Got Matooke (*Musa* spp.) for Christmas?

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Abstract

East African highland cooking banana (*Musa* spp., 'Matooke', AAA-EA genome) prices are sensitive to supply dynamics given their perishable nature. Despite large temporal fluctuations in farm-gate prices and food security, no efforts have been made to shift banana production towards periods of high banana prices and low food security. This study evaluated the influence of sucker emergence period on harvest period and yield, with the aim of proposing alternative desucker management that could shift production towards low supply periods. 150 AAA-EA ('Enyeru') mats were selected on ten farms in Ntungamo district (southwestern Uganda). Under farmer management, the mats were researcher-monitored weekly from 2005 to 2007 to record dates of sucker emergence, flowering and harvest and bunch weight. Date records were respectively grouped into quarters that corresponded to dry (Q1: December–February; Q3: June–August) and wet seasons (Q2: March–May; Q4: September–November). Harvest peaks occurred in Q3 and Q4 due to the significantly ($P<0.05$) larger numbers of suckers that emerged in Q4 and early Q1 compared to the rest of the year. Few bunches were harvested in Q1 due to low sucker emergence in late Q1 of the preceding year. By the time farmers desuckered after the wet season, suckers that emerged late Q1 were likely to be removed because they appeared smaller than those that emerged in Q4 and early Q1. Bunches harvested in Q1 were fewer and significantly lighter (25%) than those harvested in Q3. The weight loss was offset by the fact that farm-gate bunch prices/kg were up to 50% higher in Q1 than in Q3. Preference selection of suckers emerging in late Q1 will be more profitable, improve food security and reduce farm nutrient exports. Recommendations will need to be tailored to cultivar and altitude.

INTRODUCTION

The importance of East African highland cooking banana (*Musa* spp., AAA-EA genome) as a staple food crop is so high that its local term 'Matooke' is synonymous with food in several communities in Uganda. Per capita consumption of 'Matooke' is between 220 and 460 kg/year (FEWSNET, 2004), making Uganda the largest per capita banana consumer in the world. Bananas are dominantly produced by smallholder farmers (<1 ha), who sell surplus production at the farm-gate or local collection centers for onward transport to the larger urban centers. In this way, the farmers earn a large part of their cash income for sustaining their livelihoods (Bagamba, 2007). Over the past four decades, the on-farm fresh banana fruit yields in Uganda averaged less than 10 t/ha/year (FAO, 2008), which is low compared to the highest recorded yields (60–70 t/ha/year) in the region (van Asten et al., 2004). This implies that there is considerable scope for improving production and incomes of banana farmers in Uganda. Although much research has focused on generating technologies to reduce losses caused by plant biotic stresses (e.g., Gold et al., 1994, Bananuka et al., 1999; Rukazambuga et al., 2002) little has been done to improve banana yields and spread harvest dates of banana to maximize profit.

After planting banana material of homogenous size and nature at a single point in time, the harvest period spreads out from a relatively short period (<2 months) to a full-year process after only 3–4 crop cycles later. Banana plantations in Uganda are generally several years to decades old and thus plants at different phenological stages can be found in the field at any given time of the year. Nevertheless, harvest dates of bananas in

Uganda exhibits strong seasonality. Low production or supply periods result in price hikes whereas peak harvest periods result in glutted markets and floor prices. Low margins mean that farmers may be forced to consume produce or suffer substantial post-harvest losses as the income is less than the cost of marketing and due to the perishable nature of the produce, they cannot be stored when ripe.

A survey conducted in southwestern Uganda in 2004 reveals that up to 100% of the farmers interviewed considered the months from October to February as periods of food shortage, while up to 99% reportedly experienced abundant food supplies in the months from May to August (P. Van Asten, pers. commun.). These findings corroborated the temporal variations in farm-gate prices for fresh bananas recorded earlier in southwestern Uganda (S. Abele, pers. commun.), which hit their peak and low levels within the periods reported to be of food scarcity and food abundance, respectively (Fig. 1). The period of food scarcity includes the Christmas season, during which 'Matooke' is in high demand. There is thus a need to identify ways and means for spreading production and harvest over time for enhanced food security and profit.

