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Improved Legume-Cereals Based Cropping Systems for Improved productivity and Natural Resource Management by Resource Poor Crop-Livestock Farmers in West Africa

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Abstract
Most farmers in West African savannas grow local varieties of grain crops in various intercropping systems with little or no purchased inputs. In these systems, legumes yields are low due to shading by cereals and lack of plant protection measures while cereal yields are low due to lack of fertilizer. A large scale farmer participatory on-farm evaluation and dissemination of the system involving about 5000 farmers, covering different agro-ecological zones in the savannas of West Africa was conducted from 2002 to 2007 to demonstrate the superiority of the improved systems on-farm and its importance in natural resource management. The system involved growing improved cowpea varieties with cereal in a 2 cereal: 4 cowpea row to row arrangements, with selective application of inorganic and organic fertilizers to the crops and 2 to 3 insecticide sprays to cowpea. The improved cropping systems, gave over 300% increases in value of the crop produce depending on locations. Feeding the residues of cereals alone to small ruminants resulted in weight loss while feeding the residues of cowpea or groundnut alone resulted in the weight gain of about 13% and 12% respectively. Supplementing the cereals residues with about 300g of cowpea or groundnut residues per day resulted in slight gain in weight and thus the body weight was maintained. Farmers were able to generate an average of 550 kg manure (dry weight) in 60 days of confine feeding of average of 6 ruminants (sheep and goat).

Keywords: **cowpea, cereals, intercropping, planting pattern, strip-cropping**

Introduction
Because of high population pressure, the traditional farming system can no longer sustain crop and livestock production. Recent estimates indicated that the annual nutrient losses exceed 26 kg of N, 3 kg of P, and 19 kg K per hectare (Sanginga et al., 2003). The negative balance of nutrients in the soil leads to rapid decline in crop yield. Therefore improved agricultural practices have to be developed to sustain food production. A combination of improved varieties of component crops and improved cropping systems for higher productivity and profitability with a minimum use of insecticides and fertilizers have been developed for the moist and dry savannas of West Africa (Ajeigbe *et al.*, 2006). This system includes feeding of crop residues to small ruminants in permanent enclosures on the home compound and returning of the manure to the field.

The system in the northern Guinea savanna zones encourages intensification by double cropping the cowpeas within the season and also judicious use of inorganic fertilizer and manure. In the Sudan savanna zone where the rainfall is about 600 – 800 mm, the system involves 2 rows of densely planted improved sorghum variety: 4 rows of densely planted improved medium maturing cowpea variety. On-farm evaluation of these systems covering several states has shown over 300% increase in productivity, enhanced income generation and improved livelihoods of the farm families (Singh and Ajeigbe, 2007). This paper describes the superiority of the improved strip cropping system involving cereals with a greater proportion of improved cowpea that maximizes the benefits of limited fertilizers and pesticides and minimizes competition between cereals and legumes as well as improving the quality of crop residues and enhances crop-livestock integration.

Materials and Methods

The traditional intercropping involving 1 row of cereal: 1 row of cowpea was tested against, wider strips involving 1 row cereals: 2 rows cowpea; 2 rows cereals: 2 rows cowpea; 2 rows cereals: 4 rows cowpea and sole crops of cereals and cowpea to assess the overall productivity and economic returns on-station (Ajeigbe *et al.*, 2006). On-station experiment was also conducted to determine the most efficient combinations of feeding crop residues of major cereals and legumes with and without bran supplement to 'Yankassa' rams in confinement over a 70-day period and their effect on weight gains by the rams. To validate the results of these on-station trials, several on-farm trials were also conducted. Farmers were encouraged to confine small ruminants for stall feeding of the crop residues in the later part of the dry season. The livestock weight gain and manure generated in the last 60-70 days of the dry season were measured.

Results and Discussions

The results of on-station trials involving millet and cowpea are presented in Table 1. In the millet-cowpea trial, 2 millet: 4 cowpea and sole cowpea gave the highest gross returns and sole millet the lowest. It was also evident that the cowpea yields under 1 row cereal: 1 row cowpea was much lower than expected due to severe competition with cereal. In the sorghum-cowpea trial, highest gross economic returns were from sole crop cowpea and 2 sorghum: 4 cowpea system (Ajeigbe *et al*., 2006; Singh and Ajeigbe, 2007).

