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Management and use of dairy cattle feed resources on smallholder certified organic pineapple farms in Central Uganda

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Abstract: Formulation of exclusively organic diets that meet maintenance and production requirements of dairy cattle is a major limitation to production of premium organic products of animal origin. This study was therefore carried out to assess the use and availability of feed resources and the coping strategies used by farmers to overcome dry season feed shortages on 64 smallholder certified organic pineapple farms. Data was collected using semi-structured questionnaires and two focus group discussions. Majority of households were headed by males (62.9%) while average age of respondents was 42.5 years. Farmers allocated more land ($P<0.05$) to organic pineapple production compared to livestock. Beside dairy cattle, farmers also kept chickens, goats and pigs. Tethering was the commonest cattle management system. Fifty three percent of respondents reported using both natural pastures and crop residues as major dairy cattle feed resources while only 19% reported using elephant grass. Banana peels (25.1%) and sweet potato vines (24.7%) were the most important crop residues fed to cattle. Farmers reported high cost of concentrates and scarcity of feeds as their biggest challenges in dairy cattle production. Of the respondents, 51.4% conserved feed for their cattle as fodder banks. As a coping strategy to feed shortages, majority (42.9%) of farmer scavenged for feed resources from both organic certified and nonorganic neighbouring farms which is contrary to organic livestock farming standards. It was, therefore, concluded that management of livestock feeding in the study area fell short of the requirements for organic livestock feeding standards. Research to develop strategies that can use alternative on-farm feed resources

through ensiling organic pineapple wastes during the dry season is recommended as a long term strategy to address feed challenges for organic livestock farmers.

Key words: Dairy cattle, feeding systems, organic livestock farming

Introduction

There is a growing recognition of ecosystem benefits of organic agriculture in the world (Sandhua *et al.*, 2010). Organic agriculture sub-sector of Uganda is one of the most developed in Africa (Preißel and Reckling, 2010). Uganda has witnessed a rise in certified organic pineapple production in the central region mainly because of the premium prices that are enjoyed by organically certified farms (IFAD, 2005). However, despite the steady progress in certified crop production, there is limited exploitation of the well documented benefits of integrating livestock as a fundamental part of the organic farming systems. Integration of livestock into organic crop production offers benefits such as the utilisation of crop residues as feed for livestock and the provision of organic manure as a fertiliser (Rahmann and Böhm, 2005; Herrero *et al.*, 2010). Even though some research has been carried out in organic livestock production systems in Africa, much of the available literature has been to a large extent reported from the temperate regions (Chander *et al.*, 2011).

Organic livestock production systems are premised on production of food under high animal welfare standards. However, achieving complete organic balanced feed rations that produce adequate growth rates and high product quality is still a challenge (Rahmann and Godinho, 2012). Furthermore, this challenge may even become greater under organic livestock systems which restrict the use of certain feeds but also require that at least 60% of the feed requirements of animals have to be produced on-farm or be produced in collaboration with other organic farms (EAS 456: 2007). Such stringent requirements may not be easily met by the majority of smallholder dairy farmers.

To address some of these feed challenges in the tropics, a lot of research efforts have been directed towards the use of low cost alternative feed resources (Aregheore, 2000; Katongole *et al.*, 2012). Moreover, developing appropriate low cost technologies to improve conservation and utilization of such feed resources in the tropics is still a daunting challenge. Understanding the various feed resources and coping strategies used by farmers to overcome dry season feed shortages is important in future planning and development of appropriate technologies to ensure resilience of the organic systems as farmers prepare to covert to organic milk production. The major objectives of this study were, therefore, to assess the use and availability of feed resources under different cattle management systems on smallholder certified organic pineapple farms as well as to understand the coping strategies currently used by farmers to address dry

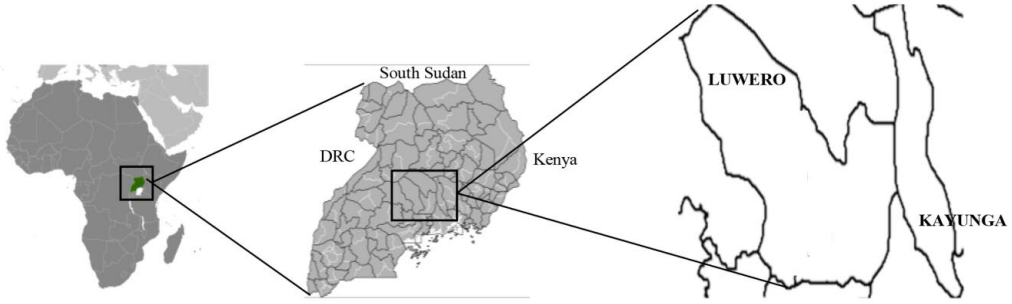

Figure 1 - Map of Uganda showing the location Kayunga and Luwero districts.

season feed shortages in relation to requirements of organic livestock feeding standards.

Materials and methods

Description and selection of the study site

An exploratory survey was conducted in two districts of central Uganda in the Lake Victoria basin namely Luwero (00°49'59"N 32°29"58"E) and Kayunga (00°42'09"N 32°53'20"E) which are located 75 km from Kampala the capital city (Figure 1). The districts have a bimodal rainfall pattern and receive between 1125 to 1300 mm of rainfall per annum. Besides pineapples, farmers in the study area also grew a variety of other crops including coffee, bananas, maize, beans and vegetables.

