RESEARCH ARTICLE Agricultural Science Digest, Volume 46 Issue 3: 476-481 (June 2026)

Silage Practice and the Factors Related to its Adoption in the Chlef Area (Northwest Algeria)

Hemza Bouzina[1,2], Leyla Hadef[1,3], Brahim Hamad[1,3]

10.18805/ag.DF-803

ABSTRACT

Background: The study is aimed at exploring the decision to adopt silage practice among the farmers with a special interest in determining reasons behind the failure to adopt the practice.

Methods: The information was obtained in the form of structured face-to-face interviews of 526 farmers carried out between February 2024 and June 2025. The discussion analyzes the impact of the demographical factor, farm characteristics and other situational factors on the extent of uptake of silage technology.

Result: The results indicate that adoption of silage is far too low in the study region. However, a statistically significant correlation ($P<0.05$) was found between silage adoption and the major occupation of the respondent, whereby livestock breeders were more likely to adopt silage than those in other agricultural positions. Of all the farm-related factors, the production of grain and fodder crops indicates a close correlation with silage practice ($P<0.05$) and fodder producers are more likely to embrace the practice. Additionally, the purchase of land by farmers makes them more likely to adopt silage than when land is inherited. The majority of the respondents use silage, but not from their own production and they manage semi-developed farms. The study also highlights the major impediments to adoption, which include technical constraints and scarcity of water, both of which have demonstrated a significant statistical ($P<0.05$) effect on the non-adoption rates. Based on such findings, it is recommended that support strategies that focus on the promotion of silage practice should be implemented.

Key words: Adoption, Breeder, Farmer, Livestock, Silage.

INTRODUCTION

Livestock production forms a critical part of food security at the global scale. It sustains the rural livelihoods and is a foundation for broader economic growth. The livestock industry is specifically socioeconomically relevant to Algeria and particularly to the rural areas, where it serves as one of the key sources of livelihoods to many families (Bousbia *et al*., 2024). However, the industry is facing a steady issue, the most acute of which is a strong decrease in the production of fodder. Such degradation is attributable to the cluster of climatic and environmental stress, which encompasses regular droughts, the degradation of land, desertification, and the increase in the substitution of fodder crops with more lucrative cereals (Habib *et al*., 2025).

Due to the growing limitations, it has become a necessity to diversify the fodder sources and also to ensure a constant supply of livestock feed, particularly during the dry season. Methods like hay making and the use of multi-nutritional feed blocks have been implemented in the Algerian farms recently. Nevertheless, there is insufficient technical expertise and popularization of the practices, particularly in small-scale livestock farms (Guedjal *et al*., 2023).

Silage is a type of fermentation method used to preserve fresh forage that provides an intervention in the face of feed shortage, and maintenance of livestock productivity during drought periods (Kengoo *et al*., 2023; Bhatt *et al*., 2025; Eren *et al*., 2025). However, the degree to which it is implemented in Algeria and, by extension, most of the African continent is minimal. A survey of feed management strategies amongst certified organic producers of pineapples in Central Uganda found that only 10% of the respondents were aware of silage as a method of feed conservation (Kiggundu *et al*., 2014). This poor uptake is normally attributed to a set of barriers, such as high cost of implementation, poor compatibility with the current farming systems, and restricted access to practical and user-friendly silage technologies (Melese *et al*., 2019; Tufail *et al*., 2020).

There have been several studies undertaken on the adoption of silage in various parts of Africa (Muinga *et al*., 2015), but not in Algeria. Silage is not well utilized in Algeria,

[1]Department of Agronomy, Faculty of Natural and Life Sciences, University of El Oued, 39000 El Oued, Algeria.
[2]Laboratory of Biology, Environment and Health, Faculty of Natural and Life Sciences, University of El Oued, 39000 El Oued, Algeria.
[3]Laboratory of Hygiene and Animal Pathology, Institute of Veterinary Sciences, University of Tiaret, 14000 Tiaret, Algeria.

Corresponding Author: Hemza Bouzina, Department of Agronomy, Faculty of Natural and Life Sciences, University of El Oued, 39000 El Oued, Algeria.
Email: hbouzina895@gmail.com; bouzina-hemza@univ-eloued.dz

How to cite this article: Bouzina, H., Hadef, L. and Hamad, B. (2026). Silage Practice and the Factors Related to its Adoption in the Chlef Area (Northwest Algeria). *Agricultural Science Digest.* **46(3):** 476-481. doi: 10.18805/ag.DF-803.