There are several ways of staggering production and harvest dates, such as the use of irrigation, planting dates and growing crops across a range of temperature zones. In smallholder banana production the simplest and lowest cost method is through suckering regimes. Bananas vegetatively reproduce through suckers (i.e., shoots) at the base of the plant (Robinson, 1986). Sucker production by a mother plant is low during early growth and flowering. In general, each mother plant produces between two to ten suckers in each plant cycle, depending on variety and environmental factors. However, to improve bunch yields farmers remove excess suckers (i.e., to desucker), to leave a maximum of three plants of three generations/stool or mat. Most studies on desuckering regimes have been geared towards maximizing overall banana yields (Eckstein et al., 2000), while ignoring socio-economic factors related to harvest period. From such studies, farmers have been advised to adopt systems of follower sucker selection that will ensure high bunch weight and short cycle duration through maintenance of optimal plant density for minimum competition. Size/sturdiness and direction of emergence of the follower sucker are thus more emphasized than the time of year of emergence.

Practically, farmers in Uganda desucker during the dry season (December–February and June–August), after a phase of prolific plant growth and sucker production during the wet season. Farmers often avoid desuckering in the wet season because of the presence of intercrops and/or the competing labor demands of annual crops, which enjoy higher priority over the perennial bananas. This seasonality in follower sucker selection may be the cause of the observed seasonality in harvest in Uganda. For example, in a related study using 'Dwarf Cavendish' (AAA genome) in South Africa in which sucker selection was not seasonally scheduled, Kuhne (1975) reported that the date of sucker emergence determined the harvest dates, with a marked seasonal tendency. This study therefore evaluated the effect of period of sucker emergence on period of harvest among East African highland bananas in Uganda with a view to designing alternative sucker management regimes for more profitable banana production.

MATERIALS AND METHODS

Site

The study was conducted in Nyakyera sub-county in Ntungamo district in southwestern Uganda (00°47'14" S; 30°13'52" E). The area received an average of 1,043 mm rainfall/year over seven years from 1999 to 2006 in bimodal distribution (March to May and September to December). Daily minimum and maximum air temperatures were 14 and 26°C, respectively (FAO, 2006). The soils are highly weathered sandy-loams with very low weatherable mineral reserves on (mica-)schist parent rock.

Selection of Farms and Plants

Ten farms were selected in a stratified random manner. Stratification was done by

wealth class ('poor', 'moderately wealthy' and 'wealthy') and farm location according to slope position ('middle-upper slope', 'middle-lower slope' and 'valley bottom'). At each farm, 15 mats of the most popular East African highland banana 'Enyeru' were selected randomly and proportionately spread out in the relative distance classes close, mid-distant and remote from the homestead to cater for production gradients that may exist within a farm. Left under the host farmer management, the mats were monitored weekly over a period of two years (2005–2007) for date of sucker emergence, flowering and harvest, as well as fresh bunch weight and number of hands and fingers/bunch. A rain gauge, with which daily rainfall records were taken, was installed near the survey farms.

Statistical Analysis

Plant emergence, flowering and harvest data were grouped accordingly into quarters following the date of recording. The quarters were defined as follows: Q1 (December to February); Q2 (March to May); Q3 (June to August); and Q4 (September to November). The quarter limits were selected to approximate to the wet and dry seasons in the study area. One-way analysis of variance (ANOVA) was performed in SPSS 11.0 to assess the effect of quarter of emergence on banana growth duration and yield parameters. Associations between quarter of emergence and quarter of either flowering or harvest were measured using Pearson's chi-square test in SPSS 11.0.