Sampling procedure and sample size

The study was conducted in two districts which were purposively selected because they are the major pineapple growing areas, and have the largest share of organically certified pineapple farms in the country. From each district, three sub-counties with the highest number of organic pineapple farmers were purposively selected to make a total of 6 sub counties. After consultations with field training officer from the National Organic Movement of Uganda (NOGAMU) and concerned personnel from the organic pineapple export companies, twelve organic pineapple farmers who also possessed at least one dairy cow were randomly selected per sub-county resulting into a total of 36 farmers per district.

Data collection and analysis

Data was collected using a semi-structured questionnaire which was pre-tested and subsequently administered to capture the farmers' demographic characteristics

and their farm production practices through face to face interviews. In addition, two focus group discussions (one per district) were conducted to corroborate the information gathered in direct interviews. The focus group discussions comprised of at least 10 persons including chairpersons, from the different farmer groups, two progressive farmers from each group and the representatives from pineapple processing centres. Data obtained from the study was analysed using the Statistical Package for Social Scientist (SPSS 16.0) to generate descriptive statistics for the variables. Analysis of variance (ANOVA) was also performed using SAS (version 9.1) to test for differences in the size of land and number of livestock of the different species. P-values less than 0.05 were considered significantly different.

Results

Socio-demographic characteristics

The respondents interviewed, 62.9% were males, and 37.1% were females. Majority of the house hold interviewed were male headed (87.1%) while only 12.9% were female headed. The average age of respondents was 42.5 years but ranged between 21 and 64 years. Ninety three per cent of respondents had attained some level of formal education while only 7% had never attended school at all. Of the farmers who had attended school, 67.1% had completed primary school level.

Ninety four percent of the respondents reported farming as the major source of household income. Other sources of income included trading in agricultural produce (3%), employment as civil servant (1.5%) and other non-agricultural incomes sources (1.5%). Only 8.6% of the household depended on family labour to carry out all farm activities while the majority (91.4%) hired labour in addition to family labour. In addition, focus group interviews revealed that many youth have moved away from the rural areas to work in towns for quick and daily paying jobs making it even harder to find the more energetic labourer in rural farming communities. Majority of the farmers (84.4%) used their own money to acquire the initial animals for the dairy enterprise. Other important sources of acquisition of dairy cattle included donations (10.9%) and hand-outs from government agencies (4.7%).

Management systems for dairy cattle

Three major grazing systems were identified in the study area. Tethering (n=39 farms; 60.9%), which involved tying the cow on a rope and occasionally moving it from time to time to a fresh grazing area, was identified as the most dominant management system. Zero grazing (n=17 farms; 26.6%) and extensive grazing (n=8 farms; 12.5%) were the other two management systems. Under zero grazing, cattle

were totally confined with limited movement and the farmers offered water and feed to the animal kept in an enclosure while in extensive system animals were herded and left to roam in the wilderness in search for pastures and water but returned home in the evening. Both the tethered and extensively grazed cattle were occasionally supplemented with crop residues and other feed resources in the evening upon returning to their resting areas.

Land holding and use

Farmers allocated more land to organic pineapple production than to livestock production. However, other competing enterprises such as annual crops production and growing of other perennial crops (i.e. coffee and vanilla) were allocated an even higher proportion of land compared to organic pineapple and livestock production enterprises.

The grazing system influenced size of land apportioned to the different enterprise as shown in Table 1. As expected, livestock under extensive systems were allocated more land ($P<0.05$) compared to livestock under tethering and zero grazing systems. Organic pineapple production was carried out on 3.6 and 3.0 acres of land where extensive and tethering systems of grazing were practiced, respectively. The land allocated to organic pineapple, however, drastically dropped from 3.6 acres on farms that practiced extensive grazing to 1.6 acres on farms where farmers practiced zero grazing. While land allocated to livestock and organic pineapple production varied ($P<0.05$) with grazing system, land allocated to other competing enterprises was not influenced ($P>0.05$) by the grazing system.

Animal species kept by farmers

The percentage number of farm that kept each of the different animal species across the three cattle management systems are presented in Figure 2. All zero grazing

Table 1 - Least square means of land size allocated to livestock and organic pineapples by farmers in the study area.

	Grazing system			
Farm enterprise	Extensive	Tethering	Zero grazing	SEM
Livestock	3.1[a]	1.7[b]	1.3[b]	0.57
Organic pineapples	3.6[a]	3.0[a]	1.6[b]	0.53
Other uses[§]	3.9	3.6	4.1	0.53

[abc] Least square means in the same column with different superscripts were significantly different at $P<0.05$;
§ included cultivation of other crops, construction of the homestead and land under farrow.

