Effect of Harvesting Time after Irrigation on Soil Loss due to Cassava Tubers

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Abstract

Impact of land use and land use changes on soil erosion process have received attention and still alarming. Land use changes mainly affect water, wind and tillage erosion. Soil loss due to crop harvesting (SLCH) which is a soil erosion process that occurs during the harvest of crops such as cassava, sweet potato, carrot, beetroot, radish, potato, ginger, onion, yams, green-amaranth, leek and groundnut. Those crops are mostly cultivated in Jaffna peninsula and cassava is a major food crop for poor farmers or small holder farmers which are cultivated under low input except the irrigation. Cassava was cultivated 259 ha in Maha, 159 ha in Yala and average yield was 25MT / ha in Jaffna in 2011. It is planted as a mono crop or intercrop at early stage and cultivated throughout the year. Easy and un-damageable uprooting of the cassava plant mainly depends on soil moisture, texture and agronomic practices. This study focused on the effect of harvesting time after irrigation on SLCH. Soil moisture had a linear positive relationship $R^2 = 0.65$ with plant specific SLCH (SLCH spec/p). Soil moisture level decreased from the day after irrigation (from field capacity) and has lower soil moisture in the evening than morning due to of the day temperature. Similarly estimated crop specific SLCH crop was slightly lower than morning harvesting because of soil moisture effect. The harvesting time after irrigation showed weak negative correlation r = 0.75 (p-value 0.07) with soil moisture level. But harvesting time showed strong negative correlation r = 0.96 (p-value 0.003) with SLCHcrop. Average plant specific SLCH spec/p was 80.7 g / root and crop specific SLCH crop was 6.7 kg / ha / harvest loss in Valliagmam area in Jaffna. From this study that could be suggested to do harvesting at evening and to avoid harvesting at field capacity level. Soil loss under cassava justifies the need to conduct further investigations on this process of soil erosion on wide variation in soil and cassava tuber characteristics.

Key words: Cassava, Crop-harvest, Irrigation, SLCH, Soil-loss

Introduction

Soil erosion is one of the major processes leading to soil degradation. Water and wind erosion, mass movements, and more recently, tillage erosion are considered the most important soil erosion processes (Ruysschaert et al. 2004). In Europe, scientists focused on an often neglected, but apparently significant, soil erosion process, i.e., soil loss due to crop harvesting (SLCH). This type of soil loss is caused by the harvest of certain crops such as adventurous root tubers (cassava and sweet potato), tap root tubers (carrot, beet root, radish and turnip), stem tuber (potato), rhizomes (ginger, turmeric), bulbs (onion, garlic), corms (taro and yams), vegetables (leeks, green amaranth) and fruit (groundnut). During the harvesting, soil adhering to the crop, loose soil (soil clods) and rock fragments are exported from the field plot and rarely returned (Isabirye et al. 2007). The SLCH depends on soil factors (soil moisture, soil texture, soil organic matter and soil structure), crop factor (root shape, skin roughness and surface area), agronomic practices (plant density, yield, manure application and intercropping) and method of harvesting (Ruysschaert et al. 2005). Isabirye et al. (2007) stated that fine earth adhering to the crop and loose soil are harvested and removed from the field together with crop. Crop types are grown worldwide and cover large areas; but little or no attention has been given to the important of SLCH in the field.

Cassava is an important security food crop in small holder farming. That is cultivated around 237 ha in Maha, 140 ha in Yala in 2010 and 259 ha in maha, 159 ha in yala in 2011 in Jaffna. Normally Cassava was locally harvested and consumed at the same day. If been damaged, cyanogenic glucoside compound will be activated and the toxic hydrogen cyanide (HCN) will be released. In such situation it should be carefully

harvested and be consumed within 24 hours. Irrigation is the major cost in low input agriculture crop of Cassava other than the land preparation cost. The SLCH is mainly determined by the soil moisture level. So this study focuses on assessment of soil loss due to Cassava harvesting on time of harvesting after irrigation.

Materials and Methods

Before the study, a pre test was done by personal interviewing of selected cassava farmers about pre-harvest, harvesting and post-harvest operations related to SLCH. Then the soil physical properties such as soil moisture (thermo-gravimetric method), bulk density (tube core method), soil particle size distribution (sieve method) and soil texture (hydrometer method) were determined by standard methods.

This study was conducted in Vlligamam area in Jaffna district during January, 2012 and February, 2012 at long non rainy days. Five representative cassava fields, with almost the same soil type and the same age group trees were selected to minimize the bias in results. Fields were irrigated in the evening and the cassava plants were up rooted by hand similar to farmer's practices from the next day - 1st day morning, 1st day evening, 2nd day morning, 2nd day evening and 3rd day morning. At the each time of harvesting, soil samples were collected and the soil moisture content was determined. Root tubers were carefully separated and washed out without damaging and the weight was recorded. Water used for washing was allowed to be settled, drained out, allowed to sun drying and let in oven at 105°C for 24 hrs.

The soil losses were calculated per unit of net crop mass, per root/tuber and per unit of area according to the SLCH definitions proposed by Ruysschaert et al. (2004). Mass-specific SLCH [SLCHspec (g/g) = (Mds+Mrf)/Mcrop; where Mds is the total mass of oven-dry soil; Mrf is the mass of rock fragments (as the crop is harvested by hand Mrf will be zero in this study);

Mcrop is the net crop mass of the sample (mass of the washed Cassava)], *plant-specific SLCH* [SLCHspec/p (g/root) = (Mds+Mrf)/NPl; where NPl is the number of root in the sample] and *crop-specific SLCH* [SLCHcrop (kg/ha/harvest) = SLCHspec * Mcy; where Mcy is the net crop yield]. All the data were analyzed by 'R' statistical online software (Wessa, 2012) and Microsoft excels spreadsheet.

