Influence of land preparation methods and vegetation cover on population abundance of *Mastomys natalensis* in Morogoro, Tanzania

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ABSTRACT. A Capture-Mark-Release study was carried out in Morogoro, Tanzania, from April 1999 to April 2001 to investigate the effects of land preparation methods and cropping systems on population abundance of *Mastomys natalensis* in crop fields. Two land preparation methods (tractor ploughing; slash and burning) and two cropping systems (mono-cropping with maize; inter-cropping with maize and beans) were included in the study. The experimental design was a Complete Randomized Design with 2x2 factors, with two replicates. In slash and burn fields, rodent population abundance and distribution were strongly influenced by vegetation cover regardless of the type of cropping system. Higher rodent population peaks occurred in dense vegetation cover in slash and burn relative to tractor ploughed fields. In contrast, there were no obvious associations between vegetation cover and population abundance in the tractor ploughed fields, particularly in the mono-cropping system. A negative correlation between vegetation cover and population abundance of *M. natalensis* was obtained in fallow land surrounding the crop fields ($r = -0.63$; $p \leq 0.05$). The results show that the effect of vegetation cover on population abundance of *M natalensis* in crop fields is strongly influenced by the type of land preparation methods. Tractor ploughing and clearance of fallow land surrounding crop fields could be a useful method to reduce the invasion of crops by *M. natalensis*.

KEY WORDS : *Mastomys natalensis*, vegetation cover, land preparation methods, population abundance, Tanzania.

INTRODUCTION

Burning of vegetation in order to destroy rodent habitats has been a common practice in East Africa (GREEN & TAYLOR, 1975). In Tanzania, many farmers burn their fields in the aftermath of the harvest or immediately before ploughing. This probably changes the habitat for a short duration, but most likely it has no detrimental effect on the future population size of rodents because burnt areas soon have new vegetation and are re-invaded rapidly. The type of farming practices affects the nature of the habitat, shelter and population density of rodents (MAKUNDI et al., 1999). A mosaic of small plots of various crops, intermingled with patches of fallow and permanent grass-land, combined with minimum land preparation and subsequent flourishing of weeds, creates favourable conditions for rodents species especially *M. natalensis* and results in a high degree of damage (TAYLOR, 1968; MWANJABE, 1993; MYLLYMÄKI, 1989).

Little attempt has so far been made to determine interactions of rodents with the various cropping systems found in many agricultural areas under different land management practices (YEBOAH & AKYEAMPONG, 2001; WHISSON, 1996). One of these interactions, for example, is the influence of agricultural practices on certain ecological characteristics of rodent populations. In this study we tested the hypothesis that rodent population characteristics are influenced by land preparation methods and land management practices. Thus we investigated the relationship between rodent population abundance and vegetation cover in different cropping systems and land preparation methods.

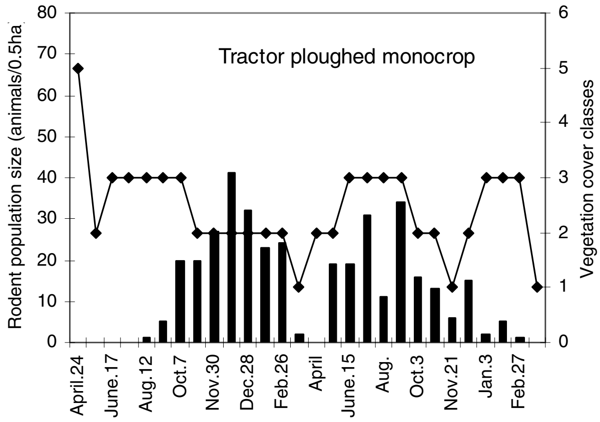
MATERIALS AND METHODS

The study area was located at Solomon Mahlangu Campus (Mazimbu), Sokoine University of Agriculture, Morogoro, Tanzania (6°46'S 37°37'E, 480m above sea level). A capture-mark-recapture (CMR) study was conducted during the 1999 - 2000 cropping seasons. Eight 70x70m grids were prepared, consisting of 7 parallel lines, 10m apart, and 7 trapping stations per line (total of 49 trapping stations/grid), also 10m apart. One Sherman live trap was placed on each trapping station. A 200m-300m wide zone of fallow land separated the grids from each other. The grids were subjected to two types of cropping systems (mono-cropping and inter-cropping) and two land preparation methods (tractor ploughing; slash and burning). The mono-cropping system consisted of a monoculture of maize and the inter-crop consisted of a mixture of maize and beans. The experimental design was a Completely Randomized Design (CRD) with 2x2 factors replicated twice. The grids were ploughed in November 1999 and February 2000 during the short and long rain seasons, respectively. Tractor ploughing was done using a disc plough at a depth of 30cm, a normal rooting depth for most annual crops. Slashing was done manually and the vegetation was left to dry and subsequently burned. Maize sowing followed a standard procedure (planting lines 90cm apart, plant holes 60cm apart, and three seeds per planting hole). The bean crop was sown 3 weeks after the maize, at a spacing of 50cm x 10cm. All necessary agronomic practices such as fertilizer application and weeding were carried out in all the plots. Triple Super Phosphate (20kg/ha) and Nitrogen (40kg N/ha) were applied before sowing and 3-4 weeks after sowing, respectively.

