American-Eurasian J. Agric. & Environ. Sci., 11 (1): 71-78, 2011
ISSN 1818-6769

Potentials of Cowpea (*Vigna unguiculata*) for Dry Season Seed and Fodder Production in Sahelian Sandy Soil of Niger

[1]*Saidou Addam Kiari,* [2] *H.A. Ajeigbe,* [3]*Hide Omae,* [3]*Satoshi Tobita and* [4] *B.B. Singh*

[1]National Institute of Agronomic Research of Niger (INRAN) PO Box 429 Niamey Niger
[2]International Institute for Tropical Agriculture (IITA) Kano, Nigeria
[3] Japan International Research Center for Agricultural Sciences (JIRCAS)
[4]Department of Soil and Crop Sciences, Texas AandM University, College Station, Texas, USA

Abstract: Recent surge in dry cowpea seed price, grain and fodder demand in Niger Republic has resulted in the search for appropriate cultivars for dry season production for seed, grain and fodder. However, in addition to the common constrains to cowpea production in the wet season, high temperature in the months of March, April and May is a major concern in cowpea production in the dry season in the Sahelian condition of Niger. Preliminary trials have shown that it is possible to grow cowpea in the dry season if heat tolerant varieties can be found. Consequently, four cowpea cultivars, (IT97K-499-38, IT98K-205-8, Ghana-1 and IT97K-499-35) selected from previous trials were evaluated for their dry season grain and fodder production potentials. Results revealed that the potential for dry season cowpea grain and fodder production is very high, with a grain harvest ranging between 200 and 2183 kg/ha and an average of 1452 kg/ha, which is much higher than wet season production. Three extra-early and heat tolerant cultivars (IT97K-*499-38, IT98K-205-8 and* IT97K-*499-35)* have major grain yield advantages in the dry season over the cultivar, "Ghana-1" which consistently produce lower grain yields but higher fodder production in the dry season. At a current (2009) market price of 750-900 F CFA and 900 to 1000 F CFA /kg (US$ = 480 F CFA)(2010) of dry grain and fodder bundle respectively, dry season cowpea production stands first as an alternative for farmers to increase income, from the grain, seed, fodder and enrich soil for next rainy season. This is a profitable agribusiness for farmers in the country and across the boarder. Farmers could get even higher returns during the dry season harvest, which coincide with the beginning of wet season, peak demand for seed and fodder.

Key words: Dry season seed multiplication · Improved varieties of cowpea · Vigna unguiculata · Grain · Fodder

INTRODUCTION

Nigeria is the world's leading cowpea (*Vigna unguiculata*, (L.) Walp.), producing country, producing over 2.91 million ton of dry grain in 2008, [1]. Other countries in Africa such as Niger (1.57 million tons) Ghana, Burkina Faso, Senegal and Cameroon, are significant producers. Outside Africa, the major production areas are Asia, North, Central and South America.

Cowpea is a highly nutritious food crop; the seed contains about 25% protein together with several other nutrients [2]. In addition, cowpeas contain bioactive antioxidants such as vitamin C, carotenoids and phenolic compounds [3; 4]. Some phenolic compounds exist as natural antioxidants and represent an important group of bioactive compounds in foods which may prevent the development of many diseases, including atherosclerosis, cancer, etc [5]. Protein content of the leafy cowpea parts consumed annually in Africa and Asia is equivalent to 5 million tones of dry cowpea seeds and this represents as much as 30% of the total food legume production in the lowland tropics [6]. The tender shoot tips and leaves can be consumed as soon as the plants reach the seeding stage and immature pods and seeds can be consumed during the fruiting stage [7]. Harvested dry seeds can be ground into slurry to make cowpea cake (*allale*), or deep fried into bean balls (kosei) or boiled in water and give

Corresponding Author: Saidou Addam Kiari, National Institute of Agronomic Research of Niger (INRAN) PO Box 429 Niamey Nigeria.

