Forage Seminar

Antsirabe
November 25th-28th 2019

Réseau ARChE_Net
Projet ECLIPSE

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LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT

Contents

Introduction

The ARChE_Net team is composed by 31 partners in 7 Indian Ocean countries.

3 MAIN CHALLENGES

- Satisfy the increasing food demand in animal production
- Compensate climate fluctuations
- Compensate economic fluctuations of input and raw materials

3 MAIN GOALS

- Define strategies to adapt ruminant production systems to environmental and socio-economic changes
- Strengthen the exchange of skills and sharing analytical and training capacities
- Share data and providing innovative management tools

Sustainable forage based livestock production

PETERS, M. et al. (CGIAR)

THE ROLE OF ANIMAL SOURCE FOODS IN HUMAN HEALTH

In addition to micronutrients, animal source foods contain essential amino acids and proteins. Although many other foods possess these and other nutrients, such diverse foodstuffs are often unavaible, unaffordable or inaccessible by the poor. To meet her daily iron need, a healthy woman would have to eat eight times more spinach than cooked cow's liver because the iron in spinach is bound to fiber, it is less bioavailable than that in liver. Milk supports child growth and may provide greater benefits in nutritionally worse-off communities. Meat can improve outcomes in a child's cognitive development. The forage-based cattle sector plays a key role in food and nutrition security but also in poverty alleviation. Improvements in animal fedding and sustainable intensification are the most promising strategies for mitigating these impacts.

But it is also associated with causing negative environmental impacts such as emissions of greenhouse gases, degradation of land and deforestations, water pollution and depletion, biodiversity threatened.

The inclusion of forages in cattle production systems has the potential to increase yield, efficiency and nutritional value of livestock production, with less environmental impact. However, adoption and use by the pro-

ducers remain limited due to :

◊ Economic factors
◊ Lack of knowledge
◊ Limited perceived benefits by the producer
◊ Risk aversion and uncertainty

LIVESTOCKPLUS - THE SUSTAINABLE INTENSIFICATION OF FORAGE

Three innovative/intensification processes :

◊ Genetic : improved yield, quality, stress resistance
◊ Ecological : better management of mixed crop-forage-tree livestock systems
◊ Socioeconomic : better management of mixed crop-forage tree livestock systems

Livelihood benefits :

◊ Food and nutrition security
◊ Manure organic fertilizers
◊ Adaptation to climate change
◊ Income generation
◊ Poverty alleviation

HOW TO IMPROVE THE LIVELIHOODS OF POOR CROP-LIVESTOCK FARMERS IN THE TROPIC

Intensifying production while reducing the environmental footprint, by mitigation and adaptation, an unique breeding program which generates apomictic Brachiaria and Panicum hybrids for the tropics adapted to stresses, building the next generation hybrids for floodable regions, invest in additional modernization efforts.

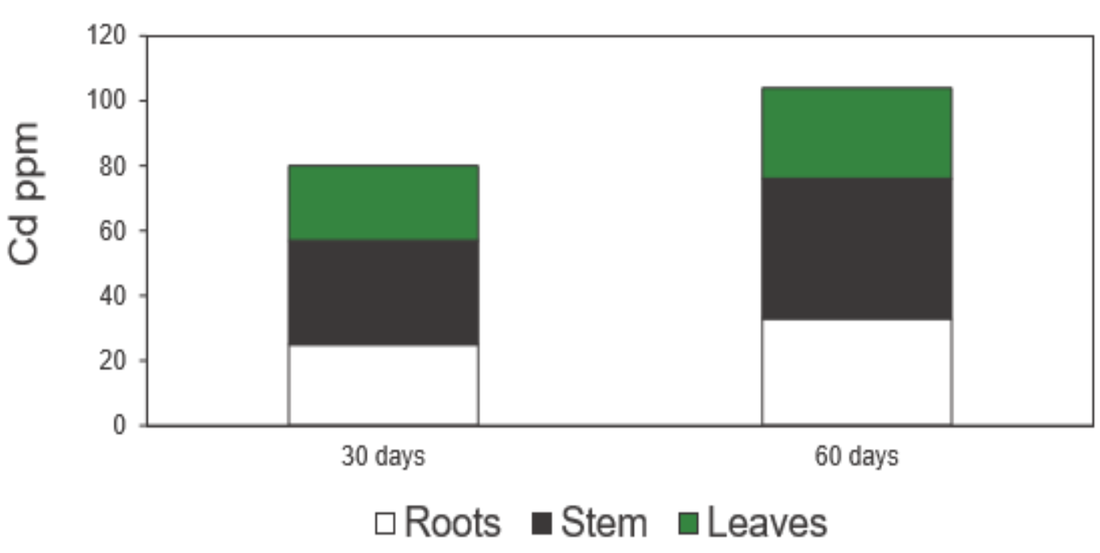
FORAGES ENVIRONMENTAL ASSESSMENT

Cleaned - ex-ante environmental impact assessment of livestock systems

- Models (MS-Excel, R) – developed jointly by CIAT and ILRI
- CLEANED assesses greenhouse gas emissions, water use, carbon accumulation, soil erosion, nutrient balances, productivity, profitability at farm level
- Works in data-poor environments, farmers and other value chain actors provide feedback

Phytoextraction potential of cadmium by Napier grass (CIAT 26850)

- Hydroponic study to test ability of Napier grass to uptake Cd
- Cd accumulated mostly in above ground tissue
- Nutrient disorders were symptoms associated with excess of cadmium, but only noticeable after ~40 days old plants
- > 90% of Cd could be recovered from shoot tissue by washing tissue on solutions of 0.5 N HCL



