Mapping livestock feed resources and targeting technologies: Making the most of FEAST and TechFit

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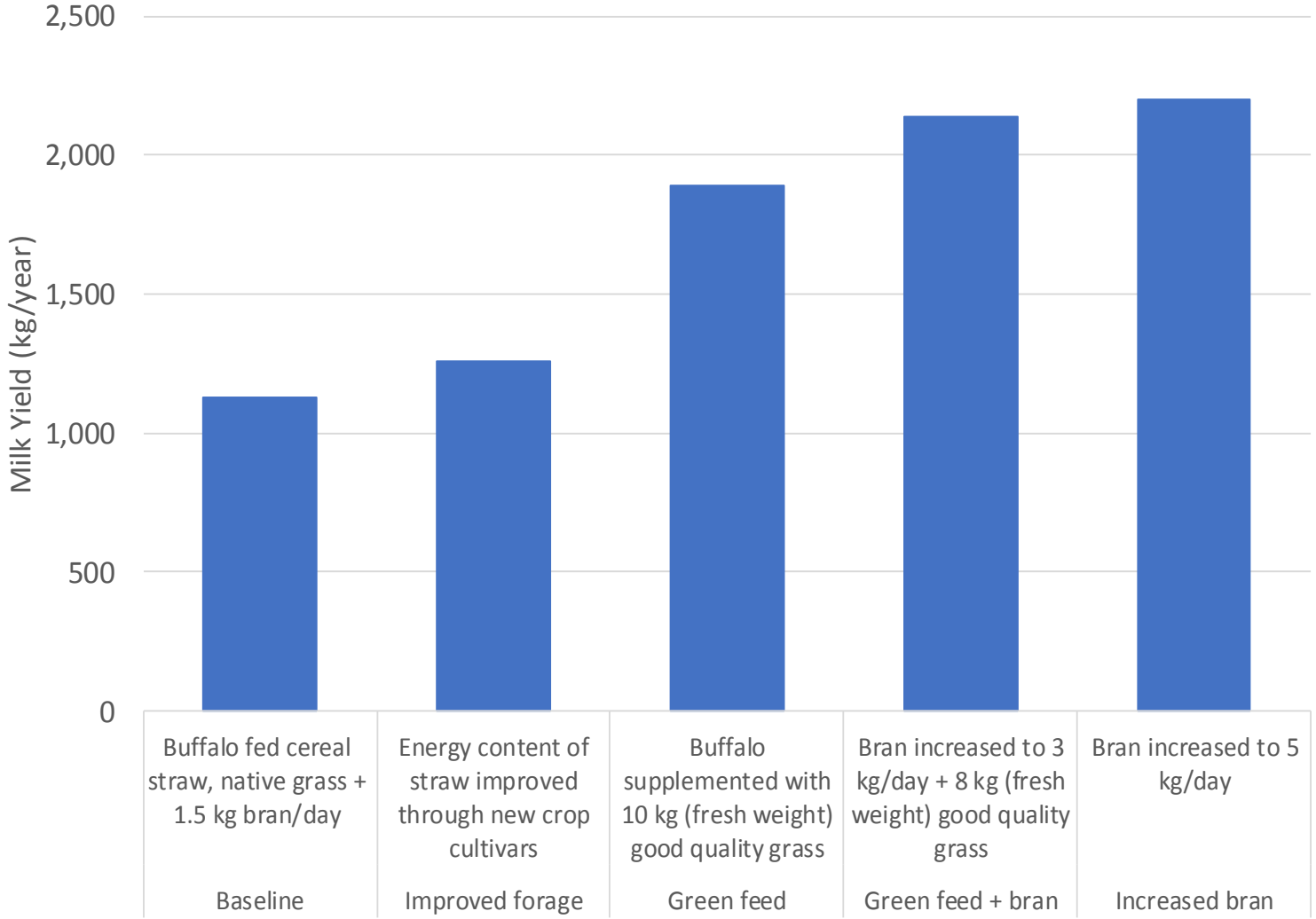
Feed is a key issue in developing world livestock systems

Potential narrowing of yield gap through improved feeding



Mayberry, D., Ash, A., Prestwidge, D., Godde, C.M., Henderson, B., Duncan, A., Blummel, M., Ramana Reddy, Y., Herrero, M., 2017. Agric. Syst. 155, 43–51.

