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Improved silage manufacturing technique

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Abstract

In the rainy season, abundant, high-quality forage decreases in quantity and quality in the dry season. Silage production is necessary. Silos in large farms are expensive, micro-silos are envisaged for small farmers. The confection begins with a micro-silo in a fragile transparent plastic bag and small drums replaced by a resistant opaque bag and large barrel after in a welded tarpaulin. Green and ensiled plant materials are analyzed bromatologically and organoleptically. Tests on animals fed silage with silos in tarpaulin are methods. The plants used are Stylosanthes *guianensis CIAT 194* and *Zea mays* in early and late stages, *Brachiaria brizantha*, and *Pennisetum giganteum* tardif. Eight cows are tested with *Zea mays* ensilated in large tarpaulins and twelve lambs with *Pennisetum* compared to *Zea mays* ensilated in small tarpaulins. *Stylosanthes*, a legume rich in nitrogen, young silage has a loss of nitrogen. Harvested late, silage improves this content. The protein content of *Zea mays* ensiled increases and is significantly higher than that of *Pennisetum*. The organoleptic quality of silages from the first micro-silos does not fully satisfy good manufacturing practices. The technical aspects are oriented to the evolution of ensilassion. Cows fed silage in *Zea mays* tarpaulin have a high weight gain compared to controls. This of the sheep fed *Pennisetum* is lower than those fed *Zea mays*. *Pennisetum* presents an advantage by its high biomass. The silage manufacturing technique improves by satisfying good practices.

Keywords: fodder, silage, micro-silo, technical improvement in manufacturing

1. Introduction

Madagascar is a country dominated by a rainy season and a dry season. During the rainy season, forages for ruminants are abundant and of high nutritional quality, while in the dry season their values decrease in both quantity and quality. In addition, through the programme of the Partnership Research Facility/Altitude and Sustainability Production System (DP/SPAD) in the study of the animal 'place in the conservation of nutrients in production systems with low input levels (Mohamed-Saleem M A, 1994) [9], the FOFIFA/Centre National de la Recherche Appliquée au Development Rural has realized the cultivation of plants in direct seeding under Vegetal Cover (SCV). Thus, the Integration Agriculture Livestock (IAE) was initiated. And high biomass was produced under upland conditions during the rainy season (GSDM 2008) [6]. Natural tropical forages are deficient in nitrogen. The nitrogen value of grasses decreases rapidly with regrowth age (César J, 2001) [1]. Nutritional deficiency is observed during the dry season.

As a result, the activity, in the project Recycling of Plant and Animal Waste (BIOVA) followed by the project Ecological intensification pathways for the future of crop-livestock integration in African agriculture (EcoAfrica), encourages the practice of conservation systems such as silage and fanaison by fodder derived from these SCV plants. The development of silo silage is expensive and even more, it is used for large farms. The majority of farmers own only small herds. Procedures for improving micro-silo manufacturing techniques were considered. At the beginning, a transparent and fragile plastic bag and small drums were used, then replaced by an opaque and resistant plastic bag and large drums and at the end, a welded tarpaulin. At all stages of the study, green and ensiled plant materials are analyzed bromatologically and NIRS. Animal tests with silage with micro-silos in welded tarpaulin are performed. The improvement of production techniques is determined by the nutritional value of silages and their organoleptic quality.

Materials and Methods

The activity has been started as long as the fodder is still green. The method of harvesting fodder for silage is presented in Table 1.

Table 1: Method of Harvesting Forage

Fodder	Stage
Early *Zea mays*	Milky stage
Late *Zea mays*	Seed maturity
Early *Stylosanthes* CIAT 194	Beginning of spike
Late *Stylosanthes* CIAT 194	Total spike
Brachiaria brizantha	Total spike
Pennisetum giganteum	Spike

Stylosanthes guianensis CIAT 194 is one of the cover plants used in the Support Project for the Dissemination of Agro-Ecological Techniques in Madagascar. These forage legumes perform two essential functions in pastures and rangelands, On the one hand, they balance the feed ration of livestock by their wealth of nitrogen and mineral salts, and on the other, they improve the fertility of the soil by enriching it with nitrogen (Toutain B *et al.*, 1994) [10].

