

Green Manuring



SOUTH AFRICAN SUGARCANE
RESEARCH INSTITUTE

Green Manuring



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CONTENTS

Introduction	3
Principles of green manuring	4
The benefits of green manuring	4
Choice of crops	5
Summer Crops	7
Legumes:	
<i>Sunnhemp</i>	8
<i>Velvet bean</i>	9
<i>Cowpeas</i>	10
<i>Dolichos bean</i>	11
<i>Soybean</i>	12
Non-legumes:	
<i>Forage sorghum</i> & <i>Babala</i>	14
<i>Buckwheat</i>	15
Winter Crops	17
Legumes:	
<i>Serradella</i>	18
<i>Grazing vetch</i>	19
<i>Lupins</i>	20
Non-legumes:	
<i>Black and White oats</i>	21
Summary tables	22-23
Further reading	24

Introduction

The soil environment is an extremely complex system. To achieve optimum yields, a sugarcane plant should be able to extract as much water and nutrients as it requires from the soil. This is made easier when the soil is in good health. One way in which soil health can be improved is through green manuring.

Green manuring involves the use of selected crops to improve soil health. In the sugar industry, this practice is particularly important to break the sugarcane monoculture and improve overall soil health. There are also benefits from a decrease in diseases and pests that are hosted within the soil from one cane crop to the next.

This manual provides sugarcane growers with information on a number of green manure crops that can be grown in both winter and summer. Apart from a brief discussion about the principles and benefits of green manuring, this manual serves as a guide for choosing the right green manure and provides guidelines on soil requirements, time of planting, fertilising, pest, disease and weed control and harvesting practices.



Principles of Green Manuring

The practice of growing green crops to improve the humus content of soil is referred to as “green manuring”. Green manuring has been a common practice for centuries. Records show that some 3 000 years ago legumes were incorporated into rice paddies in China. The use of beans, vetches and lupins as a source of nitrogen and a means of breaking monoculture was also well understood by the Romans.

In South Africa, trials conducted by SASRI as early as 1925 showed the benefits of using green manures to rejuvenate old cane land. More recently, there has been renewed interest in this practice to improve soil physical, chemical and biological conditions and decrease the incidence of pests and diseases specific to sugarcane. Green manures have a wide range of properties, and different species can have the following benefits to the soil:

- Breaking the monoculture (along with pest and disease cycles)
- Weed control
- Nematode control
- Addition of nitrogen
- Increasing microbial populations
- Increasing organic matter levels
- Protecting the soil surface during fallow periods

Green manures are generally hardy crops, and do not require a lot of management. After the final cane crop has been killed, green manure seeds can be broadcast, incorporated with a disc harrow and allowed to grow for 3-9 months, depending on the crop and season.

Recent research, both local and international, has shown that green manure residues do not need to be incorporated into the soil to benefit the land: where time allows, green manures should be mowed or sprayed with herbicide, and the residue left on the surface to decompose. This minimises soil disturbance, helping to maintain structure and lessen organic matter depletion, as well as lowering mechanical inputs. Incorporation of legume material also encourages a quick flush of nitrogen release, which can be leached out of the soil profile before the subsequent cane crop's roots can access it; leaving this material on the surface encourages the slow release of nitrogen.

The benefits of green manuring

Yield response

Early trials at Shakaskraal and Mount Edgecombe showed sugarcane yield improvements of 5-20% after a bare fallow and 10-40% after a green manure crop, when compared with continuous cane cultivation. Small, non-significant responses were noted in the following ratoon crops in a number of trials. In general, legume fallows tended to be superior to non-legume fallow crops.

Since then, excellent work has been carried out on the effects of green manuring on mainly irrigated duplex soils in Swaziland. The mean yields of 13 fallowed and green manured 40 ha blocks of land compared with the mean yields of 13 non-fallowed blocks of land, when corrected for seasonal variations, improved by roughly 20% in the plant crop, with no residual effects measured in the ratoon crops. Follow-up trials showed yield increases of 8-10% in the plant and first ratoon crops after green manures, with no significant differences in subsequent ratoons.

Trials conducted in Australia showed that after a range of rotational break crops were grown over a one-year fallow period, the subsequent sugarcane yield was 15-25% higher than after continuous sugarcane. Further Australian research has shown that sugarcane yields subsequent to green manures generally show improvements for the plant and one to two ratoon crops.

Impact on soil fertility

- In the research conducted in Swaziland, yield increases were related to prolific rooting with improved soil physical properties, particularly the air-filled porosity, infiltration rate and lowered resistance to depth penetration.
- In Swaziland, soil organic matter levels were adversely affected by bare fallowing, but increased slightly with green manuring.
- Studies in Taiwan indicated that green manuring contributed up to 15% of the nitrogen taken up, depending on the legume used. Australian studies have demonstrated the potential for significant reductions in nitrogen fertiliser applied to cane fields grown after legume crops.
- Recent studies conducted by SASRI have shown that various green manures increase the availability of phosphorus, potassium, calcium and magnesium when compared to continuous sugarcane.

