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Utilization of crop residues and agro-industrial by-products in livestock feeds and feeding systems of Uganda

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Abstract

The extent of utilization of crop residues and agro-industrial by-products and the socio-economic constraints limiting their integration in crop- livestock production feeding systems in three agro-ecological zones (Lake Victoria Basin, Western Rangelands and the Eastern Semi-Arid Zone) of Uganda were examined. Data were collected from 150 randomly selected respondents using structured and semi-structured questionnaires. Farmers' responses on the constraints faced in utilization of crop residues in the three agro-ecological zones was pooled and subjected to nonparametric statistics (Kruskal–Wallis one-way analysis of variance) to determine if significant differences existed between the different constraints. Utilization of agro-industrial by-products was highest in the LVB with 56% of the respondents reporting their use. The least levels of utilization of agro-industrial by-products were reported in the ESAZ by only 6.26% of the respondents. Maize bran and Dairy meal were the most utilized agro-industrial by-products reported by 36.33 and 31.3% of the respondents, respectively. Maize stover and banana peels were reported to be the most utilized crop residues for animal nutrition in the three agro-ecological zones. Most of these residues were produced on farmers' farms with less than 5% of the farmers purchasing them. Highest utilization of maize stover (over 80% of respondents) was reported in the LVB followed by the ESAZ (32%). Banana peels were noted as the most utilized crop residues in the WR (79%). The study revealed that inadequate knowledge, poor quality and limited availability of agro-industrial by products and crop residues are major factors for limited use of the feed resources. Improving the utilization of agro-industrial by products and crop residues should therefore first target improving farmers knowledge and availing technologies for improving the quality of crop residues.

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Introduction

Mixed crop–livestock production systems constitute an important source of livelihoods to the majority of smallholder farmers involved in agricultural production in Uganda (Twinamasiko, 2001). Integrating crops and livestock is critical in diversifying smallholder farmers' sources of income and employment (Rao and Hall, 2003). Livestock act as a storehouse of capital and an insurance against crop production risks, a coping mechanism against livelihood shocks as well as a vital source of dietary protein. In such production systems, crop residues constitute an important source of low-cost feeds (Smith, 1993; Tsopito, 2003), supplying over 20% of the ruminants' energy requirements (Burns, 1982) as well as contributing between 40-60% of the total dry matter intake in many tropical countries (Rao and Hall, 2003). Enormous quantities of different types of crop residues are produced as a renewable resource in integrated crop-livestock systems but most of them are being wasted, unused, undeveloped or poorly utilized (Makkar, 2002; Tingshuang *et al.,* 2002). The need to harness crop residues as an important source of livestock feed in Uganda has recently captured much attention. This is because the natural pastures that used to provide the main diet of ruminants are dwindling due to the escalating conversion of rangelands to crop lands to feed the increasing human population (Mugerwa *et al.,* 2011). Simultaneously, the cattle population is also increasing at a rate of 2.5% annually to meet the additional meat and milk demands in the local and regional markets (MAAIF and UBOS, 2009). The net effect of such increased pressure on land would be decreased area of grazing land per animal, leading to overgrazing, destruction of natural grasslands and starvation of livestock especially during dry seasons. During such periods, the use of crop residues and agro-industrial by-products play an important role in reducing dry season feed stress, hence mitigating the otherwise heavy weight losses of animals and mortality due to inadequate nutrition (Simbaya, 2002).

Numerous ways of crop by-product utilization exist amongst smallholder farmers (Preston, 1995). These may have a strong cultural and economic basis and may vary from society to society depending on the type of residue available (Tsopito, 2003). In many developing countries, the feeding regimes aim to use crop residues and agro-industrial by-products as the principal component of the diet as these are the locally available and relatively cheap resources. Keftasa (1988) reported that, crop residues provide 40 to 50% of the animal feed requirements in Ethiopia while Olayiwole and Olorunju (1987) reported that livestock derive 18% of their dry matter intake from crop residues in Nigeria.

