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Research Paper

Cowpea [*Vigna unguiculata* (L.) Walp] clipping management technology 2: A potential for sustain yield and food security in the savannah regions of Nigeria

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***Abstract*.** The cowpea crop [*Vigna unguiculata* (L.) Walp], is a vital food crop in the semi-arid tropics where it is reported to be the second most important food legume crop in tropical Africa; grown mainly for their mature grains/seeds. It therefore features prominently in the farming systems of the region. The late planting of the dual purpose cowpea often result in poor vegetative growth with little or no grain production. As a result, it has been difficult to improve the productivity of these varieties using only cultural practices. However, it has been observed that if the cowpea crop plant is cut (clipped) before senescence, it can regenerate after defoliation (and provided there is enough soil moisture), to produce grains. This could help in improving on the food security situation in the region. In the light of the above, this study was carried out on the research field of the Institute for Agricultural Research, Ahmadu Bello University, Samaru, Zaria, Nigeria; During the 2002 to 2005 wet seasons; with the objective of determining the influence of intra-row spacing, clipping height and time on the yield of the dual purpose cowpea. The treatments were laid out in a Randomized Complete Block (RCB) design, replicated three times. The data was analyzed statistically using the analysis of variance test (ANOVA); and the means compared using the Duncan Multiple Range Test (DMRT). Results showed that cowpea grain and pod yield were generally highest at the closest (15 cm) intra-row spacing. Though, higher grain yield was produced with the unclipped (control) plants compared to the clipped plants; the control plots produced statistically similar pod yields on plots clipped at 25.0 cm heights. Generally, higher pod and grain yields were recorded when crop plants were clipped at 64 DAP than at 74 and 84 DAP, respectively. Threshing percentage, harvest index (HI) and 100-seed weight were not influenced by the treatments Based on the results of these investigations, it can be concluded that the adoption of this innovative clipping management technology, holds great potential to increasing the yield of cowpea, for these low inputs, low technology, resource poor farmers in a sustainable manner; and thus substantially contribute in enhancing the general food security situation in the savannah region of the tropics and indeed globally.

Keywords: Clipping, farmer, innovation, management, potential, regenerate, resource-poor, yield, senescence, technology.

INTRODUCTION

The cowpea crop plant [*Vigna unguiculata* (L.) Walp], a dictyledonea belonging to the family Fabaceae; formerly Leguminosae (Onwueme, 1979; Singh et al., 1997), are an important food for human beings. The cowpea is most important in the semi-arid tropics where it is reported as the second most important food legume crop in tropical Africa; where they are grown mainly for their mature seeds (Onwueme and Sinha, 1991; Encarta, 2005). The crop therefore features prominently in the farming systems of the region. According to Singh and Rachie

(1985), Nigeria is the leading producer of cowpea with 77.7% of total world production annually.

The dual purpose cowpea is grown for grain and fodder (haulm), yield. For high seed quality, it is desirable that the sowing date should be such as to enable the crop to flower close to the end of the rains and for the seeds to mature in dry weather while there is stored moisture in the soil. The existing traditional farmers practice is to sow cowpea at wide spacing's of 90 × 30 cm (Onwueme and Sinha, 1991), 50 × 25 cm or 75 × 20 cm, for semi-erect indeterminate high branching types and 16 × 34 cm or 17 × 40 cm, for erect, determinate and low branching types (Singh and Rachie, 1985). Generally, for higher yields, closer spacing is recommended. The spacing of rows is adjusted to suit the type of cultivar i.e. either erect or spreading. Erect cultivars will be sown at closer spacing than spreading types (Onwueme and Sinha, 1991).

Early maturing cultivars produce a crop in about three months, while late cultivars do so in about five months (Onwueme and Sinha, 1991), and yields are reportedly low (Singh and Rachie, 1985); under traditional farming systems where cowpea yields are reported to vary widely between 250 and 1000 kg/ha of dry grain. However, using new varieties, under improved agronomic practices and good management, yields of between 1500 and 2000 kg/ha are obtainable in 60 to 75 days, with two or three insecticide applications (Onwueme and Sinha, 1991; IITA, 1992).

