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*Full Length Research Paper*

# Schistosomiasis: A comparative study of its socio-economic consequences in different types of irrigation schemes in Tanzania

**Farida S. Salehe[1], M.M.A. Mtambo[2], A.K.P.R Tarimo[3], A.Z. Mattee[4] and Shombe N. Hassan[5]**

[1]Development Studies Institute, Sokoine University of Agriculture, P.O. Box 3024 Morogoro, Tanzania.
[2]Department of Veterinary Medicine and Public Health, Sokoine University of Agriculture, P.O. Box 3021 Morogoro, Tanzania.
[3]Department of Agricultural Engineering and Land Use Planning, Sokoine University of Agriculture, P.O. Box 3003 Morogoro, Tanzania.
[4]Department of Agricultural Education and Extension, Sokoine University of Agriculture, P.O. Box 3002 Morogoro, Tanzania.
[5]Department of Wildlife Management, Sokoine University of Agriculture, P.O. Box 3073, Morogoro, Tanzania.

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**This study was carried out through a cross-sectional design in June through August, 2010 in modern, improved traditional and traditional irrigation schemes in Kilimanjaro and Morogororo Regions, Tanzania. A total of 240 irrigation rice farming respondents were selected purposively at head, middle and tail of each scheme. Interviews using structured questionnaires with closed and open-ended questions were used to collect data. T-test was used to determine variation in different variables for infected farmers between irrigation schemes, and for the same variables between infected and non-infected farmers within the same irrigation schemes. Infection was least at a traditional scheme, but high at a modern scheme both in Kilimanjaro Region. Consequently, infected farmers at Kilimanjaro modern scheme lost the highest number of working days on treatment and care of oneself/family members, 14-30 days per season compared to 4-13 days for infected farmers at a traditional scheme in Morogoro Region. We also found significant difference on income accrued from rice selling between infected farmers in modern ($p > 0.001$) and traditional schemes ($p > 0.001$). Moreover, there was a significant difference in net working hours per month between infected versus non-infected farmers in modern ($p>0.001$), improved traditional ($p = 0.006$) and traditional ($p > 0.001$) schemes. Since some of infected farmers in Morogoro schemes sold what could have been their food, assets and livestock the study concluded that schistosomiasis has not only caused illness to those infected, but it had impact on socio- economic development of those infected and their households at large.**

**Keywords:** Socio-economic effects, Schistosomiasis, Irrigation farming communities, Morogoro and Kilimanjaro Regions.

## INTRODUCTION

Schistosomiasis is a water-borne disease that has been spreading in the tropics for the past few years as a result of landscape changes associated with the establishment of irrigation schemes (Umeh et al., 2004). Vector-borne diseases such as schistosomiasis are not only an outcome, but a cause of poverty (Gallup and Sachs, 2001). Increase in morbidity and mortality, and decline in productivity due to schistosomiasis infection have effects similar to those of malaria. In Nigeria, for example, schistosomiasis reduced workers' productivity, cash income, rates of land clearing, and farm size (Umeh et al., 2004). A study done in sugarcane irrigated estate in Tanzania found a significant difference in economic productivity of about 3 to 5% between uninfected and infected schistosomiasis workers (Fenwick and Figenshou, 1971). Also, a study on paddy growers in Morogoro, in Tanzania found differences in net working hours per month between infected and non-infected farmers within traditional and modern irrigation schemes prior to and after translating time exhausted on treatment and caring of oneself/other family members into financial cost (Salehe and Hassan, 2012). Usually, direct impacts caused by schistosomiasis lead to enormous annual economic losses and inhibit socio-economic development as it lowers production and income of those people infected (Salehe and Hassan, 2012; URT, 2008; Hotez and Ferris, 2006; King et al., 2005). Further, the disease has a long term effect on the society as it impairs childhood growth and cognitive development, prevents children from attending school and adults from being productive members of their communities and work forces thus reduced productive capacity (Hotez and Kamath, 2009).

