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Land preparation for increased sweetpotato production in Ghana

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Abstract. Sweetpotato in southern Ghana is planted mainly on manually constructed mounds. A land preparation study was initiated on 16 farmers fields in 2001, and advanced to a total of 19 demonstration plots in 2002 and 2003. The objectives were to compare the agronomic feasibility and farmers' perception of manual and mechanized construction of, and management of sweetpotato on ridges with farmers' practices. Planting on ridges resulted in a significant (P=0.05) increase (38%) in sweetpotato tuber yield over farmers' practice of planting on mounds under favourable rainfall, as a result of increased number of tubers and crop growth per unit area. Planting on flat land resulted in drastic yield reductions of 28% and 59% from ridges in the major and minor seasons respectively. Farmers' perception of overall ease of manual management was similar for ridges and mounds. However, differences were reported in various aspects of management, with construction being easier on mounds (score=2.6) than on ridges (score=3.3), weeding easier on ridges (score=2.0) than on mounds(2.6), and harvesting easier on mounds (score=1.3) than on ridges(score=1.7) Mechanized ridging, using tractor mounted ridgers was demonstrated on farmers' fields in 2003, and was shown to be much easier and in some areas less expensive to construct than mounding and manual ridging. Ridging has the potential to increase national sweetpotato production through increased yield per unit area, removal of drudgery associated with land preparation, and increase in the acreage under sweetpotato production in Ghana.

Introduction

Among the root crops, sweetpotato *(Ipomoea batatas)* production in Ghana ranks fourth after cassava, yam and cocoyam. It was reported that an estimated 78,000 households were engaged in its production in 1999 with annual value of 18.2 billion cedis (Ghana Statistical Service, 2000). Current production estimate is expected to increase due to recent research and extension interventions in sweetpotato production in Ghana.

Major constraints in sweetpotato production in southern Ghana (Brong Ahafo, Ashanti, Eastern, greater Accra, Central and Volta Regions) are low plant population density due to widely spaced mounds, variable planting dates, no organic or inorganic fertilizer application, and lack of market in the Ashanti and Brong-Ahafo Regions (Dankyi *et al.*, 1997; and Anchirina *et al.*, 1997) and non availability of planting material.

Land preparation for sweetpotato cultivation consists of bush burning or tractor ploughing after which hoes and sometimes mattocks are used to prepare mounds. Ridges are sometimes made with hoes and in certain cases on ploughed land; sweetpotato is planted directly on the flat ground without mounds or ridges (Dankyi *et al.*, 1997; and Anchirina *et al.*, 1997). Ridges are also constructed with bullock ploughs in the Upper East region. In the Central and Volta Regions of the country, sweetpotatoes are planted predominantly on irregularly and widely spaced mounds resulting in low plant populations. The objectives of the study are

1) to determine the agronomic feasibility and farmers' perception of the different sweetpotato land preparation methods 2) quantify yield response to planting on ridge, mound and flat, and 3) involve farmers in the selection of the best land preparation method for sweetpotato production.

Materials and Methods

A sweetpotato land preparation study was initiated in 2001 on farmers' fields in the Central and Volta Regions of Ghana. Ten sweetpotato farmers were selected for major season (April/May) plantings and 1 for mid season (July) and 6 for minor season (August/ September) plantings in the Central and Volta Regions of Ghana. The agroecologies of the sites were coastal and forest-savanna transition zones. A collaborating farmer either ploughed or slashed and burned the fields after which three plots each 8m wide and 10m long were demarcated and randomly assigned 3 land preparation treatments: 1. ridges 2.mounds and 3. flat with mounds as farmers' practice. Flat treatment consisted of planting directly on the ground without raising a seed bed. The experimental design was randomized complete block with farmers as replications for a total of 10 replications in the major season and 6 replications in the minor season. One site was planted at mid-season in July. Sweetpotato variety 'Sauti', an improved 4 month yellow skinned and yellow fleshed variety was used in 13 sites. Existing 'local' varieties were used at 3 other sites due to lack of planting material. Data were collected on seed bed size, ease or difficulty of management by farmer, plant biomass, tuber yield, tuber characteristics, and insect damage. At harvest in 2001, field days were organized for 5-25 farmers per site. Data were analyzed statistically using SAS (SAS Inst. 1988), and variables subjected to regular analysis of variance. In major season 2002, 9 demonstration plots of ridges as a land preparation method for sweetpotato production were established in the Central and Volta Regions using improved variety 'Sauti' in 7 locations and local red variety in 2 locations. Each plot was ¼ acre in size and 2 field days were organised per plot during the vegetative stage and at harvest. In 2003, ten ¼ acre demonstration fields were established with two sites mechanically ridged with tractor mounted ridgers.

