

The <u>Africa Research In Sustainable Intensification for the Next Generation</u> (Africa RISING) program comprises three research-in-development projects supported by the United States Agency for International Development (USAID) as part of the US Government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING is creating opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition and income security, particularly for women and children and conserve or enhance the natural resource base.

The three regional projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads the program's monitoring, evaluation and impact assessment.

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#### **FOREWORD**

This training module has been prepared for use by livestock production woreda experts. It is intended as a practical guide to cover some of the basic principles and practices of quality feed resourcing and using for the cool and moist highland agro-ecologies. The module is part of a series of attempts by the Africa RISING Ethiopian highlands project to capacitate local development practitioners in the application of proven feed and forage innovations that improves feed resource availability, quality and livestock productivity without negatively affecting the environment. The module has been developed considering the results of the project's research for development works in selected highland research sites as well as lessons from other recent literature reports. We thank all contributors who helped in the preparation of this document. We hope that the module would be useful and helps woreda level livestock experts to provide trainings or advisory services.

#### **ACKNOWLEDGEMENTS**

We acknowledge the funding from the USAID in Washington to the Africa RISING project in the Ethiopian Highlands, the International Development Association (IDA) of the World Bank to the Accelerating the Impact of CGIAR Climate Research for Africa (AICCRA), funders for the Mixed Farming Systems through their contributions to the funders CGIAR Trust Fund.

#### **HOW TO USE THE MODULE**

This module is primarily intended to be used as a practical guide and a reference for woreda level livestock experts who are expected to train development actors in the field and lead implementation of feeds and forage interventions. The module will also serve as a source of reference and information for development agents on the ground who give guidance and training to farmers and other forage value chain actors. Based on the need and level of prior exposure users of this module may choose to refer to a section of their interest or may go through the whole module. Readers are advised to go through the assessment questions and checklists to evaluate their current understanding of the technologies and to know whether they have internalized the relevant information provided in this module.

## **MODULE LEARNING OBJECTIVES**

This module is intended to enable readers to:

- 1. Describe the economic and environmental benefits of improved forages in the smallholder mixed crop–livestock system
- 2. List the important cultivated forage options for feed resourcing in the highlands
- 3. State essential agronomic practices and production requirements of the forages, as well as their use practices to optimize crop–livestock productivity
- 4. Identify niches for the different species of improved forage integration in the farming system
- 5. Plan and execute forage development innovations as per the requirements for each innovation
- 6. Describe postharvest feed handling as well as feeding practices that optimize usage at farm level

## **MODULE OVERVIEW**

This module intends to provide hands on skills and knowledge to woreda livestock production specialists and extension development workers on the essentials of feed resourcing strategies in the highland mixed crop—livestock systems. The module derives practical lessons from years of research for development works. Rather than dealing with a list of forage technologies that could work in the highlands, this module focuses only on selected feed and forage innovations that have been validated by the Africa RISING project and proved to be effective and favourably accepted by farmers to improve the feed resource base of smallholder farmers and contribute to environmental sustainability. The module provides key explanations as to why integrating improved forages is necessary now more than ever in the highland ecosystems. It discusses about promising forage options with a high probability of impact including oat—vetch mixture, fodder beet, desho grass and tree lucerne. Moreover, the module deals with practical postharvest feed handling and using practices to minimize wastage of feed resources and optimize on farm feed use for improved livestock productivity.

#### SESSION 1 OATS-VETCH MIXTURE FORAGE



#### SESSION LEARNING OBJECTIVES:

- Describe the important features of oat-vetch
- Identify suitable sites for oats-vetch production
- Be able to explain essential agronomic, storage and usage practices



#### **PREASSESSMENTS**

a.	Do y	/OU	know	what	oats-v	etch	mixture	is?

i. Yes; ii. No.

b. Can you list the benefits of oats-vetch mixture?

i. Yes, I can list the benefits; ii. Yes, but partially; iii. No.

c. Do you know the time oat-vetch forage should be harvested for use as feed?

i. Yes; ii. No.

d. Do you know how should the forage be used by farmers when feeding livestock?

i. Yes; ii. No.



## SESSION OVERVIEW

This session is intended to give the readers relevant information about the characteristics of oats-vetch mixture forage, essential agronomic practices and its potentials to provide quality fodder for livestock production. The session specifically describes factors to consider during site selections, seeding, harvesting, conservation and use.



## WHAT IS OAT-VETCH MIXTURE?

Oats and vetch are different forage plants but, in this section, they are described together taking into consideration the way they are used. Oat (Avena sativa) is an erect annual grass which can grow up to 2 m tall, with a vigorous root system. Vetch is also an annual herbaceous legume.

There are different species of vetch, but the highly productive and well adapted species that can be intercropped with oat include Vicia villosa and V. dasycarpa. Vetch has a scrambling and climbing growth habit.

