Efficient feed utilization through improved feed troughs for small ruminants in Southern Mali

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The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-in-development projects supported by the United States Agency for International Development (USAID) as part of the U.S. Government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING is creating opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three regional projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads the program's monitoring, evaluation and impact assessment.

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Contents

Summary

The ruminant feeding systems of smallholder farmers in mixed crop and livestock systems in Sudano-Sahelian zone of West Africa is often characterized by waste as animals eat part, and trample and urinate on the rest. Given the feed shortage particularly in the dry season, efficient utilization of the available feed resources is essential to minimize waste as to feed more animals and to reduce nutrient loss. To promote efficient feed use, the use of improved feed troughs were demonstrated in three Africa RISING project intervention communities in Sirakele, Zanzoni and M'Pessoba in Koutiala district in southern Mali in the late (March/April 2019) and early dry (February 2020) seasons. Forty five farmers were selected randomly in the three intervention communities who were trained in the use of improved feed troughs made with commercial materials (plank and corrugated iron sheet) for small ruminants. Each farmer was provided with one improved feed trough which was then compared with the traditional feed trough. The quantity of feed offered (both in the morning and evening), and that was wasted during the feeding were measured for six consecutive days, both for the traditional and improved feed troughs in the three study sites across all seasons. A survey questionnaire was administered to all participating farmers to document their opinions about the benefits of the technology to efficient feeding systems. The results of the 6 days monitoring of the use of the traditional and improved feed troughs showed that the improved feed troughs reduced feed waste significantly in all the three communities across all seasons. The percentage of waste in feeding crop residues to the animals using the traditional feed troughs were 7.73±0.92, 26.13±3.30, and 13.32±1.39 in Sirakele, Zanzoni and M'Pessoba, respectively in the late dry season compared to less than 1% with the improved feed troughs during the same season in Sirakele and M'Pessoba, respectively while it was 3.33% in Zanzoni which implies about 7%, 23% and 12% feed saved in Sirakele, Zanzoni and M'Pessoba, respectively. Similar trends were observed in the early dry season. Farmers spent slightly less time in feeding the animals with the improved feed troughs than using traditional feed troughs, but the differences were not significant in both seasons across communities. Male adults were largely responsible for feeding the animals in the three study communities across all seasons (late and early dry seasons) though female adults and boys were also involved. The participating farmers confirm the benefits of the improved feed troughs which are consistent with our results. These results show that the efficiency of feed utilization can be significantly increased through the use of improved feed troughs.

Introduction

Seasonal feed scarcity, particularly in the dry season, is the norm in Sudano-Sahelian zone of West Africa. The ad-hoc manner of feeding the available feed resources by the smallholder farmers using traditional feed troughs is often characterized by waste as animals eat part, and trample and urinate on the rest. The extent of feed wastage may vary with seasons, the type of feed, number of animals being fed and the type of feed troughs used. Given the feed shortage particularly in the dry season, efficient utilization of the available feed resources is essential to minimize waste as to feed more animals and to reduce nutrient loss. Efficient utilization is also critical to cost-effective livestock production systems in the region.

Under the Africa RISING project in Ethiopia, improved feed troughs have been designed, tested and evaluated for feeding ruminants (cattle, sheep and goats) by International Livestock Research Institute (ILRI). Results from monitoring of the use of the improved feed troughs in four sites in Ethiopia showed that using improved feed troughs saved 27% of the cereal and legume residues offered to the animals compared to the traditional feed troughs. Besides, the improved feed troughs led to a significant increase in the amount of manure collected according to feedback from the participating farmers in the Africa RISING project sites in Ethiopia. The success stories in Ethiopia around this simple technology have led to an enquiry about the feasibility of testing the same technology in West Africa. This study therefore aimed at testing, validating and demonstrating the effect of improved feed troughs on feed utilization by both cattle and small ruminants in Koutiala district in southern Mali. The objectives of this study were: (i) To test, validate and demonstrate the effect of improved feed troughs on feed utilization by small ruminants in Koutiala district in southern Mali. (ii) To assess the effect of season on feed utilization by the farmers using the improved feed troughs in the three intervention communities. (ii) To build the capacity of smallholder livestock keepers in improved feeding systems to reduce waste and improve animal productivity.

