Performance of some local and improved cowpea lines as a dual-purpose crop (Leaf /Fodder and Grain)

H. K. ADU-DAPAAH, K. AHENKORA, B. ASAFO-ADJEI, J. ADJEI, & J. N. ASAFU-AGYEI
Crops Research Institute, P. O. Box 3785, Kumasi. Ghana

Abstract

A systematic programme was initiated at the Crops Research Institute, Kumasi to (i) evaluate the performance of local and improved cowpea *(Vigna unguiculata* (L.) Walp) lines for their leaf, grain and fodder yields, (ii) determine the nutrient composition and sensory attributes of some lines, and (iii) determine economic feasibility of dual purpose cowpea production. The study was carried out at Fumesua during the minor seasons from 1994 to1996. The design of the experiment was split-plot with three replications. The main plot treatments were leaf picking and no leaf picking. The sub-plots were the 15 cowpea lines. Each line was planted on a four-row plot of 5 m long, spaced at 60 cm × 20 cm. Data were collected on the following parameters: number of days to maturity, leaf yield, grain and fodder yield, also nutritional composition of dried leaves, sensory evaluation and economic feasibility of the dual purpose cowpea production. Picking of fully expanded third and fourth trifoliate leaves from the apical bud commenced 28 days after planting (DAP), till 50 per cent flowering. Significant ($P < 0.05$) differences among the lines were observed for leaf, grain and fodder yields, maturity and nutritional composition and sensory scores. Leaf picking delayed maturity by 6 days in some lines. Lower total fresh leaf yields were associated with early maturity in most lines. Differences were observed in the lines in their response to leaf picking. Percent crude protein in the leaf ranged from 27.1 to 35.1. Four lines *viz.* Soronko, Ejura erect, IT87D-551-1 and IT87D-1931 combined high grain and fodder yields. Financial benefits derived from the dual-purpose system was one and half times that of seed only harvest.

(Original scientific paper accepted 29 Jun 04.)

Introduction

Cowpea *(Vigna unguiculata* (L.) Walp) is a major source of vegetable protein for most Ghanaians. It is also an important component in the cropping system of small-holder farmers (Asafo-Adjei *et al.,* 1995). In most cowpea growing areas in Africa, the grain is used for human consumption, while the fodder is fed to livestock (Rowland, 1993). In some parts of Ghana, especially Upper West, Upper East and Volta regions, the tender leaves are periodically plucked, cooked and used to prepare stew or soup. In addition to the above uses of cowpea, it has other agronomic benefits which other leafy vegetables do not have (Paul *et al.,* 1988). It is an efficient nitrogen fixer, tolerates heat and drought, establishes rapidly resulting in less soil erosion and lower weeds pressure (Zuofa *et al.,*1992). Deforestation, urbanization and bushfires have led to a decline in soil fertility with the attendant loss of most traditional leafy vegetables (Kalloo, 1992).

A lot of work has been done on the use of cowpea as grain (Singh & Ntare, 1985; Steele *et al.,* 1985) but research on its use for dual-purpose as grain, leafy vegetable and fodder is limited (Akundabweni *et al.,* 1990). The objectives of this study were 1) to evaluate the performance of fifteen local and improved cowpea lines for their grain, leaf and fodder yields 2) provide information on some nutrient composition and sensory attributes of some cowpea lines and 3) to determine the economic feasibility of dual-purpose cowpea production.

Materials and methods

Fifteen local and improved cowpea lines differing in morphological and phenological characteristics were selected. These lines were evaluated at Fumesua during the minor seasons of 1994-1996. A split-plot design with three replications was used. The main plot treatments were leaf picking and no leaf picking, while the sub-plot treatments were the 15 cowpea lines. Each plot consisted of four rows of 5 m long spaced 60 cm. Three seeds

were planted in each hill, 20 cm apart within rows. The seedlings were thinned to two per hill, 2 weeks after emergence.