RESULTS

Temporal Trends in Banana Production

The monthly banana production exhibited the expected seasonal peaks and lows (Fig. 3), although the Q2 (March to May) wet season was relatively dry (Fig. 2). Furthermore, the first half of Q1 (December to mid-January) still received a relatively large amount of rainfall and only February and June–July were relatively dry compared to long-term averages. Production peaked from mid-Q3 (July) to mid-Q4 (October) and from there declined to a low level throughout Q1 (Fig. 3). Only 14% of the annual production/farm was harvested in Q1 whereas Q3 and Q4 each had over 30% of the annual production. However, plants that emerged in Q1 along with those that emerged in Q4 accounted for the greatest proportion of annual production/farm ($P<0.05$), while those that emerged in the Q3 dry season accounted for the least (Table 1, Fig. 4). There was a strong association between quarter of emergence and quarter of harvest ($P<0.01$). About 45% of plants harvested in Q3 and 60% of those harvested in Q4 emerged in Q4 and Q1, respectively, while up to 50% of those harvested in Q1 were plants that emerged in Q1 of the preceding year (Fig. 4). Plants that emerged in late Q1 (i.e., from mid January until end February) were significantly ($P<0.05$) more likely to be harvested in Q1 (December to February) than those that emerged in early Q1 (December to mid January).

Banana Growth and Yield Trends across Quarters of Sucker Emergence

Plants that emerged in either Q2 or Q3 took about three months longer ($P<0.05$) in the vegetative (from emergence to flowering) growth phase than those that emerged in either Q1 or Q4 (Table 1). There was a strong association between quarter of emergence and quarter of flowering ($P<0.01$). Plants that emerged in Q1 were significantly ($P<0.05$) likely to flower in either Q3 or Q2, while those that emerged in either Q2 or Q3 were significantly ($P<0.05$) likely to flower in Q4. Plants that emerged in Q4 were significantly ($P<0.05$) likely to flower in Q1 (Fig. 5). Irrespective of the quarter of emergence, all plants took approximately four months in the bunch-filling (from flowering to harvest) growth phase. The vegetative growth period for plants that emerged in either Q2 or Q3 was significantly ($P<0.05$) longer than that for plants that emerged in either Q1 or Q4 by about 2.5 months (Table 1).

The mean bunch weight for plants that emerged in Q1 was significantly lower than that for plants that emerged in either Q4 or Q3 by about 30 and 25%, respectively (Table 1). The difference in mean bunch weight for plants that emerged in Q2 and that for plants

that emerged in either Q3 or Q4 was not significant (Table 1). Plants that emerged in Q1 had significantly (P<0.05) lower number of fingers/bunch (less by about 34 fingers or 25%) compared to that for plants that emerged in either Q3 or Q4. The number of hands/bunch was similar (P>0.05) across all quarters of emergence (Table 1).

DISCUSSION

Temporal Trends in Sucker Emergence and Timing of Harvest

Banana production in Uganda is entirely rain-fed. The temporal trends in banana production (seasonal variation in banana growth and yields) can be explained by the seasonal variation in rainfall received in the study area. The proportion of the mean annual total rainfall received in the study area increased as follows: Q3 < Q2 < Q1 < Q4 (Fig. 2). The number of harvested bunches/farm relative to sucker emergence period followed the same trend (Table 1), with least harvested bunches originating from suckers that emerged in Q3, then Q2, followed by Q1 and Q4. Similarly, the crop cycle length was also much longer in Q3 and Q2, compared to Q4 and Q1.

The observed banana production trend (high production from May–October and low production from November–April) approximates local farmers' observation that May to August is normally a period of food abundance, while October to February is often a period of food scarcity, respectively (P. Van Asten, pers. commun.). In this study, peak production occurred in October. This may have been due to the exceptionally wet conditions experienced in Q1 of 2005/2006 and 2006/2007 (Fig. 5), which is otherwise usually a dry period in the study area.

Drought conditions delay leaf emergence (Turner and Thomas, 1998) and flowering (Robinson and Alberts, 1987). Excessive loss of moisture through transpiration during the dry season triggers stomatal closure (Thomas and Turner, 2001), causing a reduction in photosynthesis (Turner and Thomas, 1998). As a result, the growth process is slowed down, lengthening the growth cycle (Robinson and Alberts, 1987). Therefore plants that emerged in either Q2 or Q3, which were relatively dry periods (Fig. 2), took up to two months longer in the vegetative growth phase than those that emerged in either Q1 or Q4 (Table 1), which were relatively wet periods (Fig. 2).

