

Efficient feed utilization across seasons through improved feed troughs for small ruminants in Northern Ghana

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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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Summary

The ad-hoc manner of feeding available feed resources to ruminants by 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 piloted in three Africa RISING project intervention communities in northern Ghana namely Duko and Tibali in Northern region; Gia in Upper East region. In the late dry season (March/April 2019) and wet season (September/October 2019) , 10 farmers were selected randomly from each community out of which at least three were women, all farmers were trained on the use of improved feed troughs made with commercial materials (plank and corrugated iron sheet) for small ruminants.

In the early dry season (February 2020), additional five farmers were selected randomly in each intervention community who were trained on the use of feed troughs constructed entirely with local materials (woods and with thatched roof). Hence, 30 farmers were involved in the study in the late dry and wet seasons whereas 45 farmers were involved in the early dry season. 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 which 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. Data collection on the use of improved feed troughs constructed with local materials was only conducted in the early dry season when the model was introduced. Data was also collected on the time spent in feeding the animals. Manure collected by the farmers was also measured only in the early dry season. 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 methods compared to improved feed troughs constructed with commercial materials showed that the improved feed troughs reduced feed waste significantly in all the three communities across all seasons.

The percentages of waste in feeding the animals using the traditional feed troughs were 35%, 22% and 27% in Duko, Gia and Tibali, respectively in the late dry season compared to less than 1% with the improved feed troughs during the same season, which implies about 34%, 21% and 26% feed saved in Duko, Gia and Tibali, respectively. Similar trends were observed in the wet and early dry seasons. The time spent in feeding the animals was almost halved with the improved feed troughs in the three communities in the late dry season and early dry season. The time spent feeding and percentage wastage were similar for both improved feed troughs which implies that feed troughs constructed with local materials are as good as those constructed with commercial materials despite the fact that the former were considerably cheaper (about Ghc 234) than the commercial ones (about Ghc 1,149). More manure were collected from improved feed troughs than from traditional feed troughs in Duko and Tibali in the early dry season. Male adults were largely responsible for feeding the animals in the three study communities across all seasons (late dry, wet 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 available feed resources by smallholder farmers is often characterized by waste as animals eat part, and trample and urinate on the rest. The extent of feed wastage may vary with the seasons, the type of feed and number of animals fed. 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 ILRI. Results from monitoring of the use of the improved feed troughs in four sites in Ethiopia showed that it 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 the 2 regions (Northern and Upper East) in northern Ghana. 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 the 2 regions in northern Ghana (Northern and Upper East regions). (ii) To build the capacity of smallholder livestock keepers in improved feeding systems to reduce waste and improve animal productivity.

Methodology

Ten farmers were selected randomly from each intervention community namely Duko and Tibali in Northern region and Gia in Upper East region out of which at least three were women who were trained in the use of improved feed troughs made with commercial materials (plank and corrugated iron sheet) for small ruminants. In the early dry season, 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. In the late dry season (March/April 2019) and wet season (September/October 2019), 30 farmers were involved in the data collection whereas 45 farmers were involved in the early dry season (February 2020) with the addition of the improved feed troughs constructed entirely with locally available materials (Table 1).

