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Socioeconomic Assessment of a Tsetse and Trypanosomosis Control Program in Southwest Ethiopia

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Abstract

A socioeconomic study was made to assess the outcome of a tsetse and trypanosomosis control operation conducted in Chewaka settlement station, Southwest Ethiopia, during 2005-2007 through comparisons of data before and after the control program within Chewaka, and between Chewaka and a non-controlled adjacent site, Bikiltu Didessa peasant Association. Retrospective and crossectional questionnaire survey methods were used to generate data for the study. Results showed that the total livestock and cattle population in chewaka increased by 116% and 1039 %, respectively, and the total cereal production increased by 63.2 %. During this period the overall livestock and cattle population in Bikiltu decreased by 45.7% and 47.5%, respectively, and the total cereal production declined by 35.6%. The average number of cattle bought per house hold per year in Chewaka, 1.15 head, was significantly higher (P=0.000) than the average number of 0.55 head in Bikiltu. The chances of cattle and oxen mortality in Bikiltu were 10 and 6 times (OR= 6.5 and 10.2) more likely than in Chewaka and the chance of abortion in cows in Bikiltu was more than 10 times as compared to Chewaka (OR=10.79). The control operation in chewaka settlement station resulted in rapid growth of livestock and crop production, fast expansion of farmland, improved income from animal sell and increased animal purchasing power.

Keywords: Chewaka; Bikiltu Didessa; Ethiopia; Socioeconomic; Tsetse; Trypanosomosis

Introduction

Tsetse transmitted trypanosomosis affects 37 Sub-Saharan Africa (SSA) countries; an estimate of 160 million cattle and 260 million sheep and goats are kept in this area of risk extending over 10 million km^2 of land (Erkelens *et al*., 2000). The annual losses directly attributed to trypanosomosis in terms of reduced meat and milk production, expenditure for trypanocidal drugs and costs to control the vector was estimated at 1.2 billion USD, furthermore, If the lost potential in livestock and crop production is included the total cost in sub-Saharan Africa would reach to more than 4 billion USD each year (FAO, 2001). Attempts to quantify the economical impact of trypanosomosis have taken into account the direct (mortality, fertility, milk production, animal traction and weight) and indirect effects on key productivity measures (Shaw, 2004). Livestock kept under trypanosomosis challenge have 6-20 % higher annual calf mortality, a 6-19 % lower calving rate and a 20% decrease in milk yield (Shaw, 2004). Up to 38% weight loss and a reduction in work efficiency of oxen used to cultivate the land are additional direct effects of the disease (Shaw, 2004). Moreover, tsetse and trypanosomosis prevent the integration of crop farming and livestock keeping, which is crucial to the development of sustainable agricultural systems and therefore, affect human settlements in fertile zones (Feldmann *et al*., 2005). At present, self-sufficiency in food production is a pressing task for most of the developing countries of the world since the rate of growth in food production lags behind the rate of

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population growth.

During the past decades livestock and particularly cattle could not be introduced and used for agricultural production in to some 200,000 km2 fertile valleys in the West and South-western parts of Ethiopia, as a result, human and livestock populations are concentrated in tsetse and trypanosomosis free but ecologically fragile highlands with the resultant effect of overgrazing over-ploughing, soil erosion, land degradation, loss of resources and poverty (Tikubet, 1999). Annual losses to the National economy are estimated to exceed 200 million USD due to mortality and morbidity of livestock, denied access to land resources and the costs of controlling the disease (Vreysen *et al*., 1999). Land suitability studies carried out in areas of low population density in southern, southeastern, southwestern and western Ethiopia revealed that the tsetse-infested lowlands in the western part of the country have the best potential for expanded agriculture, provided that the tsetse/trypanosomiasis constraint can be overcome (FAO, 1987). Hence, utilization of the tsetse-infested areas with high agricultural potential through resettlement program remained the major priority of the Ethiopian government during the last few decades. Chewaka settlement station is one of settlement sites established in Southwest Ethiopia during 2004, since then, an integrated tsetse and trypanosomosis control operation comprising targets, live baits and chemotherapy has been carried out which was thought to have significant effect on livestock and agricultural production, and livelihood of the society in the area.