Methodology

Forty-five farmers were selected randomly from three Africa RISING intervention communities in Koutiala district in southern Mali namely Sirakele, Zanzoni and M'Pessoba, and were trained in the use of improved feed troughs made with commercial materials (plank and corrugated iron sheet) for small ruminants. The breakdowns of those trained in February 2019 were 20 farmers in Sirakele, 15 farmers in Zanzoni and 10 farmers in M'Pessoba. The 45 farmers were involved in the data collection in both late (March/April 2019) and early dry seasons (February 2020). Each farmer was provided with one improved feed troughs which was then compared with the traditional feed troughs. The design of the improved feed troughs with commercial materials was carried out by a local artisan based on the specifications provided by ILRI Ethiopia. The model and pictures of the improved feed troughs were presented to the participating farmers in the selected communities for their views on the design. Most of the farmers preferred construction of the troughs for their small ruminants as many of them owned few heads of cattle. Each improved feed troughs with commercial materials for sheep and goats was constructed at a cost of about 100,000 FCFA (USD 169). The improved feed troughs are two sided and can be used by up to 12 sheep and goats. The quantity of feed offered (both in the morning and evening) and that was wasted during the feeding were measured for six consecutive days, both for the traditional feed troughs, for example spreading a portion of the feed on the ground, using bowls, wooden troughs etc. and improved feed troughs in the 3 intervention communities in the late and early dry seasons. The feed offered were mainly crop residues such as groundnut haulms, cowpea hay and leaves from trees. The amount of time spent in feeding the animals (bringing back dispersed feed, keeping animals to feed comfortably) was recorded. A survey questionnaire was also administered to all participating farmers to document their opinions about the benefits of the technology to efficient feeding systems.

In the early dry season (February 2020), additional five farmers were selected randomly in each intervention community to build feed troughs entirely with local materials (woods and with thatched roof). Using the locally available construction materials was meant to reduce the cost which will facilitate adoption by the farmers. The improved feed troughs made with locally available materials cost about 15,000 FCFA (about USD 25).

Data analysis was performed with SAS using Means Procedures for descriptive statics while GLM Procedures was used to assess the effect of types of feed troughs, season and community on the feed offered, time spent feeding the animals and percentage of wastage. Mixed effect model was used with season and community as random variables while feed trough type was the fixed variable. Unless otherwise specified, the level of significance was set at $P < 0.05$.

Training of farmers in efficient feed utilization using improved feed troughs

Following the construction of the improved feed troughs, 45 participating farmers including 12 women were trained in the use of the improved feed troughs in the three intervention communities in February 2019. The objective of the training was to build their capacity in the efficient feeding with the improved feed troughs. The training largely entailed demonstration of how to use the feed troughs.

Picture 1: An improved feed trough for small ruminants constricted with commercial materials in Sirakele Koutiala. Photo credit: Théophile Dembele/AMEDD.

Picture 2: Improved feed trough for small ruminants constructed with locally available materials in Sirakele. Photo credit: Théophile Dembele/AMEDD.

Picture 3: Traditional feed trough for small ruminants in Sirakele. Photo credit: Théophile Dembele/AMEDD.

Results and discussion

Profiles of the participating farmers

At least one of the participating farmers were women in all the 3 intervention communities (Figure 1a and b). The average age (mean ± standard error) of the participating farmers were 50.65±2.96, 56.00±2.91 and 35.40±3.28 years in Sirakele, Zanzoni and M'Pessoba, respectively during the data collection in the late dry season (March/April 2019). The average age (mean ± standard error) of the participating farmers in the early dry season was similar (Table 1). The average age of the participating farmers was significantly lower in M'Pessoba than in Sirakele and Zanzoni. The primary activity or occupation of the participating farmers in this study was mixed crop and livestock farming (Figure 2a and b) though there were a few farmers in Zanzoni and M'Pessoba who reported that they were engaged only in livestock husbandry. Seventy-five percent of the participating farmers in Sirakele had no formal education (Figure 3a and b) whereas 40% of the farmers in M'Pessoba had secondary school education. Generally, the farmers had much more sheep and goats than cattle (Table 1) in all the intervention communities. Farmers in Sirakele had significantly higher sheep and goat than those in Zanzoni and M'Pessoba.