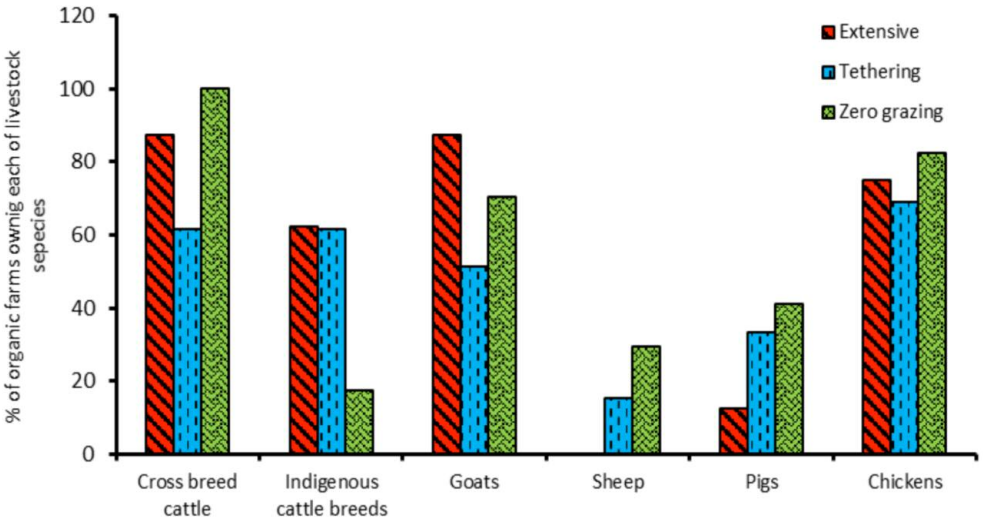

Figure 2 - Graph showing the percentage distribution of livestock species under the different cattle management systems.

farms (100%) kept crossbred dairy cattle but 70.6% of the farms kept goats and only 29.4% kept sheep. On the other hand, 87.5 % and 61.5% of the farms under extensive and tethering also kept crossbred dairy cattle, respectively.

The least square means of the number of different livestock species owned are summarised in Table 2. The grazing system significantly influenced the number of cattle, pigs and chickens kept by the farmer. While on average zero grazing farms kept at least 2.0 crossbred dairy cattle each, farms under extensive system kept a significantly higher ($P<0.05$) number. Similarly, the highest number ($P<0.05$) of indigenous cattle, pigs and chickens were kept under extensive grazing system.

Table 2 - Least square means of number of different livestock species kept by farmers.

	Cattle management system			
Livestock species	Extensive	Tethering	Zero grazing	SEM
Dairy cattle				
Crossbred breeds	3.1[a]	2.4[b]	1.8[b]	0.81
Indigenous breeds	9.8[a]	2.8[b]	1.0[b]	1.25
Goats*	4.6	4.1	3.5	0.86
Sheep*	-	2.8	2.0	NE
Pigs*	5.0[a]	3.2[b]	3.7[b]	1.82
Chickens*	10.2[a]	10.1[a]	6.2[b]	0.86

[abc] Least square means in the same row with different superscripts differ significantly at $P<0.05$;
NE- not estimated; *number of animals includes males, females, young and old.

Reasons for keeping dairy cattle

Milk for home consumption was reported as the most important reason for keeping dairy cattle (25%). Cattle was also reported to be kept as a source of manure for soil fertility management (24.6%), wealth accumulation (21.9%), sale of surplus milk for households to generate income (18.0%) and sale of calves for income generation (10.5%).

Animal feed resources

A summary of the major feed resources used under the different grazing systems is presented in Table 3. Majority of farmers reported crop residues (26.5%) and natural pastures (26.5%) as the most common feed resources across the three grazing systems followed by elephant grass. Agro-industrial by-products were the least used resource. More zero grazing farms reportedly fed dairy cattle on elephant grass, forage legumes, fodder trees and Agro-industrial by-products compared to those which practiced extensive and tethering grazing systems. Forage legumes used by farmers included *Canavalia ensiformis*, *Mucuna pruriens* and *Lablab dolichos* while the fodder tree species included *Calliandra calothyrsus*, *Gliricidia sepium* and *Sesbania sesban*.

Major crop residues used during the dry season

Major crop residues that were used on the farms are summarised in Table 4. Banana peels (25.1%) and sweet potato vines (SPV) (24.7%) were reportedly the most common crop residues used as feed resources while maize stover (12.8%) was the least used across the three grazing systems. Pineapple wastes were mostly fed to extensively grazed cattle (21.9%) compared to cattle under tethering (21.5%) and zero grazing

Table 3 - Major feed resources used under the different dairy cattle management systems.

	Percentage responses			
Feed resource category	Extensive grazing	Tethering	Zero grazing	Average
Crop residues	25.8	31.5	22.1	26.5
Natural pastures	25.8	31.5	22.1	26.5
Elephant grass	19.4	16.9	20.8	19.0
Forage legumes	9.7	9.7	10.4	9.9
Fodder trees	9.7	8.1	11.7	9.8
Agro-industrial by-products†	9.7	2.4	13.0	8.4

† mainly include maize bran and cotton seed cakes

Table 4 - Percentage use of the various crop residues under the different grazing systems.

	Percentage responses			
Crop residue type	Extensive grazing	Tethering	Zero grazing	Average
Banana peels	25.0	27.1	23.3	25.1
Sweet potato vines	25.0	25.7	23.3	24.7
Pineapple wastes	21.9	21.5	17.8	20.4
Banana pseudo-stems	12.5	16.7	21.9	17.0
Maize stover	15.6	9.0	13.7	12.8

(17.8%). More zero grazing farmers depended on banana pseudo-stems (21.9%) compared to farmers who tethered (16.7%) or extensively grazed their cattle (12.5%).

Perception and use of pineapple wastes as feed for dairy cattle

When asked whether they would choose to feed pineapple wastes to their cattle, 78.6% of farmers indicated their willingness to use the pineapple wastes as feed while 21.4% reported they would never feed pineapple wastes to their dairy cows. In depth inquiry from focus group discussions revealed that even the farmers who were willing to feed pineapple wastes to their cattle also had reservations in using the feed resource and were only willing to provide just a limited quantity. The pineapple crop residues consisted of peels, crowns (leaves) and occasionally the pomace (fibrous residue after extraction of juice). Sixty nine percent of the farmers fed only fresh peels, 25% fed both pineapple crowns and peels while only 6% fed all three types including the pomace (Figure 3). Of those that fed the organic pineapple wastes, 95% fed fresh peels while 5% dehydrated the peels before feeding it to cattle.