Despite their demonstrated role in ruminant nutrition, crop residues are however low in metabolized energy and crude protein (Devandra, 1991; Preston, 1995; Tingshuang *et al.,* 2002). Considerable research effort has gone into improving their nutritional value through crop management, breeding and physical, biological and chemical treatment of residues as well as supplementation through high protein oil cakes, green fodder, and tree leaves (Preston, 1995; Kristjanson and Zerbini, 1999; Kristjanson *et al.,* 2002). However, the on-farm adoption of these technologies has been reported to be very low over the years (Devandra, 1999; Tsopito, 2003; Benin *et al.,* 2007). Several factors have been cited to influence the adoption and utilization of crop residues in different countries and these include availability, quality, price, labour costs and capital investment in processing (William, 1989; Jayasuriya, 1993; Tingshuang *et al.,* 2002). It was however concluded that understanding the socio-economic factors limiting the utilization of crop residues and adoption of new feeding systems is the most fundamental principle in assessing the need for additional and alternative feeding systems or improving on the existing feeds and feeding systems for improved adoption and utilization by farmers (Tsopito, 2003). Unlike some countries where more research and information exist on availability,

improvement and utilization of crop residues and agro-industrial by-products (Devandra, 1991; Preston, 1999; Tsopito; Tingshuang *et al.,* 2002), there is limited information on the extent of utilization and the associated socio-economic constraints limiting the utilization of crop residues and agro-industrial by-products in Uganda. This study was conducted to assess the utilization of crop residues and agro-industrial by-products as well as the associated constraints in their utilization in Uganda so as provide a basis for future research on improving the nutritional value and development of appropriate feeding strategies involving crop residues and agro-industrial by-products. This will in a long run lead to better livestock production and, hence, better living standards of the people.

Materials and method

Sample size and selection

The survey was conducted in three districts purposely selected to represent three agro-ecological zones of Uganda. The districts included Jinja, Kiruhura and Katakwi which represented the Lake Victoria Basin (LVB), Western Rangelands (WR) and the Eastern Semi Arid Zone (ESAZ) respectively. The three zones were selected basing on the predominance of exotic and cross bred animals and smallholder zero grazing farmers (LVB), extensive grazing systems and predominance of Ankole and cross bred cattle (WR) and extensive systems and predominance of zebu cattle (ESAZ). The District Production Department provided a sampling frame which contained all cattle keeping households from the selected districts. After consultations with the district extension staff, fifty households were then selected from each district following systematic random sampling procedures. The total number of cattle keeping households in each district was divided by 50 to obtain an n^{th} value. The first household was then chosen randomly but the subsequent households were chosen after every n^{th} value until all the 50 households had been selected in each district.

Data collection methods and analysis

Primary qualitative and quantitative data was obtained using structured and semi-structured pre-tested questionnaires administered by way of one on- one direct interview while secondary data was got from published articles and reports among others. The study design was cross sectional and both qualitative and quantitative data were collected to gain an in-depth understanding of the level of utilization crop residues and agro-industrial by-products by farmers and the constraints associated with utilization of the feed resources. Graphs and cross tabulation tables were drawn using Statistical Packages for Social Sciences (SPSS.19). In these Graphs and cross tabulation tables, analysis was done with a corresponding percentage. Data on farmers' responses on the constraints faced in utilization of crop residues in the three agro-ecological zones were pooled and then subjected to nonparametric statistics (Kruskal–Wallis one-way analysis of variance) to determine if significant differences existed between the different constraints. Farmers were asked to rank the constraints to utilization of agro-industrial by-products and crop residues in order of importance from 1 to 5. In this case the most critical constraint was ranked as number one and the least as number five. The computed sum and mean of ranks were compared using multiple pair wise comparisons to establish the significance differences among different constraints (Dunn, 1964). XLSTAT (2011) was used to generate summary statistics (frequencies, percentages and means) for most variables and later tabulated.

Results

Utilization of agro-industrial by-products

Farmers supplement their animals with various types of agro-industrial products (Table 1). Utilization of agro-industrial by-products was highest in the LVB with 56% of the respondents reporting their use in animal nutrition. The least levels of utilization of agro-industrial by-products were reported in the ESAZ with only 6.26% of the respondents. Maize bran and Dairy

meal were the most utilized agro-industrial by-products reported by 36.33 and 31.3% of the respondents, respectively. The use of pollard was only reported in the LVB while utilization of cakes/husks and home-made concentrates were only reported in the WR. The high costs and limited availability of agro-industrial by-products were noted as the major reasons constraining their utilization by majority of the respondents (Figure 1). Over 50% of the respondents reported high costs of agro-industrial by-products as the major constraint to utilization in the WR and the ESAZ but only 15% of the respondents reported the constraint in the LVB, emphasizing its significance in the former zones.