Conclusions

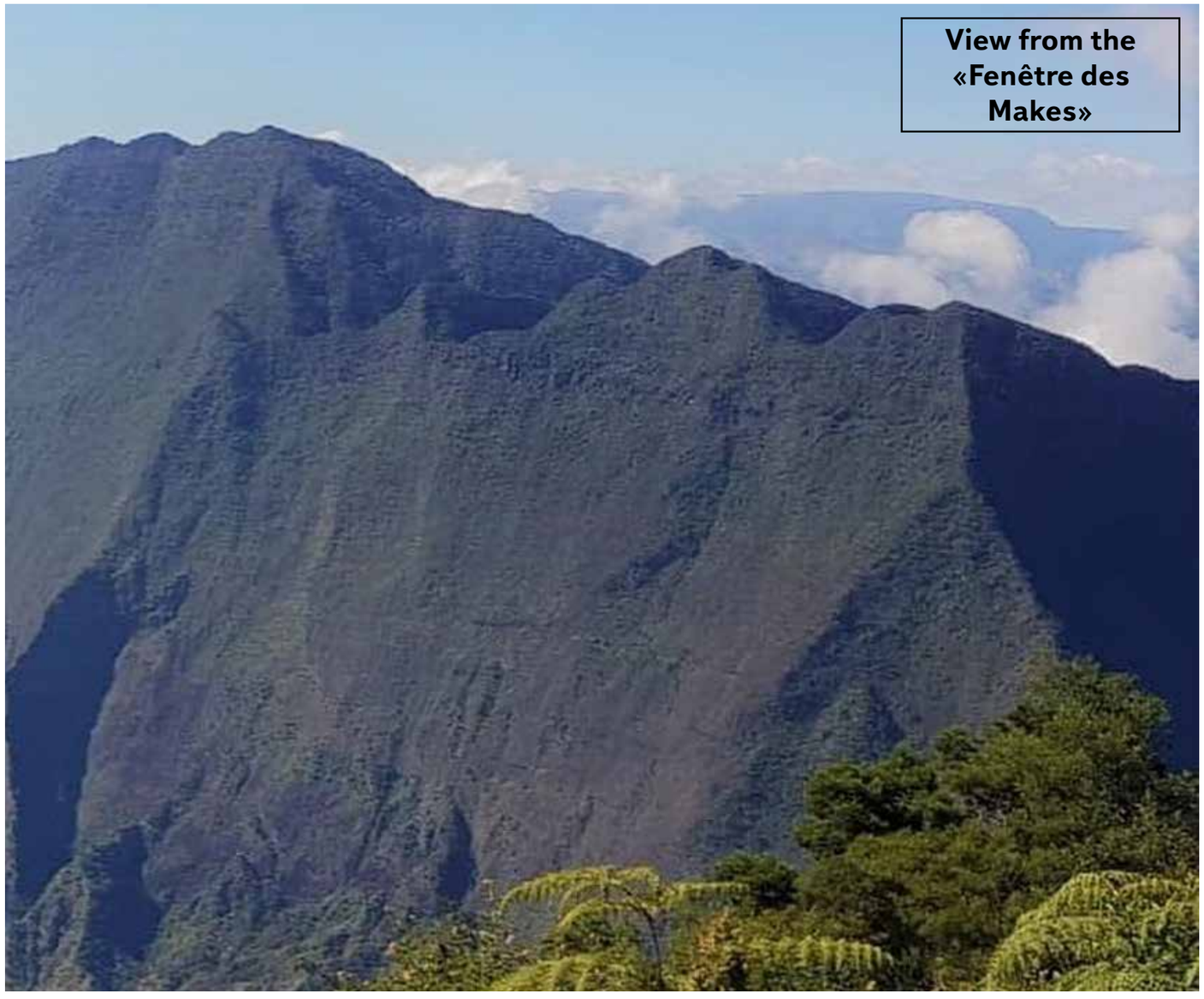
◊ The establishment of grass-legume associations should be accompanied by specific training and extension pograms that overcome the lack of knowledge and experience in the use of tropical forage legume.

◊ This will reduce uncertainties associated with technology adoption and increase adoption rates.

◊ The access to financial resources needs to be improved in order to provide the required framework for technology adoption

Testing multi-species fodder crop in Reunion Island

DERBOIS, P. (Cirad)



View from the «Fenêtre des Makes»

Trials on multi-species grasslands are conducted in Reunion Island with the aim of identifying forage species adapted to the pedoclimatic and social context of Reunion Island. Indeed, its young soil of volcanic origin, its humid tropical climate (a marked dry and wet season) and its difficulty to mechanize agriculture in some places make Reunion Island a special territory.

Saint-Joseph agricultural high school, photo by the Association Réunionnaise de Pastoralisme (ARP)

A trial has therefore been set up on an irrigated plot of land at the Saint-Pierre experimental station of 3500 m², previously fallow. Five mixtures of grasses and associated legumes were sown at 20 kg/ha, compared to the control grass species Chloris, with three replicates per modality. The grass species used were Chloris, Setaria and Brachiaria. The leguminous species used are Glycine, Alfalfa, Desmodium and Stylosanthes. A commercial mixture of Millet and Alexandrian Clover was also used for one of the modalities.

In order to identify the most suitable species, three criteria will be evaluated: the yield of the species (quadra method), the floristic diversity of the mixture (recovery rate and species distribution) and the nutritional value of the forage (using NIRS (Near Infrared Spectrometry) technology: dry matter, cellulose, crude protein, etc.).

As regards prospects, a new trial will be set up at the Saint Joseph agricultural high school in 2020 and the data from these trials will be used to provide advice to Réunionese farmers on the diversification of species in their meadows.

Fodder legume symbioses for tropical farming systems

O'Hara, G. (Murdoch University)

The Centre for Rhizobium Studies of the Murdoch University has an international rhizobia strain collection of about 16,300 strains. It is specialized in research and training in the science of legume nitrogen fixation, focusing on improving crop, pasture and forage legume production in farming systems and solving problems that compromise legume use in agriculture. In order to do so, legumes and rhizobia have to match to climates, soils and farming systems and rhizobia ecology, physology genetics and N-fixation have to be integrated. The centre identifies and describes new rhizobia to develop inoculant strains.

Nitrogen is a primary limitation in many agricultural systems.

Insufficient use of Symbiotic Nitrogen Fixation (SNF) in Global Agriculture

Only **30%** of anthropomorphic **N** in Agriculture from **SNF** (and proportion is declining)

107 Tg used per year from N fertilizers

60 Tg obtained per year from SNF

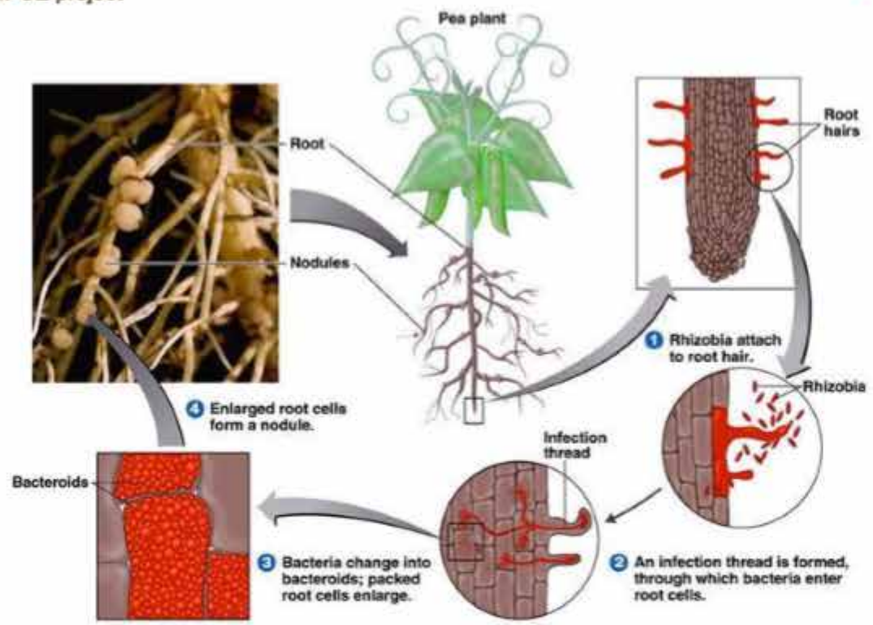
SYMBIOTIC N² FIXATION FOR SUSTAINABLE AGRICULTURE

- Symbiotic legumes are significant in many farming systems
- Provide N-inputs into soil without N-fertilizers
- Benefits include lower C-footprint, reduced nutrient run-off into surface & ground water
- Globally worth > $US65 billion pa
- In Australia, contributes ~ $3 billion of fixed N_2 to our $65 billion farming assets

RHIZOBIA AND SYMBIOTIC N² FIXATION

ECLIPSE project

Rhizobia and symbiotic N_2 fixation



N_2 fixation is the end-result of a complex molecular interaction between host and rhizobia

N-fixation depends on 4-way interaction:

1. Genome(plant)
X
2. Genome(rhizobia)
X
3. Environment
X
4. Management

COMMON «MYTHS» ABOUT RHIZOBIA

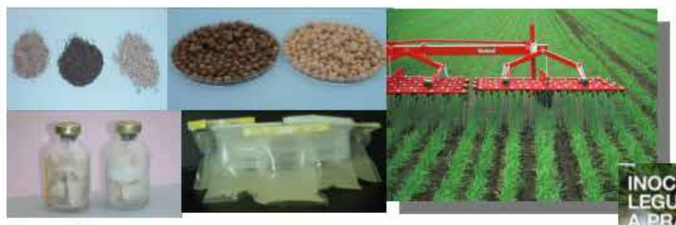
- All rhizobia are symbiotic
- All symbiotic rhizobia fix N when they nodulate
- All symbiotic rhizobia fix N equally well
- All Nodules on a root system contain the same rhizobia
- All Nodulated legumes add N to soils
- All inoculation is successful

None of these are true !