Submitted: 17-10-2025 **Accepted:** 11-02-2026 **Online:** 26-02-2026

and the factors affecting this low adoption have not been well recorded.

The current paper thus proceeds to review the current level of silage practice and the major constraints hindering the widespread uptake of the practice among farmers and livestock breeders in the northwestern province of Chlef.

MATERIALS AND METHODS

Study area

The current study is conducted in the wilaya of Chlef, located in the southwest of Algeria, an area about 200 km west of Algiers and an extension of the wilaya to some 300 km, comprising some of the communes of this wilaya. The area is characterized by significant climatic diversity: the northern part uses a sub-humid Mediterranean climate and the southern part has more of a continental climate that is marked by sharp winter coldness and, without exception, very warm summers. Chlef is among the agricultural regions of Algeria that are of high potential and thus allow a wide array of farming activities.

Survey and data collection

To achieve the goals of the present study, initial consultations were made with experts from the Directorate of Agriculture. The consultations provided useful information on the main fodder resources of the Chlef region, the storage techniques that are being used, the possibility of their increased use, and the factors that restrain silage production in the region. In addition, the consultations provided background information about the major farmers and livestock breeders in the area. At this initial stage, secondary materials were compiled against some indicators: the situation with land tenure, land under cover of crops, population of livestock by type and the number of villages in the countryside. The expert consultation's findings helped to shape a structured survey questionnaire.

To assess the clarity, effectiveness, and relevance of the survey instrument in the collection of the outlined information, a pilot study was first conducted on a sample size of 20 participants. Based on the findings of this pilot exercise, the questionnaire was further refined. A formal survey conducted independently was then used to identify the farmers' fodder storage and usage practices, the most common fodder crops that are planted by the farmers, and the main barriers to silage adoption. The study involved the use of a structured questionnaire that was administered in face-to-face interviews with 526 livestock breeders and farmers in Chlef province. This survey was carried out between February 2024 and June 2025. The demographic composition of the respondents was presented in Table 1.

The current questionnaire was designed as a three-part tool. Section 1 required socio-demographic information such as age, gender, geographical residence, educational qualification, farming experience, and the nature of agricultural activity the farmer is involved in. In this section, the perceived major barriers to the use of silage as reported

Table 1: Socio-demographic profiles of the surveyed respondents (n = 526).

Variable	Groups	Frequencies (n)	Proportion (%)
Gender	Male	502	95.4
	Female	24	4.6
Age (years)	18-29	17	3.2
	30-39	80	15.2
	40-49	145	27.6
	50-59	106	20.2
	Above 60	178	33.8
Education	Primary	178	33.8
	Secondary	168	31.9
	Tertiary	166	31.6
	University	1	0.2
	None	13	2.5
Experience (years)	5-9	67	12.7
	10-19	264	50.2
	20-29	142	27.0
	Above 30	53	10.1
Agricultural activity	Principal	436	82.9
	Secondary	90	17.1
Operators' profession	Farmer	270	51.3
	Breeder	180	34.2
	Trader	22	4.2
	Employee	54	10.3
Agricultural training	Yes	109	20.7
	No	417	79.3

by the respondents were also obtained. Section 2 asked questions regarding the main factors that led to the non-adoption of silage practices, and Section 3 collected farm-specific data and current farming activities, which included the legal status of ownership, the type of farming operation, the total land area, the type of crops being planted, the quantity of livestock, and the current silage use. Most of the questions were closed-ended, having predetermined answers "yes" or "no", "male" or "female", or multiple choice answers such as "lack of appropriate technology" or "lack of mechanization".

All the interviews were done in person, and the researchers followed strict confidentiality measures to protect the data of the participants.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) version 27.0 was used to analyze the primary data collected. Descriptive analyzes were carried out and expressed in terms of means, frequencies, and percentages to shed light on respondent characteristics and the dominant trends in silage production. Chi-square tests or Fisher's exact tests were applied to test the group-wise differences and determine the statistical significance of the associations, as the situation necessitated. All the tests considered a P-value of less than 0.05 as statistically significant.