Studies on schistosomiasis and its socio-economic effects on agricultural productivity are very important for evidence-based mitigation and control measures. However, at present Tanzania lacks comparative studies on the consequences of the disease for irrigation schemes in regions located in different geographical locations. Only Salehe and Hassan (2012) compared the consequence in traditional, improved traditional and modern irrigation schemes, all in the same region, meaning that the farming communities in the three schemes have overlapping experiences in irrigation paddy growing. Therefore, this study compares the irrigation paddy growers in traditional, improved traditional and modern irrigation schemes in Morogoro region versus their counterparts in Kilimamjaro region. Because the two regions are classified under the same agro-ecological zone, we assume that the congruence in this factor resolves differences that could arise in respect of climatic characteristics. Subsequently, we expect differences in socio-economic effects of schistosomiasis on the communities to associate with separate factors, particularly those linked to planning, design and construction of irrigation infrastructures in traditional irrigation schemes. Given the fact that design and construction of infrastructures in traditional irrigation schemes is based on indigenous knowledge and materials, the considerations have a substantial influence on the quality of design, construction and water management practices. The two parameters may in turn have significant influence on the extent of schistosomiasis morbidity and mortality and thus greater socio-economic impacts. Specifically, the study seek to evaluate the effects of schistosomiasis on paddy production, amount of money and time spent on schistosomiasis treatment and care and time spent on irrigation farming activities. The study hypothesizes that traditional irrigation schemes will have more schistosomiasis infected farmers and therefore less paddy production and net income balance compared to farmers in modern and improved traditional irrigation schemes.

*Corresponding Author's E-mail: faridasalehe@yahoo.co.uk; Tel: +255 023 2604645; +255 0782 872248; Fax: +255 023 2604646

## MATERIALS AND METHODS

### Study Area

This study was conducted in six irrigation schemes namely Mkindo, Chabi and Mwega in Morogoro Region, and Kikavu Chini, Njoro and Lower Moshi in Kilimanjaro Region. Mwega and Lower Moshi are 'modern schemes' since their intakes, main and secondary canals, drop and division structures are lined with concrete. Mkindo and Kikafu Chini are considered as 'improved traditional schemes' because their intakes, division structures and part of their main canals are constructed using concrete materials while the rest of the infrastructures are earth-lined. Chabi and Njoro are categorized as 'traditional irrigation schemes' because their intakes, main and secondary canals and other irrigation infrastructures are earth-lined. In this case, designing and the construction is based on indigenous knowledge and skills. The major economic activity by farming communities in all six schemes is irrigation paddy farming although maize and beans are also grown in Mwega, Chabi, Lower Moshi and Kikafu Chini schemes.

Morogoro Region is located on the eastern side of Tanzania Mainland, between 5º58' and 10º00'S and between 35º25' and 38º30'E (URT, 1997). Here, Mkindo scheme was constructed in 1982 and uses Mkindo River as a source of irrigation water (PEMA, 2003). The scheme is situated in Mvomero District between 8-10ºS and 28-

37ºE (Mboera et al., 2007) whereas Mwega and Chabi schemes are located in Kilosa District, 06º42'S and 37º02'E. Overall, rainfall pattern in Morogoro Region is bimodal with short rains starting in mid October through December, and long rains from March to May (URT, 1997). Therefore, average annual rainfall ranges from 600mm in low lands to 1200mm in the highland plateau whereas average annual temperature varies between 18ºC on the mountains to 30ºC in river valleys. In most parts of the region, the average temperatures are almost uniform at 25ºC. Information about administrative boundaries and people, climate, topography and soils for the districts and respective schemes is detailed in Salehe and Hassan (2012).

On the other hand, Kilimanjaro Region is located in the north eastern part of Tanzania Mainland, south of the Equator between 2º 25' and 4º 15'S and 36º 25' 30" and 38º 10' 45" E (URT, 1998). Each of the three irrigation schemes in the region is located in a separate administrative district, with Kikafu Chini in Hai at 03º14'S and 37º15'E; lower Moshi in Moshi rural, 03 00'ºS and 37.5º00'E; and Njoro in Moshi, 3°21'00"S and 37°19'59.88"E. Hai is the largest of the three districts with an area of 2,112 $km^2$ followed by Moshi rural, 1,713 $km^2$, and Moshi urban, 58 $km^2$. Lower Moshi scheme consists of two intakes namely Rau and Mabogini (Tarimo et al., 1998). Rau River also serves as the source of water for household use by communities in lower Moshi area while Njoro scheme receives water from Njoro springs, which originate from Njoro forest. Kikafu Chini scheme receive irrigation water from Kikafu River.