Brachiaria brizantha, a grass, is also one of these cover plants and is of African origin. It adapts to a wide variety of sandy or acidic soils but does not tolerate poorly drained soils. It is very drought resistant and remains green throughout the dry season. Its hardiness, adaptation to drought, and its ability to spread make it a forage species particularly adapted to the spread of artificial pasture in rural areas. It is a source of protein and carotene at the end of the dry season and is easily ensiled (Granier P and Lahore J, 1966) [4]

Pennisetum giganteum, is a large perennial grass, up to 5m tall with a relatively long inflorescence and powerful stem. Its root system is strong and fibrous, capable of rapidly descending to a depth of 2 m to extract water and minerals (Xhanxi L, 2010) [11]. This plant is very resistant to drought and remains green even during the dry season. The annual yield of this grass is 300 Tons of green matter per hectare, (Web3)

Zea mays, an annual plant with a solid upright stem, consists of nodes and internodes and is 1.5 to 3.5 m tall and 5 to 6 cm in diameter. A monoecious plant, it bears male and female flowers on the same stem. Its root system is fasciculated. It is superficial and does not exceed 50 cm of depth. Adventitious aerial roots can also form on the lower nodes and settle in the soil. (Sumbuso 2006)

It generally grows at an altitude of 1800m, with an optimal temperature of 19°C, and an annual rainfall of 100mm of water during the entire period of its vegetation. *Zea mays* requires deep, soft, cool, relatively light and humus soils. (Sumbuso 2006).

The silage was made following the following steps: manufacture of micro-silos, cutting and transport of the fodder, grinding (2 to 5 cm) and placing in silo by aggressively pressing the fodder. A good settling reduces the maximum air, a very important condition to obtain a good silage. (Web1 and Web2)

It is also essential to ensure that forages are not contaminated with soil or plant waste and that they can retain leafy parts. The quality of the silage depends on the harvest conditions of the plant as the beginning of the seeding for the grasses: Brachiaria brizantha, *Pennisetum giganteum* and *Zea mays*. They can maintain a food value as close as possible to that of green forage. (Paragon B.-M *et al*, 2004) [5]

After 2 and a half months of ensilassions, the animal test is carried out. In the meantime, the bromatologic and SPIR analyses of these green and ensiled fodder were carried out in the laboratory. Organoleptic tests on these silages have been carried out.

Animal tests are carried out on cows fed micro-silo silage in large and small welded tarpaulin on sheep.

For cows, the experiment is carried out on 8 cows, 4 for the control lot and 4 for the tested lot. The controls are in extension while the tested are in free stall. The rations distributed to animals are not iso-protein or iso-energy but the objective is to determine the difference in the use of a traditional method between the productions of silage. Its experimental apparatus is presented in Table 2.

Table 2: Experimental system for cows fed silage in micro silo in large welded tarpaulin

Ration	Controls	Tested
Natural pasture (8h)		
Zea mays silage		9Kg/d
Rice straw	10 to 15 Kg/d	
Food supplement	1,5 Kg/d	

For sheep, 12 locally bred lambs, about 14 months old and with an average weight of 18.45 1.45 kg, divided into 3 lots of 4: control lot, lot *Pennisetum g*, and lot *Zea mays* were processed. In order to ensure the homogeneity of these sheep and to reduce the effect of the environment, all lots are similar to each other. Each individual was placed in boxes measuring 1.4 m x 2.4 m in size.

These animals have been vaccinated against pasteurellosis and peste des petits ruminants. Each sheep received a dose of 1 ml of Ivomec-D (ivermectin plus, clorsulon), as well as a half-tablet of Albendazole 250 mg of IMVAVET, of which a second dose was given 10 days later. Regular animal health monitoring was also carried out by a veterinarian.

In this study, in order to facilitate the identification of animals, RFID (Radio Frequency Identification) electronic chips were used. The objective of this test is to compare the effect of *Pennisetum giganteum* silage with that of *Zea mays*.