Impact on pests and diseases

- A number of green manures have marked effects on nematode populations. Studies conducted by SASRI have shown that oats, sunn hemp and forage sorghum can decrease plant pathogenic nematode numbers, while velvet beans increase numbers of the spiral nematode *Helicotylenchus*, which mitigates damage by other species.
- The potential for controlling pathogens such as RSD and mosaic, as well as pests such as eldana, requires further research. This could further improve the economics of green manuring.

The greatest benefit from green manuring will be in the rainfed areas on grey sandy soils, where increases in nitrogen and organic matter will be most beneficial. However, most soils will benefit from having a break from the monoculture of sugarcane.

It is important to note that minimum tillage should be practised on the following slopes:

Slopes > 10 % (on erodible soils);

Slopes > 13 % (on moderately erodible soils);

Slopes > 16 % (on resistant soils).

On slopes steeper than those listed above, green manures should either be drilled (if a planter is available, and the field is accessible), or else a species chosen that can be planted by hand.



Choice and use of green manure and cover crops

Green manure and cover crops can be used in rotation with sugarcane to promote soil sustainability. Green manure crops are alternative crops to sugarcane and tend to improve soil structure, add nitrogen to the soil, recycle a number of plant-essential nutrients and return organic matter to the soil. Cover crops are used for soil protection and weed suppression during fallow periods. Both are beneficial in breaking pest and disease cycles. A number of crops have the potential to perform well in rotation with sugarcane, when grown in the correct season. Commonly used crops include:

SUMMER CROPS	
Legumes	Non-legumes
Sunn hemp	Forage sorghum
Velvet beans	Babala
Cowpeas	Buckwheat
Dolichos beans	
Soybeans	
WINTER CROPS	
Legumes	Non-legumes
Serradella	White oats
Grazing vetch	Black oats
Lupins	

All of these crops have been chosen because they are generally hardy, and can be grown with little or no fertiliser. This keeps costs to a minimum. Fertilising your green manure crop will, however, improve its appearance and yield, and much of the potassium and phosphorus applied to a green manure crop will be available to the subsequent cane crop. Growers should remember that green manure crops are often less acid-tolerant than sugarcane (see summary tables on pages 22 and 23), and liming operations should be carried out before green manuring, to facilitate optimal growth.

The following section contains brief notes on the most common green manure crops for sugarcane systems.



SUMMER CROPS

(Legumes / Non-Legumes)



LEGUMES

Sunn hemp (*Crotalaria juncea*)

Sunn hemp was introduced into the sugar industry during the late 1920s and was used as a natural source of nitrogen until the advent of artificial sources of N, such as urea, during the 1930s.

The plant is very hardy, grows rapidly, and can produce up to 10-12 tons of dry above-ground biomass per hectare. This tall herbaceous annual has bright yellow flowers and roots that form numerous lobed nodules. It is not suitable as green fodder and care should be taken not to allow it to become old and woody.

Soil requirements and field preparation

Sunn hemp thrives in deep soils ranging from sands to medium clays, provided they are well drained. It tolerates a soil pH in the range 5.0 to 8.4.

Once the old cane stools have been eradicated, the soil should be disced in order to prepare a fine seed bed. Sunn hemp seeds are small, thus a fairly good seedbed is necessary to ensure a good stand.

Time of planting

Sunn hemp may be broadcast at 50 kg/ha from September to the end of December; planting later than this will not result in optimal growth. Seeds do not require inoculation, but irrigation – if available – at planting is desirable for good germination in dry areas. When the seeds have been broadcast, the field should be disced with a disc harrow (to a depth of 5 to 10 cm) to incorporate. Sunn hemp, along with other small-seeded green manures, will grow better if the field is rolled after discing; but on farms where a roller is not available, this is not essential.

In warm irrigated areas, sunn hemp – along with other traditional summer crops – can be grown in winter under irrigation. Growth will not be nearly as abundant as in summer, but a crop of 0.5 – 1 m tall can nonetheless be achieved with beneficial effects on the following cane crop.

Fertilising

Sunn hemp is hardy and grows well without fertiliser; it will, however, respond to N, P and K in the following amounts (see table above).

Weed control

This is usually not necessary as the crop forms a dense cover which smothers weeds effectively.

Fertiliser (kg/ha)	Soil fertility status			
	Low	Moderate	High	Very High
Nitrogen	60	40	20	0
Phosphorus	30	20	10	0
Potassium	60	40	20	0

Disease and pest control

Sunn hemp is highly resistant to nematodes, and is not generally prone to attacks by pests or diseases. Diseases such as stem break can be minimised by selecting a well-drained soil and ensuring that the same field is not planted to sunn hemp more than once in four years.