The objective of this study was to determine the socioeconomic outcome of a tsetse and trypanosomosis control operation conducted in the newly established Chewaka settlement station during 2005 to 2007 through: 1) Comparisons of pre-control and post-control achievements in Chewaka settlement station. 2) Comparisons of post-control achievements in Chewaka with achievements, at the same period, in tsetse uncontrolled adjacent site, Bikiltu Didessa Peasant Association.

Materials and methods

Study area

The study was conducted in Chewaka settlement station and Bikiltu didessa peasant association found in high tsetse infested region of Ethiopia at a distance of 600 kms Southwest of Addis Ababa. The area is located between latitudes of 080 35' 23" and 080, 42', 25" N and longitudes of 0360 01' 27" and 0360, 23', 58" E at an Altitude of 1100-1768 meters above sea level (Fig. 1).

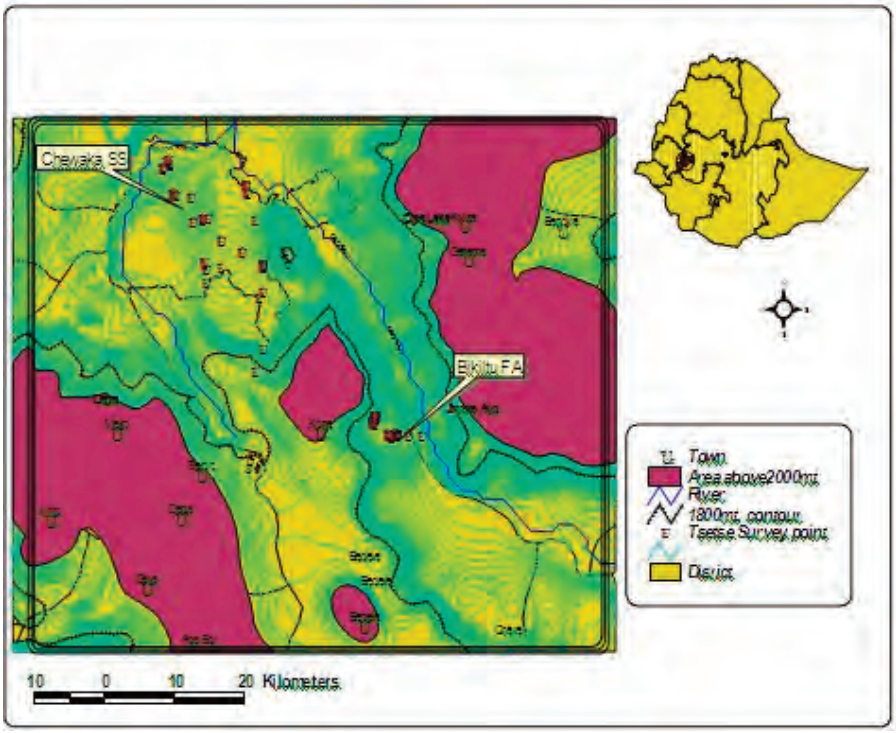

Fig. 1. Map of the study area

Tsetse and trypanosomosis situation

Prior to 2004 there were neither humans nor livestock residing in Chewaka settlement station due to its high tsetse infestation, however, in 2004 the area was inhabited by 80,000 settlers and an extensive tsetse and trypanosomosis control was conducted during 2005-2007. On the contrary no control activity has been carried out in Bikiltu didessa since its establishment in 1985 although significant number of livestock were reared with the aid of trypanocidal drugs.

Study design

Retrospective study and cross-sectional questionnaire survey study designs were employed for the study, data on human and animal population, cultivated land and cereal production of the study sites were gathered from the Agriculture and rural development offices of Chewaka, Bedelle and Dabo districts. The multistage random sampling technique was utilized for the questionnaire survey where by villages were selected first and households (hh) were selected second. A structured questionnaire was used to interview eighty heads of households at each study site to collect data required for socioeconomic impact assessment of trypanosomosis, such as: livestock and crop production, animal sell, animal purchase, livestock mortality and abortion.