Table 1. Agro-industrial by-products utilized by farmers in the three agro-ecological zones.

Agro-ecological zone	Distribution of usage and percentage of agro-industrial by-products						
	Dairy meal	Maize bran	Pollard	Cakes/ husks	Home-made rations	Others	Total
LVB	24	28	4	0	0	0	56
WR	4.17	8.33	0	2.08	4.17	2.08	20.76
ESAZ	3.13	0	0	0	0	3.13	6.26
Total	31.3	36.33	4	2.08	4.17	5.21	

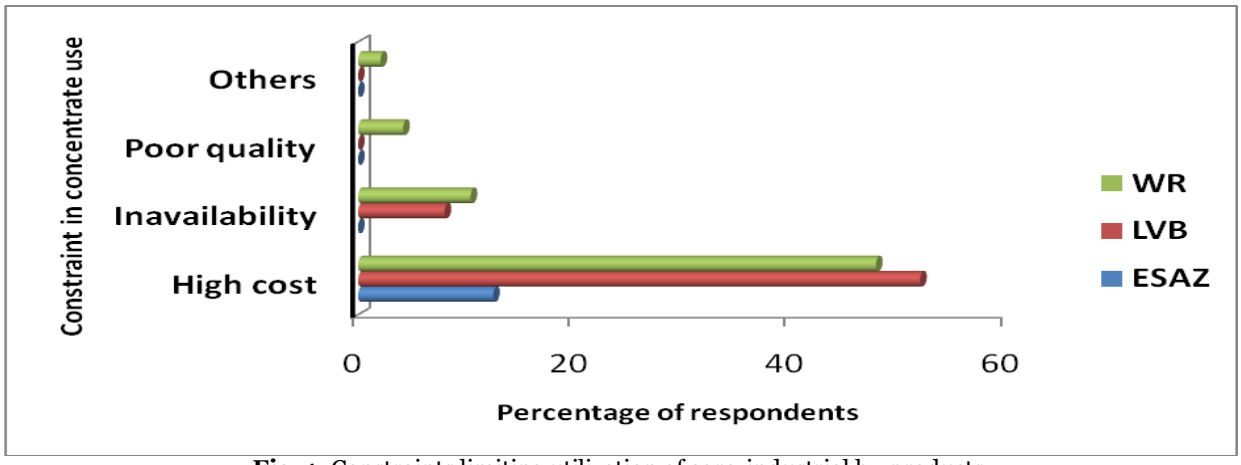

Fig. 1. Constraints limiting utilization of agro-industrial by-products.

Utilization of crop residues for livestock nutrition

Overall, maize stover and banana peels were reported to be the most utilized crop residues for animal production in the three agro-ecological zones (Figure 2). Most of these residues are produced on farmers' farms with less than 5% of the farmers purchasing the residues. Highest utilization of maize stover (over 80% of respondents) was reported in the LVB followed by the ESAZ (32%). Banana peels were noted as the most utilized crop residues in the WR (79%). Other commonly used crop residues included rice straw, cotton husks and sweet potato vines.

Only 14% of farmers were noted to process crop residues before feeding them to dairy animals. Of the farmers that process crop residues, 46.2% were noted to execute nutritional improvements technologies through highly fermentable energy sources such as

adding molasses. The rest of the farmers (54%) practice physical processing technologies such chopping and only one farmer reported the use of biological processing technologies. Only 15% of the farmers were noted to preserve crop residues. However, preservation was only practiced in the LVB and WR with 94% out of those preserving residues simply drying them and only 6% preserved them in form of silage. Non parametric analysis of variance using Kruskal-wallis tests indicated that farmers ranking of constraints faced in utilization of feeds differed significantly ($p< 0.0001$, DF=7, $Chi^2=14.1$) for the different constraints (Table 2). Farmers ranked inadequate knowledge on crop residue utilization, poor quality of residues and labour intensiveness as the most important constraints.