Results and Discussion

Management and crop growth. In the major season overall ease or difficulty of sweetpotato management on ridges was found to be similar to mounds. They were both ranked between easy and difficult (Table 1). Further discussions with the farmers revealed that there was the need to break down management into land preparation, weeding and harvesting which was done in the minor season. Results indicated that (Table 2) land preparation by ridging which is new to farmers in the area of study was found to be difficult compared to mounding which was ranked between difficult and easy. Preparing flat land was obviously easy. Although it was observed that farmers in Volta Region constructed taller mounds than in Central region, on a farmer's field, ridges were constructed as high as mounds (Table 2). Weeding was found to be easy on ridges, between difficult and easy on mounds and difficult on flat. Better plant biomass production (Table 2) and ground cover by vines on ridges than the irregularly spaced mounds apparently lead to better weed suppression. Difficulty in weeding on flat could be due to the poor plant stand and reduced plant growth resulting in the observed greater weed infestation. Flowering (Table 2) occurred only in the local sweetpotato varieties. Harvesting was between easy and very easy on ridges, very easy on mounds and difficult on the flat. Overall management was easy on ridges and mounds and difficult on flat due to the difficulty of weeding and harvesting on flat. The issue of difficulty of manual preparation of ridges was mentioned mostly by farmers in the Central region, who it was observed did not plough their fields,

Table 1: Farmer's perceptions of sweetpotato management under different land preparation methods, 2001.

Land preparation method	Time for land preparation (hrs/ha)	Ease of management			Mean	
		Seed bed construction	Weeding	Harvesting		
	Major season	Minor season	Minor season	Minor season	Major season	Minor season
Ridge	149	3.3	2.0	1.7	2.3	2.3
Mound	142	2.6	2.6	1.3	2.7	2.2
Flat	0	1.9	3.2	3.0	1.4	2.7
$SED_{(0.05)}$	30.3	0.32	0.38	0.33	0.29	-

*1=very easy; 2=easy; 3= difficult; 4= very difficult 5= too difficult.

Table 2: Sweetpotato growth under different land preparation methods. Central and Volta Regions, 2001.

Land preparation	Seed bed size (cm) Minor season		Days to 50% flowering		Fresh vine weight per plant (g)		Total fresh vine weight (t/ha)
Method	Height	Width	Major season	Minor season	Major season	Minor season	Minor season
Ridge	46	85	61	74	668	418	15.5
Mound (FP)	45	84	63	76	595	413	10.4
Flat	-	-	62	77	494	363	11,1
SED (0.05)	3.5	3.4	0.8	1.0	80	56	-

and women farmers. Ridging unlike mounding, is amenable to mechanization and has been described as an improved land preparation method, which affords better control of plant population than mounds and facilitates other field operations in yam production (Orkwor and Asadu, 1998). At the field day, demonstrating ridging with tractor mounted ridger, mechanized ridging was found to be cheaper than mounding. Even in localities where ploughing is most expensive, mechanized ridging did not add any extra cost compared to mounding. Mechanized ridging with tractor mounted ridgers could be provided as a commercial service, as is currently the case with ploughing and harrowing for majority of farmers in Ghana. This will eliminate the drudgery associated with land preparation; facilitate the expansion of farm sizes and increase sweetpotato production.