Data analysis

All collected data were entered in to the excel spread sheet and transferred to the SPSS statistical software (SPSS inc. 11.5, 2001). Descriptive statistics and percentages were used to summarize data; the General linear model was used to compare mean values and the Odds Ratio was computed for analysis of data on mortality and abortion of cows.

Results

Outcomes of this study showed that the tsetse and trypanosomosis control program conducted in Chewaka settlement station during 2005-2007 resulted in an overall growth of livestock and cattle population by 116% and 1039%, respectively (Fig. 2). Goats were the first animals purchased in large numbers and introduced in to the settlement station during the first year as they were thought to be less affected by trypanosomosis. Among the livestock species donkey showed the highest population increment 1253%, and sheep and goat showed an increment of 111% and 86%, respectively. On the other hand, the overall livestock and cattle population in Bikiltu tsetse uncontrolled study site decreased by 45.7% and 47.5%, respectively, and the sheep and goat population declined by 26.6% and 47.3%, respectively (Fig. 3). Results of the questionnaire survey showed that the average number of cattle and oxen owned by a household in Chewaka, 1.44 and 1.23 head were significantly lower (p=0.000) than the average number owned by a household in Bikiltu, 5.01 and 2.15 heads, respectively, and the mean number of small ruminants, 3 head /hh, in Chewaka was significantly higher (p=0.000) than the mean number in Bikiltu, 1.39 head (Table 1).

