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Adoption of forage conservation technologies by dairy farmers in temperate Bhutan

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ABSTRACT

The study aimed to identify socio-economic factors influencing adoption of forage conservation technologies mainly silage making and urea treated straw. Both probability and non-probability multi-stage clustering sampling techniques were used to gather information. Ten villages (5 each from two *gewogs*) were randomly selected to interview 100 household representatives. Semi-structured questionnaire was used for data collection. Among dairy farmers, females outnumbered males in the adoption of silage making technology. Age also influenced technology adoption and more middle aged dairy farmers adopted silage making. Silage making was adopted more by farmers who were members of dairy groups and those who owned crossbreed cattle. Factors that had no influence on technology adoption were, size of household and landholding, level of education, and cattle herd size.

INTRODUCTION

Feeding cattle with quality forage during lean season is a major challenge facing smallholder farmers in southeast Asia. Fodder conservation is a common practice to address forage scarcity and has become popular among dairy farmers in developed countries. Since feeds and feeding account for 60 to 70% of expenditure in livestock farm (Kundu et al. 2005), different cost effective technologies were introduced to encourage and promote adoption of fodder conservation practices (FAO 2010). Among technologies, silage making and urea treated straw are widely known practices of fodder conservation. However, different socio-economic factors determine the rate of adoption of these technologies by dairy farmers.

Lack of financial resource has been identified as the main reason for non-adoption of silage making in developing countries (Reiber et al. 2010). On the contrary, large households with active members willing to contribute to farm work have positive influence on adoption of agricultural technologies (He et al. 2008). The size of land owned by household also plays an important role in technology adoption due to the fact that owning more land allows integration of forages in cropping system, indicating better possibility of adopting forage technology (Gebremedhin et al. 2003).

Farmer's age and educational background are other important factors influencing adoption of new farm technologies. Elderly farmers have tendency to avoid activity which requires more labour (El-Oste a et al. 1999; Quddus 2013). Adoption of modern agriculture technologies was found low in both young and old farmers in Ethiopia (Berhe 2015; Kyalo 2016). Similarly, individuals who can read and write are more likely to adopt new innovations (Mwamuye et al. 2013; Aysun and Cennet 2014). However, the higher level of formal education lowers the chance of adoption of forage technology because of better economic opportunities associated with higher education (Gebremedhin et al. 2003). Gender does not have influence on adoption of silage making technology (Njeri et al. 2013), however, Mudzengi et al. (2014) claims that women are better adopters of maize stover urea treatment technology than men.

Cattle breed and herd size also play an important role in technology adoption. Farmers with more number of high yielding dairy cows irrespective of breeds are more likely to take up modern dairy farming practices (Aksoy et al. 2011; Mekonen et al. 2009). Farmers with small herd size and low productive cows are less likely to adopt technology on urea treated straw (Roy and Rangnekar 2006; Owen et al. 2012). On the other hand, farmers with big cattle herd are found to adopt silage making technology over pasture grazing because grazing by big cattle herd causes trampling damages to pasture (Reiber et al. 2010).

Non-adoption of technology is also linked to lack of significant difference in milk yield between cows fed with and without urea treated straw (Singh et al. 2007). García-Martínez et al. (2009) compared the cost of urea treated straw and the revenue generated from milk sale. They found it less profitable although urea treated straw increased intake of nitrogen, palatability, digestion, and minimized liver fluke infestation in cattle (Roder 1998; Wageningen 1985). Cows fed with silage with or without grain supplement produce more milk than feeding hay with or without grains (Brown et al. 1963).

Institutional setting in a locality also influences adoption of farm technologies. Presence of milk cooperatives is

associated with adoption of best management practices in dairy farming (Rahelizatovo and Gillespie 2003). Galdino et al. (2014) contradict with a claim that cooperative in the vicinity is not very important for the adoption of new technologies. Trainings and cross visits by farmers have positive influence on adoption of new technologies by facilitating farmer to farmer interactions (Millar and Connel 2009; Arráiz et al. 2015). However, silage making is technically challenging and quite often silage is spoiled by mould formation, termites, and rain seepage (Kyalo 2016). A study by Shiferaw et al. (2009) showed that government subsidy encourages farmers to get acquainted with the new farm technologies and gain knowledge and skills on technology usage. However, most farmers adopt technology as long as there is subsidy.