What is needed for successful plant inoculation?

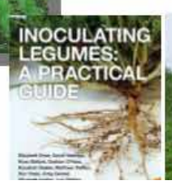
1. Effective strain of rhizobia for target legumes

2. Survival of strain in target soil environment



3. Delivery systems that work
inoculant carrier & inoculation method

2. Must test *in situ* in farmers fields



4. Farmer uptake of inoculant technology

Continuous need to educate new generations of farmers

1. Can SNF be optimized for tropical forages?

2. Need innovation to increase adoption tropical forage legumes & their rhizobia

3. Can inoculants improve establishment, production and persistence of legumes?

4. Are granule inoculants that can be treated as fertilizer beneficial?

5. Can animals help spread legume seeds and rhizobia in mixed species systems?

THREE SNF RESEARCH THEMES DIRECTLY LINKED WITH ECLIPSE PROJECT

1 Optimization of SNF- enhanced exploration and exploitation of rhizobia diversity

2 Targeted collection of wild legume germplasm and rhizobia

Both will require new strains of rhizobia

3 Optimize benefits of inoculants during introduction, establishment and production phase - need on farm field research trials - inoculant products, inoculation methods

Contribution of cactus to ruminant's diet in Madagascar

SALGADO, P. (Cirad) et al.

THE STUDY

This study has been carried out in 2018 and funded by DryGrow Foundation. The results have been submitted for the Animal Journal. The research team has studied how Opuntia Stricta, an invasive specie of cactus, can contribute to ruminant's diet. The study has been carried out in Ambovombe in the experimental station of the NGO GRET.

CONTEXT

The area witnesses irregularities in precipitations and drought periods.The annual variations vary from 300 to 800 mm. These phenomena lead to feed shortage for animals and populations, a decrease of the quality and availability of ressources after the wet season. As a consequence, the concentrated feed reach very high costs.

The objectives of the study are :

◊ Species utilisation by simple technology process

◊ Effects on intake (feed/water)

◊ Effects on digestibility and performance (growth)

◊ Effects on digestive physiology (villus)

TYPE OF ANIMAL

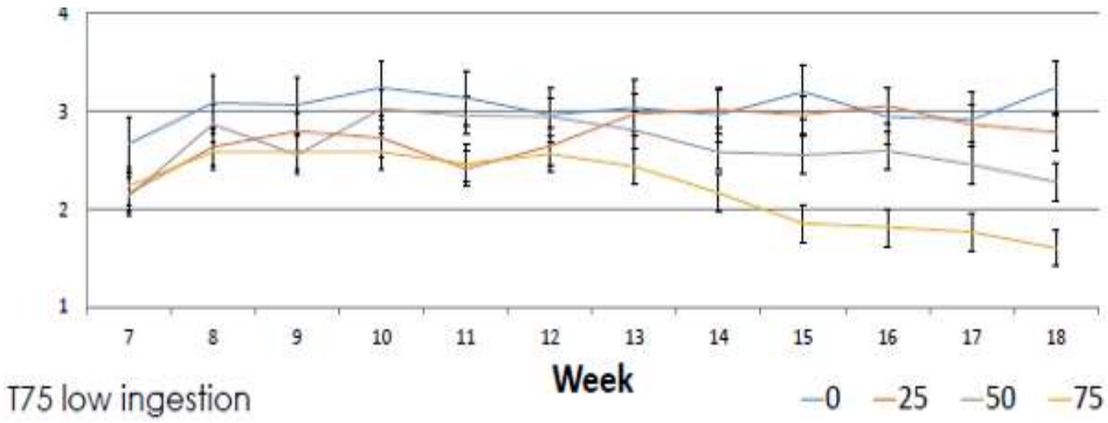
20 non-castrated males of 8 month old
12 kg initial live weight
Adaptation phase of 6 weeks and experimental phase of 18 weeks

TECHNOLOGY PROCESS

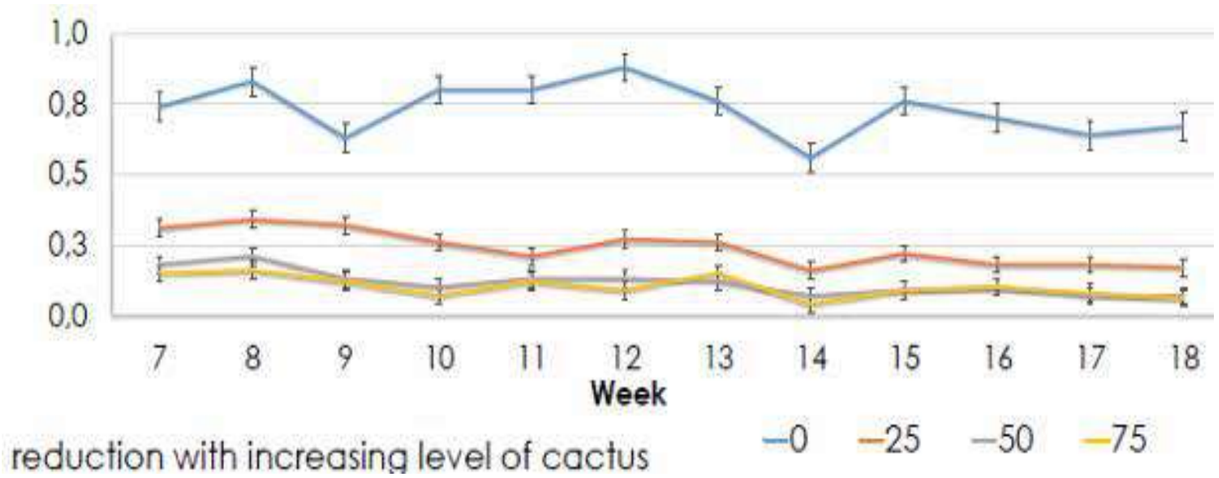
Cactus clacodes are crushed with a machine specially designed for this purpose.