Results and Discussion

The removal of soil by this soil erosion process causes loss of valuable top soil and nutrients, as this soil is seldom spread onto the field plot of origin again (Ruysschaert et al. 2005). Correlation between the determined soil physical properties and calculated SLCH parameters were analyzed by Pearson product moment. Percentage of clay showed a positive correlation with SLCHcrop (r = 0.66) similar to the other studies mentioned in Li et al. (2006) who have obtained a negative correlation. The % of fine sand and the % of coarse sand had negative correlation with SLCH parameters similar to studies but not strong. In particle size sieve analysis, uniformity coefficient (Cu) and coefficient of variance (Cc) showed strong negative correlation with SLCH parameters. Possible explanation for this result is the strong correlation between sieve analyses Cu with SLCH crop. Li et al.

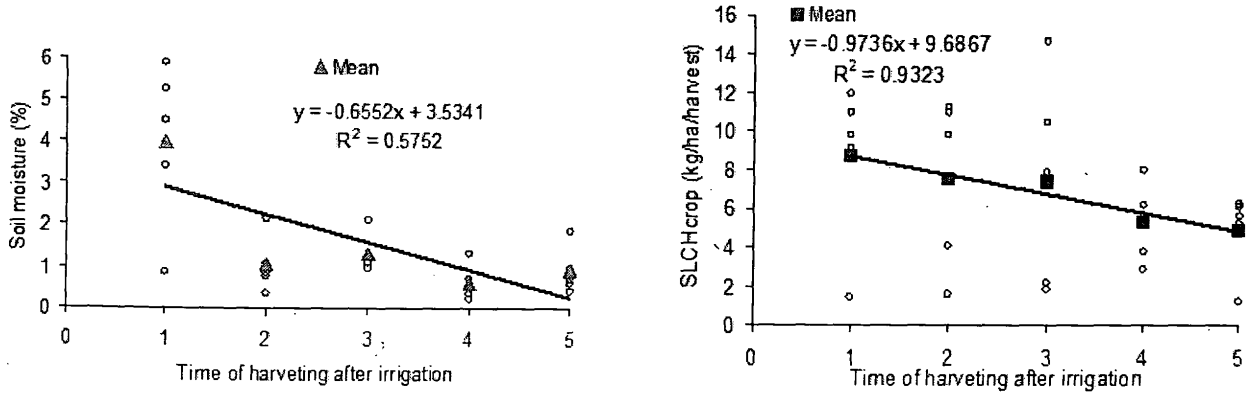

Figure 1: Relationships between time of harvesting after irrigation on soil moisture (left) and SLCHcrop (right) (1,2,3,4,5 represent 1st, 2nd, 3rd, 4th and 5th harvesting)

(2006) indicated that harvesting operation also interacted with soil texture and other variables and these interactions are also might be the reason why no significant multiple regression equation was found.

Previous studies showed soil moisture has exponential and linear relationship between SLCH parameters (Isabirye et al. 2007, Li et al., 2006 and Ruysschaert et al., 2005). Isabirye et al. (2007) obtained exponential correlation of $R^2 = 0.14$ and simple regression equation was $SLCHspec = 0.0069e^{0.0589MC(\%)}$ for their Cassava study where MC denotes the moisture content. From this study soil moisture showed positive linear relationship of $R^2 = 0.65$ ($r = 0.81$ and p-value is 0.05) with SLCHspec/p and simple regression equation was SLCHspec/p = 17.6MC(%) + 53. Soil moisture content at harvesting time, influenced both by soil properties (e.g., soil texture) and antecedent weather conditions, induces a large variability in SLCH values (Ruysschaert et al. 2005).

The harvesting time after irrigation showed negative correlation r = 0.75 (p-value 0.07) and r = 0.96 (p-value 0.003) with soil moisture level and SLCHcrop respectively (Figure 1). But harvesting time after irrigation showed not significant level (r = -0.7 and p-value 0.09) with SLCHspec. The possible explanation for not significant correlation at time of harvesting after irrigation with soil moisture level due to variation of soil properties, root characteristics and agronomic practices between field & plot and within the field & plot.

The harvesting at field capacity level showed slightly higher SLCH values than other harvesting time. The morning time had slightly high moisture level than the evening because the evening moisture level was affected by the day temperature. And SLCHcrop value was slightly lower at evening time of harvesting comparing with morning time due to soil moisture effects. In famer's level, the harvesting time (morning or evening) was determined by distance from field to residence and from field to market. From this study could be suggested to do evening harvesting but aware of quality of harvested tuber because of HCN formation. From this study, estimated average plant specific SLCHspec/p was 80.7 g / root and crop specific SLCHcrop was 6.7 kg / ha / harvest loss in Valliagmam area in Jaffna.

Conclusions

This research was an assessment the importance of soil loss due to cassava harvesting and correlation between harvesting time after irrigation. The harvesting time after irrigation showed not significant level with soil moisture and negative strong correlation with SLCHcrop. Average soil loss by cassava harvesting in Jaffna Valligamam (sandy clay loam textural class) was 6.7 kg/ha/harvest. Soil water content is a major factor affecting the amount of soil lost, but further research is necessary under a broader variation of soil texture types and root characteristics of cassava tuber.

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