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Crop Residue Production, Utilization and Constraints to its Utilization for Livestock Feeding in Adami-Tulu District, Ethiopia

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ABSTRACT A survey involving 100 households was conducted in Adami Tulu district of Ethiopia to investigate the extent of crop residue production, utilization and socio-economic limitations facing their utilization for livestock feeding. The results indicated that although large amounts of crop residues are annually produced and are mainly used for livestock feeding, their full and efficient utilization was hindered partly by economic problems and partly by inadequate know-how of the farmers as to the handling and processing of the residues. Strengthening the financial capabilities of farmers through credit systems and training them in the proper methods of handling and processing of their residues are highly recommended.

INTRODUCTION

Within tropical systems, Africa is second to Asia in crop residue production with a total production of 2.2 tons of dry matter per livestock unit of herbivores (Kossila, 1985). In Ethiopia, it is estimated that a total of 13 million tons of crop residues are annually produced (Seyoum and Zinash, 1998).

Crop residues are among the most widely available, low-cost feeds for ruminants in the majority of developing countries (Smith, 1993). In industrialized countries, the contribution of straws rarely exceeds 20 to 40 per cent of the diet, the rest of the ration being cereal grains, highly-fertilized grasses and legumes and oil seed cakes (Preston, 1986). In mixed crop-livestock farming systems, livestock provide important inputs to cropping, especially manure and traction whereas, crops in turn provide livestock with feed in the form of residues and by-products (ILCA, 1992). Where crop and livestock production are segregated, most crop residues are wasted or used for non-feed purposes like bedding, mulching, firewood and building material (Kossila, 1988).

In spite of the fact that large quantities of fibrous crop residues are used as animal feeds in many developing countries (Kossila, 1988), there are certain constraints to their efficient utilization. Kossila (1985) stated that a much lower level of crop residue utilization is possible because of problems of collection, transportation, storage, processing, alternative use, seasonal availability and an apparently poor nutritional value. The bulky nature of straws/stovers makes it difficult and costly to transport them thus inhibiting their greater and efficient utilization for livestock feeding. Owen and Aboud (1988) cited the risk of loss due to fire and reduction in nutritive value due to molding and damage by vermin and insects as the major problems associated with the storage of crop residues.

In Ethiopia in general and Adami Tulu district in particular, information on the quantity of crop residues that is annually produced, the extent of their utilization and constraints related to their utilization is scanty. A study on these aspects of crop residues is essential as it will form a springboard for future research and management programs that will lead to the efficient utilization of these feed sources. Accordingly this study was initiated to assess and document the extent of crop residue production, utilization and the possible limitations facing their utilization for livestock feeding.

METHODOLOGY

This study was carried out at two agricultural development sites in Adami Tulu district, located in the middle rift valley at an altitude of 1600 to 1650 meters above sea level and a distance of about 160 km south of Addis Ababa along the Addis Ababa-Moyale high way. The district has a semi-arid climate with a mean annual rainfall of 763.7 mm. The mean annual maximum and minimum temperatures are 27.2°C and 12.7°C, respectively.

Information regarding crop residue production, utilization and constraints were retrieved by interviewing 100 households using structured questionnaire. The total households in the selected sites were stratified into four strata according to their farm size, and a proportional number of households were systematically selected from each stratum.

To estimate the potential annual crop residue production, grain yield figures obtained from the sampled households during the 1995/96 and 1996/97 cropping seasons were converted to crop residue yields using 3, 2 and 1.5 as multipliers for maize, wheat and barley, respectively as suggested by Kossila (1988). For teff and haricot bean, a grain to residue ratios of 1:3 and 1:1, respectively, were used (Tesfaye, 1999).

Finally, the data were analysed using the SPSS (Statistical Package for Social Sciences) software programme. Descriptive statistics (frequency distribution and tabulations) were employed to describe the different parameters.

