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Utilization of introduced forages by smallholder dairy farmers in Uganda

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Abstract

Elucidation of factors influencing utilization of introduced forages is critical in formulation of interventions to foster their integration into smallholder dairy production systems. The study sought to identify introduced forages cultivated by farmers and the socio-economic factors influencing their preference and adoption in Masaka, Mityana and Wakiso Districts of Uganda. *Pennisetum purpureum* was the most cultivated fodder with 70.5% of respondents cultivating it. Farmers differed (X^2=919.6, P < 0.0001) in their ranking of factors influencing their preference for introduced forages. Farmers' raking of "high yielding" was higher (p<0.001) than for other factors in all the three districts. Adoption was found to be a function of age, land ownership and level of education. The probability of a farmer adopting introduced forages differed among age groups (X^2=11.3, df= 4, p=0.024), systems of land ownership (X^2=12.1, df= 4, p=0.017) and levels of education (X^2=10.1, df=3, P=0.018). The results of the study revealed that efforts aimed at promoting integration of introduced forages into smallholder dairy systems need to focus on high yielding forages as well as ensuring availability of adequate sources of planting materials.

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Introduction

Smallholder dairy production is vital in the livelihoods of most crop-livestock farmers in terms of providing nutrition, manure for crop production and generating income and employment in Uganda. Smallholder dairies are concentrated in the small-scale dairy production systems producing about 60% of milk and contributing over 80% of the marketed output (Kabirizi, 2006).

Productivity of smallholder dairy production systems in Uganda is however constrained by inadequate quantity and quality of feed resources (Kabirizi, 2006). Bwonya (2006) also reported that feed scarcity was the major constraint to productivity of smallholder crop-livestock farming systems in Kenya. Feed scarcity is usually manifested as seasonal variations in quantity and quality of feed mainly pronounced during the dry season. Feed scarcity results from the escalating demographic pressure on available land and the rising competition between forage production and other enterprises for land, hence restricting forage production to smaller portions of farmland (Bwonya, 2006). Baltenweck et al. (2007) noted that smallholder farmers subsist on small pieces of land averaging to 1.5 hectares for both crops and animals production. While allocating land resources, they give first priority to food crop production (Kabirizi, 2006) and only less than 22% of the available farmland is usually allocated to forage cultivation. The feed scarcity problem faced in smallholder dairy production systems is being exacerbated by the escalating frequency and intensity of severe droughts attributed partly to climate change and variability (NAPA, 2007). The extremely high temperatures and the associated high evapo-transpiration rates have resulted in insufficient soil moisture to ensure adequate forage establishment and availability. Forage quality and quantity declines during the dry season resulting in a reduction of over 40% in milk yield; reduced feed intake, distortion of the estrus cycles, poor body condition and long calving intervals. Farmers therefore miss opportunities to benefit from high prices of milk during the dry season because of inadequate feeding resulting from feed shortages.

The combined effect of climate change induced droughts and limited land for forage production, has resulted into inadequate forages of livestock nutrition, poor animal performance and eventually low productivity/profitability of smallholder dairy production enterprises. Integration of drought tolerant and high yielding forages per unit of available land can help to offset the feed security problem emanating from limited availability of land resources and climate change induced droughts. Accordingly, high yielding and drought tolerant forages including *Lablab purpureus*, *Setaria sphacelata* (giant staria) and *Brachiaria mulato* have been introduced into smallholder dairy systems to improve animal nutrition as well as to overcome forage scarcity. Unfortunately, utilization and adoption of introduced forage is limited to few farmers implying that there could be several factors constraining the integration of such forages into intensive crop-livestock systems. Clear understanding of factors constraining production and integration of introduced forages is critical in enhancing their integration in smallholder dairy farming systems. The objectives of this study were: (1) To identify the forages cultivated by farmers and the factors influencing preference for particular forages and (2) To identify farmer specific variables that enhance integration/adoption of improved forages among smallholder dairy systems.