Both oat and vetch have similar agro-ecological adaptations and are widely adapted to the mid and cool highlands of Ethiopia (2,300 to 3,000 metres above sea level, masl). Oat–vetch mixture grows well on a wide range of soil types including highly acidic soils (as low as pH 4.5). But the mixture performs best on well drained, fertile, loamy soils. The forage mixture tolerates poor soil fertility and frost. External input requirements such

as fertilizers are minimal. Photo 1 depicts a well performed oat-vetch mixture in Sinana woreda of the Bale zone.



Photo 1. Oat-vetch mixture.



## **BENEFITS**

Oat and vetch are among the few improved forage options that are very well adapted to the highlands of Ethiopia, especially for resource poor farmers. The two forages have been promoted through the extension system and in many cases the forages have been grown as sole crops. In recent years, the Africa RISING project has adopted an approach of growing the two forages as intercrops rather than sole crops. This innovation has proved to have several benefits compared to growing them separately. Some of the important benefits are the following:

In terms of nutritional composition oat is mainly a source of energy, while vetch is a source of protein (legume). As a result, oat–vetch mixture provides a balanced forage diet in terms of energy (9–10 MJ/kg DM) and protein (14% CP) for ruminant livestock. Studies have indicated that a well prepared oat–vetch mixture hay or green forage can replace expensive concentrate feeds in the diet of fattening sheep or lactating cows. As concentrate feeds are usually not easily accessible to smallholder farmers, home grown oat–vetch mixture can be a cheap source of supplemental feed to increase the income of farmers.

- The biomass productivity is quite high, ranging from 11–18 t of dry matter per hectare, depending on the soil type and management.
- Several studies have shown that growing oat and vetch as a mixture is more
  productive, easy to manage and use than growing them as sole crops. The mixture
  is found to increase land productivity as the two forages have different growth
  forms and complement to each other.
- Vetch fixes atmospheric nitrogen and contributes to biological nutrient replenishment to the soil. The oat crop benefits from the nitrogen fixation by the vetch.
- The mixture has a short growth cycle and can be ready for use between 60–90 days of planting. It is suitable for both rainfed and irrigated fodder production.
- Although the two forages are annual crops, the mixture can regenerate within the same growing season. The regrowth will be vigorous if the forage is grown under irrigation.
- Oat-vetch forage is a suitable crop for rotation with wheat, barley, faba bean and field pea.

#### **PRODUCTION AND USE**



A good practice of oat-vetch production will involve seed selection, site selection, land preparation, establishment, plot management and harvest

a. Seed sourcing and setting optimum seed rate:

Oat and vetch are propagated by seed. The seeds of both forages germinate well under normal conditions.

The following are essential points to consider regarding seeds and seed rate:

- High viability (germination) is obtained if the seeds are well dried (moisture content less than 14%) prior to storage. Therefore, it is necessary to check the dryness of the seed through sensory inspections for a quick judgement of quality/ viability. This can be done by breaking a few seeds with teeth. If the seeds break easily, it is an indication that the seeds have the right level of dryness (low moisture).
- Conducting a germination test gives an objective evaluation of the viability of
  the seeds and it is recommended that germination test is done regularly before
  seeding. The test can be done by woreda experts provided that the experts
  received hands on training on germination test and modest a quality checking
  laboratory is available. Petri dish and tissue paper are the items required for the
  test.
- The average recommended seed rate for oat–vetch forage establishment is 75 kg oat and 25 kg vetch per hectare. For a timad of land a quarter of the above seed rate is required (i.e. 19 kg of oat and 6.3 kg of vetch). The seed rate could

be adjusted depending on the level of germination percentage and purity. For example, if the germination rate is low, it is advisable to increase the seed rate to 90 kg of oat and 30 kg of vetch per hectare.

## b. Site selection, land preparation and establishment:

- Although oat-vetch forage can grow on a range of soil types, well drained fertile soils provide the maximum yield. Therefore, it is important to select a site which is not waterlogged.
- The land should be ploughed at least twice to prepare a uniform textured plot for forage establishment.
- Row planting or broadcasting may be used depending on the local condition. If
  row planting is practiced, oat and vetch seeds are sown on alternate rows. That
  is, a row planted with oat seeds is followed by a row planted with vetch seeds.
  However, under farmers conditions, it is easier to plant oat-vetch forage by
  broadcasting. Prior to broadcasting it is necessary to mix the two forage seeds
  uniformly.
- The blanket fertilizer recommendation is 18–23 kg N and 20–30 kg P per ha at sowing and top dressing with urea at tilling.

If broadcast, mix oat and forage seeds uniformly before sowing.

## c. Plot management:

After seeding, it is important to follow up on germinations after a week. Oat seeds germinate quicker than vetch seeds, but gradually the vetch catches up. Generally, both seeds do not have major germination problem. In some cases, however, vetch may have reduced germination due to immature seeds. If the germination is low (below 50%) it is advisable to over sow the plot with additional seeds.

Hand weeding during the early days of establishment 1–2 weeks after full emergence is recommended. If grown with irrigation, the frequency of irrigation may depend on the irrigation technique and the level of water applied during each irrigation time. But the fodder plot should be irrigated at least once in a week until it reaches maturity.