RESULTS AND DISCUSSION

Crop Residue Production

The types of crop and the estimated amounts of their residues produced in the study area during the 1995/96 and 1996/97 cropping seasons are given in table 1. In both years, maize stover, teff straw and haricot bean haulms were abundantly produced, their estimated production being 197.8, 25.8 and 21.7 tons dry matter (DM) for the year 1995/96, and 336.7, 48.8 and 36.9 tons DM for the year 1996/97, respectively. The higher total crop residue production in the year 1996/97 compared to the year 1995/96 was attributed to the higher annual rainfall during that year which favoured both the crop and their residue production.

Table 1: Area cropped (ha) and estimated crop residue production (ton DM) in the study area

Crop type	*1995/96*		*1996/97*	
	Area[1]	*Residue production*[2]	*Area*[1]	*Residue production*[2]
Maize	111.9 (100)	197.8	115.3 (100)	336.7
Tef	31.7 (67)	25.8	34.2 (74)	48.8
H. bean	39.4 (79)	21.7	38.4 (78)	36.9
Wheat	12.9 (36)	12.8	17.1 (42)	27.5
Sorghum	3.8 (14)	5.0	3.9 (17)	13.2
Barley	8.8 (30)	8.5	10.0 (33)	14.0
Total	208.4	271.5	218.9	477.2

1 Figures in parenthesis are percentages of households who grew that particular crop
2 Calculated on the basis of 94% DM

Taking the average of the two years and assuming an average effective use of 60 per cent, the estimated annual crop residue production by the sampled households was about 0.8 tons DM per Tropical Livestock Unit (TLU). Kossila (1985) reported a production of 0.6 ton DM per TLU per annum for the whole country. The figures in the current study seem to have been exaggerated, since: (1) the grain yield data were purely based on farmers estimation which might have been overestimated, (2) there was unavoidable wastage during collection and feeding, (3) there could be problem of accurate reporting as farmers might have forgotten the figures from 1995-97 and (4) the residues were also used for purposes other than livestock feeding. Moreover, it was possible that most of the sampled households could be those who had fever animals as sampling was based on farm size. It cannot be concluded, therefore, that all the potential production was used for livestock feeding. The production figures, are nevertheless, useful because they indicate the types and amount of crop residues that can be produced in the district.

CROP RESIDUE UTILIZATION

The different uses to which the crop residues produced in the study area were put are given table 2. All the available types of residues were used for livestock feeding. This is likely because of the acute feed shortage in the area. Only maize and sorghum stovers were used as fuel mainly because of their woody nature. For similar reasons, they were also used for construction of house walls and roofs, and grain storage barrels. The role of teff straw and, in rare cases, wheat straw in construction consists in their use, together with mud, as binding materials for walls of local houses and barrels. Second to cattle feeding, wheat and barley straws are used as a filling material in making local mattresses.

Wheat straw used relatively less for livestock

feeding because of the health problem that it causes. Ninety five per cent of the households growing wheat reported that the straw is poor in feeding value and causes health problem to cattle. However, scientific reasoning for this is not available, except that Mcdonald et al. (1995) found wheat straw to be so poor in nutritional value (unless alkali treated) that its usage as a feed for farm animals is not recommended.

of transportation by the majority of farmers is that most of the crop residues are wasted as some of the farmers are also unable to hire donkeys and carts. Out of about 90 per cent of the households who reported to have had wastage of maize and sorghum stovers, 91 and 84 per cent, respectively attributed the wastage to their inability to collect the residues (Table 4). For all other types of residues, improper storage was reported to

Table 2: Crop by-product utilization by the sampled households

Residue type[1]	*Crop by-product usage*[2]					*Total No. of uses out of 5*	*Relative importance value (%)*[3]
	Animal feed	*Construction*	*Fuel*	*Sale*	*Mattress making*		
MS	69	96	95	3	–	4	80
TS	86	34	–	6	–	3	60
HBH	88	–	–	–	–	1	20
WS	44	52	–	10	9	4	80
SS	63	61	50	–	–	3	60
BS	58	–	–	10	7	3	60
No. of residues used	6	4	2	4	2		

1 MS = Maize stover, TS = Teff straw, HBH = Haricot bean haulms, WS = Wheat straw, SS = Sorghum stover, BS = Barley straw.
2 Numbers under each usage indicate percentage of households using the crop residue for that use
3 Total No. of uses of residue as per cent of overall number of uses (5 in this case)

Constraints to Crop Residue Utilization

The major constraints related to crop residue utilization, especially for livestock feeding, are collection, transportation, storage and feeding. Table 3 shows the percentage of households who reported to have these problems.