Harvesting

Sunn hemp may be mowed when it is in flower (70 to 100 days after planting), by which time it will have achieved a height of between 0.7 and 2 metres, depending on growing conditions. If it has started to grow too tall, it can be mowed before flowering to make it easier to handle. Sunn hemp residue should preferably be left on the soil surface to decompose. It normally takes 5 to 6 weeks for the residue to decompose in a warm, moist environment. If time does not allow, the residue can be incorporated to a depth of 10-15 cm into the soil before ridging for replant.



Velvet bean (*Mucuna spp.*)

Velvet beans grow luxuriantly under favourable conditions, and have been an industry favourite for many years. They are a long-season crop, providing soil cover for up to 9 months compared to most other green manure crops which last for 3-5 months. They are therefore ideal for long fallows: velvet beans can be planted in early summer, allowed to grow until autumn, mowed down and allowed to decompose on the soil surface until cane is planted in spring. The plant grows vigorously with long, trailing vines which intertwine with each other to produce a tangled mass of stems and leaves up to 0.7 m high. Flowering occurs approximately four months after planting and seed is ready for harvesting five to six months later. Vines begin to lose their leaves four to five months after flowering. Velvet beans can be grazed by cattle, goats and sheep at the soft pod stage.

Soil requirements and field preparation

Velvet beans thrive in deep soils ranging from sands to medium clays, provided they are well-drained. They tolerate a soil pH in the range 5.0 to 7.0.

Once the old cane stools have been eradicated, the soil should be disced. Velvet bean seeds are large, so a fine seedbed is not a necessity.

Velvet beans are one of the cover crops that can be planted on steep slopes where machinery cannot be used. Once the final cane crop has been sprayed, velvet beans can be planted by hand by digging a shallow hole with a hoe every 0.5 m in the old cane interrow, dropping a seed into each hole and closing the hole by foot.

Time of planting

Plant from October to December, when rainfall can be expected. In the upland and midlands areas, velvet beans should not be planted before November, as they are susceptible to late season cold conditions.

Seeding

Seeds can be broadcast by hand, or applied using a fully open Spandicar setting. Drive up and down the field with the opened Spandicar and then drive diagonally. Disc the beans into the soil to a depth of 50 mm, or roll with a Cambridge roller.

Use up to 80 kg beans/ha planted in rows if the crop is to be used as cattle feed; otherwise 30-50 kg/ha for standard green manuring. Ask your seed supplier for a suitable inoculant.

Fertilising

Fertiliser is generally not necessary if velvet beans are grown after sugarcane. Velvet beans will grow vigorously on all soil types that are well-drained and with adequate available phosphorus.

Weed control

Generally not necessary as velvet beans provide dense ground cover and compete effectively with weeds.

Harvesting

Velvet beans are one of the only commonly used South African green manures that can practically be harvested by hand. Seeds can be stored and used to replant as a green manure in the following season. Keep in mind, however, that much of the nitrogen fixed by this plant will be removed in the seed, leaving little for the following cane crop. Harvesting the pods should be done when the seeds are mature, roughly July/August. The seed pods can be threshed with sticks on a concrete floor, after which the husks and vine residues may be removed by sieving or forced air. Generally the seeds are not attacked by insect pests, and can be stored in a dry room.

If the seeds are not to be harvested, mow the velvet beans between flowering and soft pod stage. If time allows, leave the residue on the soil surface to decompose naturally before replanting cane.

Additional comments

Volunteer beans growing in a plant cane field are easily controlled with post-emergence herbicides containing Atrazine or Paraquat.

Velvet beans should not be eaten: even small amounts can cause an upset stomach.



Cowpeas (*Vigna unguiculata*)

Cowpeas are a warm season annual legume native to Africa. They have been used as green manures or cover crops, and to suppress weeds. Seedlings have large leaves and quickly provide a canopy. The plants produce a strong tap root which can explore deep soil profiles for moisture. The species is adapted to hot, moist climates and can be grown successfully under rainfed conditions as they are considered to be drought tolerant. Cowpeas are also tolerant of nematode damage but can increase nematode numbers in sandy soils. They are therefore not recommended for very sandy soils – although they grow well here – unless a nematicide is used when planting subsequent sugarcane.

Soil requirements and field preparation

The species performs well on a variety of soil types from highly acidic to neutral, but is less tolerant of alkaline conditions. Best growth occurs on sandy loams with good drainage and aeration. Cowpeas tolerate a soil pH from 4.3 to 7.9.

Time of planting

Plant from October to December. If possible, irrigate at planting, as seeds require moist soil for germination.

Seeding

A seeding rate of 20 kg/ha can be used; up to 50 kg/ha can be planted if high weed pressure is predicted, or on very poor soils. Plant no deeper than 5 cm. Inoculate with EL type rhizobia before planting. EL type inoculum can persist for several years in the soil, so inoculation of subsequent cow pea crops is usually not necessary. Cowpeas can be broadcast by hand, or using a Spandicar.

Seeds should be incorporated using a shallow (10 cm) disk harrow.