Materials and methods

Study area

The study was conducted in the sub-humid agro-ecological zone of Uganda which hosts the majority of smallholder crop-livestock farmers. Three districts (Masaka, Mityana and Wakiso) were selected for the study based on the intensity of smallholder crop-livestock production systems in the areas. Masaka District is located 00 15° and 00 43° south of the equator and 31° and 32° East, with average altitude of 115m above sea level. The district has a total area of 6413.3 km² with the total land area being 3214 km². Its topography is undulating and has plains. The soils are generally ferralitic clay loams. It has a tropical climate with bimodal rainfall pattern characterized by two rainy seasons with dry spells occurring between January to March and July to August. The mean daily temperature ranges between 10 °C - 30 °C. According to the Population and Housing Census (2002), the estimated population is 767759 people of which 389835 are females. The major economic activity is agriculture (smallholder crop-livestock production systems). Constraints to agriculture production are prolonged droughts that lead to crop failure and increased feed scarcity.

Mityana district is located 64 km from Kampala along Kampala-Mubende road. Mityana District is lies between 00 27° North and 32 03° East. It is bordered by Kiboga in the North, Wakiso in the East, Mpigi in the South east, Butambala and Gomba in the South, and Mubende Districts in the west. It is made up of gentle slopes with open U-shaped valleys. It has tropical climate with a bimodal rainfall pattern. The mean annual rainfall ranges between 1279 mm-1544 mm with high rainfall intensity between March to June and August to November. The mean daily temperature ranges between 15 °C - 28 °C. According to the population and housing census (2002), its population was estimated at 266100 people with 16885 males and 18239 females. The major economic activity is agriculture (smallholder crop-livestock production systems). The average land size in this area is 1-3acres and most farmers keep 1-2 dairy cattle under stall feeding with negligible grazing.

Wakiso District encircles Kampala District and it is bordered by Nakaseke and Luwero Districts in the North, Mukono District in the East, Kalangala District in the South, Mpigi in the South east and Mityana District in the North West. Its located 00 24°N and 32 29°S; its elevation is 3937 ft above sea level. Its population is estimated at 957300 people with the majority being Baganda and Luganda being the common language used. Its total area is 2704 km². The area has a bimodal rainfall pattern with March- April and October- November as the wettest months. The area receives between 1200-1300 mm of rainfall and its average daily maximum and minimum temperatures are 27 °C and 17 °C respectively. The major economic activity is agriculture that is carried out by smallholder farmers. In this area animals are mainly raised under intensive management systems, particularly, stall feeding (Zero grazing). This is because the area is a peri-urban one and hence there is limited land to carry out extensive grazing. The animals raised are Friesians and their crosses with indigenous animals due to high market for milk in the city of Kampala.

Sample size, selection and data collection

Two sub-counties were purposively selected from each district based on the intensity of smallholder crop-livestock production systems. The District Production Department provided a sampling frame which contained all smallholder crop-livestock households from the selected sub-counties. After consultations with the district extension staff, thirty five respondents were selected from each sub-county resulting into seventy respondents per district following systematic random sampling procedures. The total number of dairy farming households in each sub-county was divided by 35 to obtain the n^{th} value. The first household was then selected randomly from the sampling frame and the subsequent households were selected every after the n^{th} value until when thirty five households were obtained per sub-county and seventy households per district. Qualitative and quantitative data were obtained using standard and semi-structured pre-tested questionnaires administered by way of one-on-one direct interviews. Focus group discussions (one per sub-county) were also held to corroborate the information gathered in direct interviews. The questionnaires and focus group discussions were intended to capture information such as acreage and types of improved forages cultivated by farmers, factors influencing farmers' choice of improved forages and farmer specific variables affecting adoption of improved forages among others.