Table 3: Distribution of households (h/hs) according to problems associated with each crop residues

Residue type	*Per cent of households having*		
	Coll. & Trans. problem	*Storage problem*	*Feeding problem*
MS	98	75	81
HBH	88	71	2
TS	73	33	5
WS	77	73	81
BS	73	59	0
SS	100	60	87

Collection and Transportation Problems

In the study area, it was found that only 44 per cent of the sampled households had their own donkeys and donkey cart to transport their crop residues. The consequence of lack of this means

have been the major cause of wastage. Besides, a certain proportion of crop residues like wheat straw, haricot bean haulms and sorghum stover is also wasted as these residues are not needed by some farmers for livestock feeding.

With regard to crop residue wastage, Thairu and Tessema (1987) stated that a small part of the thousands of tons of crop residues available in the crop-land of Kenya are used as feed due to the difficulties of collection, transportation and storage. Sibanda (1986) reported that farmers who do not collect their stover, but leave it in the field, could possibly lose half of its value through trampling by animals. In the present study, though it was not possible to estimate the actual loss of crop by-products due to various factors, the loss, particularly of maize and sorghum stovers, could be very high as most of the farmers were not able to collect these residues but used them *in situ*.

More than 70 per cent of the sampled households stated that they had problems in collecting and transporting all their crops and crop residues from the fields to homesteads (Table 3). The

major problems were labour, capital, lack of donkey and donkey cart, and distance. Forty per cent of the sampled households were identified as having no donkey and donkey cart and 35 per cent as having labour and financial constraints to transport their crop residues. The distance from the fields to homesteads was a problem of a few (12%) farmers. The maximum distance reported was about 5 km.

Table 4: Distribution of households according to causes of crop residue wastage

Residue	*% of h/hs whose wastage cause was:*		
type	*Inability to collect*	*Improper storage*	*Residue not needed*
MS	91	8	1
HBH	39	53	8
TS	15	85	–
WS	13	48	39
BS	11	86	3
SS	84	6	10

Storage and its Problems

The storage of crop residues is undertaken either by stacking it in the open air near homesteads or in shelters. It was found that the majority of the sampled households (64 and 81% for maize and sorghum stovers, respectively) did not store these residues. They rather feed them *in situ* (Table 5) as storage demands transportation of the residue from the field to the storage sites. In all other crop by-products, stacking in the open air near homesteads was found to be the dominant method of storage as evidenced by more than 50 per cent of the sampled households.

Storage, as a problem, was reported by as few as 33 and as many as 75 per cent (Table 3) of the households for teff straw and maize stover, respectively. The major problems were mould and termites. Generally the former plays an important role accounting for most of the storage problems of almost all types of crop residues. This is likely because most of the residues stacked in the open air are exposed to moist conditions.

Feeding and Its Problems

Table 5 indicates the percentage of households employing the different strategies of feeding crop residues. About 66 per cent of the respondents pointed out that they graze their animals on maize and sorghum stovers *in situ* after the ears are removed. This is in agreement with the work of Kabatange and Kitalyi (1989) in which, for 61 per cent of the respondents, they found grazing in the crop fields after grain harvest to be the most common method of availing crop residues to livestock. All other crop residues were mostly stacked near homesteads after threshing and fed in stall. As can be seen from the table, some respondents stated that they also allow their animals to feed on the crop residues like haricot bean haulms, wheat straw, sorghum stover and barley straw directly from threshing grounds.