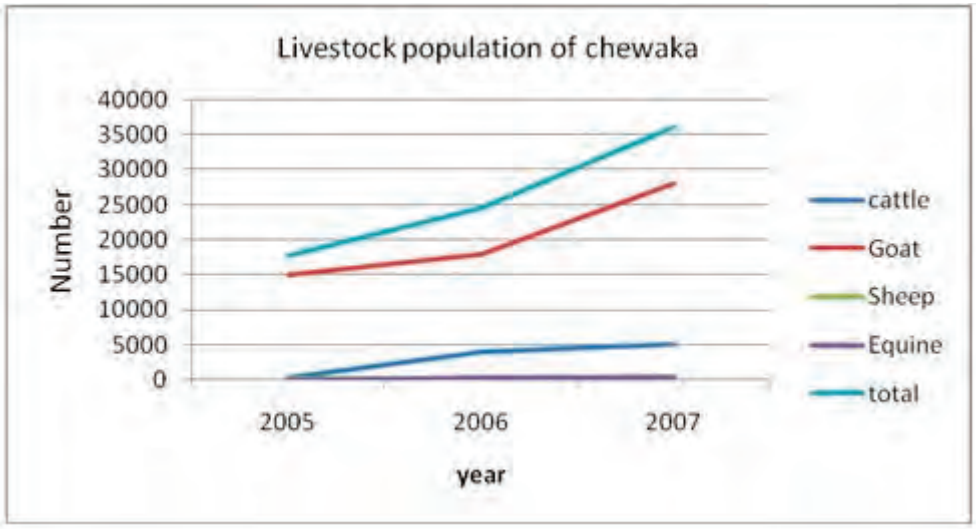

Fig. 2. Livestock population of Chewaka study site

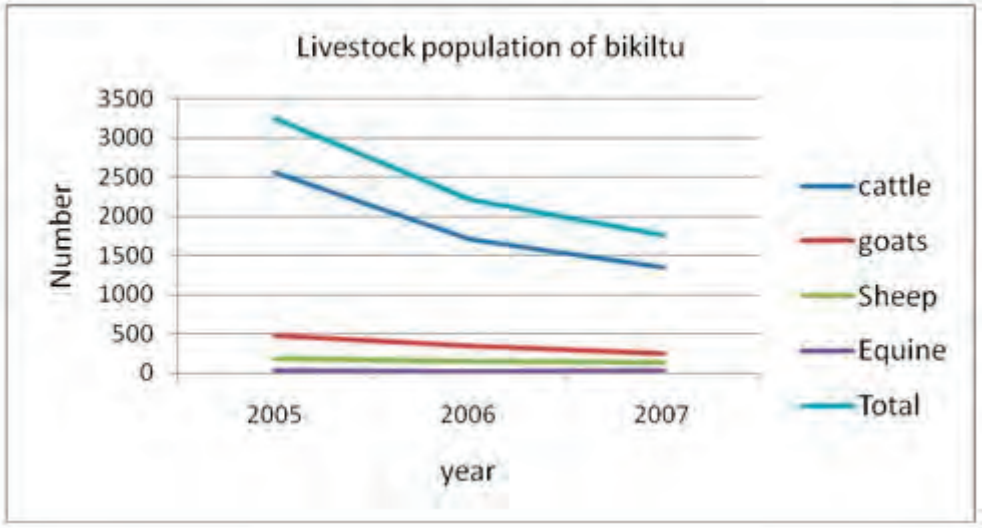

Fig. 3. Livestock population of Bikiltu study site

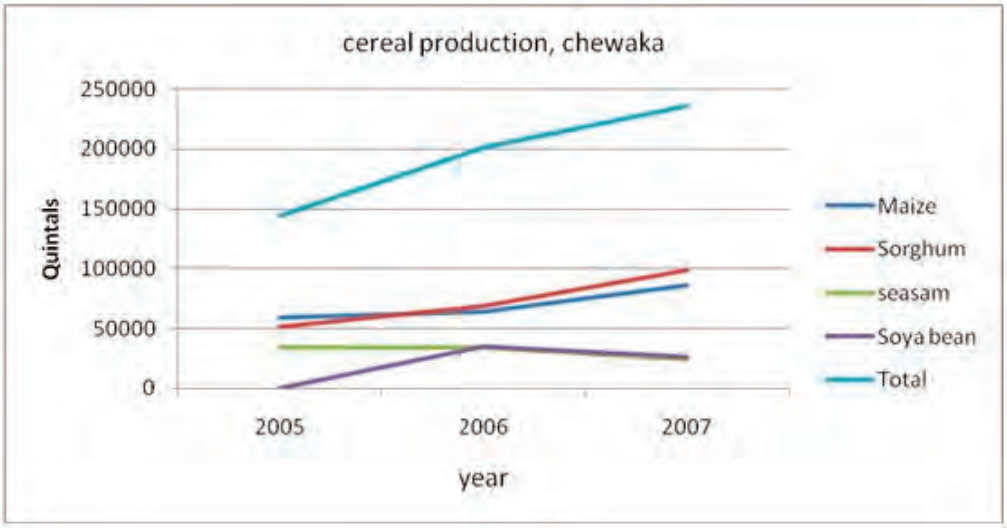

Fig. 4. Cereal production in Chewaka study site

Four types of crops: maize, sorghum, sesame and soybean were commonly cultivated at both study sites. In Chewaka, the increment in cultivated land during 2006 and 2007, 63.7% and 18.3%, resulted in boost of cereal production by 39.5% and 17%, respectively (Figs.4 and 6), during this period, although the total cultivated land in Bikiltu increased by 47.1% the total cereal production dropped by 35.6% (Figs. 5 and 6). The household survey showed that in the tsetse controlled site drought oxen work 720 hours/year (hr/yr) (6 hr/day for 120 days), while in the tsetse uncontrolled site oxen work 240 hr/yr (3 hr/day for 80 days) which was about one third of the efficiency of oxen in the controlled site.

Animal sell and purchase

Sixty six percent of the interviewed farmers in Chewaka and 24% in Bikiltu sold animals during the preceding one year period with an average of 0.85 (95% CI=0.69-1.00) and 0.34 (95% CI=0.18-0.49) head of cattle sold/hh in Chewaka and Bikiltu, respectively, revealing a significant difference (p=0.000) in animal sell between the two study sites (Table 2). Moreover the purpose of animal sell differ in the two study sites: in Chewaka 98% of the sell were fattened oxen sold for butchery while in Bikiltu 59% of the sell were debilitated oxen and 41% were breeding cows and young stocks sold as a result of repeated trypanosome infections. Farmers in Bikiltu also verified that they were frequently obliged to sell small ruminants to purchase trypanocidals for their cattle. Eighty five percent of the respondents in Chewaka and thirty six percent in Bikiltu bought animals during the year period, on average a household in Chewaka bought 1.15 animals which was double that of Bikiltu, 0.55 an-