Researcher driven feed solutions often fall short

Why?

- Not suitable for local context
- Not dealing with the key constraints
- Do not sufficiently involve farmers and other local stakeholder in their selection and design
- Do not take account of wider system constraints such as labour, markets etc.

Complete diet blocks lying unused - India

Forage chopper lying unused - India

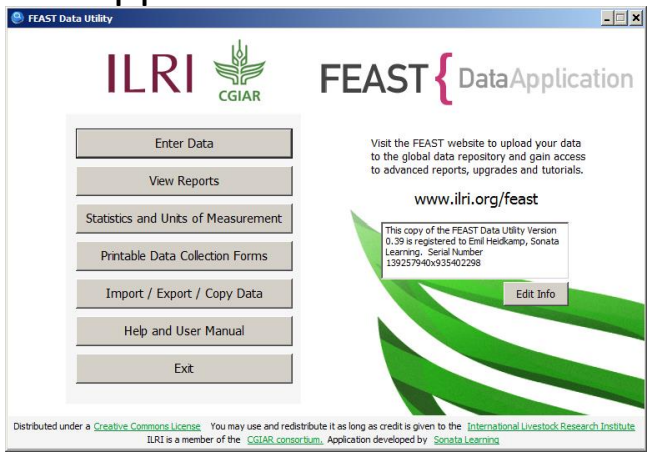
What is needed to avoid futile feed development?

- A systematic approach to assessing the feeding context
- Looking wider than just feed
- Involving farmers and local stakeholders in the process
- Asking the right questions in a structured way
- Matching feed options with local system

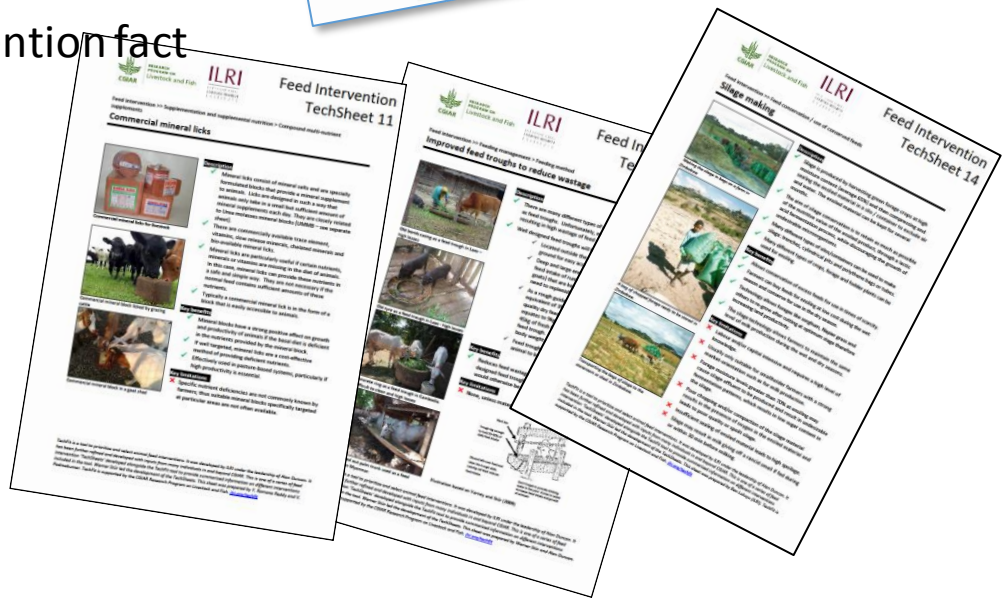
Feed Assessment Tool (FEAST)