Table 5: Percentage of households employing different strategies of feeding crop residues

Residue	*Percent of households*			
type	*Employing in situ*	*Employing stall feeding*	*Feeding from threshing ground*	*Not using at all*
MS	67	33	–	–
HBH	–	54	43	3
TS	–	100	–	–
WS	–	57	16	27
BS	–	97	3	–
SS	66	17	17	–

Problems associated with feeding of crop residues result mainly from improper feeding practices, or are caused by the physical nature of the residues. Both *in situ* grazing and feeding from threshed residue upon the ground are regarded as improper feeding practices in the sense that they result in inefficient utilization of the residues as a result of the trampling effect of animals, and the spoilage by their dung and urine. In investigating the role of crop residues in intensive smallholder system in the tropics, Smith (1993) reported that when left on the field, crop residues rapidly deteriorate, and a large amount is usually trampled upon and wasted.

Physical nature of residues as a feeding problem is evident mostly in maize and sorghum stovers. These residues are hard and stemy so that, animals prefer the finer parts thus causing significant losses of the residues. About 98 per cent of the respondents reported the prevalence of this feeding problem for maize and sorghum

stovers. Another crop residue reported to have a feeding problem is wheat straw. According to the farmers' belief, it causes animal health disorders when fed, especially during the wet seasons. This is the reason why 27 per cent of the respondents stated that they do not use this residue for livestock feeding (Table 5).

In addition to the above-mentioned constraints, crop residues have also nutritional problems limiting their efficient utilization for livestock feeding. All farmers knew that crop residues are poor in their nutritive value; however, almost none of them treated their residues, either physically, (except the inevitable threshing of cereals like teff, barley, wheat and haricot bean), or chemically or used supplementary feeds to amend the feeding value of their crop residues. Only 19 and 8 per cent of the households revealed that they crop and thresh, respectively, their maize stover compared with 5 and 3 per cent in the case of sorghum stover.

Constraints to Improving the Nutritional Quality of Crop Residues

Regarding the constraints farmers face in treating their crop residues and in using supplements to improve the nutritional status of crop residues, the major ones were labour for physical treatment, and lack of know-how for all other improvement strategies (Table 6). The other major constraints were lack of finance for physical treatment and lack of access to chemical treatment and concentrate supplementation. Planting leguminous plants such as *leucaena* and *sesbania* species to be used as supplements in crop residue feeding systems was the only improvement strategy constrained by the scarcity of land. The farm size distribution in the study sites indicated that about 60 per cent of the sampled households own 2 and less hectares of cropping land. This is hardly enough to grow subsistence crops let alone forage plants for supplementing crop residues.

Table 6: Percentage of households facing constraints in using methods of improving the nutritional status of crop residues

Constraint	*Per cent of h/hs facing constraints to use*			
	Physical treatment	*Chemical treatment*	*Concentrate supplement*	*Legume supplement*
Finance	26	1	1	–
Labour	73	–	–	–
Access	–	14	46	4
Know-how	1	85	53	69
Land	–	–	–	27

With regard to crop residue treatment, Smith (1993) listed chopping, grinding, ensiling with urea or animal manure, and ammoniation using urea as the most appropriate methods of improving the feed value of crop residues at the smallholder level. This study, however, revealed that under current condition where farmers are constrained by lack of finance and know-how, none of these methods were applied.

CONCLUSIONS AND RECOMMENDATIONS

This study revealed that although crop residues are produced in large amounts in the study area, their full and efficient utilization for livestock feeding was hindered by economic problems and by inadequate know-how of the farmers as to the handling and processing of the residues. As a result, a significant wastage of these valuable feed sources was evident in the area. Most of the residues are also put to other uses although they are primarily used for livestock feeding.

The study also indicated that almost none of the interviewed farmers practised any of the methods known to improve the feeding value crop residues. The major bottlenecks for the failure to apply these strategies were inadequate knowledge about the methods, lack of finance and accessibility to the methods. In this regard, strengthening the financial capabilities of farmers through credit systems and training them in the proper methods of handling and processing of their residues are highly recommended. For these to be effective, the role of government and strong extension services is of par amount importance.

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