Similarly, the rainfall pattern of Kilimanjaro Region is bimodal, with long and main rainy season from March to May and the short rainy season from October through December. The driest period happens during July to October, while March, April and May are the wettest months (http://www.weadapt.org/knowledge-base/wikiadapt/key-findings-from-tanzania-ncap-project). Rainfall and temperature are very much influenced by altitude and the direction of slope in mountainous areas Rohr and Killingtveit (2003), however, the mean annual temperature in Moshi township, 813 m above sea level is 23.4°C (Walter et al., 1975).

According to projections based on 2002 population and housing census (URT, 2011), Kilimanjaro Region was estimated to have a population of 1,636,000. The two main ethnic groups are Chagga, who are the majority, and Pare, the minority. Other relatively small ethnic groups are Wakahe and Wakwavi. Within the Chagga and Pare, there are sub-ethnic groups that identify themselves either by their different dialects, according to the geographical identity or both. There are at least 5 Chagga sub-ethnic groups. These include the Wamachame who speak Kichagga Kimachame; Wakibosho who speak Kichagga Kibosho, Wamarangu who speak Kichagga Kimarangu; Warombo who speak Kichagga Kirombo and Wauru who speak Kichagga Kiuru, to mention a few. Similarly, the Wagweno found in northern part of Pare are a sub-ethnic group of the Pare, therefore speak both Kipare and Kigweno.

**Research Design, Sampling Procedure and Data Collection**

A cross-sectional research design was adopted for the study. The study was carried out between June and August, 2010. Purposive sampling was used to obtain the schemes for the study while random sampling with equal number of respondents in each scheme and region was employed. Respondents were chosen by the researcher from the list of farmers practicing paddy farming provided by the village governments in the six schemes. The researcher chose the names according to farmer's location in the scheme (upstream-13 respondents, middle stream-13 respondents and downstream-14 respondents). A total of two hundred and forty respondents (meaning 120 from each region of which 40 were from each scheme) were selected from the six schemes. Interviews using structured questionnaires with closed and open-ended questions were conducted. Information collected included acreage of paddy cultivation, amount of paddy produced, amount of rice sold, amount of money accrued from rice selling, amount of money and hours spent on schistosomiasis treatment and care and net working hours spent per month on irrigation farming activities.

**DATA ANALYSIS**

T-test was used to determine variation in different variables for infected farmers between the three types of irrigation schemes (i.e. traditional, improved traditional and modern) and for the same variables between infected and non-infected farmers within the same type of irrigation schemes. In Table 1, the number of respondents in each category of a given variable was expressed as percentage of total number of respondents interviewed in a scheme whereas in Table 2, the number of respondents in a scheme for each category of a given variable was expressed as percentage of total number of infected respondents interviewed in a region.

**RESULTS AND DISCUSSIONS**

**RESULTS**

**Respondent's socio-demographic characteristics**

Out of 240 farmers interviewed in the six irrigation schemes, 141 were male and 99 females. Majority of them

**Table 1.** Socio-demographic characteristics of farmers in Morogoro and Kilimanjaro schemes surveyed. The values outside and inside brackets refer to number and percentage of respondents interviewed in a scheme, respectively (n=40 respondents in each scheme).