Fertilising

Although cowpeas do well on poor soils and can grow without fertiliser inputs, they often respond to added phosphorus. Phosphorus is important for seed set and should be applied at 40 kg/ha. Soil potassium levels greater than 80 mg/L are sufficient.

Weed control

Weeds are generally not a problem as cowpeas produce aggressive, thick herbage which shades out weeds. Glyphosate or Paraquat may be used two weeks before planting to provide a clean seedbed. Trifluralin is the only herbicide registered for use on this crop.

Disease and pest control

Cowpeas are susceptible to various pests (thrips; nematodes; insects) and diseases (rust; various viruses) but when grown as a green manure, it is not economically viable to spray them. Although the cowpeas may look less than impressive when infested, they generally grow fairly well in spite of this. Avoid planting them consecutively on the same land, and use good quality seed.

Harvesting

Cowpeas should be mowed at flowering. If time allows, leave the residue on the soil surface to decompose naturally before replanting cane. Cowpea seeds are susceptible to attack by insects and so are not easy to store for long periods of time; harvesting of the seeds is thus not usually viable for sugarcane growers.

Cowpeas are suitable for forage or silage.



Dolichos bean (*Dolichos lablab*)

Dolichos beans are a subtropical species that grows best under hot, moist conditions. Although not as vigorous as velvet beans, the Dolichos bean retains a good green cover during the winter months, and is another green manure that can be used during a long fallow. If seed is used liberally, the plant develops very thick vines and grows to a height of 500 mm. As a long growing season is required, best results are obtained when these beans are planted in early spring, i.e. August to September in warm areas, and late September to October in cooler areas. Flowering then takes place in autumn, and the seed matures the following spring. Dolichos beans can be grazed or used to make silage.

Soil requirements and field preparation

Dolichos beans establish easily on a variety of soil types, including sandy and slightly acidic soils. After eradication of the old cane stools, disc the field if the slope allows, in preparation for planting. Care should be taken not to disturb the soil more than is necessary.

Time of planting

Plant after the first reliable spring rains.

Seeding

Seeds can be broadcast by hand or from a Spandicar type fertiliser spreader at an appropriate setting for the seed size. The seed can either be disced into the soil with a light disc or rolled with a Cambridge roller.

A seeding rate of 30-50 kg/ha should be used. Seed should be treated with cowpea inoculant.

Fertilising

Nitrogen fertiliser is generally not necessary as dolichos beans fix atmospheric nitrogen. Although dolichos beans generally grow well without any fertiliser, they may respond to phosphorus; this can be applied according to soil test results for sugarcane.

Weed control

This is generally not necessary. The beans are very effective at smothering weeds. Dolichos is highly sensitive to 2,4-D, M.C.P.A., 2,4-D-B and dicamba; use of these herbicides in nearby fields should be avoided.

Disease and pest control

There are no significant disease or insect problems with this crop. Leaf eating insects defoliate the plant from time to time, but with little adverse effect.

Harvesting

Dolichos beans are treated in the same manner as velvet beans. If grown for seed, harvest in August to September, preferably before the onset of the rainy season. Follow the procedure described for velvet beans. Dolichos can be grazed or made into silage.

Additional comments

- Regrowth of Dolichos beans can be a problem in subsequent cane crops. In order to control regrowth,
 - Be sure to terminate the beans before mature seed is produced – preferably during flowering;
 - Repeated sprays may be required during early sugar-cane growth to control bean regrowth.
- Do not eat the dried beans: large quantities can be toxic.



Soybean (*Glycine max*)

Soybeans can be grown as a cash crop, but their value as a green manure is also substantial.

Soybeans (or soyas) are a summer legume capable of fixing high quantities of nitrogen. They therefore contribute positively in reducing N fertiliser inputs to following cane crops. As with the other leguminous green manures, N carried over from soybeans is in an organic form which reduces the risk of leaching and ensures availability to successive sugarcane crops over a longer time span. Soybeans are tolerant of the acidic soils commonly found in sugar growing areas, provided that molybdenum is supplied to facilitate nitrogen fixation. Molybdenum is normally less available in acid soils.

Soil requirements and field preparation

For good soybean growth, a well-drained and fertile soil with a fine seed bed and good moisture holding capacity is needed. Preparing the seedbed gives an opportunity to incorporate any recommended lime, or fertiliser and cane stubble. Water requirements during the five months of growing season vary from 500 mm to 800 mm depending on the prevailing climate. Soybeans do not tolerate high temperatures well and will require more water in an attempt to keep cool. Soybeans are sensitive to Atrazine or broadleaf type herbicides and must not be planted in soils where the prescribed waiting period has not yet elapsed.

Time of planting

Soybeans are photoperiod sensitive and crop duration for most cultivars will vary significantly across latitude and planting date.

When used as a green manure crop, soybeans can be planted from August to February on the coast, or October to January in upland areas. Crop height and biomass will, however, reach a maximum with a November planting date.