A higher number of harvested plants emerged in either Q4 or Q1 compared to those that emerged in either of the drier Q2 and Q3 (Table 1). This may have been due to the fact that banana sucker emergence is usually more prolific during the wet season than the dry season. The harvest peaks in Q3 and Q4 were due to suckers that emerged in Q4 and Q1, respectively (Fig. 3). The Q1 production was mainly due to suckers that emerged in the second half of Q1. Since few suckers emerged in the second half of Q1, the harvest in Q1 in the subsequent year was very low. It should be noted that 60% of production in Q4 (Fig. 4) was mainly due to suckers that emerged in the first half of Q1. This was caused by farmers' tendency to defer desuckering until the dry season in January–February. At that time, the suckers that emerged in November to early December are the ones that appear most vigorous, giving them an advantage to be selected over the suckers that emerged in January–February.

Temporal Variations in Banana Bunch Parameters

Bunch weight and number of fingers/bunch increased with the quarter number of sucker emergence (i.e., Q1 < Q2 < Q3 < Q4), with suckers emerging in Q1 having significantly lower (P<0.05) bunch weights than those that emerged in other quarters (Table 1). This could mainly be due to differences in rainfall distribution at the time of flowering (Robinson, 2003). Whereas plants that emerged in Q1 often flowered during the dry Q3 period, plants that emerged in Q2 and Q3 flowered in the wetter Q4 and Q1. According to Robinson and Alberts (1987), finger and hand initiation are more sensitive to moisture stress than fruit development. This therefore explains the difference in yield parameters between plants that emerged in either Q1 or Q4. This study shows that sucker emergence period not only influence length of the growth cycle and time of harvest as

shown by Turner and Hunt (1987), but also the overall bunch weight. Apparently, farmers' desuckering practice in the dry season either consciously or subconsciously favors selection of plants that flower in the wet season and thus yields heavier bunches than plants that flower in the dry season. The 20–30% decrease in bunch weight for plants that flower in the dry season is more than compensated for by the doubling of their price/kg that results in up to 50% increase in revenue.

CONCLUSION

Considering the large intra-annual banana farm-gate price fluctuations, farmers in southwestern Uganda would be better off selecting suckers in such a way that a proportion of their annual production coincides with the period of traditionally low supply, and hence high price and low food security; i.e., December to February. Concretely, in this particular study area and for the cultivar selected ('Enyeru'), we advise that farmers reduce on the number of suckers that emerge in the second half of Q4 and those that emerge in the first half of Q1, and retain suckers that emerge in the second half of Q1. In this way, banana production may be regulated for enhancing farmers' food security and livelihoods. Approaches for attaining this synchrony and the associated opportunity costs need to be evaluated in Uganda's banana cropping systems, adjusting for different cultivar × altitude combinations. Generally, seasonal rainfall patterns are important determinants of rain-fed banana production.

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Tables

Table 1. Variation in banana (*Musa* spp.) growth and yield parameters with quarter of sucker emergence in Ntungamo, southwestern Uganda in 2005 to 2007.

	Quarter of sucker emergence (mean ± SE)[1]			
	Q1	Q2	Q3	Q4
Vegetative growth (days)	525±11a	630±14b	606±19b	511±13a
Reproductive growth (days)	140±3a	126±5b	132±6ab	134±4ab
Total crop cycle length (days)	650±10a	735±15b	738±21b	655±12a
Number of hands/bunch	9.2±1.0a	8.2±1.6a	8.1±2.1a	8.4±1.4a
Number of fingers/bunch	109±4a	119±6ab	133±9b	140±5b
Bunch weight (kg)	15.7±1.0a	17.6±1.6b	19.7±2.1b	20.7±1.2b
Number of bunches/farm	6.4±0.8a	3.3±0.6b	1.7±0.5c	4.8±0.7ab

[1]Means followed by the same letter in a row are not significantly (P>0.05) different; SE = standard error; Q1: December-February; Q2: March-May; Q3: June-August; Q4: September-November.