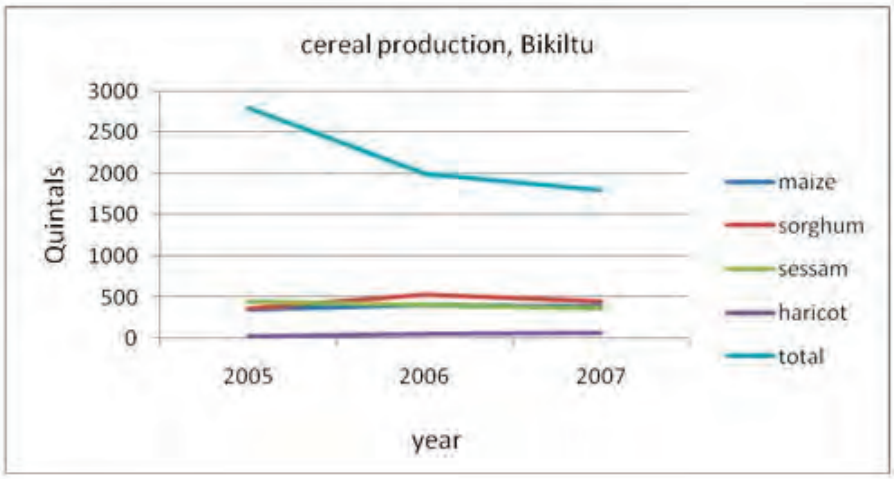

Fig. 5. Cereal production in Bikiltu study site

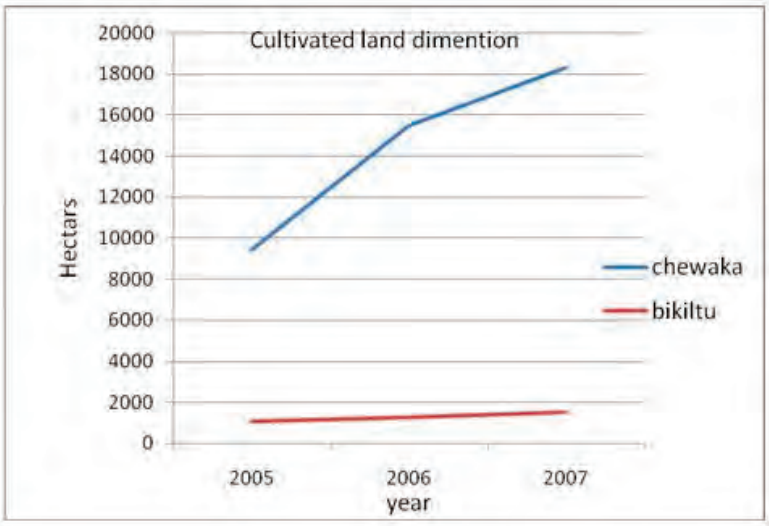

Fig. 6. Dimension of cultivated land in Chewaka and Bikiltu study sites (2005-2007)

imals/hh/yr. Farmers in Chewaka bought 0.99 (95% CI=0.87-1.08) head of bulls/hh/yr which was significantly higher (p=0.000) than the average number of bulls purchased by farmers in Bikiltu ,0.11 (95% CI=0.05-0.231), head/hh/yr. The average number of oxen purchased/hh/yr in Bikiltu 0.28 (95% CI=0.192-0.358) was significantly higher (p=0.000) than the average number of oxen bought/hh/yr in Chewaka (Table 2). The motive of animal purchase varies between the two study sites in that the majority of animals, 99%, bought in Chewaka were young animals (bulls) for fattening and traction while most of the animals bought, 52%, in Bikiltu were oxen to replace those died of trypanosomosis.

