlozi et al., 2006). The northern area has a humid to sub-humid climate and annual rainfall ranges from 1500 to 2000 mm while the southern part of the district is much drier with annual rainfall between 600 mm and 1200 mm (Karimuribo et al., 2005). Overall, the rainfall is bimodal with a short wet season from October to December and a long wet season from March to May. The topography is almost flat, with an average attitude of 414 m above sea level and a land slope of 0% to 1%. The soils are considered to originate from the parent material, which is Mica-rich alluvium of diverse origin (Msanya et al., 2003). Three ethnic groups dominate the district, these are the Luguru, the Kaguru and the Kwere and the human population is estimated at 259,347 residents (URT, 2006).

Kilosa district is twice the size of Mvomero district, with a land area of 14,245 km^2. Rainfall is also bimodal, with short- and long wet seasons occurring at about the same period of time

as in Mvomero district. The dominant ethnic groups are the Kaguru, the Sagara and the Vidunda, and the total human population is estimated at 488,191 people (URT, 2006). The dominant soils in Mwega and Chabi are vertisols and fluvisols. Although agriculture is the main land-use type both in Mwega and Chabi, primarily through irrigated farming (maize, beans, rice and onions), rainfall is scanty and sporadic, such that the two areas hardly receive an annual rainfall of about 360 mm.

Mwega scheme lies on a riverine terrace that has an altitude ranging from 615m to 535m above sea level, with a land slope ranging from 0% to 0.5%. The maximum temperature for the Mwega and the Chabi schemes spans from 27 ºC to 35 ºC.

2.2 Study Design and Sampling Procedure

A cross-sectional study design using structured interview as a method of collecting data was carried out from March to April 2010. The study employed disproportionate stratified sampling because of its comparative advantages over proportionate stratified sampling (Babbie, 2001). Stratification was based on farmers' location in the scheme –i.e. upstream, middle stream and downstream. Each village government in all schemes through village extension officers provided a list of irrigation rice growers including their names, sex and location in the scheme. Then, names of farmers were randomly selected. Structured interviews were carried out through questions administered to a total of 120 farmers in all three schemes, 40 farmers in each scheme. Information on the number of rice acres cultivated, the amount of rice produced, the amount of rice sold, and the amount of money accrued from rice sales and expenditure on schistosomiasis treatment and care were focused on. Other variables recorded were net working hours per month, net working days per season, and the total number of hours spent on schistosomiasis treatment and care.

2.3 Data Analysis

Data were first checked for normal distribution using Kolmogorov-Smirnov test (level of significance: p=0.05). After ascertaining the normal distribution, between-scheme difference for infected farmers on the above variables were tested using one way Analysis of Variance (one way-ANOVA) and a t-test to test for differences on the same variables between infected and non-infected farmers within schemes and irrespective of schemes. Percentages were additionally used to describe the data.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Overview of demographic characteristics of the sample population of farmers

Out of 120 farmers sampled in the three irrigation schemes, 69 were male and 51 female. Further, 80% of the sampled population was at a productive age of 20 to 50 years while 20% were over 50 years. With regard to marital status, 82% were married, 12.5% were single while the rest comprised widows, widowers and divorced. While majority of the farmers (86.7%) had primary-school-level education; 7.5% were illiterate and 5.8% had secondary-school-level education and above. The proportions of farmers for each demographic characteristic were not uniform throughout the three types of irrigations schemes (Table 1).

Table 1. Socio-demographic characteristics and proportion of farmers investigated in the surveyed irrigation schemes in Morogoro Region

Characteristics	Scheme areas		
	Improved traditional (Mkindo)	Traditional (Chabi)	Modern (Mwega)
Age category of respondents			
-Work force category	21- 50 years (72.5%)	20 - 50 years (87.5%)	20 - 50 years (82.5%)
-Senescent category	Above 50 years (27.5%)	Above 50 years (12.5%)	Above 50 years (17.5%)
Sex			
-Male	52.5%	67.5%	50%
-Female	47.5%	32.5%	50%
Education level			
-Primary	82.5%	85	92.5%
-Secondary	2.5%	7.5%	5%
-Above secondary school	2.5%	0%	0%
-illiterate	12.5%	7.5%	2.5%
Marital status			
-Single	12.5%	7.5%	5%
-Married	75%	92.5%	87.5%
- Widow	7.5%	0%	5%
-Widowed	0%	0%	0%
-Divorced	5%	0%	2.5%

