Guidelines for the establishment and management of sown pastures

The following presents a brief outline of the main issues and common pitfalls in relation to pasture establishment and management.

Seed

1. True variety: Be sure that the seed is really that of the variety you wish to plant. The best way to do this is to obtain seed from a reputable source.
2. Seed quality: Use only high quality seed to establish the pasture. Quality is measured in terms of purity and germination. If you are using commercially supplied seed, try to obtain a recent seed analysis statement for the seed you are planning to sow, since this will show these details. Purity is expressed in terms of the percentages of seed of the sown variety, other crops and weeds, of inert matter (incl. pieces of straw, soil etc.), and of broken seed. Pay special attention to the weed seed in the sample since you do not want to introduce new, potentially serious weeds into your system. The analysis will also give germination details for the sample, which includes the percentage germinable and hard seed. If the seed has relatively poor viability such as <40% viable seed (germinable seed + dormant seed (hard seed that will germinate once scarified, or otherwise dormant seed - see #3 below)), this indicates poor seed vigour, and is likely to lead to poor field germination and establishment.
3. Dormancy: Many grasses are subject to post-harvest dormancy, which means germination improves for up to 12 months after harvest, as germination inhibitors in the glumes break down. Careful removal of spikelet glumes can accelerate this process, but can damage seed if tackled with excessive vigour.
4. Grass seed purity: The units that are referred to as seeds in grasses are actually spikelets that comprise one or more florets subtended by a pair of glumes. Sometimes there is no caryopsis (grain) formed in the spikelet although it still appears to be healthy seed. The level of empty glumes can be deduced from levels of live seed in the seed analysis.
5. Seed treatment:

   a. Scarification: The seedcoat (testa) of legumes is often impermeable to water, thus slowing germination. Known as hard-seededness, it gradually breaks down with weathering, allowing the seed to germinate. This can be a valuable characteristic in obtaining a spread of germination, and hence reducing the risk of poor establishment from a single rainfall event with poor follow-up moisture. If too high, it can equally give poor germination immediately post-sowing when it is important for the sown species to compete with regenerating weeds. The level of hard-seededness can be broken down by cracking the seed coat without damaging the embryo. This can be achieved mechanically using sand paper or any other abrasive method, chemically with concentrated sulphuric acid, or with hot water or dry heat. Different methods are more appropriate with different species. It is best to ensure that the seed is scarified sufficiently to give about 50% germination in samples with high hard-seededness.
   b. Inoculation: For pasture legumes to be useful, they require the presence in the soil of a strain of nitrogen-fixing bacteria (rhizobium) suited to an effective symbiosis, and some legumes are very specific in their rhizobium demands. Where there is doubt that a suitable strain of rhizobium exists in the soil, a culture of the bacterium is introduced, usually on the seed, in a process called inoculation. The culture is most

commonly in the form of a peat culture (a black powder), but may also be a slope culture on agar gel, or rarely a freeze-dried culture. Peat cultures should be kept well sealed and cool, and out of the sunlight until they are used. Ideally, the rhizobial culture is mixed into a slurry with an inert glue such as methyl cellulose and mixed with the seed to provide a thin coating over the seed. The seed should then be spread out in the shade to dry before sowing. Seed should be sown as soon after inoculation as possible. If seed is to be mixed with fertiliser, most types of which will kill the rhizobium, it should be covered with a thin layer of fine lime ($CaCO_3$) powder while the glue layer is still moist, in a process called pelleting. On very acid soils or on others where molybdenum is likely to be deficient, and for species with a high Mo demand e.g. Neonotonia wightii, molybdenum trioxide (66 % Mo) should be incorporated into the lime to deliver 150 to 300 g/ha (100 - 200 g/ha Mo).

Land Preparation

The most important aims of land preparation are providing a moist environment for germination, and minimising competition for the developing seedling. For effective germination, it is best to have moist soil pressed closely against the seed, which is best achieved with a fine, firm seedbed. Sometimes cultivation is not possible due to the nature of the terrain, nor advisable, due to exposure to erosion hazard. In such cases, it is still important to eliminate competition from established plants, which is best achieved using a herbicide such as glyphosate. In erosion prone areas, it may be possible to divert runoff water away from the cultivated area to be planted using diversion banks, or to leave uncultivated contour strips of natural grass at intervals through the area to break the flow of water and minimise the chances of rill formation and soil loss.

