Lessons from silage adoption studies in Honduras

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Abstract. Silage adoption has so far been low in the tropics, particularly under smallholder conditions. Innovation and adoption processes of silage technologies were promoted in drought-constrained areas of Honduras using a flexible, site-specific and participatory research and extension approach. A total of about 250 farmers participated in training workshops and field days conducted in 13 locations. Smallholders successfully ensiled maize, sorghum and/or *Pennisetum* spp. mainly in heap and earth silos whereas little bag silage (LBS) adoption was low. LBS proved useful as a demonstration, experimentation and learning tool. A 'silage boom' occurred in five locations where favourable adoption conditions included the presence of demonstration farms and involvement of key innovators, lack of alternative dry season feeds, perceived benefits of silage feeding, a favourable milk market and both extension continuity and intensity. The lack of chopping equipment was the main reason for non-adoption by low-income smallholders. The study showed that when targeting production systems needs and farmer demands, silage promotion can lead to significant adoption, including at smallholder level, in the tropics. This experience could contribute to increase the effectiveness and sustainability of silage extension in similar situations elsewhere.

Keywords: Dry season, farmer-to-farmer extension, forage conservation, participatory experimentation, tropical forages.

Introduction

Adoption of silage technologies has been low in the tropics and subtropics, especially by resource-poor smallholders, due to reasons such as lack of know-how, lack of financial means and insufficient benefits and returns on investment (Mannetje 2000). R&D needs to develop strategies to enhance adoption of forage conservation technologies by the poor. Innovative approaches to forage conservation with technologies such as little bag silage (LBS) can get silage into smallholder farming and livestock systems (Wilkinson *et al*. 2003).

This study was embedded in a research project conducted by CIAT (Centro Internacional de Agricultura Tropical) and the Honduran Directorate of Agricultural Science and Technology (Dirección de Ciencia y Tecnología Agropecuaria, DICTA) between 2004 and 2006. Silage making was promoted during farmer training workshops and field days in different drought-constrained areas of Honduras (Reiber *et al*. 2010). Research objectives of this study were to assess the adoption, potentials, and constraints of silage, including little bag silage (LBS).

Methods

A total of about 250 farmers participated in training workshops and field days conducted in 13 locations. Two extension strategies were applied: 'promotion of innovate-ion' (PI), characterized by stimulating acceptance and adaptation processes among silage novices, was applied in seven locations, and 'promotion of adoption' (PA), characterized by scaling-out of site-adapted solutions through farmer-to-farmer promotion, was applied in six locations. Furthermore, three different extension intensities were distinguished according to the number of training sessions and the presence of a technician to directly support farmers. Little bag silage (LBS) technology was used as a learning tool to demonstrate silage principles and experiment with adaptable technology components.

Research methods comprised surveys based on structured questionnaires, participatory experimentation with and evaluation of LBS, and organoleptic evaluation of silage fermentation quality. Farms were classified according to their herd size into small (1-20 head of cattle; 64 farmers), medium (21-50 head; 69 farmers), large (51-100 head; 58 farmers) and very large (>100 head; 31 farmers). A further grouping was made into silage adopters (farmers who made silage at least once and intended to re-use/repeat the practice), non-adopters, potential adopters (farmers who reliably intended to adopt) and rejecters (farmers who made silage at least once but decided to reject it). Data analysis included descriptive statistics and non-parametric tests.

Results

Continuous silage promotion can lead to significant adoption

As a result of the training and promotion activities, silage was adopted by 53% of participants, of which 20%, 26%, 36% and 18% were from small, medium, large and very large farms, respectively. Depending on the research location, the strategy 'promotion of innovation' (PI) resulted in total adoption of 0-29% with an average of 19%. Adoption increases ranged from –5% to 24% between

2003/04 and 2006/07 with an average increase of about 9%. In contrast, 'promotion of adoption' (PA) resulted in total adoption of 13-79% with an average of 57%. Adoption increases ranged from –40% to 57% between 2003/04 and 2006/07, with an average increase of about 31%. The difference in total adoption between the strategies was significant (P<0.05). With respect to extension intensity, adoption increases were 12.5%, 10.4% and 32.7% for low, medium and high extension intensity, respectively.

In the area of Yoro, where silage was promoted under strategy PA and high intensity in four locations, the total number of adopters increased from 11 farmers in 2002/03 to 102 farmers in 2006/07. The proportions of all livestock keepers making silage reached 23% in Yoro, 36% in Yorito, 41% in Sulaco and 37% in Victoria. The proportion of small-scale farmers making silage increased from 0% in 2003 to 16% in 2006/07. Lack of feed during the dry season, the presence of key silage adopters who experienced a positive effect of silage (mainly from maize and sorghum) on livestock production, improved milk market conditions, motivated farmer groups, experienced and trained extension staff and continuous silage promotion were identified to contribute to the dissemination of silage technology in the area. In contrast, less adoption occurred where one or more of the above mentioned conditions were not met (Reiber *et al*. 2010).

