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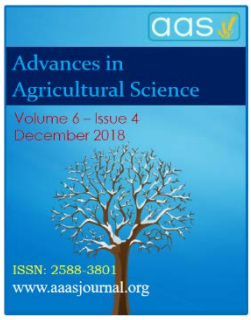

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Determinants of rice byproducts utilization as ruminant livestock feed in Ethiopia: the case of Fogera District

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ABSTRACT

The study was conducted with the objective to determine the status of farmers' rice byproduct utilization as feed in Fogera district, northwestern Ethiopia. Eighty smallholder farmers were selected purposely based on livestock population and rice production access. A semi-structured questionnaire was administered to selected farmers systematically. The collected data was analyzed using SPSS descriptive statistical analysis. The result indicated that the majority of respondents in the study area were with the range from 31 to 50 years (55%). Education status of respondents showed that the majority of household heads were able to read and write (27.5%) followed by elementary school (26.25%) and high school (17.5%) completed. The main dry season feed in the majority of households (46.25%) was found to be grazing and crop residues. The majority (64.62%) of farmers use rice byproducts as livestock feed, followed by both feed and house construction. Types of byproducts used for animal feed by respondent's elucidated majority (61.5%) use rice straw, considerable proportion (26.15%) rice bran and (12.30%) use both straw and bran for animal feed based on availability. The sources of rice byproducts indicated for many of respondents (66.7%) was farm produced, 18.5% use purchased and 18.4% get rice byproducts both from farm produced and purchasing for their animal feed. Type of animals fed rice byproducts include cattle in the case of majority of respondents (49.23%), cattle and equine, followed (24.62%), and all animals (13.85%), respectively. In livestock owners, rice byproducts are fed to livestock as sole feed and mixed with other feeds, however, the majority (69.2%) of households provides sole followed by both sole and mixed with other feeds (16.9%). Many of the respondents (55%) apply drying followed by addition of salt water (22.5%) as method of improving the rice byproducts. The main constraints observed in rice byproducts utilization as feed were seasonal deficiency of byproducts (25.5%) followed by lack of awareness (16.25%). Though these problems prevail in the study area, rice byproducts are being used as a major crop residue feed with little or no improvement applied. Generally, it can be included that rice byproducts were found very important feed resources in the rice dominated farming system of Fogera district. To exploit these products properly, farmers need to be assisted through proper agricultural extension service and supply in the form of credit service. Moreover, further on detailed on-farm experimentation should be done to demonstrate better utilization of the products as livestock feed.

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Introduction

The economy of Ethiopia is largely dependent on agriculture which contributes about 43.2% of the country's Gross Domestic Product (GDP), and about 85% of the population is engaged in it (CSA, 2016). In the country, crops are grown for one or more main product such as food grain and byproducts. The byproducts such as straws and stubble grazing are leftovers after harvesting and after processing are 'by-products' of the main crop (Adri Vink,2015). Feed shortage both in terms of quantity and quality is a major problem hindering the development of livestock industry in Ethiopia (Ahmed et al., 2010; Solomon et al., 2010). The common feed resources available in the high and mid lands of the Ethiopia are mainly natural pasture, crop residues and stubbles (Mesay et al., 2013; Zewdie and Yoseph, 2014), and natural grazing land is the predominant feed sources in lowlands (Malede and Takele, 2014). In the integrated crop livestock production systems, crop residues are the main feed resources. Fallow lands, forest and shrub lands are also the feed resources in different agro-ecologies of Ethiopia (Ahmed et al., 2010). The factors contributing to this deficit in dry matter (DM) supply are fast deterioration of the natural grazing land associated with a rise in crop cultivation, over stocking, and recurrent droughts. In Ethiopia, the tendency of allocating natural grazing lands for crop cultivation has been increasing to satisfy the grain production needs of rapidly increasing human population. One of alternative feed resources is crop residues especially cereal residues. Residues of cereals and pulses account for about 26% of the total feed utilized and ranked second to grazing (64%) in mixed crop-livestock production system of Ethiopia (CSA, 2016). With an increase in human population, more land is used to crop production and only fragments of marginal lands will be left for forage production in Ethiopia. Consequently, ruminants feed largely on crop residues particularly on cereal straws as their basal diet (Fekede et al., 2011; Dawit et al., 2013).

