

# Using green manure to improve the soil fertility

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## Introduction

This document focuses on **the use of Vetch (*Vicia villosa*) and Lupin (*Lupinus albus*) as green manure to improve the soil fertility** in the highlands farms of Southern Ethiopia. It aims at helping field technicians to support farming families in the presentation of the practice, by addressing the following main contents:

1. What is meant by “green manure” and what are the benefits
2. Calendar: when to cultivate green manure
3. Calculating the quantity of seeds to be produced and the surface needed for seeds multiplication according to the area to be treated with green manure
4. Plot selection: where to apply green manure
5. When and how to sow the seeds
6. How to conserve the seeds for the following year
7. Chopping and incorporation
8. What impact can be expected on the crop yield after green manure
9. Other uses of Vetch

## 1. What is meant by “green manure” and what are the benefits

Green manure involves **planting a crop that is meant to cover the soil for a certain period and then to be incorporated in order to increase its fertility**. Cropping one or several plants as green manure allows to **feed the soil** by adding organic matter to the soil thanks to **incorporation of the top part of the plant, but also to the decomposition of the roots**. By providing a soil cover and producing a significant quantity of biomass, it contributes to:

- ✓ Reduce water evaporation and soil temperature, as the soil is not left bare, and increases water infiltration
- ✓ Protect the soil from erosion
- ✓ Conserve the moisture
- ✓ Limit the weeds’ propagation
- ✓ Add biomass to the soil and improve its structure
- ✓ Increase the availability of several nutrients in the soil.
- ✓ Reduce pest and disease infestation.

By carrying out these functions, green manure provides the following benefits:

- ✓ **Increase the yield and improve the quality of the following crop**
- ✓ Enable **a better optimisation of the fertiliser** for the next season, and allows in certain conditions to reduce the quantities of fertiliser used (especially urea).

After several comparative trials with farmers<sup>1</sup>, two legume species have given good results and shown excellent adaptation in those altitudes: vetch and lupin. As legume, those species also contribute to increase the nitrogen content in the soil, through nitrogen-fixing symbiotic bacteria in their root nodules that help fixing atmospheric nitrogen in a form that the plants can use (those nodules can be seen visually on the roots). Beyond those two legumes, let’s note that **there are many other species that can be used as green manure**, alone or combined, offering various advantages.

As the crop is usually chopped and incorporated before the seeds are matured, **a major challenge remains to produce the seeds for the next year in a separate dedicated plots**.

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<sup>1</sup> Trials have also been conducted with *Sesbania sesban*, alfalfa and *Desmodium*, that appeared to be less adapted for green manure in the highland conditions.

Below : vetch can be used as green manure, but it is also an excellent fodder. This melliferous plant can be mixed with oat or maize, associated with fodder grass or even integrated in natural pastures.



Below: this white lupin specie is only dedicated for fertility improvement and must not be used for fodder or human consumption as such. The leaves and the seeds are toxic and must not be consumed. There are other types of lupin (sweet lupin) that are edible but the tested varieties were less appropriated for green manure (smaller biomass production).



## 2. Calendar: when to cultivate green manure

In the highlands of Southern Ethiopia, as only part of the lands are cropped during the off-season (Belg), it is possible to plant a **fast growing crop as green manure in a short period of time (3 months)**. Indeed, the period between the small rains (arriving usually in March) and the preparation of the lands for the main cropping season (Meher starting in July) is relatively short.

Ideally, **green manure should be sown as soon as there is enough moisture in the soil** (as of February if the rains are on time), and then chopped and integrated while preparing the land for the main cropping season (land preparation is usually done in May - June). On average, **the time between sowing and chopping is 105 days (3,5 months)**.

|           |                          | BELG |   |   |   |   | MEHER |   |   |   |   |   |   |
|-----------|--------------------------|------|---|---|---|---|-------|---|---|---|---|---|---|
| Operation |                          | J    | F | M | A | M | J     | J | A | S | O | N | D |
| 1st Y     | Seed production          |      |   |   |   |   |       |   |   |   |   |   |   |
|           | Minimum tillage & sowing |      |   |   |   |   |       |   |   |   |   |   |   |
| 2nd Y     | Chopping & incorporation |      |   |   |   |   |       |   |   |   |   |   |   |
|           | Sowing next crop         |      |   |   |   |   |       |   |   |   |   |   |   |

**⚠ Important note:** an abnormal delay of the Belg rains may compromise the use of green manure for the Belg season, considering that a minimum of 80 days is required for the plants' development before chopping and incorporation.

