Innovation, result and method demonstration of mobile fodder chopper for optimum exploitation of fodder resources- A case in Mali

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Abstract

With an objective to demonstrate the innovation , result and method demonstration of mobile fodder choppers for efficient use of the available crop-residues using purposive sampling in the two districts of Koutiala and Bougouni a survey was conducted in 8 villages with 239 farmers from October and December 2015.After the introduction of technology a two-week long demonstration training was organized in Bougouni and Koutiala using the concepts of innovation platform and technology parks three mobile chopper machines were introduced in three villages. An overall 372 persons from 9 villages of Africa rising were trained on use of chopper technology. The middle age group of men and women participated in the training from the selected villages of Koutiala. Chopper demonstration was done using the crop residues of varieties of sorghum, maize, and cowpea. The output of chopped residue was based on the type of crop used. Maize variety Kalo sabae gave less output than dry sorghum variety Grinkan stover. The output from the machine was also dependent on how fast the machine is fed with crop residues. A large majority of men and women farmers reported to mainly collect crop residues for use as animal feed. A large majority of the men and women farmers indicated that crop residues were not cut, and often the crop residues were burnt. A small minority indicated that crop residues were cut using hâche. It was further observed that green fodder was not cut at all. As not many farmers can avail such equipment it is important to make chopper machines available to the farmers through community ownerships.

Key words: Mobile fodder chopper, cost benefit of technology, Mali

Introduction

Often crop residues are fed inefficiently to the animals which lead to increase pressure on biomass and wastage. Apart from that animals do selective feeding of leaves and thick stemmed crop residues are left unutilized leading it sometimes to be burnt by farmers. The solution to reduce wastage and make efficient use of the available crop-residues is through a simple technique of chopping. Thus the specific objectives of the study were: a) to make the farmers aware about the technology of chopping green and dry fodder for optimum and efficient utilization of crop residues using a machine and its cost benefit of technology and b) to identify a local fabricator who could make machine which cut green and dry fodder (innovate it) as per Malian situation.

Materials and Methods

Before the introduction of the technology, using purposive sampling in the two districts of Koutiala and Bougouni a survey was conducted in 8 villages. The total sample size was 239. The unit of analysis was farmer. A total of 30 men and women farmers were randomly selected from each four villages of Zansoni, Sirakele N'Golonianasso and Nampossela thus making total of 120 farmers in Koutiala similarly from the 4 villages of Bougouni- Flola, Sibirla, Medina and Dieba with the sample size 119. The survey was carried out between October and December 2015.After the introduction of technology a two-week long demonstration training was organized in Bougouni and Koutiala using the concepts of innovation platform and technology parks wherein three mobile chopper machines were introduced in three villages.

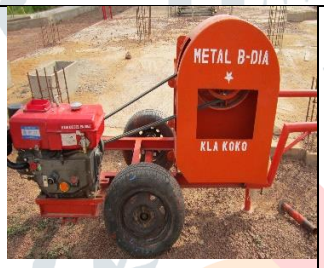
Results and Discussion

An overall 372 persons from 9 villages of Africa rising were trained on use of chopper technology. Specially 305 farmers participated in the mobile chopper demonstration from the 9 villages. Chopper demonstration was done using the crop residues of varieties of sorghum, maize, and cowpea. The output of chopped residue depends on the type of crop used. Maize variety *Kalo sabae* gave less output than dry sorghum variety *Grinkan* stover. The output from the machine was also dependent on how fast the machine is fed with crop residues. A large majority of men and women farmers reported to mainly collect crop residues for use as animal feed. A large majority of the men and women farmers indicated that crop residues were not cut, and often the crop residues were burnt. A small minority indicated that crop residues were cut using coupe-coupe and hâche. The middle age group of men and women participated in the training from the selected villages of Koutiala, Men farmer age profile in Koutiala and Bougouni were similar, while in Bougouni younger women participation was observed. In Koutiala and Bougouni women farmers had more small ruminants in their herds, and the total fodder collected in cartloads by the men farmers were more than women farmers. More farmer organization participation was observed from Bougouni (21) than from Koutiala (14).