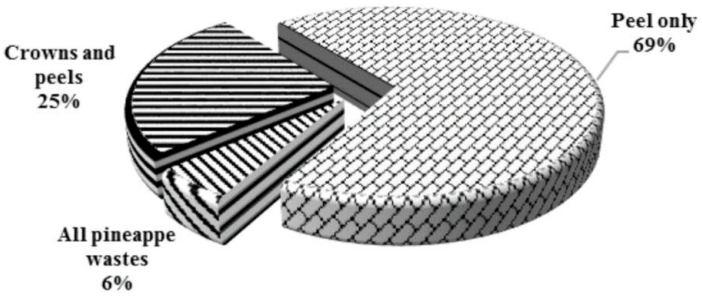

Figure 3 - Percentage of use of the different pineapple processing by-products by farmers in feeding their cattle.

Feed conservation

A big percentage of the farmers (51.4%) conserved feeds for their dairy cattle. However, fodder banks of elephant grass were the only form of feed conservation reported by farmers. The elephant grass fodder banks were planted on the boundaries of the farm plots of land. When asked whether farmers knew any other methods of feed conservation, only 10% reported having heard about silage while the majority had no idea of silage as a method of feed conservation.

Challenges faced by dairy cattle farmers

The major challenges as perceived by farmers are presented in Table 5. Across the three grazing systems, high cost of concentrate (18.1%) and shortage of feed resources (18.0%) were the biggest challenges. These were closely followed by the high cost of hiring farm labour (17.2%) and shortage of grazing land (16.7%). Livestock diseases were perceived to be more prevalent and therefore a bigger problem among the zero grazing farmers (12.2%) compared to 11.3% and 9.5% for extensive and zero grazing farmers, respectively. Water shortage for dairy cattle was perceived to be a bigger problem under extensive grazing (9.1%) compared to tethering (5%) and zero grazing (5.6%) systems. Limited market (3%) was the least reported challenge faced by the dairy farmers. Even though market for milk was not reported as a major challenge, in depth analysis through group discussions revealed that farmers either had to sell their milk for cash or on credit to their consumers.

Coping strategies for feeding dairy cattle in the dry season

The coping strategies adopted by farmers to address feed shortage during the dry season are presented in Table 6. On average, majority of farmers resorted to scavenging

Table 5 - Challenges faced by cattle farmers under the different management systems.

	Percentage responses			
Challenge	Extensive grazing	Tethering	Zero grazing	Average
High cost of concentrates	18.2	19.5	16.7	18.1
Feed shortage	18.2	18.0	17.8	18.0
Scarce and expensive labour	15.9	18.0	17.8	17.2
Land shortage	18.2	17.5	14.4	16.7
Diseases	11.3	9.5	12.2	11.0
Low milk prices	9.1	8.0	11.1	9.4
Water shortage	9.1	5.0	5.6	6.6
Limited market	-	4.5	4.4	3.0

Table 6 - Dry season coping strategies used by the farmers during the dry season under the different

	Percentage responses			
Coping strategy	Extensive grazing	Tethering	Zero grazing	Average
Scavenge for locally available feed	33.3	50.7	44.8	42.9
Graze swamps	33.3	31.5	0.0	21.6
Purchase of fodder	11.1	9.6	41.4	20.7
Reducing herd size	22.2	8.2	13.8	14.7

for any locally available feed resources (42.9%) from both organic and nonorganic certified farms in their neighbourhood. Other coping strategies included grazing of cattle in swamps with the exception of zero grazed cattle which were kept under total confinement. Purchase of fodder grasses especially elephant was another common coping strategy (41.4%) among the zero grazing farmers. Reduction in herd size was a popular destocking strategy that was reportedly used under extensive grazing system to ensure feed availability for the more productive animals during the dry season.

Discussion

Socio-demographic characteristics

Average age of respondents was about 42.5 years probably suggesting that fewer youths are engaged in farming. Majority of households were headed by males which possibly indicates that organic farming is perceived more as a cash generating activity rather than for food security. This observation is derived from the general perception of patriarchal society where gender roles dictate that women are always responsible for activities related to food production (Bolwig *et al.*, 2007) while the men are responsible for activities related to earning income for the family. This study revealed that majority of the farmers had acquired some level of literacy. This provides a platform for learning and information sharing between the farmers and the numerous NGOs that support organic farming in the area. Literacy among farmers was earlier reported to improve the level of adoption of new technology in farming households (Umoh, 2006; Lukas and Cahn, 2008) and the ability of households to utilise market information and available market opportunities (Lubungu *et al.*, 2012).

Majority of households in this study hired labour to complement on family labour requirements. This is consistent with earlier findings (Ndugire, 2010) which indicated that transition from conventional to certified organic farming resulted into increased on-farm investment into more labour intensive practices such as control of weeds and pests. Very often, hired labour was sourced externally to ensure that family labour was not completely diverted from production of food crops needed for household food

security (Bolwig *et al.*, 2007). It was, therefore, envisioned that labour shortages during the peak production season may force farmers to prioritise pineapple production to livestock rearing since the former is perceived more profitable than the latter (Bolwig *et al.*, 2007). Meanwhile, the youths opted to engage in other income generating activities such as commuter motorcycle riding rather than farming because of the perceived quick returns from such ventures compared to agricultural production.