Trapping was conducted in each grid for three consecutive nights at intervals of four weeks. Traps were baited with peanut butter mixed with maize bran and were inspected early in the morning. Animals were marked by toe-clipping. The trapping station, sex, weight, and reproductive status of captured animals were recorded. Animals were later released at the station of capture. Plant cover estimations were done during the monthly capture session and were used to assess the effect of cover on population size. In each grid, the assessor moved diagonally across the grid from point 1A to 7G and from 1G to 7A. At each point a qualitative estimation of ground cover (other than maize crop) was made using a scale of 1-5, in quadrate measuring 5m*5m. The corresponding values were : 1 = no cover (< 15%); 2 = sparse cover (15-40%); 3 = moderate cover (41-65%); 4 = dense cover (66-90%); 5 = very dense cover (>90%). In the surrounding fallow land, cover estimation was done on all the four sides of the grids. The relationship between vegetation cover and rodent population abundance was investigated. Three parameters were used in the fittings : population size, vegetation cover in the field and vegetation cover in the fallow land. Correlation analysis was performed between the different factors using Pearson–moment product correlation. Population data were log transformed to normalize them before the analysis.

RESULTS AND DISCUSSION

The population dynamics of *M. natalensis* in the study area followed an already established pattern (TELFORD, 1989; LEIRS, 1995), but showed marked variations between individual fields brought about by land preparation methods and cropping systems. Slashing and burning, tractor ploughing, monoculture and intercropping resulted in differences in the habitats available to the rodents. Shelter and production of plant biomass were specifically altered by the land preparation methods. Slashing and burning took place in November and new vegetative growth occurred immediately after the onset of the short rains. This was followed by an increasing population size, probably due to an invasion from the fallow land (MERCELIS & LEIRS, 1999) and early breeding, which for *M. natalensis* occurs with the onset of short rains (LEIRS et al., 1993).



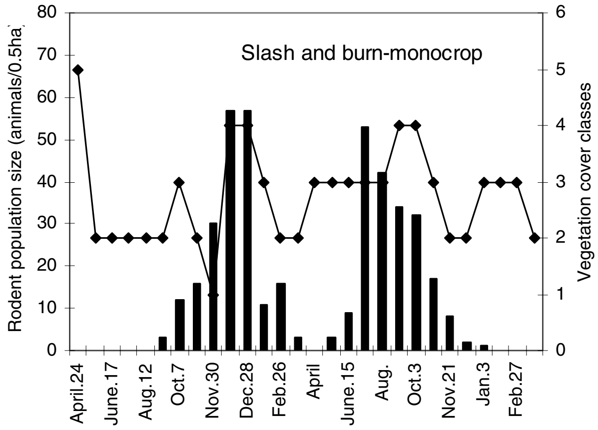
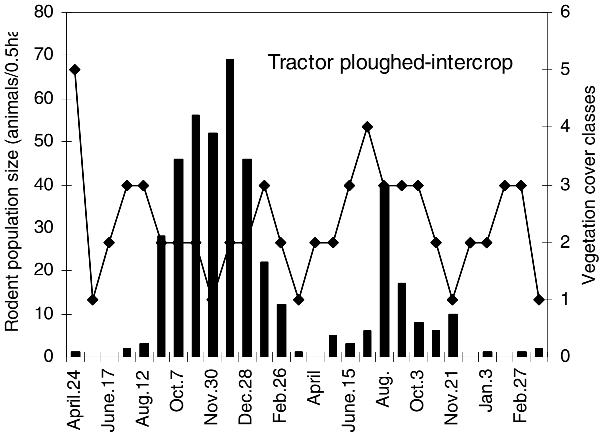


Fig. 1. – Rodent population abundance (bars) and vegetation cover (lines) in tractor ploughed fields (monocrop) and slash and burn fields (monocrop). Data were collected at intervals of four weeks.

Figs 1 and 2 show that higher population peaks were found in dense vegetation cover in slash and burn field than in the tractor ploughed fields. There was no obvious association between vegetation cover and population abundance in the tractor ploughed fields, particularly in the mono-crop. A negative correlation between vegetation cover and population abundance of *M. natalensis* was obtained in the fallow land (Pearson Product – Moment correlation; $r = -0.63$, $p \leq 0.05$).

Population sizes increased with increasing cover in the slash and burn fields and decreasing cover in the fallow land ($r^2 = -0.62$; $p \leq 0.05$). In the tractor ploughed fields population size remained low as cover increased ($r^2 = -0.51$; $p \leq 0.05$).