Sowing

More pasture plantings fail through sowing too deeply than too shallowly. Seed size and soil texture are important in determining sowing depth - the smaller seed and the heavier the soil, the shallower the planting depth. While there are some large-seeded forage species with 5,000-50,000 seeds/kg, most forages have small to minute seeds (100,000 to >10 million seeds/kg). In general, small seeds are best sown as close to the surface as possible, and larger seeds at 2-5 cm. In more arid areas, there may be advantage in planting more deeply to enable the developing seedling to access stored moisture more readily. However, a good practice is to broadcast seed on the surface, cover lightly by whatever means are available, and press the soil around the seed - best done with a heavy roller, or intensive livestock activity. Sowing in rows has the advantage of facilitating hand-, chemical- or mechanical-weeding between the rows of developing seedlings.

Grazing/defoliation management

The basic principles to observe are:

- Graze/cut as regularly as is feasible to obtain the highest feed quality. Feeding value declines rapidly with age of regrowth, as increasing amounts of lignin are laid down. Although longer intervals between grazing/cutting may result in higher DM yields, animal production is usually poorer.

- Always maintain a green leaf residue after grazing/cutting. The rate of regrowth is initially directly related to the amount of leaf remaining to intercept light and support photosynthesis. With severe cutting or heavy grazing, there is a delay in active regrowth while plants redevelop sufficient foliage to support growth.
- It is also important to retain a significant amount of leaf on legumes, because the amount of nitrogen fixed is related to the photosynthetic leaf area on the plant. The amount of nitrogen in a system drives the productivity of the system.

Fertility management

All plants need the various plant nutrients for growth, but vary in the amount of each they require. However, they will only grow to the level set by the limiting nutrient i.e. if the soil is low in phosphorus, no amount of additional nitrogen or any other nutrient will make the plants grow beyond the level set by the amount of phosphorus available to the plant. Soils vary in their ability to supply nutrients, and so it is necessary to know the fertility of the soil, and the fertility demands of the forage varieties to be sown. Chemical analysis of the soil will give an indication of its fertility, and knowledge of the characteristics of the plant will help in determining its nutrient requirements e.g. Bothriochloa spp. usually have a low demand for N and P, while Panicum spp. have a high demand. In general:

- Legumes have a high requirement for P, S, and Mo.
- Grasses have a high requirement for N and P, and also K for some species (e.g. Setaria sphacelata), which have luxury uptake of this nutrient.

Deficiencies of these and other nutrients can often be detected by the presence of deficiency symptoms such as leaf yellowing, full descriptions of which are available in the literature. Tissue chemical analysis can also provide an indication of deficiency, but is very dependent on taking samples of particular phenology.Typical levels of nutrient required at planting and for maintenance are:

	N (kg/ha)	P(kg/ha)	K(kg/ha)	S(kg/ha)	Mo (g/ha)
At sowing	0–50	20-60	50-100	0-30	100-200
Annual maintenance	50-300	10-20	25-50	30	100-200*

Levels of nutrient used will depend on soil type, species used, level of production required, and production system (cut-and-carry systems requires greater maintenance inputs than grazing systems).
*Only applied every 3 years, but caution on Cu deficient soils.

Weed management

Weeds compete with the sown species and reduce productivity of the pasture. They can result from inadequate land preparation or excessive grazing. If seed is sown into a weedy seedbed, the ready-established weeds suppress the developing forage seedlings. If pastures are over-grazed, cattle select their preferred species and avoid others, leading to a build-up of unpalatable species i.e. weeds. Weeds at establishment can be controlled by hand-weeding, or spraying with selective herbicide. Non-selective herbicides such as glyphosate can be used if the sown species are in obvious rows. While weeds in established pastures can be similarly controlled, the most effective control is adoption of more lenient defoliation management

practices. Judicious high mowing can also be a valuable tool to tip things back in favour of the sown species, particularly with annual weeds.

Further reading

Humphreys, L.R. (1994) Tropical Forages: Their role in sustainable agriculture. Longman Scientific & Technical, Essex, England 414p ISBN 0-582-07868-7

Roberge, G. and Toutain, B. (eds) (1999) Cultures fourragères tropicales 369p CIRAD ISBN 2-87614-361-5.

Skerman, P.J., Cameron, D.G. and Riveros, F. (1988) Tropical forage legumes. FAO Plant Production and Protection Series, no. 2, FAO, Rome 832p ISBN 92-5-102190-2.

Skerman, P.J. and Riveros, F. (1990) Tropical grasses.