Three sprays of Karate (15 g a.i./ha) and Dimethoate (400 g a.i./ha) were applied sequentially to control insect pests during the growing season. The first spray was carried out just before flowering and the second and third as and when it was necessary to spray. Leaves were picked, following the practice normally adopted by farmers in the Upper East and Upper West regions. The fully expanded third and fourth trifoliate leaves from the apical bud were picked from all plants of the two central rows. On the branches, however, the entire apical buds, including the third and fourth leaves were picked. Leaves were picked at weekly intervals commencing at 28 days after planting and terminated at 50 per cent flowering. To avoid border effects on grain yields of picked plots, leaves were picked from the border rows also. Fresh weight of picked leaves was determined in the field immediately after harvesting using Doran weighing scale (0,000 kg).

At maturity, dried pods from the two central rows of each subplot were harvested. After threshing, the total grain weight for each plot was recorded as plot yield. At the final grain harvest, the total grain weight for each plot was recorded. All plants in the two central rows were cut at soil level and both fresh and dry fodder yields determined after sun drying for 10 days. The differences in grain yield between leaf picking and no picking plots were calculated and expressed as a percentage reduction in grain yields as consequence of leaf picking. In the second part of the experiment, 10 lines selected from the first experiment were grown at Busa and Sankana in the Upper West Region. Most recent upper mature leaves at 6 weeks after planting (WAP) were used. Leaves were harvested early in the morning at 6.00 a.m. and put in black plastic bags. Plant materials were dried at 65 °C overnight in a forced air oven. Moisture, phosphorus and percent protein contents were determined by methods outlined by Association of Official Analytical Chemists (AOAC, 1970).

For sensory evaluation, leaves from seven cowpea lines (four improved and three local) were cooked for 15-20 min. Thirty consumers from two communities in the Upper West Region and 30 from Kumasi comprising farmers, extension staff and market women evaluated the cooked samples for leaf size, taste and overall acceptability. A nine point, labelled scale was used in the evaluation (where 1 = disliked extremely and 9 = liked extremely). To establish economic feasibility of dual-purpose cowpea production, a cost benefit analysis was carried out. Data collected from all the activities were analyzed using the analysis of variance (ANOVA) with the MST ATComputer software.

Results and discussion

Significant ($P < 0.05$) differences in the lines tested were observed for the characters measured (Table 1). Fresh leaf yield ranged from 1.2 to 7.8 t/ha. Ayiyi, IT87D-556-6 and IT87D-1627 constituted a low leaf yield group, while Soronko, IT87D-551-1, IT87D-453-2 and IT87D-1931 constituted a high leaf yield group. Most of the low leaf yields are early maturing (59-65 days), therefore, only two pickings were made from these varieties. Appreciable number of high leaf yielders were late maturing (75-85 days) and permitted 3-4 pickings which agrees with work done by Akundabweni *et al.* (1990), who observed a significant positive correlation between leaf yield and time to maturity. They concluded that the later variety matured the more pickings were possible resulting in higher yield, which confirms the observations in the present study.

Significant ($P < 0.05$) differences were observed in the grain yield among the lines evaluated. Grain yield ranged from 0.6 t/ha to 1.3 t/ha for the leaf picking treatment and from 1.0 t/ha to 1.8 t/ha for the no picking treatment. Leaf picking caused a reduction in grain yield ranging from 13 per cent to 45 per cent in all varieties. The results agree with what was reported by Ezedinma (1973) and

TABLE 1

Mean Fresh Weight of Leaves and Maturity Periods of Fifteen Cowpea Varieties/lines

Entries	*Leaf weight t/ha*	*Maturity (days)*	
		No picking	*Picking*
Legon Prolific	4.0	80	82
Ex-Adidome	2.9	66	70
Soronko	6.0	63	71
TV × 1948-01F	6.9	62	69
IT87D-551-1	7.2	59	67
IT87D-1931	6.8	68	74
IT87D-1627	1.3	74	77
Ayiyi	1.2	61	67
Amantin	7.0	65	70
IT86D-1 03 8	6.5	65	72
IT87D-556-6	5.4	68	75
Ejura Erect	5.1	69	75
IT85-F-867-5	4.0	60	68
CR -06-07	2.8	66	72
IT87D-453-2	7.8	67	75
Mean	5.0	66.2	72.2
CV (%)	12.0	4.3	3.8
SE	3.5	2.0	2.0