Cowpea has been shown to possess a great potential for increasing food legume production, if grown as a sole crop (Singh et al., 1997), even at the farmers spacing's, provided appropriate cultural and management practices are adopted. According to Onwueme and Singh (1991), the special value of legumes as food has always been appreciated, but it has recently been emphasized as a result of increasing world population and the awareness of our need to produce more food, especially more protein.

In the savanna area, the dual purpose types are sown later in the season and at wider spacing's. As a result of the short growing season often experienced, the late planting of the dual purpose cowpea often result in poor vegetative growth with little or no grain production. But when these dual purpose cowpea varieties are planted early in the season, and at closer intra-row spacing, like the grain types, they grow vegetative and the reproductive phase is either suppressed or completely absent. As a result, it has been difficult to improve the productivity of these varieties using only cultural practices. However, it has been discovered and observed that if the cowpea plant is cut (clipped) at 7 to 10 Weeks after Planting (WAP), before senescence, it can regenerate after defoliation (and provided there is enough soil moisture), and produce grains (Singh, 1993; Odion and Singh, 2005b). This ability of the cowpea plant to maintain some growth or at least survive under dry soils conditions is explained in part by the fact that it is drought hardy and the deep rooted growth habit of some varieties accounts for the crop's ability to grow and yield under the semi desert conditions of the African Sahel (Singh et al., 1997). Thus, Odion and Singh (2005b) concluded that the reproductive growth of the dual-purpose cowpea varieties was enhanced in these trials by the clipping management despite the close intra-row spacing under which the crop was grown. Hence, they postulated that it is possible that after clipping, the re-growth from clipped plots behaved like the semi-erect grain type of cowpea that are grown at this closer intra-row spacing's.

The fact must be underscored here that since the cowpea crop when cut at the vegetative growth phase can regenerate provided there is enough soil moisture; then it is possible to grow cowpea crop for "green manure" by clipping its foliage and allowing the clipped crop plants to grow to maturity for grains (Odion and Singh, 2005b). The advantage of the above stated practice is in the ability of these low resources, low input and low technology based farmers to improve and sustain crop productivity; as appreciable grain yields are obtained.

In this regard, it could be implied that increasing crop yields could further improve on the family, national and global food security situation. And food security on the one hand, may be defined as the ability of food deficit countries, or regions or households within these countries, to meet target levels of consumption on a yearly basis (Siamwalla and Valdes, 1980).

In the light of the above, this study was carried out with the objective of determining the influence of intra-row spacing, clipping height and time on the yield of dual purpose cowpea.

MATERIALS AND METHODS

Field experiments were carried out on the research farm of the Institute for Agriculture Research, Samaru, Nigeria, during the 2002, 2003, 2004 and 2005 cropping seasons. Samaru (11°11′N, 07°38′E and 686 m above sea level) is located in the northern Guinea savanna agro-ecology of Nigeria (Keay, 1959). Usually, rainfall in the region establishes between mid-May and early June and peaks in July/August. Total annual rainfall ranges between 883 and 1062 mm, with an average of 945.20 mm. The dry season starts at about mid-October and extends to the end of April. The mean minimum and maximum temperatures during the rainy seasons range between 14 to 22 and 29 to 34°C, respectively. The soil of the experimental site at the beginning of the trials in 2002 was loamy characterized by a pH of 6.60; low organic carbon content low organic carbon content (0.299 g kg^{-1}); and low nitrogen (0.087 g kg^{-1}); a phosphorus value of 6.51 mg kg^{-1} and a low level of potassium (0.10 cmol kg^{-1}).

The treatments comprised of three intra-row spacing, 15.0, 30.0 and 45.0 cm on ridges 75 cm apart; three clipping heights (no clipping control - 0 , 12.5 and 25.0 cm); and three clipping periods (64, 74 and 84 days after planting – DAP) respectively. Factorial combinations of these treatments were laid out in a Randomized Complete Block (RCB) design; replicated three times.

The land was ploughed and harrowed twice using mechanical power to give a good soil tilt; then ridged and demarcated into gross and net plot sizes of 9.0 and 4.5 m^2, respectively. The planting operation was carried out manually. Two seeds of cowpea were planted per hole at about 5cm depth.

Fertilizer was applied at the recommended rate of 10 kg N ha^{-1}, 36 kg P_2O_5 ha^{-1} and 20 kg K_2O ha^{-1} (Enwezor et al., 1989). Weeds were controlled at planting using Gramazone (Paraquat) as a pre- and post-emergence herbicide; supplemented with manual weeding operations. Post-emergence protection against insect pest and fungal attacks were provided using the insecticides and fungicides as and when necessary.