RESULTS AND DISCUSSION

Table 2 shows that the rate of adoption of silage technology among the respondents is very encouraging, as only five of the 556 respondents said they use the technology in their farms. The six main reasons why the non-adoption happened, as elicited by the questionnaire, were technical issues, which were the most commonly cited barrier, with 26.3% of those surveyed naming it as a non-adoption impediment. The rest were named in much lesser percentages: the absence of awareness (10.6%) and the absence of sufficient mechanization (13.1%).

The data set described in Table 3 explains the interrelationship between socio-demographic factors and the silage practices. The analysis of the discussed variables showed that most of them did not show statistically significant impacts on silage adoption (P>0.05). However, there were significant findings with respect to the occupational status, which had a strong connection with the silage use (χ^2= 7.674; P=0.040). Specifically, it was demonstrated that livestock breeders were more inclined to adopt silage practices compared to people who are crop farmers, trade, or work in non-agricultural industries.

The academic study, as summarized in Table 4, explains the connection between the farm-specific variables and adoption of on-farm silage production. The aspect of cereal farming versus fodder farming stands out as the factor that has the most influence on silage adoption (χ^2 = 386.300; P = 0.000). Farmers who planted fodder crops like maize and sorghum had much higher chances of practicing silage than those who planted cereal crops alone. The status of land tenure also turned out to be a critical determinant: agriculturalists whose land was owned under traditional or customary land tenure were highly unlikely to engage in silage production compared with those who owned land on formal land tenure basis (χ^2=326.200; P=0.000). The empirical results indicate that farmers who had bought their land were significantly more predisposed to adopt the silage technology to their enterprises as compared to the farmers who had inherited their land.

It was also found that 99.2% of the respondents consumed silage but did not produce it themselves (χ^2 = 104.200; P=0.010), which indicated the existence of a pervasive dependency on external providers of silage. In the academic debate of farm typology, the farm respondents that were semi-modern showed the greatest tendency to embrace the preservation of fodder in silage (χ^2 = 11.312; P=0.004). In addition, technical constraints and lack of water were the two major constraints to silage adoption as identified by the respondents (χ^2 = 7.356; P = 0.044). None of the other farm characteristics were found to have any statistically significant association with silage adoption; that is, type of agriculture operation, total land area, or number of cattle (P>0.05).

The information gathered by 526 respondents showed that about 99 per cent fell under the category of adopters of silage, with the non-adopters category being only 1 per cent. This makes the popularity of purchased silage in livestock feeding systems of the Chlef region seem to surpass the production of the same on-farm. These statistics are very close to those presented by Muinga *et al*. (2015) of Kenya, where the sample recorded the involvement in silage production among only 8.2% of the respondents. According to Makau *et al*. (2019), a low rate of awareness and adoption of forage conservation practices was reported among smallholder farmers in sub-Saharan Africa in general.

The information shows that in the case of the sample, technical challenges are found to be the major barrier to the adoption of silage practices. This conclusion aligns with Muinga *et al*. (2015), who attributed the low spread of forage conservation measures to the lack of feed resources and the lack of technical knowledge. In addition to the technical issues, water shortages, the lack of available funds, little mechanization, and a moderate degree of related awareness became secondary constraints.

Table 2: Main reasons for the non-practice of silage (n = 521: 99%).

Reasons	Frequencies (n)	Proportion (%)
Expensive	49	9.4
Bad experience (technical concerns)	137	26.3
Water sources deficiency	136	26.1
No money (state subsidy)	76	14.6
Shortage of mechanization	68	13.1
Lack of awareness	55	10.6

The current findings are in line with the literature that has already reported several obstacles to using silage technologies. As an example, Reiber *et al*. (2010) rated their high purchase and operating costs and the scarcity of the essential equipment, in particular, fodder chopping machines. The survey has provided a statistically significant relationship between silage adoption and the occupational category of the respondents (χ^2=7.674; P=0.040). In particular, the livestock breeders displayed a greater tendency to embrace silage technology than the farmers, traders and employees. This tendency could be explained by the fact that the breeders are more dependent on silage as a major feed source, which in turn increases their readiness to invest and utilize the technology compared to other occupational groups that use silage during the season only. Part-time farmers who considered dairying as a secondary occupation portrayed middle rates of silage adoption, hence showing the mediatory effect of the professional terrain on the implementation of silage. In an agricultural production scenario, Owhal *et al*. (2024) found that the majority of the cattle farmers rely on the supply of cereal-residue feed as opposed to growing dedicated forages exclusively, which limits the adoption of silage production.