Question guide and household survey

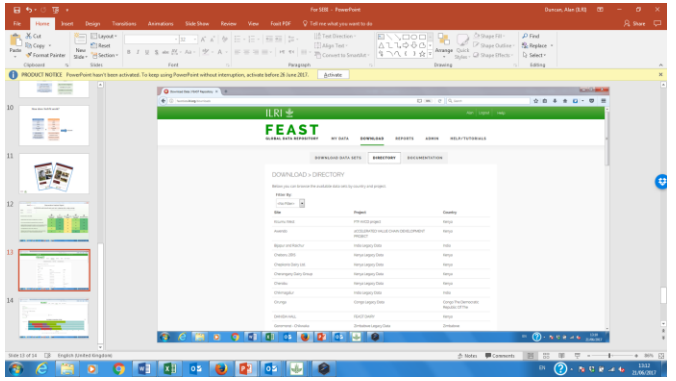
Data app



Intervention fact sheets



Global data



How does FEAST work?

1. PRA Exercise

- Overview of **farming system** and livestock feed aspect
- **Milk marketing**, veterinary services
- **Major problems** for livestock production

2. Individual farmer survey

- Quantitative information on **crop-livestock production, feed availability, feeding rations**
- Qualitative information - **perception on feed quality**

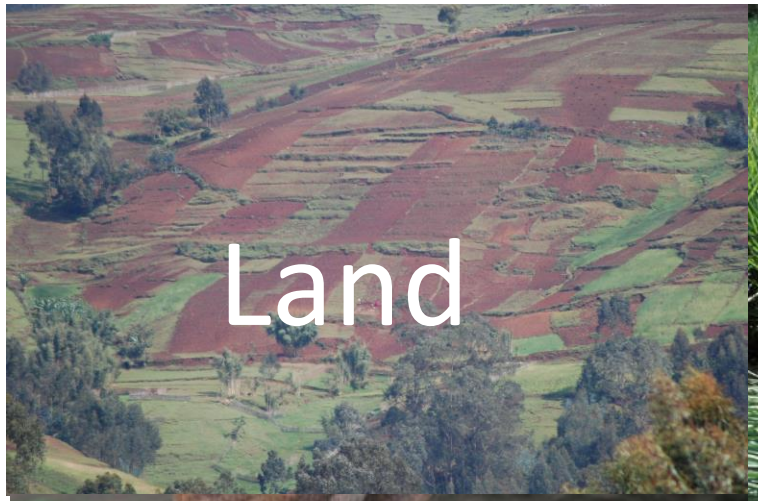
3. Data analysis and developing interventions

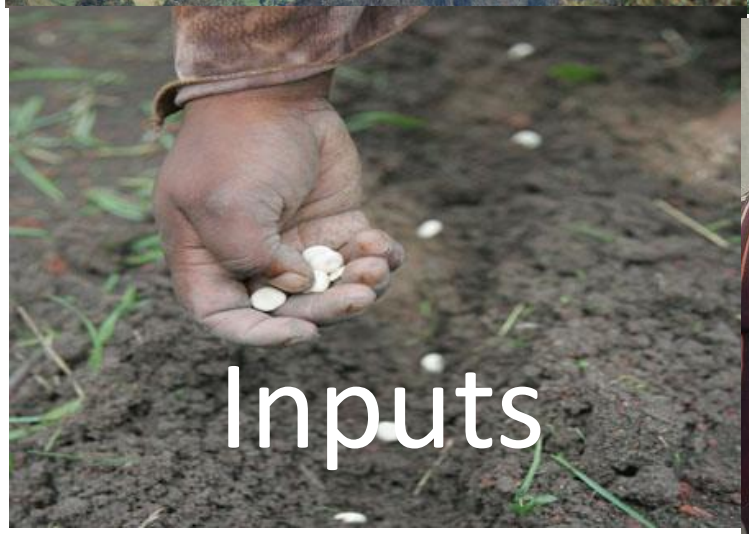
- Enter data in **FEAST template**
- Based on results develop **ideas** for **intervention**
- **Look at intervention ranking analysis**

Matching feed options to local system

- What are the key elements of the “local system”?
- Techfit tool
  - Matching feed options to different local conditions
  - Series of expert workshops: Dehra Dun, Hanoi, Addis Ababa
  - Developed spreadsheet-based intervention ranking tool
  - Now incorporated into FEAST