The fields were planted on 13th July, 17th July, 7th June and 17th June, in 2002, 2003, 2004 and 2005, respectively. The cowpea crop was clipped (harvested) at 64, 74 and 84 days after planting (DAP). The first clipping was done on 15th September, 2002; 19th September, 2003; 10th August, 2004, and 17th August, 2005, respectively. The clipped fodder was placed on the plots to decay and act as a source of organic manure; while the clipped plants were left to grow to maturity alongside the control (unclipped) plots for further yield analysis.

Four plants per plot were sampled at 64, 74 and 84 DAP for the determination of the following parameters: Pod yield (kg ha^{-1}), 100-seed weight (g), total clipped fodder yield (t ha^{-1}), threshing percentage (%), harvest index (HI), seed/grain yield (kg ha^{-1}).

The data collected was compiled and analyzed statistically using the analysis of variance test (F-test) as described by Snedecor and Cochran (1967). The means were compared using the Duncan Multiple Range Test-DMRT (Duncan, 1955).

RESULTS

Threshing percentage and harvest index

In the combined analysis for 2002 to 2005, threshing percentage was significantly highest at the 15 cm intra-row spacing than at 30 and 45 cm. Similarly, the threshing percentage recorded at 45 cm intra-row spacing was significantly higher ($p \leq 0.05$) than at 30 cm. In 2002, the threshing percentage recorded at 45cm was significantly higher than was obtained at 15 and 30 cm; while the recorded threshing percentage at 15 cm was in turn statistically higher than at 30 cm. In 2002 and the combined analysis for 2002 to 2005, the control (unclipped) plots significantly produced higher threshing percentage than the clipped plants. Similarly, plants clipped at 25.0 cm height, significantly produced higher threshing percentage than those clipped at 12.5 cm height. However, plots clipped at 25.0 cm recorded higher threshing percentage than those clipped at 12.5 cm heights. In 2002 and the combined analysis for 2002 to 2005, threshing percentage significantly decreased with increasing clipping time from 64 to 84 DAP (Table 1).

Throughout the period of this trial, intra-row spacing did not significantly influenced harvest index (HI). In 2002, clipping at 25.0 cm produced significantly higher HI values than clipping at 12.5 cm height and the control. On the other hand, the unclipped plants (control) recorded significantly higher HI values over plots clipped at 12.5 cm height. In 2002, clipping at 64 DAP produced significantly higher HI values than clipping at 74 and 84 DAP which were statistically at par; while the combined analysis for 2002 to 2005, showed that the HI value consistently, significantly reduced with increase in clipping time from 64 to 84 DAP (Table 2).

Pod yield and 100 seed-weights

Intra-row spacing did not significantly influenced pod yield, though the pod yield produced at 15 cm intra-row spacing was generally higher than those obtained at 30 and 45 cm. In 2002 and the combined analysis for 2002 to 2005, the control and clipping at 25.0 cm gave similar pod yields; while pod yield of plants clipped at 25.0 cm heights were significantly higher than those clipped at 12.5 cm. Pod yield was not significantly affected by clipping time in all the years of this trial and the combined analysis for 2002 to 2005 (Table 3).

Intra-row spacing, clipping height and time had no significant effect on 100-seed weight throughout the investigation (Table 4).

Total harvested fresh fodder and grain yield

Grain yield was not significantly influenced by intra-row spacing; but was higher at 15 cm intra-row spacing than at 30 and 45 cm. The height of clipping significantly affected grain yield in 2002 and the combined analysis for 2002 to 2005. The control (unclipped plants) produced significantly higher grain yield than clipping at both 12.5 and 25.0 cm height; while crop plants clipped at 25 cm height produced significantly higher grain yield than those clipped at 12.5 cm height. The time of clipping had no significant influence on grain yield throughout the investigation. However, crop plants clipped at 64 WAP produced higher grain yield than those clipped at 74 and 84 WAP (Table 5).

The intra-row spacing showed that in 2002, fresh fodder yield significantly decreased with increasing intra-row spacing from 15 to 45 cm; while the combined

Table 1. Threshing percentage (%) of cowpea as influenced by intra-row spacing, clipping management and time treatment at Samaru, Zaria, Nigeria.