The average age (mean \pm standard error) of the 30 participating farmers were 50.30 ± 1.27 , 47.40 ± 1.30 and 47.00 ± 1.40 years in Duko, Gia and Tibali, respectively in the late dry and wet seasons. In the early dry season, the average age of the participating 45 farmers were 49.47 ± 1.03 , 48.20 ± 1.42 and 46.33 ± 1.07 years in Duko, Gia and Tibali, respectively. Each farmer was provided with one improved feed trough 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 while the improved feed troughs with locally available materials were constructed by each farmer. The model and pictures of the improved feed trough were presented to the participating farmers in the selected communities for their views on the design. Most of the farmers favoured construction of the troughs for their small ruminants as many of them don't own cattle. Each improved feed trough with commercial materials for sheep and goats was constructed at a cost of about Ghc 1,149 (USD 194) whereas the improved feed troughs made with locally available materials cost about Ghc 234 (about USD 39). The improved feed troughs constructed with commercial and local materials 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 Tibali and Duko in Northern Region, and in Gia in Upper East Region across late dry, wet and early dry seasons. Data collection on the use of improved feed troughs constructed with local materials was only conducted in the early dry season when the model was introduced. The amount of time spent in feeding the animals (bringing back dispersed feed, keeping animals to feed comfortably) was recorded. Manure collected by the farmers during the data collection period was also measured in the early dry season. Most of the feedstuffs offered were crop residues which varied with seasons. In the late dry seasons, feed resources offered were groundnut haulms and pigeon pea residues. The same crop residues were offered in the early dry season in addition with yam peels. In the wet season, maize straw (chopped or non-chopped) and groundnut haulms along with grasses such as dasho and itch grasses were offered. Data collection was conducted in March and April 2019 in the late dry season. For the wet and early dry seasons, the data collection was carried out in September/October 2019 and February 2020, respectively.

A survey questionnaire was also administered to all participating farmers to document their opinions about the benefits of the technology to efficient feeding systems. Modifications made by the farmers to the improved feed troughs were also monitored. Feed samples from

the feed offered and leftovers were collected in the wet season and were analyzed using NIRS technique for dry matter, ash, nitrogen, fiber (Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL), Metabolizable Energy (ME) and *in vitro* Organic Matter Digestibility. 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 $P < 0.05$.

Table 1. Number of beneficiary farmers in the intervention communities

Community	Improved Feed trough – Commercial materials		Improved Feed trough – Local materials		Total
	Male	Female	Male	Female	
Duko, Northern region	5	5	3	2	15
Gia, Upper East region	5	5	3	2	15
Tibali, Northern region	7	3	4	1	15

Training of farmers in efficient feed utilization using improved feed troughs

Following the construction of the improved feed troughs, training was conducted for the beneficiaries in Tibali and Duko on the 17th January 2019 and 2nd and 3rd January, 2019, respectively while the training of farmers in Gia took place in March, 2019. The farmers were trained to mount the trough at a suitable location that is dry ground with sufficient shade. The farmers, on their own accord, provided fencing around the structure to keep out stray animals during feeding. Twenty-nine youths from Youth Empowerment for Life (YEfL) NGO, Tamale also participated in the training in Tibali. The involvement of the Youth group in the training is to explore the employment opportunity that the construction of improved feed troughs for farmers in villages outside Africa RISING project. For the local artisan engaged for the construction of the improved troughs it is an income generating activity for him as interested farmers are directed to him. The breakdown of those trained is presented in Table 2 below.

Table 2. Breakdown of those trained in design and use of improved feed troughs

Category	Male	Female	Total
<i>Duko (beneficiary farmers)</i>	5	5	10
<i>Duko (other farmers)</i>	10	0	10
<i>Tibali (beneficiary farmers)</i>	7	3	10
<i>Youth Empowerment for life (Tibali)</i>	19	10	29
<i>Gia (beneficiary farmers)</i>	5	5	10
<i>Grand Total</i>	46	23	69



Picture 1. Members of Youth Empowerment for life (YEfL) and farmers observing construction of feed trough in Tibali. Photo credit: Sadat Salifu.CSIAR-ARI.



Picture 2. A newly constructed improved feed trough with commercial materials in Tibali. Photo credit: Augustine Ayantunde/ILRI.



Picture 3. Improved feed trough constructed with locally available materials in Duko.
Photo credit: Augustine Ayantunde/ILRI.