Table 3: Experimental device for sheep fed silage in micro-silo in small welded tarpaulin

Ration	Controls	Lot *Pennisetum g.*	Lot *Zea mays*
Cynodon	2,29	1,62	1,69
Pennisetum giganteum silage	-	0,56	-
Zea mays silage	-	-	0,50
Rice bran	0,52	0,58	0,50
Groundnut cake	0,01	0,01	0,01

Thus, the weight of cows and sheep is monitored.

Results

The results of the analyses of all forages studied are presented in tables 4, 5, 6 and 7. For all tables DM: Dry Matter; MM: Mineral Matter; IA: Insoluble Ash; Ca: Calcium; P: Phosphorus; CP: Crude Protein; CB: Crude Fiber

Table 4: Chemical composition of fodder preserved in transparent plastic bags and small drums

	Brachiaria brizantha			***Zea mays***						***Stylosanthes guianensis CIAT 194***					
	Green	**Drum**	**Bag**	**Geen**		**Drum**		**Bag**		**Green**		**Drum**		**Bag**	
	Late			**Early**	**Late**	**Early**	**Late**	**Early**	**Late**	**Early**	**Late**	**Early**	**Late**	**Early**	**Late**
DM	43,8	40,2	40,2	24,2	33,6	20,4	30,4	21	43,5	44,8	66,2	36,7	58,5	39,1	56,7
MM	11,7	7,3	7,3	6,7	4,3	9,3	4	4,7	5,3	4,7	4	9,3	4,3	5,3	4,7
IA	5,3	4	4,7	1,7	1	1,7	0,7	1	1,7	0,7	1,3	0,3	0,7	0,3	0,3
Ca	0,7	0,17	0,46	0,86	0,47	0,22	0,48	0,58	1,03	1,26	0,19	0,96	1,28	0,98	1,07
P	2,39	1,81	2,16	2,5	2	1,54	0,9	1	2,09	0,05	0,44	1,99	0,57	2,2	2,09
CP	6,8	8,9	8,6	8,1	5,2	8,5	5,8	10,2	7,8	11,3	7,9	3,8	9	4,5	8,9
CF	38,3	62,3	53,3	35,2	39,1	37	27,8	28,8	32,5	49,7	54	50	48,3	34,5	42

Table 5: Chemical composition of fodder preserved in opaque bags and large drums

	Brachiaria brizantha			***Zea mays***						***Stylosanthes guianensis CIAT 194***					
	Green	**Drum**	**Bag**	**Geen**		**Drum**		**Bag**		**Green**		**Drum**		**Bag**	
	Late			**Early**	**Late**	**Early**	**Late**	**Early**	**Late**	**Early**	**Late**	**Early**	**Late**	**Early**	**Late**
DM	40,8	49,6	47,6	30,5	35,7	26,5	26,3	20,8	23,0	31,8	39,0	39,5	49,3	38,3	48,9
MM	8,3	5,2	7,3	8,0	5,8	13,2	4,8	15,6	6,9	7,4	4,8	12,6	6,3	15,2	8,1
IA	1,15	6,13	7,47	1,24	1,36	0,72	1,79	0,97	2,96	0,71	0,17	0,71	1,03	0,82	1,04
Ca	3,86	0,80	0,79	1,76	2,96	0,90	0,82	0,55	0,39	1,66	1,92	3,78	2,97	2,17	1,51
P	0,99	0,65	0,46	0,70	0,79	1,76	0,51	0,95	0,39	0,97	0,74	1,42	0,18	0,38	0,09
CP	8,4	9,0	8,9	15,6	13,5	13,0	12,6	13,9	12,9	17,6	11,8	16,7	13,3	18,3	13,5
CF	33,4	30,4	31,2	29,7	33,4	26,5	28,6	25,4	27,8	33,5	37,9	30,5	36,0	26,7	31,4

Table 6: Chemical composition *Zea mays* preserved in large welded tarpaulin

	Green	**Ensile**
DM	27,1	25,6
MM	5,6	8,7
Ca	2,48	2,40
P	0,20	0,10
CP	7,3	11,3
CF	33,2	29,9

Table 7: Chemical composition of fodder preserved in small welded tarpaulin

	Pennisetum giganteum		***Zea mays***	
	Green	**Ensile**	**Green**	**Ensile**
DM	28,3	29,0	28,5	28,4
CP	8,3	8,3	9,1	9,3
CF	30,0	31,2	28,8	29,7
MM	9,4	10,0	6,8	6,9

Table 8 shows the weight evolution of cows fed *Zea mays* silage in large welded tarpaulin.