#### d. Harvesting:

Harvesting stage (time) affects the biomass yield and forage quality. Oat–vetch mixture is harvested together. Harvesting the forage prior to the bloom/booting stage results in low dry matter yield, but it is of high quality in terms of digestibility, metabolizable energy and protein content. On the other hand, late harvesting well beyond the flowering stage gives high biomass yield but with compromised nutritional quality.

The recommended right time of harvest is when about 50% of the vetch stand flowers, which coincides with the booting stage for the oat.

• If the forage is grown with irrigation, it can be harvested twice, the first at about 45 days of growth and the second when the regrowth oat forage starts to flower.

The forage can be fed to animals fresh, in the form of hay or silage. Oat-vetch mixture makes excellent hay and conserving excess biomass in the form of hay is recommended.

It is advised to feed the forage as a supplement to locally available feeds. On farm trials indicated that by supplementing lactating cows with about 2 kg of well prepared oatvetch hay, it was possible to increase the milk yield of cows by at least 50%. A sheep fattening also indicated that by supplementing about 0.3 kg of oat–vetch hay per day to grass based basal diet, it was possible to achieve an average body weight gain of 86 g, in comparison to 106 g daily gain achieved with concentrate supplements. The economic gain is found to be much higher for the oat–vetch supplement given the cost and accessibility of concentrate diets.

A frequent usage problem is that when the forage reaches harvest stage, farmers tend to feed it as a sole diet in large quantities, leaving little for use as a supplement. Important usage advice is to use it as a supplement, not as a basal feed or as the main component of the diet. The daily supplement can be mixed with other locally available feeds or given separately apportioned in the morning and afternoon. When mixing with grasses and crop residues, it is advised to mix 1 part oat–vetch hay with 3 part local feed resources (1:3 ratio). Generally, for cattle 2–3 kg of oat–vetch hay and for sheep 0.3 kg of hay daily would be enough to achieve satisfactory performance. Fresh oat–vetch forage contains about 25–30% of dry matter. If the forage is fed fresh, the quantity should be adjusted to obtain the required daily dry matter supplement. For example, the equivalent of 2–3 kg of hay is 6–9 kg of fresh oat–vetch forage; and similarly, 0.3 kg of the hay is equivalent to 1 kg of fresh mass.

Use oat-vetch mixture as a supplement to locally available feeds to optimize its use and benefits.

## **SEED PRODUCTION**



The grain yield of oat in Ethiopia varies over the different agro-ecologies and varieties, where grain yield is lower for forage varieties. Oats grown for seed production uses lower seeding rates and higher fertilizer levels. Seed yields on average ranges between 1 to 3.5 t/ha with average straw yields of about 5.5 t/ha. The seed production and harvesting practice is quite like that of other cereal crops such as barley and wheat.

Seed production from vetch species such as V. sativa and V. narbonensis is easier as they are early maturing and good seed producers. However, seed crops of V. villosa, dasycarpa and atropurpurea are late maturing varieties, with indeterminate growth of flowers, which make them susceptible to frost. Generally, vetch seed production should be done in frost free areas. In Ethiopia seed productivity ranges from 7 to 23 quintal/ha depending on the management and species.

## ASSESSMENT QUESTIONS

- 1. Where is oat-vetch mixture forage most suited to grow?
- 2. State the important benefits of growing oat–vetch in a mixture rather than as a sole crop.
- 3. State the nutritional benefits of oat-vetch forage.
- 4. When should oat-vetch forage be harvested for use as feed?
- 5. How should the forage be used by farmers when feeding livestock?

#### **SESSION 2 FODDER BEET**



## SESSION LEARNING OBJECTIVES

- Describe the characteristics of fodder beets
- Describe the benefits of using fodder beet for livestock feeding
- Be able to explain essential agronomic, storage and usage practices of fodder beets



#### **PREASSESSMENTS**

- a. Do you know where fodder beet most suited to grow?
  - i. Yes; ii. No.
- b. Can you list the benefits of fodder beet?
  - i. Yes, I can list the benefits; ii. Yes, but partially; iii. No.
- c. Can you list the agronomic practices used in establishing fodder beet plot
  - i. Yes, I can list the practices; ii. Yes, but partially; iii. No.



## SESSION OVERVIEW

This session provides summarized information about the nature of fodder beet, its role as a source of high energy feed supplement and the important management practices regarding fodder establishment, production and use for ruminant livestock.



## WHAT IS FODDER BEET?

Fodder beet (Beta vulgaris subsp. Vulgaris L.) is an annual/biennial plant with thick roots that is suitable for cultivation in a cooler climate. The root tuber together with the leaf provides good quality fodder for livestock. Fodder beet needs a long growing season (6–7 months) and fertile soil to perform well. Fodder beet grows in the highlands of Ethiopia (1,800–3,000 masl) with an annual rainfall of at least 750 mm. It needs a fertile and well drained soil for optimal productivity. The crop is sensitive to acid soils. It requires a pH of 6.5 to 8.0 for a proper growth. The crop is not suited to waterlogged areas. Photo 2 depicts a well performed fodder beet in Jawe kebele of Lemo woreda, an Africa RISING site in the Southern Nations, Nationalities, People (SNNP) region.