Yield and physical characteristics of tubers. Ridging resulted in a significant (P=0.05) increase (38%) in sweetpotato tuber yield over farmers' practice of mounding in major season (Fig. 1) and yielded similarly to mounds in the minor season. Tuber yields were significantly lower for sweetpotato planted on flat fields. Average rainfall from three of the locations during the 4 months growing period was 500mm in the major season and

207mm in the minor season. Yields were lower in the minor season. However, the higher yield advantage of ridges in the major season over other land preparation was not evident in the minor season. Apparently drought stress was a contributory factor to the observed trend, resulting in the bridging of the gap between number of tubers on the ridges and mounds (Figure1). The lower plant population density on mounds was compensated for by the bigger tuber sizes in the minor season as shown by the tuber weight per plant. In the major season, this compensation was not achieved and tuber size from ridges and

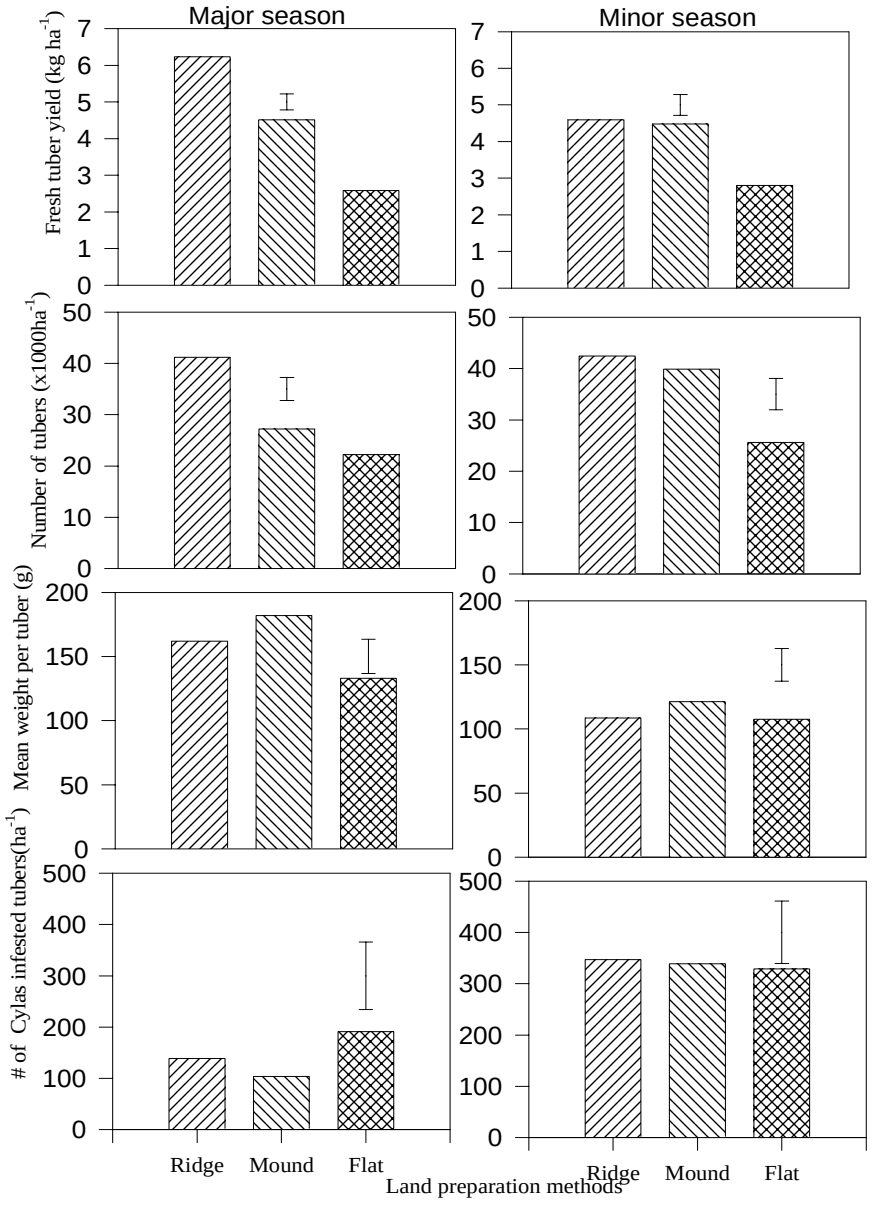

Figure 1: Effect of land preparation method on yield and tuber charcteristics of sweetpotato. Vertical bars represent 2 x Standard Error.