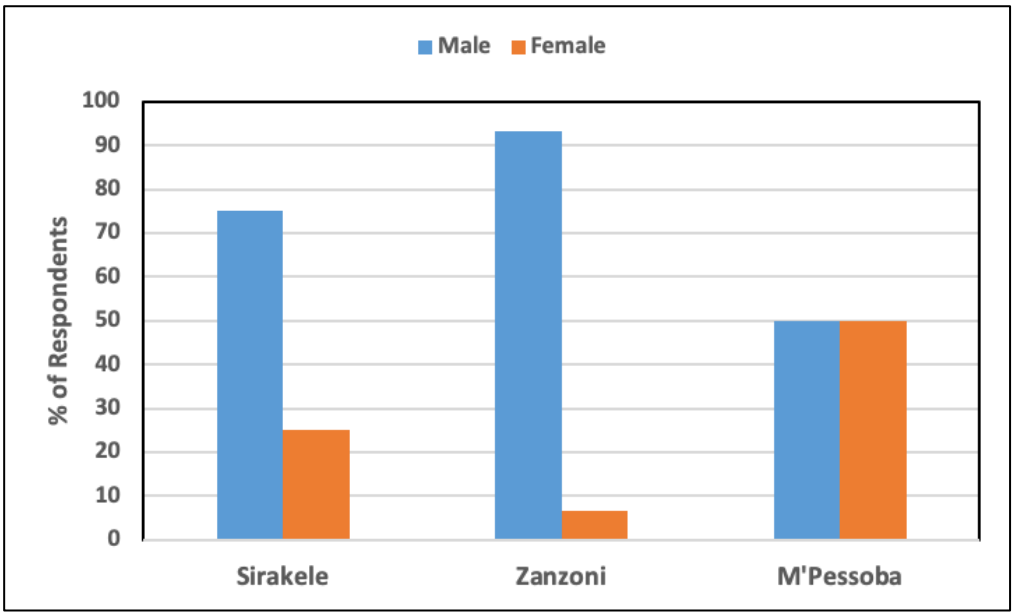

Figure 1a: Sex of participating farmers in the late dry season (March/April 2019) in the intervention communities (Sirakele n=20; Zanzoni n=15; M'Pessoba n=10).

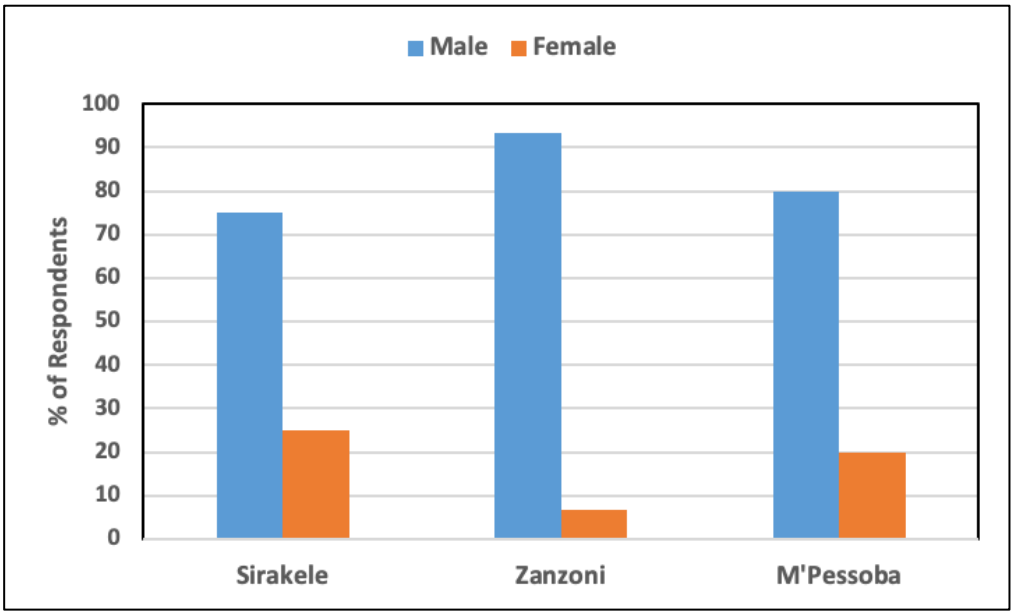

Figure 1b: Sex of participating farmers in the early dry season (February 2020) in the intervention communities (Sirakele n=20; Zanzoni n=15; M'Pessoba n=10).