Figures

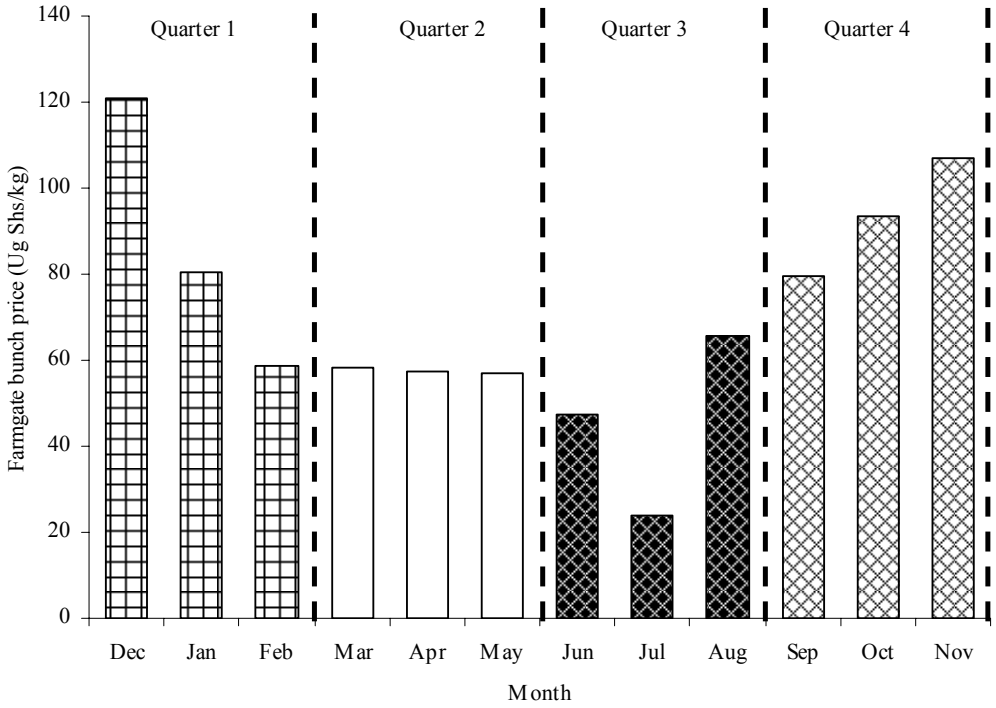

Fig. 1. Five-year monthly average (1997–2002) for farm-gate prices in Mbarara, southwestern Uganda Source: P. Van Asten, pers. commun.