Context attributes





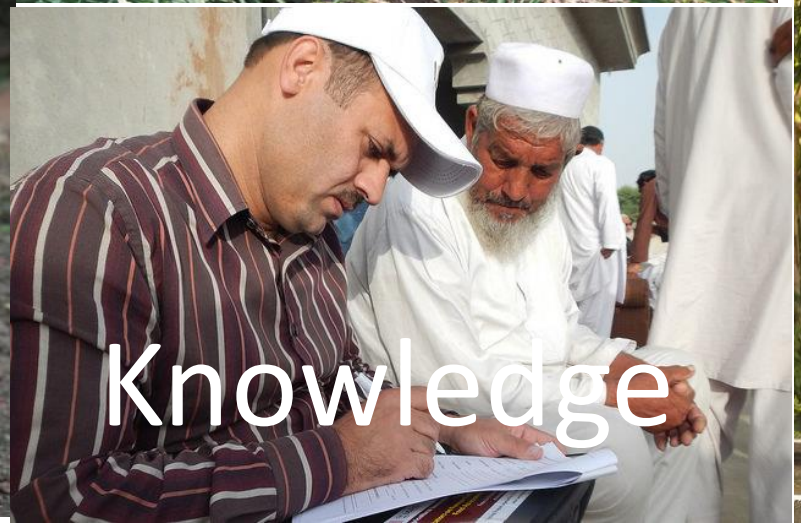


Photo credits, ILRI and Alan Duncan

Key feed constraint

What farming system are we working in?

What is the core commodity?

- Cattle/buffalo breeding (cow-calf)
- Cattle/buffalo fattening
- Dairy cattle / buffalo
- Sheep/goat breeding
- Sheep/goat fattening
- Pig breeding (sow-piglets)
- Pig fattening

To recap – the system can be described by various simple attributes

Key context attributes
Land
Labour
Credit
Input
Knowledge
Water

Key constraint Quantity, quality, seasonality
What is the system? Mixed intensive, agro-pastoral etc
What is the commodity? Dairy, sheep fattening etc

Feed interventions

Intervention	Title
1	Pulverization of dry fodders and crop residues
2	Chopping of dry feeds
3	Chemical treatment: urea treatment
4	Soaking in water
5a	Wet by-products: horticultural and brewers waste
5b	Wet by-products: Enset / banana leaves and stems
6	Dry by-products: Cereals
7	Protein by-products
8	Energy supplementation
9	Balanced concentrate supplements
10	Blocks: Urea molasses mineral licks
11	Powder: Commercial mineral licks
12	Supplementation with green fodder
13	Hay making
14	Silage making
15	Legume leaf and seed meals
16	Purchased crop residues or hay
17	Collective action to improve communal area management
18	Rehabilitation of degraded pastures
19	Grasses in cut & carry systems
20	Grasses for managed grazing systems
21	Irrigated fodder production
22	Herbaceous legumes, grown in monoculture or mixed with grasses
23	Fodder trees and shrubs
24a	Roots and tubers: Sweet potato vines
24b	Roots and tubers: Cassava foliage
25	Short duration and annual fodder crops
26	Thinnings, tops and leaf strips
27	Crop - forage intercropping
28	Cereal and legume varieties with better straw quality
29a	Dual purpose legumes
29b	Creep feeding - calves, lambs, kids, piglets
30	Calf feeding: rearing on milk replacers
31	Improved feed troughs to reduce wastage
32	Chopping of green fodder and forages
33a	Complete feeds for ruminants
33b	Complete feeds for pigs
34	Amino acid supplementation

Feed interventions

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Feed Intervention TechSheet 31

Feed intervention >> Feeding management > Feeding method

Improved feed troughs to reduce wastage

Old bomb casing as a feed trough in Laos – high losses

Old tyre as a feed trough in Laos - high losses

Concrete ring as a feed trough in Cambodia. Difficult to clean and high losses

Hollowed out palm trunk used as a feed trough in Myanmar.