Results from the on-farm trials indicate gross incomes ranging from Naira 107,000 (US$ 1,070) to Naira 130,000 (US$ 1,300) in the improved systems compared with Naira 23,000 to Naira 57,000 in the traditional systems in the Sudan savanna (Kano State) zone (Table 2). A mean total food grain yield of 3112 kg/ha was obtained comprising of 1750 kg of cowpea and 1473 kg of maize and 4179 kg/ha total fodder made up of 2254 kg of cowpea fodder and 1925 kg of maize stover in the Northern Guinea savanna (Kaduna State). Thus, participating farmers greatly benefited from the improved system. The superiority of the system emanates from several factors. The two cereal rows have no competing border rows and therefore, they yield equivalent of almost three rows. The two-third cowpea and one-third cereal combination minimizes fertilizer use and maximizes profit because of the higher prices of cowpea grain and fodder and at same time it leaves positive residual soil nitrogen balance. Farmers are adapting this planting system to other crops combinations. It is now common to see 2:4 row to row of maize-cotton, maize-soybean, and sorghum-groundnut combinations on farmers field in the savannas of Nigeria.

The result of the on-station livestock feeding trial is shown in figure 1. Feeding the residues of cereals alone resulted in a mean weight loss of 14% for sorghum, 16% for maize and 11% for millet while feeding the residues of cowpea or groundnut alone resulted in the weight gain of about 13% and 12% respectively. Supplementing the cereals residues with about 300g of cowpea or groundnut residues per day resulted in slight gain in weight and thus the body weight was

maintained. However, addition of 300g wheat bran and 300g cowpea or groundnut residues to the cereals in the daily diets of each ram resulted in about 19% mean weight gain. Thus, bran showed a small but significant additive effect on weight gain. On-farm stall fed small ruminants in the northern Guinea savanna gained an average of 3 kg per animal less than 60 days, farmers were able to generate an average of 614 kg manure (dry weight) during this period (Table 3). In Kano State (Sudan savanna), the mean live weight gained per animals was over 4 kg in 65 days, while farmers were able to generate an average of 550 kg manure (dry weight). Crop residues used for the feeding trials were mainly cowpea and groundnut haulms, maize stover and various brans of sorghum, maize and millet and other house hold by-products.

Conclusion

The traditional intercropping system produces more cereal residues and less legumes because the legumes do not perform well due to competition for light. Recently developed improved and more productive strip-cropping system involving 2 rows of cereals: 4 rows of legumes produce higher grain yields as well as sufficient quantities of cereals and legume residues for balanced feed to ensure adequate livestock productivity. Stall feeding of ruminant allows the farmers to increase manure generation in the homestead which can also be taken to the field for soil fertility maintenance.

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Reference

Ajeigbe, H.A., Oseni, T.O., and Singh, B.B. 2006. Effect of planting pattern, crop variety and insecticide on the productivity of cowpea-ceral systems in Northern Guinea Savanna of Nigeria. *Journal of Food, Agriculture and Environment* 4(1):145-150.

Henriet, J., van Ek, G.A., Blade, S.F. and Singh, B.B.. 1997. Quantitative assessment of traditional cropping systems in the Sudan savanna of northern Nigeria. I. Rapid survey of prevalent cropping system. Samaru J. Agri. Res. 14:27-45.

Mortimore, M.J., Singh, B.B., Harris, F. and Blade, S.F. 1997. Cowpea in traditional cropping systems. In: Singh; B.B., Mohan Raj, D.R., Dashiel K.E., and Jackai, L.E.N. (eds.) *Advances in Cowpea Research* Co pub. of IITA and JIRCAS. IITA Ibadan, Nigeria.

Sanginga, N., Dashiell, K.E., Diels, J., Vanlauwe, B., Lyasse, O., Carsky, R.J., Tarawali, S., Asafo-Adjei, B., Menkir, A., Schulz, S., Singh, B.B., Chikoye, D., Keatinge, D., Ortiz, R., 2003. Sustainable resource management coupled to resilient germplasm to provide new intensive cereal-grain-legume-livestock systems in the dry savanna. Agriculture Ecosystems and Environment 100, 305-314.