Table 1: Age and livestock assets of participating farmers in Sirakele, Zanzoni and M'Pessoba in Koutiala district in Southern Mali

Late dry season (April 2019)				
Village	**Age**	**Cattle**	**Sheep**	**Goat**
Sirakele (n=20)	50.65±2.96[a]	3.85±1.57[a]	12.50±1.23[a]	12.50±1.69[a]
Zanzoni (n=15)	56.00±2.91[a]	1.00±0.89[b]	6.40±1.05[b]	2.93±0.97[b]
M'Pessoba (n=10)	35.40±3.28[b]	4.00±1.64[a]	4.20±1.55[b]	2.60±1.40[b]
Early dry season (February 2020)				
Sirakele (n=20)	51.30±2.90[a]	2.11±0.87[a]	12.85±0.89[a]	12.30±1.31[a]
Zanzoni (n=15)	54.40±2.56[a]	1.00±0.44[a]	9.90±0.98[a]	4.20±1.25[b]
M'Pessoba (n=10)	36.30±3.27[b]	1.40±±0.62[a]	3.90±1.57[b]	1.00±0.22c

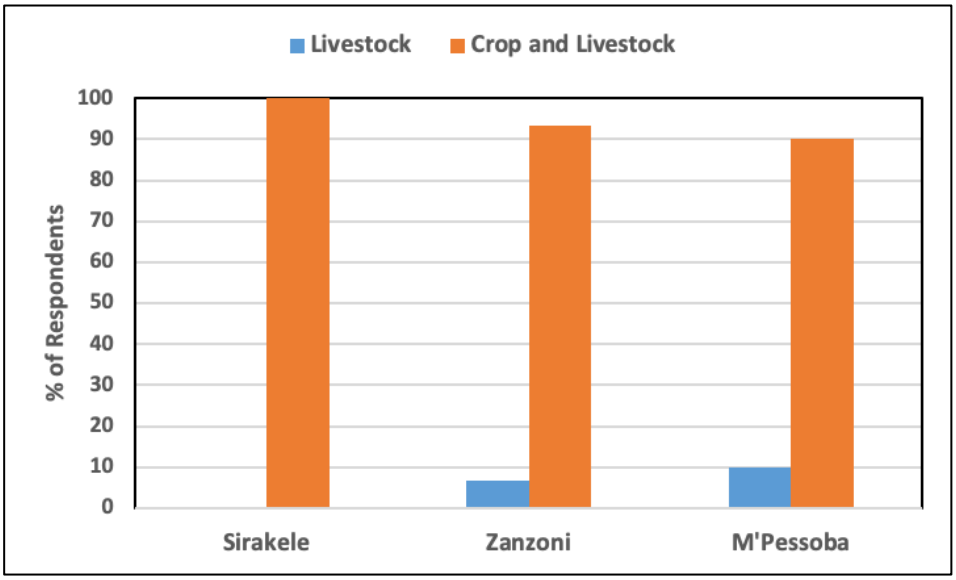

Figure 2a: Primary activity of the participating farmers in the late dry season (March/April 2019) in the intervention communities (Sirakele n=20; Zanzoni n=15; M'Pessoba n=10).

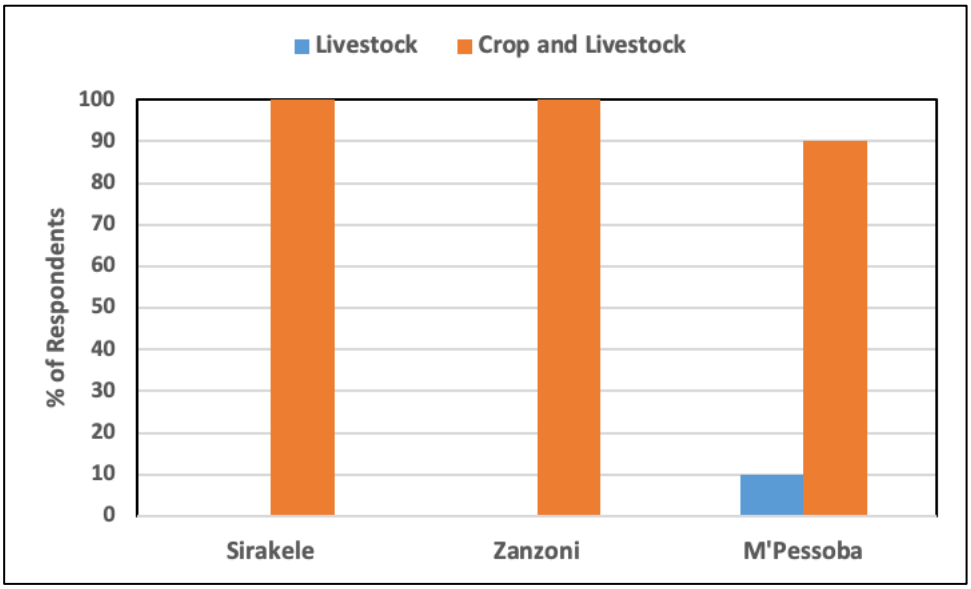

Figure 2b: Primary activity of participating farmers in the early dry season (February 2020) in the intervention communities (Sirakele n=20; Zanzoni n=15; M'Pessoba n=10).