Description

- ✓ There are many different types of containers that farmers use as feed troughs. Unfortunately, many are not well suited resulting in high wastage of feed – up to 25% wastage!
- ✓ Well designed feed troughs will have the following features:
  - ✓ Located outside the actual pen and placed off the ground for easy access and cleaning.
  - ✓ Deep and large enough to hold 30-40% of daily feed intake of ruminants (i.e. cattle, sheep and goats) that are kept in pens all day, so farmers need to replenish feed only 3 times per day.
  - ✓ As a rough guide, ruminants need to eat the equivalent of 3% of their body weight in good quality dry feed per day. For a 300kg cow this equates to 9kg of dry matter or approximately 45kg of fresh feed each day, which requires a large feed trough. For pigs the rule of thumb is 4% of body weight of high quality feed per day.
  - ✓ Feed troughs need a neck bar that encourages the animal to keep its head in the pen while eating.

Key benefits

- ✓ Reduces feed wastage, which can be as high as 25%. A well-designed feed trough reduces feed costs and saves land that would otherwise be needed to grow the 'wasted' feed.

Key limitations

- ✗ None, unless materials need to be purchased.

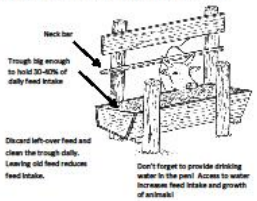

Illustration based on Varney and Stür (2009)

TechFit is a tool to prioritize and select animal feed interventions. It was developed by ILRI under the leadership of Alan Duncan. It has been further refined and developed with inputs from many individuals in and beyond CGIAR. This is one of a series of feed intervention 'TechSheets' developed alongside the TechFit tool to provide summarized information on different interventions included in the tool. Werner Stür led the development of the TechSheets. This sheet was prepared by Werner Stür and Alan Duncan. TechFit is supported by the CGIAR Research Program on Livestock and Fish. ilri.org/techfit

Concrete feed trough, Almora, Uttarakhand, India.

Photo credit Nils Teufel

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Feed interventions

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Feed Intervention TechSheet 13

Feed intervention >> Feed conservation and use of conserved feeds

Hay making

Making manual hay bales

Wooden box for making hay manually

Finished product – manual hay making

Description

- ✓ Hay preserves fodder in a dry form. Nutrients are preserved with minimum loss and in a storable form so they can be available as feed at the time of scarcity.
- ✓ Small scale hay making can be done with a sickle/machete and the dried hay can be baled manually using a box baler. This method produces a wide range of rectangular bales usually weighing between 10-20 kg.
- ✓ Large scale hay making requires a tractor to cut forages using a rotary disk mower, raking and baling hay using a mechanical baler. This method produces either (a) large round or rectangular bales (6-foot diameter bale) or (b) standard rectangular bales usually weighing between 13-15 kg.

Key benefits

Manual box baling:

- ✓ Compresses loose hay and increases storage capacity.
- ✓ Although haymaking is labour intensive, baling reduces total costs of handling as compared to loose hay.

Baling in general:

- ✓ Hay is an easily tradable feed and helps alleviate seasonal feed shortages.
- ✓ It helps farmers maintain high milk production throughout the dry season, when feed is in short supply. It thus increases total farm milk production.
- ✓ It may enable farmers to increase herd size and so increase profitability of animal production.

Key limitations

- ✗ Depends on sufficiently long dry periods to enable drying and baling. Hay quality deteriorates quickly if drying is interrupted by rain.
- ✗ Hay must be cut while the forages are not too old (high amount of leaf and a few stems). Then it must be cut and turned to facilitate fast drying.
- ✗ Hay must be baled at a moisture content of 16-20%. Baling hay if too wet will spoil the hay.
- ✗ An ideal hay bale should have a high leaf: stem ratio; the mass of leaf content should equal the mass of stem content.