RESULTS

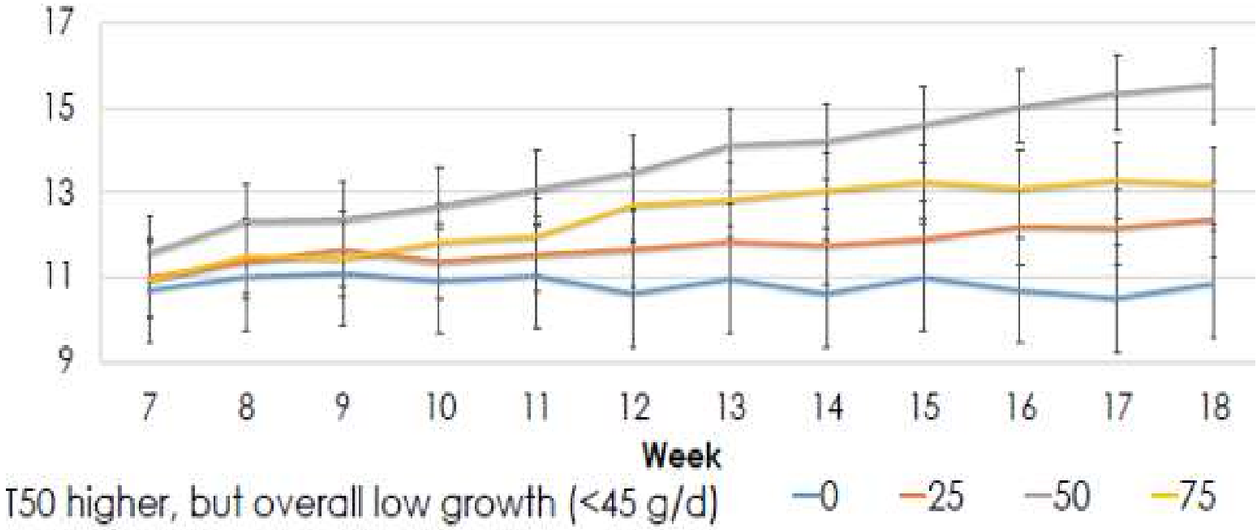
FEED INTAKE (%LW)



WATER INTAKE (LITRE/DAY)

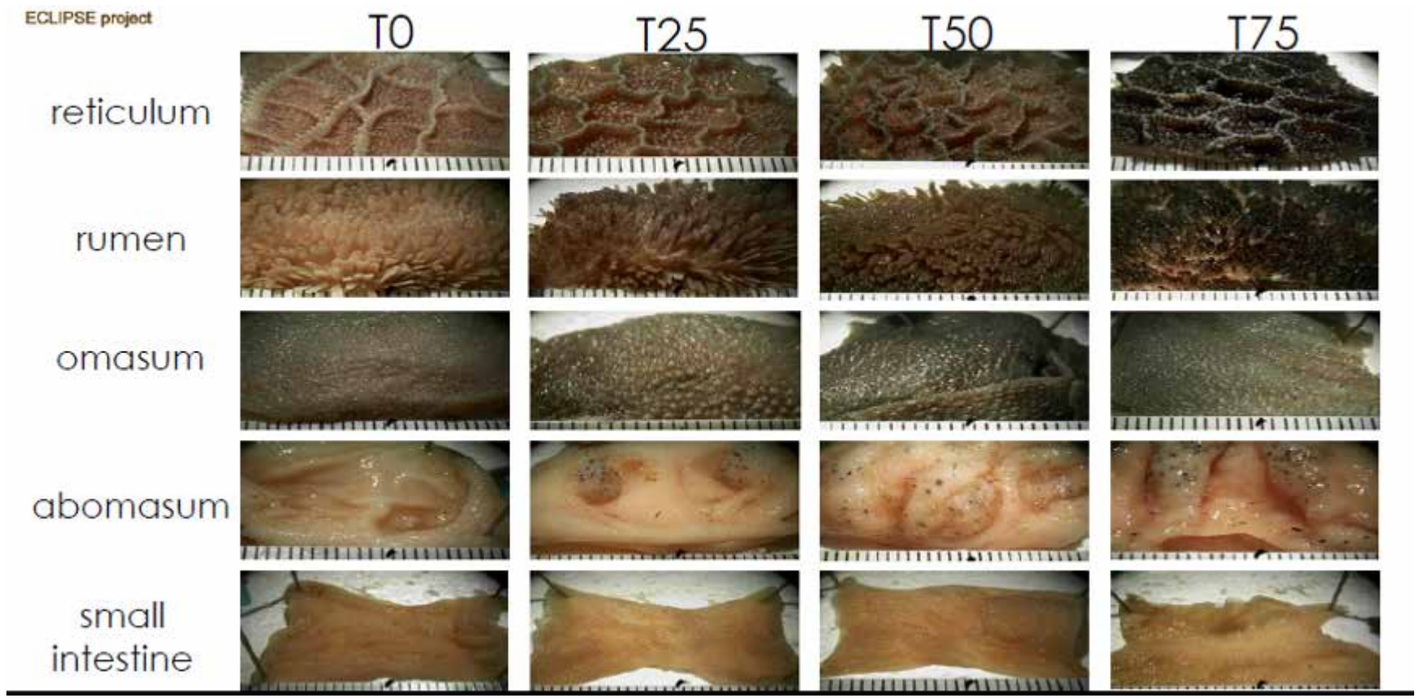


LIVE WEIGHT EVOLUTION (KG)



T50 higher, but overall low growth (<45 g/d)

CHARACTERISTICS AND STAINING OF THE DIGESTIVE TRACT



The use of banana discarded for animal feeding in Mozambique

MUNGOI, M. (UEM)

CONTEXT

Mozambique is located on the east coast of southern Africa. Its climate is predominantly semi-arid with the following distribution (Reddy 1984) :

- Arid 2%
- Semi-arid 80%
- Sub-humid 15%
- Humid 3%

The tropical savanna area in Mozambique has a half-year-long dry season.

The BIOVA project studies how to recycle plant and animal biomass in agricultural systems that combine crop and livestock production. It aims to :

- Increase agricultural productions
- Improve recycling and conservation of biomasses produced on farm
- Promote production systems based on conservation agriculture
- Encourage crop-livestock synergies

CHARACTERIZATION OF FEED RESSOURCES FOR LIVESTOCK

The Ministry of Agriculture and Food Security (MASA) of Mozambique and TechnoServe held international conference on controlling banana diseases in the African banana industry. The conference brought together international experts, banana producers, donors, governments and other

private sector partners to discuss strategies for the prevention and containment of BBTV and Panama Disease Foc TR4, with a particular focus on Mozambique. The objective of the conference was to share knowledge and best practices, as well as outline a way forward to build a thriving African Banana.

Why Banana for animal feeding ?

As world demand for milk and meat increases, competition in the use of crops for human food and for animal feeding is becoming more intense. World grain production, for example, has declined in recent years, and, as the consequence, stocks have been depleted and prices have risen to such a high level that it is becoming uneconomic to continue feeding grain to livestock as generously as in the past.

In banana-producing countries, there is a large supply of banana almost all year round, even though the crops are intended almost entirely for human consumption. However, considering the losses that occur during the harvesting, transportation, storage and marketing processes, which exceed 30%, **there is a large availability of fruits that can be used in animal feeding.**

ECONOMIC ASPECTS TO TAKE INTO ACCOUNT

Bananas are an important part of the staple diet as well as an important source of income for rural households.

Commercial production has increased substantially in Mozambique in recent years with considerable investments by the private sector especially Maputo, Manica and Nam-

pula provinces.

More than **80%** of banana produced by commercial farms are exported regionally (especially South Africa), but also to the Middle East and Europe. About **20% of total production is consumed locally.** Plantations in Maputo are usually open in selling rejected fruits. Many banana plantations are willing to sell to non-retail customers, since all the trees and foliage are to be composted after harvesting season. Economic Value of the average farm price per ton of rejected banana is 2,000 Mt ≈ 31 USD.