Introduction of Technology

Initially a mobile chopper technology was made available in Koutiala which could cut green and dry fodder. Taking first model as a base, as per local Malian situations two machines were fabricated. Thus, a total of three mobile choppers were introduced in selected villages. Two choppers were introduced in Koutiala and one was introduced in Bougouni. The description and design aspects for comparative analysis of the three choppers introduced is described in (table 1). The choppers were used for demonstration in 9 villages. The first machine had three knives for cutting dry and green stover as against second and third machine, which had two blades. Choppers consist of a metal frame in which a flywheel, with two-three knives mounted on it, spins and the fodder is pushed through the wheel by hand. The knives are adjustable for angle and must be regularly sharpened, also knives can be easily taken out and are also replaceable through the help of local manufacturer. In all the machines, before starting there

Table 1: Innovation, result and method demonstration three introduced chopping machine technology

			
Location	Koutiala	Bougouni	Koutiala
Price of the machine (CFA)	650,000	600,000	473,005
Weight of the machine(kg)	150	150	90
Engine	R180	R180	IMEX
Power type	Diesel	Diesel	Diesel
Weight of engine(kg)	75	75	60
Rated speed(Rotation per minute)	2600	2600	2600
Horse power	7.7	7.7	7.1
Tyre- max load rating(kg)	412		437
Maintenance	easy	easy	easy
Change of lubricant oil (hours)	100	100	100
Change fuel filter element(hours)	300	300	300
Manufacturer and location	Mr. Issa Diabaté, Metal B Dia, Kla, Koko,	Mr. Djire Dramane, Niena, Mali	Mr. Boubacar Adamou, C'Darma Dosso, Niger

	Koutiala, Mali		
Phone number	+223-75412513, +223-66215585	+223-76061793,+223-69642980	+227-96870393
Special advantage	Mobile can be used with donkey carts , chops green and dry fodder (60-240kg/hour)	Mobile can be used with donkey carts, chops green and dry fodder(90-155kg/hour)	Mobile can be used with donkey carts, chops green and dry fodder(60-100kg/hour)

was a requirement of putting water. The forages were cut in size of 2-3 inches and more improvement is required for cut quality of different types of forages. There was strain felt in arms because of energy used to start and work with the machine while chopping. It was advised to use cloth to cover head, nose and mouth to avoid dust. After rotating the key, along with pressing the knob was the method to start, each machine. After a workout of 10 hours one required to change oil within 15 days. Maximum capacity of diesel in all machines was 10 litres. Care was required to avoid accidents from the machines. The common problem observed in the machine was with the wear and tear of the belt, which was easy replaced in the market and the cost was between 1500-2000 CFA. The machines were easy to repair by the local manufactures, local traders working in ground nut oil processing machines. Upon all materials available the fabricators were able to make the machine in three days with 4-10 personnel's. Since electricity supply is often erratic and undependable in rural areas, diesel as a power source was used. Choppers were used in research purpose as reported by manufacturers, and there were no choppers available for local purchase.

Demonstration of the technology in Koutiala and Bougouni

Along with the partners in 9 villages of overall 372 persons were trained on use of chopper technology. Specially 305 farmers participated in the mobile chopper demonstration from the nine villages. In Koutiala at four villages including demonstration at the technology park at village Mpessoba, a total of 171 participated in the demonstration, out of which 60 were men and 60 were women Table 2 below indicates the socio-economic profile of the villagers from the four selected villages of Koutiala. The age of the men farmers varied between 41-48 years while in women farmers it varied between 41-59 years. For men farmers herd size ranged for cattle from 4.53 to 21.86, in sheep 5.6 to 14, in goats in the range of 7.6 to 11 while in case of women farmers herd size ranged for cattle ranged 3.8 to 35, in sheep between 2.8 to 29.8., and goats in range of 5.26 to 32.2. Women farmers had more small ruminants in their herds.

Table 2: Socio-economic profile of the villagers in Koutiala

VILLAGES(n=4)	Total (N=120)	GENDER	Parameters	Age	Number of animals			Fodder available in cartloads
					Cattle	Sheeps	Goats	
Sirakele	n1=15	M	Mean	52.8	4.53	8.73	8.26	12.93
			Std. deviation	14.61	3.41	14.52	12.28	13.47
	n2=15	F	mean	57.13	3.8	4.33	3.93	5.8
			Std. deviation	10.28	2.21	3.47	5.29	5.60
Nampossela	n3=15	M	mean	41.26	5.93	6.73	7.6	11.86
			Std. deviation	9.16	4.26	4.77	5.44	9.14
	n4=15	F	mean	49.69	11.2	10	12.93	14.13
			Std. deviation	6.93	9.60	7.88	9.23	14.05
N Golonianasso	n5=15	M	mean	48.46	21.86	14.33	11	26.4
			Std. deviation	14.17	15.86	12.99	6.62	34.83
	n6=15	F	mean	41.4	35.06	29.86	32.2	18.8
			Std. deviation	6.60	37.18	35.64	38.90	18.61
Zanzoni	n7=15	M	mean	48.4	10.13	5.6	7.66	15.4
			Std. deviation	10.72	11.51	6.99	3.86	12.64
	n8=15	F	mean	59	5.06	2.8	5.26	6
			Std. deviation	7.40	8.44	3.44	3.82	3.77