Photo 2. Fodder beet plant (left) and tuber (right).







Fodder beet is among the few forage options that performs well in the cool highlands. However, like other forage types, the scale of its adoption is limited. The main reason appears to be due to limited awareness about its benefits among farmers and lack of sustained popularization and challenges related to supply of seeds. Africa RISING project introduced and tested different varieties of fodder beet, which proved to be highly acceptable and profitable for farmers to grow. Some of the observed benefits include the following:

- It produces high biomass (around 200 quintals DM/ha) of very good nutritional quality in terms of energy source for livestock (12–13 mega joule metabolizable energy per kg DM) in one growing season.
- It has a modest level of protein content (6–10%) and is highly digestible (70–80% digestibility).
- Using fodder beet to supplement low quality feeds will considerably increase the productivity of animals.
- On farm feeding trials in the Africa RISING sites indicated that by supplementing 8–10 kg of fodder beet tuber per day per animal, milk of lactating cows was increased by 30%.
- Use of fodder beet reduces feeding costs of lactating cows, as it can effectively replace other energy supplements such as wheat bran and maize.
- In cooler highlands, it produces seeds easily.
- It can propagate by seedlings and sale of seedlings can be a good source of income for smallholder farmers who are engaged in fodder beet production.
- It tolerates shade and grows in excellent condition in backyards using the manure of animal barns. In doing so it helps to enhance nutrient cycling.

#### PRODUCTION AND USE



## a. Seed sourcing and optimum seed rates

Fodder beet is propagated through seeds. For fodder beet seed production highland areas (around 2,700 masl) are highly suitable. But the plant can produce viable seeds in areas where it is grown for tuber production. Kulumsa research centre has served as the main source of fodder beet seed for several years. Currently the seeds can be sourced from different research centres. Generally, the seeds germinate easily. The seed rate is 8 kg/ha. The seeds can be drilled directly once the seedbed is prepared. Alternatively, seedlings can be raised in nurseries and later transplanted to the field.

#### b. Site selection

Fodder beet requires a deep and fertile soil which is well drained. Backyard fields are highly suitable for fodder beet production, as such soils are rich in nutrients. As the crop is sensitive to soil acidity, it is important to select sites which are not acidic or necessary to apply lime before the crop establishment.

## c. Plot management and establishment

Fodder beet requires a clean (weed free) and well prepared seedbed and does better in light or loam soils. The forage responds well to fertilizer applications. About 10–15 t/ ha of farmyard manure should be applied at establishment. Under rainfed conditions, seeds should be planted just at the beginning of the main rainy season. Seeds should be sown 2 cm deep and in rows 50 cm apart. The plants can later be thinned to give 25 cm spacing between plants. Alternatively, seedlings raised in nurseries for 2 months can be transplanted to main plots at the beginning of the rainy season. This approach has provided very good results in the Africa RISING project sites. Seedlings can be raised with supplemental irrigation during the belg season and then immediately transplanted to fields when the rainy season starts. This practice gives farmers more control of the survival of the crop, ensures longer plant growth periods and higher yields.

## d. Weeding

Fodder beet requires effective hand weeding, especially during the early establishment period (the first 1–2 months). It is always advisable to keep the plot free from weeds.

## e. Hoeing and soil piling

Hoeing and piling the soil around the roots is essential to facilitate increased root development and growth. Such practices should be done once per month until the crop is ready for use. In addition, it is important to inspect the plot regularly (once per week) to check if additional hoeing and soil piling is needed so that the tuber is not exposed on the surface.

# f. Harvesting Harvesting and use

The tubers will be ready to harvest and use after 6 months after planting. When the plant is ready for harvest, it sheds several of the leaves and there will be no observable active growth of new leaf shots. If there is extended rain or the plot is irrigated the plant may start to flower. The tubers should be harvested carefully by digging them out of the ground. They need to be washed and separated from any soil material.

## USE

In general, washed tubers can be used in intensive management systems on dairy or fattening farms by chopping before feeding. Tops (leaves) may also be fed to livestock after wilting. The tops can also be grazed or made into silage by mixing them with other grasses. Tubers can be stored after harvest for 4–5 months if not damaged during harvest. The high sugar content makes fodder beet palatable and a valuable energy source for ruminants.

Lactating cows need to gradually adapt to feeding on fodder beet, starting with small amounts to avoid the risk of acidosis.

At the start of feeding, it is advised to start with 2 kg of fresh beet tuber (1 kg of tuber in the morning and 1 kg in the afternoon) and gradually increasing the amount over a week to up to 10 kg of tuber per day. Always feed fodder beet after animals have consumed other roughage feeds to avoid the risk of stomach disorder due to a rapid drop in the rumen pH which is called acidosis. The tuber can also be included in the diet of pigs.

Always feed fodder beet after animals have consumed other roughage feeds.