Dairy cattle management systems

Tethering was the most common management system probably because farmers have small land sizes with several competing interests. The system is widely permitted on smallholder organic farms (Rahmann and Godinho, 2012) as a form of intensification as opposed to extensive grazing which is phasing out as a result of the shrinking farm land sizes (Vaarst and Alrøe, 2012). However, tethering restricts the animals to an area of a given radius which restricts free movement of the animals and their natural grazing behaviour contrary to organic livestock production requirements.

Although extensive systems provide livestock with natural conditions to display their natural behaviours as required under organic livestock systems (Nalubwama *et al.*, 2011; Vaarst and Alrøe, 2012), it was the least practised. This was probably because the size of agricultural land continues to decline in the face of the ever increasing human population. Nonetheless, extensive systems provide the best entry point for farmers who wish to convert to organic animal husbandry management (Nalubwama *et al.*, 2011). Unfortunately, the system predisposes cattle to contraction of infectious and endemic diseases and pests (Vaarst and Alrøe, 2012).

On the other hand Zero grazing is the most appropriate management system where farmers own very small plots of land. The system provides the best opportunity for collection of animal manure which is the cheapest source organic fertiliser and key in ensuring the continuous recycling of nutrient on the farm. Nevertheless, the system does not guarantee free movement and natural grazing behaviour of animals. As such, the East African Organic standards (EAS 456:2007) only permit the practice of zero grazing as an organic system of livestock production where it is deemed the most sustainable way of using the available land resources.

Land holding and use

Land under livestock was relatively small compared to other land uses possibly suggesting that livestock is a secondary enterprise to organic pineapple production in the area. Ownership of small landholdings has been reported to result into intensification of dairy production (Bebe *et al.*, 2003). Most of the Farmers allocated

relatively larger portions of their land to pineapple production compared to livestock. The rationale for more land allocation to the organic pineapple enterprise probably suggests that organic pineapple production is more profitable than the livestock enterprise.

Animal species kept by farmers

Alongside dairy cattle, farmers kept a wide range of other animal species on their farms. Chickens were the most kept livestock specie. Local poultry keeping is liked by most farmers as backyard enterprise due to the small space requirements as well as being a cheaper source of food of animal origin for many rural households.

Surprisingly, extensive farmers kept the highest number of crossbred cattle. This was possibly because some of these farmers have access to large land sizes to graze and maintain such improved dairy breeds. Majority of the farmers kept indigenous cattle breeds possibly because they are adapted to the local conditions such as feed scarcity (Kebreab *et al.*, 2005; Nalubwama *et al.*, 2011) and their perceived inherent resistance to diseases and pests. In turn, such adaptations of indigenous breeds are useful in organic agriculture where they guarantee reduced use of synthetic chemicals and drugs without which exotic breeds cannot survive (Haas and Bapst, 2004). However, the biggest challenge with the indigenous breeds is their inherently low milk production potential (Kebreab *et al.*, 2005). Moreover, Friesian cattle breeds, which were popularly kept by the smallholder zero grazing farmers, are difficult to sustain where feed and other input are limited (Kebreab *et al.*, 2005). Likewise, Haas and Bapst (2004) noted that it is very demanding to keep and maintain Friesian cattle under strict organic production condition. Therefore, crosses of such exotic dairy breeds with the local breeds are likely to be the most feasible solution if livestock is to be integrated into organic pineapple production.

Reasons for keeping dairy cattle

Majority of farmers kept dairy cattle as a source of milk for the household consumption and to sell the surplus as a source of income. However, most of the milk produced was consumed by the households since majority of farmers kept mostly indigenous breeds which have a low milk yield potential. Other reasons for keeping dairy cattle included the need for collection of cattle manure which is the cheapest source of organic fertilisers that can be used by smallholder farmers.

Animal feed resources

Natural pastures and crop residues were the most important feed resources used by the majority of the dairy farmers. Preference for natural pastures and crop residues

was possibly because they are cheap and locally accessible to farmers (Masama *et al.*, 2005; Ngongoni *et al.*, 2006). However, despite its abundance, tropical natural pastures are usually of low quality and experience a rapid decline in nutritional quality with maturity (Mpairwe, 2005).

Farmers used a variety of crop residues to feed their animals because these resources are equally cheap and readily available. Utilisation of alternative feed resources like crop residues is key in addressing dry season feed shortages under smallholder dairy production in Uganda (Mpairwe, 2005). Even though cattle are adapted and have potential to degrade highly fibrous crop residues with the help of rumen microbes (Preston and Leng, 1984), dairy cattle fed crop residues need to be supplemented with readily available energy and by-pass protein (Leng, 1986) in order to improve on rumen function. However, under smallholder dairy systems, the level of use of crop residues has been reported to be constrained by the cost of collection and transportation, cost of storage and processing (Mpairwe, 2005) and seasonal availability (Orodho, 2006).

Limited use of agro-industrial by-products as feed for dairy cattle observed among the farmers was consistent with earlier observations (Kabi *et al.*, 2013) and could be attributed to limited availability and high cost (Walshe *et al.*, 1991). Even when these agro-industrial by-products are available to farmers, their quality is often questionable (Orodho, 2006), resulting into inconsistent animal production. Farmers are rational and will only continue to use commercial concentrates if the milk to concentrate price ratio is greater than 1.0 (Walshe *et al.*, 1991). More zero grazing farmers reported using agro-industrial by-products compared to farmers who were practicing tethering and extensive grazing. This was probably because zero grazing farmers anticipated higher milk returns on commercial feed supplementation of improved dairy cattle breeds.