3.1.2. Socio-economic effects of schistosomiasis

3.1.2.1. Comparison of infected farmers between schemes

Over 60% (63.3%) of all farmers surveyed reported to have had at one time in their life suffered from schistosomiasis illness. The traditional scheme (Chabi) exhibited the highest number of victims, whereas the improved traditional irrigation scheme (Mkindo) and modern irrigation schemes (Mwega) had about the same number (Table 2a). Financial expenditure on schistosomiasis treatment and care among infected farmers differed significantly between modern, improved traditional and traditional schemes. The differences were detected between improved traditional and traditional schemes ($P<0.001$) and between improved traditional and modern schemes (Table 2b). In this regard, a comparatively larger proportion of infected farmers in the traditional scheme spent about Tshs 51,000.00 to 100,000.00 from rice sales on treatment and care due to schistosomiasis illness compared to infected farmers in other schemes (Table 2a). Also, the tendency of infected farmers to sell crops such as maize, assets such as radios and bicycles or livestock to raise money for treatment and care of themselves or of a family member was more prominent in traditional compared to infected farmers in improved traditional and modern irrigation schemes (Table 2a).

Table 2a. Cost of schistosomiasis to surveyed farmers in Improved traditional, traditional and Modern irrigation schemes in 2009 (time lost due to schistosomiasis illness not converted into monetary terms)

Variables		Percentage of farmer's response in irrigation schemes			
		Improved traditional (Mkindo)	Traditional (Chabi)	Modern (Mwega)	Total
Farmers infected by schistosomiasis		24(32)	29 (38)	23(30)	76(100)
Working days lost	1-3	20(26.3)	2(2.6)	3(4.0)	25(32.9)
	4-13	2(2.6)	19(25)	21(27.6)	42(55.2)
	14-30	2(2.6)	7(9.2	0	9(11.8)
Monetary cost (Tshs.)	5,000-50,000	18(23.7)	19(25)	19(25)	56(73.7)
	51,000-100,000	0	8(10.5)	3(3.9)	11(14.4)
Loss of crops and assets	Sold maize	0	5(6.6)	3(3.9)	8(10.5)
	Sold bicycle, radio and mattress	0	1 (1.3)	0	1(1.3)
	Sold livestocks such as goat and chicken	4(5.2)	6(7.9)	1(1.3)	11(14.4)

** Number in parenthesis refers to percentage of infected farmers (respondents).*

Similarly, there were significant differences on hours spent on schistosomiasis treatment and care and on number of net working hours per month between schemes (Table 2b). The difference on hours spent on schistosomiasis treatment and care was found between infected farmers in improved traditional and traditional schemes and between traditional and modern irrigation schemes (Table 2b). Contrary, differences on the number of net working hours per month were found between traditional and improved traditional, and were marginally different between traditional and modern schemes (Table 2b).

Table 2b. Multiple comparisons (using Tukey HSD) of time spent and expenditures associated with treatment and care of oneself or a family member due to schistosomiasis illness between improved traditional, traditional and modern irrigation schemes

Variable	Multiple comparison between schemes	p-value
Hours spent on schistosomiasis treatment and care	Traditional versus improved traditional	<0.001
	Traditional versus modern	0.028
Net working hours per month	Traditional versus Improved traditional	0.002
	Traditional versus modern	0.056
Money spent on treatment and care	Improved traditional versus traditional	<0.001
	Improved traditional versus modern	0.014

3.1.2.2 Comparison of infected versus non-infected farmers: all schemes pooled together

Only net working hours per month showed a significant difference between infected and non-infected farmers (Table 3). Infected farmers had 49 working hours less per month (approximately two days) than non-infected farmers (Table 3).