Conclusion

◊ Whole, green, ripe or dried bananas are used quite successfully in animal nutrition.

◊ The banana is of great value in terms of nutrition, being an energy source with great potential in animal feed.

◊ Energy source in the form of starch or immature green, and in the form of saccharose if they are in the mature form.

◊ Supplementation for proteins and minerals are generally needed if banana is utilized as feed.

Alternate feed resources in tropical areas

REDDY K. (PVNR TVU)

With regard to feeding of livestock, the tropical areas have certain common problems, such as high population density (pressure on land), high incidence of poverty and underdevelopment, high dependence on agriculture and livestock, dependence on rain-fed crops, high temperatures and prolonged dry spells, poor crop/fodder yields, and high incidence of animal diseases. The above factors directly or indirectly contribute to feed shortages and a searching for alternate feed resources is the next best option to sustain the livestock rearing activity and livelihood of the people. Feed is the main driver of livestock production.

It accounts for a major cost of livestock production (60-70%). Poor feeding affects the productivity , health and behavior of animal.

The major classes of the alternate feed resources :

◊ Agricultural crop residues

◊ Agro-industries by-products

◊ Brewery/ethanol industry wastes

◊ Fodder trees

◊ Forest produce

◊ Animal Protein sources

◊ Sea weeds & Others

The major source of dry matter among all the alternate feeds is crop residue of maize, sugar cane, grain sorghum, soybean, pulses and wheat. When alternate feeds are fed to live stock, it is important to consider the anti-nutritional factors and toxins present in them. Technologies are developed to treat the feed resources for removal or minimizing such undesirables elements.

Shortage green fodder, dry fodder, and concentrate is a reality in most tropical areas. There is no scope to overcome shortage due to pressure on land. Shortage can be overcome with the judicious use of non-conventional feeds stuff. More research is needed on nutrient and anti-nutritional content of unconventional feeds and proper utilization methods. Crop residues have low nutritional value, bulky and fibrous. The best way to utilize them is by feed-block technology. It supplies balanced feeds

Approximately 500-550 Mt of crop residues are produced per year in the country, which is the single most important fodder (63% of total available DM accounted by crop residues)

and utilizes the wasteful crop residues tree leaves etc. Densified complete feed block (DCFB) is composed of forage, concentrate and other nutrients in desired proportions to fulfill nutrient requirement. The processing steps are as given below.

◊ Grinding and mixing of concentrate ingredients.

◊ Chopping or shredding straw/crop residue

◊ Add concentrate components to chopped straw in desired proportion

◊ Add molasses in a mixer & mixing of ingredients

◊ Transfer to a hydraulic press to convert the mix into a block.

The advantages of the technology are :

◊ Provides a balanced ration to ruminants

◊ Ability to incorporate unconventional and agro-industrial byproducts

◊ Availability in all seasons

◊ Require lesser storage space

◊ Trouble free and easier to transport

◊ Less feed wastage

◊ Improved productive and reproductive performance

◊ Development of Feed Banks as pre-disaster management measure

◊ Stover based CFB on growth, nutrient utilization and carcass characteristics in sheep is being done at present.

As part of the ECLIPSE project, in-vitro evaluation of complete feed blocks with guar meal at various inclusion levels using the selected binder was carried out. Preparation and evaluation of the effect of cereal stover based CFB on growth, nutrient utilization and carcass characteristics in sheep is being done at present.

Chemical or biological straw treatment for ruminant nutrition

Degradation of wheat straw by Pleurotus Ostreatus

MARTENS, S. et al. (Saxony State Office for Environment, Agriculture and Geology)

Straw and stovers are among the most abundant agricultural residues world-wide. Thus, they represent a potentially important feed resource for ruminants. Although they contain a valuable source of fibre, the digestibility is low as lignin covers the cellulose and hemicellulose structures. The aim of various research approaches has thus been to break down the indigestible lignin to make the digestible fibres available to the animal. At the Saxony State Office in Germany, we tested the practical applicability of

different procedures, both chemical and biological, under current conditions. Chemical treatments mean the use of alkaline media to destroy the hydrogen bonds. Biological treatments mostly refer to the enzymatic degradation of lignin by white-rot fungi. The efficacy of both depend on many different factors.

TREATMENTS WITH NaOH

A promising treatment in our experiments was the application of 60 g NaOH dissolved in 600 ml H2O per kg wheat straw, which was sprayed directly on the straw and allowed to act for 2-7 days. It increased the NDF digestility, the in-vitro gas production and the enzymatically dissolvable substance compared to the untreated wheat straw. Higher concentrations of NaOH were also effective. However, they increased the content of crude ash exorbitantly.

FUNGAL TREATMENT

In a first approach, wheat straw was soaked in abundant water for 24 h and rinsed thereafter for 3 h. Spawn for inoculation was prepared beforehand letting white-rot fungi (Ceriporiopsis subvermispora, Pleurotus ostreatus) grow on cereal grains. This spawn was mixed in the humid straw, which was then packed in perforated plastic bags. With a second layer, it was stored in a dark place with controlled temperature for fungal growth. Triplicates were removed weekly to investigate the weekly change of the nutritive composition of the straw up to week 6. After one week of incubation with Ceriporiopsis subvermispora, the NDF digesti-

bility was increased. However, in-vitro gas production and enzymatically soluble organic substance decreased continuously up to day 35 and did not achieve the original value within 42 d.

FIRST CONCLUSIONS

The controlled application of dissolved NaOH might be an option to increase ruminal digestibility of straw. Soaking in abundant water reduces the content of water soluble nutrients in the straw. An alternative might be the defined addition of water to remoisten the straw to about 25 % dry matter. As fungi always utilize carbohydrates for their own growth the right point in time has to be found to balance between lignin decomposition and organic matter losses. We are currently evaluating further straw treatments.

Fodder development : BAIF work

TAKAWALE, P. (BAIF)

ABOUT THE BAIF

BAIF Development Research Foundation is a Non Government Organization established in 1967 by late Dr. Manibhai Desai. Its mission is to create opportunities of gainful self-employment for the rural families, especially disadvantaged sections, ensuring sustainable livelihood, enriched environment, improved quality of life and good human values. This is being achieved through development research, effective use of local resources, extension of appropriate technologies and up gradation of skills and capabilities with community participation. BAIF is nonpolitical, secular and professionally managed organization.

BAIF's programmes are spread out in 13 different states of India covering different ecosystems, agro-climatic zones and communities covering 5.39 million families. The core programmes of BAIF are Livestock Development, Agriculture and Agro-forestry, Natural Resource Management while Environment & Energy, Women Empowerment, Community Health are the complimentary programmes. The Livestock development programmes are on cross breeding/breed upgradation, fodder development, feed formulations, forward linkages, training and advice.

BACKDROP

The current scenario in India is that of a huge gap between the availability and the need of feed and fodder resources. This gap is expected to further widen in the coming decades.

Unless a concerted attempt is made to bridge the gap, the impact on the livestock based production can be disastrous. This will further negatively affect the livelihoods of millions of farmers.The major feed resources for livestock in India are grasses, community grazing on common lands and harvested fields, crop residues and agricultural by-products, cultivated fodder, edible weeds, tree leaves from cultivated and uncultivated lands and agro-industrial by-products.