Seeding

For optimal growth, soybeans should be planted in rows; however, if a planter is not available, soybeans can be broadcast and incorporated. A plant population of approximately 150 000 to 300 000 plants per ha (15-30 plants/m²) is a general recommendation for green manure crops. Since seed size can vary from 13 g/100 seeds to as much as 30 g/100 seeds, the quantity of seeds required for planting can vary from 40 kg/ha to 90 kg/ha.

Depth of incorporation varies from 1 cm in heavy clay soils to 5 cm in sandy soils.

A suitable inoculant should be obtained from your seed supplier.

In general, those cultivars best suited for grain yield are also best as a green manure.

Fertilising and Inoculation

Soybeans are self sufficient in nitrogen, provided that successful nodulation is achieved and maintained with soybean specific *Bradyrhizobium japonicum* inoculant. This nitrogen fixing bacteria is not indigenous to South African soils and instructions accompanying the inoculant should be followed meticulously, especially where soybeans are planted for the first time. The inoculant should be treated with care, as it contains live organisms; inoculated seed should be planted as soon as possible.

Soybeans will respond to P-fertiliser in soils with a P-status of less than 20 ppm and to K-fertiliser in soils



with a K status below 90 ppm. In soils with a pH of less than 5.8 (water) or 5 (CaCl₂), molybdenum (25 g sodium molybdate/ha) should be added as a seed dressing before adding the inoculant. Seeds should then be planted immediately.

Weed control

The soybean is a broadleaf crop, and as such provides an excellent opportunity to eradicate grasses. Glyphosate can be used on 'Roundup Ready' registered cultivars.

Disease and pest control

Soybeans are susceptible to fungal diseases (e.g. soybean rust; *Sclerotinia*), insect damage (e.g. cutworm; soybean looper; stink bug) and, in certain cultivars, nematode damage.

When used as a green manure, it is not generally economically viable to spray soybeans for pests and diseases; a disease like rust, however, could cause crop failure. If the crop is kept until the seed is harvest-mature, it should be sprayed at flowering; for a green manure crop, however, it is advisable to mow the crop down when fungal diseases develop.

Soybeans will increase root-knot nematode numbers if this nematode is present in sandy soils.

Harvesting

For green manuring purposes, soybeans should be mowed or sprayed out between flowering and early pod



fill. Soybean seeds do not store well, and hand-harvesting the seed to use in the following season is not practical. If the seeds are harvested for commercial purposes, keep in mind that much of the nitrogen fixed by this plant will be removed in the seed, leaving little for the following cane crop.

Additional comments

- Soybeans can be grazed, but they have weak regrowth. They can also be used for hay and silage.
- Volunteer soybeans in sugarcane are not a concern due to their sensitivity to Atrazine-type herbicides.



NON-LEGUMES

Forage sorghum (*Sorghum x Sudan grass hybrid*) and Babala (*Pennisetum glaucum*)

Forage sorghum and babala (pearl millet) are annual summer grasses. They grow fast and can withstand fairly dry conditions – babala more so than forage sorghum. Both species can be grazed by cattle, but forage sorghum should not be grazed when wilted, and never grazed by horses. Forage sorghum produces a natural nematicide that is released when it is chopped and incorporated into the soil.

Soil requirements and field preparation

Babala and forage sorghum grow in a wide range of soils, provided that waterlogging is not a problem. A pH greater than 5 and acid saturation less than 15% is suitable. Soils should be disced before planting.

Time of planting

Plant these species from October to December.

Seeding

Seeds can be broadcast by hand or from a Spandicar type fertiliser spreader at an appropriate setting for the seed size. The seed can either be disced into the soil with a light disc or rolled with a Cambridge roller. A seeding rate of 25-30 kg/ha should be used.

Fertilising

Babala and forage sorghum grow well without any fertiliser. They will, however, respond to nitrogen.

Weed control

This is generally not necessary. Forage sorghum in particular is effective at suppressing weeds.

Disease and pest control

It is not economically viable to spray these crops for pests or diseases, which may attack the crop from time-to-time with little adverse effect.

Harvesting

It is not economically viable to harvest these seeds by hand, and they are vulnerable to insect attack during storage. Babala and forage sorghum should be killed at the start of seeding, so that regrowth does not become problematic in the following cane crop. As forage plants, these crops will regrow if mowed down; they should

therefore be sprayed with glyphosate, or mowed and disced into the soil. Mowing and discing will facilitate the release of natural nematicides from forage sorghum. Failure to prevent regrowth could cause problems in the subsequent cane crop, as most grass herbicides – to kill the sorghum or babala – will also damage the cane.

Additional comments: Grazing

Forage sorghum is an excellent source of fodder. The following precautions should, however, be taken when grazing:

- Never allow horses to graze forage sorghum.
- Allow re-growth of 500 mm after drought or light frost; don't graze for at least 7 days after frost.
- Don't graze if the stand shows signs of drought (wilt-ing).
- Avoid heavy topdressings of nitrogen if the sorghum is to be grazed.



