

Improving agricultural labour efficiency through oxenization and its impact on food security in Ukerewe District, Tanzania

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SUMMARY

A formative evaluation was undertaken in Ukerewe District to elicit the benefits of ox-plough over hand-hoe tillage. One hundred twenty two respondents who were selected purposively from their involvement in the project that introduced ox-plough technology in Ukerewe were interviewed. The interview employed a questionnaire designed to capture data on availability of agricultural labour, labour expenditures for tillage and weeding, crop growing cycles, crop yields and income expenditure on food as they were at the beginning and at the end of the project. It was found that adoption of ox-plough technology reduced tillage labour from 7.14 man-days to 1.58 man-days per acre, whereas weeding labour in farms ploughed using ox-ploughs decreased from 6.78 man-days to 4.58 man-days per acre. Further, adoption of ox-plough technology lead to increase in crop growing cycles, acreage and crop yields from 1.03, 0.9 and 13.3 to 1.9, 3.11 and 37.2, respectively. Concurrently, the ratio of annually produced cereal bags to household size improved from 1.73 to 4.83, while the ratio of income generated to income expended on food increased from 1.63 to 3.10. In abridgement the intervention reduced farming drudgery to create a room for increasing cropping cycles, a factor which interacted with improvement in soil characteristics and enhanced weed control due to increased tillage depth and hence tremendously increase in crop yield. It was concluded that ox-plough technology harnesses potentials for addressing hunger poverty.

Keywords: acreage, agricultural productivity, cropping cycles, labour, tillage

INTRODUCTION

A large proportion of inhabitants of sub-Saharan Africa continue to suffer from poverty of the form of food insecurity. Low efficiency in utilization of agricultural labour is one of the major contributors to this form of poverty. Inefficiency in agricultural labour utilization, constrains the pace of food production through limiting acreage (Brian and Kienzie, 2006). The problem of low labour utilization efficiency in traditional farming systems of Sub-Saharan Africa is centred on dependence on traditional farming

technologies (IFAD, 2003). Over 80% of the primary land preparation of the cultivated land in Sub-Saharan Africa still relies on hand hoe technology (Rickman *et al.*, 2013).

Extending agricultural mechanization through substitution of technology for primary tillage operation from hand hoe to animal traction is envisaged to harness immense potential for increasing agricultural food production in rural Africa. The advantage of ox-ploughing is not merely reduction of drudgery but it rather enhances rain season utilization for

cropping and improves agronomic properties of the soil. Savings in time for crop land preparation enhances the switching of cropping cycle to the time limited rainy season. On the other hand, because ox-plough tillage is of a greater depth than that of hand hoe, substitution of hand hoe by ox-plough in cultivation brings about more loosening of the soil to improve aeration, killing of troublesome weeds and release of nutrients from the soil to improve its suitability for crop cultivation (Reicosky and Allmaras, 2003).

Inhabitants of the Lake zone area of Tanzania are well known to be aggressive in agriculture but have been among the major sufferers of food insecurity and poverty in recent years (Odada *et al.*, 2006). Their volume of agricultural production has remained stagnant, while human population has increased rapidly (Odada *et al.*, 2006). Fishing, which used to serve as another major means of deriving livelihoods has collapsed following abusive utilization of the resources (Odada *et al.*, 2006). Low level of agricultural mechanization and unreliable rainfall both factors compounded a big problem of massive flux of middle age inhabitants from the rural areas to urban and peri-urban areas, thereby lowering agricultural labour supply and constraining agricultural production, ending-up into food insecurity (Odada *et al.*, 2006).

While it is widely accepted to be an affordable intermediate technology suitable for mechanizing agricultural operations in most of the traditional systems of Tanzania, ox-plough technology is still underexploited (Mlengeri *et al.*, 2015). For Ukerewe District in particular, utilization of ox-plough technology was practically new until very recently, although the technology has been in use in the

neighbouring mainland areas. Limited exploitation of draught power as an affordable, renewable and environmental friendly energy source for mechanized agriculture in the locality was being limited by lack of skills and less tangible issues like attitudes in a way similar to that reported by Oseguera *et al.*, (2007). The indigenous zebu cattle of Ukerewe are morphologically similar to those found in other part of the country but their calm temperament, suggest more draft potential. The soil of the area is of sandy type which is easy-to-turn and the weather condition is favourable for draught work (UDC, 2015).

In view of the livelihood vulnerability of smallholder farmers from food insecurity and the essence of mechanized tillage in the agricultural labour-drained District, Tanzania Livestock Research Institute (TALIRI)-Mabuki and its collaborators through a project titled 'Introduction of Draught Animal Drawn Implements Technology for Farming in Ukerewe' embarked on introducing ox-plough technology for crop land preparation at three villages in the district. The intervention transferred ox-plough technology and built farmers' capacity for the technology use. This study was undertaken in order to evaluate among the new ox-plough technology users, the benefits of ox-plough over hand hoe technology in crop land preparation, especially with regard to enhancement of agricultural labour productivity and alleviation of hunger poverty in Ukerewe.