The current study systematically compared various farm and agricultural practice features in order to determine the key determinants of silage production. The results show that the cultivation of cereals and forage crops is the most potent factor in this respect (χ^2 = 386.300; P=0.000). Farmers, who have in their crop rotations the forage crops, corn and sorghum, are more likely to adopt silage-making procedures than those whose fields are solely cultivated with cereals. Agronomic literature has always shown that forage crops, which are bred to be used as fodder, have an increased moisture content and higher nutrient density; those properties make them particularly suitable for ensiling.

The adoption of silage technology had a statistically significant relationship with the land ownership status (χ^2=326.200; *P*=0.000). In particular, landowners who had bought their land were shown to have a much higher propensity for silage farming as compared to landowners who had inherited their land. These findings suggest that new landowners are traditionally associated with a high level of motivation related to the modernization of agricultural production and with the improvement of the efficiency of operations through implementing innovative technologies. On the other hand, people who inherit land may hold onto traditional farming methods more strongly because their practices seem to be a family heritage, so they are more conservative and less likely to embrace change or innovation.

The discussion developed in this study reveals the statistically significant relationship between the use of silage and its adoption by the farmers. The results show

Table 3: Effect of socio-demographic profiles of participants on silage practices (n=526).

Variables	Groups	Silage practices (Yes) n (%)	Silage practices (No) n (%)	Odds ratio	(χ^2; F)	*P*-value
Gender	Male	5(1.0%)	497(99.0%)	1	0.241	1.000
	Female	0(0.0%)	24(100.0%)	/		
Age (years)	18-29	0(0.0%)	17(100.0%)	1	6.255	0.103
	30-39	3(3.8%)	77(96.2%)	/		
	40-49	0(0.0%)	145(100.0%)	/		
	50-59	1(0.9)	105(99.1%)	/		
	Above 60	1(0.6)	177(99.4%)	/		
Education	Primary	1(7.7%)	12(92.3%)	1	7.701	0.203
	Secondary	2(1.1%)	176(98.9%)	0.136		
	Tertiary	1(0.6%)	167(99.4%)	0.071		
	University	1(0.6%)	165(99.4%)	0.072		
	None	0(0.0%)	1(100.0%)	/		
Experience (years)	5-9	0(0.0%)	67(100.0%)	1	0.964	0.820
	10-19	4(1.5%)	260(98.5%)	/		
	20-29	1(0.7%)	141(99.3%)	/		
	Above 30	0(0.0%)	53(100.0%)	/		
Agricultural activity	Principal	5(1.1%)	431(98.9%)	1	1.040	0.594
	Secondary	0(0.0%)	90(100.0%)	/		
Operators' profession	Farmer	0(0.0%)	270(100.0%)	1	7.674	0.040
	Breeder	5(2.8%)	175(97.2%)	/		
	Trader	0(0.0%)	22(100.0%)	/		
	Employee	0(0.0%)	54(100.0%)	/		
Agricultural training	Yes	0(0.0%)	109(100.0%)	1	1.317	0.589
	No	5(1.2%)	412(98.8%)	/		

that, though the majority of the respondents use silage as animal feed at present, a small percentage of them are involved in the production of silage. The current study highlights a very sharp gap between the willingness of farmers to utilize commercially prepared silage in their feeding plans and the actual capacity of farmers to create silage on-site. Mannetje (1999) has indicated that this gap implies that a large segment of producers is ready to have silage in a ready-made form, but they do not have the time or resources to produce it by themselves.

The findings revealed that explanations provided regarding the non-adoption of silage were linked to the actual adoption, and the influence was found to be significant (χ^2 = 7.356; P=0.044). The most serious were the technical constraints and water shortage. All these barriers, which are based on low levels of awareness about silage, a lack of access to practical training, and high prices of equipment, will eventually reduce the likelihood of adoption. A subsequent statistical study in Honduras by Reiber *et al*. (2010) revealed that technical constraints formed a significant constraint to the adoption of silage, especially in small and medium farms. The inability to find equipment to buy early on inhibited the adoption of the forage chopper. The high cost of equipment was cited as a significant barrier to medium-scale operations, with large farms often finding silage production unnecessary, which reduced the spread of the technology to farms of a certain size.