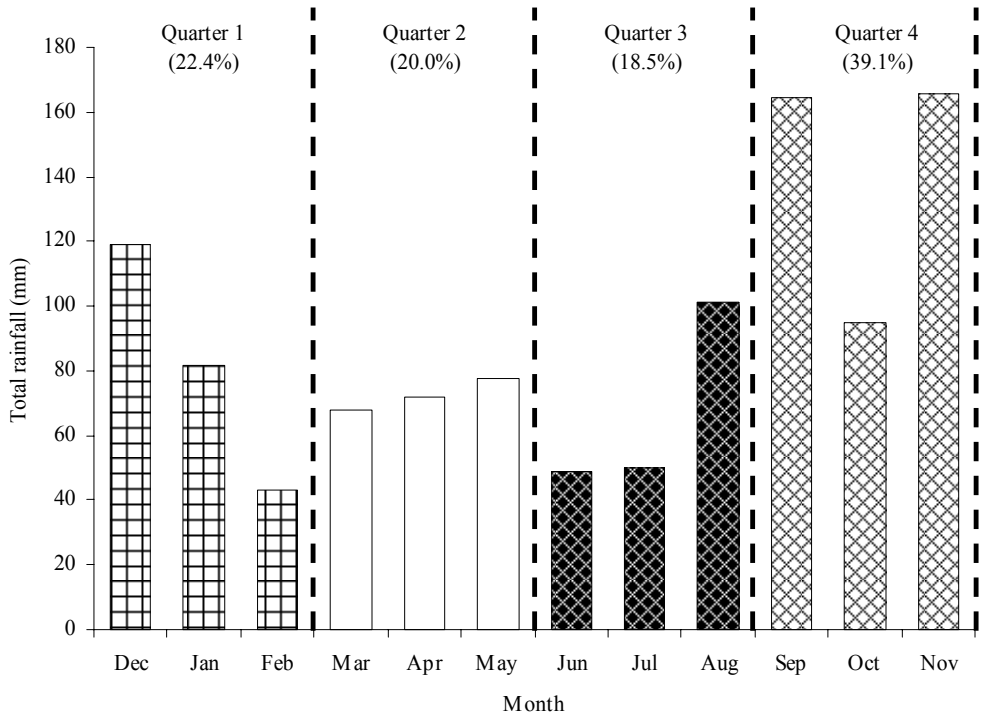

Fig. 2. Mean monthly total rainfall in Ntungamo, southwestern Uganda, 2005–2007. Figures in parentheses represent percentage of annual total rainfall.

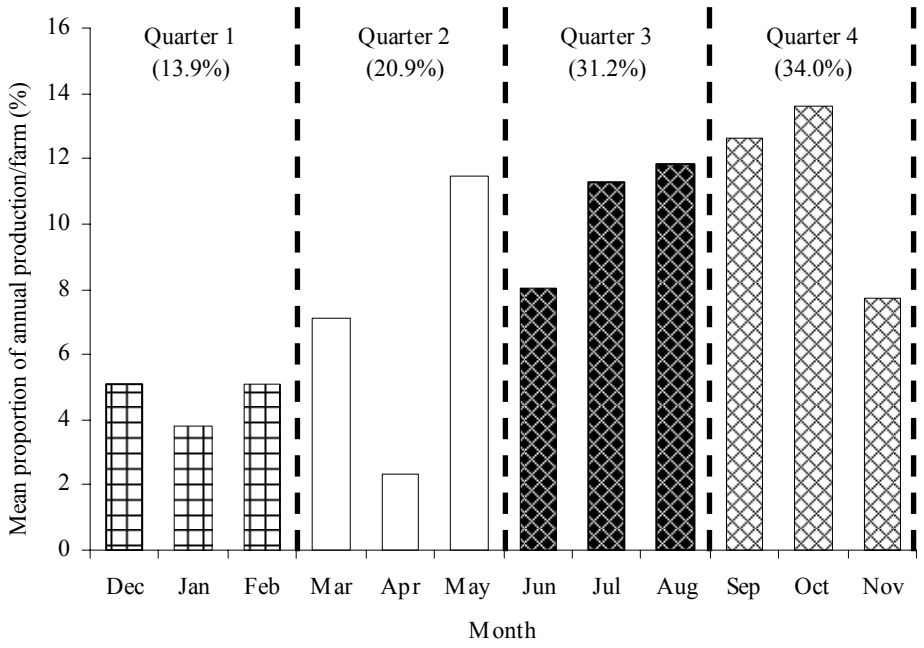

Fig. 3. Mean annual banana (*Musa* spp.) production/farm in Ntungamo, southwestern Uganda (*n*=10 farms), 2006–2007. Figures in parentheses represent percentages of annual total banana production.