product black in color (dan wake) that can be ate with oil and pepper, or the seeds could be boiled together with rice, mixed with sauce or stew and consumed directly. Cowpea has wide soil type adaptability and is considered more drought tolerant than ground nut in Niger [8]. Tolerance to drought reduces the use of irrigation and subsequently the cost of production. It is also used as a cover crop [2] and as fodder for livestock [9]. Another advantage of cowpea is the addition of nitrogen to soil through nitrogen fixation and even benefiting a succeeding cereal crop. In Niger, cowpeas are produced extensively in 5 of the 6 (Maradi, Zinder, Tahoua, Dosso and Niamey) regions. It is a popular crop with individual field throughout the country. There is wide diversity in grain and plant type ranging from white seeded to brown, grey and speckle and erect, erect semi erect and prostrates types as well as photosensitive and insensitive cultivars. It is a major crop found in intercropping with cereal crops like millet and sorghum. However, yield is low due to various biotic and abiotic constraints including soil fertility decline, draught, Striga infestation, insect and disease pests, intercropping, lack of use of inputs especially improved seed, pesticides and fertilizers.

Cowpea grain is also attacked in storage by bruchid which can lead to significant loss of grain or grain market value in storage. Rural poor farmers generally do not keep enough grain/seed for next season while seed companies dealing in cowpea seeds are almost non-existence in Niger. Therefore cowpea seed and grains as well as fodder are scarce at the beginning of the rains and prices are very high. These lead to farmers using poor quality seed for planting resulting in poor stands, weak seedlings and low yields. Growing cowpea in the dry season for seed, grain and fodder will therefore be attractive if the dry season constraints can be overcome. The main constraints to cowpea production in the dry season in Niger are water and heat. The average day temperature in April-May is 40.39°C and temperatures of above 40°C are very common. The dry season also coincides with long day lengths and the photosensitive cowpea varieties produce little or no flower under this condition. Appropriate varieties must therefore be heat tolerant and photo-insensitive.

Food production in semi-arid regions of Africa is seriously reduced by water scarcity [10]. This scarcity of water has more effects on countries such as Ethiopia, Sudan and Niger and this lead to hunger and famine in these countries. International food assistance has even become integral to Niger's agricultural economy [11]. Challenges of providing food for the population coupled with rainfall scarcity, has led to the development of irrigated agriculture in Niger Republic [12]. The irrigation potential of Niger is estimated to be 270,000 ha out of which 140,000 ha about 52 % are situated in the River Niger valley. The total area presently developed for irrigation is about 78, 000 ha, which is equivalent to 2% of the total cultivated land in the country [13]. The availability of these irrigated areas offers possibilities for profitable cowpea production in the dry season.

The aims of this study are: i] to evaluate four cowpea cultivars for dry season production potentials, ii) to determine whether early flowering among the cultivars may be related to yield of fodder and seed, iii) to build the capacity of small holder cowpea farmers to the profitability and/or opportunities in dry season cowpea seed multiplication in agricultural business and iv) to assess the nitrogen fixation capacity of the cowpea used through nodules.

MATERIALS AND METHODS

Experimental Site Description: A field experiment was conducted for 2 years at Sadore, ICRISAT, Niamey, West Africa, (13° 14 N latitude, 2° 17 E longitudes, 231 m altitude). Sadore is in the bioclimatic Sahelian agro ecological zone as having a mono-modal rainfall pattern with an annual rainfall of 550 mm [14]. Top Soils in the study area are sandy, siliceous isohypothermic and classified as Psammentic Paleustalf [15]. The agriculture system in this area is rain fed millet based cereal-legume and livestock interaction. The site is sandy (90 %) and the pH is slightly acidic (4.7) with low organic carbon content (0.24 %) and the available P is less than 10 ppm.

Plant Materials: Four cowpea varieties (IT97K-499-38, IT98K-205-8 and IT97K-499-35) developed at the International Institute for Tropical Agriculture (IITA), Nigeria, widely accepted in Niger through disseminated in collaboration with National Institute of Agronomic Research in Niger (INRAN) and Ghana-1 (a local variety from Ghana, obtained from a local farmer who travelled to Ghana) were used for the trial (Table 2). Seeds were grown for seed multiplication at ICRISAT Sahelian Center (ISC) (13° 14N and 2° 17` E) Niamey.