Mortality and Abortion

In tsetse infested region the direct impact of trypanosomosis would be evident through mortality and other production losses, only 9% of the interviewees in Chewaka and 81% in Bikiltu stated deaths of their animals during the year period. The average cattle mortality /hh/yr in Bikiltu, 3.03 head, (95% CI=2.6-3.4), was significantly higher (p=0.000) than the average mortality of 0.09 head /hh/yr in Chewaka. In general cattle and oxen in Bikiltu had an OR of 10.19 (95% CI=4.46-23.33) and 6.56 (95% CI=3.19-13.45) mortality as compared to cattle and oxen in Chewaka, respectively (Table 3). Abortion of cows was commonly reported in Bikiltu, out of the total respondents 2.5% (2/80) in Chewaka and 30 % (24/80) in Bikiltu stated abortion of their cows. The average number of aborted cows in Chewaka, 0.03/hh/yr, was significantly lower (p=0.000) than the average number in Bikiltu, 0.5 /hh/yr. Cows in Bikiltu had an OR of 10.79 (95% CI=2.57- 45.37) abortion rate as

compared to cows in Chewaka (Table 3). It was emphasised by more than eighty percent of the respondents in Bikiltu that abortion of cows were concurrent with clinical cases of trypanosomosis regardless of the stage of their gestation period.

Table 1. Questionnaire survey results showing number of animals owned by a household in Chewaka and Bikiltu study sites (Dec 2005-Nov 2006)

Animal Type	Bikiltu			Chewaka		
	Mean	95%CI		Mean	95%CI	
		LB	UB		LB	UB
Oxen	2.2	1.88	2.42	1.2	1.08	1.38
Cows	1.2	0.89	1.41	0.1	0.00	0.10
Cattle	5.0	4.23	5.79	1.4	1.29	1.59
Shoats[a]	1.4	0.99	1.79	3.0	2.27	3.73
Equine	0.1	0.05	0.20	0.2	0.10	0.28

Trypanocidal drug handling

Results of the questionnaire survey showed that all of the interviewees in Chewaka never handled trypanocidal drugs, do not differentiate trypanocidals and treat their animals at the veterinary clinic in the site. In contrast, all of the interviewees in Bikiltu possess personal syringes and trypanocidals at their home and differentiate drugs available on market. More than 90% of the respondents in Bikiltu stated that the treatment frequency of an animal would not be longer than six weeks; some animals may even need a twofold treatment per month which bored the community in the area. Dosages of drugs were not well known by farmers therefore both prophylactic and curative drugs were administered repeatedly until sick animals show improvement of condition. Out of the respondents 85% stated that they prefer Diminazene aceturate to Isometamidium chloride because of its fast action in improvement of condition and stated that their usual sources of drugs were drug smugglers in the area. Shortage of drugs might occur at times but farmers were cautious in storing some quantity as sickness of animals might be detected during night time and rapid administration of drugs would be crucial for recovery of severely ill animals. Veterinary clinics were located at far distant of Bikiltu study site; hence farmers were obliged to move their animals for an average of 4-6 hours to reach at them. Based on results of the questionnaire survey, considering a treatment interval of 6 weeks, a treatment frequency of 8 times /yr and a cost /dose of 1.00 USD, the total expense for trypanocidal drug/head of cattle was estimated to USD 8.00 /year.

Livestock management

Livestock management has a pivotal role in productivity and health of animals, personal observations and questionnaire survey results verified that cattle management greatly differ in the two study sites, in chewaka, animals were usually tied under tree shades around farm areas and fed with chopped sugar beet, grass and farm by-products; pass the night in warm barns with comfortable beddings and were not exposed to rain and cold. In Bikiltu study site, cattle usually graze in the savannah grasslands and bushes and were not provided with any type of additional feed, they were not protected from rain and cold of the night as they were congregated in open fenced field with non-comfortable beddings. Settlers of chewaka were descendents of eastern part of the country where the tradition of animal feeding, housing and fattening as well as preservation and storage of crop by-products are well developed whereas, in Bikiltu these traditions were not well known; hence animals were solely dependent on their day time grazing for body maintenance and production. In Chewaka, the