Treatment	Threshing percentage		
	2002	**2005**	**Combined (2002 – 2005)**
Intra-row spacing (cm)			
15	56^{b}	53^{a}	56^{a}
30	55^{c}	47^{c}	52^{c}
45	57^{a}	52^{b}	54^{b}
SE±	0.02	0.02	0.01
Clipping height (cm)			
0 (Control)	62^{a}	53^{a}	56^{a}
12.5	50^{c}	47^{b}	50^{c}
25.0	57^{b}	53^{a}	55^{b}
SE±	0.02	0.02	0.01
Clipping time (DAP)			
64	60^{a}	51^{b}	55^{a}
74	55^{b}	50^{c}	54^{b}
84	51^{c}	52^{a}	52^{c}
SE±	0.02	0.02	0.01

Means followed by different letter(s) are significantly different at 5% level of probability using Duncan's Multiple Range Test (DMRT).

Table 2. Harvest index (HI) of cowpea as influenced by intra-row spacing, clipping management and time treatment at Samaru, Zaria, Nigeria.

Treatment	Harvest index		
	2002	**2005**	**Combined (2002 – 2005)**
Intra-row spacing (cm)			
15	0.09	0.15	0.19
30	0.08	0.17	0.18
45	0.06	0.15	0.18
SE±	0.008	0.013	0.011
Clipping height (cm)			
0 (Control)	0.08^{b}	0.16	0.19
12.5	0.05^{c}	0.14	0.17
25.0	0.11^{a}	0.17	0.19
SE±	0.008	0.013	0.011
Clipping time (DAP)			
64	0.19^{a}	0.21^{a}	0.24^{a}
74	0.03^{b}	0.13^{b}	0.17^{b}
84	0.02^{b}	0.14^{b}	0.14^{c}
SE±	0.008	0.013	0.011

Means followed by different letter(s) are significantly different at 5% level of probability using Duncan's Multiple Range Test (DMRT).

analysis for 2002 to 2005 showed that fresh fodder yield was significantly higher at 15 cm intra-row spacing than at 30 and 45 cm intra-row spacing; which were in turn statistically at par with each other. The influence of clipping height on harvested fresh fodder yield was not significant throughout the study. In 2002 and the combined

Table 3. Pod yield (kg ha^{-1}) of cowpea as influenced by intra-row spacing, clipping management and time treatment at Samaru, Zaria, Nigeria.

Treatment	Pod yield		
	2002	2005	Combined (2002 – 2005)
Intra-row spacing (cm)			
15	1,428.80	1,818.90	1,328.59
30	1,385.80	1,691.40	1,246.76
45	1,248.00	1,835.40	1,297.66
SE±	88.88	94.93	55.11
Clipping height (cm)			
0 (Control)	1,310.50a	1,905.30	1,314.74a
12.5	788.00b	1,604.90	1,073.83b
25.0	1,116.50a	1,835.40	1,272.53a
SE±	88.88	94.93	55.11
Clipping time (DAP)			
64	1,490.50	1,790.10	1,338.80
74	1,343.40	1,802.50	1,324.79
84	1,228.70	1,753.10	1,209.44
SE±	88.88	94.93	55.11

Means followed by different letter(s) are significantly different at 5% level of probability using Duncan's Multiple Range Test (DMRT).

Table 4. 100-seed weight (g) of cowpea as influenced by intra-row spacing, clipping management and time treatment at Samaru, Zaria, Nigeria.

Treatment	100-seed weight		
	2002	2005	Combined (2002 – 2005)
Intra-row spacing (cm)			
15	20.01	19.46	19.89
30	19.96	19.46	19.74
45	19.98	19.23	19.66
SE±	0.30	0.22	0.15
Clipping height (cm)			
0 (Control)	19.57	19.62	19.75
12.5	20.02	19.03	19.62
25.0	20.37	19.49	19.93
SE±	0.30	0.22	0.15
Clipping time (DAP)			
64	20.03	19.39	19.72
74	19.57	19.44	19.75
84	20.36	19.32	19.83
SE±	0.30	0.22	0.15

Means followed by different letter (s) are significantly different at 5% level of probability using Duncan's Multiple Range Test (DMRT).

analysis (2002 to 2005), the fresh fodder yield produced from plots clipped at 74 and 84 DAP were statistically the same; but significantly higher than the fresh fodder obtained from plots clipped at 64 DAP (Table 6).