Data analysis

Kruskal Wallis test (Non parametric test of one way variance) was conducted using XLSTAT (2011) to find out whether there were significant differences in the farmers' ranking of factors affecting their preference for improved forage species that they cultivate. Seven factors were ranked by farmers using a scale of 1-7, with 7 being the most important influencing farmers preferences and 1 being the least important factor. The computed sums of ranks were compared using multiple pair wise comparisons to establish the significance differences among different factors (Dunn, 1964). In characterizing farmers' responses on adoption of improved forages, a general linear model (GLM) assuming binomial error distribution of farmer responses was used. We hypothesized that the adoption of improved forages by farmers was a function of farmers' specific variables which included age, education level, type of land ownership, major livestock enterprise, number of animals owned, major off farm activity, family size, farming experience in both livestock and crops and farm size. The farmers' responses on adoption (adopters or non-adopters) were used as the dependent variables while farmers' specific variables were considered as the explanatory variables. The data was then subjected to logistic regression following the requirements of logit model in XLSTAT (2011) to find out whether there was a significant relationship between these variables and adoption of improved forages. XLSTAT (2011) was used to generate summary statistics.

Results

Socio-demographic characteristics

The overall mean age of all respondents involved in the study was 51.57 years (Table I). Most of respondents in Masaka (49%) and Mityana (44%) Districts were between 41-50 years of age while in Wakiso District, majority of respondents (61%) were between 51-60 years of age. Majority of the respondents (82.4%) were male with a small percentage of 17.6% being female respondents. Most of the farmers (99% of respondents) were literate having at least acquired primary education. Very few respondents (only 3%) were illiterate and were all found in Masaka District. Majority of farmers in Masaka (59% of respondents) and Wakiso (43%) Districts had acquired primary education while most of the farmers in Mityana District (41%) had acquired secondary education. The total farm area utilized for agriculture production was less than 5 acres for most of the households. Out of the available total farmland, majority of respondents (66%) in Wakiso reported that less than 0.5 acres were allocated to cultivation of introduced forages while more area (between 1-1.9 acres) was reported to be under introduced forage cultivation on most farms in Masaka and Mityana Districts. Generally, the household sizes ranged between 3-6 people in Masaka and Wakiso (54%) districts while most of farmers in Mityana District reported the household size to be greater than eleven people. The highest average number of cattle per household was reported in Masaka and Mityana with each household having at least 4 heads of cattle. The highest average number goats were reported in Masaka with at least 6 goats per household while the highest average number of sheep was reported in Masaka and Wakiso with each household having at least 4 sheep.

Introduced forage types cultivated by farmers

Types of introduced forages grown by farmers are shown in Table II. Fodder grasses constituted the bulk of forages cultivated by smallholder farmers in the study area. The average area (1.28 acres) under cultivation of fodder grass species was 172%, 120% and 120% higher than the area under herbaceous legumes, pasture grasses and fodder tree species respectively. Napier grass (*Pennisetum purpureum*) was the most cultivated fodder grass species with 70.5% of total respondents cultivating the grass species. The average acreage under Napier grass production was 1.09 acres slightly lower than that of Giant setaria (1.47).

Table 1. Socio-demographic characteristic of farmers.

Variable	Masaka % of respondents	Mityana % of respondents	Wakiso % of respondents
Sex (N=210)			
Male	91.4	98.6	58.6
Female	8.6	1.4	41.4
Education level (N=210)			
None	2.9		
Primary	58.6	24.3	42.9
Secondary	21.4	41.4	31.4
Post secondary	17.1	34.3	25.7
Age (N= 210)			
Less than 30 years	1.4	4.3	2.9
30-40 Years	10	4.3	24.3
41-50 Years	48.6	44.3	1.4
51-60 Years	27.1	31.4	61.4
61 Years and above	12.9	15.7	10
Land ownership (N= 210)			
Traditional	28.6	42.9	48.6
Freehold	17.1	11.4	42.9
Leased	2.9	11.4	-
Rented	51.4	34.3	8.5
Total farm area (N= 210)			
Less than 5 acres	64.3	51.4	64.3
5-9 acres	15.7	21.4	25.7
10-14 acres	18.6	12.9	8.6
15-19 acres	1.4	14.3	1.4
Area under introduced forages (N=181)			
Less than 0.5 acres	29.9	6.6	66
0.5-0.9 Acres		1.6	
1.0-1.9 acres	62.7	62.3	17
2 acres and above	7.5	29.5	17
Area under local pastures (N=64)			
Less than 0.5 acres	95.8	71.4	66.7
0.5-0.9 acres		7.1	33.3
1 acre and above	4.2	21.4	0
Household size (N=210)			
Less than 3 people	14.3	1.4	20
3-6 people	42.9	25.7	54.3
7-10 people	38.9	21.4	25.7
11 people and above	4.3	51.4	0