Table 2: Kruskal-wallis analysis of variance table showing farmers' ranks of constraints in crop residue utilization

Constraint	Overall mean of ranks ($p = 0.0001$, DF=7, $Chi^2=14.1$)	Rank per constraint
Inadequate knowledge on utilization	103.572[a]	1
Bulkiness of residues	147.480[b]	4
Poor quality	138.833[ab]	2
Inadequate knowledge on processing	153.308[b]	5
Labor intensive	145.500[ab]	3

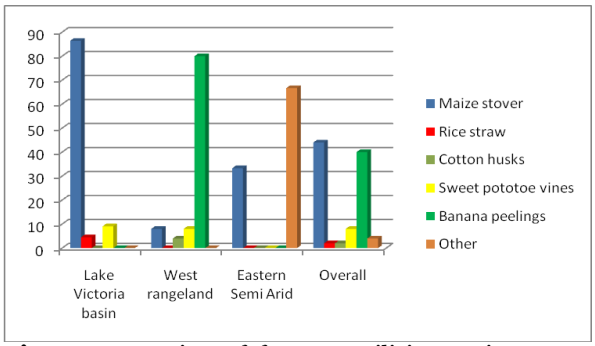

Fig. 2. Proportion of farmers utilizing various crop residues in the three agro-ecological zones.

Discussion

Utilization of agro-industrial by-products by farmers

The possible explanation for the high utilization of agro-industrial by-products in the LVB is three fold. 1. Most of the agricultural processing industries such sugar factories, maize milling, oil and feed manufacturing factories are located within the LVB. For this reason, farmers in the LVB have an easy access to most of the agro-industrial by products. The high prices of agro-industrial by-products in this zone is however attributed to high competition between other livestock types (especially non-ruminants) and ruminants. It should be noted that this zone has the highest population of non-ruminants in the country (MAAIF and UBOS, 2009) and hence tha high cost of agro-industrial products. At the same time the few processing plants in other zones provide some agro-industrial by-products at a low cost to farmers because of the limited competition for them. 2. The farmers in the LVB are largely smallholder farmers with limited land holdings for forage production. As such, the available forage is usually deficient to meet the nutritional requirements of their animals paving way for high levels of supplementation. 3. The smallholder farmers in the LVB largely keep cross-breed animals whose response to supplementation with concentrates is high as compared to local breeds. This could possibly be the same reason for the reduced utilization of agro-industrial by-products in the ESAZ where farmers largely keep local breeds. Given the fact that natural pastures are usually deficient in protein, it was not surprising to note that farmers in WR whose animals depend on natural pasture supplement them with

cakes, dairy meal and home-made concentrates to augment the protein deficient pastures. The limited use of home-made concentrates despite its high affordability by farmers was probably because the farmers had limited expertise to formulate the concentrates suggesting a need for more farmers' training.

Utilization of crop residues for livestock nutrition

The high utilization of maize stover and banana peels was attributed to the increased cultivation of maize and bananas in the LVB and the WR respectively. The increased cultivation of these crops ensures high availability of crop residues and reduced costs which hence leads to their increased utilization. This is in line with studies by William (1989) and Tsopito (2003) who noted high prices and limited availability as major factors constraining the utilization of crop residues. Therefore areas with more residues like LVB and WR also have high utilization rates compared to ESAZ where there are few crop residues. The results were suggestive that interventions to enhance utilization of residues need to focus first on maize stover and banana peels in the LVB and WR respectively. Given the low nutritive value of crop residues, farmers need knowledge in processing and utilization of crop residues for better animal production. Because earlier interventions for increasing the productivity of animals in Uganda basically focused on breeding and health, limited emphasis was devoted on utilization of crop residues and thus the wide knowledge gap in farmers. As such, farmers are not aware of the most appropriate handling practices for specific crop residues and thus the mention of labour intensiveness as a constraint in their utilization. These findings are consistent with earlier studies that mentioned low nutritive value (Tingshuang et al., 2002), labour costs (Jayasuriya, 1993), knowledge and capital (Tsopito, 2003) as major constraints for adoption and utilization of crop residues in livestock feeding systems. What matters however is the extent to which these factors influence utilization in different areas.

Conclusions and recommendations

The conclusions drawn from this study are that lack of knowledge, poor quality and limited availability of agro-industrial by products and crop residues are major factors for limited use of these feed resources in Uganda. Improving the utilization of agro-industrial by products and crop residues in dairy production should therefore first target improving farmers knowledge and availing technologies for improving the quality of crop residues. In areas where high costs of agro-industrial by products deter farmers from their use, great emphasis should be put on improving the nutritive value of available crop residues if economical supplementation is to be achieved.

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