## SEED PRODUCTION

Fodder beets flower and produce seeds in the second year after planting. Fodder beet plot dedicated for seed production should therefore be left untouched beyond the six months of growth. To trigger flowering, the plant needs a cold period known as vernalization. It is thus important that a typical highland with a cool agro-ecology is selected for fodder beet seed production. When the seeds of fodder beet are ready for harvest, they can be collected by stripping. Seed yield is about 400–500 kg/ha.

## ASSESSMENT QUESTIONS

- 1. Where is fodder beet most suited to grow?
- 2. What type of soil does fodder beet require for optimal tuber development?
- 3. Describe the agronomic practices in the establishment of fodder beet plot.
- 4. What are the nutritional qualities of fodder beet?
- 5. How should fodder beet be harvested and fed to animals?

#### **SESSION 3: DESHO GRASS**



#### SESSION LEARNING OBJECTIVES:

- Describe the characteristics of desho grass
- List the role of the grass in the mixed crop-livestock system
- Be able to explain essential agronomic, storage and usage practices



#### SESSION OVERVIEW

This session describes the main characteristics of desho grass, its functions as feed and biological stabilizer of soil and water conservation structures in watershed. The session specifically details where and how the grass can be grown to improve feed resource availability and environmental sustainability.



## **PREASSESSMENTS**

a.	Do	vou	know	where	desho	is	most	suited	to	arow?

i. Yes; ii. No.

- b. Can you list why desho grass is suitable for use in soil and water conservation?
  - i. Yes, I can list the benefits; ii. Yes, but partially; iii. No.
- c. Can you list the management practices that help to obtain high biomass yield from desho grass?
  - i. Yes, I can list the benefits; ii. Yes, but partially; iii. No.
- d. Do you know activities that should be done to ensure persistency of desho grass plots?
- i. Yes; ii. No.



## WHAT IS DESHO GRASS?

Desho (Pennisetum pedicellatum) is a perennial grass that is indigenous to Ethiopia and belongs to the Poaceae family (Photo 3). The scientific name of this grass is still unsettled. EIAR refers this grass as P. glausifolium. The grass is a perennial forage and has an extensive root system that anchors it well in the soil. It grows upright and can reach a maximum height of 90–120 cm, depending on soil fertility. The grass can grow anywhere from 1,500–2,800 masl and in medium-to-low fertility soil. Photo 3 depicts a well performing desho grass in the ILRI Addis Ababa campus.

Photo 3. Desho grass.





## **BENEFITS**

Desho grass has multiple functions and produces good quality forage.

- It is suitable to integrate in the cropping systems as it can grow well in backyard plots, along fences/border lines and on soil and water conservation structures (soil bunds).
- Desho grass is uniquely suited to biologically reinforce terraces constructed within arable lands and enclosures to protect soil erosion and increase water infiltration.
   The grass has an extensive root system that effectively stabilizes soil bunds.
- Growing desho grass on terraces provides multiple functions: good quality fodder for animals; improves soil fertility of arable lands and increase crop as well as overall land productivity.
- The crop can be harvested 3–4 times per year under rainfed conditions and up to 9 times per year if irrigated. The biomass yield ranges between 10–15 t/ha per year with rainfed production and about 20–25 t/ha per year with irrigation and nutrient input.
- Desho provides good business opportunities for farmers through the sale of grass cuts as fodder and root splits as planting material. Several farmers in southern and central Ethiopia have used root splits of desho grass as a cash crop.
- Desho grass is highly palatable and can be used as a good source of basal forage for all classes of livestock. On average this forage has a crude protein content of 10% and in vitro dry matter digestibility of 58%.

#### PRODUCTION AND USE



## a. Planting material sourcing and handling

Desho grass is propagated through root splits, as it hardly sets viable seeds. Root clumps can be transported long distances provided that the roots are uprooted intact with a bunch of soil with it. Before the planting material is uprooted, it is very important to prepare the plot where it is going to be established and the splits should be immediately planted upon arrival. It is highly recommended that the root splits are planted within three days they are uprooted from the source for optimal survival. The root clumps should be separated into several splits containing four to five tilling before planting.

#### b. Site selection

Desho grass thrives on a range of soil conditions and topographies. Backyard plots, along fencing lines, roadsides, soil bunds/terraces and enclosure areas are among the sites where desho grass can be established successfully. To produce optimal forage biomass, the grass needs fertile soils and regular nutrient addition/fertilization after establishment.

## c. Plot management

To successfully establish desho grass it usually requires a well prepared land. It is thus advisable to prepare a plot free of other weeds. If the grass is to be established on backyard and outfield plots, it is important that the plot is ploughed at least once. For soil and water conservation purposes, it is recommended to plant at 10 cm intervals along bunds, with at least 10 cm between rows. For grazing lands, it is recommended to plant at 50 cm intervals with 50 cm between rows. The leafy part of planting material should be removed before planting to reduce competition before establishment. After tilling/opening the soil with hoes, place the split in the soil and press the basal soil around the seedling.

Compost or manure should be applied at a ratio of about 4,500 kg/ha during establishment and about 1,000 kg for maintenance once per year. The establishment and maintenance of desho requires labour and the crop is susceptible to intensive free grazing.

Organic/inorganic fertilizer application is essential for maintenance and persistency of desho plots.