Cereal crops like rice are being expanded in Ethiopia which help in alleviating livestock feed shortage. Rice has become a highly strategic and priority commodity for food security in Africa(Table 1). The discovery of wild rice in the Fogera plain in the early 1970s was the basis for rice introduction in Fogera district as well as in the Amhara region. Since then, Fogera district is regarded as one of major rice production areas of Ethiopia. In Fogera, potentially about 35,300 smallholders are engaged in rice production with average land size of 0.58 ha per household with a potential production of 85,990 tons of rice. The existing land coverage for rice production is above 20,000 hectares and rice is known as "white gold"

The land size for rice cultivation is increasing from time to time and there is big tendency of changing the style of production from other crops to rice by most of the farmers settling on Fogera plains. The primary importance of any crop residue management system is to maximize the economic benefit from the waste resource and maintain acceptable environmental standards. Hence, proper use of crop residues including rice byproducts could help to mitigate the problem of livestock feed in the highlands of Ethiopia. However, no organized study conducted on the farmers' perception about the utilization has been done in the area. Farmers awareness about the use such byproducts traditionally, there is little or no knowledge on the status of utilization and the prevailing constraints in the study area. Therefore, this assessment was done to determine the status of rice byproduct utilization and to identify constraints available in the study area.

Materials and Methods

Description of study area

Fogera District is one of the districts of Amhara National Regional State and found in South Gondar Zone. It is situated at 110 58 N latitude and 370 41

E longitude. The district is bordered by Libo Kemkem district in the North, Dera district in the South, Lake Tana in the West and Farta district in the East. The altitude ranges from 1774 up to 2410 masl allowing a favorable opportunity for wider crop production and better livestock rearing (IPMS, 2005).

Sampling design

From the district two rice producing Kebele's (local administration) were purposely selected represented the study population. A cross-sectional and retrospective type of studies were conducted using survey questionnaire, group discussion and observation were

used to collect data on characteristics and practices of rice byproduct utilization in smallholder farming system.

Data collection and statistical analysis

The primary data was collected through a cross-sectional investigation. Semi-structured questionnaire was used to include data pertaining to socio-economic characteristics: demographic nature, size of house hold education and age. In addition farm size, livestock species kept; methods and strategies of rice byproducts utilization were collected. Livestock holding per household was converted to tropical livestock unit using the conversion factors (ILCA, 1992). Constraints related to feed shortage in terms of quantity and quality visa vis mitigation strategies were collected. The data was complemented with information obtained from key informants and secondary data derived from district office of agriculture. The collected data was systematical coded and analyzed with Statistical Package for Social Sciences (SPSS) (version 20 2011).

Results and Discussion

Gender, age and educational characteristics of respondents

The age and educational characteristics of respondents are shown in Table 2. Of the total of respondents the majority (94%) were male while the rest of them were female. This may be associated with the fact that male headed households have more access to agricultural technologies due to their exposure to different out-of-house issues. The finding was in agreement with different reports (Mekuriaw et al., 2011; Assefa et al., 2014; Asmare and Yayeh, 2017). The majority of respondents in the study area were with the range of 31 to 50 years (55%).The results of the current finding disagrees with reports of Asmare et al. (2016) and Atalaye *et al* (2014) who reported the average age of respondents were 43.2$\pm$1.0 years for Metkele Zone and Burie District, Ethiopia, respectively.

The mean family size of respondents in the study area was 6.55 per household. The average family size in the study areas was comparable but relatively higher to 6.22 (Kebede et al., 2012) reported for Bure district of ANRS, and it is also higher than the two lowland districts (Mandura and Pawe) of Metekel zone of Benshangul Gumz region ranging 6.04 to 6.94 (Mekuriaw *et al.* 2011). The result was also larger than that reported by Tesfaye (2007) with over all mean family size of 5.7 persons in Metema district in Northwest Ethiopia and national rural average (5.1) (ERSS,2013).

The majority of household heads were able to read and write (35.38%) with comparable proportion of elementary school completed households (33.85%). The result also showed that there were still many (27.69%) that could not read and write in the area. This indicates there is still the highest numbers of respondents who could not read and write in all altitudes which could have high influences on awareness and adoption of emerging technologies and extension activities. This agreed with Ezeibe *et al.* (2014) who reported that the low levels of education of the households have an influence on

Table1. Rice Production, no. of HHs and area coverage (2009-2015) in Fogera District

Production Season	Area Coverage	No of Kebeles	Males	Females	Total
2009/10	9256	23	11026	1111	12137
2010/11	11146	26	12354	1725	14079
2011/12	15119	26	17094	1325	18419
2012/13	16070	27	20240	1325	21565
2013/14	19310	-	-	-	-
2014/15	19334	-	-	-	-
2015/16	20896	-	-	-	-

Source: District Office of Agriculture

Figure 1. Map of study area

adoption of improved poultry management practices. Furthermore, Bruna et al. *(*2014) reported that education is the main issue in agricultural development (especially primary and secondary schooling had higher impact on agricultural development compared to any other level of education). Therefore, in the study area, these (36.38%) illiterate had its own impact on utilization of existing resources, technology transformation and adoption in the study areas.