Low usage of forage legumes and multipurpose fodder trees observed across all the grazing systems presupposes that farmers were not able to provide sufficient crude protein to their animals. Moreover, fodder legumes and multipurpose trees are a known cheap source of protein for dairy cattle (Lukuyu *et al.*, 2012). Such feed resources help to bridge the gap between supply and demand of protein especially during the dry season (Mapiye *et al.*, 2006). For example, Nakiganda *et al.* (2005) comparing different supplementation regimes of commercial concentrates and forage legumes concluded that forage legumes can cost-effectively replace concentrate as supplement in dairy cattle diets. In addition, multipurpose tree species have been reported to control helminths in ruminants (Pathak, 2013).

The low utilisation of legume feed resources may be attributed to limited access to planting materials, lack of knowledge of the potential benefits and limited availability of land where to plant (Mapiye *et al.*, 2006). However, tropical fodder trees and forage legumes need to be used with caution because they contain anti-nutritional

factors (Mero and Udén, 1998) which act to depress intake, digestion and absorption of nutrients (Akande *et al.*, 2010).

Elephant grass usage was common across the grazing systems mainly because farmers were reportedly encouraged to grow it on the boundaries of their plots. The grass was reported to be used as a source of fodder for dairy cattle, but also as a biological barrier to control soil erosion (Nyaata *et al.*, 2000), and a barrier to control drift of synthetic chemicals from neighbouring conventional farms.

Dry season crop residues used by smallholder farmer

Banana peels and sweet potato vines were the most common crop residue used by farmers. These findings are consistent with reports by Katongole *et al.* (2012), who reported sweet potato vines and banana peels to be important in feeding smallholder dairy cattle. The banana peels were earlier reported to be fed to livestock throughout the year (Mpairwe, 2005) because bananas are a staple food and therefore grown and consumed throughout the year. Majority of the zero grazing farmers also reported to use banana pseudo-stems as a dry season feed. The banana pseudo-stems have high moisture contents ranging between 75 to 90% and are usually fed in fresh form or in sliced form as feed supplement to dairy cattle especially in the dry season (Sruamsiri, 2007). A high proportion of Zero grazing farmer (Table 5) who reported using banana pseudo-stems as a feed resource highlighted the vulnerability of the system to feed scarcity given that banana pseudo-stems have a low feeding value.

Maize stover was not considered an important crop residue in this study contrary to reports in other smallholder systems where it has been shown to be very important in feeding livestock (Methu *et al.*, 2001). This was probably because virtually all the maize stover was left in the fields after harvesting the cob resulting into significant wastage and deterioration in the nutrient content. With time, the stover becomes more fibrous and lignified (Aregheore, 2000) thus making it less digestible and acceptable to livestock (Orodho, 2006). Besides, the maize stover was also frequently ploughed back into the soil as an organic amendment thus limiting its use as a livestock feed.

Perception and use of pineapple wastes as feed for dairy cattle

Cottage pineapple processing facilities were projected to generate about 500 metric tonnes of fresh pineapple wastes during the dry season. Feeding pineapple peels alone was the most common practice across all the three grazing systems possibly because of its high sugar content and perceived better palatability to cattle. However, crowns were considered to be dangerous because of the prickly nature of the leaves to livestock and humans thus limiting the quantities that could be fed. The pomace from pineapple juice extraction was also not commonly given to the animals because of limited availability. The scepticism in using large quantities of pineapple wastes as

feed could be attributed to the perceived negative effects associated with feeding these resources to cattle. Farmers believed that pineapple wastes could cause mouth and stomach ulcerations in cattle and that feeding pineapple wastes resulted into low butter fat milk. Low utilisation of the pineapple wastes could also have been attributed to the bulky nature and high moisture contents of the pineapple residues which made their transportation from the collection centres difficult.

Feed conservation

Seasonal variability in feed supply and availability is a major challenge to increasing dairy production under smallholder systems. This can be overcome through appropriate feed conservation techniques (Kebreab *et al.*, 2005) either in form of silage or hay. However, the concept of feed conservation seemed entirely new to majority of the farmers which was consistent with earlier findings by Katongole *et al.* (2012). Farmers only conserved feed in form of fodder banks of elephant grass because this was considered the simplest form of conservation (Gallaher and Pitman, 2001). The low levels of interest in feed conservation was partly attributed to the fact that farmers kept a small number of animals but also because farmers lacked knowledge about these techniques. Moreover, establishment of these fodder banks was not an entirely conscious strategy adopted by farmer as a way of integrating livestock fodder into organic pineapple production but largely as a recommendation to control drift of synthetic chemicals from neighbouring nonorganic farms.

Challenges faced by dairy cattle farmers

Farmers faced several challenges but those related to feeds seemed to overwhelm them more as indicated in Table 6. This is consistent with earlier findings which reported shortage of feeds under smallholder dairy production (Mugerwa *et al.*, 2012). Similarly, the high cost of dairy concentrates could be attributed to limited availability of agro-processing industries. However, lack of disposable income could limit the effective demand and utilisation of dairy feed concentrates. Moreover, poor nutrition of dairy cattle has been reported to result into low milk yields, low calving rates, late age at calving and long calving intervals (Ngongoni *et al.*, 2006).