Table 5. Harvested fresh fodder (t ha^{-1}) of cowpea as influenced by intra-row spacing, clipping management and time treatment at Samaru, Zaria, Nigeria.

Treatment	Harvested fresh fodder yield		
	2002	2005	Combined (2002 – 2005)
Intra-row spacing (cm)			
15	42.86[a]	19.03[a]	18.96[a]
30	29.88[b]	11.81[b]	13.95[b]
45	19.05[c]	12.98[b]	11.43[b]
SE±	2.90	1.97	0.93
Clipping height (cm)			
0 (Control)	-	-	-
12.5	30.26	16.48	15.22
25.0	30.93	12.74	14.22
SE±	2.90	1.97	0.93
Clipping time (DAP)			
64	7.64[b]	9.33[b]	7.30[b]
74	43.66[a]	19.50[a]	19.31[a]
84	40.49[a]	15.00[a]	17.73[a]
SE±	2.90	1.97	0.93

Means followed by different letter(s) are significantly different at 5% level of probability using Duncan's Multiple Range Test (DMRT).

DISCUSSION

Influence of intra-row spacing, clipping height and time on yield of cowpea and food security

Mean dry grain and pod yield of cowpea was recorded higher at 15 cm intra-row spacing (highest crop density) in the combined analysis (2002 to 2005). Odion and Singh (2005b) had reported similar findings at 15 cm intra-row spacing's. This could be ascribed to the increase in number of plants per unit area which resulted in a commensurate increase in the assimilatory area, which is basically the total area of leaves; and the efficiency with which this assimilatory area functioned during the crops growth. Consequently, increased light absorption and its full utilization is achieved by the close crop canopy which ensures an adequate coverage of the soil surface; not allowing for the incoming solar radiation to fall on bare ground and thus be wasted. With time, this enhanced the crop photosynthetic efficiency. If at all there was shading of leaves at such close intra-row spacing, dry matter production and yield was not adversely affected (Arnon, 1977; Williams and Joseph, 1976; Williams, 1975; Loomis and Williams, 1963). Consequently, the general favorable response of cowpea to closer intra-row spacing was similarly manifested in a number of yield contributing components such as threshing percentage, pod yield and 100-seed weight. Indeed, the significant contribution of these attributes to the photosynthetic activity of crop plants have been variously underscored (Tetio-kagho and Gardner, 1988; Williams and Joseph, 1976; Loomis and Williams, 1963; Gardner et al., 1985; Arnon, 1977). Intra-row spacing did not influence threshing percentage, HI and 100-seed weight as these are controlled by the inherent genetic constituent of the crop. However, it is worth noting that the harvest index (HI) of cowpea was generally observed to be very low (0.14 to 0.24); indicating that the efficiency of the movement of dry matter to the harvested part of the plant is low. Thus, there is still room for increasing the yields of the cowpea crop; either by increasing the total dry matter produced in the field, or through increasing the proportion of economic yield (HI) or both (Gardner et al., 1985). Though clipping management practices have been reported to be more common with grasses and forage legumes (Chapparo and Sollenberger, 1991). It has been discovered that the cowpea crop plant has a high capacity to regenerate after it has been clipped provided there is adequate moisture (Odion and Singh, 2005a, b).

In the present study, though cowpea grain yield of the control produced higher grain yield than those clipped; the pod yield of the control plots were statistically not different with the pod yield of crop plants clipped at 25.0 cm height. This low yield differences could be explained and ascribed to several factors among which is the fact that, the longer stem stouts possessed a greater number of reproductive lateral buds. Their re-growths were therefore able to grow faster caught up with the control plots and with time attained near similar yield levels (Chaparro and Sollenberger, 1991; Tewolde and Mulkey,

Table 6. Grain yield (kg ha^{-1}) of cowpea as influenced by intra-row spacing, clipping management and time treatment at Samaru, Zaria, Nigeria.