| Characteristic | Morogoro | | | Kilimanjaro | | |
|---|---|---|---|---|---|---|
| | Chabi (traditional) | Mkindo (improved traditional) | Mwega (modern) | Njoro (traditional) | Kikafu (improved traditional) | Lower Moshi (modern) |
| **Age category** | | | | | | |
| 20-50 years | 35 (87.5) | 29 (72.5) | 33 (82.5) | 22 (55) | 22 (55) | 22 (55) |
| >50 years | 5 (12.5) | 11 (27.5) | 7 (17.5) | 18(45) | 18(45) | 18 (45) |
| **Sex** | | | | | | |
| Male | 27 (67.5) | 21 (52.5) | 20 (50) | 28 (70) | 24(60) | 21 (52.5) |
| Female | 13 (32.5) | 19 (47.5) | 20 (50) | 12 (30) | 16 (40) | 19 (47.5) |
| **Education** | | | | | | |
| Secondary | 3 (7.5) | 2 (5) | 2 (5) | 3 (7.5) | 9 (22.5) | 3 (7.5) |
| Primary | 34 (85) | 33 (82.5) | 37(92.5) | 37 (92.5) | 29(72.5) | 33(82.5) |
| Illiterate | 3 (7.5) | 5 (12.5) | 1 (2.5) | 0 | 2 (5) | 4 (9) |
| **Marital status** | | | | | | |
| Single | 3 (7.5) | 5 (12.5) | 2 (5) | 4 (10) | 0 | 1 (2.5) |
| Married | 37 (92.5) | 30 (75) | 35 (87.5) | 33 (83) | 33 (82.5) | 39 (97.5) |
| Widow | 0 | 3 (7.5) | 2 (5) | 2 (4) | 2 (5) | 0 |
| Widowed | 0 | 0 | 0 | 1 (3) | 0 | 0 |
| Divorced | 0 | 2 (5) | 1 (2.5) | 0 | 5 (12.5) | 0 |

Number in parenthesis refers to percentage of respondents interviewed

(67. 9%) were at active productive age of 20 to 50 years while minority (32.1%) were over 50 years. However, total number of senescent farmers in Kilimanjaro schemes was more than twice those of Morogoro schemes. Regarding marital status, a high percentage (86.3%) were married, a few (6.2%) were single while the rest comprised widows, widowers and divorcees. Education wise, most of them (84.5%) had primary-school-level education, while a few (6.2%) were illiterate and 9.3% had ordinary secondary-school-level education (Table 1). Interestingly, no illiteracy was observed among farmers of Njoro scheme (Table 1).

### Extent of infection and economic losses due to schistosomiasis illness

Generally, infection was least in Njoro scheme, but high in Lower Moshi and Chabi schemes (Table 2) as approximately three quarters of their respondents had suffered from the disease in a three year period (between 2006 and 2008). Moreover, infected farmers in Lower Moshi lost the highest number of working days on treatment and care of oneself/family members following schistomiasis illness, 14-30 per season, contrary to infected farmers in Chabi who lost only 4-13 days (Table 2). However, infected farmers in both Lower Moshi and Chabi had their expenditures on treatment and care in the range of TShs 5,000-50,000 though regional wise, the infected farmers in Morogoro region were the majority at both ranges of financial cost with majority of payers coming from Chabi (Table 2). While none of the infected farmers in Kilimanjaro schemes sold any crops, livestock or other items to cover costs related to treatment and care, infected farmers in Morogoro with majority from Chabi did sell various items (Table 2).

### Schistosomiasis effect on rice production and income generation on infected farmers

Results from the study showed significant difference on acreage of rice cultivated for infected farmers in traditional schemes, Njoro and Chabi (p=0.05) and marginal difference for improved traditional schemes, Kikafu Chini and Mkindo (Table 3). Furthermore, amount of rice sold and amount of money accrued from rice selling were significantly different for all three types of irrigation schemes i.e. modern, improved traditional and traditional (Table 3). However, amount of rice produced and income balance differed significantly for the infected farmers in modern schemes, Lower Moshi and Mwega, and for traditional schemes, Njoro and Chabi (Table 3). In all

**Table 2.** Number of farmers infected with schistomiasis**,** cost of schistosomiasis in terms of working time lost, cash as well as crops and assets. The numbers in parenthesis refer to percentage of all farmers infected within the study schemes of a region.