Field Experimentation: Four varieties were evaluated in trials conducted in ICRISAT Sahelian Research Centre, Sadore describe above, in the dry seasons of 2009 and 2010. The trials were conducted between February and May 20 of each year. A randomized complete block (RCB) design with three replicates of each variety was used.

Table 1: Minimum and maximum temperature from 2001-2008 in April-May at Sadore

Year	Month	Temp°c max	Temp°c min	Solar radiation (MJ/m2)
2001	April	41.23	26.92	25.54
2001	may	40.54	28.42	24.04
2002	April	41.81	27.47	25.49
2002	may	41.77	28.39	24.89
2003	April	35.91	26.27	25.27
2004	April	40.80	27.40	24.86
2004	May	39.18	27.30	24.95
2005	April	41.93	26.72	26.89
2005	May	40.02	72.59	25.89
2006	April	41.20	25.89	28.45
2006	May	40.08	27.46	25.12
2007	April	41.70	22.92	8.65
2007	May	39.75	27.48	24.59
2008	April	40.18	26.84	26.15
2008	May	39.63	26.84	26.15
	Mean	40.39	26.83	24.60

Table 2: Cowpea mostly used in Niger

	Yield (t/ha)	Seed size	Seed coat texture	Growth habit	Maturity	Striga	Other characteristics
TN-5-78	1.5	S*	BR	Semi erect	Medium	S	Photosensitive
KVX-30-309-66	1.6	L	WR	Semi erect	Medium	S	Photosensitive
IT89KD-374-57	1.7	M	WR	Semi erect	Medium	S	Photosensitive
IT90K-372^{-1}-2	1.7	M	WR	Semi erect	Medium	S	Photosensitive
IT97K-499-35	1.6	M	WR	Semi erect	Medium	R	Grain/fodder
IT97K-499-38	1.7	M	WR	Semi erect	Early	R	High Fodder
IT98K-205-8	1.4	M	WR	Erect	Early	R	Grain/fodder
TN256-87	1.5	M	CR	Semi erect	Medium	S	Grain/fodder
Aloka	0.8	S	SP	Semi erect	Medium	S	Grain
Danila	0.9	S	WR	Semi erect	Medium	S	Photosensitive

Seeding was done manually. Plots were 10m x 10m, 1 tonne/ha of manure were applied and the fields were watered to field capacity before planting. Four seeds were planted per hill and later thinned to 2 plants / hill a week after germination. The planting density was 70cm between rows and 20 cm between hills. Data collected include days to 50% flowering, nodules number, harvest index and grain and fodder yields

Weeds were controlled manually. Chemical insecticide was applied twice to control pests occurrences in the dry season. Both fresh pod and dry-mature pod harvests were done manually. Data were analyzed using the Analysis of Variance (ANOVA) using GenStat [16] . Relationships between selected variables were also examined.

RESULTS AND DISCUSSION

Major constraint to the dry season improved cowpea production include insect attack, storage, insufficient water, nematodes, lack of land, lack of seed, lack of fertilizer and lack of credit. However, producing cowpea seed and fodder during the period of crisis will allow farmers to buy insecticide, triple bags for storage, fertilizer and early maturing cowpea seeds. Ghana cowpea has good performance in terms of fodder production and high nodule number compare to the others cowpea lines that are early maturing and most of grain as well as fodder producing type (Tables 3 and 4). There is highly significant difference ($P<0.01$) the cowpea varieties for days to fifty per cent flowering and flower number both in 2009 and 2010 dry season but the two sister lines (IT98K-499-35 and IT98K-499-38) are not different even for nodule number and harvest index. The lack of flower in Ghana-1 indicate probably the photosensitivity nature of that variety and the high nodule number indicate its long duration cowpea type as shown by [17], The low harvest index (2-5%) in both years of Ghana-1 indicated that the variety is more of fodder type and photosensitive.

Table 3: Yield potential performance of cowpea at Sadore, 2009.