Results and discussion

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 constructed with commercial materials (Table 3) showed that the improved feed troughs reduced feed waste significantly in all the three communities (Duko and Tibali in Northern Region, and Gia in Upper East region) across all seasons (late dry, wet 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 was about 35%, 22% and 27% in Duko, Gia and Tibali, respectively in the late dry season compared to less than 1% with the improved feed troughs during the same season, which implies about 34%, 21% and 26% feed saved in Duko, Gia and Tibali, respectively (Table 3). Similar trends were observed in the wet and early dry seasons. Across communities, the feed wastage was significantly lower in Gia than in Duko and Tibali. 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 less time in feeding the animals with the improved feed troughs as they did not have to spend time to gather the dispersed feedstuffs as with the use of the traditional feed troughs across all seasons (Table 3). The time spent in feeding the animals was almost halved with the improved feed troughs in the three communities in the late dry season and early dry season but the difference in time spent feeding the animals between the traditional and improved feed troughs in the wet season was lower than in the other two seasons (Table 3).

Table 3. Comparison of the use of the traditional and improved feed troughs (commercial materials) for small ruminants in Duko and Tibali, Northern region, and in Gia, Upper East Region, Ghana across seasons

Late dry season (March/April 2019)						
Variable	Duko		Gia		Tibali	
	Traditional	Improved	Traditional	Improved	Traditional	Improved
Time spent feeding (min/day)	22.42±1.77 ^a	13.00±1.23 ^b	11.78±0.42 ^a	5.60±0.13 ^b	14.00±0.84 ^a	6.83±0.41 ^b
Number of animals	3.50±0.16 ^a	4.10±0.14 ^a	4.99±0.10 ^a	5.10±0.04 ^a	3.90±0.15 ^a	4.32±0.13 ^a
Quantity of feed offered (g/day)	2175±87.67 ^a	2213.33±70.57 ^a	1498.50±30.35 ^a	1530±11.72 ^a	2340±88.72 ^a	2532.20±76.85 ^a
Quantity wasted (g/day)	767±45.30 ^a	10.45±2.04 ^a ^b	336.68±14.17 ^a	4.83±1.74 ^b	625.78±49.17 ^a	10.63±2.25 ^b
% of feed wasted	35.26±1.84 ^a	0.47±0.09 ^b	22.47±1.85 ^a	0.32±0.11 ^b	26.74±1.67 ^a	0.42±0.09 ^b
Wet season (Sept/Oct 2019)						
Variable	Duko		Gia		Tibali	
	Traditional	Improved	Traditional	Improved	Traditional	Improved
Time spent feeding (min/day)	30.30±1.77 ^a	19.22±0.73 ^b	15.90±0.71 ^a	17.53±0.45 ^a	27.85±0.73 ^a	20.78±0.82 ^b
Number of animals	3.50±0.17 ^a	3.50±0.16 ^a	4.70±0.08 ^a	4.90±0.04 ^a	4.70±0.08 ^a	4.98±0.02 ^a
Quantity of feed offered (g/day)	2155±94.19 ^a	2100±94.06 ^a	2820±50.02 ^a	2940±23.43 ^a	2880±46.87 ^a	3004.63±41.68 ^a
Quantity wasted (g/day)	660.67±55.98 ^a	92.33±16.59 ^b	594.67±31.29 ^a	16.00±6.14 ^b	1071.15±62.06 ^a	132.40±31.94 ^b
% of feed wasted	30.66±1.91 ^a	4.40±0.79 ^b	21.09±1.31 ^a	0.54±0.22 ^b	37.19±2.04 ^a	4.41±1.06 ^b
Early dry season (February 2020)						
Variable	Duko		Gia		Tibali	
	Traditional	Improved	Traditional	Improved	Traditional	Improved
Time spent feeding (min/day)	28.88±1.00 ^a	14.08±0.43 ^b	25.55±0.86 ^a	15.08±0.49 ^b	27.85±±0.72 ^a	17.50±0.47 ^b
Number of animals	3.70±0.15 ^a	3.70±0.15 ^a	4.60±0.09 ^a	4.60±0.09 ^a	5.20±0.08 ^a	5.20±0.08 ^a
Quantity of feed offered (g/day)	2220±92.75 ^a	2220±92.75 ^a	2760±51.81 ^a	2760±51.81 ^a	3120±46.86 ^a	3120±46.86 ^a
Quantity wasted (g/day)	723.08±31.55 ^a	1.54±0.02 ^b	521.59±24.42 ^a	2.34±0.065 ^b	899.50±30.29 ^a	1.83±0.23 ^b
% of feed wasted	32.57±2.29 ^a	0.07±0.01 ^b	18.90±1.13 ^a	0.08±0.03 ^b	28.83±1.04 ^a	0.06±±0.01 ^b