1 cartload ~50-100 kg

The animals were sent for dry season feeding as the residues are left on the field and limited amount is collected for animal feeding purpose. Total fodder collected in cartloads by the farmers ranged between 6 (300 kg) to 26 (1320 kg) cartloads on the day of survey. Men farmers reported to collect fodder between 11.8 (593kg) to 26.4(1320kgs) cartloads while women farmers collected in the range of 5.8 (290kg) to 18.8 (940kg) cartloads. Taking technologies to scale was possible through local ownership, working through farmer organizations. Overall a total of 14 farmer organizations from Koutiala participated in the demonstration apart from the members of NGO like AMEDD, IER, feed manufacturer and ICRISAT. In general, 10 men farmer organizations

participated in the demonstration while a total of 4 women farmer organizations participated. The details and the village names are indicated in table 3.

Table 3: Details of the farmer association in Koutiala participating in the demonstration

SN	Village	Gender	Association
1	Sirakele Men	M	Tièsiriton
2	Sirakele Women	F	O Daohenan
3	Nampossela Men	M	Panafo
4	Nampossela-Women	F	Ni Pang Lo
5	N'Golonianao Men	M	CPVC1, CPVC3 and CPVC4
6	N'Golonianasso Women	F	CPVC3
7	Zanzoni Men	M	CPVC; Dunkafa; Toukorola; Ansar Dine; Wayeti
8	Zanzoni Women	F	Benkadi

The table 4 below clearly indicates that a large majority of men and women farmers reported to mainly collect crop residues for use as animal feed. A large majority of the men and women farmers indicated that crop residues were not cut, sometimes burnt. At village level these tasks are also performed by the traditional methods which, although cheap, were characterized by high labour, time use and burdensome. As a small minority indicated that crop residues were cut using coupe-coupe and hâche, as indicated in table 3.

Table 4: Use and method of collection of residues in Koutiala

Indicators		**Villages**							
		Zanzoni		N Golonianasso		Namposella		Sirakele	
		Men	Women	Men	Women	Men	Women	Men	Women
		Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency
Reason of the collection of residues	Animal feed	11(73)*	13(86.6)	15(100)	12(80)	15(100)	12(80)	13(86.6)	12(80)
	Organic manure only	0	2(13.3)	0	1(6.66)	0	1(6.66)	2(13.3)	2(13.3)
	Both animal feed and organic manure	4(26)	0	0	2(13.3)	0	2(13.3)	0	1(6.66)

Cutting straws	Yes	5(33.3)	1(6.66)	2(13.3)	10(66.6)	4(26)	10(66.6)	1(6.66)	5(33.3)
	No	10(66.6)	14(93.3)	13(86)	5(33.3)	11(73.3)	5(33.3)	14(93.3)	10(66.6)
Cutting straws with	Axe	3(20)	1(6.66)	3(20)	8(53.3)	1(1.66)	8(53.3)	1(6.6)	3(20)
	Feet	2(13.3)	0	1(6.66)	2(13.3)	3(20)	2(13.3)	0	1(6.66)
	Hâche	0	0	0	0	0	0	0	1(6.66)

*Figures in brackets are %.

This was a cumbersome, as the feets and hands of the farmers were pained, and the output generated was less in quantity and quality. It was further observed that green fodder was not cut at all.

Table 5: Details on the demonstration of chopping stovers in 5 villages of Koutiala

SN	Village	Gender	Crop	Variety name	Mean Chopped stover kg/hour	Mean labours used
1	M' Pessoba	M	Sorghum	Fadda	100	2
2	N'Golonianasso	W	Sorghum	Grinkan	240	2
		M	Sorghum	Grinkan	240	4.6
3	Nampossela	W	Maize	Dembanuma	146	9.6
		M	Maize	Dembanuma	146	2
4	Sirakele	W	Maize	Checkclow	72.76	2
		M	Maize	Kalo saba	60	1.85
5	Zanzoni	W	Sorghum	Sèguètana	200	1.44
		M			200	2.53

Findings from table 5 of the chopper demonstration revealed that the output of chopped stover depends on the type of crop used. Maize variety Kalo saba gave less output than dry sorghum variety Grinkan stover. The output from the machine is also dependent on the speed the machine if fed of crop residues. Some farmers took considerable amount in hand to be put for efficient chopping. Thick stemmed green dual purpose Fadda needed more time in chopping than quality protein maize variety Dembanuma. In Koutiala, for demonstration mean labour used was 9.6 to 1.4. Although for efficient work one labour was sufficient.