Genotypes	D50pcFlw	Flw Nb	Nd Nb	Biomass	HI %
IT97K-205-8	31a	35a	53a	6013	24.32b
IT98K-499-35	36b	21.67b	80.7a	7067	25.8bc
IT98K-499-38	36b	22b	140a	7350	29.74c
Ghana^{-1}	50c	0c	313.3b	6543	5.18a
F pr.	<.001	<.001	0.026	Ns	<.001

Table 4: Yield potential performance of cowpea at Sadore 2010

Genotypes	D50pcFlw	Flw Nb	Nd Nb	Biomass	HI%
IT97K-205-8	31a	29a	60a	4037a	33.63b
IT98K-499-35	35.33b	19.33b	76.7a	4903ab	29.96b
IT98K-499-38	35.67b	19.67b	139a	5733b	31.4b
Ghana^{-1}	50c	0c	400b	5277b	2.08a
F pr.	<.001	<.001	0.001	0.022	<.001

D50pcFlw, days to fifty per cent flowering; Flw Nb, Flowers number, HI%, percentage harvest index; Nd Nb, Nodules number.

Table 5: Yield potentials performance of cowpea and generation of profits, 2009

Genotypes	Grain kg ha^{-1}	Tia	Fodder kg ha^{-1}	Fd Rolls	PrixF/ha	PrixG/ha
IT97K-205-8	1460b	584b	3880a	1293a	1293333a	525600b
IT98K-499-35	1833bc	733.3bc	4230ab	1410ab	1410000ab	660000bc
IT98K-499-38	2183c	873.3c	4517b	1506b	1505556b	786000c
Ghana-1	333a	133.3a	5993c	1998c	1997778c	120000a
F pr.	<.001	<.001	<.001	<.001	<.001	<.001

Table 6: Yield potentials performance of Cowpea and generation of profits 2010

Genotypes	Grain kg ha^{-1}	Tia	Fodder kg ha^{-1}	Fd Rolls	PrixF/ha	PrixG/ha
IT97K-205-8	1337b	534.7b	2700a	900a	900000a	481200b
IT98K-499-35	1470b	588b	3433ab	1144ab	1144444ab	529200b
IT98K-499-38	1800c	720c	3933b	1311b	1311111b	648000c
Ghana-1	110a	44a	5167c	1722c	1722222c	39600a
F pr.	<.001	<.001	0.003	0.003	0.003	<.001

Tia = 2.5 kg grain; Fd Rolls = 3 kg fodder; PrixF/ha = cost of fodder per ha; PrixG/ha = cost of grain per ha.

There is significant difference (P< 0.05) between the varieties in 2010 for biomass production but no difference occurs between IT98K-499-38 and Ghana-1 indicating that the former is dual purpose cowpea (producing both grain and fodder).

Dry season cowpea grain and fodder become available in April/May when price peak and farmers are able to get maximum profit. A tonne of dry season cowpea can yield a gross return up to between133.200 f cfa-873.200 f cfa /ha (500 f cfa = $1). Data from market show that price of cowpea cultivated in dry season was 4 times higher than the price of the one produced in rainy season. Similarly, cowpea fodder price from rainy season is 1/3 of that of dry season production.

Results of the two years studies are shown in Tables 5 and 6 below. Highly Significant differences (P < 0.01) exist between the varieties for grain and fodder production as well as economic benefits and the results are consistent with time. Grain yield varied between 110-2183 kgha-1 from 2009 to 2010. The highest yield of IT98K-499-38 may be related to the continuous water supply and continuous harvest of mature pods. The variety IT98K-499-38 is consistently more profitable than the remaining varieties.

The results indicated that the environmental conditions prevalent in the Sadore region favor the production of dry cowpeas grain and fodder better than the field during the rainy season and that the four cultivars evaluated in this study could be developed as the major cowpea lines for the production of dry seed ("dry cowpea seed in Niger) in the region and indeed mature seeds of these high yielding cultivars could be exported to other cowpea producing nations for dry cowpea production.