Box baled hay, Rwanda

Photo credit Ben Lukuyu

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Feed Intervention TechSheet 25

Feed intervention >> Fodder production, grassland development and utilization> Improved planted forages

Short duration and annual fodder crops

Maize fodder crop for dairy, India

Improved sorghum fodder crop demo, India

Pearl millet, water-efficient fodder crop, India

Cowpea cultivated as green fodder

Description

- ✓ Annual or short-duration fodder crops planted for animal feed and harvested in the same season. Includes maize, wheat, barley, sorghum, oats, cowpea, alfalfa and fodder legumes.
- ✓ They can be fed fresh or made into hay or silage. Maize and sorghum need to be chopped before feeding.
- ✓ Growing fodder crops such as fodder oats for cool season feed supply or sorghum/maize for dry season feed supply (hay/silage) is a major strategy to overcome feed scarcity at particular times of the year.
- ✓ Most fodder crops are grown to address a quantity constraint (e.g. sorghum, maize) but some also address quality constraints (e.g. alfalfa, cowpeas).

Key benefits

- ✓ Can deal with particular feed constraints and may be one of few options for producing large quantities of feed in dry areas (e.g. sorghum).
- ✓ When fed fresh, most fodder crops are very palatable and provide good quality feed. Green feed improves the intake of dry basal crop residues.
- ✓ Leguminous fodders are high in protein and are good supplements to low-quality basal feeds.
- ✓ Short duration fodders can exploit residual soil moisture late in the wet season or can be planted in between food crops.
- ✓ There is high demand for fodder crops, particularly in peri-urban areas and in the dry season. Dried fodder crops can be transported easily to markets.
- ✓ Growing fodder crops on-farm reduces feeding cost when compared to purchased feeds.

Key limitations

- ✗ Fodder crops remove nutrients and deplete soil fertility unless manure or other fertilizers are returned to the field.
- ✗ Feed quality of some dried fodder crops such as sorghum can be low and they need to be chopped, soaked and/or pulverized before they can be used as basal feed.
- ✗ Presence of plant secondary metabolites (Saponins, oxalates cyanogens etc.)

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Oat/vetch annual crop, Ada'a, Ethiopia

Photo credit Alan Duncan

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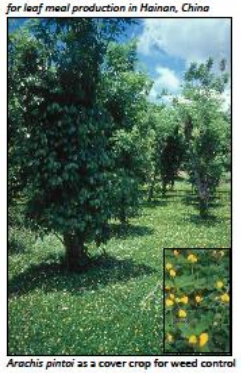
Feed Intervention TechSheet 22

Feed intervention >> Fodder production, grassland development and utilization> Improved planted forages

Herbaceous legumes, grown in monoculture or mixed with grasses

Legume cover crops under rubber trees, grazed by sheep in Malaysia

Stylosanthes guianensis as soil cover and for leaf meal production in Hainan, China



Arachis pintoi as a cover crop for weed control in a pepper plantation

Description

- ✓ Many creeping, twining and shrubby legumes have multiple uses.
- ✓ Annual (short-lived) and perennial forage legumes can be grown in monoculture for feed (or soil cover) or with grasses as pasture. Some dual-purpose legumes produce seeds for human food and the vegetative part of the plant can be eaten by animals. Food/feed legumes include *Vigna unguiculata* (cowpea); soil cover/feed legumes include *Centrosema molle* (centro) and *Pueraria phaseoloides* (kudzu); and for pastures *Arachis pintoi*.
- ✓ Most legumes need to be sown from seed. Some stoloniferous species, such as *Arachis pintoi* can easily be established vegetatively.
- ✓ In general, (a) legumes have a higher nutritive value but are less productive than grasses; (b) in the dry season, legumes are more readily eaten than grasses.
- ✓ Forage legumes are generally grown for strategic use: (a) as a feed supplement for highly productive animals such as dairy cows, or (b) for particular times of the year such as the dry season or whenever high-quality feed is needed.

Key benefits

- ✓ Legumes, via bacteria ("rhizobia") in root nodules, can fix nitrogen from the air making them independent of N fertilization. This may enrich soil fertility and can benefit subsequent food crops.
- ✓ Legumes have a high protein content and high nutritive value. The feed quality of legumes decreases much slower than in grasses which deteriorate quickly with age.
- ✓ Many legumes are drought tolerant because their deep-reaching root system can access moisture deep in the soil.

Key limitations

- ✗ Grass-legume pastures require a high level of knowledge and management skills to ensure persistence of the legumes.
- ✗ While many legumes nodulate freely with native rhizobia, some inoculation with a specific rhizobia strain is needed for effective nitrogen fixation.
- ✗ Seed is often not readily available.