Increasing use of sorghum and Pennisetum *spp. ensiled in heap silos by smallholder silage novices*

While silage was made almost exclusively from maize in 2004, 3 years later about 49% of the silage adopters ensiled at least 2 different crops with an increasing share of sorghum [66% ensiling maize, 61% ensiling sorghum, 20% cut-and-carry grasses (*Pennisetum* spp. 'King Grass' or 'Camerún'), 6% sugarcane, 4% *Brachiaria brizantha* cv. Toledo and 4% cowpea (*Vigna unguiculata*)]. Small-scale farmers ensiled relatively more cut-and-carry grass than larger-scale farmers.

In 2007, the average area per farm dedicated to silage production was 2.3 ha, with 1.7 ha, 2.3 ha, 2.7 ha and 3.0 ha for small, medium, large and very large farms, respectively. The average areas of maize, sorghum and cut-and-carry grasses for silage were 1.2 ha, 1.0 ha and 0.1 ha, respectively. Small, medium and very large farms dedicated a larger area to sorghum than to maize, whereas on large farms the area of maize was more than twice the area of sorghum. Maize and sorghum silage were generally of high-quality and preferred to silages of other forages (Reiber *et al*. 2010).

The share of adopted low-cost silos such as heap and earth silos increased with decreasing farm size, whereas the share of cost-intensive bunker silos decreased (Fig. 1). However, this did not hold for very large farms, where more heap silos were used than bunker silos. According to location, preferences for specific silo types evolved (Fig. 2). Heap silos, the most adopted silo type (41%), were mainly used by silage novices in Yoro, Olancho and Jamastrán (El Paraíso) and were considered as 'silo for the poor'.

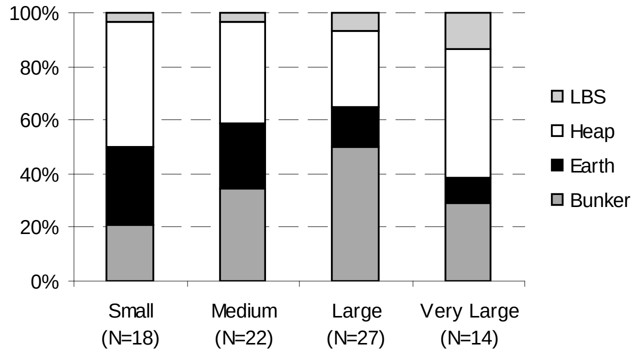

Figure 1. Silo types used by farm size categories.

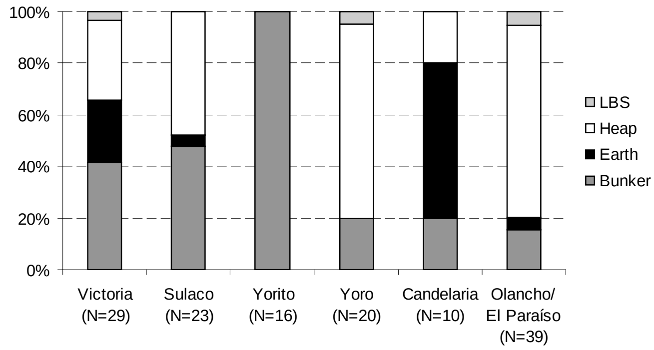

Figure 2. Adopted silo types per location (Reiber *et al*. 2010).

LBS and its potential as demonstration, experimentation and learning tool

Little bag silage was only adopted by about 5% of farmers. Main drawbacks were lack of suitable plastic material in rural areas and high aerobic spoilage losses due to plastic perforations caused by rodents. Advantages of heap silage over bag silos were *e.g.* less risk of aerobic spoilage losses, lower cost per unit of silage, and no need of investment in storage facilities (Reiber *et al*. 2010). The most suitable LBS material was a tubular bag with a plastic thickness of 152 µm (calibre 6). The use of a mould (*i.e.* a plastic barrel) during bag silage preparation was shown to ease compaction while protecting the plastic bag from tearing and puncturing: The bag is placed inside a vertically cut barrel, which is kept shut, *e.g.* with ropes, during compaction and subsequently opened to remove the bag.

Participatory experimentation with and evaluation of LBS revealed that molasses as an additive in wilted grass silage (T4) proved more effective for the reduction of pH than other additives (T5 and T6). Farmers' assessment of smell and their preference ranking were higher for all silages with additives than without, irrespective of DM content (Table 1). Farmers learned that: (1) short wilting and the addition of sugar-containing additives, especially molasses, improve fermentation quality of grass silage; and (2) wilted silages, although presenting a better smell, were more prone to increased spoilage losses (Reiber *et al*. 2009).