Buckwheat (*Fagopyrum esculentum*)

Buckwheat is valuable as both green manure and cover crop. It is a short season crop, which is often utilised as an emergency measure where other crops have failed. One of the benefits of buckwheat is that its flowers attract beneficial insect predators, which feed on insect pests of sugarcane.

As a green manure, it decays rapidly to provide organic matter for the soil.

Soil requirements and field preparation

Buckwheat can be grown at pH's of 4.5 - 7, although it prefers a pH of 5 - 7. This crop can be planted on poorly prepared seed beds that are generally unsuitable for other crops, but will perform best if soil is disced and harrowed for good tilth. It is suitable for a variety of soil types and grows on poor and rocky soils better than most crops.

Time of planting

Buckwheat has a relatively short life cycle and may be planted much later in the summer than legume cover crops. Planting may be done from November to early February. Germination occurs within four days and flowering begins at around 30 days. Flowering may last for 45 days or more.

Seeding

The recommended seeding rate is 40 to 55 kg/ha. Broadcast seed and incorporate with light discing to a depth of 15 to 20 mm.

Fertilising

Fertiliser applications are usually unnecessary. Buckwheat utilises relatively unavailable nutrients in the soil. It grows rapidly and has a great feeding capacity for nutrients, especially phosphorus. It adds nothing to the soil except organic matter, but when used as a green manure has a stimulating effect on crops that follow because it releases the nutrients it has accumulated.

Weed control

Herbicides are rarely used in this crop.

Disease and pest control

Diseases are normally not a problem. Buckwheat is a vigorous crop that is tolerant of pests. Downy mildew may occur but usually does not affect yield, and should not be treated.

Harvesting

For practical reasons, seed production and harvest is not advised when buckwheat is used as a green manure in sugarcane systems. When grown as a cover crop, buckwheat should be mowed down 7 to 10 days after flowering, or before seed is set. Residue breaks down rapidly after mowing, enriching soil with both organic matter and stored nutrients.

Additional comments

Buckwheat tends to wilt in midday heat. Growers observing the midday wilting of buckwheat may be tempted to irrigate excessively. This is not necessary because the plants require little water, and generally recover from wilting during the night.





WINTER CROPS

(Legumes / Non-Legumes)



LEGUMES

Serradella (*Ornithopus sativus*)

Winter legumes generally produce less biomass than summer legumes, and there are fewer winter choices. Serradella performs fairly well as a winter legume on poor sandy soils. It grows well when mixed with black or white oats, where the characteristics of each species benefit the soil. Serradella can be grazed during winter and will regenerate if not grazed during the flowering stage.

Time of planting

Winter planting is recommended from March to early May, provided the danger of frost is past. In cooler areas, serradella can be planted from late March/early April. Growers in warmer areas should wait until late April for planting, and can plant as late as early June, provided that enough moisture is present.

Soil requirements and field preparation

A soil pH of 4.5 to 6.5 is recommended. Disc fields so that a fairly good tilth is obtained. Seeds should be planted into a moist soil, or ahead of expected rainfall. Very clayey soils and frost-prone areas should be avoided.

Seeding

A seeding rate of 20-30 kg/ha should be used. Seeds can be broadcast by hand. An inoculant should be obtained from your seed supplier.

Fertilising

Serradella grows well in low-fertility soils, and can be grown without fertiliser; it does, however, respond to phosphorus and sulphur fertilisers.

Harvesting

It is not generally viable to harvest serradella seeds by hand due to the small size of the seed. Serradella may be mowed down between flowering and early pod-fill. Due to its fairly low biomass, serradella residue can be left on the soil surface prior to ridging.



Grazing vetch (*Vicia dasycarpa*)

Grazing vetch is another popular green manure choice for winter fallows. It grows on a wide variety of soil types and is hardy and acid tolerant. It grows well when mixed with oats and, under favourable conditions, forms a thick mat on the soil which shades out weeds.

Time of planting

Winter planting is recommended during March and April.

Soil requirements and field preparation

Grazing vetch tolerates soil pH's of 4.5 – 8.2. It grows well in clay and loam soils, but does not flourish in very sandy or waterlogged soils. Disc fields so that a fairly good tilth is obtained.

Seeding

A seeding rate of 25 kg/ha should be used. Broadcast the seeds and incorporate with a shallow disc harrow. Seeds should be inoculated – ask your seed supplier for a suitable product.

Fertilising

Grazing vetch grows well in infertile soils, and does not need to be planted with fertiliser.

Weed control

Grazing vetch generally grows into a thick enough stand that weed control is not necessary.

Harvesting

It is not generally viable for sugarcane growers to harvest grazing vetch seeds by hand. Vetch should be sprayed out with glyphosate (at least 6 L/ha) at the start of flowering; it should not be allowed to produce ripe seed, which has a hard coat and can become weedy.



Lupins (*Lupinus angustifolius*)

Lupins have performed well as a winter legume on poor sandy soils. Bitter lupins are less palatable to herbivores than sweet lupins, and generally perform better as green manures due to higher biomass production. Care should be taken to use only locally grown seed, as anthracnose (a plant fungal disease) may be carried on seeds from other areas.