Table 8: Weight changes in cows fed *Zea mays* silage in large welded tarpaulin

Weeks	Weight in Kg						
	Initial	1	2	3	4	5	6
Control cows	251,75	251,5	253,75	251,00	245,25	240,75	236,50
Cows tested	288,00	290,25	298,25	302,75	306,25	310,00	312,75

Cows fed silage have a weight increase of 288.00Kg to 236.50Kg but the control cows have regressive weights of 251.75Kg to 236.50Kg.

The weight evolution of the sheep tested by Pennisetum giganteum compared with those fed with Zea mays ensilated in small welded tarpaulin bags is shown in Table 9.

Table 9: Comparison of weight trends of sheep fed *Pennisetum giganteum* and *Zea mays*

Weeks	**Weight in Kg**								
	Initial	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Control	18,7	19,2	19,8	20,0	20,5	20,8	21,1	21,4	21,6
Zea mays	19,5	20,2	20,9	21,4	21,9	22,4	22,8	23,2	23,6
Pennisetum giganteum	17,4	18,1	18,8	19,1	19,4	19,8	20,1	20,4	20,7

On all different types of food, weight increases.

Discussion

The essential value of fodder is based on its protein content. Figures 1, 2, 3 and 4 illustrate the protein content of fodder from different types of micro-silos.

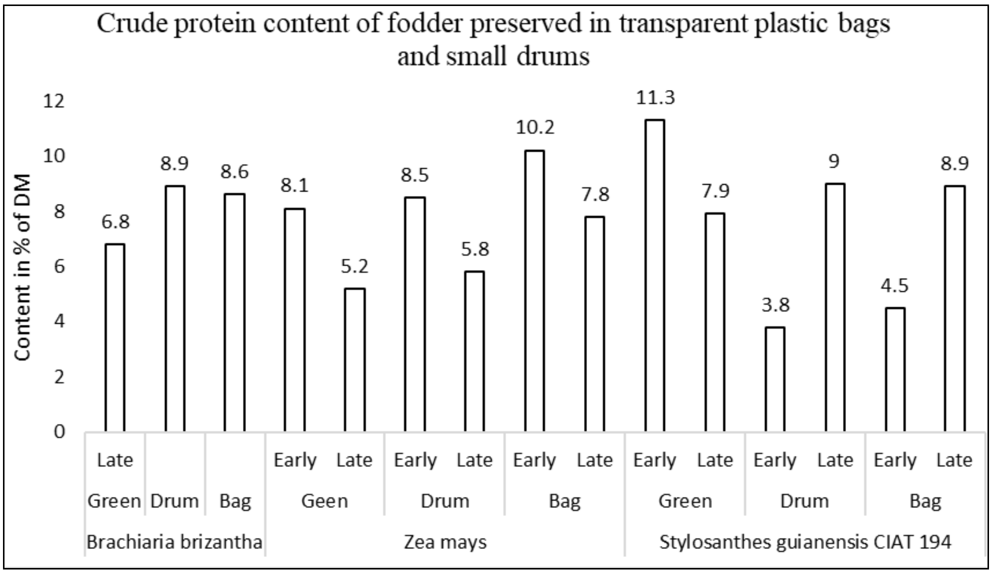

Fig 1: Crude protein content of fodder preserved in transparent plastic bags and small drums