| Variable | Kilimanjaro schemes | | | | Morogoro Schemes | | | |
|---|---|---|---|---|---|---|---|---|
| | Kikavu Chini) | Lower Moshi | Njoro | Total | Mkindo | Mwega | Chabi | Total |
| **Farmers infected** | 12 (23.5) | 30(59) | 9 (17.6) | 51 (100) | 24 (32) | 23 ( 30) | 29(38) | 76 (100) |
| **Working time lost (days)** | | | | | | | | |
| 1-3 | 1 (1.9) | 5 (9.8) | 0 | 6 (11.8) | 20 (26.3) | 3 (4.0) | 2 (2.6) | 25 (32.9) |
| 4-13 | 10 (20) | 14(28) | 6 (11.8) | 30 (58.8) | 2 (2.6) | 21 (28) | 19 25) | 42 (55.2) |
| 14-30 | 1 (1.9) | 11(22) | 3 (5.9) | 15 (29.4) | 2 (2.6) | 0 | 7 (9.2) | 9 (11.8) |
| **Financial cost (Tshs)** | | | | | | | | |
| 5,000-50,000 | 12 (23.5) | 28(55) | 9 (17.6) | 49 (96.1) | 18 (23.7) | 19 (25) | 19(25) | 56 (73.7) |
| 51,000-100,000 | 0 | 2 (3.9) | 0 | 2 (3.9) | 0 | 3 (3.9) | 8(11) | 11 (14.5) |
| **Crops and assets** | | | | | | | | |
| Sold maize | 0 | 0 | 0 | 0 | 0 | 3 (3.9) | 5 (6.6) | 8 (10.5) |
| Sold bicycle, radio and mattress | 0 | 0 | 0 | 0 | 0 | 0 | 1 (1.3) | 1 (1.3) |
| Sold live stocks | 0 | 0 | 0 | 0 | 4 (5.2) | 1 (1.3) | 6 (7.9) | 11 (14.5) |

situations, schemes in Kilimanjaro region (Lower Moshi, Kikafu Chini and Njoro) were always on the higher side compared to those in Morogoro region.

### Expenditures and time spent on schistosomiasis treatment and care for infected farmers

Table 3 also shows significant difference in the amount of money spent on schistosomiasis treatment and care for infected farmers in improved traditional schemes, Kikafu Chini and Mkindo with farmers in Kikafu Chini spending more than twice the amount expended by their fellow farmers in Mkindo. Moreover infected farmers in Chabi and Mwega schemes spent more than 5% of their income accrued from rice selling on treatment and care compared to other schemes (Table 3). Results further show significant difference in number of hours spent on schistosomiasis treatment and care for Mwega and Lower Moshi scheme (Modern) as well as for Mkindo and Kikafu Chini schemes (improved traditional). Infected farmers in Mwega and Mkindo spent relatively less time compared to their counterparts in Lower Moshi and Kikafu Chini. In addition, infected farmers in Njoro (traditional scheme) and Lower Moshi scheme (Modern scheme) spent more than 50% of their time per month on schistosomiasis treatment and care compared to other schemes. Equally, there were significant differences in net working hours spent per month on irrigation farming activities for infected farmers in modern (Mwega and Lower Moshi) and improved traditional schemes (Mkindo and Kikafu Chini), with Lower Moshi and Kikafu Chini remaining with less networking hours.

### Schistosomiasis burden between infected and non infected farmers: schemes with the same design and characteristics pooled together

Significant differences with regards to net working hours spent per month on irrigation farming activities existed between infected and non-infected respondents for modern, improved traditional and traditional schemes, and in all cases non-infected farmers had more net working hours per month (Table 4). Infected farmers in modern, improved traditional and traditional schemes lost 81 hrs (corresponding to 7 days), 33 hrs (corresponding to 3 days) and 101 hrs (corresponding to 8 days), respectively, due to schistosomiasis illness. However, only traditional schemes showed significant difference between infected and non-infected farmers on the amount of rice produced and sold, and income balance accrued from rice selling