mounds were not statistically different ($P \leq 0.05$), resulting in higher yields on ridges. At one site, Afife, the trial was planted with a very high yielding local white skinned are fleshed variety 'Yevuvi' in July. This variety yielded 20,635 kg ha^{-1} on ridges, 21,062 kg ha^{-1} on mounds and 17,323 kg ha^{-1} on flats. There is the need to include such already existing high yielding materials in current breeding programs in the country.

Tuber shape was distinctly different on ridges and mounds, with slender elliptical tubers obtained on ridges and oblong shaped tubers on mounds. Width and height of ridges and mounds were similar. There was no correlation between mound height or width and tuber yield.

Insect damage to tubers was negligible in the major season, and increased in the minor season, with more than doubling of number of tubers with damage by weevils *(Cylas* spp.) (Fig. 1). *Cylas* damage was not affected by land preparation method in either the major or minor season. It was observed that exposed tubers were predisposed to *Cylas* damage; therefore, reridging during the first weeding and covering up exposed tubers could minimize the damage. The use of a 5-1 plastic jerry can traps with 1g litre water of a detergent (Omo) solution placed 15cm above the canopy has been recommended in the control of African *Cylas* species of sweetpotato in Uganda (Smit *et al.*, 1997). Millipede damage was observed in one location in the Volta region in the minor season, with higher infestation on ridges (23%) than on mounds (9%) and flat (19%). Apparently, this was due to the continuity and ease of movement of the millipede through the seed bed offered by ridges. Quality of tubers in terms of appearance was lowered by millipede damage. In the absence of recommended chemical control, mounding for sweetpotato production would be a better option in areas endemic to millipede damage.

During field days in 2002, 197 people comprising of 129 male and 53 female farmers and 17 Agricultural Extension staff of the Ministry of Food and Agriculture were exposed to ridging as a land preparation method, sweetpotato production in general, and the improved variety 'Sauti' in the Central and Volta Regions. At harvest field days,

Table 3: Partial budget analysis for planting sweetpotato on ridges in the Central and Volta Regions of Ghana. Major Season 2002.

	Central region(slash and burn)	Volta region(ploughed)
Yield (kg ha^{-1})	7 085	6 720
Adjusted yield (kg ha^{-1})	5 668	5 376
Price /50 kg bag (cedis ¢)	65 000	32 000
Gross field benefits	3 684 200	3 440 640
Cost per hectare (cedis,¢)$1 = ¢7000 (2002)		
Slashing	27 000	27 000
Ploughing/ hoeing	45 000	375 000
Ridging	750 000	280 000
Planting	150 000	150 000
1st weeding	270 000	300 000
2nd weeding	135 000	100 000
Harvesting	180 000	300 000
Carting	170 040	268 800
Total cost that vary	2 375 040	2 043 800
Net benefits (in cedis)	1 309 160	1 396 840
Net benefit (US$)	187	200

farmers were given some vines to plant on their own farms.

Economic benefits. Partial budget analysis (Table 3) from the demonstration plots indicates that sweetpotato production is a profitable business with net benefits of ¢1.3 million /ha (US$187) and ¢1.4 (US$200) million /ha per season in the Central and Volta Regions respectively under ridging. It is apparent that net benefits could be further increased if higher price is obtained through improved marketing of the crop especially in the Volta region and lowering of cost of ridging in the Central region through mechanization.

Conclusion

Planting sweetpotato on ridges resulted in a significant ($P \leq 0.05$) increase (38%) in yield over the farmer's practice of planting on mounds in the major season (April/May), with no significant increase in the minor season (August/September) plantings. Adoption of ridging as a land preparation method has the potential to increase sweetpotato production in Ghana through increased yield per unit area and increased total area under sweetpotato production through expansion of farm sizes.

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