Time of planting

Winter planting is recommended from April to early May, provided the danger of frost is past. The optimum temperature range is 15-25°C. In areas where the mean monthly maximum temperature exceeds 26°C, heat damage may occur. Summer production is recommended in cooler areas or at high altitudes.

Soil requirements and field preparation

The deep tap root system of lupins suggests that this crop requires a deep Hutton or Oakleaf sandy loam to obtain optimum yields. A soil pH of 5.5 to 6.5 is recommended. Disc fields so that a good tilth is obtained. Never plant in a dry soil. If rainfall in March and April is below average, irrigation will be necessary to ensure good germination. Regardless of planting time, moisture is essential for germination.

Seeding

A seeding rate of 50 kg/ha should be used. Seeds can be broadcast by hand. Lupins should be inoculated just prior to planting. Molybdenum deficiencies are common, and seeds should be treated with molybdenum, especially in low pH soils. Seeds are easily treated by rotating in a drum filled with a mixture of inoculant, a molybdenum carrier, and sticker.

Fertilising

Lupins do not require nitrogen at planting. Soil phosphorus levels of 15-20 ppm require the addition of 100-200 kg/ha superphosphate. Potassium levels of 120 mg/L or greater are adequate.

Weed control

Broadleaf weeds in lupins can be controlled with Simazine; other options are available, and should be discussed with your herbicide rep. Use of the hormone group of herbicides (2,4-D, Dicamba, MCPA and 2,4-DB) near lupins must be avoided as these will cause damage.

Harvesting

If grown as a green manure, lupins may be mowed when pods are in the milk-dough stage. For silage, harvest when the pods are well-formed, before the leaves turn yellow; allow them to wilt before making silage. It is not generally viable to harvest these seeds by hand.



NON-LEGUMES

Black (*Avena strigosa*) and White (*Avena sativa*) Oats

*Oats are one of the most popular green manure choices for winter fallows. They are relatively drought-tolerant and hardy. Oats have been shown to suppress the creeping Mapstone grass (*Digitaria abyssinica*; also known as Abyssinian finger grass, East African finger grass, Dunn's-vingergras and Kweekvingergras) for some time after having grown in a field. They also act as catch crops, holding nutrients in the soil and preventing leaching during the fallow period, before decomposing to release these nutrients to the subsequent cane crop. They are also good 'nurse crops', performing well in mixes with winter legumes (e.g. serradella or grazing vetch). Oats can be grazed by cattle, and suppress nematode numbers. Black oats (with a dark-coloured seed) and white oats (with a cream-coloured seed) have very similar properties, and both can be grown as green manures, although black oats are preferred as green manures due to higher biomass production.*

Time of planting

Winter planting is recommended from March to May. In cooler areas, oats can be planted from late March/early April; growers in warmer areas should wait until late April for planting, and can plant as late as early June, provided that enough moisture is present in the soil.

Soil requirements and field preparation

A soil pH greater than 4.5 is recommended. Oats can tolerate moderately saline soils. Disc fields so that a fairly good tilth is obtained. Regardless of planting time, moisture is necessary for germination; seeds should be planted into moist soil, or ahead of anticipated rainfall.

Seeding

A seeding rate of 50 kg/ha should be used. Seeds can be broadcast by hand. In some areas of the midlands, on humic soils, a lower seeding rate can be used in order to reduce biomass to a manageable amount.

Fertilising

Oats grow well on a wide range of soil types, and do not need to be planted with fertiliser. They will respond to N, P and K, however, and these nutrients can be discounted when fertilising the following cane crop.

Weed control

Oats generally grow into a thick stand - weed control is therefore not necessary. Oats are also well-known to have allelopathic (chemical suppression) effects on a number of weed species, and as such provide their own 'herbicides' during growth. Oats also suppress populations of plant-parasitic nematodes.

Harvesting

It is not generally viable for sugarcane growers to harvest oat seeds by hand. Oats should be sprayed out with glyphosate at the start of flowering; they should not be allowed to produce ripe seed.