**Table 3.** Social economic effects of schistosomiasis on infected farmers in Modern, Improved traditional and traditional irrigation Schemes in Kilimanjaro and Morogoro Regions

| Variables | Modern schemes | | | Improved traditional schemes | | | Traditional schemes | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mwega | Lower Moshi | p-value | Mkindo | Kikavu Chini | p-value | Chabi | Njoro | P-value |
| Acres of rice cultivated | 0.9565 | 1.1417 | 0.119 | 0.84 | 1.0625 | 0.057 | 1.0086 | 1.3889 | 0.019 |
| Amount of rice produced (kgs) | 1,256.96 | 2,129.33 | <0.001 | 1,236.00 | 1,553.33 | 0.155 | 1,045 | 2,129 | <0.001 |
| Amount of rice sold (kgs) | 1,052.61 | 1,824.00 | <0.001 | 909.6 | 1,374.17 | 0.019 | 885.17 | 1,900.00 | <0.001 |
| Amount of money raised from rice selling(Tshs) | 526,300 | 902,000 | <0.001 | 515,000 | 687,000 | 0.045 | 442,590 | 956,670 | <0.001 |
| Money spent on schistosomiasis treatment and care (Tshs) | 28,652 | 28,533 | 0.979 | 12,222 | 28,917 | <0.001 | 34,250 | 31,778 | 0.772 |
| Income balance (Tshs) | 497,650 | 873,470 | <0.001 | 505,800 | 658,170 | 0.075 | 408,000 | 925,000 | <0.001 |
| Expenditure on treatment and care (%) | 5.4 | 3.2 | | 2.4 | 4.2 | | 7.7 | 3.3 | |
| Expected number of hours for irrigation farming activities per month in absence of sickness | 214 | 207 | 0.545 | 203 | 207 | 0.656 | 209 | 241 | <0.001 |
| Hours spent on schistosomiasis treatment and care | 57.95 | 106.27 | 0.015 | 34.67 | 76.42 | 0.02 | 98.07 | 131.44 | 0.295 |
| Time spent on schistosomiasis treatment and care (%) | 27 | 51 | | 17 | 37 | | 47 | 55 | |
| Net working time (hrs) per month on irrig. farming activities | 161 | 103 | 0.004 | 189 | 148 | 0.011 | 122 | 119 | 0.916 |

(Table 4). Consequently, non infected farmers produced, sold and saved more income from rice selling compared to those infected.

## DISCUSSION

### Respondent's socio-demographic characteristics

Apparently, more than three quarters (81%) of farmers interviewed in Morogoro schemes were at the productive age between 20-50, and less than a quarter (19%) above 50 years. Contrary, only 55% of the interviewed farmers in Kilimanjaro schemes were aged between 20-50 years and the remaining, 45% above 50 years. The trend implies that while a greater proportion of irrigated rice farmers in Morogoro schemes engage in the paddy farming activity at an early stage, majority in Kilimanjaro region seem to engage in paddy farming closer to and after retirement from other production activities. Youths in Kilimanjaro Region have relatively more job opportunities at their disposal from both Government and private sectors compared to their fellows in Morogoro Region hence delayed engagement in irrigated rice farming. The opportunities include those associated with tourist industry (hotel and tour company); horticulture such as flower farming; coffee and banana farming, woodwork industry; local brew making (*mbege*); industrial employment; trading; transportation business and other various sectors of production and services.

**Table 4**. Independent-sample t-test to test socio-economic effect of Schistosomiasis on infected versus non infected respondents in modern, improved traditional and traditional irrigation schemes when similar schemes in the two regions were put together.

| Variables | Irrigation schemes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Modern | | | Improved traditional | | | Traditional | | |
| | Infect | Non-infected | p-value | Infect | Non-infected | p-value | Infected | Non infected | P-value |
| Acreage of rice cultivated | 1.0613 | 1 | 0.538 | 0.9122 | 1.0349 | 0.35 | 1.0987 | 1.1607 | 0.557 |
| Amount of rice produced (Kgs) | 1750.75 | 1530 | 0.192 | 1338.92 | 1710.23 | 0.197 | 1302 | 1726 | 0.023 |
| Amount of rice sold (Kgs) | 1489.25 | 1298.52 | 0.221 | 1060.27 | 1480.7 | 0.127 | 1125.33 | 1521.43 | 0.028 |
| Schistosomiasis treatment and care costs (Tshs) | 28,585 | x | x | 18,900 | x | x | 33,649 | x | x |
| Total income balance | 710,380 | 649,280 | 0.424 | 555,220 | 637,560 | 0.277 | 531,000 | 761,000 | 0.012 |
| Hours spent on treatment and care | 87 | x | x | 49 | x | x | 106 | x | x |
| Hours spent on irrigation activities per month | 209 | 212 | 0.813 | 209 | 201 | 0.414 | 222 | 227 | 0.525 |
| Net working hours per month | 128 | 212 | <0.001 | 176 | 203 | 0.006 | 121 | 227 | <0.001 |