The heavy capital outlay involved in purchasing the equipment was cited as one of the greatest barriers to medium-scale plants, making bigger farming units consider silage production unnecessary. As a result, the scale of farms where the technology was implemented was rather limited. This research lends credence to the results of Ndah *et al*. (2022) in Tanzania, which showed that inadequate access to water limits the ability of farmers to grow fodder, thus limiting the adoption of conservation practices like silage. It is interesting to note that some of the respondents who reported the scarcity of water as an obstacle still adopted the use of silage.

Table 4: Effect of farms and agricultural practice characteristics on silage practices (n=526).

Variables	Groups	Silage practices (Yes) n (%)	Silage practices (No) n (%)	Odds ratio	(χ^2; F)	*P*-value
Legal status of farms	Purchase	5(62.5%)	3(37.5%)	1	326.200	0.000
	Legacy	0(0.0%)	518(100.0%)	/		
Type of exploitation	Individual	5(1.2%)	425(98.8%)	1	1.125	0.590
	Collective	0(0.0%)	96(100.0%)	/		
Farm total area (ha)	1-9	2(0.8%)	237(99.2%)	1	0.783	1.000
	10-19	3(1.2%)	240(98.8%)	1.481		
	20-29	0(0.0%)	24(100.0%)	/		
	Above 30	0(0.0%)	20(100.0%)	/		
Agricultural practice type	Modern	0(0.0%)	14(100.0%)	1	11.312	0.004
	Semi-modern	5(3.4%)	141(96.6%)	/		
	Traditional	0(0.0%)	366(100.0%)	/		
Cereals and fodder crop planting	Durum wheat	0(0.0%)	451(100.0%)	1	386.300	0.000
	Soft wheat	0(0.0%)	70(100.0%)	/		
	Corn	1(100.0%)	0(0.0%)	/		
	Sorghum	3(100.0%)	0(0.0%)	/		
	Others	1(100.0%)	0(0.0%)	/		
Number of cattle	5-10	1(0.3%)	360(99.7%)	1	10.433	0.094
	11-20	4(3.1%)	127(96.9%)			
	21-30	0(0.0%)	27(100.0%)	/		
	31-40	0(0.0%)	6(100.0%)	/		
	Above 30	0(0.0%)	1(100.0%)	/		
Silage use	Yes	4(0.8%)	521(99.2%)	1	104.200	0.010
	No	1(100.0%)	0(0.0%)	/		
Reasons for the non-practice of silage	Expensive	0(0.0%)	49(100.0%)	1	7.356	0.044
	Technical concerns	0(0.0%)	137(100.0%)	/		
	Water sources deficiency	5(3.5%)	136(96.5%)	/		
	State subsidy	0(0.0%)	76(100.0%)	/		
	Shortage of mechanization	0(0.0%)	68(100.0%)	/		
	Lack of awareness	0(0.0%)	55(100.0%)	/		

CONCLUSION

There are seasonal changes in the quality and quantity of the forage in Algeria, which often cause shortages in the feed supply. Production of silage has been a practical and cost-effective solution to this predicament. Although preservation of feeds is gaining importance in recent commercial livestock production systems, silage is yet to be established widely among farm operators in the Chlef region, particularly those that do not grow forage crops, those bound by small-sized private land ownership, or those who stick to traditional farming systems completely free of mechanization and current technology. The continued spread of silaging practices depends on the promotion of fodder crop production, the easing of the conversion to individually owned arable land, the increased exposure to modern agricultural technologies and the facilitation of the targeted training and awareness-raising programmes that will highlight the usefulness of silage as an instrument to improving the productivity of livestock.

Conflict of interest

The authors declare that there are no conflicts of interest.

REFERENCES

Bhatt, N., Misra, D.B., Misra, A. and Tyagi, N. (2025). Analysing the effect of silage feeding on blood metabolities of different producing *Murrah* buffaloes. *Indian Journal of Animal Research*. **59(5):** 811-817. doi: 10.18805/IJAR.B-5426.

Bousbia, A., Gueroui, Y., Aouadi, A., Teweldebirhan, M.D., Bessa, R.J.B., Symeon, G. and Boudalia, S. (2024). Typology analysis of cattle farms in Northeast Algeria: Potential for sustainable development. *Agricultural Systems*. **218:** 103995. https://doi.org/10.1016/j.agsy.2024.103995.