From the interview of the participating farmers on how the time gained was spent, the farmers in the Northern region intervention communities (Duko and Tibali) spent the extra time saved on their primary activity i.e. farming or trading (in the case of women in Duko who cook food for sale or process rice). Farmers in Gia, Upper East region spent the time saved in their vegetable gardens. For the households where male children have to feed the animals or take them to grazing (in the rainy season), the children did not have to take animals to graze in the evenings because of availability of more feed through reduction in wastage with the use of improved feed troughs.

Comparison of the traditional and improved feed troughs constructed with commercial and local materials in the early dry season

In an attempt to ensure an affordable improved feed trough as those constructed with commercial materials are relatively expensive for many farmers, another model of the improved feed trough was constructed using locally available materials in the early dry season. Data was then collected on the use of two types of improved feed troughs along with the traditional feed troughs in the early dry season. The results are presented in Table 4. The time spent feeding the animals reduced significantly with the use of both improved feed troughs constructed with commercial and local materials when compared with the traditional feed troughs in all the three intervention communities. The time spent feeding the animals was almost halved. Feed wastage was reduced by both improved feed troughs when compared to the traditional feed troughs by between 18 and 31%. The results of time spent feeding and percentage wastage were similar for both improved feed troughs which mean that feed troughs constructed with local materials were as good as those constructed with commercial materials despite the fact that the former were considerably cheaper than the commercial ones. However, the improved feed troughs constructed with commercial materials can last longer (at least 5 years) than those constructed with the local materials which may not last for more than 3 years. The results suggest that feed efficiency can be significantly improved using the feed troughs constructed with locally available materials at a relatively low cost which can facilitate adoption by the resource-poor households. This is already the case in Duko where two farmers constructed the improved feed troughs with local materials on their own. To facilitate adoption of improved feed troughs with local materials, the model has been shared with the NGO Heifer International, Tamale and with the Livestock Development officers of Northern Region and Kassena Nankana district.

Table 4. Comparison of the use of the traditional, improved feed troughs with commercial materials and improved feed troughs with local materials for small ruminants in Duko and Tibali, Northern region, and in Gia, Upper East Region, Ghana in early dry season (February 2020)

Duko			
Variable	Traditional (n=15)	Commercial materials (n=10)	Local materials (n=5)
Time spent feeding (min/day)	27.50±0.82 ^a	14.08±0.43 ^b	13.27±0.54 ^b
Number of animals	3.55±0.13 ^a	3.70±0.15 ^a	3.20±0.22 ^a
Quantity of feed offered (g/day)	2120±76.55 ^a	2220±92.75 ^a	1920±129.93 ^a
Quantity wasted (g/day)	689.56±32.41 ^a	1.54±0.02 ^b	13.33±8.04 ^b
% of feed wasted	32.53±1.77 ^a	0.07±0.01 ^b	0.69±0.31 ^b
Gia			
Variable	Traditional (n=15)	Commercial materials (n=10)	Local materials (n=5)
Time spent feeding (min/day)	27.77±0.90 ^a	15.08±0.49 ^b	13.03±0.61 ^b
Number of animals	4.07±0.12 ^a	4.60±0.09 ^a	3.00±0.20 ^b
Quantity of feed offered (g/day)	2440±71.45 ^a	2760±51.81 ^a	1800±122.05 ^b
Quantity wasted (g/day)	448.94±25.43 ^a	2.34±0.06 ^b	6.00±0.32 ^b
% of feed wasted	18.40±1.30 ^a	0.08±0.03 ^b	0.33±0.16 ^b
Tibali			
Variable	Traditional (n=15)	Commercial materials (n=10)	Local materials (n=5)
Time spent feeding (min/day)	31.53±1.08 ^a	17.50±0.47 ^b	17.70±0.81 ^b
Number of animals	5.13±0.05 ^a	5.20±0.08 ^a	5.00±0.24 ^a
Quantity of feed offered (g/day)	3080±31.73 ^a	3120±46.86 ^a	3000±50 ^a
Quantity wasted (g/day)	885.78±28.03 ^a	1.83±0.23 ^b	2.41±0.02 ^b
% of feed wasted	28.76±0.95 ^a	0.06±0.01 ^b	0.08±0.02 ^b