Paul *et al.* (1988) on the study on cowpea leaf picking and no leaf picking in Nigeria. It, however, disagrees with Metha (1971) who reported in a related study in Uganda that removal of all tender leaves did not adversely affect grain yield. It is worthy to note that Metha (1971) conducted his trial in a high rainfall area where cowpea does not flower unless it is defoliated. This is in contrast with the present study which was conducted in the minor seasons when most cowpea farmers grow cowpea for good quality grain. The reduction in grain yield could be attributed to the loss of new leaves which are photosynthetically more efficient than the bottom older leaves (Brown *et al.*, 1966). The leaf picking treatment was imposed up to 50 per cent flowering. This is the period during which the plants make their most vigorous growth and need more assimilate and nutrients (Ezedinma, 1973). Since the source of the assimilate was reduced as a consequence of leaf picking, there was abortion of a greater number of flowers and pods. This might have contributed to the reduction in grain yield. This is in consonance with results from a similar study carried out in Ibadan, Nigeria by Akundabweni (1990).

Significant ($P < 0.05$) differences were observed in the lines with respect to their fodder yields (Table 2). Dried fodder yield ranged from 1.9 t/ha to 23.3 t/ha when the leaves were not picked up to 50 per cent flowering and from 1.4 t/ha to 23.5 t/ha when the leaves were picked. The results conform to the work reported by Paul *et al.* (1988) on fodder production in cowpea. Fodder is of utmost importance in livestock feed preparation especially during the dry season when bush fires clear most vegetative matter in transition and savanna agro-ecological zones of Ghana. The identification of promising lines in this study will go a long way to help livestock farmers improve their feeding of livestock in Ghana.

The nutrient composition of raw cowpea leaves are indicated in Table 3. The moisture content ranged from 10.6 to 12.1per cent dry weight basis, phosphorus content from 303.6 mg/100 g to 468.9 mg/100 g, ascorbic acid content from 64.2 mg/100 g to 148.0 mg/100 and protein content from 27.1 to 34.2 per cent. The results show significant differences ($P < 0.05$) in the lines evaluated for all the nutritional components studied. These figures compare favourably with what was obtained by Nielson *et al.* (1997). Sensory scores for cowpea leaves are presented in Table 4. Differences ($P < 0.05$) in score among the lines were observed for leaf size and overall acceptability. There were no significant

TABLE 2

Mean Dry Grain, Fresh Fodder Yields (t/ha) and Percentage Grain Yield Reduction Resulting from Leaf Picking of Fifteen Cowpea Varieties (mean over 3 years)

Entries	*No picking*		*Picking*		*Grain*
	Grain	*Fodder*	*Grain*	*Fodder*	*yield reduction (%)*
Legon Prolific	1.0	6.0	0.8	6.9	20
Ex-Adidome	1.1	3.8	0.8	2.2	27
Soronko	1.0	16.5	1.3	9.3	28
TV × 1948-01F	1.4	9.1	1.1	10.1	21
IT87D-551-1	1.7	22.8	1.3	13.1	24
IT87D-1931	1.5	23.3	1.3	21.9	13
IT87D-1627	1.1	3.0	0.6	1.4	45
Ayiyi	1.2	4.7	0.7	4.5	42
Amantin	1.4	6.9	1.0	4.1	29
IT86D-1O38	1.7	12.2	1.2	9.4	29
IT87D-556-6	1.3	7.5	1.1	6.8	15
Ejura Erect	1.6	19.1	1.3	23.5	19
IT85-F-867-5	1.1	1.9	0.8	2.5	27
CR-06-07	1.2	3.9	0.9	3.2	25
IT87D-453-2	1.3	15.5	1.1	16.3	15
Mean	1.3	10.4	1.0	9.0	
CV (%)	21.7	19.0	22.7	22.5	
SE	0.2	9.8	0.1	8.9	

differences in the scores for taste. The results contrast the claim by farmers that improved cowpea leaves are bitter compared to the local cowpea leaves (Rowland, 1993). The financial benefits from selected cowpea lines evaluated for dual-purpose are presented in Table 5.