Treatment	Grain yield		
	2002	2005	Combined (2002 – 2005)
Intra-row spacing (cm)			
15	891.11	953.63	888.27
30	815.19	918.78	850.92
45	751.85	874.65	753.27
SE±	60.95	62.80	37.05
Clipping height (cm)			
0 (Control)	1340.00^{a}	992.16	988.26^{a}
12.5	436.30^{c}	816.20	685.32^{c}
25.0	681.85^{b}	938.69	818.86^{b}
SE±	60.95	62.80	37.05
Clipping time (DAP)			
64	924.44	932.41	866.80
74	800.37	926.82	838.01
84	733.33	887.82	787.65
SE±	60.95	62.80	37.05

Means followed by different letter(s) are significantly different at 5% level of probability using Duncan's Multiple Range Test (DMRT).

1990). Indeed, it has been noted that, the effect of clipping varies with species and is related to the amount of photosynthetic area remaining after defoliation, which may still maintain a critical leaf area index (LAI) - 95% of light absorption (Gardner et al., 1985). This finding has shown that, in essence, through the adoption of this clipping management practice, it is possible to grow a crop of "dual purpose" cowpea for both grain and fodder; in conformity with the finding of (Odion and Singh, 2005a; Singh, 1993); who in their investigations in the Sudan savanna agro-ecology, found that when "dual purpose" cowpea is planted early in the season it grows vegetatively and if the vegetative growth is clipped, it produces the re-growth crop which now behaves like the late planted semi-erect grain type of cowpea that are grown at closer intra-row spacing, and thus producing better pod and grain yields. They reportedly obtained grain yields of over 500 kg/ha for the cowpea local variety (1696). This study, in the Guinea savannah, has produced even higher grain yield 33 to 44%; probably due to the more favorable climatic conditions of the northern guinea savannah agro-ecology (Sambo, 2009; Sambo and Odion, 2011). And further in conformity with the findings of various researchers (Tewolde and Mulkey, 1990; Eldredge, 1935; Camery and Weber 1953; Cloninger et al., 1974; Hicks et al., 1977; Ogunlela and Ologunde, 1984; Chaparro and Sollenberger, 1991; Faire brother and Brink, 1990; Adjei and Gentry, 1996).

Pod and grain yield were generally high when crops were clipped at 64 DAP, against those clipped at 74 and 84 DAP. It has been reported that it took the cowpea (1696) crop, 74 days to first flowering and 76 days to 50% flowering (Musa, 1990). This period is noted to be within the early and late-pod filling stage of cowpea (Gardner et al., 1985). Therefore, induced stress (through clipping) of any kind and nature at this stage could have deleterious effect on crop growth and yield (Williams, 1975). In addition, early clipping at 64 DAP, aside the fact that it fell outside the critical stages of the crop growth, gave the crop a time advantage for the re-growth to re-establish good root development, grow vegetatively and attain high leaf area (LA) to support the reproductive growth phase. Consequently, observed difference in yield with increasing time of clipping has been explicitly explained in terms of the leaf area duration (LAD), that is, LAI integrated over time. Indeed, the longer days advantage for vegetative re-growth of crop plants clipped at 64 DAP, allows it time to express the magnitude and persistence of its leaf area or leafiness during the period of growth; and usually, LAD is closely correlated with yield; because the interception of solar radiation over longer periods of time generally means greater total dry matter production. Large differences in total biomass yields are often a much or more the result of duration of photosynthesis as of photosynthetic rate. As such, flowers produced late in the flowering period, however, were less likely to produce mature pods by harvest, resulting in decreased seed yield with late clipping (Gardner et al., 1985).

In this regard, increase cowpea yield, enhances food availability for the family (Sambo and Odion, 2011). The food security of household, defined as one which has access to enough food for individual members to lead a healthy life, could be greatly enhanced if this clipping management technology is adopted. What is important for households and individuals is the availability and adequacy of food intake; and this intake can either be produced or procured (Alamgir and Arora, 1991).

CONCLUSION

The result of this investigation has shown that, indeed, the application of this innovative clipping management technology has many advantages. It has great potential of sustainably increasing yield, sometimes substantially. In addition, the large quantity or volume of these green, clipped organic plant biomass produced on-farm, when added into the soil, has the potential of maintaining and/or improving the fertility status of this degraded nutrient deficient savannah soils of the tropics. Certainly, such innovative low input technologies need to be encouraged and supported; as this has the potential of increasing the food security and/ or poverty situation in the region and indeed globally.

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