Manure collected using different feed troughs in the early dry season

The results of manure collected using traditional and improved feed troughs in the three intervention communities are present in Table 5. Significantly ($P < 0.05$) more manure was collected from improved feed troughs than from traditional feed troughs in Duko and Tibali whereas there was no significant difference in the quantity of manure collected in Gia between the traditional and improved feed troughs. In both Duko and Tibali, the quantity of manure collected from improved feed troughs constructed with commercial materials doubled the quantity collected from animals using the traditional troughs. In all communities, the manure quantity collected from animals using improved feed troughs was the highest. Unlike the traditional troughs which are small and often placed anywhere, the improved feed troughs allow for the animals to be concentrated in the same area as they eat from the troughs which implies that the manure is deposited around the feed troughs and generally easy to collect. Lack of significant difference in the quantity of manure collected in Gia from different feed troughs could partly be attributed to non-fencing of the improved feed troughs which implies that fecal outputs were deposited by the animals outside the area of the feed troughs and might not have been collected. The improved feed troughs are fenced in Duko and Tibali which enhanced collection of more manure.

Table 5. Manure collected from the use of the traditional, improved feed troughs with commercial materials and improved feed troughs with local materials for small ruminants in Duko and Tibali, Northern region, and in Gia, Upper East Region, Ghana in early dry season (February 2020)

Duko			
Variable	Traditional (n=15)	Commercial materials (n=10)	Local materials (n=5)
Manure g DM/day	52.25±4.85 ^a	136.00±28.25 ^b	82.47±22.09 ^{ab}
Manure g DM/animal/day	14.72±1.34 ^a	36.76±5.42 ^b	25.77±5.84 ^{ab}
Gia			
Variable	Traditional (n=15)	Commercial materials (n=10)	Local materials (n=5)
Manure g DM/day	52.37±5.17 ^a	56.81±6.82 ^a	47.37±12.17 ^a
Manure g DM/animal/day	12.87±2.12 ^a	12.35±2.19 ^a	15.79±3.85 ^a
Tibali			
Variable	Traditional (n=15)	Commercial materials (n=10)	Local materials (n=5)
Manure g DM/day	73.74±2.08 ^a	180.81±31.47 ^b	160.14±23.95 ^b
Manure g DM/animal/day	14.37±0.98 ^a	34.77±6.21 ^b	32.03±4.67 ^b

Quality of the feed offered to the animals in the wet season

From the analysis of the samples of feed offered to the animals with different feed troughs in the three intervention communities in the wet season, groundnut haulms had the higher nitrogen content and *in vitro* organic matter digestibility than all other feed types (Table 6). This is expected as legume residues are generally of better nutritional values than cereal straws and grasses as our results showed (Table 6). Other feed types offered to the animals using different feed troughs were maize straw, desho grass (*Pennisetum pedicellatum*) and itch grass (*Rottboellia conchinchinensis*).