X= mean value not calculated since non infected farmers neither did spend money nor did they waste time (hrs) on schistosomiasis treatment and care.

**Extent of infection**

Despite that infection was high in a modern (Lower Moshi) and traditional (Chabi) schemes in Kilimanjaro and Morogoro Regions, respectively, yet the state was concomitantly least in Njoro, a traditional scheme in Kilimanjaro Region. This sequence depicts no clear pattern with regard to traditional versus modern and improved traditional schemes even though the total number of infected farmers in Morogoro schemes was higher than in Kilimanjaro schemes (Table 2). Probably, Njoro had the least number of schistomiasis victims due to its location. Being within Moshi municipality (about 3 kilometers from City centre), the scheme is easily accessed by agricultural extension and health officers who visit the scheme to sensitize farmers about transmission and control of schistomiasis among other things. Moreover, irrigation farming through canals constructed using indigenous knowledge, material and equipment is a deep rooted practice in Kilimanjaro Region (Tagseth, 2008; Lein, 2004; Gillingham, 1999; Grove, 1993). The long experience in irrigation farming may have developed along with knowledge and awareness about the disease transmission and control measures.

On the other hand, compared to other schemes, Chabi (traditional scheme) made a larger contribution to the relatively high level of infection observed for Morogoro schemes. Health services are freely and easily accessed (within the villages) by farmers in Mwega and Mkindo schemes thus helping to reduce the extent of infection. Contrary, both lack of health services within Chabi village and reliable transport to distant villages where health services are available accounts for the high level of infection in Chabi (Salehe and Hassan, 2012). To make the situation worse, even pharmacies are not available in the village. Consequently, the disease continues to spread from the infected farmers given the fact that they do not have toilets in the scheme and irrigation infrastructures are poorly managed.

**Schistosomiasis effect on rice production and income on infected farmers**

Performance of infected farmers in Kilimanjaro schemes (Lower Moshi-modern, Kikafu Chini-improved tradition and Njoro-traditional) was better than Morogoro schemes in terms of acreage of rice cultivated, amount of rice

produced, amount of rice sold and money accrued from rice selling and income balance (Table 3). Conversely, schistomiasis had negative effect on rice production and income of infected farmers in Morogoro schemes. These results correspond with the study done in Nigeria by Umeh et al. (2004), where schistosomiasis is found to reduce workers' productivity and cash income.

Good supply and/or good rationing of irrigation water during dry season, ability to hire labour by a family with a sick member and access to a good and reliable market bestowed additional advantage to irrigation rice farmers in Kilimanjaro schemes. For example, as result of sufficient water throughout the year, farmers in Njoro (traditional scheme in Kilimanjaro) grow rice twice a year and do hire labour. Consequently, farmers on average cultivated more acreage of rice, produced and sold more rice and generated higher income per growing season than their colleagues in Chabi (traditional scheme in Morogoro) and the rest of schemes in Kilimanajaro and Morogoro Regions.