Even though majority of the farmers reported having market for their milk, focus group discussions revealed that farmers had to make a trade-off between selling their milk either on cash or on credit basis. In scenarios where the farmer opted for cash, a few consumers were willing to pay immediately and as such the farmers faced a risk of failing to get market for their milk. However, majority of the consumers preferred to pay on a monthly basis in which case the farmer were assured of market for their milk. Many of the farmers opted for the latter option but with a risk of incurring bad debts. Many zero grazing farmers felt that the prices offered for their milk were low

possibly because under this intensive system, the unit cost of milk production is usually higher compared to the other two grazing systems.

Generally, farmers perceived the challenge of diseases to be of less economic importance compared to feed and land shortage. This was possibly because majority of farmers kept indigenous cattle breeds which are resistant and are adapted to many of the local endemic diseases. This is consistent with earlier observation that the most feasible approach to integrating livestock into organic crop production is through use of indigenous breeds that are tolerant to the major tropical diseases and pests (Nalubwama *et al.*, 2014).

Dry season coping strategies

Majority of the farmers resorted to scavenging for locally available feed resources in order to provide feed to their cattle. Feed resources comprised of crop residues from both organic certified and nonorganic neighbouring farms as well as natural pastures along the roadside. As a coping strategy for dry season feeding, farmers also grazed poor forages in swamps and other marginal lands. However, none of the zero grazing farmers reported grazing their cattle in swamps even during the dry season. Avoidance of such fodder was probably because swamps are usually grazed communally and therefore zero-grazing animals risked contracting diseases and parasites. Alternatively, some of the farmers reportedly sold off some of their animals as a destocking strategy to ensure optimal feed availability for the most productive animals in the herd. Buying fodder (i.e. elephant grass) was a major coping strategy by zero grazing farmers. However, this arrangement is usually constrained by the high cost of transportation of the fodder and yet farmers will only continue to buy fodder as long as the dairy enterprise remains profitable.

Conclusions and future prospects

Based on the results of this study, feed related challenges are a major limitation to smallholder dairy production among certified organic pineapple farmers despite availability of a wide variety of feed resources. The current reliance on natural pastures and on-farm crop residues ensure a sustainable and closed nutrient cycle as required under organic systems. However, there is need to ensure that the sources of these feed resource comply with standards of organic livestock production. As a coping strategy to feed shortages, majority of farmers resorted to scavenging for locally available feed resources from both organic certified and nonorganic neighbouring farms to ensure feed availability for their dairy cattle. Moreover, inadequate knowledge on technologies for processing and preservation of crop residues and the negative perception held by farmers about feeding pineapple wastes significantly reduced their utilisation as feed for the dairy cattle. It was, therefore, concluded that management of livestock feeding

in the study area fell short of the requirements for organic livestock feeding standards. Research to develop strategies that can use alternative on-farm feed resources through ensiling organic pineapple wastes during the dry season is recommended as a long term strategy to address feed challenges for organic livestock farmers.

References

Akande K. E., Doma U. D., Agu H. O. and Adamu H. M., 2010. Major antinutrients found in plant protein sources: Their effect on nutrition. Pakistan Journal of Nutrition 9: 827-832.

Aregheore E. M., 2000. Crop Residues and Agro-industrial By-products in Four Pacific Island Countries: Availability, Utilisation and Potential Value in Ruminant Nutrition. Asian-Australian Journal of Animal Science: 266-269.

Bebe O. B., Udo H. M. J., Rowlands G. J. and Thorpe W., 2003. Smallholder dairy systems in the Kenya highlands: breed preferences and breeding practices. Livestock Production Science 82: 117-127.

Bolwig S., Odeke M. and Gibbon P., 2007. Household food security effects of certified organic production in tropical Africa: a gendered analysis, EPOPA.

Chander M., Subrahmanyeswari B., Mukherjee R. and Kumar S., 2011. Organic livestock production: an emerging opportunity with new challenges for producers in tropical countries. Rev. sci. tech. Off. int. Epiz 30: 969-983.

Gallaher R. N. and Pitman W. D., 2001. Conservation of Forages in the Tropics and Subtropics.

Haas E. and Bapst B., 2004. Swiss organic dairy farmer survey: Which path for the organic cow in the future? In: Organic livestock farming: potential and limitations of husbandry practice to secure animal health and welfare and food quality, Witzenhausen, German

Herrero M., Thornton P. K., Notenbaert A., Wood M. S., Msangi S., Freeman H. A. , Bossio D., Dixon J., Peters M., van de Steeg J., Lynam J., Parthasrathy R. P., Macmillan S., Gerard B., McDermott J., Seré C. and Rosegrant M., 2010. Smart investments in sustainable food production: revisiting mixed crop livestock systems. Science 327: 822-825.

IFAD 2005. Organic agriculture and poverty reduction in Asia: China and India focus. Thematic evaluation. International Fund for Agricultural Development (IFAD), Rome.

Kabi F., Bareeba F.B., Kwizera M., Walekhwa P., Prasad V.D.S.R., Raju D.V.N., Rubaramira J. and Ssekitoleko A., 2013. Public-private partnerships for unlocking the potential of dairy cattle productivity in Uganda for improved livelihoods. livestock Research for Rural Development 25.

Katongole C.B., Nambi-Kasozi J., Lumu R., Bareeba F., Presto M., Ivarsson E. and Lindberg J.E., 2012. Strategies for coping with feed scarcity among urban and

peri-urban livestock farmers in Kampala, Uganda. Journal of Agriculture and Rural Development in the Tropics and Subtropics 113: 165–174.

Kebreab E., Smith T., Tanner J. and Osuji P., 2005. Review of undernutrition in smallholder ruminant production, Nairobi, Kenya. p 306.