### 3. Calculating the quantity of seeds to be produced and the surface needed for seeds multiplication according to the area to be treated with green manure

A key challenge is to anticipate the seeds' production for the next year. As the crop is chopped and incorporating before it produce seeds, the seeds' production needs to be done separately. **A specific plot has to be dedicated during the Meher to produce the seeds for the green manure of the next year as well as a smaller amount of seeds for the next year seeds' production.** Indeed, the rainy season appears to be more appropriated to produce seeds as compared to dry season. Cropping the green manure is done during the Belg season whereas the seeds production is preferably done during the Meher season. Here is an indicative table to calculate the number of seeds and the surface required for seeds' production **per 100 m<sup>2</sup>**. Based on the surface to be covered, this number has to be multiplied to calculate the needs (i.e.: to cover 1000 m<sup>2</sup>, you will need to allocated 10 times more surface for seeds' production which will be 100m<sup>2</sup>).

| To cover 100m <sup>2</sup>                                        | Vetch                 | Lupin            |
|-------------------------------------------------------------------|-----------------------|------------------|
| Quantity of seeds for green manure in Belg                        | 0,25 kg               | 1 kg             |
| Quantity of seeds for the seeds' production in Meher              | 0,05 kg               | 0,2 kg           |
| Surface needed to produce the seeds in Meher                      | 10m <sup>2</sup>      | 10m <sup>2</sup> |
| Total seeds needed (green manure + seeds production of next year) | 0,3 kg                | 1,2 kg           |
| Plantation: seeds requirements per ha                             | 25 kg/ha <sup>2</sup> | 100 kg/ha        |
| Seed production: yield per ha                                     | 500 kg/ha             | 1 200 kg/ha      |

**VETCH:** per 100m<sup>2</sup>, you need:

|                                                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0,25kg of seeds for the green manure<br>+ 0,05kg of seeds for seeds multiplication for next year, to be produced on a surface of 10 m <sup>2</sup><br>= 0,3kg of seeds |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**LUPIN:** per 100m<sup>2</sup>, you need:

|                                                                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1kg of seeds for the green manure<br>+ 0,2kg of seeds for seeds multiplication for next year, to be produced on a surface of 10 m <sup>2</sup><br>= 1,2kg of seeds |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### 4. Plot selection: where to apply green manure

It is **not** advised to use legumes' species as green manure just after or before cropping another legume specie (after or before fava bean for instance). It is advised to **do green manure after or before a cereal (wheat, teff for lower highlands, barley) or potato.**

For instance, in the following cropping pattern, it is particularly interesting during the Belg of the 2<sup>nd</sup> year

| Year | Meher       | Belg                                            |
|------|-------------|-------------------------------------------------|
| 1    | Fava bean → | No green manure                                 |
| 2    | Wheat →     | <b>Green manure +++</b>                         |
| 3    | Wheat →     | Green manure possible <b>if no legume after</b> |



Picture on the left: incorporation of green manure (here vetch) after a bit more than 3 months of growth. After 2 ploughs, the vetch will be well incorporated.

Right : a field left bared during the Belg season

<sup>2</sup> Note that the recommended density per ha may vary depending on the variety, as there are several vetch varieties. On the literacy, it is often 40kg/ha but here, considering the specificities of the variety used in the area, that takes wider area per plant it has been reduced to 25kg/ha.