Eren, A., Karadenız, E. and Kaya, A. (2025). Silage quality and economic efficiency analysis of Hungarian vetch (*Vicia pannonica* Crantz) and oats (*Avena sativa L.*) mixed at different ratios. *Legume Research*. **48(10):** 1795-1803. doi: 10.18805/LRF-707.

Guedjal, F., Bir, A. and Mouffok, C. (2023). Feeding practices of dairy owners in semi-arid region of Algeria. *Asian Journal of Dairy and Food Research*. **42(4):** 459-464. doi: 10.18805/ajdfr.DRF-299.

Habib, B., Saadaoui, M., Benmehaia, M.A., Kacimi Elhassani, M., Djoughlafi, A., Soufan, W., Nazim, M., Doghbage, A., Almutairi, K.F. and Belhouadjeb, F.A. (2025). Risk assessment of livestock feed supply in the context of climate change, a case from North Africa. *Applied Ecology and Environmental Research*. **23(1):** 269-289. https://doi.org/10.15666/aeer/2301_269289.

Kengoo, N., Bishist, R., Devi, S., Gautam, K.L. and Khalandar, S. (2023). Qualitative analysis of apple pomace based maize silage for animal feeding. *Asian Journal of Dairy and Food Research*. **42(3):** 292-297. doi: 10.18805/ajdfr.DR-1878.

Kiggundu, M., Kabi, F., Mette, V., Nalubwama, S. and Odhong, C. (2014). Management and use of dairy cattle feed resources on smallholder certified organic pineapple farms in Central Uganda. *Journal of Agriculture and Environment for International Development (JAEID)*. **108(2):** 207-225. https://doi.org/10.12895/jaeid.20142.253.

Makau, D.N., Vanleeuwen, J.A., Gitau, G.K., Mckenna, S.L., Walton, C., Muraya, J. and Wichtel, J.J. (2019). Effects of calliandra and sesbania supplementation on weight gain in dairy calves on smallholder farms in Kenya. *Preventive Veterinary Medicine*. **172:** 104787. https://doi.org/10.1016/j.prevetmed.2019.104787.

Mannetje, A.T. (1999). The Future of Silage Making in the Tropics. In: Silage Making in the Tropics with Particular Emphasis on Smallholders. Proceedings of the FAO Electronic Conference on Tropical Silage.

Melese, W., Assefa, A. and Dehninet, K. (2019). Improved forage production practice and challenges in Libokemkem district, Ethiopia. *Agricultural Science Digest*. **38(4):** 280-284. doi: 10.18805/ag.D-133.

Muinga, R.W., Saha, H.M., Lewa, K.K., Munga, G.S., Mambo, L.C., Bimbuzi, S. and Mburu, L. (2015). Cassava based napier grass silage for increased milk yield during the dry season in coastal Kenya. End of Project report Eastern Africa Agricultural Productivity Project (EAAPP).

Ndah, H.T., Schuler, J., Nkwain, V.N., Nzogela, B., Mangesho, W., Mollel, R., Loina, R., Zander, P. and Paul, B.K. (2022). Determinants for smallholder farmers' adoption of improved forages in dairy production systems: The case of Tanga region, Tanzania. *Agronomy*. **12(2):** 305. https://doi.org/10.3390/agronomy12020305.

Owhal, H., Kolhe, S., Bhokre, S., Doiphode, A., Bhalerao, S., Kardile, S. and Kolhe, R. (2024). Adoption of silage production practices by dairy farmers in western Maharashtra. International. *Journal of Agriculture Extension and Social Development*. **7(7):** 425-434. https://doi.org/10.33545/26180723.2024.v7.i7f.833.

Reiber, C., Schultze-Kraft, R., Peters, M., Lentes, P. and Hoffmann, V. (2010). Promotion and adoption of silage technologies in drought constrained areas of Honduras. *Tropical Grasslands*. **44:** 231-245.

Tufail, M.S., Mbuku, S., Mutimura, M., Guo, X. and Piltz, J. (2020). Utilisation of Conserved Forage To Improve Livestock Production on Smallholder Farms in Asia and Africa. [K.M. Broadfoot (Ed.)], Proceedings of the 22nd International Grassland Congress, Sydney, Australia.