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Soil losses due to cassava and sweet potato harvesting: A case study from low input traditional agriculture

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Abstract

Soil loss due to crop harvesting (SLCH) has been established as an important soil erosion process that has significantly contributed to soil degradation in highly mechanised agriculture. This has stimulated the need to investigate the importance of this process of erosion under low input agriculture where, until now, only water and tillage erosion are known as important phenomena causing soil degradation. This study was conducted in Eastern Uganda with the following objectives: (1) to assess the amount of soil lost due to the harvesting of cassava roots and sweet potato tubers under low input agriculture, (2) to look into the factors that influence variations in these soil losses, and (3) to estimate the amount of plant nutrients lost due to SLCH for cassava and sweet potato. Soil sticking to roots and tubers was washed and the soil suspension oven dried to estimate the amount of soil lost after harvesting. Mean annual soil loss for cassava was 3.4 tonnes ha^{-1} and for sweet potato was 0.2 tonnes ha^{-1}. Ammonium acetate lactate extractable soil nutrient losses for cassava were $N = 1.71$ kg ha^{-1} $harvest^{-1}$, $P = 0.16$ kg ha^{-1} $harvest^{-1}$, $K = 1.08$ kg ha^{-1} $harvest^{-1}$ and for sweet potato were $N = 0.14$, $P = 0.01$ kg ha^{-1} $harvest^{-1}$, $K = 0.15$ kg ha^{-1} $harvest^{-1}$. Difference in soil loss due to crop harvesting for cassava and sweet potato could be due to: (1) smaller yields of sweet potato leading to smaller soil losses on an area basis, (2) smoother skin and less kinked morphology of sweet potato that allowed less soil to adhere, and (3) the fact that sweet potato is planted in mounds which dry out faster compared to the soil under cassava. Soil moisture content at harvesting time and crop age were significant factors that explained the variations in the soil lost at cassava harvesting. Soil loss under cassava justifies the need to conduct further investigations on this process of soil erosion under low input agriculture.

Keywords: Soil erosion; Soil degradation; Soil loss; Cassava; Sweet potato; Roots; Tubers; Uganda; SLCH (soil loss due to crop harvesting)

1. Introduction

When harvesting crops such as sugar beet (*Beta vulgaris* L.), potato (*Solanum tuberosum* L.), chicory root (*Cichorium intybus* L.) and carrot (*Daucus carota* L.), significant soil loss can occur. Soil sticking to the harvested crop and soil clods are exported from the field and rarely returned. Hence, this soil volume represents a true soil loss and is referred to as soil losses due to crop harvesting (SLCH). Research conducted in highly mechanised agriculture in Belgium (Poesen et al., 2001) has shown that mean SLCH was similar to those of other soil erosion processes. This justified the need to incorporate SLCH into future assessments of soil

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degradation and sediment budgets. However, one of the questions that remains is whether this soil erosion process is also significant for low input agriculture as practised in Uganda.

Cassava (*Manihot esculenta*) and sweet potato (*Ipomoea batatas* (L.) Lam.) are important food security crops in Uganda (Muwanga et al., 2001; Otim-Nape et al., 2001). These crops have been grown under traditional low input agriculture with an estimated national production for 2003 of 5.3 Tg of cassava and 2.5 Tg of sweet potato. National average yield for the improved SS4 variety is 55 and 4 tonnes ha^{-1} for cassava and sweet potato, respectively (Muwanga et al., 2001; Otim-Nape et al., 2001). Cassava is grown as a sole crop with a spacing of 1 m × 1 m. As a sole crop, intercropping with maize, millet and beans occurs at early stages of the crop. Intercropping throughout the crop cycle is done at wider spacings of about 1.5–2 m. Plant stems of about 30 cm in length are normally planted in holes 20–30 cm deep. Harvesting occurs normally 12 months after planting, but early maturing varieties can be harvested 6 months after planting. Cassava is harvested by using a hand hoe or is simply uprooted by hand. Farmers harvest as the need arises and therefore the harvesting can be spread over time with crops harvested at different ages. After harvesting, the roots are broken from the stems and placed in a basket for home transportation. Cleaning of roots before transportation is not common. Part of the stalk is retained for replanting while part is discarded. Leaves and discarded stems are sometimes left in the field or sometimes used as domestic fuel.

Sweet potato is grown as sole crop on mounds that vary from 60 to 120 cm in diameter. The average mound density is 7408 mounds per hectare and each mound contains four sweet potato vines (Fig. 1). Harvesting is done by hand using special 'chop' sticks, although hoes are often used later in the crop cycle. Harvested tubers are left for some time to dry in the field before they are transported by basket. Cleaning of tubers before transportation is not common. After harvesting, farmers normally leave crop residues in the field but some use them as fodder for housed animals like cattle and pigs. Harvesting of sweet potato can be throughout the year.

Fig. 1. Sweet potato mounds about 1 month after planting.

Like other annual crops (Stoorvogel and Smaling, 1991; Srivastava et al., 1996), production of cassava and sweet potato is associated with soil degradation in the form of nutrient depletion or mining and soil loss due to water erosion (Nkedi-Kizza et al., 2003; Ebanyat et al., 2003). Nutrient loss estimates due to sweet potato product removal are 46 kg ha^{-1} $year^{-1}$ (*N*), 8 kg ha^{-1} $year^{-1}$ (*P*) and 55 kg ha^{-1} $year^{-1}$ (*K*) in Uganda (Wortmann and Kaizzi, 1998).

Investigations into SLCH as another possibly important source of soil and nutrient loss under tropical low input traditional agriculture are non-existent. This study attempts to fill this knowledge gap and aims to get an insight on quantities of soil and nutrients lost where harvesting of roots and tubers is by hand hoes and 'chop' sticks.

The objectives of this study were: (1) to assess the magnitude of SLCH for cassava and sweet potato under low input agriculture in Uganda, (2) to investigate the factors that determine the intensity of soil loss, and (3) to determine the magnitude of soil nutrient loss from SLCH.

2. Materials and methods

2.1. Study area

The crop and soil samples were collected from Iguluibi and Namagera villages situated in Mayuge district in eastern Uganda on the northern fringe of Lake Victoria (Fig. 2). Lake Victoria catchment (193,000 km^2) supports approximately 30 million people and is spread over Tanzania (44%), Kenya (22%), Uganda (16%), Burundi (7%) and Rwanda (11%). Agriculture, livestock and fishing form the basis for the livelihood of the majority of the population living around the lake (LVEMP, 2004). Over the past 50 years, eutrophication and siltation have become a threat to the lake's fisheries and have been linked to reduced vegetation cover and inappropriate agricultural practices that are a major source of soil sediments (Verschuren et al., 2002; Balirwa et al., 2003).

Mean annual air temperature is 28 °C and the study area is characterised by two rainy seasons (mid March–June and September–December) with a mean annual