## d. Harvesting

After planting, the grass can reach the first harvest in four months. When harvesting it should always be at a height of 5–8 cm above the ground to allow quick regeneration. Subsequent harvest heights may depend on the local condition, but it is recommended to cut after it reaches 50 cm of height.

The grass is suitable for a cut-and-carry feeding practice and can be fed to both small and large ruminant livestock. It can also be conserved as hay for dry season feeding. When making hay it is usually important to frequently turn the drying mass so that it will not over dry and bleach. Desho grass is susceptible to intensive grazing and it should be used only for a cut-and-carry feeding practice.

Avoid free grazing on desho grass plot for persistency of the grass.



## SEED PRODUCTION

The grass rarely gives seeds and propagation is mainly through root splits.

## ASSESSMENT QUESTIONS

- 1. Where is desho grass most suited to grow?
- 2. How is desho grass propagated?
- 3. What makes desho grass suitable for use in soil and water conservation?
- 4. What management practices help to obtain high biomass yield from desho grass?
- 5. What should be done to ensure persistency of desho grass plots?

#### **SESSION 4: TREE LUCERNE**



#### LEARNING OBJECTIVES

- Describe the features of tree lucerne and its growth requirements
- · List relevant procedures in establishing the fodder tree
- Identify suitable sites for tree lucerne farming
- Describe the functions of tree lucerne and how it can be used as livestock fee



## SESSION OVERVIEW

This session tries to describe the multifunctional roles that tree lucerne can play in the highlands of Ethiopia with emphasis on the fodder value of the tree. The session describes relevant knowledge and skills required to successfully establish, raise and use tree lucerne as a source of high quality fodder, soil fertilizer, bee fodder and carbon sink.



#### **PREASSESSMENTS**

a. Do you know where is the suitable place to grow tree lucerne?

ii. No.

- i. Yes;
- b. Do you know the reason why tree lucerne is the best option for cooler highland areas of Ethiopia?
  - i. Yes; ii. No.
- c. Can you list the factors to be considered when selecting a site for tree lucerne establishment?
  - i. Yes, I can list the benefits; ii. Yes, but partially; iii. No.
- d. Do you know the optimal size required to transplant tree lucerne seedling?
  - i. Yes; ii. No.



#### WHAT IS TRFF I UCFRNF

Tree lucerne (Chamaecytisus palmensis) is one of the few leguminous fodder and fertilizer tree species that perform well at high altitudes. The plant fixes and adds nitrogen to the system, hence enhancing soil fertility. Commonly the tree is also referred to as tagasaste. Tree lucerne can grow in areas from 2,000 to over 3,000 masl in the Ethiopian highlands.



## **BENEFITS**

Tree lucerne is a typical multipurpose tree which provides several benefits for farmers. Although this tree has been introduced decades ago to highland areas, the scale of its use remains limited. Several factors including knowledge gaps on the benefits and management of the tree and poor survival of the tree seedlings under free grazing conditions

may contribute to the low adoption. Africa RISING project has conducted a series of on farm trials and demonstrations to transfer the necessary knowledge and skills on the use of tree lucerne. Among the main benefits of the tree are the following:

- The tree is well adapted to the highland agro-ecologies where other fodder trees do not survive.
- The tree is a fast grower if managed well and reaches for about 2 m height within 9 months of planting.
- Its leaves and edible branches are rich in readily digestible nutrients, with 20–25% crude protein and about 70% digestibility.
- It produces about 8–10 t of edible dry matter per hectare and using the leaves as
  a supplement effectively replaces expensive concentrates. In the Africa RISING
  sites, providing 300–400 grams of tree lucerne leaf was found to be enough to
  obtain a daily body weight gain of more than 70 grams in small sized Menz sheep.
  This body weight gain was superior to previous trials obtained using concentrate
  supplements.
- Giving a lactating dairy cow 1 kg per day supplement of dried tree lucerne leaf feed can increase milk yields by up to 1.2 litres.
- It is a voracious nitrogen fixer (100 kg/ha) and helps to improve soil fertility. As a result, it is often called a fertilizer tree.
- When planted on soil bunds or as an alley crop in arable lands, its deep roots help to recover nutrients that are beyond the reach of annual crops, in addition to soil and water conservation roles.
- The plantation serves as an important carbon sink and contributes to localized climate change mitigations.
- As a perennial plant, it helps to provide much needed good quality green fodder during the dry period. The seeds of tree lucerne can be included in poultry rations to improve yolk colour.
- The flowers serve as important bee fodder.
- The wood from tree lucerne serves to prepare farm tools, including pitchfork.

#### PRODUCTION AND HARVESTING



a. Seed sourcing and management

Establishment is done with seedlings. The seeds have a hard cover and need pretreatment before planting break the hard coat cover. The treatment can be done by scarifying the seeds with sandpaper or immersing the seeds in boiling water for five minutes. If boiling water treatment is used, it is important to check if the coat has been softened by breaking a seed with teeth. If one feels the cover is soft with teeth, it means the treatment is enough. If the cover is still hard the hot water treatment can be extended up to 10 minutes.