In case of Bougouni table 5 indicates the socio-economic profile of the villagers from four selected villages. The age of the men farmers varied between 42 to 48 years while in women farmers it varied between 33 to 44 years. Men farmer age profile in Koutiala and Bougouni were similar, while in Bougouni younger women participation was observed. In comparison to Koutiala, herd size of sheep and goats were less.

Table 5: Socio-economic profile of the villagers in Bougouni

Villages N=4)	Total (N=120)	GE	Parameters	Age	Number of animals			Fodder available in cartloads
					CATTLE	SHEEPS	GOATS	
Djeba	n1=15	M	mean	42.06	49	6.66	7.33	22.33
			Std deviation	9.96	53.91	5.35	5.20	12.70
	n2=15	F	mean	42.86	3.2	4.46	4.53	7.86
			Std deviation	8.51	2.14	2.41	1.30	4.94
	n3=15	M	mean	47.46	13.66	5.13	4.53	28
Sibirila			Std deviation	12.49	12.80	5.26	5.64	16.51
	n4=15	F	mean	38.06	2.73	1.66	2.13	10.66
			Std deviation	9.13	2.98	1.79	2.03	6.74
	n5=15	M	mean	46.6	12.66	1.86	4.73	12.53
Madina			Std deviation	17.36	24.91	3.99	5.92	12.07
	n6=15	F	mean	44.73	1.13	1.93	5.13	3.73
			Std deviation	13.18	1.45	1.62	3.99	2.54
	n7=17	M	mean	45.58				
Flola			Std deviation	17.28				
	n8=12	F	mean	33				
			Std deviation	8.93				

For men farmers herd size in cattle was more than that of Koutiala and ranged from 12.66 to 49. In sheep herd sizes ranged between 1.86 to 6.66, and 7.6 to 11 in goats. Like in Koutiala, women farmers had more small ruminants in their herds, while in case of women farmers herd size of cattle, sheep and goats was less than Koutiala. The herd size for women farmers ranged from 1.13 to 3.2 for cattle, 1.6 to 4.4.for sheep and 2.1 to 5.1 for goats. The animals were sent for dry season feeding as the residues are left on the field and

limited amount is collected for animal feeding purpose. Total fodder collected in cartloads by the farmers ranged between 3.7 (186 kg) to 28 (1400 kg) cartloads. Men farmer collection of fodder was similar to that of Koutiala. Men farmers collected fodder between 12.53 (626 kg) to 28 (1400 kg) cartloads while women farmers collected lesser than Koutiala woman farmers with the range of 3.7 (186 kg) to 10.6 (533 kg) cartloads on the day of survey. Crop residues were often burnt. It is reported in other regions (**FAO, 2011**) for example that when fodder cultivation was promoted and chaff cutters were introduced in Mahboobnagar district of Andhra Pradesh (a southern state of India), fodder wastage was reduced by up to 30 percent.

The table 6 below indicates that overall a total of 21 farmer organisations from Bougouni participated in the demonstration apart from the members of NGO like Mobiom, IER, feed manufacturer and ICRISAT.

Table 6: Details of the farmer associations in Koutiala who have participated in the demonstration

SN	Village	Gender	Association
1	Djeba Men	M	Waratchi, CPC, Coton Bio, Nkrematchi
2	Djeba Women	F	Siratchi, Nasiratchi,Coton Bio, Nkrematchi
3	Sibirila Men	M	CPC, Cooperative Bio
4	Sibirila Women	F	CPC, Cooperative Bio
5	Flola Men	M	Benkadi, Warate, Union Elevage, CPC1, Waratchi
6	Flola Women	F	Tilabo, Tonba, Baroni, Bioni, Nteninko, Foukanidjinatchi and Baintchi
7	Madina	M	Cooperative Bio
8	Madina	F	Cooperative Bio

In general, 10 men and 11 women farmer organizations participated in the demonstration. The table 7 below clearly indicates that 100 percent of men and women farmers reported having experience in collecting crop residues for use as animal feed. But on the other side, 100% of the farmers were not cutting the crop residues.