Table 7: Correlations among selected parameters of cowpea yield potential

D50pcFlower	D50pcFlower	Flwer_Nb	Grain_kg_ha	HI%	NOD_NB	PrixFPha	PrixGPha
Flwer_Nb	-0.92						
Grain_kg_ha	-0.77	0.64					
HI%	-0.86	0.76	0.97				
NOD_NB	0.84	-0.77	-0.68	-0.77			
PrixFPha	0.86	-0.85	-0.74	-0.86	0.73		
PrixGPha	-0.77	0.64	1	0.97	-0.68	-0.74	
Biomass_kg_ha	0.01	-0.19	0.49	0.29	-0.04	0.22	0.49
Fane_kg_ha	0.86	-0.85	-0.74	-0.86	0.73	1	-0.74

Cowpea agriculture is synonymous with dry seed production in most regions of the world. This study has demonstrated that dry cowpea seed production could also be an important activity before rain fed season in West Africa. With a two year significant dry grain yield range of 110 - 2183 kg ha^{-1} (Tables 5,6), dry cowpea seed production agriculture in dry season can compete favorably with the dry seed agriculture production in rain fed season. The fodder varied significantly from 2.7 t - 5.9 t and these grain and fodder production can be profitable to producer for a cash revenue ranging from 39 600-1 997 778 F CFA.

Although the focus of this study is on dry seed yield, however, the high fresh seed yields of the four cultivars may be of interest to human consumption during that period of food crisis especially in Niger. The dry grain yield recorded in this study is not similar with the results on cowpea yield ranged from 680.2 - 1120.9 $kgha^{-1}$ [10] and are higher than the results of Okiror *et al.*[18] also higher than 1131 - 1483 kg ha^{-1} as reported previously English *et al.* [19]. Mandal *et al.* [20] also observed a significant cowpea varietal difference for nodule number and nodule weight as well as nitrogenase activity indicating a good possibility of breeding between the early maturing lines and fodder producing type from Ghana.

On the performance of the individual cultivars, it may be observed that the variety "Early maturing IT97K-499-38" could be selected as the top variety suitable for Niger. It also has the potentials for high dry seed yield as well as fodder for animals feeding. The variety consistently outperformed the other three cultivars in the two years of our study. With the current average market price of 900 f cfa kg^{-1}, dry cowpea seed especially in 2010.

The four cowpea cultivars in our study have range of number of days to 50% flower between (31 - 50 days) and flowering date is highly correlated (r = 0.84) with nodule number and that gave an indication on nitrogen fixation (Table 7). Number of days to flowering is negatively correlated with grain yield and this suggests that high yield could not be directly linked to earliness in flowering (Tables 3 and 4). Therefore, the high yield recorded for "Early maturing IT97K-499-38" (Table 7) may not necessarily be due to its earliness in flowering but to other factors like nodulation trait. Our findings are in agreement with earlier reports on positive and significant correlation between yields characteristics (pods number, fodder and grain yield) and flowering date in some crop plants [21]. However, our results differ with those obtained by Makeen *et al.* [22].