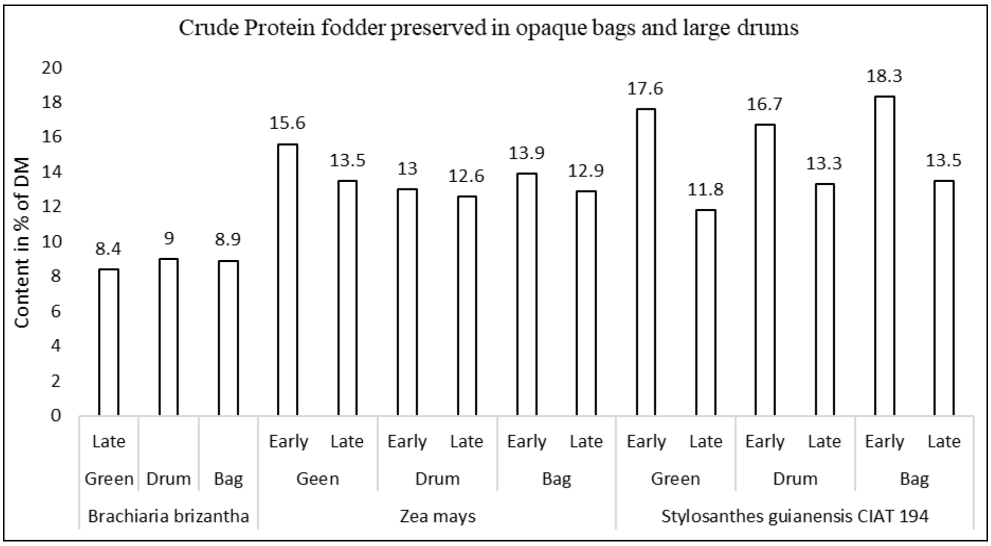

Fig 2: Crude Protein content of fodder used in opaque bags and large barrels

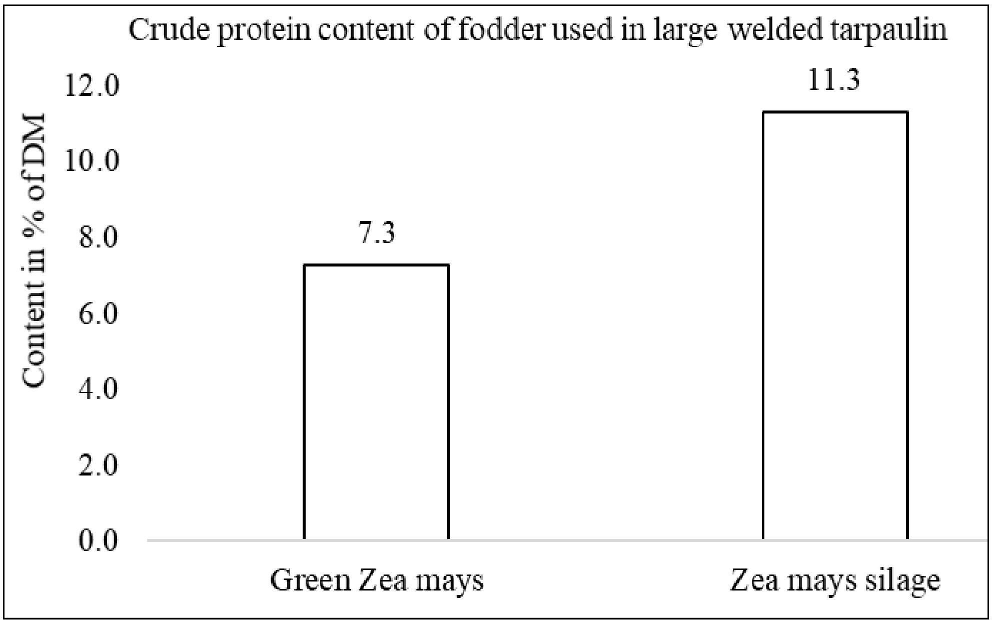

Fig 3: Crude protein content of fodder used in large welded tarpaulin

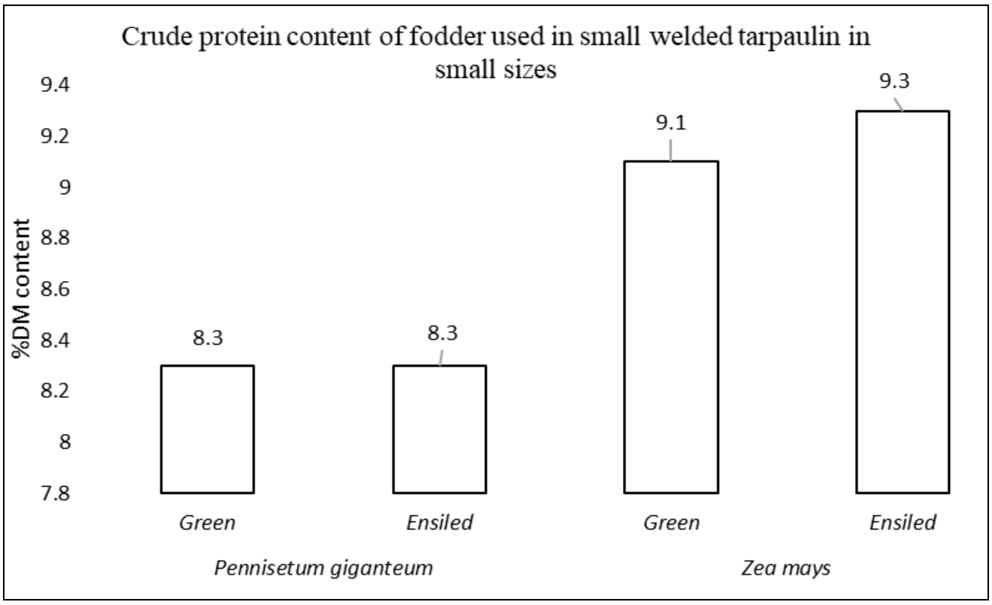

Fig 4: Crude protein content of fodder used in small welded tarpaulin

Stylosanthes guianensis CIAT 184 belonging to the family of legumes, has a fairly high total nitrogen content. It is then essential to limit its quantity in the ration of dairy cows to avoid ammoniacal poisoning that can cause the animal to explode. Young and still green, Stylosanthes have a good protein content. When Stylosanthes was ensiled, there was a loss of nitrogen. Being a legume, it has a low soluble sugar content that makes it difficult to ferment milk. This promotes the proliferation of bad butyric bacteria, resulting in ammonia loss as a result of poor fermentation. Conversely, silage improved the protein content for *Stylosanthes guianensis CIAT 184* harvested late whether it was bagged or in cask. Indeed, *Stylosanthes* are harvested late contain less water, allowing the forage to ferment well.

In the case of *Zea mays* ensilated, the protein content increases.

Ensilated *Brachiaria* in both types of silos have an equivalent protein content when they are still green. This indicates that the fermentation went well and that all the conditions to have a good silage product were met: the total anaerobic of the medium, a slightly acidic pH.

The number of silos must be adapted to the size of the herd and the feeding schedule of the cows.

For the comparison of *Pennisetum giganteum* and *Zea mays* forages, the protein content of *Pennisetum giganteum* ensiled is similar to that in the green state. However, for *Zea mays*, the protein content increases when it is silaged, this was observed during the silage previously carried out.