Land and livestock holding of respondents

The land and livestock holding characteristic of respondent is shown in Table 3. Mixed crop-livestock production system is the dominant farming

system in the district. The livelihood of respondents in the study area was solely (100%) crop-livestock farming. Livestock production is subsistence-oriented and is an important component of the mixed farming system and is well integrated with crop production. Livestock species kept by the farmers comprise cattle, sheep, goats, equines and chicken. Cattle are the dominant species per household, mainly used for draught power, followed by milk and meat production, income and manure for maintaining soil fertility. The result is in agreement with reports of different authors (Selamawit, 2015; Asmare et al., 2016; Zeru and Lijalem, 2016) in Ethiopia.

The average land holding per household in the study area was 1ha from which on average 0.9 ha was used for crop production and the rest (0.1ha) used for forage production purpose. The major crops grown in the study area were rice, maize, finger millet, teff, hot pepper and niger seed which cover 38.13, 24.12, 22.56, 6.61, 4.66 and 2.33%, respectively. The overall land covered by the above crops occupies about 98.14% of the total cultivable land while the rest (1.86%) was covered by horticultural crops like potato and lettuce. In the district from the total cultivable land 43.58% was cultivated using irrigation and residual moisture from the rainy season. This indicates that the district has much irrigable land for food and forage crop production.

Livestock feed resources

The dry and wet season livestock feeds resources of respondents are shown in Table 4. The type of available feed resources in the study area includes natural pasture, crop residue, hay and supplements like salt, and some

indigenous and improved fodder trees. The feed resources of livestock in dry and wet season were found almost the same which might be due to shortage of land that has made respondent not base only on grazing and use straw and other feeds in both seasons. Similar reports also reported for different areas of Ethiopia (Mekuriaw and Asmare, 2014; Asmare et al., 2016; Zeru and Lijalem, 2016).

Seasonal livestock feed shortage was the major problem for livestock production both study areas in which farmers have different strategies to mitigate the problems. The livestock feed resources and feeding system of the current study area is in agreement with different reports in different parts of the country (Tonamo et al., 2015: Asmare et al., 2016; Gashe et al., 2017). As indicated in other parts of the country (Fetsum *et al.*, 2009) growth crop production and increment of livestock number are considerably adding the feed shortage in the study areas.

Rice byproduct utilization of households

Function of rice byproducts for the household

The Function of rice byproducts for the household is shown in Fig 2. Result of overall rice byproduct utilization indicated that rice byproducts are used for different functions such as animal feed and assist in house construction as well as local mattress making. From the total of respondents, the majority (64.62%) households in the study area use rice byproducts as animal feed, followed by both feed and house construction. The current finding is in agreement with various reports (Atuhaire et al. 2014; Valbuena et al. 2015; CSA, 2016).

Utilization of rice byproducts as feed for livestock

The species of livestock animals fed rice byproducts in the study area is shown in Table 5. The majority of respondents 43 (66.7%) use farm produced, 12 (18.5%) use purchased and 10 (18.4%) get rice byproducts both from farm produced and purchasing for their animal feed. Similar trend of utilization has been reported in a research conducted for crop residue trade-off by Valbuena et al. (2015). In the study area, rice byproducts in the study area are used as feed for different livestock species including equine. Overall, the majority (49.23%) of

Table 2. Age and educational characteristics of respondents

Age category	Frequency (Percent)	Educational Characteristics	Frequency (Percent)
18-30 years	17(21.25%)	Illiterate	14(17.5%)
31-40 years	22(27.5%)	Read and Write	22(27.5%)
41-50 years	22(27.5%)	Elementary school	21(26.25%)
51-60 years	12(15%)	High School	14(17.5%)
> 60 years	7 (8.75%)	Certificate and above	10(12.5%)
Total	80(100%)		80(100%)

Table 3. Land and livestock holding characteristics of respondents

Species of Livestock	Holding (TLU)
Cattle (TLU)	4.71
Sheep (TLU)	0.2
Goats (TLU)	0.21
Donkey (TLU)	0.8
Mule (TLU)	0.8
Chicken (N)	11
Honey bee colony (N)	4
Land holding (ha)	1
Crop land (ha)	0.9
Forage land (ha)	0.1

N=number; ha=hectare; TLU=Tropical Livestock Unit.