Singh, B.B. and H. A. Ajeigbe, 2007. Improved Cowpea-cereals-Based Cropping Systems for Household Food Security and Poverty Reduction in West Africa. Journal of Crop Improvement. Vol. 19, No.1/2 pages 157-172, 2007

Table 1. Cereal-Cowpea productivity in different planting patterns, 2001.

Pattern	Yield kg/ha				LER	LER	Total	Naira*
	Cowpea		Cereal					
	Grain	Fodder	Grain	Fodder	Cowpea	Millet	LER	Value
Millet-cowpea								
1M: 1C	340	580	1530	3747	.26	.72	98	38647
1M: 2C	485	709	1049	2322	.36	.49	.85	37557
2M: 2C	390	576	1433	3230	.29	68	.97	38684
2M: 4C	841	1652	898	2087	.63	.42	1.05	55510
Sole millet	-	-	2121	6292	-			31742
Sole cowpea	1331	1848			-			62700
Sorghum-Cowpea								
1S: 1C	343	946	1187	5339	.26	.84	.1.10	39156
1S: 2C	432	1417	842	5137	.32	.60	.92	41697
2S: 2C	378	1065	965	5317	.28	68	.96	38647
2S: 4C	914	2346	490	3497	.67	.35	1.02	60135
Sole sorghum	-		1411	1042	-	-	27174	
Sole cowpea	1331	1848		-	-		61369	

* Based on 2001 prices. Cowpea grain @ N35/kg, cowpea fodder @ N8/kg, millet and sorghum grain @ N12/kg millet & sorghum fodder @ N1/kg. Conversion rate 1 US dollar = 100; M = millet, C = cowpea.

Table 2. Productivity of improved cowpea-based systems in northern Nigeria

System	No. of *Farmers*	Cowpea yields *Mean Kg/ha*		Cereals yields *Mean Kg/ha*		Total naira *Mean value*
		Grain	**Fodder**	**Grain**	**Fodder**	
Kano State (Sudan savanna)-2003						
Sorgh-cowpea (impd.)	349	1137	1942	688	2429	107,350
Traditional	29	301	834	786	1308	49,404
Kano State (Sudan savanna)-2004						
Sorgh.-cowpea (impd.)	211	1025	2221	1333	5415	127,387
Millet-cowpea (impd.)	131	1008	2918	1132	4424	130,186
Traditional	78	135	389	264	2412	23,745
Kaduna State (Northern Guinea savanna)-2003						
Maize-cowpea (impd.)	192	1757	2106	1333	1711	153,004
Traditional	43	458	526	993	1274	52,085
Kaduna State (Northern Guinea savanna)-2004						
Maize-cowpea (impd.)	324	1743	2402	1612	2139	160,588
Traditional (maize-cowpea)	9	541	733	544	1038	57,386
Traditional (sole maize)	12	-	-	833	976	24,034

Prices: Cowpea grain = N50/kg, cowpea fodder = N15/kg, cereals grain = N24/kg
Cereals fodder = N2/kg, groundnut grain N36/kg, groundnut fodder = N15/kg

Source: Singh and Ajeigbe, 2007

Table 3. Mean number of farmers, livestock and weight gained by livestock during dry season feeding trial, 2007

	Mean Number			Mean Weight (kg)			
State	Farmers	Livestock	Days	Initial	Final wt	Increase	Manure
Kaduna	20	101	58	23.4	26.1	3	614
Kano	95	407	65	21	25.6	5	550