But the protein content of *Pennisetum giganteum* is lower than that of *Zea mays* in both the green and the ensiled state.

The organoleptic tests of the silages are carried out just at the opening

- Silage in a small drum and transparent plastic bag When silage was made in this form, the drum was not filled to the top edge of the container, leaving air between the forages and the lid resulting in:
- A strong presence of mould on the upper part of the drums and around the holes in the bags
- A strongly marked black colour, with a rancid odour mixed with the smell of vinegar due to the presence of mould on the upper part.

On the other hand, the lower part (50%), remains intact, and has all the characteristics of a good silage with its slightly browned colors, and its pleasant smell of tobacco.

In general, the aspects of the initial forages were found. The fodder is all browned, with a pleasant smell of tobacco mixed with a little light caramel. These characters reveal a good silage. Only *Stylosanthes guianensis* CIAT 184 at the early stage have a slightly dark green colour but still have the smell of tobacco, characteristic of a good silage. This observation indicates a poor fermentation process and not unsuccessful silage. In fact, *Stylosanthes guianensis* CIAT 18 being legumes, the sugar content is low enough for the fermentation process to be activated quickly putting to profit the development of bad bacteria that are butyrics. In addition, *Stylosanthes* is a cheap source of protein and its forage would allow animals to improve their physical condition (Msiska H D C). Therefore, a preliminary prefanage and the addition of a preservative or grasses are necessary.