Table 7: Use and method of collection of residues in Bougouni

Indicators		**Villages**							
		Djeba		Sibirila		Madina		Flola	
		Men	Women	Men	Women	Men	Women	Men	Women
Reason of the collection	Animal feed	15(100)	15(100)	15(100)	15(100)	15(100)	15(100)	17(100)	12(100)
	Organic manure only	0	0	0	0	0	0	0	0

of residues	Both animal feed and organic manure	0	0	0	0	0	0	0	0
Cutting straws	Yes	0	0	0	0	0	0	0	0
	No	15(100)	15(100)	15(100)	15(100)	15(100)	15(100)	17(100)	12(100)
Cutting straws with	The axe	0	0	0	0	0	0	0	0
	Feet	0	0	0	0	0	0	0	0
	Hache	0	0	0	0	0	0	0	0

Findings from table 8 of the chopper demonstration revealed that the output of chopped stover depends on the type of crop used.

Table 8: Details on the demonstration of chopping stovers in 4 villages of Bougouni

SN	Village	Gender	Crop	Variety name	Quantity of stover chopped kg/hour)	Mean (Labours used per hour)
1	Djeba	M	Maize	Dembahnouma	91.70	2
2	Sibirila	W	Maize	Dembahnouma	91.70	2
		M	Rice straw	Local	155	2
			Cowpea haulm	Dounanfana	100	
3	Madina	W	Maize	Dembahnouma	105.75	2
		M	Maize	Dembahnouma	105.75	2
4	Flola	W	Maize	Dembahnouma	100	2
		M	Maize	Dembahnouma	100	2

Maize variety Dembahnouma a variety from Ghana which literally means "good mother" gave highest output of 105.75 kg/hour. Farmers were very happy when the cowpea haulm was chopped using machine, and they felt that the chopped material was even better than maize. The output from the machine depends also on how fast the chopper is fed with crop residues. Some farmers took considerable amount in hand to be put for efficient chopping. Generally, in demonstration in a participatory way, in Bougouni 2 farmers/ labours were used. One was bringing the stover, the other was putting it inside the feeder of the machine. In general, one labour is sufficient.

Cost benefit analysis of technology and business case

Introducing a new technology for sustainable intensification can increase or decrease costs. This depends on the expenses needed to acquire and maintain the new technology compared to the expenses needed to maintain the old system., wherein the a) farmer do not cut the fodder but burns it, b) leave crop-residues on the field c) use local sowing equipment and or feet to cut the dry fodder. However, there are other factors

besides cost to consider. A new technology may bring benefits such as improvements in feed utilization, conservation and reducing wastage that are worth extra expenses. This work requires more data collection on the aspects, however from the preliminary results of our discussion with farmers, we have found that the individual ownership wherever possible can work but for taking technology to scale community ownership is recommended. Based on the limited period collected data the cost benefit is as follows: As not many farmers can avail such equipment because they reel under crop failures and dwindling returns. Under such situations, it is important to make chopping machine available to the farmers through community ownerships. The machine work should create a demand during the harvest season from September to December. Chopping 20 charrettes or 2 tonnes / 10 hours will make the business give reasonable profit. In the given business model we have set the price at 500 FCFA per 100 kg chopped.

Table 9: Cost benefit analysis of technology and business case

Location	Existing practice	With introduced chopping technology
Labour cost/10 hours	0	0
Price of fuel 10 hr/litre (CFA)	0	5800
Misc. Cost	0	200
Total cost	0	6000
Quantity chopped in kg/10hr	10	2000
Cost of chopping in CFA/10 hours	0	6000
Selling price of stover in CFA	100	20000
Benefit	100	26000
Profit in CFA/10 hr	100	20000

In case technology appears to be expensive at the implementation stage more research is required to be made for a low-cost technological solution. The choppers given to farmer unions covering the at least 6 villages in Bougouni and 6 villages in Koutiala can cater to the needs of the farmers. Chopping is a good method for efficient use of crop residues as animal feed. Chopped stovers of sorghum and maize will increase feed intake and/or better performance of animals. This will be especially better for women and men farmers who keep small ruminants for supplement and even intensive feeding when cowpea and groundnut haulms are added will solve the issues of quality and quantity of dry season feeding in livestock. There is a need to incentivize farmers so that they feel the compelling future of retaining stubble for soil improvement and partly collect it for economic gains. There is a need to “run awareness drives to inform, train farmers about the adverse impact of stubble burning on environment, health and soil. It involves commitment from the government and donors for active support. The government is required to make machines available to farmers through farmer unions as most small holder farmers will otherwise continue with the age-old practices. More awareness drives are required to be run by government and non-government, international, private organizations on the efficient use of crop residues and avoidance of stubble burning on environment, health and soil and efficient use of crop residues.

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