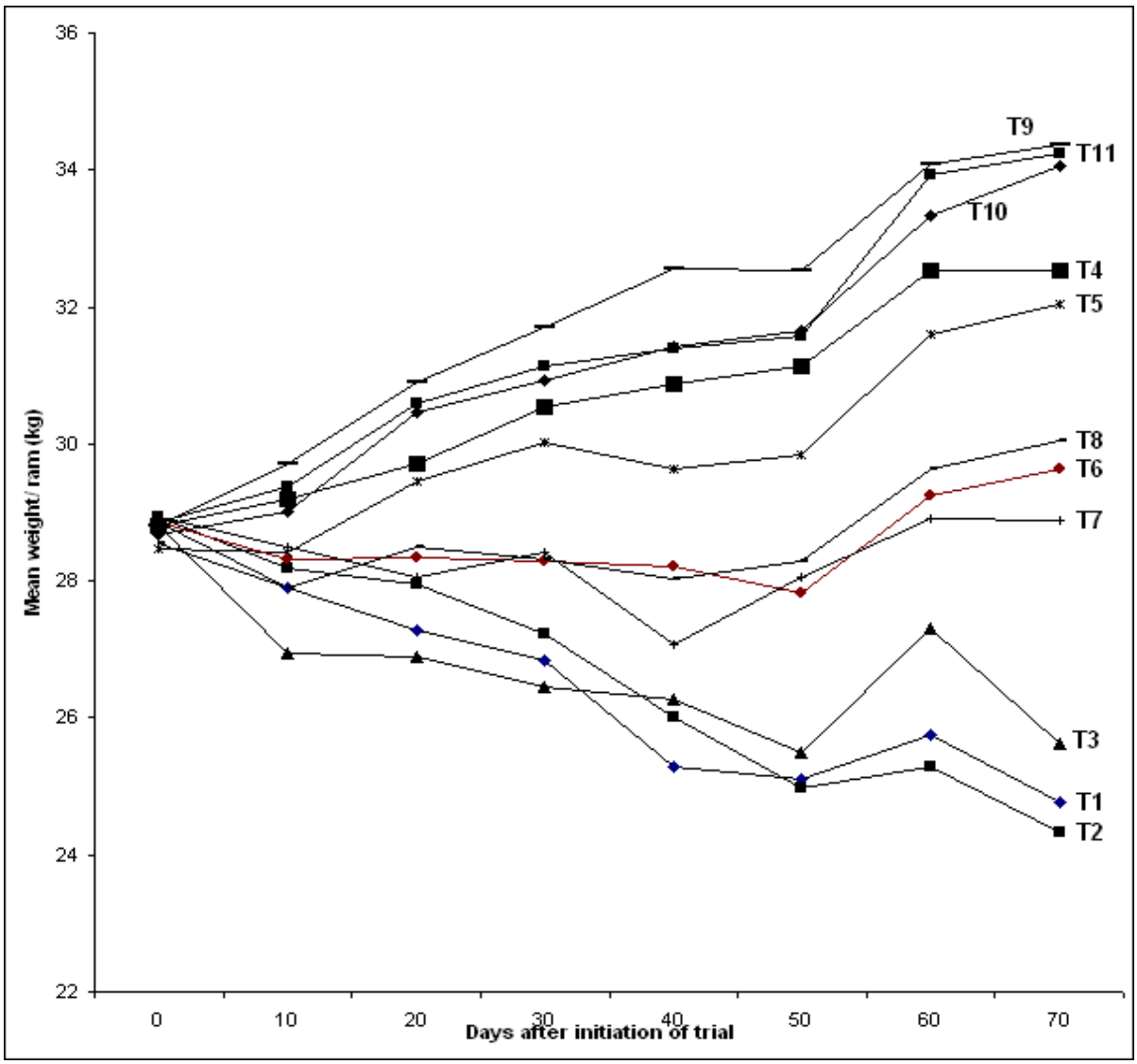

Fig. 1. Effect of feeding crop residues on weight gain in Yankassa rams.

T1= 1.5kg sorghum fodder daily per animal, T2= 1.5kg maize fodder daily per animal, T3= 1.5kg millet fodder daily per animal, T4= 1.5kg cowpea fodder daily per animal, T5= 1.5kg groundnut fodder daily per animal, T6= 1.5kg sorghum fodder + 300g cowpea fodder daily per animal, T7= 1.5kg sorghum fodder + 300g groundnut daily per animal T8= 1.5kg sorghum fodder + 200g bran daily per animal, T9= 1.5kg cowpea fodder + 200g bran daily per animal, T10= 1.5kg sorghum fodder + 300g cowpea fodder + 300g bran daily per animal T11= 1.5kg sorghum fodder + 300g groundnut fodder + 300g bran daily per animal