#### b. Site selection and establishment

Tree lucerne is highly susceptible to waterlogging and it is essential to identify a site for establishment which is well drained. Establishment is done with seedlings. Seedlings must be raised for at least three months in a nursery. It is preferable to raise seedlings in bags.

Seedlings that are at least 45 cm tall are preferable for planting and a planting hole of 30–40 cm in depth is recommended to protect the taproots. The commonly recommended optimal spacing for tree lucerne plantation is 1 m between plants and 1 m between rows. When intercropped with other crops, wider planting spaces can be used. It can be planted as a live fence, a fodder lot, a part of soil and water conservation structures, a boundary plant or intercropped with crops and vegetables.

## c. Plot management

Tree lucerne seedlings require regular spot weeding. Fencing should be erected to protect the trees against incursion by livestock, including trampling and browsing during the establishment period. The use of mulch and/or manure is recommended to help retain moisture in the soil and suppress weeds. The plants should be watered soon after planting to improve survival and growth rates.

## Avoid planting tree lucerne

- a. under eucalyptus and any other trees
- b. planting in waterlogged areas and
- c. protect seedlings from browsing

## d. Harvesting

A well managed tree lucerne seedling reaches for the first cut in about 9 months. The tree should be cut at a height of 1–1.5 m above the ground. The first cut allows the tree to branch and grow laterally. Subsequent harvest should maintain this height for optimal biomass yield and ease of management. The plant can be harvested 2–4 times per year, depending on growing niches and management practices. Access to reliable water supply and management factors—including fencing planted seedlings to protect from browsing, mulching during dry periods, clean spot weeding and applying organic fertilizers have been observed to significantly enhance survival and growth of tree lucerne at Africa RISING planting sites.

## USE

The foliage can be fed to livestock green or wilted or preserved in the form of hay and used as needed. Animals, especially cattle, which do not have prior exposure to the fodder may not eat the green leaves readily. In this case it is important to wilt the leaves, mix them with other feeds that the animal commonly consumes before offering. This kind of step-by-step exposure is always important. Tree lucerne foliage has got moderate levels of condensed tannins which do not affect feed intake and digestibility but would help to improve the overall ruminal fermentation of feed consumed.

Tree lucerne flowers extensively and as a result it is an important bee fodder. Smallholders who keep beehives can benefit quite a lot from this tree. Tree lucerne bear considerable amount of seed and the seeds can also be used as good sources of poultry feed.



## SEED PRODUCTION

Tree lucerne flowers extensively and as a result it bears a considerable amount of seed. Seedpods turn from pale green to brown and then to dark brown as they mature on the tree matured pods should be hard harvested by picking the pods or cutting branches containing matured pods. To test whether the seeds are ready to harvest, twist the dark brown pods and feel them. If they crack or pop open, it is an indication of right time of harvest. The harvested pods should be allowed to dry further in a shade, where the pods will open and release the seeds. The seeds can also be used as good poultry feed ingredient.

## ASSESSMENT QUESTIONS

- 1. Where is tree lucerne most suited to grow?
- 2. What are the factors to consider when selecting a site for tree lucerne establishment?
- 3. What is the optimal size of tree lucerne seedling for transplantation?
- 4. Why is tree lucerne the best option for cooler highland areas of Ethiopia?
- 5. What are the main nutritional qualities of tree lucerne?

#### SESSION 5: FEEDING TROUGHS TO IMPROVE USE OF FORAGES



#### LEARNING OBJECTIVES

- Describe the benefits of improved feeding troughs to reduce postharvest feed losses
- State its role in improving the use of cultivated forages
- List specifications for constructing feeding troughs
- Conduct trainings on constructing the structure
- · Advise on suitable designs of feeding troughs based on farm contexts



## SESSION OVERVIEW

This session describes the multidimensional benefits of improved feeding troughs in improving postharvest use of forages and promoting sustainable feeding practices including cut-and-carry feeding systems in the smallholder system. It presents feeding trough designs with details of measurement specifications. This session gives information on what type of troughs are suited for different farm settings and conditions. With this information readers will be able to guide farmers and train local carpenters on the construction and use of the farm structure to optimize feed use at household level.



#### **PREASSESSMENTS**

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а.	Do vou	know the	penerits of	constructing	Improved	тееа	trougns?

i. Yes; ii. No.

b. Are you familiar with improved feed troughs designs for cattle?

i. Yes; ii. No.

c. Do you know what type of materials would be needed for feed trough?

i. Yes; ii. No.



# WHAT IS A FEEDING THROUGH?

Feeding troughs are important farm structures required by livestock producers used to feed animals. In the highlands of Ethiopia farmers have different experiences of using feeding troughs.