Table 4. Dry and wet seasons feeds and feeding of livestock

	N	Percent
Dry season feed		
grazing and crop residues	42	52.5
Grazing ,crop residues and hay	21	26.25
grazing, crop residues and improved fodder	17	21.25
	80	100
Wet season feed		
grazing and crop residues	43	53.75
grazing, crop residues and hay	15	18.75
grazing, crop residues, hay and improved fodder	12	15
grazing, crop residues and concentrate	10	12.5
Total	80	100

N=number

respondents feed their livestock rice byproducts for cattle and equine, followed by cattle (24.62%), and all animals (13.85%). In Ethiopia different authors reported that the rice straw and bran could be used as animal feed for different species (Derso, 2009; Asmare et al.,2010; Hailu et al., 2011). Moreover, the information was in line with Heuze and Tran (2015) showed that rice and its byproducts could be used for different species of animals.

In the current study area, rice byproducts were fed to livestock as sole feed and mixed with other feeds, however the majority (69.2%) of households provides sole either straw or bran followed by both sole and mixed with other feeds (16.9%). The finding showed that rice straw and rice bran are being used as sole feed or mixed with other supplementary feeds. In all respondents, the amount of rice straw and bran offered to animals in the study area is done based on estimation without quantification for each animals. . The finding was in agreement with earlier reports in Ethiopia (Tesfaye and Chairatanayuth, 2007).

Nutritional improvement of rice byproducts

The current practices of rice byproduct nutritional improvement strategies of respondents are shown in Table 6. The study revealed that respondents use different methods to improve rice byproducts particularly rice straw such as drying, salt water spraying before feeding, urea treatment, and chopping of straw. However, the majority of respondents 54(83.33%) apply drying and chopping followed by drying only (15%). Although these physical treatments are important in increasing the intake of rice byproducts particularly rice straw, the practices have no effect on nutritional improvement of feeds (McDonald et al., 2010). Smallholder farmers do not apply better nutritional improvements on rice byproducts such as urea treatment due which might be associated with lack of inputs and awareness. However, as rice byproducts are usually low in crude protein, it is vital that supplementation of with a protein source and a more easily accessible energy source will improve the performance and production of the animals (Sarnklong et al. 2010; Alam et al., 2016).

Skill of respondents on rice byproduct management

Among rice producers respondents only 23% have got training on rice byproduct utilization techniques while the majority (77%) has not got any training. The status of training of respondents in the current study is comparable to the results of Asmare et al. (2016) for desho grass utilization in Burie zuria district in northwestern Ethiopia. However, the importance of training and visit to farmers' field has significant importance on the adoption of technology in tropics (Hussan et al., 1994; Rahman, 2007). In line with this, (Ampaire and Rothschild, 2010) indicated that farmers who had received more training and support had less disease in pigs in the six months preceding the study than those who had not been trained or who had the animals for a shorter period of time.

Suggested rice byproduct improvement strategies

The rice byproduct improvement strategies of respondents are shown in Table 7. Respondents were asked to suggest future rice byproducts improvement strategies and have mentioned different types. Nevertheless, the majority of respondents were indicated that proper drying, chopping, addition of salt water and supplementation with concentrate mixture and bran as options of improvement in the future utilization or rice byproducts. This finding indicates that many extension demonstration works should be done in the area about the utilization and feed value improvement options in the study area.

It is known that chemical treatment of roughages like rice straw and other byproducts would increase the nutritive value of the roughage. Research conducted using lactating crossbred cows in