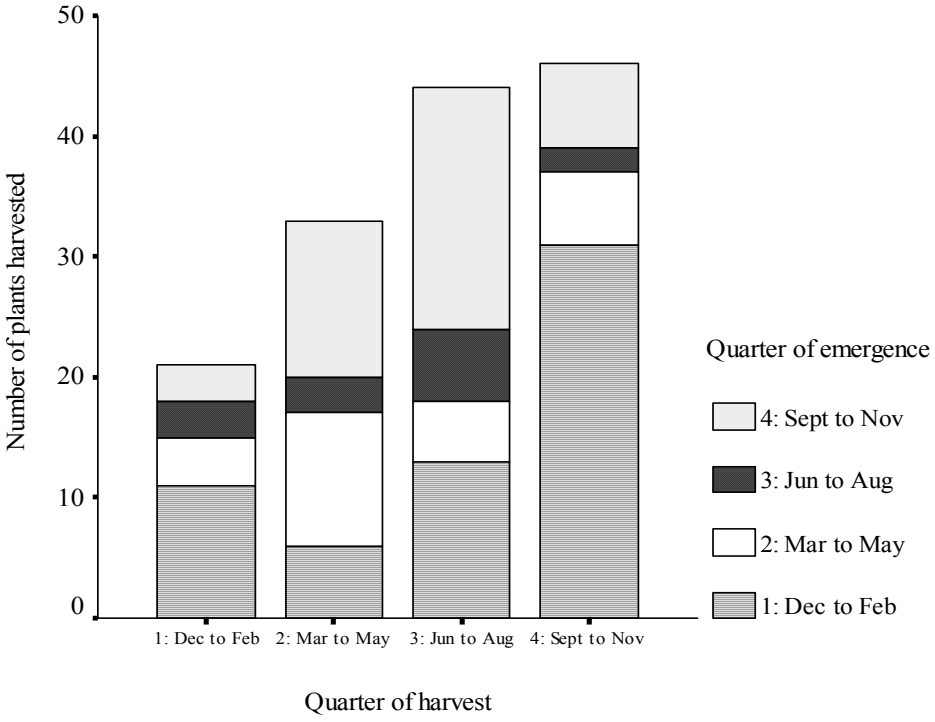

Fig. 4. Number of banana (*Musa* spp.) plants harvested/quarter/farm in Ntungamo, southwestern Uganda, relative to quarter of sucker emergence, 2005–2007 (*n*=150 mats).

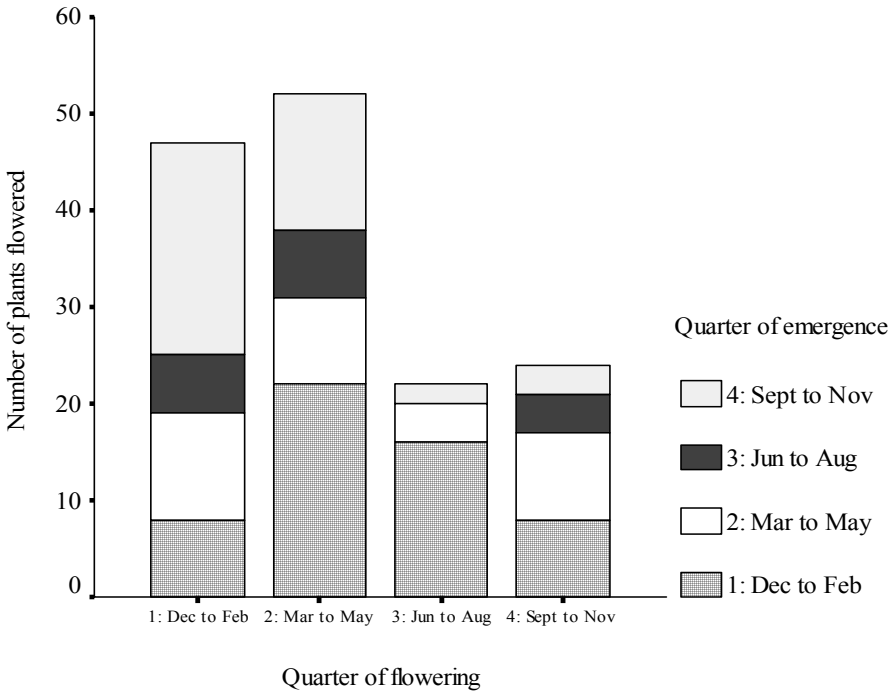

Fig. 5. Number of banana (*Musa* spp.) plants flowered/quarter/farm in Ntungamo, southwestern Uganda, relative to quarter of sucker emergence, 2005–2007 (n=10 farms).