Feed resourcing and feeding are an integral component of livestock production systems. However, most farmers offer feed to their livestock on the ground. This traditional practice leads to loss of a considerable amount of feed biomass due to trampling, defeca-

tion by the animals and contamination. Africa RISING project has designed, validated and promoted an improved feeding trough to minimize feed wastage and improve the way cultivated forages are used. On farm observations and feedback from farmers have proved that this technology is very important to use available feed resources efficiently. Through the projects thousands of farmers have adopted the technology. The following are the main benefits:

- Improved feeding trough has been confirmed to save about 30% of the feed offered which otherwise would be wasted under the traditional practice.
- It reduces the need to frequently watch out animals while feeding, hence reducing labour demand for taking care of animals in the homestead by at least 10–20%.
- As women and children are the family members who are mainly responsible for feeding and looking after livestock in the homestead, the technology has got a gender dimension and directly benefits these members of the household.
- This practice has also an environmental benefit as it encourages cut-and-carry feeding system in areas where grazing lands are limited and enclosures are adopted to recover degraded lands through improved forages.
- Limited movement of animals means that most of the feed energy consumed is used for production.
- Manure collecting and handling can be done relatively easily with the use of well constructed feeding troughs.

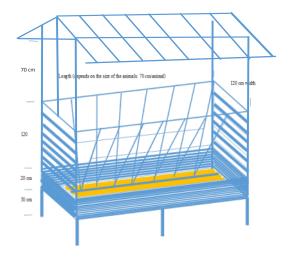
## HOW TO CONSTRUCT A TROUGH:

The improved feeding trough design that Africa RISING project has validated and promoted is shown in Figure 1. It is designed to be either one sided or two sided feeder depending on where it is to be erected. Following this design local carpenters can build feeding troughs with locally available resources. Nails are the factory products that should be available to construct the structure. Roofing can be done using either locally available materials such as grass mats or polyethylene sheets or corrugated iron sheets. For cattle, the trough specifications are the following:

- Height from the ground: 50 cm.
- Feeder depth where concentrate mixes and finely chopped roughages are offered: 20–25 cm.
- Width of the feeder for two sided trough: 120 cm; for one sided trough 70 cm.
- Height of the trough's roughage storage compartment from where animals can access: 120 cm.
- Length of the trough is 70 cm per animal. For example, for four animals the length of trough required is 2.8 m in the case of one sided trough: and 1.4 m in the case of two sided trough. That means the length of the trough can be adjusted based on the number of animals the farmer has.
- A two sided feeding trough works well in the middle of a barn or in the backyard.
- A one sided feeding trough is suitable to construct attached to a wall of a barn or house.

In areas where termites are abundant, feeding troughs need to be constructed in such a way that the part of the wooden structure under the soil is not exposed to termite attack. Africa RISING field study indicated that farmers could recover the costs of construction in six months to one year of use, while the trough can continue to be used for several years (Figure 2). In other words, it is worth investing from the economic point of view. Local carpenters, who have been trained, could provide service to individual farmers and use it as a source of income.

Figure 1. Two sided (left) and one sided (right) cattle feeding trough design specification.



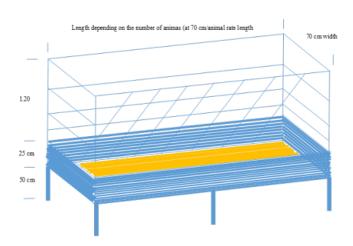


Figure 2. Two sided feeding troughs under use.





#### ASSESSMENT QUESTIONS

- 1. What are the benefits of having a feed through?
- 2. What are the benefits of constructing feeding troughs at household level?
- 3. Describe the alternative feed trough designs that can be used by farmers?
- 4. What do farmers need to construct feeding troughs?

#### SUMMARY OF THE MODULE

Feed is the main input required in livestock production. Feed resources have become scarce due to population growth (human and livestock) and resource limitations (especially land and water). Especially in the highlands of Ethiopia the problem is prevalent. To cope with such emerging challenges, it is essential to adopt technologies that can increase availability and quality of feed resources. In this module we selected some of the feeds and forage technologies that have been widely validated and proved to produce greater impact in feed and livestock production. Unlike lowland areas, where there are several forage and fodder tree options for feed production, cooler highlands of Ethiopia have limited options.

Africa RISING project has conducted on farm participatory evaluation on the technologies presented in this module. There is strong evidence that by capitalizing on the technologies described in this module it would be possible to considerably improve feed resource availability, livestock productivity and livelihood of the farming community. The technologies are environmentally friendly and are known to contribute to soil fertility, erosion control and carbon sequestration on top of the contribution as a good source of feed.

Salient examples are: 1) the contribution of oat–vetch mixture forage in maintaining soil fertility and improving land productivity, 2) the role of fodder beet in nutrient recycling as it can be grown in the backyard next to animal farms along the manure drainage lines. As fodder beet requires nutrient rich soils, it is highly effective in returning nutrients from the manure to the animal, 3) Desho grass is extremely effective in stabilizing soil bunds, controlling soil erosions and increasing water infiltration to the soil. On top of that when planted within croplands it is effective in capturing leached nutrients and using it to produce much needed good quality forage from, 4) tree lucerne is a multifunctional tree with a lot of benefits to the farming system, 5) improved feed troughs encourages cut-and-carry feeding practices that have high value in protecting the environment. Generally, the technologies described in these modules are very helpful to improve livestock productivity and protect the environment.