Crop residues include fine straws, coarse straws, leguminous straws; sugarcane tops etc. and are the single largest bulk feed material available easily to the farmers for feeding ruminants. India is rich in livestock resources and the livestock sector alone contributes nearly 25.6% of total value of output in Agriculture sector.

However, further growth of the sector is much dependent on availability of fodder. Low productivity is a major cause of concern. Another prime challenge is huge shortage of fodder, more so during drought situations and summer. The demand will reach to 1012 million MT of green fodder and 631 million MT of dry forage by the year 2050. At the current level of growth in forage resources, there will be 18.4 % deficit in green fodder and 13.2% deficit in dry fodder in the year 2050. Other than essential incorporation of crop residues into soil, diversion of crop residues for packaging and other industrial requirements will

worsen the demand and supply situation. Other than essential incorporation of crop residues into soil, diversion of crop residues for packaging and other industrial requirements will worsen the demand and supply situation.

CHALLENGES

The reasons for the considerable gap in the availability of green and dry fodder can be traced to a variety of factors, ranging from increased burden of livestock population beyond the carrying capacity of land; a shrinkage of commons used as grazing lands as well as the continuing drop in the operational land holding size; a shift in cropping patterns towards mono-cropping and cash crops; and the lengthening of value chains disrupting traditional circular economies that provided a variety of feed resources from the farm produce directly to the farmer's livestock operations.

The major challenges pertaining to Feed and Fodder availability are:

◊ Strategic shifts in the farm sector: shift to reduced crop diversity and increased focus on cash crops, reduced emphasis on tree-based fodder.

◊ Externalities attributed to large populations and shrinkage of commons: large cattle populations beyond the carrying capacity of land, large human population leading to reduction in size of operational holdings; reduced availability of grazing lands and access to forest-owned grazing pastures. Changes in Value Preservation: Reduced availability of crop residues and limited adoption of fodder preservation practices such as silage, hay and leaf meals.

◊ Changes in Farm Production: reducing quantity of home-grown feed and fodder;

scarcity of quality fodder seed.

DIRECTIONS FOR FODDER SECURITY

The following future directions appear relevant to be taken up:

◊ Changes in Farming Systems

◊ Introduction of Newer Technologies

◊ Technology Packaging and Dissemination

The problem will now have to be addressed partly by corrective strategic and policy choices to counter the negative effects of the above transformations, but also developing and harnessing improved technology:

◊ Better fodder crops — particularly emphasis on dual purpose crops and through reviving forgotten varieties

◊ Improved technologies for production of high nutrition sources such as Azolla and duckweed, use of hydroponics

◊ Widespread application of fodder preservation methods such as silage, leaf meals and legume blocks etc

◊ Use of unconventional fodder sources such as spineless cactus

◊ Renewed thrust on developing tree fodder resources

◊ Mechanism for widespread dissemination of the above measures to wider scale.

The national level efforts have been taken up through the main Institutes / Programmes. The agriculture research was mainly aimed at producing crop varieties with high harvest index with hardly any attention being paid to crop residue production. While the institutional base in the country is straining to work on the challen-

ges, the private sector, the civil society, and particularly the NGOs like BAIF, contribute substantially in these areas.

BAIF have a long track record of breeding excellent fodder varieties, work on agro-biodiversity conservation and unconventional fodder resources. BAIF work in this area covers developing fodder crop varieties, development of region specific intensive fodder production technologies, conservation and promotion of promising landraces, standardizing production of unconventional fodder resources such as Azolla and spineless cactus, applying modern technologies such as molecular markers and gene-tillling, community based initiatives eg.- silvipasture management, input production- quality seed and planting material, biofertilizers, and large scale field dissemination programs.

BAIF research is focused on maize, pearl millet, sorghum, lucerne, B x N hybrid, range grasses and legumes for development of new varieties/hybrids for fodder and dual purpose.

WORK UNDER ECLIPSE PROJECT

Work was carried with objectives of to calibrate NIRS machine developed by CIRAD, Reunion, France and compare the analysis data generated by chemical method of analysis versus NIRS method. Training cum workshop on application of NIRS was conducted by Julia Vuattoux & Serge Nabeneza from CIRAD. Two hundred forty three samples of five crops analyzed using chemical method and NIRS machine as per the prescribed protocol.

Use of brewer grains for animal feed in Madagascar

RAKONTDRAINIARIVELO Phillibert et al. - Fifamanor

Around the world, brewer grains are widely used for dairy animals feeding. In fact, they are a great resource of protein (27-33% DM) and are also palatable, enabling to increase milk production. In Madagascar highlands, this resource is easily available due to local industrial brewing plant.

The aims of this study were to :

◊ Assess impact of brewer grains feeding on cows' growth and milk performance

◊ Determine the optimal utilization of this resource in local dairy cow feeding.

In 2016, 3 groups of 3 cows presenting similar weight (550 kg in a average) and production level (between 15 to 25 kg of milk. day-1.cow-1) have been fed during 24 days in the experimental farm of Fifamanor with different brewer grains supplies: no brewer grains (L0), 5 kg of gross matter (L05) and 10 kg of gross matter (L10).

Results showed that **level of production of L10 was higher** (23.45 kg of milk.day-1.cow-1) comparing to L05 (19.46 kg of milk.day-1.cow-1) and L0 (17.28 kg of milk.

day-1.cow-1).
However, the distribution of 5 kg of gross matter of brewer grains appeared to be nutritionally and economically more relevant. Indeed, energy content of milk produced from L10 was lower than L0 and L05 (respectively 2.6% vs 3.6%) while production cost for milk was in an average 918 295 Ar.l-1 for L05 vs 306 925 Ar.l-1 for L0 and 605 125 Ar.l-1 for L10. To conclude, when distributed in a balanced way, brewer grains use for dairy cows feeding could lead to both increase in milk production quality and quantity for high productive cows in central highlands of Madagascar. Some field experimentations should be led into farms to confirm such results.

Fodder conservation/ silage in Madagascar

ANDRIARIMALALA, J. H., MOHAMED, M., RAKOTOMANANA R. (FIFAMANOR)

In Madagascar, dry season constraints livestock activities while natural resources, the main feeding resources for local extensive livestock systems, are rarely available and fodder cultivation is limited by lack of rains. In this sense, silage is an interesting issue while it enables resources conservation from rainy season. Two different studies have been led to test different ways.

The first one conducted by FIFAMANOR was based on sweet potato silage. Sweet potato is widely grown in Madagascar, **provides**

food security during the lean season and shows high productivity (25 to 50 t.ha-1). The study aimed to :

◊ Test the technique for conservation of sweet potato vines and roots by silage

◊ Observe the feeding behaviour of dairy cattle consuming this feed and evaluate their performance.

Sweet potatoes vines and roots were chopped into pieces about 2.5cm and filled and compacted into five metal drums of 250 litres. Silage samples have been collected before and after silage for chemical (DM, ash, fibres, pH) and physical aspects (consistency, smell, colour and the presence of mould) analyses.

Results have shown interest for such techniques while nutritional and aspects characteristics are similar with corn silage (smell, pH. etc.) despite of presence of mould in some samples.

Moreover, sweet potato silage have been distributed to 4 young bulls from 9 to 10 months during 21 days (5 days of adaptation and 16 days of data collection), supplemented by 2 kg of feed concentrate and associated or not to silage corn (sweet potato/corn ratio: 100:0 ; 90:10 ; 75:25 ; 60:40 ; 50:50).