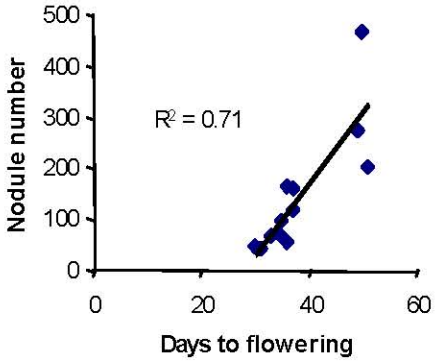

Fig. 1a: Relationship between Days to 50% flowering and Nodules number09

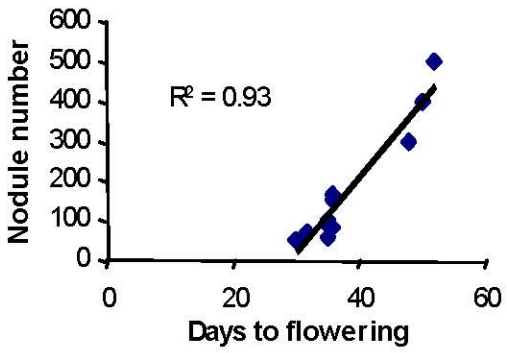

Fig. 1b: Relationships between day to flowering and nodule number10

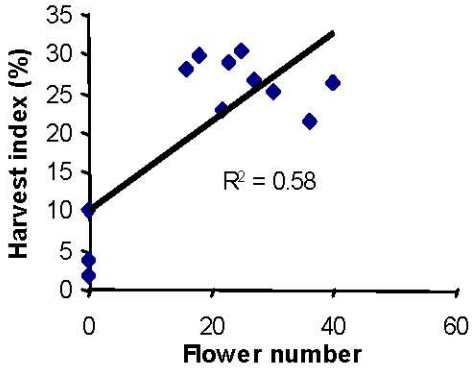

Fig. 2a: Relationship between flower number and Harvest index09

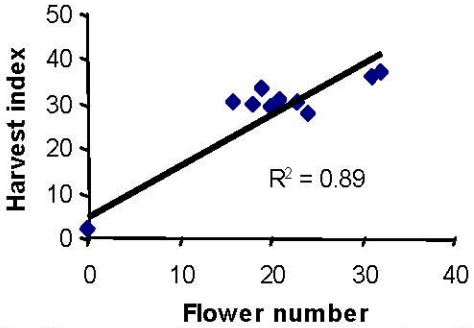

Fig. 2b: Relationship between Flower numbr and harvest index10

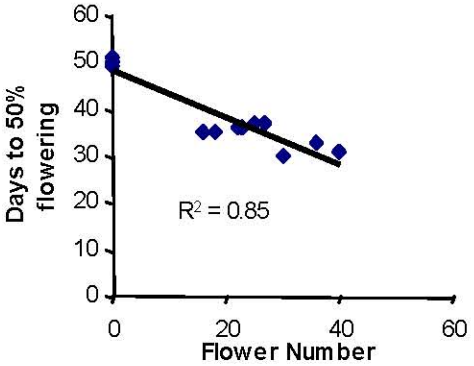

Fig. 3a: Relationship between flower number and days to 50% flower number and days to 50%