MATERIALS AND METHODS

Study area

This study was conducted in Ukerewe District, Mwanza region in Tanzania. Ukerewe District is located within the Lake Victoria Basin area of Tanzania. The

District is an island in the Lake Victoria lying between Longitude 31° 30' and 32° 5' East of Greenwich and Latitude 1° 30' and 2° 20' South of the Equator (UDC, 2015). In the District the altitude varies between 1,150 m and 1,670 m above sea level. The District has a total area of 6,400 km² out of which only 640 km² constitute land surface. Human population in Ukerewe is estimated at 261,000 people (UDC, 2015). Major livestock kept are cattle whose population is estimated at 52,200 (UDC, 2015). The major crops grown are paddy, maize, cassava and citrus fruits. This study was undertaken specifically at Bukindo, Bugolola and Gallu villages as these were the specific sites at which the project was implemented.

Sampling and data collection

The study villages (Bukindo, Bugolola, and Gallu) were selected purposively at the beginning of the project to balance the agro-ecological representation of the District. Respondents from 122 households (Bukindo village n=44, Bugolola village = 36 and Gallu village n= 42), which were engaged as beneficiaries in the project were interviewed. A structured questionnaire was administered to heads of household to collect information on: household size, sex ratio, age distribution, number of household members supplying agricultural labour, tillage labour expenditure (hours per acre per person), weeding labour expenditure (hours per acre per person), cereal growing cycles per year, land cultivated per year (acres), cereal crop yields (100 kg bags), annual income generated and an expenditure of income on food. District Profile information (presented under study site description) were obtained as secondary data from District Livestock and Fisheries Officer (DLFO). The research design assumed that the farmers made no other changes in their way of farming apart from the

interventions from the project. Ox-ploughs were used also in preparation of farms of non-cereal crops but the study monitored outputs from cereal crops only because of measurability.

Data analysis

All the data were firstly coded, entered into Microsoft Excel spread-sheet, cleaned and transformed to suit the analysis. Data related to the cereal crop yields and income generated were computed based on household size and income expenditure on food to obtain ratios. The household expenditure - income ratio (i.e. the household budget used for food expenditure against income generated) were compared on the basis of time lines, before and after interventions to ascertain the impact on labour efficiency and food security. Independent sample t test was performed using Statistical Package for Social Sciences (SPSS, 2011) to compare the means of the two groups (before intervention and at the end of the intervention) in order to determine whether the population groups means are statistically significant different.

RESULTS

Household compositional characteristics

Results for household compositional characteristics are summarised in Table 1. The results showed that village means for household size vary slightly across villages between 7.30 and 8.24 with overall mean of 7.70. The numbers of males per household were slightly below those of females at all sites with overall mean of 3.63 for males and 4.07 for females. The largest age group was that of children (4.8 out of 7.7 total equivalent to 62.34%) and mean number of household members supplying agricultural labour per household was 2.27 (equivalent to 29.48%).

Table 1: Means for household compositional characteristics in Ukerewe

Household Characteristic	Village Means \pm se			Overall Mean \pm se
	Bukindo	Bugolola	Galu	
Household size	8.24 \pm 1.83	7.56 \pm 1.58	7.30 \pm 0.97	7.70 \pm 1.12
Gender distribution				
• Males	3.99 \pm 0.74	3.43 \pm 0.82	3.48 \pm 1.02	3.63 \pm 0.87
• Females	4.25 \pm 0.61	4.15 \pm 0.77	3.82 \pm 0.89	4.07 \pm 0.78
Age distribution				
• Elders (60 years old and above)	1.2 \pm 0.01	1.1 \pm 0.04	0.98 \pm 0.02	1.1 \pm 0.03
• Middle age (18-59 years old)	3.3 \pm 0.03	1.3 \pm 0.06	3.6 \pm 0.07	3.6 \pm 0.05
• Children (aged below 18 years)	4.5 \pm 0.06	5.7 \pm 0.09	4.2 \pm 0.08	4.8 \pm 0.08
Members supplying agricultural labour	2.43 \pm 0.15	2.18 \pm 0.32	2.20 \pm 0.19	2.27 \pm 0.26

Agricultural labour efficiency

Table 2 presents a summary of the results on labour expenditures for hand hoe and ox-plough technologies as they were used by the respondents at the beginning and at the end of the project, respectively, with means of both tillage and weeding labour showing significant ($P<0.05$) differences between the technologies used in the two timelines under comparison. In actual figures, the replacement of hand hoe by ox-plough technology in tillage lead to

reduction in tillage labour from 7.14 man-days to 1.58 man-days per acre and weeding labour from 6.78 man-days to 4.58 man-days per acre. Deductively the replacement of hand hoe technology by ox-plough technology for tillage lead to savings of labour use in tillage by 77.9% and in weeding by 32.4%. Therefore, by changing the tillage technology from hand hoe to ox-plough considerable reduction in drudgery was realized also in subsequent weeding operation.