In the mono-cropped fields, rodent population size increased with decreasing cover in the fallow land ($N = 76$; $r^2 = -0.54$; $p \leq 0.05$), while in the inter-cropped fields rodent population increased with decreasing cover in the fields. A high rodent population size occurred in the inter-cropped fields when cover was low. Seasonal variation in population size in relation to vegetation cover was observed. During the short rains and non-cropping season (dry season), population size increased with increasing cover in the fields.



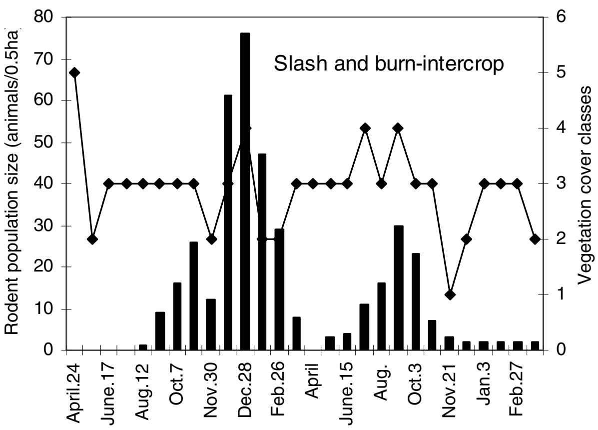


Fig. 2. – Rodent population abundance (bars) and vegetation cover (lines) in the tractor ploughed fields (intercrop) and slash and burn fields (intercrop). Data were collected at intervals of four weeks.

The selection for suitable habitat by *M. natalensis* is viewed to be a behavioural process, which maximizes fitness. Vegetation, apart from providing food resources, acts as cover for protection from predators. *M. natalensis* generally avoid exposed places to reduce the risks of predation (MOHR et al., 2003). The habitat changes were an important factor in the abundance of *M. natalensis* in the different fields. In crop fields, the changes are usually drastic and occur over a short period of time, which also brings about changes in the rodent population densities. The different types of treatments (tractor ploughed *versus* slash and burn and mono *versus* inter-crop) were associated with a sequence of habitat changes both temporally and spatially, and these are reflected in variation in the rodent population abundance in the different fields.

The fallow land with dense grass and weed cover became more and more unfavourable for *M. natalensis* particularly when new vegetation got established in the slash and burn and tractor ploughed fields. This is reflected in the negative correlation between cover and population abundance in the fallow land. MAKUNDI et al. (2000) reported that agriculture is a major disturbing factor in any ecosystem, and further commented that the timing and intensity of this activity may affect the species diversity and richness. This suggests that animals migrated from the fallow land to the crop fields and established new home ranges.

The opportunistic behaviour enables *M. natalensis* to take advantage of changes in habitats, particularly in relation to food resources. According to TAYLOR & GREEN (1976), when cereals and weed seeds were abundant, both grass and dicotyledonous plants (as found in the fallow land) were eaten sparingly or were absent in the diet of *M. natalensis*. It has been suggested that the fallow land at certain stages during the growth of the crop is a less suitable habitat compared to the crop fields.

It is apparent that agricultural activities may increase species richness (*M. natalensis*) whereas in the undisturbed fallow land the dominance of this species is reduced. This observation conforms to general theories in species succession (ODUM, 1971). In Australia, STICKEL (1979) reported that in a crop field – hay mosaic (analogous to crop –fallow land mosaic in our study area) the entire population of house mice moved from their long established home ranges in a hay field to a field of ripening wheat where they established new home ranges. Other studies have also shown the importance of farming practices on movements of populations of rodents. According to NEWSOME (1969a, b) the growth and harvest of wheat in Australia had major influence on the migration of house mice.

Our study shows a strong association between population size and vegetation cover in slash and burn fields. It is apparent that these fields were less disturbed than the tractor ploughed fields. This suggests that populations of *M. natalensis* build-up faster in slash and burn fields (mono and intercrop fields) than in the tractor ploughed fields probably due to higher survival and recruitment. Since the distribution of animals in the tractor ploughed fields was not random but was restricted to the edges (MASSAWE et al, 2003), it is an indication that there was less migration and colonization of these fields irrespective of the cover.

It is apparent that surrounding fallow lands in crop fields are an important consideration in rodent pest management. For example, studies in the Victoria Mallee, Australia, showed that fence-lines were the most important donor habitats because they provided abundant grass seed early in the breeding season (SINGLETON, 1989; TWIGG & KAY, 1994). Rodent management in such fields should aim at destruction of ground cover which affects rodents immediately by exposing them to predators and, more slowly, by removing their food supplies. Populations of *M. natalensis*, have been observed to increase after cover removal in adjacent fields (GREEN & TAYLOR, 1975). GREEN & TAYLOR (1975) therefore suggested that any attempts to reduce rodent numbers over wide areas by means of cover destruction would have to be coordinated so that all harbourage is removed at more or less the same time.

Our study also shows that following land preparation, animals escape into the fallow lands adjacent to crop fields. Therefore, removal of the fallow patches and field sanitation measures, when conducted by all or the majority of farmers will reduce rodent population size in crop fields.

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