**Schistosomiasis effect on expenditures and time spent on treatment and care of patients**

Infected farmers in Kikafu Chini scheme (Kilimanjaro-improved traditional) spent more money and time on schistosomiasis treatment and care and had few net working hours per month spent on irrigation farming activities compared to their counterparts in Mkindo scheme (Morogoro-improved traditional). Nevertheless, infected farmers in Kikafu Chini cultivated more acres of rice, sold and earned more money from rice selling than those in Mkindo, therefore did not experience economic loss as would be expected. This was made possible through either hiring labour, being helped by relatives/friends or both hiring labour and assistance from friends/relatives to compensate for the time they were unable to work. Also, infected farmers in Lower Moshi spent more hours on schistosomiasis care and treatment and consequently remained with less net working hours per month compared to Mwega, but produced and sold more rice and received more earnings from rice selling. Compensation of time lost in agriculture by friends or relatives is documented elsewhere (Conly, 1975; Castro and Mokate, 1988; Nur, 1993). This is done by sacrificing their other activities or leisure time. Kilimanjaro Agricultural Training Centre (K.A.T.C) provides regular training to farmers in Lower Moshi scheme under the funding by Japan International Cooperation Agency (JICA). This practice together with compensated labour may have contributed to elevated production despite the constraints posed by schistomiasis.

In addition to human labour, mechanised labour is readily available in Kilimanjaro schemes as a number of rural households have tractors and power tillers for their use and business (hiring) compared to Morogoro Region. According to a report by URT (2011) in the years 2007 and 2008, 14,442 and 8,985 households in Kilimanjaro use tractors respectively, compared to 6,822 and 4,427 households in Morogoro respectively. This means that as long as a family that looses production time on treatment and care of their patient(s) is capable of hiring either human or mechanised labour, it will not experience economic loss due to reasons associated with illness. Therefore, results of this study fits well with findings in Mali by Audibert and Etard (1998) on the impact of schistosomiasis in rice growing households, who report that falling sick does not cause direct effect on rice production.

**Schistosomiasis burden between infected and non infected farmers: schemes with the same design and characteristics pooled together**

The significant differences in net working hours spent per month on irrigation farming activities between infected and non-infected farmers and the subsequent high values for non-infected farmers in modern, improved traditional and traditional schemes (Table 4) is due to the fact they had none of their time committed to seeking for treatment and care of oneself/ other family members. Moreover, significantly higher amount of rice produced and sold, and income balance accrued from rice selling by the non-infected farmers in traditional irrigation schemes is due to the fact they had no financial expenditures to treatment and care compared to their infected counterparts. Infected farmers spent 106 hours (approximately 9 days on treatment and care) and had 30% less in income balance compared to their non- infected fellows. This is due to the reason that infected ones had to spend more of their time and money seeking treatment and care while those not infected continue with irrigation farming activities and spend their money on buying agricultural inputs such as fertilizers, pesticides and on labour hire. This result corresponds with the study done by Blas et al. (2006), in the northern and southern portions of Leyte Province in the Philippines who reports that, the total days lost per person per year due to schistosomiasis is 45.4.

## CONCLUSION AND RECOMMENDATION

### CONCLUSION

Based on results reported, the study concludes that schistosomiasis does not only cause illness to those infected, instead it may as well impact on the socio economic development of the entire household. Selling of what could have been their food, assets and livestock by infected farmers in traditional and modern irrigation

schemes in Morogoro Region to cover schistosomiasis treatment costs is indicative of how hard the farmers in the region are being hit by the disease compared to their counterparts in Kilimanjaro Region. On the one hand, these findings partly support, and on the other, partly reject the hypothesis due to the fact that Morogoro traditional and Kilimanjaro modern schemes had large number of infected respondents compared to other schemes. This calls for improvement of the traditional irrigation infrastructures such as lining of intake, canals and other infrastructures using concrete materials to minimize possibility of accumulation of mud and vegetation growth which favours snails breeding. Least level of infection in Kilimanjaro traditional scheme, but high in Kilimanjaro modern and Morogoro traditional schemes underscore the need for health and agricultural officers to sensitize all farmers irrespective of category of irrigation scheme.

## RECOMMENDATION

Deliberate efforts are required to show clearly the link between schistosomiasis and irrigation farming in modern, improved traditional and traditional schemes all over Tanzania. Farmer's awareness and provision of education on schistosomiasis and how it relates with water needs to be taken into consideration. Ways of reducing schistosomiasis prevalence among irrigation farming communities need to be explored in designing future schistosomiasis mitigation measures/control measures. Also education on early hospital reporting in case one sees any signs relating to schistosomiasis is very important in order to minimize treatment and care costs.


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## Competing Interests

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