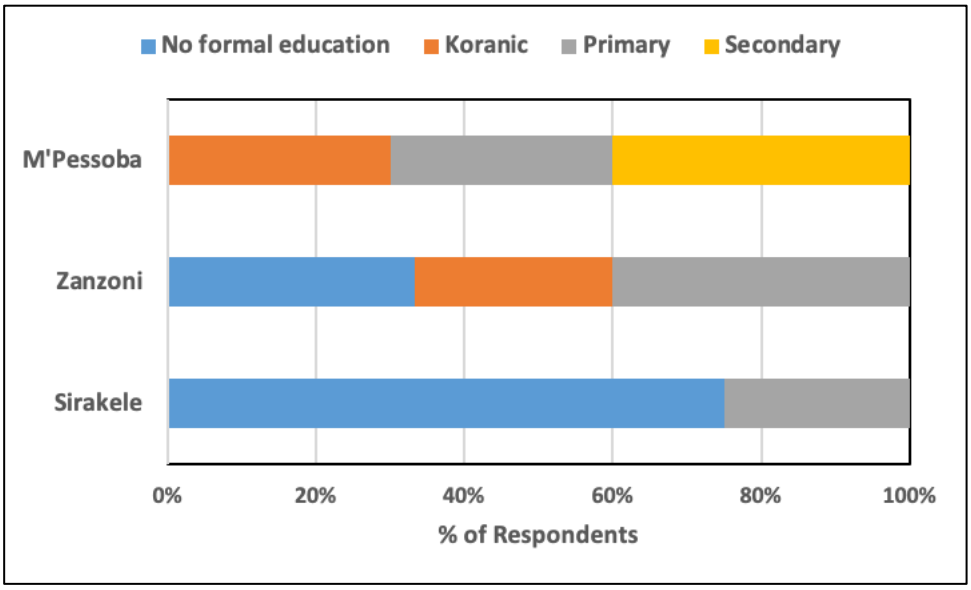

Figure 3a: Education level of participating farmers in the late dry season (March/April 2019) in the intervention communities (Sirakele n=20; Zanzoni n=15; M'Pessoba n=10).

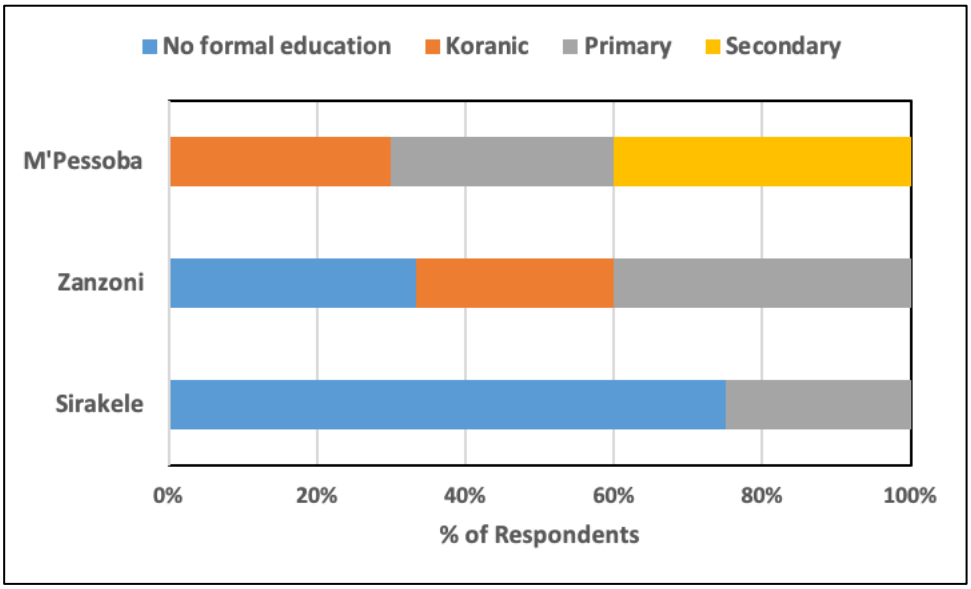

Figure 3b: Education level of participating farmers in the early dry season (February 2020) in the intervention communities (Sirakele n=20; Zanzoni n=10; M'Pessoba n=10).