## **5. When and how to sow the seeds**

☞ **For green manure:** minimum tillage is advised before sowing the seeds. But it is possible to sow vetch without tillage, just by broadcasting the seeds. However, farmers usually prefer minimum tillage in order to facilitate faster germination and growth. For the density, recommendation is with **50 cm between rows and 30 cm between seeds**. If some straws remain, it is not necessary to cut it (see the picture) as green manure grows well in the remaining straws (even good to help vetch climbing). Seeds have to be sown as soon as there is enough moisture in the soil.

☞ **For seeds production:** seeds can be sown in June-July around the home garden, with 50 cm between rows and 30 cm between seeds inside the row. **Collection of the seeds can be done in November – December, when the pods are dried.** Lupin may sometimes take little more times to get ready to be collected, depending on the weather conditions. **It is essential that the pods are well dried when collecting the seeds.**



*Picture lupin growing directly inside the straw.;*

## **6. How to conserve the seeds for the following year**

Seeds of lupin and vetch have to be **stored in a dried area**. In case of attack, it is advised to conserve the seeds in ashes or sand within a basket or bottle.

## **7. Chopping and incorporation**

**Open grazing control is mandatory when practicing green manure.** When the crop has produced a good biomass and has started flowering (usually in May, or beginning of June if it was planted late), it is time to chop it by using sickle or machete. After chopping, vetch or lupine **will be incorporated while ploughing the soil to prepare the next crop**. **Two ploughings are needed to obtain a full decomposition and incorporation.** Then, 2 to 3 weeks after, the Meher crop can be sown



## **8. Impact that can be expected on the crop yield after green manure**

Several measurements have been carried out on adjacent plots to compare the biomass and the yield on wheat and teff with and without using green manure before. **On average, the effect on the biomass ranges from +10 to +28%, whereas the impact on the yield ranges from +10 to +50%.**

## 9 Considering other uses of vetch

Vetch has also other uses and benefits. For instance it is a very good fodder which, mixed with grass or oat, may bring a significant improvement of the ration for the cattle and particularly for the milk production.

But for the farmers to get those various benefits, **they first need to produce sufficient quantity of seeds!**

Here below, we present possible uses that can be done by a farmer with an initial quantity of seeds of 250 grams, as a “start-up” to produce seeds.

- Initial quantity of seeds planted for seeds multiplication: 250 grams, planted in July on 100m<sup>2</sup> by the farmer to produce his/her own seeds
- Quantity of seeds collected (December – January): 5kg

These 5kg of Vetch seeds can serve for different uses:

| Various use of vetch seeds |                                                                                                  | Qty of seed used as example | Plot size                                                                                                                                                                                                                                                                                                                              |
|----------------------------|--------------------------------------------------------------------------------------------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                          | As <b>green manure</b> : planted on cereal crop field in March                                   | 2.5kg                       | Green manure to treat 1 000 m <sup>2</sup> (½ timad)                                                                                                                                                                                                                                                                                   |
|                            |                                                                                                  | 1.25kg                      | 500 m <sup>2</sup> (1/4 timad)                                                                                                                                                                                                                                                                                                         |
|                            |                                                                                                  | 0.5kg                       | 200 m <sup>2</sup>                                                                                                                                                                                                                                                                                                                     |
|                            |                                                                                                  | 0.25kg                      | 100 m <sup>2</sup>                                                                                                                                                                                                                                                                                                                     |
| 2                          | As <b>fodrage</b> :<br>→ mixed with different grass species<br>→ intercropped with oat and maize | 2kg                         | About 800m <sup>2</sup> that can be used: <ul style="list-style-type: none"> <li>▪ Associated with grass species in fodder plot</li> <li>▪ On hedges of grass on SWC structures (after cutting the grass)</li> <li>▪ On natural grass plots</li> <li>▪ Inter-cropped with oat and maize that are used for fodder production</li> </ul> |
| 3                          | For <b>further seeds multiplication</b> in Meher season for the next year                        | 0.5kg                       | On 100 to 200 m <sup>2</sup> for seeds production on a plot where the soil fertility is not too high                                                                                                                                                                                                                                   |

Here below, an example of vetch production integrated with fodder grass. This combination allows harvesting a very nutritive fodder.