Table 2. Introduced forages grown and the average area cultivated.

Introduced forage/fodder type	Frequency	Percentage	Average area cultivated (acres)
Pasture grasses			
Chloris spp.	18	8.6	0.74
Panicum spp.	4	1.9	0.25
Bracharia spp.	3	1.4	0.75
Average acreage			0.58
Herbaceous legumes			
Lablab	71	33.8	0.33
Mucuna	42	20	0.19
Siratro	4	1.9	0.34
Centro	20	9.5	1.32
Others	21	10	0.2
Average acreage			0.47
Fodder grasses			
Napier grass	148	70.5	1.09
Giant setaria	14	6.7	1.47
Average acreage			1.28
Fodder trees			
Calliandra	99	47.1	0.32
Leucaena	10	4.8	1.25
Gliricidia	1	0.5	0.5
Others	2	1	0.25
Average acreage			0.58

Table 3. Factors affecting farmers' preference of introduced forages to grow.

District value	Factors	Sum of ranks	X^2, df, P
Masaka p<.0001	High yielding	29704.0^a	**306.348, 6,**
	Drought tolerant	25123.5^b	
	Availability of planting materials	20336.5^c	
	Cost of planting materials	15717.5^d	
	Knowledge on agronomy	13550.0^e	
	Palatability to animals	9493.5^f	
	No selection criteria	6370.0^g	
Mityana p<.0001	High yielding	30275.0^a	**313.865, 6,**
	Drought tolerant	17255.0^d	
	Availability of planting materials	24535.0^b	
	Cost of planting materials	19251.0^c	
	Knowledge on agronomy	8715.0^f	
	Palatability to animals	1405.0^e	
	No selection criteria	6195.0^g	
Wakiso p<.0001	High yielding	30555.0^a	**371.405, 6,**
	Drought tolerant	17115.0^d	
	Availability of planting materials	25235.0^b	
	Cost of planting materials	21175.0^c	
	Knowledge on agronomy	8855.0^f	
	Palatability to animals	12985.0^e	
	No selection criteria	4375.0^g	

Although the average area under Giant setaria production was slightly higher than that of Napier grass, Napier grass was the most desired forage species by majority of the respondents. Other than cultivation of fodder grass species, most farmers had cultivated herbaceous legumes to supplement the low nutritive value of fodder grasses. Lablab and Mucuna (*Mucuna pruriens*) were the most cultivated herbaceous legumes produced by 33 and 20% of the respondents respectively. Calliandra (*Calliandra calothyrus*) was the most cultivated fodder tree species among smallholder dairy farmers in the study area and when compared with all other species cultivated by farmers, the fodder tree species was second to Napier grass in terms of intensity of cultivation.