Th results from the study indicated that there was variation in the financial benefits among the lines. The range is from $70 (Soronko) to $280 (IT87D-1931). Overall, it can be stated that it is financially beneficial to embark on dual-purpose cowpea production. The result is of relevance to improving the nutritional, health and livelihoods of resource poor farmers. Farmers would normally adopt a technology depending on productivity and profitability of the technology. (Ahenkora *et. al.*, 1998). The study has shown that varietal differences exist for cowpea leaves, fodder and grain yields. This indicates that there is the possibility of developing dual-purpose cowpea varieties with high leaf and fodder yield with acceptable grain reduction. High grain plus high leaf/fodder yield potential is a complex trait and prospects for progress in an improvement programme would be expected only if the heritable components of the multi-trait are properly understood. Consequently, a quantitative study of the magnitude of the genotype × environment interaction and strategies to minimize it in assessing and selecting dual-purpose types have to be found. Having understood the heritable components and minimized genotype× environment interaction, factors responsible for high yield expression from the high grain but low leaf/fodder genotype have to be introgressed into the high leaf /fodder but low grain yielders. For effective rejection of poor combinations and

TABLE 3

Nutritional Composition of Dried Cowpea Leaves (100 g edible portion)

Entries	*Moisture (%)*	*Phosphorus (mg)*	*Ascorbic acid (mg)*	*Protein (%)*
Legon Prolific	13.5	303.6	33.5	31.8
Ex Adidome	11.8	362.0	131.0	31.5
Soronko	11.9	376.0	69.3	31.8
TV × 1948-01F	13.0	343.5	64.2	31.2
IT87D-551-1	11.8	463.0	148.0	30.6
IT87D-193 1	11.7	386.4	89.0	30.7
Ayiyi	12.4	408.0	85.1	34.1
Amantin	11.3	350.6	107.6	28.0
IT86D-1038	12.9	303.9	82.0	33.6
IT87D-556-6	12.5	431.8	87.1	33.2
Ejura Erect	10.6	468.9	115.6	27.1
IT85F-867	10.9	317.8	118.3	31.3
CR-06-07	9.6	364.1	102.5	31.8
IT87D-453-2	11.7	413.4	140.7	33.7
IT87D-1627	12.3	408.0	96.1	33.1
Mean	11.9	380.5	98.1	31.7
SE*	0.5	0.2	10.5	0.6

Values are means of at least triplicate determinations.
* Within columns, standard error differences of two means exceeding two times this value are significant ($P < 0.05$).

TABLE 4

Sensory Scores for the Leaves of Selected Cowpea Lines

Entries	*Leave size*	*Taste*	*Overall acceptability*
IT86D-1038	7.7	6.3	7.2
IT87D-556-6	7.2	6.4	7.5
Legon Prolific	5.4	6.6	5.4
Soronko	8.0	6.5	8.0
*Omandow	6.6	6.0	5.4
*Dapial Kumbo	6.2	6.3	6.0
*Waliplatuoli	6.3	6.4	5.8
Mean	6.8	6.3	6.5
SE	0.7	0.3	0.7

*Local varieties

segregation in early generations, a suitable and dual purpose potential multi-trait selection index is of utmost importance.

Conclusion

It could be concluded from the study that there was variation in leaf, grain and fodder yields and that 1.2-8.1 t/ha of highly nutritious cowpea leaves could be harvested for food. Leaf picking appreciably reduced grain yield in some lines, however, leaf picking did not affect fodder yield. It was also noted that cowpea leaves vary in nutritional composition and overall acceptability but not in taste. This can be exploited in breeding to develop dual-purpose cowpea varieties with broad leaves, higher dry matter, protein and consumer acceptability. There were no differences in taste between the local and improved cowpea leaves, allaying farmers' fears that improved cowpea leaves are bitter. Financial benefits derived from the dual-purpose system was 1.5 times that of seed - only harvest. The selected lines would be evaluated on farmers' fields.

Acknowledgement

The authors wish to thank the National Agricultural Research Project (NARP) for providing funds and logistical support for

TABLE 5

Net Income and Financial Benefit from Cowpea Lines Evaluated for Dual Purpose and Seed only Harvest.