In Bhutan, fodder conservation practices mainly silage making and urea treated straw were introduced over three decades ago. These practices met with little success due to high cost and labor demand (Roder et al. 2001). Besides cost and labor, the earlier studies have not investigated other socio-economic factors that could provide more explanations to non-adoption of improved forage conservation practices. Therefore, a study was conducted with the objective to identify important socio-economic factors influencing the adoption of silage making and urea treated straw.

MATERIALS AND METHOD

A survey was conducted in Chhoekhor and Tangsibji *gewogs* (blocks) of Bumthang and Trongsa *dzongkhags* (districts), respectively, during the months of January and February in 2016. Chhoekhor is located in the northern part of Bumthang, 2,600 m above sea level (masl) with mean annual temperature of 18ºC and annual rainfall of 680 mm. Tangsibji falls within the altitude range of 1800–3000 masl with annual average rainfall of 410 mm. The area has maximum and minimum annual average temperature of 20.1°C and 10.1°C, respectively.

Both probability and non-probability multistage cluster sampling techniques were used. The two *dzongkhags* and the *gewogs* were selected purposely because in these areas dairy farming is the primary livestock activity. From each *gewog*, five villages were randomly selected and 100 households were sampled.

Semi-structured questionnaire with both close- and open-ended questions was used for interviewing households. Besides primary data, secondary data from respective livestock *gewog* centers were also collected.

Data analysis

The data were edited, coded and processed in Microsoft Excel program. While 100 samples were analyzed for adoption of silage making, only 37 samples qualified for the analysis of adoption of urea treated straw. The data were analyzed using Statistical Package for Social Sciences (SPSS) version 23.

RESULTS AND DISCUSSION

Gender and Age

The proportion of respondents adopting silage making and urea treated straw differed by gender. The majority of respondents adopting both silage making and urea treated straw were females (Table 1). It suggests that females are involved more in livestock farming activity in the study area. Forage conservation activities were generally carried out during day when males are engaged in off-farm labour such as house and road construction. It is consistent with the findings of Singh et al. (2014) that more than 90% of dairy development activities in developing countries are carried out by women. Wangchuk and Wangdi (2015) also reported women being increasingly involved in animal husbandry and the growing leadership of women in domestic affairs in alpine environment.

Majority of respondents adopting both silage making and urea treated straw were middle aged farmers in the age range of 41–55 years (Table 1). The minimum and maximum age of respondents were 25 and 72 years, respectively. The study revealed that there is low adoption of forage conservation technology by young and old people. This is similar to the findings of Berhe (2015) and Kyalo (2016) that adoption of modern agricultural technology is low by both young and old aged people. In this study, while the low adoption by younger people may be linked to their interests on other economic activities, the low adoption by older people could be probably due to these technologies demanding more labour and capital (El-Osta and Morehart 1999; Quddus 2013).

Table 1 Gender and age wise adoption of forage conservation practices.

	Adoption of silage making		Adoption of urea treated straw	
	n	%	n	%
Gender				
Female	28	59.6	5	62.5
Male	19	40.4	3	37.5
Total	47	100	8	100
Age				
25-40	9	19.1	4	50
41-55	28	59.6	4	50
56-72	10	21.3	0	0
Total	47	100	8	100

Education level

Type and level of education received by respondents are presented in Table 2. Over half of the respondents who adopted silage making were illiterate, whereas about half of the respondents who adopted urea treated straw received primary level education. It shows that education background has less influence on adoption of forage conservation technologies. It contradicts the findings of Mwamuye et al. (2013) and Aysun and Cennet (2014) that individuals with better education are more likely to take up dairy innovation than the illiterate ones. In this study, there are two possible explanations for the weak influence of education on technology adoption. Firstly, besides high labor and capital demand, silage making involves killing of insects and worms, which is against the religious sentiments. Dorji et al. (2008)

Table 2 Type and level of education of dairy farmers adopting silage making and urea treated straw.

Type and level of education	Adoption of silage making		Adoption of urea treated straw	
	n	%	*n*	%
Monastic	4	8.5	1	12.5
Primary	15	31.9	4	50
Secondary	3	6.4	1	12.5
No education	25	53.2	2	25
Total	47	100	8	100

attributed low adoption of silage making by dairy farmers in peri-urban areas of Chamkhar valley in Bumthang to religious sentiments. Secondly, farmers seemed to lack adequate technical skills to prevent spoilage of silage. In the case of urea treated straw, it could be mainly due to high labor demand and cost of urea that led to its low adoption. Similar finding has been reported by Roder et al. (2001).