Factors affecting farmers' preferences of introduced forage species to grow

Farmers' ranking of factors influencing their preference for introduced forage species cultivated on farmers' farms are presented in table III. The factors ranked by farmers included high yielding, palatability to animals, drought tolerant, cost of planting materials, availability of planting materials, knowledge on agronomy and no selection criteria. Kruskal–Wallis test showed that there was a significant (X^2=919.603, P < 0.0001) difference among farmers' ranking of factors influencing their preference for improved forage species. The significant differences in farmers' ranking of the factors were maintained among the various districts. Farmers' raking of the factor "high yielding" was significantly (p<0.001) higher than for other factors in all the districts with a sums of ranks being 29704, 30275 and 30555 in Masaka, Mityana and Wakiso Districts respectively. Drought tolerance and availability of planting materials were ranked as the second and third most important factors influencing farmers' preferences for improved forages respectively in Masaka District. Other factors included cost of planting material > knowledge on agronomy > palatability to animals > no selection criteria in that order of importance. In Mityana and Wakiso Districts, availability of planting materials and cost of planting materials were ranked as second and third most important factors respectively. In all districts, palatability of forages to animals was the least important forage attribute in determining farmers' choice of forages to be grown.

Factors affecting adoption of introduced forages

Adoption of introduced forages by smallholder dairy farmers was found to be a function of only three (age, land ownership and level of education) operator-specific variables (Table IV). The probability of a farmer adopting introduced forages differed significantly among age groups (X^2=11.3, df= 4, p=0.024), systems of land ownership (X^2=12.1, df= 4, p=0.017) and levels of education (X^2=10.1, df=3, P=0.018). Because adoption of introduction forages was coded as "1" and non adoption coded as "0", variables with critical values carrying a negative sign were associated with non-adoption while values with positive critical values were associated with adoption of introduced forages. Adoption of introduced forages decreased with increase in age of respondents. Results of logistic regression indicate that the probability of farmers not adopting introduced forages was significantly (p=0.028 and p=0.005) higher (p=0.028 and p=0.005) for age groups "51-60 yrs" and ≥60 yrs respectively. It was also noted that the critical values for age groups beyond 30 yrs was negative while that of the group "≤30" was positive. This implied that farmers below 30 years of age were better adopters of introduced forages than those beyond 30 years. Adoption of introduced forages was also noted to vary with systems of land ownership.

Results of logistic regression also indicated that the probability of farmers adopting introduced forages was significantly (critical value= 3.46, p=0.001) higher under the freehold land ownership system as compared to other systems. Level of education significantly influenced adoption with most of the adopters having acquired post-secondary education. In general, the variable "household labour" did not significantly affect adoption but analysis of individual labour categories indicated that the probability of adoption of introduced forages was higher for households with labour beyond 13 people (critical value=3.95, p=0.029). All household heads who relied entirely on agriculture with no other off farm activity adopted ($P < 0.05$) introduced forages. Other factors such as gender of household head, livestock and crop farming experience, major animal enterprise had no significant relationship with adoption of introduced forages.

Discussion

Introduced forage types cultivated by farmers

The high dependence of livestock on Napier grass was also reported by Staal et al. (1998) where grass formed the basal feed of over 80% of the dairy animals kept under smallholder crop-livestock systems in central Kenya. The explanation for the increased cultivation of the grass as compared to other forages species in the study area may be three fold. 1. The grass is high yielding making it possible to sustain livestock nutrition in smallholder crop-livestock systems where small portions of land are allocated to forage production. In this regard, Humphreys (1994) and Skerman & Riveros, (1990) also noted that the grass is one of the most high yielding fodder giving dry matter yields that surpass most tropical grasses. 2. For optimum growth, the grass requires high and well-distributed rainfall (more than 1000 mm per annum) although it can tolerate a moderate dry season (3-4 months) because of its deep root system. The mean annual rainfall in the study sites is adequate for cultivation of the fodder. 3. The associated benefits of integrating the grass into crop-livestock systems other than being utilized as a livestock feed. Such benefits include: control of maize stalk borer by trapping the ovipositing moths, protection of cereal crops such as maize from strong winds if planted round maize fields and prevention of run-off and erosion. Unfortunately, the sustainability of Napier based feeding systems in Uganda is threatened by the escalating prevalence of Napier stunt disease. The disease is caused by phytoplasma (Nielsen et al., 2007), which reside in the phloem of infected plants (Bové and Garnier, 2002). Napier stunt phytoplasma cause characteristic chlorosis, bushy appearance, stunting, and low biomass yield. Recent surveys revealed the incidence to range from 10 to 100%, causing herbage yield reduction of up to 60% within a few months (Kabirizi et al., 2007). This has resulted in reduced fodder for dairy animals, culminating in low milk yields and a high increase in the price of Napier grass (Kabirizi et al., 2007). The situation presents an urgent need for introduction and evaluation of alternative high yielding grasses to augment Napier grass in addition to development of appropriate disease management strategies to mitigate the effects of the disease on the grass. Potential high yielding grasses include *Brachiaria Mulato*. *B. mulato* is a pasture grass, which can serve both as a cut and carry for stall-feeding and open grazing systems. The grass yields up to 25 tons/ha (Holmann et al., 2004).