Table 6. Chemical composition of feeds offered to small ruminants using the traditional and improved feed troughs in the wet season (September/October 2019) in Northern Ghana

Village	Feed type	Dry matter (%)	Ash (%)	Nitrogen (%)	NDF (%)	ADF (%)	ADL (%)	Metabolizable energy (MJ/kg DM)	<i>In Vitro</i> Organic Matter Digestibility (%)
Duko	Maize straw (green)	93.21	14.98	2.27	60.38	36.06	2.92	7.49	53.69
Duko	<i>Pennisetum pedicellatum</i> (desho grass)	93.69	11.73	1.39	68.17	44.55	4.41	6.91	47.72
Duko	<i>Rottboellia conchinchinensis</i> (itch grass)	92.80	13.93	2.08	63.05	37.74	3.14	7.67	54.83
Gia	Groundnut haulms	92.26	9.41	2.32	44.41	31.65	7.42	8.61	59.29
Gia	<i>Rottboellia conchinchinensis</i> (itch grass)	92.90	12.31	1.47	66.44	43.64	3.94	6.84	47.56
Tibali	Maize straw (green)	92.55	13.45	2.24	60.22	35.35	3.50	7.56	53.81
Tibali	<i>Pennisetum pedicellatum</i> (desho grass)	93.36	11.74	1.30	68.51	45.34	4.80	6.80	46.97
Tibali	<i>Rottboellia conchinchinensis</i> (itch grass)	93.25	11.98	1.73	65.99	41.17	3.49	7.09	49.76

Gender group in feeding animals with different feed troughs across seasons

The results further showed that male adults were largely responsible for feeding the animals in the three study communities (Figure 1a, b, c) in all seasons (late dry, wet and early dry seasons). Female adults were more involved in feeding the animals in Gia than in the other communities. The boys tended to be more involved in feeding the animals during the wet season in all communities than in other seasons. This could be due to the fact that students are not generally in school during the wet season as it corresponds with holiday period and the boys were therefore available to help their parents in feeding the animals. 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.

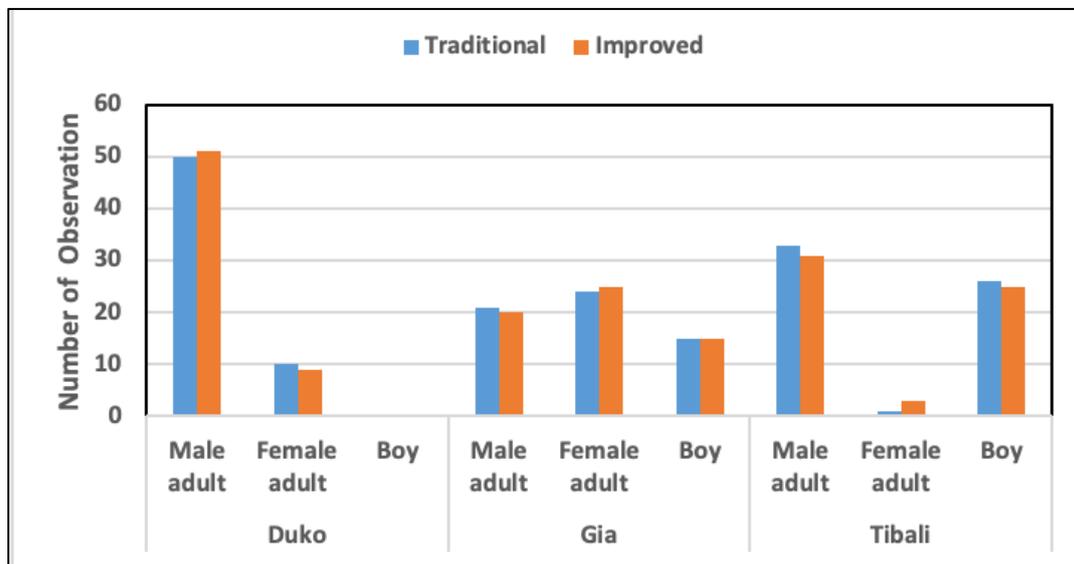


Figure 1a. Feeding of the small ruminants traditional and improved feed troughs by different gender groups in the intervention communities in the late dry season (March/April 2019).