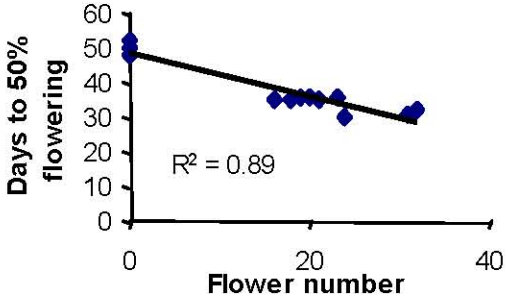

Fig. 3b: Relationship between Flower number and Days to 50% flowering10

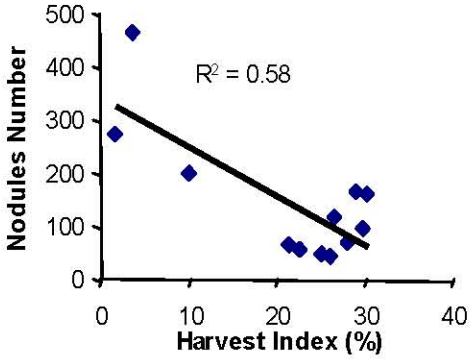

Fig. 4a: Relationships between Harvest index and Nodule Harvest index and Nodule

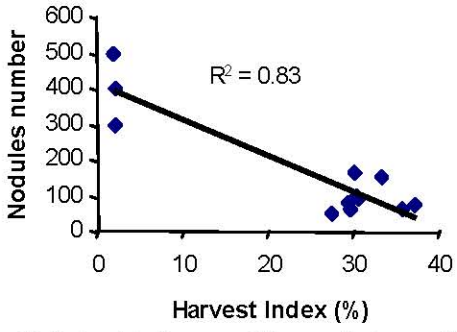

Fig. 4b: Relationship between Harvest Index and Nodule number10

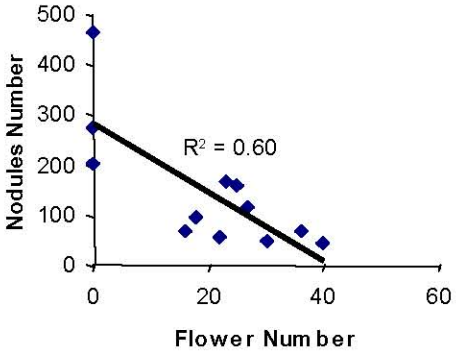

Fig. 5a: Relationship between flower number and nodules number09

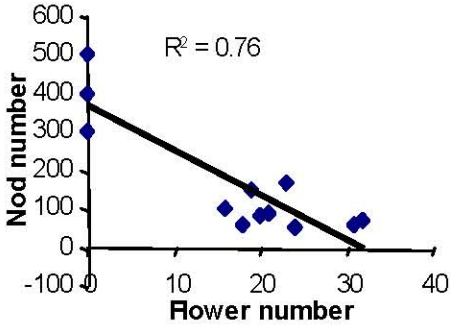

Fig. 5b: Relationship between Flower number and Nod number10

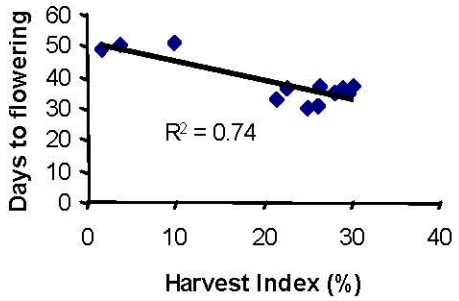

Fig. 6a: Relationship between Harvest Index and Days to 50% flowering09

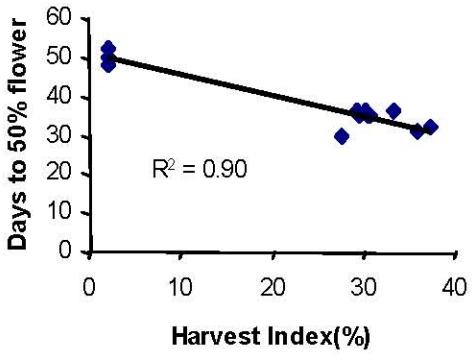

Fig. 6b: Relationships between Harvest Index and Days to 50% flowering10

CONCLUSION

Cowpea dry season production is apparently a highly profitable agribusiness for cowpea farmers in Niger. Our results show that although fresh cowpea seed production is yet to attract the attention of the major cowpea farmers, however, its net revenue generation potentials compare favorably and indeed surpass the potentials of some much improved and much genetically engineered crops such as millet, sorghum and rice. The four cultivars investigated could be adopted nationally and internationally for both the fresh seed and dry seed productions. Early or late flowering of the four cultivars may not provide significant information on their overall yield performance. Great opportunities exist in international trade on dry cowpea seeds and also the grain and fodder especially for animal. This would offer choices to both the consumers and the producers. If well managed, the variety IT98K-499-38 would be of more benefit to farmers in dry season seed multiplication.

ACKNOWLEDGEMENT

This research was funded by Japan International Center for Agricultural Sciences and the work was conducted in collaboration with ICRISAT and INRAN in Niger Republic. Tahirou Saley and Amadou Sodja provide technical support for the study.