SUMMARY: Summer crops								
Property	LEGUMES					NON-LEGUMES		
	Sunn hemp	Velvet beans	Cowpeas	Dolichos beans	Soybeans	Forage sorghum	Babala	Buckwheat
Soil pH (H ₂ O)	5 - 8.4	5 - 7	4.3 - 7.9	6 - 7	5 - 8	> 5	> 5	4.5 - 7
Soil type	Sand to med clay	Sand to med clay	Sand to loam	Sand to med clay	>12% clay	Sand to med clay	Sand to med clay	Wide range (incl. stony)
Free drainage	Important	Important	Important	Important	Important	Important	Important	Important
Seed rate kg/ha	50	30-50	20-50	30-50	50-75	25-30	25-30	40 - 55
Planting method	B/cast; disc harrow	B/cast; disc harrow	B/cast; disc harrow	B/cast; disc harrow	B/cast; disc harrow	B/cast; disc harrow	B/cast; disc harrow	B/cast; disc harrow
Planting months	Sep-Mar (slow growth after Jan)	Oct-Dec (Nov-Dec in upland)	Oct-Dec	Aug - Sep (Sep - Oct in upland)	Late Oct - early Dec	Oct - Dec	Oct - Dec	Nov - Feb
Fertiliser requirements	None	None	None	None	Yes, except N	None	None	None
Days to flower	70 - 100	90 - 150	90	270	50 - 80	60 - 90	60 - 90	30 - 60
Growth height	1.5 - 2 m	0.7 m	0.7 m	0.5 m	0.7 - 1 m	1.5 - 2 m	1.5 - 2 m	0.3 m
Best time to cut	Peak flowering	Peak flowering	Peak flowering	Peak flowering	Late podfill	Early flower	Early flower	7 days after 1 st flower
Controlling method	Mow	Mow	Mow	Mow	Mow	Glyphosate	Glyphosate	Mow
Nematode susceptibility	Low	Low	High infestation (but tolerant)	Low	Medium to high	Low	High infestation (but tolerant)	Low
Pest & disease susceptibility	Negligible	Negligible	Moderate (e.g. rust)	Insect damage	Needs protection (e.g. rust)	Negligible	Negligible	Mildew
N contribution kg/ha*	50	30	25	30	30	o (recycling only)	o (recycling only)	o (recycling only)
Forage use	Not suitable	Grazing, silage	Hay, silage	Grazing, silage	Hay, silage	Grazing, silage NOT FOR HORSES	Grazing, silage	N/A
Other uses	Adds N	Adds N; forage	Adds N; forage	Adds N; hay/silage	Cash crop; Adds N	Forage (NOT for horses); nematode control	Forage	Attracts beneficial insect predators

* Based on conservative dry matter yields; assuming 50% availability of the N to subsequent cane. Note: Seed removal from the field is estimated to remove up to 60% of this N.

SUMMARY: Winter crops				
Property	LEGUMES			NON-LEGUMES
	Serradella	Grazing vetch	Lupins	Black & White oats
Soil pH (H ₂ O)	4.5 - 6.5	4.5 - 8.2	5.5 - 6.5	> 4.5
Soil type	Sand to sandy loam	Clay and loam (not sand)	Sand to loam	Wide range
Free drainage	Important	Important	Tolerates some wetness	Important
Seed rate kg/ha	20-30	25	50	50
Planting method	B/cast; disc harrow	B/cast; disc harrow	B/cast; disc harrow	B/cast; disc harrow
Planting months	Mar-May (cool); Apr-Jun (warm)	Mar-May	Apr-May	Mar-May (cool); Apr-Jun (warm)
Fertiliser requirements	None	None	None	None
Days to flower	120	120	60 - 90	90
Growth height	0.6 m	0.4 m	0.7 m	0.4 - 0.6 m
Best time to cut	Peak flowering	Peak flowering	Peak flowering to milk dough pod stage	Start of seed head
Controlling method	Mow	Glyphosate	Mow	Glyphosate
Nematode susceptibility	Low	High infestation (but tolerant)	High infestation (but tolerant)	Low
Pest & disease susceptibility	Negligible	Negligible	Anthraxnose	Rust
N contribution kg/ha*	15	15	35	0 (recycling only)
Forage use	Grazing, hay, silage	Grazing, hay, silage	Grazing, hay, silage	Grazing, hay, silage
Other uses	Adds N; forage	Adds N	Adds N	Mapstone grass control; forage

* Based on conservative dry matter yields; assuming 50% availability of the N to subsequent cane. Note: Seed removal from the field is estimated to remove up to 60% of this N.

MORE INFORMATION

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A list of some of the institutions involved in crop research and development in South Africa are listed below; they can be contacted for further information. (Note: this is not a definitive list.)

Cowpeas:

Agricultural Research Council (ARC)-Grain Crop Institute, Potchefstroom, South Africa, www.arc.agric.za/home.

Dolichos beans:

KZN Department of Agriculture, Environmental Affairs & Rural Development, Cedara, Howick, www.agriculture.kzntl.gov.za/portal/Home.

Babala & forage sorghum:

Agricol Seeds www.agricol.co.za

Soybean cultivars & research:

Pannar seeds www.pannar.com

Agricultural Research Council (ARC) - Grain Crop Institute, Potchefstroom, South Africa, www.arc.agric.za/home.

Oats:

Agricultural Research Council (ARC) -Small Grain Institute, Bethlehem www.bigmedia.co.za/arc/grain/small_grain/about.php.

Lupins:

Agricultural Research Council (ARC) - Vegetable and Ornamental Plant Institute, Biotechnology Division, Roodepoort, www.arc.agric.za/home.asp?pid=821.

General cover crop research:

Department of Agronomy, Faculty of Science and Agriculture, University of Fort Hare, www.ufh.ac.za.





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