Table 3. Social economic effects of schistosomiasis between infected and non-infected farmers in all irrigation schemes pooled together in Morogoro Region

Variable	Mean		t- value	p-value
	Infected farmers	Non-infected farmers		
Amount of land cultivated (acres)	0.9292	0.9148	0.177	0.860
Amount of rice produced (kg)	1194.34	1267.73	-0.666	0.507
Amount of money accrued from rice sales (Tshs)	491,710	530,350.00	-0.773	0.441
Amount of money used for treatment and care (Tshs)	27,134	x	x	x
Income balance (Tshs)	474,300	530,250	-1.112	0.268
Number of hours spent on schistosomiasis treatment and care	62.74	x	x	x
Net working hours per month	152.54	201.82	-4.499	<0.001

X: statistical tests were not executable since non-infected farmers had no corresponding values for the variables

3.1.2.3 Infected farmers versus non infected farmers within schemes

Before converting time lost due to schistosomiasis treatment and care into monetary terms, net working hours per month differed significantly between infected and non-infected farmers in traditional and modern schemes (Table 4). Infected farmers in traditional schemes had about 75 less net working hours per month (equivalent to 3 working days per month) compared to the non-infected, whereas those infected in modern scheme had approximately 53 less working hours per month (equivalent to 2 working days per month) compared to the non-infected (Table 4). However, none of the variables tested showed a significant difference between infected and non-infected farmers for the improved traditional scheme (Table 4).

Conversion of time lost due to schistosomiasis illness into monetary loss did not result in significant differences between infected and non-infected farmers for the other variables (Table 5).

Table 4. Social economic effects of schistosomiasis between infected and non-infected farmers in Modern, Improved traditional and traditional irrigation Schemes in Morogoro Region before converting time spent on schistosomiasis treatment and care into monetary terms in 2009

Variable	Improved traditional (Mkindo)			Traditional (Chabi)			Modern (Mwega)		
	Infected	Non-infected	p-value	Infected	Non-infected	p-value	Infected	Non-infected	p-value
Amount of land cultivated (acres)	0.8071	0.8125	0.970	1.0086	0.9773	0.836	0.9565	0.9706	0.918
Amount of rice sold (kg)	1035.83	1149.33	0.574	885.17	899.09	0.929	1052.61	1087.06	0.836
Amount of money accrued from rice sales (Tshs)	517,920	574,670	0.574	442,590	449,550	0.929	526,300	543,530	0.836
Income balance (Tshs)	508,750	574,330	0.517	408,660	449,550	0.607	498,390	543,560	0.590
Amount of money spent on schistosomiasis treatment and care (Tshs)	12,222	0	x	35,148	0	x	29,500	0	x
Number of hours spent on schistosomiasis treatment and care	27.17	0	x	98.07	0	x	57.95	0	x
Net working hours per month	181.58	193.12	0.481	121.79	196.36	0.003	161.00	213.53	0.001

X: statistical tests were not executable since non-infected farmers had no corresponding values for the variables

Table 5. Social economic effects of schistosomiasis between infected and non-infected farmers in Modern, Improved traditional and traditional irrigation Schemes in Morogoro Region after converting time spent on schistosomiasis treatment and care into monetary terms in 2009 (exchange rate by then: 1$=Tshs 1,300.00)

Variable	Improved traditional (Mkindo)			Traditional (Chabi)			Modern (Mwega)		
	Infected	Non-infected	p-value	Infected	Non-infected	P-value	Infected	Non-infected	p-value
Amount of land cultivated (acres)	0.8071	0.8125	0.970	1.0086	0.9773	0.836	0.9565	0.9706	0.918
Amount of rice sold (kg)	1035.83	1149.33	0.574	885.17	899.09	0.929	1052.61	1087.06	0.836
Amount of money accrued from rice sales (Tshs)	517,920	574,670	0.574	442,590	449,550	0.929	526,300	543,530	0.836
Amount of money spent on schistosomiasis treatment and caring (Tshs)	29,300	0.00	x	65,534	0.00	x	50,799	0.00	x
Net income balance (Tshs)	488,620	574,330	0.393	359,120	449,550	0.258	475,810	543,560	0.406
Net working hours per month	181.58	193.12	0.481	121.79	196.36	0.003	161.00	213.53	0.001

X: statistical tests were not executable since non-infected farmers had no corresponding values for the variables.