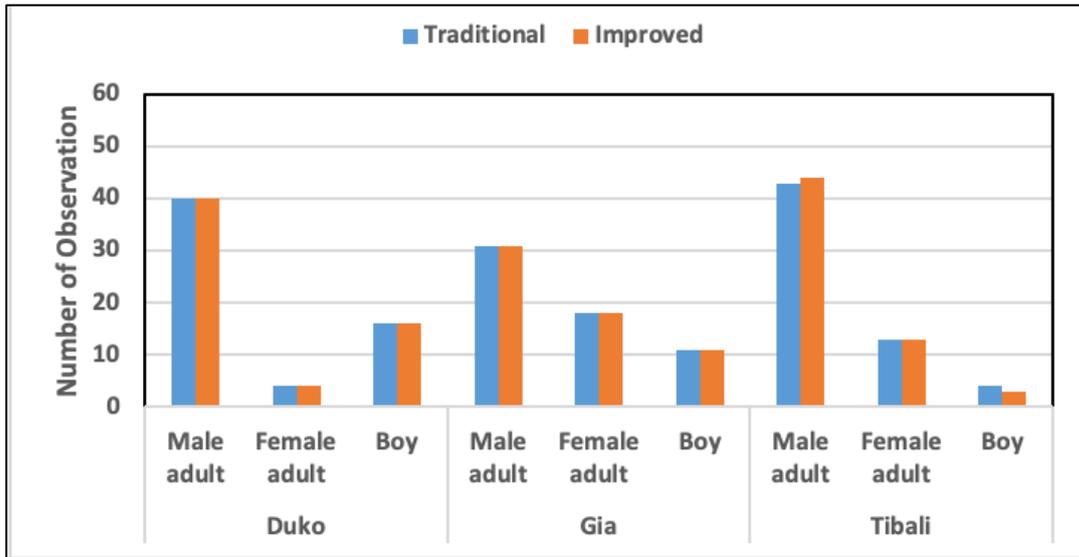


Figure 1b. Feeding of the small ruminants traditional and improved feed troughs by different gender groups in the intervention communities in the wet season (Sept/Oct 2019).