- Silage in a large drum and plastic bag opaque and resistant subsequently, the drums were well filled to the top edge and were well packed. The mould appears a small part about 2 cm deep. This reflects the absence of air. Bagged silage also has mould on its seam through which the air penetrates from where unfavourable side of this improvement. Thus the smell and colour of the silages allow us to conclude that the technical follow-up stated earlier has been well carried out except on the hashing of the fodder at the level of the peasants.
- Cubic Welded Tarpaulin Silage (Zea mays). The different fractions of the plant such as stems, leaves, spikes, stalks and seeds remain well recognizable. Silage generally has a green colour reminiscent of the initial colour of the plant but with some brown hue. The smell is fruity with a slight aroma of alcohol. The mouldy parts are found in the first twenty centimetres of the upper part of the silo. They are characterized by

increased moisture and brown colour with whitish spots.

- Cylindrical welded tarpaulin silage (Pennisetum Giganteum and Zea mays). The different fractions of the plant such as stems, leaves, spikes, stalks and seeds remain well recognizable. Silage is usually brown in colour. The smell is fruity with a slight aroma of alcohol. Mould is almost non-existent.
- Figures 4 to 9 then define the effect of these different feeds on animal growth:

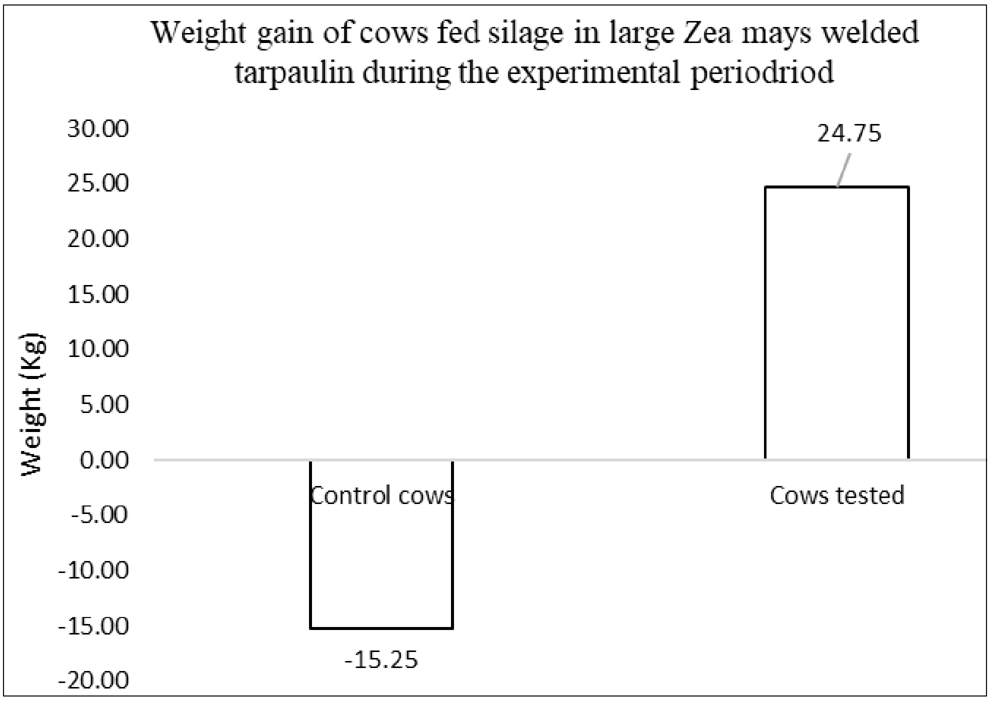

Fig 5: Weight gain of cows fed silage in large *Zea mays* welded tarpaulin during the experimental period

During the welding period, the extension (control) cows have an average weight loss of 8 kg for the first experiment and 15.25 kg for the test with the welded tarpaulin silage. This is normal because during this season, pastures are poor and contain few nutrients. So there is a shortage of feed, not to mention the watering problem. The animals are weakened leading to this loss.

The practice of conserving forage biomass is therefore very effective in preventing weight loss.