3.2 Discussion

There were more male than female respondents interviewed in traditional irrigation scheme (chabi) compared to other schemes. Irrigation infrastructures in the traditional irrigation scheme are constructed using local materials and indigenous knowledge. Such relatively inferior construction favour accumulation of mud and vegetation overgrowth, and therefore, cleaning requires high muscular efforts, which many women cannot sustain. As result, fewer women participate in irrigated rice farming.

Apparently, schistosomiasis-infected farmers in traditional scheme spent more of their income from rice farming, other crops and assets on treatment and care. They also engaged relatively more time on schistosomiasis treatment and care, a situation which led them to have fewer working hours per month in production compared to the infected farmers in modern and improved traditional schemes. Higher expenditures on schistosomiasis treatment and care for infected farmers in the traditional irrigation scheme (Chabi) than those infected in improved traditional (Mkindo) and modern irrigation scheme (Mwega) is attributable to lack of access to health services, poor roads, and poor management of the irrigation facility/infrastructures. Health services in the improved traditional and Modern scheme are accessed through village dispensaries and further enhanced through access to other areas with better health services. Infected farmers in the traditional scheme had to travel to Mwega village located 8 km away in search of health service.

Significant difference between infected and non-infected farmers only on net working hours per month in all schemes pooled together may be due to time lost in bed or seeking for treatment/care of oneself or any other family members, a situation which does not hold for the non-infected farmers. However, there is no clear reason to account for lack of significant difference on net working hours per month between infected and non-infected farmers within both traditional and modern schemes before and after conversion of number of working days lost into monetary terms. Naturally, one would expect the converted time to have impact on the direction of trend. However, there were no differences in other variables assessed – such as the number of acres of rice cultivated, the amount of rice produced and sold, and the income balance. This finding may be interpreted in at least two ways. The first relates to the traditional compensatory system. In this case, those farmers who were infected or had a member of their family ill and therefore compelled to take some days off to attend to a patient were replaced by other family members or friends. The second possibility could be that such a family hired labour to work in the field and hence maintained the amount of work done. This study provides no conclusive situation among the two possibilities. Replacement of sick people at little or no cost and, therefore, much smaller production losses than potential losses has also been reported by Koopmanshap and Van Ineveld (1992). Also, in Sudan, Nur (1993) found that work hours lost in agriculture due to malaria were compensated for by family members. Results of this study are further supported by a study conducted in Mali (Audibert and Etard 1998), which concluded that changes in health due to schistosomiasis have no direct effect on rice production, but affect the household's use of its labour resources and its ability to utilise other resources. On the other hand, a critical examination of subsistence farming in rural Tanzania shows that farmers, including the infected farmers in rice irrigated areas, do not include hired labour into production cost or translate the family/friend's labour into monetary terms. This implies that there might be some hidden costs due to loss of productivity of the family members who are pulled out of other activities to replace an infected family work force.

Nevertheless, the monthly salary for a low-wage worker in the year 2009, ($53.3) was comparatively lower than the mean monthly income from rice production of both infected ($59.06) and of non-infected farmers ($70.7). This implies that the majority of irrigation rice growers in Morogoro Region are not among the millions of Tanzanians who live below the poverty line, $1 per day with the exception of 12 infected farmers: 1 in Improved traditional scheme (Mkindo), 7 in Traditional irrigation scheme (Chabi) and 4 in Modern irrigation scheme (Mwega) whose income from rice farming happed to be less than $1 per day after converting the number of working days spent on schistosomiasis treatment and care into monetary loss.

4. CONCLUSION

This study reaches four key conclusions.

1) Net income balance is highest in the improved traditional scheme both before and after conversion of time spent on treatment and care into monetary cost, but least in the traditional scheme.
2) The hypothesis is not supported because expenditures related to treatment and care could not trigger difference in net income balance between infected-and non-infected farmers, both between and within schemes.
3) A family that replaces the labour of their family friend due to illness is likely to undergo an economic cost following abandonment of their own production activities. However, such cost is usually not accounted for in many African traditions including rice farmers in Morogoro schemes.
4) More expenditures on treatment and care in traditional than modern and improved traditional schemes calls for improvement of traditional irrigation infrastructures and sanitation as well as training on water management and cropping calendar that would “cut” the pathways of schistosomiasis transmission.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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