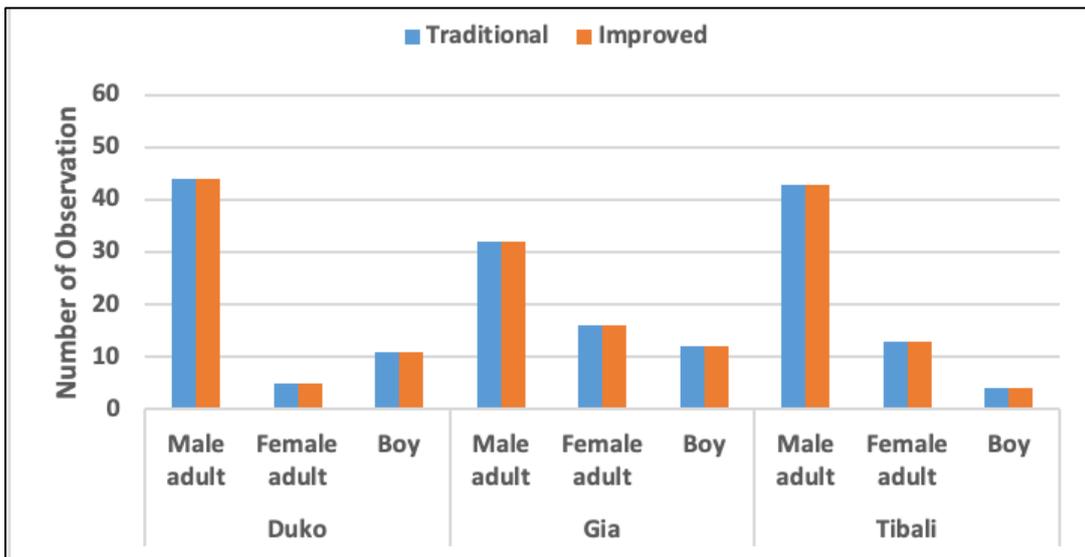


Figure 1c. Feeding of the small ruminants traditional and improved feed troughs by different gender groups in the intervention communities in the early dry season (February 2020).

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 7 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 benefit outweighs the cost 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 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. Consequently, some of them were included in the training on the design and use of the improved feed troughs in Duko. The likelihood for adoption is expected to increase with the construction of the improved feed troughs with locally available materials which cost about Ghc 234.

Table 7. Response to the perceived benefit of the improved feed troughs compared to the traditional feed troughs across seasons (1= Completely disagree; 2= Disagree; 3=Neither disagree or agree; 4=Agree; 5=Completely agree) by the participating farmers in the intervention communities.

Statement	Duko (Mode)	Tibali (Mode)	Gia (Mode)
<i>Late Dry season (March/April 2019)</i>			
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	4	4
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	2	1	1
8. The improved feed trough is only beneficial to those who have many animals	1	1	1
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	5	5	5
<i>Wet season (September/October 2019)</i>			
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	4	4
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	2	1	1
8. The improved feed trough is only beneficial to those who have many animals	1	1	1
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	5	5	5
<i>Early Dry season (February 2020)</i>			
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

Statement	Duko (Mode)	Tibali (Mode)	Gia (Mode)
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	4
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	1	1	1
8. The improved feed trough is only beneficial to those who have many animals	1	1	1
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	5	5	5

Conclusions

The main conclusions from the piloting of the use of the improved feed troughs in Duko and Tibali, Northern region, and in Gia, Upper East Region in the late dry, wet and early dry seasons are:

- The improved feed troughs reduced waste significantly in all the study communities. The percentage of waste in feeding crop residues using the traditional feed troughs was about 35%, 22% and 27% in Duko, Gia and Tibali, respectively in the late dry season compared to less than 1% with the improved feed troughs during the same season, which implies about 34%, 21% and 26% feed saved in Duko, Gia and Tibali, respectively. Similar trends were observed in the wet and early dry seasons.
- The time spent in feeding the animals was almost halved with the improved feed troughs in the 3 communities in the late dry season and early dry season but the differences in time spent feeding the animals between the traditional and improved feed troughs in the wet season was lower than in the other two seasons.
- The time spent feeding and percentage wastage were similar for both improved feed troughs which implies that feed troughs constructed with local materials are as good as those constructed with commercial materials despite the fact that the former were considerably cheaper (about Ghc 234) than the commercial ones (about Ghc 1,149). The results suggest that feed efficiency can be significantly improved using the feed troughs constructed with locally available materials at a relatively low cost which can facilitate adoption by the resource-poor households.
- In the early dry season, more manure was collected from improved feed troughs than from traditional feed troughs in Duko and Tibali whereas there was no significant difference in the quantity of manure collected in Gia between the traditional and improved feed troughs. In both Duko and Tibali, the quantity of manure collected from improved feed troughs constructed with commercial materials doubled the quantity collected from animals using the traditional troughs.
- Male adults were largely responsible for feeding the animals in the three study communities across all seasons (late dry, wet 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 can be an income generating activity for the youth as demonstrated by the enthusiasm of members of Youth Empowerment for Life who participated in the training on the design and use of the improved feed troughs in January 2019.
- To facilitate adoption of improved feed troughs with local materials, the model has been shared with the NGO Heifer International, Tamale and with the Livestock Development officers of Northern Region and Kassena Nankana district.