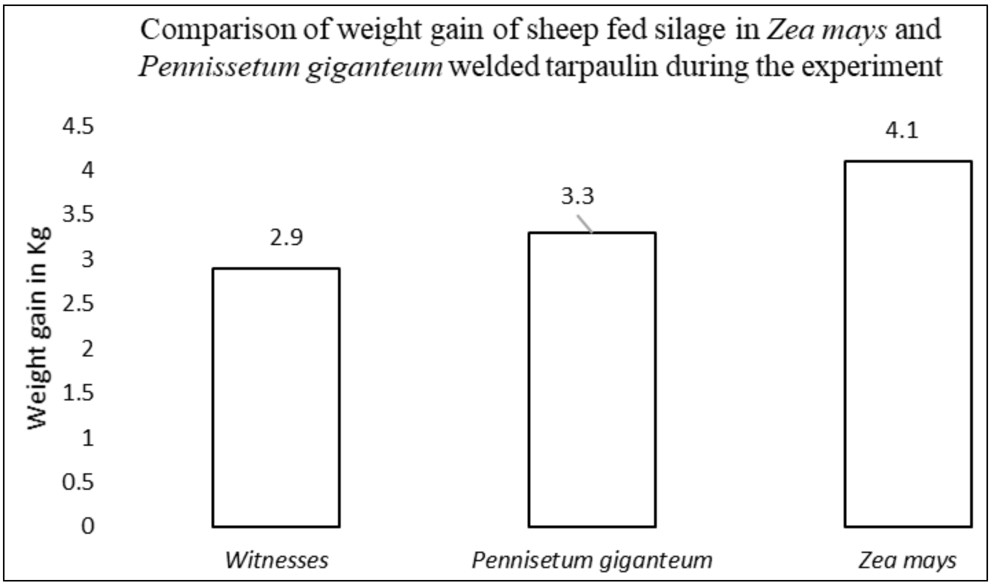

Fig 6: Comparison of weight gain of sheep fed silage in *Zea mays* and *Pennisetum giganteum* welded tarpaulin during the experiment

The weight gains of sheep are proportional to the protein content of their food. But unlike cattle, sheep can eat everything they see during the dry season, and do not suffer too much, they have no negative gain. The weight gain of animals fed by Pennisetum giganteum is lower than those fed by Zea mays because their need is not satisfied and even if the refusal decreases as they consume Pennisetum giganteum.

Conclusion

Forage biomass conservation is therefore very effective in preventing weight loss. As for farmers, semi-extensive farming is practically beneficial to avoid weight loss of cattle in the dry season.

For farmers with only a few herds (2 to 4), silo silage is expensive, which is why micro-silos such as barrels and/or plastic bags are essential. Indeed, this technical improvement shows a success. Good silage with a brown color and smell tobacco caramel is obtained. But the small-cask silo shows 50% of the musty silage. The amount of silage is small and can feed only four cows at a time per day. So it is necessary to produce several barrels during the dry season. Silos made of transparent, fragile plastic bags that are easily exposed to light have mould on each hole. However, with the larger drums and the opaque and resistant bags, only 6% of mold is found. Moreover, the manufacturing processes are more respected compared to the first experiment. The bags are opaque but on the seam mold appears. They can feed four cows for five days. Between the two packaging, the one with the barrel is more successful but if we want to have a good silage with the bags, we must weld the tarpaulins because the seam allows air to penetrate. The most acceptable results are obtained when there are no holes and the mould is less than the amount of silage manufactured. The packaging makes it possible to feed four cows for two weeks.

Pennisetum giganteum and *Zea mays* silages are made in micro-silos in cylindrical welded tarpaulins of 75 kg. They are also acceptable as micro-silos in cubic welded tarpaulins. The nutritional value of *Pennisetum giganteum* silages is lower than that of *Zea mays*. This leads to weight gain proportional to the sheep. The feed consisting of *Pennisetum giganteum* silage must be supplemented with other protein-rich raw materials. However, in particular, the great advantage of *Pennisetum giganteum* forages lies in their high biomass compared to *Zea mays*. They can feed ruminants in both the green and the silage state. They are not in competition with human food.

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