Considering perceived benefits and farmer criteria for silage adoption and rejection

Farmers perceived multiple benefits from silage, such as an average 50% milk yield increase, improved body condition,

Table 1. Participatory group evaluation of differently treated *B. brizantha* cv. Toledo LBS (Reiber *et al*. 2009).

Treatment	Bags (no.)	pH		Spoilage losses (%)		Smell (1-5)[2]	Preference ranking
		Value	SEM[1]	Range (average)	SEM		
T1: unwilted, without additive	3	4.4 bc	0.03	0-10 (5)	3	2	6
T2: unwilted, with 6% molasses	4	4.5 bc	0.07	0-7 (4)	2	4	3
T3: wilted, without additive	2	6.0 *	0.75	0-100 (50)	35	3	5
T4: wilted, with 6% molasses	4	3.9 a	0.04	0-80 (32)	20	4	2
T5: wilted, with 20% sugar cane	4	4.7 c	0.07	0-15 (5)	4	4	1
T6: wilted, with 6% sugar water	4	4.2 b	0.73	10-100 (40)	21	3-4	4

[1] SEM: standard error of the mean; [2] 1 = rotten, strong; 2 = bad; 3 = acceptable; 4 = good; 5 = very good; Different letters following means are significant difference (P<0.05); [*] T3 was excluded from test of significance between groups due to low number of bags and high spoilage losses.

fertility, and health of cows, feed security, reduced risk of production losses, lower labour requirements during the dry season, and a positive effect on pasture recuperation and production because of reduced grazing pressure.

The most frequently mentioned reason for adoption was the lack of dry season feed and the subsequent risk of livestock production losses (29%). Further motivating factors were neighbour farmers, who had already adopted and promoted the use of silage (15%), and an innovative extensionist, who himself was a prototype farmer and provided technical assistance (12%). The most frequently mentioned reasons for non-adoption of silage-making by smallholders were ‘non-availability of a chopper’ (46%) and ‘lack of money coupled with high costs’ (25%) (Reiber *et al*. 2010).

Discussion

A limitation in silage production is the lack of experience and sufficient understanding of silage-making principles, not only by farmers but also by extensionists (Froemert 1991). This becomes especially important when forages low in DM and water-soluble carbohydrates are to be ensiled. Using LBS technology as a demonstration and learning tool proved to be very useful in order to teach basic technological principles such as chopping, proper compaction and sealing within the course of a one-day farmer training or field day (‘learning by doing’) and to demonstrate the impact of various silage production practices (*e.g.* wilting, silage additives) on silage quality. As experienced during this study, the use of LBS as introductory silage system led to adaptations and adoption of earth, heap and bunker silos in several cases.

Besides the requirement of quality plastic bags, proper compaction and air-tight sealing, silage bags need to be protected from animals and direct sunlight to ensure success. Rats and mice were also reported as problems by Lane (2000). Therefore, some form of protection is recommended, either within an existing shed, or in a specialized building, *e.g.* on stilts (Lane 2000). An inexpensive and handy storage alternative is to bury the bags in a pre-dug trench as described by Otieno *et al*. (1990); this would assist in maintaining anaerobic conditions, compaction and lower temperatures.

The main constraint to silage adoption for resource-poor smallholders, *i.e.* lack of a chopper, could be overcome by its cooperative purchase, administration and use (Wilkins 2005). In his review of reasons for non-adoption of silage making in countries such as Pakistan, India and Thailand, Mannetje (2000) points out that cost, trouble and effort of silage making did not provide adequate returns and benefits, and concludes that technology of any kind will only be adopted if it can be part of production systems that generate income. In this study, farmers experienced an increase of milk yields as result of feeding high quality silage, mainly from maize and sorghum, to crossbred cows.

The successful and sustained use of silage may require more time and efforts than are allocated in most development projects and programs. Farmer motivation and participatory technology experimentation, evaluation and development are particularly important in areas where silage is less known. Thereby, farmer constraints and objectives should be linked to the purposes and objectives of silage making. Establishing the basis for wider silage adoption (*i.e.* identifying and training leader farmers) may last two years. Development projects should not stop at this stage but should scale-out adapted and efficient silage technologies through demonstrations and exchange of experiences using an integrated and participatory approach involving smallholders as well as larger-scale farmers.

Conclusion

The study showed that promotion of silage, including LBS, can lead to significant adoption in environments where: (1) seasonal lack of feed in drought-prone areas (that is, with more than 4.5 dry months) cause great production losses (*e.g.* reduced milk production); and (2) organised and motivated farmers with market-oriented dairy production existed or were emerging. LBS proved useful and could play an important role in participatory research and extension activities, as a demonstration, experimentation and learning tool that can be used to train basic technological principles and to get small-scale silage novices started with a low-risk technology. This experience could contribute to increase the effectiveness and sustainability of silage extension in similar situations elsewhere.

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