Factors affecting farmers' preferences of introduced forage species to grow

Farmers ranked "high yielding" as the most important factor considered while selecting forages to be cultivated on their farms. This was attributed to small farm sizes on which both crop and livestock production is undertaken. The farmers therefore chose forages that produce high biomass per unit of available land so as to maximize forage production on the limited available land. A similar observation was made by Gitau et al. (1994) who noted that smallholder production systems are usually concentrated in high potential areas with high population densities. As a result, farms are small with an average holding size of 0.9-2.0 ha and that sizes are still decreasing which calls for cultivation of high yielding forages per unit of available land. "Drought tolerance" was ranked second in Masaka District possibly because most parts of the district lie within the drylands of Uganda which are prone to frequent occurrences of drought attributed partly to climate change and variability. On the other hand, availability of planting materials was ranked second in Mityana and Wakiso Districts. The results of the study revealed that efforts aimed at promoting integration of improved forages into smallholder crop-livestock systems need to focus on high yielding forage species as well as ensuring availability of cost-effective and adequate sources of planting materials.

Factors affecting adoption of introduced forages

Adoption of introduced forage varieties was found to be a function of age with older peoples (>30 yrs) showing lesser chances of adoption as compared to young ones (≤ 30 yrs). The same trend was observed by Remmy (1987) who reported that young farmers adopted technologies related to vegetable production more than old farmers. Aberaw and Belay (2001) and Thirtle et al. (2003) attributed the reduction in adoption with age to increased risk aversion that builds up with increase in experience and age. This results into increased skeptism to innovation and resistance to change. The observed trend is however contrary to the general perception that adoption of technology increases with age because older people may have experience, resources and authority required to try out a given technology (Kalumba, 2008). Adoption of introduced forages was also noted to increase with education levels and this was consistent with the general belief that level of adoption of agricultural technologies is positively correlated with level of education. This is possibly because education makes farmers able to interpret the technical recommendations that may require some level of literacy. Further, Kalumba (2008) noted that literate farmers can comprehend, benefit from extension information and they are more aware of the consequences of the prevailing problems if the problems are not solved in time. Under the freehold land ownership system, farmers usually have land titles which offer them exclusive ownership and rights over utilization of the land unlike the traditional and leasehold systems. Farmers are therefore motivated to invest in technologies that are intended to improve production. Those who are not certain about the future of the land which they occupy will be reluctant to adopt.

Conclusions

Smallholder dairy production systems in Uganda are largely dependent on fodder grasses particularly Napier grass for feeding livestock. Fodder grass is occasionally augmented with legumes particularly Lablab and Calliandra. Farmers also demonstrated that the decision to cultivate particular forages was influenced by several factors but "high yielding" and "availability of planting materials" were the most important factors. Efforts to enhance utilization of introduced forages for livestock nutrition therefore need to focus on introduction and evaluation of alternative high yielding forages in addition to ensuring accessibility to high yielding varieties.

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