Comparison of the traditional and improved feed troughs across seasons

The results of the 6 days monitoring of the use of the traditional and improved feed troughs (Table 2) showed that the improved feed troughs reduced feed waste significantly in all the three communities (Sirakele, Zanzoni and M'Pessoba) in both late and early dry seasons). The quantity of feed wasted was significantly higher ($P<0.05$) with the use of traditional feed troughs than with the use of the improved feed troughs. The results confirm that the traditional feeding systems are characterized by a lot of feed waste, which if reduced will enhance efficient feeding of the animals. The percentage of waste in feeding crop residues to the animals using the traditional feed troughs were 7.73±0.92, 26.13±3.30, and 13.32±1.39 in Sirakele, Zanzoni and M'Pessoba, respectively in the late dry season compared to less than 1% with the improved feed troughs during the same season in Sirakele and M'Pessoba, respectively while it was 3.33% in Zanzoni. These results indicated about 7%, 23% and 12% feed saved in Sirakele, Zanzoni and M'Pessoba, respectively by using improved feed troughs (Table 2). Similar trends were observed in the early dry season. Across communities, the feed wastage for traditional feed troughs was significantly higher in Zanzoni than in Sirakele and M'Pessoba in the late dry season but there were no significant differences in the percentage feed wastage across communities for improved feed troughs in both late and early dry seasons. The farmers confirmed this main advantage of the improved feed troughs that it led to drastic reduction in feed waste. The results also showed that farmers spent slightly less time in feeding the animals with the improved feed troughs than using traditional feed troughs, but the differences were not significant in both seasons. Significantly more feed were offered in the early dry season for both types of feed troughs than in the late dry season which is a reflection of availability of more feed resources particularly the crop residues.

Table 2: Comparison of the use of the traditional and improved feed troughs for small ruminants in Sirakele, Zanzoni and M'Pessoba in Koutiala district in Southern Mali in late and early dry seasons

Late dry season (March/April 2019)								
Village	*Quantity of feed Offered (g/day)*		*Quantity of feed wasted (g/day)*		*Time spent feeding the animals (min/day)*		*Percentage of feed wasted*	
	Traditional	*Improved*	*Traditional*	*Improved*	*Traditional*	*Improved*	*Traditional*	*Improved*
Sirakele (n=20)	3000±150[a]	3000±150[a]	232.00±27.75[a]	20.75±7.59[b]	30.58±0.64[a]	29.12±0.34[a]	7.73±0.92[a]	0.69±0.25[b]
Zanzoni (n=15)	1000±50[a]	1000±±50[a]	261.33±33.02[a]	33.33±9.96[b]	29.50±0.75[a]	28.13±0.69[a]	26.13±3.30[a]	3.33±0.99[b]
M'Pessoba (n=10)	2600±305[a]	2600±305[a]	346.50±32.52[a]	22.60±16.01[b]	34.17±1.09[a]	32.94±1.09[a]	13.32±1.39[a]	0.87±0.80[b]
Early dry season (February 2020)								
Village	*Quantity of feed Offered (g/day)*		*Quantity of feed wasted (g/day)*		*Time spent feeding the animals (min/day)*		*Percentage of feed wasted*	
	Traditional	Improved	Traditional	Improved	Traditional	Improved	Traditional	Improved
Sirakele (n=20)	3650±197[a]	3800±171[a]	233.75±39.96[a]	7.75±3.93[b]	23.15±0.86[a]	18.60±0.73[a]	6.40±1.28[a]	0.20±0.08[b]
Zanzoni (n=10)	2400±221[a]	2800±200[a]	177.00±27.61[a]	3.00±1.81[b]	23.55±0.73[a]	20.53±0.76[a]	7.37±0.85[a]	0.11±0.09[b]
M'Pessoba (n=10)	3500±619[a]	4700±715[a]	269.00±54.03[a]	8.03±3.13[b]	30.80±2.21[a]	27.45±2.25[a]	7.69±0.94[a]	0.17±0.07[b]

Gender group in feeding animals with different feed troughs across seasons

Male adults were largely responsible for feeding the animals in all the intervention communities and across seasons (Figure 4a and b). Both female adults and boys were also involved in feeding the animals in all the communities in both late and early dry seasons. There was no report of the involvement of girls in feeding the animals with either the traditional or improved feed troughs across seasons in all the communities. The results were similar for both the traditional and improved feed troughs across seasons in all the communities.