Assessed parameters (intake, average daily gain, faeces and observations of animals behaviour) showed that **intake levels are not significantly different between rations.**

Moreover, animals **did not present any sign of digestive disorders but require a period of adaptation**. To be adopted by farmers, it appears important to create and spread vines and roots chopping machine. In addition, impact on milk pro-

duction should be assessed.

The second study conducted by FOFIFA aimed to (i) improve silage manufacturing techniques and (ii) assess impacts of such techniques on cow performances.
Maize and stylosanthes silage was chopped from 2 to 5cm length and putted in in-pit silos, small barrels and small bags.
In-pit silos appeared useful for farmers, **while the presence of mould is rare, but it is expensive and should be used for big livestock herds.** Plastic bags appeared too fragile while presence of holes during filling leads to presence of mould at holes. Drums were not filled up to the top enabling air entries and leading presence of mould (50% of total silage weight). However, small-sized drums and bags seems to be more adapted to small herds (1 bag or 1 barrel of this silage lasts 1 day for 4 cows). In addition, the nutritional values estimated by NIRS did not show loss of quality for stylosanthes silage comparing to fresh stylosanthes fodder. In addition, cows fed with supplement of stylosanthes silage during 45 days showed higher weight growth comparing to maize silage supplementation.

Canola as a livestock feed

MCGRATH, S. (CSU)

Feed gaps refer to periods of the year where feed availability from pasture is below livestock requirements. In Australia this has traditionally been thought of as a winter feed gap, where pasture growth is restricted by cold winter temperatures.

Canola (Brassica napus) is an oilseed crop grown widely in Australia, and is an important part of cropping rotations. Canola can also be a valuable dual-purpose crop. Dual-purpose crops refer to crops sown for grazing by livestock during the vegetative growth stages, with livestock then removed so that the grain can be harvested at the end of the season. Other examples of crops commonly grown as dual-purpose crops in Australia include wheat, oats, triticale and barley. Crops in Australia are traditionally grown as monocultures.

◊ Cultivars used as dual-purpose crops often have a vernalisation requirement, meaning they don't move to the reproductive stage of growth until they have had sufficient cold exposure. Management of these crops is usually with an intention to minimise the impact of grazing on grain yield.

Key concepts for grazing dual-purpose crops include:
Look for early sowing opportunities to maximise grazing potential.

◊ Grazing should not commence until plants are well anchored to prevent uprooting by livestock. Ensure grazing does not occur prior to the end of chemical withholding periods.

◊ Remove livestock prior to stem elongation (cereal crops) or before buds have elongated more than 10 cm (canola). Grazing after buds have elongated delays flowering and potentially reduces yield.

Grazing later in the season means that yield is more sensitive to residual biomass at the end of grazing due to less recovery time. Livestock are typically removed earlier from canola crops than cereal crops.
Canola appears to have higher growth rates than cereals in the autumn, but lower growth rates once temperatures reduce in the winter. Growing both canola and cereal crops may therefore allow a longer period when livestock can be grazed on crops, but also provide some insurance against poor starts (e.g. 2015 in the below Table where the cereal crop was grazed first due to slow initial germination of canola).

Using NIRS to estimate the forage composition in Madagascar, India and Reunion

NABENEZA, S., TILLARD, E. (Cirad)

WHAT IS NIRS?

The **Near Infrared Spectroscopic** is a predictive technique based on analytical references and the properties of absorption of the organic molecules.

The goal of calibration development is to identify and characterize the relationship between **spectral features** and the **variable of interest.**

WHY USING NIRS ?

A fast tool : - < 2 min/spl (sec) - multiple analyses (cheap)

Simple to operate : short training - on-line, on-field, - no sample prep. or reduced

Simple to maintain : lamps, ...

Drawbacks : - Need of calibrations (N>>)
- Limits of detectability

- low response for mineral matter

Expensive device : 40 000 euros

GOALS

◊ Develop (and transfer) new tools, based on the NIRS, to estimate the nutritive value of forages and foods, the fertilizing value of OM and the composition / fertility of soils.

◊ Giving advices to improve in real time: forage management and feeding of ruminants organic matter management and soil fertility

The approach aims to make the management of natural resources **more precise** (precision farming), and **more economical** (reduction of inputs such as mineral fertilizers and food supplements) and ecological (recycling, respect for the environment).

NIRS DEVICES

FOSS Nirsystem 5000
Spectra range: 1100-2500nm -
Fixed device -
number of data : 700

ASD Labspec4 -
Spectra range: 1100-2500nm -
Portable device - number of data : 2151

JDSU Micronir 1700 - Spectra range: 908-1876nm -
Portable device - number of data : 125

Agilent 4300 FTIR - Spectra range: 2222-15384nm - Portable device

NIRS calibrations *after spectra data base Transfer*

JDSU Micronir 1700

Dry and ground shrubs forages

Constituant	N	Moy.	E.T.	SEC	R^2	SECV	R^2 CV
Protéine	680	11.6	5.3	1.76	0.89	1.84	0.88
NDF	682	47.6	12.4	4.34	0.88	4.56	0.86
Digestibilité	426	55.4	15.7	5.36	0.88	5.55	0.87
Tanins condensés	269	5.2	5.0	1.81	0.87	1.91	0.86
%tanrad	246	5.1	4.5	1.59	0.87	1.70	0.85
Phenols totaux	185	6.7	4.2	1.48	0.88	1.57	0.86

SOME RESULTS WITH THE RELATIONSHIP WITH THE FECES SPECTRA

Constituent	Unit	n	Mean	SD	SEC	R^2Cal	SECV	R^2CV	RPD
DMI	g/kg $BW^{0.75}$	16	71.31	25.19	4.02	0.97	17.1	0.59	1.5
ASH	g/100 g MS	16	15.20	1.97	0.29	0.98	0.92	0.81	2.1
PROTEIN	g/100 g MS	16	9.25	1.43	0.30	0.96	0.44	0.92	3.3
FIBRE	g/100 g MS	16	31.77	2.32	0.90	0.85	1.10	0.80	2.1
NDF	g/100 g MS	16	62.54	3.78	1.14	0.91	1.43	0.88	2.6
ADF	g/100 g MS	16	44.47	3.80	1.01	0.93	1.27	0.90	3.0
ADL	g/100 g MS	16	15.61	2.46	1.25	0.74	1.46	0.69	1.7

DMI: Dry Matter Intake

A training workshop on application of NIRS was held at BAIF, CRS, Uruli Kanchan Pune for BAIF Staff and Serge Nabeneza from CIRAD conducted the training. Following aspects were covered during the training:

- ◊ Theoretical aspects of spectroscopy
- ◊ Advantages of NIRS
- ◊ Mechanism of NIRS
- ◊ Usage of Unscrambler Software

Practical usage of NIRS machine for analysis of BAIF's fodder samples collected from BAIF's own farm (Berseem, Lucerne, Maize, Hybrid Napier, and Cactus).

Calibrations are under development.

An Observatory of Grass Growth in Reunion Island

AVERNA, J. (Cirad) PELLIER, Y. (ARP)

Photo : Jeanne, the zootechnician of the CIRAD breeding division preparing to measure the density of grass at Piton Mahot.