Leng R. A., 1986. Drought feeding strategies, Theory and Practice. Penambul Books, Armidale, New South Wales.

Lubungu M., Chapoto A. and Tembo G., 2012. Smallholder Farmers Participation in Livestock Markets: The Case of Zambian Farmers. 66, Indaba Agricultural Policy Research Institute (IAPRI) Middleway, Kabulonga, Lusaka, Zambia.

Lukas M. and Cahn M., 2008. Organic agriculture and rural livelihoods in Karnataka, India. In: IFOAM Organic World Congress, Modena, Italy

Lukuyu B., Gachuiri C. K., Lukuyu M. N., Lusweti C. and Mwendia S., 2012. Feeding dairy cattle in East Africa East Africa Dairy Development project (EADD), Likoni Lane, off Denis Pritt Road, Nairobi, Kenya.

Mapiye C. *et al.,* 2006. Constraints to adoption of forage and browse legumes by smallholder dairy farmers in Zimbabwe. Livestock Research for Rural Development 18.

Masama E., Kusina N. T., Sibanda S. and Majoni C. , 2005. Farm-grown feed resources as factors affecting smallholder dairy production in Zimbabwe. p 555-560.

Mero R. N. and P. Udén., 1998. Promising tropical grasses and legumes as feed resources in Central Tanzania: VI. Nitrogen balance in growing bulls consuming tropical herbaceous forage legumes. . Animal Feed Science Technology 72: 387-396.

Methu J. N., Owen E., Abate A. L. and Tanner J. C., 2001. Botanical and nutritional composition of maize stover, intakes and feed selection by dairy cattle. Livestock Production Science 71: 87–96.

Mpairwe D. 2005. Undernutrition in dairy ruminants and intervention options in Uganda. In: Coping with feed scarcity in smallholder livestock systems in developing countries. p 130-148.

Mugerwa S., Kabirizi J., Zziwa E. and Lukwago G., 2012. Utilization of crop residues and agro-industrial by-products in livestock feeds and feeding systems of Uganda. International Journal of Biosciences 2: 82-89.

Nakiganda A., Upton M., Phipps R., Mcleod A., Taylor N. and Bua A., 2005. Economics of feeding strategies in smallholder dairy cattle farming systems in central Uganda. African Crop Science Society, pp. 767-769.

Nalubwama S., Vaarst M., Kabi F., Kiggundu M., Bagamba F., Odhong C., Mugisha A. and Halberg N., 2014. Challenges and prospects of integrating livestock into smallholder organic pineapple production in Uganda. Livestock Research for Rural Development 26.

Nalubwama S. M., Mugisha A. and Vaarst M., 2011. Organic livestock production in Uganda: potentials, challenges and prospects. Tropical Animal Health and Production 43: 749-757.

Ndugire N., 2010. Scaling up Organic Agriculture and enhancing its Foreign Market Access: Lessons Learned from Eastern Africa, African Trade Policy Centre.

Ngongoni N. T., Mapiye C., Mwale M. and Mupeta B., 2006. Factors affecting milk production in the smallholder dairy sector of Zimbabwe. Livestock Research for Rural Development 18.

Nyaata O. Z., Dorward P. T., Keatinge J. D. H. and O'Neill M. K., 2000. Availability and use of dry season feed resources on smallholder dairy farms in central Kenya. Agroforestry Systems 50: 315-331.

Orodho A. B., 2006. Intensive forage production for smallholder dairying in East Africa. In: Reynolds and Frame (eds.) Grasslands: Developments Opportunities Perspectives.

Pathak A. K., 2013. Potential of Using Condensed Tannins to Control Gastrointestinal Nematodes and Improve Small Ruminant Performance. International Journal of Molecular Veterinary Research 3: 36-50.

Preißel S. and Reckling M., 2010. Smallholder group certification in Uganda – Analysis of internal control systems in two organic export companies. Journal of Agriculture and Rural Development in the Tropics and Subtropics 111: 13-22.

Preston T. R. and Leng R. A., 1984. Supplementation of diets based on fibrous residues and by-products. In: F. Sundstol and E. Owen, C (eds.) Straw and other by-products as feed. p 373-413. Elsevier, Amsterdam.

Rahmann G. and Böhm H., 2005. Organic Fodder Production in Intensive Organic Livestock Production in Europe: Recent Scientific Findings and the Impact on the Development of Organic Farming. In: Integrating Livestoc-Crop Systems to meet the challenges of globalisation, Khon Kaen, Thailand. p 471-485

Rahmann G. and Godinho D., 2012. Organic animal husbandry still needs a lot of scientific support. In: Tackling the Future Challenges of Organic Animal Husbandry, Hamburg, Trenthorst, Germany

Sandhua H. S., Wratten S. D. and Cullen R., 2010. Organic agriculture and ecosystem services. Environmental Science & Policy 13: 1-7.

Sruamsiri S., 2007. Agricultural wastes as dairy feed in Chiang Mai. Animal Science Journal 78: 335–341.

Umoh G. S., 2006. Resource use efficiency in urban farming: An application of stochastic frontier production function. International Journal of Agriculture and Biology 8: 38-44.

Vaarst M. and Alrøe H. F., 2012. Concepts of animal health and welfare in organic livestock systems. Journal of Agriculture and Enviromental Ethics: 333-347.

Walshe M. J., Grindle J., Nell A. and Bachmann M., 1991. Dairy development in Sub-Saharan Africa: a study of issues and options. World Bank Technical Paper Number 135., Africa Technical Department Series.