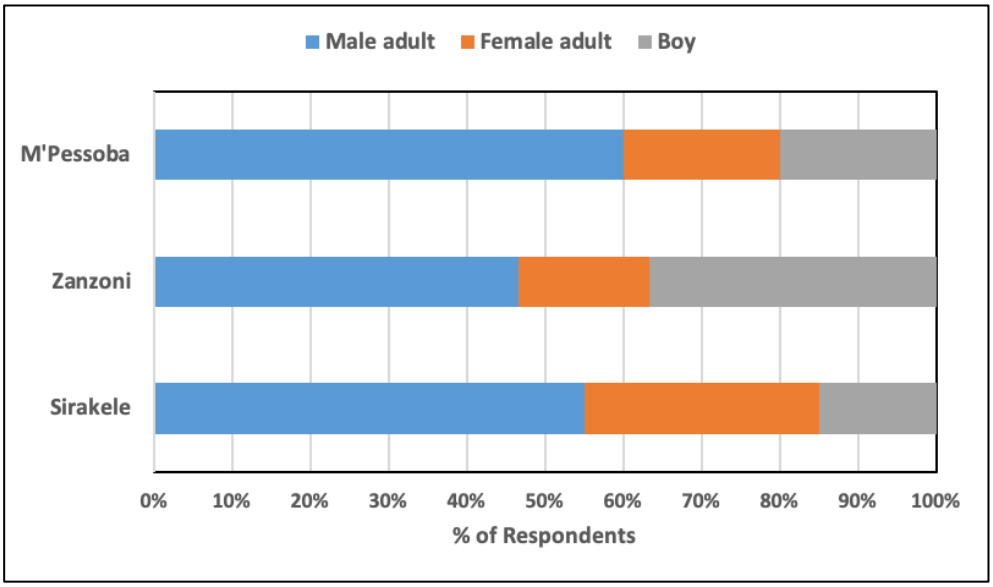

Figure 4a: Gender group of those feeding small ruminants in the late dry season (March/April 2019) in the intervention communities (Sirakele n=20; Zanzoni n=15; M'Pessoba n=10).

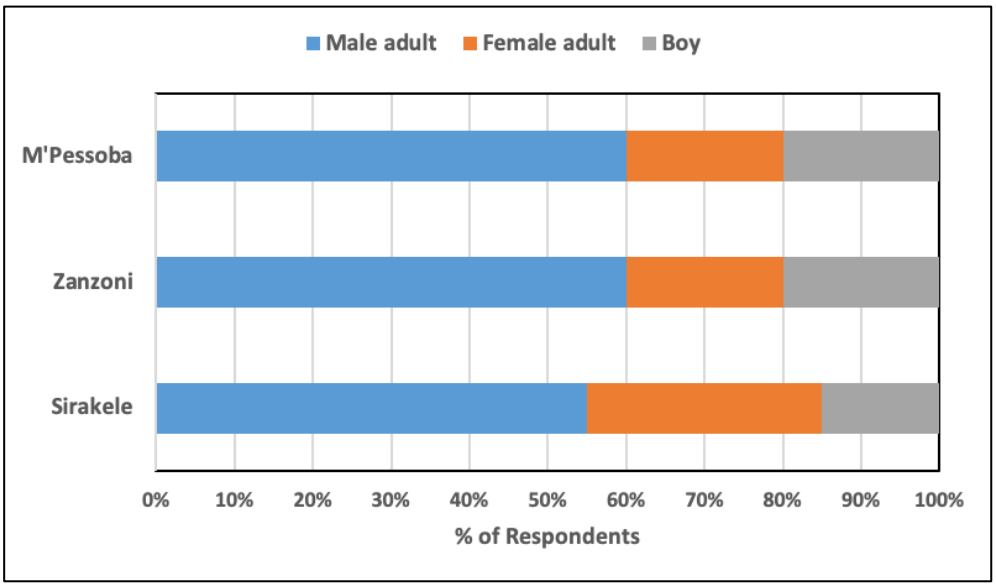

Figure 4b: Gender group of those feeding small ruminants in the early dry season (February 2020) in the intervention communities (Sirakele n=20; Zanzoni n=15; M'Pessoba n=10).