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Lucerne trial plot, Almora, Uttarakhand, India

Photo credit Alan Duncan

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Feed Intervention TechSheet 3

Feed intervention >> Improvements and feeding of crop residues and other basal feeds > Chemical treatment

Urea treatment

Pit lined with *Enset* leaves

Packing treated straw in a pit lined with heavy plastic.

Packing treated straw in a plastic bag.

Description

- ✓ Urea treatment of low quality fibrous crop residues such as straws, sugarcane bagasse and hulls improves feed intake of these feeds. Ammonia, released from the urea, weakens the lignified outer wall and increases the digestibility of the straw. It also provides a source of supplementary non-protein nitrogen.
- ✓ For 100kg of dry straw, dilute 4kg of urea in 30-40 litres of water and sprinkle over the dry straw, compress the straw and then seal the straw with plastic. This is commonly done in a plastic-lined pit, a simple concrete box or in plastic bags. Leave the straw covered for 30-45 days (30 days for hot weather; 45 days for cold weather). Then remove the cover and leave straw for at least 7 days to get rid of the ammonia smell before feeding.

Key benefits

- ✓ Provides supplementary non-protein nitrogen and increases feed intake of low-quality fibrous feed by 10-15% and a similar improvement in growth or productivity.
- ✓ While the benefit of urea treatment is relatively small it can be significant in situations where feed quality is marginal for growth.

Key limitations

- ✗ Not easily adopted by smallholder farmers.
- ✗ For smallholders the method must be simple and practical without expensive construction of silos. Also, supplies such as urea and plastic need to be available locally at reasonable prices.
- ✗ Danger of urea toxicity if too much urea is used.
- ✗ Most suitable for areas where there is excess straw available on farms which would be wasted without urea treatment. Conversely, urea treatment may be less easily adopted in areas where straw availability is limited and animals will consume all of the available feed with or without urea treatment.

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Urea treatment of maize stover, Cibitoke, Burundi

Photo credit Alan Duncan

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How does Intervention Ranking Analysis work?

Key technology attributes
Land
Labour
Credit
Input
Knowledge
Water

Key constraint mitigation
Suitability for system
Suitability for commodity
Impact on productivity

Scored for each intervention by experts

Scored for each village during FEAST

Key context attributes
Land
Labour
Credit
Input
Knowledge
Water

Key constraint Quantity, quality, seasonality
What is the system? Mixed intensive, agro-pastoral etc
What is the commodity? Dairy, sheep fattening etc

How does Intervention Ranking Analysis work?

Key technology attributes
Land
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X

Key context attributes
Land
Labour
Credit
Input
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Water
Key constraint Quantity, quality, seasonality
What is the system? Mixed intensive, agro-pastoral etc
What is the commodity? Dairy, sheep fattening etc

Score

FEAST { DataApplication

Intervention Analysis Report

31/05/2016 central,south east ward sam malaanga dairy, alego usonga

Display: Top Interventions

Scores: Normalized Scores

Click icons to sort by individual scores. (Click Here for an explanation of scores.)

Click intervention to view details.

	Mitigate Core Constraint	Relevance to Commodity	Relevance to Farm System	Match Context Attributes	Production Impact
Supplementation with energy-rich supplements e.g. molasses,	16	20	10	15	20
Use of commercial balanced compounded feeds (e.g. dairy meal)	16	20	10	14	20
Supplementation using protein by-products e.g. from meat, blood and bone, fish, legume leaf meal, biofuel co-products, oil seed, poultry litter etc.	16	20	10	14	20
Cereal byproducts (rice bran, maize, wheat, etc.)	13	20	10	15	20
Thinnings, tops, leaf strips (e.g. maize, sorghum, cassava, sweet potato, wheat, sugarcane etc.) - without sacrificing grain/tuber yield	16	15	10	20	15

Conclusion

- FEAST aims to support more systematic livestock feed intervention strategies
- Has been used in a dozen countries
- Is not a magic bullet but the process does help users to think more systematically about how to intervene
- Still needs development especially on making the scoring system more robust

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