Size of household and landholding

It is a common tendency to assume that big households have more members to contribute to the farm work and therefore, result in more likelihood of adoption of farm technologies. However, it may not be always true as indicated by this study results, which show that the majority of respondents adopting both silage making and urea treated straw were medium sized households (Table 3). Although the big households may have more members for labor contribution, it is mainly the willingness of household members to contribute to the daily farm activities that influences adoption of agricultural technologies (He et al. 2007; He et al. 2008). Similarly, households owing 5.1 to 8.0-acre land were the maximum adopters of both technologies (Table 3). The result is similar to Vannasilpa (1969) who found that majority of non-adopters of high yielding varieties of wheat have land holding from small to ten acres.

Table 3 Households and size of land holding of dairy farmers adopting silage making and urea treated straw.

Household number and land size	Adoption of silage making		Adoption of urea treated straw	
	n	%	n	%
Household members (number)				
1-3	5	10.6	1	12.5
4-6	37	78.7	7	87.5
7-9	5	10.6	0	0
Total	47	100	8	100
Size of land holding (acre)				
0.6-5	8	17	4	50
5.1-8	30	63.8	4	50
8.1-13.5	9	19.1	0	0
Total	47	100	8	100

Dairy group membership

More members of dairy group adopted silage making (Table 4). It shows that the presence of dairy group has some influence on adoption of silage making. It is because the group facilitates exchange of information and offers better market opportunities, which encourage members to adopt better technologies for higher milk production. Our finding is similar to that of Rahelizatovo and Gillespie (2003) who reported that the presence of dairy cooperatives in the community has some degree of influence on the adoption of livestock farming technologies. However, there was no difference between members and non-members in the adoption of urea treated straw, indicating that the presence of dairy group has no influence on adoption of urea treated straw. Galdino et al. (2015) reported similar finding that the presence of cooperative does not significantly influence adoption of new livestock technologies.

Table 4 Dairy group membership of farmers adopting silage making and urea treated straw.

Membership	Adoption of silage making		Adoption of urea treated straw	
	n	%	n	%
Members	25	53.2	4	50
Non-members	22	46.8	4	50
Total	47	100	8	100

Cattle breed and herd size

Majority of respondents who adopted silage making owned crossbreed cattle (Table 5). Crossbreed cattle are known to respond well to better feed by producing more milk, which appears to have positive influence on the adoption of modern dairy farming practices. It is similar to the finding of Aksoy et al. (2011) and Mekonen et al. (2009 that farmers consider milk yield potential over breed of dairy cows when they adopt forage technology. However, majority of respondents who adopted urea treated straw owned both crossbreed and local cattle. Majority of respondents who adopted both silage making and urea treated straw had cattle herd size of 7-14 cattle heads. Although the bigger herd size encourages farmers to adopt dairy farming technologies due to increased chances of getting government support (Aksoy et al. 2011; Mekonen et al. 2009), our results demonstrate that it may not be true for Bhutanese farmers. This could be because bigger herd size demands more labor and time that farmers are less willing to provide. This is due to the fact that the traditional livestock production system in Bhutan is low input based with more dependence on government support.

Table 5 Cattle breed and herd size of dairy farmers adopting silage making and urea treated straw.

Cattle breed and herd size	Adoption of silage technology		Adoption of urea treated straw	
	n	%	n	%
Cattle breed (number of head)				
Crossbreed & local	14	29.8	6	75
Crossbreed	33	70.2	2	25
Total	47	100	8	100
Cattle herd size (number of heads)				
Less than 7	9	19.1	0	0
7–14	27	57.4	7	87.5
14–20	11	23.4	1	12.5
Total	47	100	8	100

CONCLUSIONS

Amongst socio-economic factors, the adoption of silage making and urea treated straw were influenced by gender and age, dairy group membership, and cattle breed. Females and middle aged dairy farmers adopted the technologies. More dairy group members adopted silage making. Dairy farmers with crossbreed cattle adopted silage making. Factors that did not influence technology adoption were size of household and landholding, level of education, and herd size.

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