Perceived benefits of the improved feed troughs

After the 6 days monitoring of the use of the traditional and improved feed troughs, the farmers were asked to respond to a series of statements on the perceived benefits of the improved feed troughs in each season of data collection. The statements are presented in Table 3 as well as the response of the participating farmers which could be completely disagree, disagree, neither disagree or agree, agree or completely agree. Across seasons and in all the intervention communities, the farmers strongly agreed that there is less feed waste with the improved feed trough and that it reduces feed contamination. They also strongly agreed that the improved feed trough is comfortable for the animals to eat from and that the benefits outweighs the costs in the long run. Nearly all the participating farmers agreed that they would invest in constructing the improved feed troughs in the near future. They also strongly agreed that the animals tend to eat more with the improved feed troughs which can be confirmed by less quantity of leftover compared to the traditional feed troughs. They disagreed strongly that the improved feed trough is only beneficial for households with high flock size and that it is difficult for women to use. These responses by the participating farmers confirm the benefits of the improved feed troughs which are consistent with our results. Farmers who are not involved in piloting the technology within and outside the three intervention communities have approached the project team to make request for the improved troughs.

Table 3: Response to the perceived benefits of the improved feed troughs compared to the traditional feed troughs across seasons by the participating farmers in the intervention communities

Late Dry season (March/April 2019)			
Statement	**Sirakele (Mode)**	**Zanzoni (Mode)**	**M'Pessoba (Mode)**
1. There is less feed waste with the improved feed trough compared to the traditional practice	5	5	5
2. The improved feed trough reduces feed contamination with sand, feces, urine etc.	5	5	5
3. The improved feed trough is comfortable for the animal to eat from	5	5	5
4. The benefit of the improved feed trough outweighs the cost	5	5	5
5. I will invest in constructing improved feed trough for my animals	4	5	5
6. The animals eat more with the improved feed trough	5	5	5
7. The improved feed trough increases time spent on feeding the animals	4	4	5
8. The improved feed trough is only beneficial to those who have many animals	2	2	2
9. The improved feed trough is difficult for women to use	1	1	1
10. The improved feed trough will last much longer than the traditional feed trough	4	3	3

Early Dry season (February 2020)			
Statement	**Sirakele (Mode)**	**Zanzoni (Mode)**	**M'Pessoba (Mode)**
1. There is less feed waste with the improved feed trough compared to the traditional practice	5	5	5
2. The improved feed trough reduces feed contamination with sand, feces, urine etc.	5	5	5
3. The improved feed trough is comfortable for the animal to eat from	5	5	5
4. The benefit of the improved feed trough outweighs the cost	5	5	5
5. I will invest in constructing improved feed trough for my animals	4	5	5
6. The animals eat more with the improved feed trough	5	5	5
7. The improved feed trough increases time spent on feeding the animals	4	4	5
8. The improved feed trough is only beneficial to those who have many animals	2	2	2
9. The improved feed trough is difficult for women to use	1	1	1
10. The improved feed trough will last much longer than the traditional feed trough	4	3	3

1= Completely disagree; 2= Disagree; 3=Neither disagree or agree; 4=Agree; 5=Completely agree

Conclusions

The main conclusions from the piloting of the use of the improved feed troughs in Sirakele, Zanzoni and M'Pessoba in Koutiala district in southern Mali in the late and early dry seasons are:

- The improved feed troughs reduced feed waste significantly in all the study communities. The percentage of waste in feeding crop residues to the animals using the traditional feed troughs were 7.73±0.92, 26.13±3.30, and 13.32±1.39 in Sirakele, Zanzoni and M'Pessoba, respectively in the late dry season compared to less than 1% with the improved feed troughs during the same season in Sirakele and M'Pessoba, respectively and 3.33% in Zanzoni which implies about 7%, 23% and 12% feed saved in Sirakele, Zanzoni and M'Pessoba, respectively. Similar trends were observed in the early dry season.
- Farmers spent slightly less time in feeding the animals with the improved feed troughs than using traditional feed troughs, but the differences were not significant in both seasons across communities.
- Significantly more feed was offered in the early dry seasons for both types of feed troughs than in the late dry season which is a reflection of availability of more feed resources particularly the crop residues.
- Male adults were largely responsible for feeding the animals in the three study communities in both seasons (late and early dry seasons) though female adults and boys were also involved.
- The participating farmers confirm the benefits of the improved feed troughs which are consistent with our results. Farmers who were not involved in piloting the technology have approached the project team to make request for the improved troughs.
- The construction of the improved troughs with local materials reduced the cost drastically from about 100,000 FCFA (USD 169) for feed troughs constructed with commercial materials to 15,000 FCFA (USD 25) which may facilitate adoption by resource-poor farmers.