Table 2. Mean labour expenditures in tillage and weeding using hand-hoe and ox-plough technologies in Ukerewe District

Tillage technology	Mean \pm se for tillage labour (man-days per acre)	Mean \pm se for weeding labour (man-days per acre)
Ox-plough	1.58 \pm 0.29 ^a	4.58 \pm 0.73 ^a
Hand-hoe	7.14 \pm 0.84 ^b	6.78 \pm 0.44 ^b

^{ab}Means in the same column with different superscripts are significantly different ($P<0.05$)

Farm productivity

In their way of farming, the farmers who used ox-plough technology managed to increase cereal crop farming cycles per year from 1.03 to 1.9 (Table 3). The total land cultivated per household per year is an index, which changed remarkably as well from an average of 0.9 ha to 3.11 ha, thereby marking a 245% increase in acreage per household. A resultant of all these changes in the way of farming was measured in terms of crop yield per household per year. Following the intervention this increased from an average of 13.3 cereal bags to 37.2 bags, a betterment equivalent to 179.7% increase in production. The mean values for cropping cycle, acreage and yield indicated existence of significant ($P<0.05$) differences between the timelines compared.

Table 3. Least square means for agricultural productivity measures just before and at the end of the project interventions in Ukerewe District

Productivity measure	Mean \pm se at the beginning of intervention	Mean \pm se at the end of intervention
Cropping cycles	1.03 \pm 0.2 ^b	1.9 \pm 0.47 ^a
Acreage (ha)	0.9 \pm 0.56 ^b	3.11 \pm 0.89 ^a
Yield (100 kg bags)	13.3 \pm 6.5 ^b	37.2 \pm 7.18 ^a

^{ab}Means in the same row with different superscripts are significantly different ($P<0.05$)

Food security

The ratio of total number of cereal bags produced to household size and that of total annual household income to annual income expenditure on food bettered significantly ($P<0.05$) during the time frame of the project implementation (Table 4).

Table 4. Food security indices before and after adopting ox-plough technology in Ukerewe District

Index	Mean \pm se at beginning of intervention	Mean \pm se at the end of the intervention
Cereal bags: household size ratio	1.73 \pm 0.84 ^b	4.83 \pm 0.93 ^a
Income generated: income expenditure on food ratio	1.63 \pm 0.71 ^b	3.10 \pm 1.04 ^a

DISCUSSION

According to this study, members who offer labour within the household in Ukerewe are by number less than a third of the household size. This is possibly due to the occupational effect of fishing which is the second major employing economic activity in Ukerewe (Chasama and Tungu, 2018). The dominance of women and children in households is a commonly encountered demographic feature, particularly in the developing world. This study showed that the use of ox-plough technology instead of hand hoe during crop land preparation saves a lot on agricultural labour and time. The savings are significantly not only in tillage but also in subsequent weeding. The implication of the observed tillage labour savings is that users of ox-plough technology managed to save over three quarters of the time they were formerly using for preparation of their farms. The observation suggests further that, farmers who adopted the technology could use shorter time than before to prepare farms and that triggered increase in acreage. It is also possible that shortening of time required for accomplishing laborious operations of tillage and weeding allowed better switching of cropping seasons to favourable weather conditions, especially with regard to availability of

moisture in the soil to promote plant growth and ultimately high yielding.

The field capacity that was exhibited by ox-plough technology during this study is higher than the previously reported study (Rajeev *et al.*, 2009), although the technology users are beginners. The relatively high field capacity exhibited by such beginners was possibly due to lightness of the soil found in Ukerewe District (Dubey *et al.*, 2007). Ukerewe District has sandy soils, which are easy to turn during cultivation and a cool weather, which poses low heat stress to working animals (UDC, 2015). This indicates the appropriateness of the technology to the isles farming system.

It was observed that substitution of the hand hoe with ox-plough technology had multiplier effects in enhancing labour utilization even in subsequent weeding, which is another critical operation in traditional agriculture (Brian and Kienzie, 2006). Reduction in weeding labour hours as well as weeding costs as outcomes of the project intervention indicates that tillage using ox-plough was deeper than that of hand hoe. Increased tillage depth probably reduced annual weed germination and establishment, and thereby reduced weeding intensity and rendered the operation less laborious as previously reported by (Swanton *et al.*, 1999). Since, weeding took place in a shorter time after intervention than before then crops were more protected from weed infestation and this might have boosted further the yield (Dubey *et al.*, 2007). Meanwhile, weeding represents another critical labour demand peak in the traditional farming cycle (Brian and Kienzie, 2006), ox-plough technology can be exploited to achieve considerable agricultural labour savings in the

smallholder farming system in Ukerewe, District.

In conclusion, it was found that substitution of hand hoe technology by ox-plough technology in crop land preparation is feasible and was associated with tangible benefits in Ukerewe District. Its benefits includes; reducing drudgery in tillage and weeding and increasing acreage. The use of ox-plough instead of hand hoe also possibly improved soil properties affecting plant growth. All these are considered to have contributed to yielding the realized remarkable improvement in crop outputs per year. However, validation of these results in another setting and assessment of the soil degradation effects due to the technology use and other possible challenges is important prior to advocating wider dissemination.

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