Table 2. Questionnaire survey results showing number of animals sold, purchased, died and aborted in Chewaka and Bikiltu during a year period (Dec 2005-Nov 2006)

parameter	Bikiltu				Chewaka			
			95%CI				95%CI	
	Sum	Mean	LB	LB	Sum	Mean	LB	LB
Oxen sold	17	0.21	0.09	0.33	66	0.83	0.68	0.97
Total sold	27	0.34	0.17	0.51	67	0.84	0.69	0.98
Bulls purch[a]	9	0.11	0.03	0.19	78	0.97	0.83	1.13
Total purch	44	0.55	0.34	0.76	92	1.15	0.99	1.31
Oxen died	118	1.48	1.16	1.79	7	0.09	0.02	0.15
Total died	242	3.03	2.47	3.58	7	0.09	0.02	0.15
Abortion	40	0.5	0.29	0.71	2	0.03	0.01	0.060

Table 3. Odds ratio (OR) comparisons on mortality of cattle and abortion of cows /hh/yr in Chewaka and Bikiltu study sites (Dec 2005-Nov 2006)

parameters	P value	OR	95% CI for OR	
			Lower	Upper
Oxen died	0.000	6.56	3.20	13.45
Total cattle died	0.000	10.20	4.46	23.33
Cows aborted	0.001	10.79	2.57	45.37

animal-tsetse contact during most part of the year was very low as cattle were usually tied under tree shades contained by farm areas; they get in contact with tsetse only during the dry months (February-May). On the contrary, animals in Bikiltu acquire trypanosomosis throughout the year as they were constantly in contact with tsetse at grazing fields.

Discussion

The findings of this study indicated an overall growth of livestock and cattle population in Chewaka tsetse controlled site by 116% and 1039%, respectively, and increment in cereal production by 63.2 %. This result was in harmony with earlier findings of a tsetse and trypanosomosis survey in the area which reported a decline of tsetse density and trypanosomosis prevalence by 98.6% and 91.7%, respectively (Anberber *et al*., 2012). Similar finding was reported from Burra district of Nigeria where an increment of cattle population by 24,900% was attained within three years following eradication of tsetse and trypanosomosis (Putt and Shaw, 1982). The impact of trypanosomosis on African agriculture is most obviously seen in the birth and mortality rates of young animals (Erkelens *et al*., 2000) although trypanosomosis was not the only cause of abortion, results of this study showed that the chance of abortion of cows in the uncontrolled site was about ten times as compared to the controlled site, suggesting its relative importance in abortion of cows at endemic region of the disease. Previous reports by Erkelens *et al*. (2000) support this finding stating that trypanosomosis reduces calving by up to 20% and causes the death of another 20% of young stock in susceptible cattle breeds. Socio-economic surveys carried out in Yalé pastoral zone of Burkina Faso show significant increase in livestock population growth rate (up to 25%), milk production and number of draft animals, and dramatic decline in the rate of stillbirths subsequent to reduction in the incidence of trypanosomosis (Kamuanga *et al*., 2001b).

Results of this study revealed that oxen in the uncontrolled Bikiltu site showed higher mortality rate and reduction of work efficiency by 66 % as compared with oxen in the controlled Chewaka study site.. This finding was higher than a report by the Food and Agriculture Organization in Ethiopia that show a 33 % reduction in the availability and efficiency of drought animals due trypanosomosis (FAO, 1998).The difference could be due to variations in severity of the disease between the study localities or methodology used, as the present results were based on questionnaire survey. Furthermore, Abebe and Jobre (1996) reported that in tsetse infested regions of Ethiopia the problem of trypanosomosis is the main cause for the decline in the number of cattle, particularly of draught oxen, and therefore forces farmers to cultivate manually. The present study showed that almost 50% of cattle mortality in Bikiltu tsetse infested site was ascribed to deaths of draught oxen which led to decline of cereal production by 46.5%, this was in accord with a previous report in mixed farming system which state that trypanosomosis constrains the number of oxen that farmers own and reduces the average area planted per household by as much as 50% (FAO, 2000b).