REFERENCES

1. FAOSTAT. 2010. http://Fao.stat.fao.org (Acessed Sept 2010).
2. Frank-Peterside, N., D.O. Dosumu and H.O. Njoku, 2002, "Sensory evaluation and proximate analysis of African yam bean (*Sphenostylis stenocarpa* Harms). J. Appl. Sci. and Env. Manag., 6(2): 43-48.
3. Cai, R., N.S. Hettiarachchy and M. Jalaluddin, 2003. "High-performance liquid chromatography determination of phenolic constituents in 17 varieties of cowpeas", J. Agric. Food Chem., 51: 1623-1627.
4. Dobaldo, R., H. Zielinski, M. Piskula, H. Kozlowska, R. Muñoz, J. Frias and C. Vidal-valverde, 2005. "Effect of Processing on the Antioxidant Vitamins and Antioxidant Capacity of *Vigna sinensis* Var. Carilla", J. Agric. Food Chem., 53: 1215-1222.
5. Formica, J.V. and W. Regelson, 1995. "Review of the biology of quercetin and related bioflavonoids", Fd. Chem. Toxicol., 33: 1061-1080.
6. Steele, W.M., D.J. Allen and R.J. Summerfield, 1985, "Cowpea (*Vigna unguiculata* (L.) Walp.)," Grain Legume Crops, R.J. Summerfield and E.H. Roberts, eds. London, William Collins Sons and Co. Ltd. pp: 520 - 583.
7. Fery, R.L., 2002. "New opportunities in *Vigna*", Trends in crops and new uses, J. Janick and A. Whipkey eds. VA, ASHS Press, pp: 230-235.
8. Fery, R.L., 2000. "New Opportunities in *Vigna*, Trends in new crops and new ideas, J. Jamik and A. Whipkey eds. Virginia, ASHS Press, pp: 424 - 428.
9. Erkut, P. and A. Cengiz, 2004. Comparison of some cowpea (*Vigna unguiculate* L. Walp) genotypes from Turkey for seed yield related characteristics. J. Agron., 3(2): 137-140.
10. Rockstrom, J., M. Falkenmark, C. Folke, J. Barron and P. Fox, 1999. Water harvesting for drought proofing of rainfed Agriculture in Semi arid Regions of Africa. Water Conservation Forum, Grid. 13: 10.
11. Babatunde, R.O., A.O. Omotesho, E.O. Olorunsanya and A. Amadou, 2007. Optimal Crop Combination in Small-Scale Vegetable Irrigation Farming Scheme: Case Study from Niger Republic Research J. Applied Sci., 2(5): 617-622.

12. Charles, L.A., H. Sally, K. Lonsway and C. Maman, 2000. Farmer-Based Financing of operations in the Niger Valley Irrigation Schedules. Int Water Manage. Institute Res. Report, 37: 36.
13. FAO, 1999. Food and Agricultural Organization Transfer of Irrigation Management Services: Guidelines. FAO Irrigation and Drainage, Rome, pp: 58.
14. FAO, 2004b. Sahelian weather and crop situation. Report No 2. Global information and early warming system on Food and Agricultural Organization. Rome Gignou J. (1986) la fertilization raisonnee du sorgho en Afrique de l'Ouest. Agronomie Trop., 41 : 192-201.
15. Sivakumar, M.V.K. and S. A. Salman, 1999. Effect of year and fertilizer on water use efficiency of pearl millet (*Pennisetrum glacum*) in Niger J. Agric. Sci., 132: 139-148.
16. GenStat Release 10.1 (PC/ Window 2007 Lawes Agricultural Trust (Rothamsted Experimental).
17. Giller, K.E., 2001 Nitrogen Fixation in Cropping System. 2nd edition CABI Publishing..
18. Okiror, S.O., J.G. Burleigh, T. Dunbar and R. Katayama, 2002, "Report on fresh and dry southern pea yields in Southeast Arkansas", Arkansas Agric. Rural. Dev., 4: 20-23.
19. English, H., O. Porter and J.G. Burleigh, 2001, "Commercial fresh market southern pea production", Hort. Tech. Bull. # 5, Pine Bluff, AR. University of Arkansas at Pine Bluff, pp: 5-9.
20. Mandal, J., A. Chattopadhyay P. Hazra, T. Dasgupta and M.G. Som, 1999. Genetic Variability for three BNF components in cowpea Crop Research (Hisar), 18: 222-225.
21. Adeniji, O.T. and C.O. Aremu, 2007, "Interrelationships among characters and path analysis for pod yield components in West African Okra (*Abelmuschus caillei* [A. Chev] Stevels)", J. Agron., 6(1): 162-166.
22. Makeen, K., G. Abrahim, A. Jan and A.K. Singh, 2007. "Genetic variability and correlations studies on yield and its components in Mungbean (*Vigna radiate* (L.) Wilezek)", J. Agron., 6(1): 216-218.