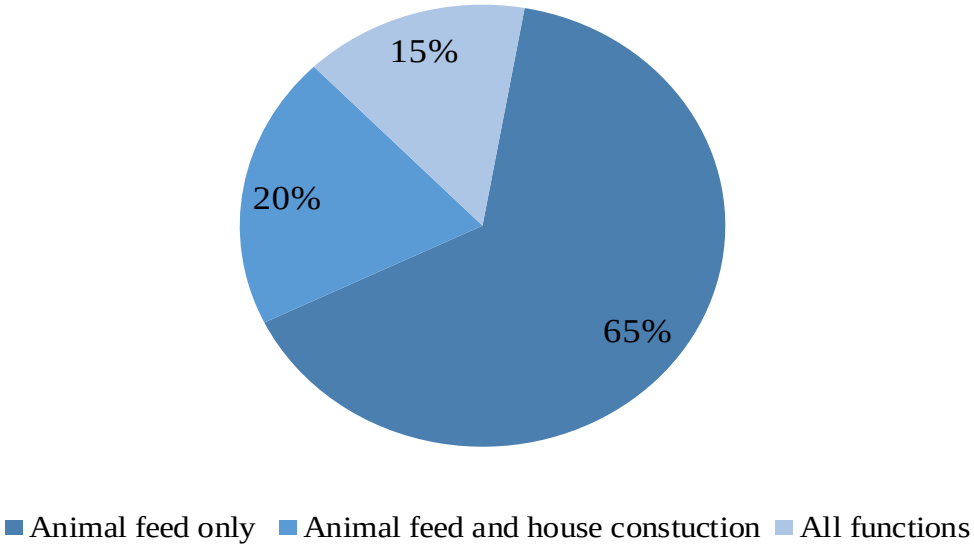

Figure 2. Function of rice byproducts for the household

Table 5. Species of animals fed rice byproducts and feeding methods of respondents

Type of Animals Feed RB	N	Percent
Cattle	18	22.5
Equines	14	17.5
Cattle and equines	32	40
Sheep	7	8.75
All animals	9	11.25
Total	80	100
Sole	45	69.2
mixed with other feeds	35	30.8
Total	80	100

N= number RB: rice products

Ethiopia, urea treated barley or teff straw were noted to replace native hay, and ammoniation was found to be economically feasible producing in milk production of cows (Derso, 2009; Hailu et al., 2011). However, none of of respondents suggested chemical treatment as an option of rice straw which might be associated with lack of awareness and cost implications of urea and labor. Moreover, other researchers also indicated that rice byproduct although major feed for ruminant animals it has low crude protein content (Khandaker et al., 2012; Su et al., 2012) indicating that it needs chemical treatments like urea treatment (McDonald et al., 2010; Nguyen et al., 2012) as well as physical treatments like chopping. Overall, treatment of straws with urea might be most suitable method for

Table 6. Rice byproducts improvement strategies of respondents

Method	N	Percent
Drying only	12	15
Spray salt solution before feeding	5	6.25
urea treatment	9	11.25
Drying and chopping	54	67.5
Total	80	100%

N=number.

Table 7. Techniques used to keep quality of rice straw by respondents

Techniques	N	Percent
Proper drying	44	55
Addition of salt water on straw	18	22.5
Urea treatment of straw	8	10
Mixing salt with bran	6	7.5
Supplementation	4	5
	80	100

N=number.

Table 8. Constraints of rice byproduct utilization by respondents

Constraints	**N**	**%**
Seasonal deficiency of byproducts	18	22.5
shortage of labor	8	10
Lack of inputs (eg. chemicals)	13	16.25
Shortage of byproducts	10	12.5
Lack of skill and awareness on utilization	20	25
Total	80	100

N=number.

small-scale farmers improve the quality of straws (Hanafi et al., 2012). On the other hand, urea price is increasing and impacts on the high cost of roughage unless there are chemicals or options are sought.

Constraints of rice byproduct utilization as feed

The major constraints of rice byproduct utilization as feed by respondents is are indicated in Table 8. The major constraints of rice byproduct utilization as animal feed in the study area can be categorized as lack of awareness about feed value of rice byproducts, shortage of rice products, poor processing and storage method of rice bran and lack of access of the byproduct. From the listed problems,lack of skill and awareness 20(25%),

followed by seasonal deficiency of byproducts 18(22.5%), followed by lack of inputs 13 (16.25%) . This elucidates that there must be an intervention such as creation of awareness about the feed value of rice byproducts and making accessible the products to users.

The use of rice byproducts in the study area was limited by lack of access and awareness in the study area. The result is in agreement with reports stated about crop residues in other parts of the world (de Leeuw, 1997; Erenstein *et al*., 2011; Valbuena *et al*., 2012).

Conclusion and recommendation

Rice byproducts such as straw and bran were used for different purposes including animal feed in the study area. The rice byproduct utilization indicated that the majority of respondents in the study area use rice byproducts as animal feed, followed by both feed and house construction. The sources of rice byproducts for animal feed were both farm produced and purchased. All herbivore animals were fed rice byproducts as sole or basal diet and supplementary to other feed types. Simple drying and chopping were used as treatment for rice straw before fed to animals; however rice bran was not treated. Although rice by products are livestock feeds in the study area smallholder farmers were not able to use such product effectively due to lack of awareness and shortage of resources. Hence, awareness creation should be given to smallholder farmers on the utilization of rice byproducts and feed value improvement methods. Moreover, detailed experiments on physical and chemical treatment and animal evaluation of rice byproducts should be conducted in the study area.

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Conflict of interest

The authors of this paper that there is no conflict of interest in the publication of this paper.

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