A grass growth observatory has been created in Reunion in 2017 as part of the Reunion Island Agricultural Innovation and Transfer Network (RITA) and the InterReg V ECLIPSE project. It provides a better understanding of grass growth dynamics and advice to farmers adapted to the seasons. It is conducted by the Réunionese Association of Pastoralism (ARP) in partnership with the Cirad.

At the start of the observatory, a representative zoning of the livestock grazing on the island was carried out. Due to the relief and insularity, these zones present strong variability in altitude, climate and the floristic composition of the meadows. In each area, the meadows of at least two holdings are monitored. The measurements are carried out according to the RMT prairies protocol, the national reference system of the Institut de l'Elevage (French Livestock Institute), adapted to the

context of the island and to the specific objectives of the network (rapid need for references, consolidation of knowledge on pastures). Two types of measurements are carried out each week on the eight farms monitored: grass growth and density. Grass samples are then dried and their feed value is analysed using near-infrared spectrometry (SPIR). The available stock of grass and the days in advance are calculated and communicated to the farmers in the network. Producers and advisors also receive a monthly newsletter with regional averages of grass growth associated with prairie management advice.

The first models calculated show three factors of variation in grass growth, density and feed value: season, area and cover type. The analysis also includes the development of a grass density reference table that will take into account meteorological data. Growth and density measurements are still ongoing. They feed the database in order to better characterize climatic episodes and adapt the advice to farmers.

Web Plateform for Real-time prediction of forage composition from NIRS

TILLARD, E. (CIRAD)

NIRSPRED (now renamed DoPredict) is a web platform, developed by CIRAD[1], to provide automated predictions of the composition of forages from spectral data. More specifically, users send via the internet infrared (IR) spectra collected from grass samples, and the platform predicts their chemical composition using statistical models.

Predictions are calculated from a database (IR spectra + laboratory reference measurements, figure opposite) gathering a wide variety of tropical and temperate fodder species, and regularly updated to improve its representativeness and prediction accuracy.

1 JUANES X.1, JULIEN L.1, LESNOFF M.1, 2020, CIRAD, UMR SELMET (CIRAD, INRA, Montpellier SupAgro), Montpellier, France

To take the heterogeneity of the data into account, the DoPredict platform uses an k nearest neighbors locally weighted PLSR model which allows more accurate prediction of samples composition. The composition parameters predicted for each IR spectrum are presented in the table below.

Predicted chemical components

	Content	Abbreviation	Unit	Reference method
1	Dry matter	DM	%	103 degrees Celsius, 24 hours
2	Mineral matter	ASH	%DM	550 degrees Celsius, 4 hours
3	Crude Protein	CP	%DM	Nitrogen x 6.25
4	Neutral Detergent Fiber	NDF	%DM	Van Soest Method
5	Acid Detergent Fiber	ADF	%DM	Van Soest Method
6	Acid Detergent Lignin	ADL	%DM	Van Soest Method
7	Crude fiber	CF	%DM	Weende method
8	In vitro dry matter enzymatic digestibility	DMDCELL	%DM	Aufrere pepsin-cellulase method
9	In vitro organic matter enzimatic digestibility	OMDCELL	%OM	Aufrere pepsin-cellulase method

The predictions of spectra sent to the platform are gathered in a file in csv format (one record per spectrum) and returned to the user (via a download link), with indicators for assessing the quality of the prediction for each spectra. In the futur, it will be possible to widen the range of parameters and resources (organic fertilizing materials, soils) to be predicted using complementary databases, resulting from research works of various research organizations (CIRAD, INRAe...).

The use of the DoPredict platform is **limited to research purposes.** Any interested user must send an authorization request to the CIRAD manager and sign an agreement specifying the conditions of use of the platform; the manager in return will send back a username and password allowing the connection.

Forage conservation techniques in the tropics *with special emphasis on small herd sizes*

MARTENS, S.

The aim of forage conservation is to supply herbivores constantly with feed of high quality and sufficient quantity throughout the year. That implies providing nutritive quality and in the case of ensiling also water.

TYPES OF CONSERVATION

There are principally two ways of feed conservation: drying and fermenting. The mode of action when dehydrating feeds is to increase the osmotic pressure to a point where neither enzymes nor microorganisms can act. The main challenge is thus to prevent remoistening. Requirements for haymaking are: forages, which homogeneously dry off, beware of disintegration of leaves and stems during drying and handling (loss ofleaves rich in protein), rapid drying.

Ensiling is a biological process under anaerobic conditions.

BIOLOGICAL PRINCIPLES OF ENSILING

Lactic acid bacteria convert available sugars to the preservative lactic acid. Both, anaerobic conditions and a low pH, prevent spoilage microorganisms to grow. However, especially during the initial aerobic phase, there is a high competition for available carbohydrates among different microorganisms such as yeasts, aerobic and other bacteria. Their main metabolites are CO2 and water, and sometimes toxins.

FORAGE

Main aspects of forage ensilability are the availability of readily soluble carbohydrates (sugars), the buffering capacity (resistance to lowering the pH -> salts of organic acids, crude protein), dry matter content (concentration of nutrients and osmotic pressure) and the epiphytic microflora present on the plant. A rapid fermentation test for 2-3 days, either with chopped forage in water (+/- sugar and if available lactic acid bacteria inoculant) or with chopped forage enclosed in small plastic bags provides insight into the ensilability of the forage. When checking the pH at the end and comparing to the initial pH and between the treatments the lowest pH will indicate if the plant needs additives for ensiling.

ASPECTS OF ENSURING SILAGE QUALITY

Silage quality is connected with factors around the forage to ensile, the ensiling technique and silage additives. These factors will determine the ensilability, the microbial activity, and thus losses, nutritive value and finally animal health and perfor-

ENSILING TECHNIQUE

Wilting the whole plants to ≥30 % DM on a clean surface provides concentrated nutrients and inhibits undesired clostridia by increasing the osmotic pressure. Chopping after wilting gives better access to the nutrients for fermentation at the cut surface. Chopping length should be adapted to the requirements for ruminating.

Silo types offer different conditions for the time needed to fill the silo, compaction and sealing, and thus temperature development. The choice for the silo type depends also on the degree of mechanization and the amounts of forage needed daily (see also photo of the workshop on the pros and cons). In order to achieve a lactic fermentation rapidly compact the and seal it soon, as anaerobiosis is the first precondition for fermentation. Thorough compaction also prevents air ingress into the stock once the silo is opened again for feeding out. Thus, spoilage through fungal growth (yeasts and moulds) can be inhibited.

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SILAGE ADDITIVES

Forages, especially legumes, which are poor in water soluble carbohydrates, can be mixed with other forages or by-products rich in sugars. Molasses is one option.

Lactic acid bacteria strains, which are tested for tropical conditions and forages, can serve as inoculants to enhance lactic acid fermentation.

SILO CONTROLLING

Control your silo regularly whether there is any damage on the surface, which allows air ingress. Repair damaged surfaces.

Once you open the silo, evaluate the fermentation quality. The desired smell is pleasant and acid, the colour should be similar to the one before ensiling, the same applies for the dry matter concentration. The lower the dry matter content the lower should be the pH.

Ensure aerobic stability of the silage: feed out regularly and control temperature and pH of the silage stock. Remove mouldy parts extensively. Observe condensation water and growth of yeasts and accelerate feed out rate accordingly.