Varieties	*Net income (US $1000)*		*Financial benefit* (US $1000)*
	Dual purpose	*Seed only*	
Soronko	570	500	70
TV × 1948-01F	500	260	240
IT87D-1931	600	320	280
Amantin	450	270	180
IT86D-1O38	540	440	100
IT87D-556-6	410	200	210
Mean	511	332	180

Total cost of production/ha: Dual purpose = US$ 584; Seed only = US$ 582 Farm gate price of seed = US$ 0.60/kg
Price of leaves = US$ 0.062/kg fresh weight
* Net income of dual purpose minus seed-only harvest

the study. The technical support provided by the staff of the Legumes Breeding Division of the Crops Research Institute (CRI) is gratefully acknowledged. The authors also thank Ms Charlotte Agyepong for secretarial assistance.

REFERENCES

Ahenkora, K., Adu-Dapaah, H. K., Asafo-Adjei, B., Asafu-Agyei, J. N., Adjei, J. & Oppong-Konadu, E. Y. (1998) Protein productivity and economic feasibility of dual-purpose cowpea. *Hort. Sci.* **33**,1160-1162.

Akundabweni, L. S., Paul, C. P. & Singh, B. B. (1990) Evaluation of elite cowpea lines for dual purpose (leave/fodder or grain). *Trop. Agric. Trin.* **67** (2), 133-136.

AOAC (1970) *Official method of analysis*, 11th ed. Washington, DC: Association of Official Analytical Chemists.

Asafo-Adjei, B., Atuahene, G., Ennin Kwabia, S. Adu-Dapaah, H., Hossain, M. A. & Soza, R. F. (1995) In *Grain Legumes Research and Production in Ghana,* p. 45. Agronomy Abstracts, Crops Science Society of America.

Brown, R. H., Cooper, R. B. & Balster, R. E. (1966) Effects of Leaf Age on Efficiency. *Crop Sci.* **6**, 206-209.

Ezedinma, F. O. C. (1973) Effects of defoliation and topping on semi-upright cowpeas *(Vigna ungui-culata* (L.) Walp) in a humid tropical environment. *Expl Agric.* **9**, 203-207.

Kalloo, G. (1992) Utilization of wild species. In *Mono-graphs on Theoretical and Applied Genetics,* pp. 149-167. Sundepur, Vanasi, India: Directorate of Vegetable Research.

Metha, P. N. (1971) The effect of foliation on seed yield of cowpea and analysis of the leaf harvest for dry matter and nitrogen content. *Tech. Comm. Int. Soc. Hort. Sci.* **21**, 167-171.

Nielson, S. S., Ohler, T. A. & Mitchell, C. A. (1997) Cowpea leaves for human consumption: Production, utilization and nutrient composition, In *Advances in Cowpea Research.* B.B. Singh, K. Dashiell, & L. E. N. Jackai (ed.), pp. 326-332. Co-production of International Institute of Tropical Agriculture (IITA) and Japan International Research Centre for Agricultural Sciences (JIRCA).

Paul, C. P., Singh, B. B. & Fatokun, C. A. (1988) Perfonnance of dual purpose cowpea varieties. *Trop. Grain Legume Bull.* **35**, 26-31.

Rowland, J. R. J. (1993) *Cowpea. In Dryland Farming in Africa.* (J.R. J. Rowland, ed.), pp. 271-275. C.T.A: MacMillan Press.

Singh, B. B. & Ntare, B. R. (1985) Development of improved cowpea varieties in Africa. In *Cowpea research, production and utilization.* (S. R. Singh and K. O. Rachie, ed.), pp. 105-135. John Wiley and Sons Ltd

Steele, W. M., Alen, D. J. & Summerfield, R. J. (1985) Cowpeas *(Vigna unguiculata* (L.) Walp) In *Grain legume crops.* (R. J. Summerfield and E. H. Roberts, ed.), pp. 520-583. London: Willian Collins Sons and Co. Ltd.

Zuofa, K. N. M. Tariah & Isirimah, N. O. (1992) Effects of groundnuts, cowpea and melon on weed control and yield of intercropped cassava and maize. *Fld Crops Res.* **26**, 309-314.