The difference in animal management practiced by the communities of the two study sites, especially the feeding and grazing traditions, could have possibly contributed for the difference in the magnitude of trypanosomosis and growth rate of livestock population between the two sites. In trypanosomosis affected area the purpose and ability of farmers to buy and sell livestock may vary depending on the impact of the disease and their economic strength. The variation in animal sell between the two study sites showed better family income in the tsetse controlled Chewaka as compared to the uncontrolled Bikiltu study site; as trypanosome free, healthy and well fed animals could fatten in short period of time. This was practically demonstrated in Chewaka study site where the community had developed custom of storing after-harvests and growing supplementary fodders such as sugar beet for oxen/bull fattening. The reduction in the catastrophes of trypanosomosis in Chewaka encouraged farmers to actively engage in small scale fattening activity which enabled them to sell nearly 1000 fattened bulls within three months of 2006.Animal purchasing power is one of the indi-

cators to estimate the economic capability of farmers in endemic areas of trypanosomosis, the significant difference in purchasing power of bulls between the two communities was accredited to better economic status of Chewaka farmers as compared to Bikiltu. Enhanced income generation was evident among Chewaka farmers as a result of selling surplus cereal and oil seed produce and fattened bulls/oxen.

Farmers in Bikiltu study site were familiar with trypanocidals available on market, Diminazene aceturate and Isometamidium chloride, and experienced the drugs for more than 20 years due to absence of tsetse control programs in the area. Farmers prefer Diminazene aceturate to Isometamidium chloride due to its fast curing effect in treated animals. Similar findings were reported from Zambia indicating that farmers frequently administer most of the trypanocide treatments and showed a strong tendency to use curative (diminazene) rather than prophylactic drug (isometamidium) (Van den Bossche *et al*., 2000). In Ethiopia, a report by Dagnachew (2004) indicated that above 60% of the interviewees used trypanocidal drugs for the last 25 years and absence of tsetse control activity led farmers to depend on chemotherapy. In endemic regions of trypanosomosis the number of treatments administered per animal over a year period reflects the magnitude of trypanosome challenge in an area (Uilenberg, 1998). Respondents in Bikiltu stated that the treatment frequency of cattle might not exceed 6 weeks and some animals may even need a twice treatment per month. Investigators from different regions of Ethiopia reported more frequent treatment intervals; Afewerk *et al*. (2000) reported a treatment interval of 4 months while Tewelde *et al*. (2004) and Dagnachew (2004) reported frequencies ranging from 3-4 and 2.5–3.5 per month, respectively. This difference might be due to the variations in the magnitude of the disease among the different study areas. In Bikiltu tsetse infested site the minimum trypanocidal drug expense to keep an animal (cattle) was estimated to 8 USD per annum. A survey conducted in tsetse uncontrolled Kénédougou province of Burkina Faso reported a yearly trypanocidal cost of 5.25 USD / animal to raise cattle in the area (Ouédraogo, 2002) which was equivalent with estimates of the current study.

Knowledge on drug dilution and dosage as well as estimation of body weight of animals were not known by 85% of the respondents in Bikiltu. Comparable findings were described by Afewerk *et al*. (2000), Tewelde *et al*.(2004) and Dagnachew (2004), reporting lack of knowledge on dosages by 43%, 57% and 55% of the interviewees, respectively. The misuse of trypanocides in Bikiltu had greatly affected efficacy of the existing drugs as evidenced through high mortality and recurrent parasitemia in recently treated animals, indicating presence of drug resistant strains in the area. Trypanocidal drug resistance had been reported from Bikiltu (Tewelde *et al*., 2004) and other locations in Southwest Ethiopia (Mulugeta *et al*., 1997; Ademe and Getachew, 2000; Afewerk *et al*., 2000; Assefa and Abebe, 2001).

Conclusion

Farmers of Chewaka settlement station perceived the benefits of the three years tsetse and trypanosomosis control program through the achievements in growth of livestock population, increment in cereal production, income rise from animal sell and enhanced animal purchasing power. However, as disease control program is decentralized and decisions are left to district/site level, these initiatives will face problems of sustainability. Therefore, the control should be implemented over a wide geographic area including Bikiltu and have to be supported by more advanced technologies like the Sterile Insect Technique (SIT) so as to eradicate tsetse in the region. Further motivation of the community in Chewaka to sustain the attained achievements and circumvent tsetse re-invasion is mandatory.

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