The AID (Animal Improved Dung) plus seeds treatment. (Summary).

The AID treatment is a cost-effective system using animals to establish vegetation, improve soils and increase plant growth.

This is a summarised and simplified version, emphasizing the use of livestock.

Soil improvers such as beneficial bacteria, fungi, rock dusts, trace elements and charcoal, as well as seeds, can be fed to livestock to improve soils and to grow forests/grassland. The soil improvers and seeds will be dispersed by livestock in their manure and many of the seeds will germinate in the dung piles. The seeds of preferably fast-growing, deep-rooted plants should be used. Dung beetles, earthworms and termites will further disperse and incorporate the improved dung into the soil and increase the availability of nutrients and water holding capacity, while their tunnels improve soil structure, including air and water infiltration, and facilitate deeper and wider root growth, resulting in greater plant growth. Livestock can treat/seed areas such as pastures, orchards, vegetable gardens and degraded land, improving the soil and establishing vegetation, or enhancing existing vegetation. The AID treatment will work best with the planned grazing system developed by Allan Savory (holistic management).

The best thing that can be done to improve most soils is to add organic matter (material which contains carbon). Organic matter generally improves fertility and soil structure, which improves air and water relations, and root penetrability. The organic matter in soils comes mostly from plants and soil life such as mycorrhizal fungi, which comes from carbon dioxide in the atmosphere. Fast-growing plants (high biomass plants) fix more carbon, so that more carbon is added to soils, which improves soils, which enhances plant growth, which adds more carbon to soils, and so on.

Fast-growing, deep-rooted plants and grassy forests

Grasses are generally the greatest producers of organic matter, and grass under trees can grow better, or at least some types of grasses under some types of trees. Partial shade can enhance grass productivity, especially if this is combined with nutrient-rich litter fall from deep-rooted nitrogen-fixing trees. If the tree canopy is naturally relatively open, or it allows more light through at some time in the year, (due to the choice of tree species) or it is maintained that way through thinning and coppicing, there will be greater productivity from the combination of grass and tree growth. Shade-tolerant varieties of grasses can also be used.

In an experiment in Sri Lanka, growing nitrogen-fixing trees and grass in a mixed forage system enhanced the yield and quality of the understorey grass and total output of the system. For example, increased grass productivity has been recorded with the nitrogen-fixing trees, *Prosopis*, *Gliricidia*, *Erythrina*, *Faidherbia albida* and *Albizia* spp.

Australian research suggests a "canopy effect" of 33% through to more than 100% growth increase in grasses or crops grown below trees, and that the quality of grasses under some trees may increase, remaining green for longer into the dry season, and fallen tree leaves (e.g. poplar, *Robinia, Albizia*) provide extra fodder.

Some trees/shrubs also provide nutritious seedpods, e.g. *Gleditsia, Prosopis, Faidherbia* and carob. Extra fodder allows a higher stocking rate. A farmer in Australia added rows of Tree Lucerne (Tagasaste) plus perennial pasture, and nearly trebled his stocking rate. Some livestock, such as goats, Eland and Galloway and Bali cattle, are non-selective feeders, and so can efficiently utilise grass as well as leaves and pods from trees.

A forest also provides a protective buffer against climatic extremes, improving livestock growth rates and health, and decreasing mortality rates of young animals. Forests transpire more moisture into the air, and produce bacteria which seed clouds, and so the potential exists to even modify the local climate (cooling, increasing precipitation).

The roots of tropical trees are usually about 20% or so of the total biomass, while the roots of perennial prairie grasses in North America are commonly 80% of the plant. Grasses in a planned grazing system (plus associated soil life) are thus likely to produce more organic matter in the soil than trees. However, tree roots may grow deeper, and deep-rooted plants can bring nutrients to the surface and may reach underground water, so a complementary combination of grasses and deep-rooted nitrogen-fixing trees with a light canopy can be synergistic.

Planned grazing

Well-managed livestock can improve soils, restore vegetation, control weeds, reduce dry vegetation that could burn in a fire, and even introduce seeds of less flammable species of plants to reduce the intensity of fires.

Intensive planned grazing allows plants to recuperate, or new plants to establish, after grazing/browsing, and maintains a permanent vegetation cover, unlike typical set stocking which leads to plant exhaustion and bare soil. Grazing low to the ground is generally avoided. Grazing might be for a few days (or even hours) followed by a few weeks to many months or even years of rest/regrowth/new plant establishment. See Allan Savory's inspiring work at http://seedmagazine.com/content/article/greener_pastures., and www.holisticmanagement.org.

Planned grazing requires efficient control of the movement of livestock. Livestock could be manually herded, or confined cheaply with portable, solar-powered electric fencing, or permanent fencing, which could be multi-purpose living fences - see "The living fence: its role on the small farm", at www.echonet.org. Intensive planned grazing systems usually require a minimum of 4 separate fenced or hedged areas, but 12 or more is better (some farmers work with more than 70). Another approach is to use moveable pens, which may need to be predator proof. Alternatively, animals can be tethered where low numbers are involved.

Dispersing soil improvers and seeds using animals

Large numbers of active animals bunched together will break up soil crusts with their hooves (which improves seed germination and water/air penetration), and deposit and distribute improved dung. Sheep or goats following cattle, for example, will graze vegetation down to lower levels (if desired), and their hooves will further spread and trample the dung, seeds, and soil improvers into the soil. Chickens and pigs could follow. Dung beetles then make tunnels, burying “improved” manure down to 30 or even 50 centimetres deep. Their outward circle of influence may be about 90cm in diameter, therefore dung piles that are an average of about 1 metre apart or less, should give a reasonable distribution. Their tunnels are likely to last more than 10 years and form channels for root growth, and water and air infiltration. They also increase the permeability of subsoils, encouraging deeper biological activity and root growth. Manure which is quickly buried will experience very little in the way of losses due to volatilisation, leaching, or surface run-off of nutrients into rivers and lakes.

Dr. Bernard Doube concludes that “dung beetles, plus deep-rooted perennials, plus managed sporadic heavy grazing is good for farm profitability and good for storing carbon deep in the soil profile”. He also estimates that introducing dung beetles results in 20-40% more roots and at least a 20% increase in dry matter production in almost any soil, with an equivalent increase in stock carrying capacity.

Earthworms will also spread the “improved” manure and make nutrients more available to the growing seedlings (through the action of grinding and bacteria in their digestive tract, earthworms produce casts in which nutrients are more available for plant uptake and growth). Low to moderate rates of chemical fertilizers can increase earthworm populations (more fertilizer equals more plant growth providing more food and mulch), and increase the nutrient status of casts. Earthworm activity also improves soil structure and relieves soil compaction. Dung is also spread by termites.

Following the AID plus seeds treatment, stock will need to be excluded for as long as it takes for the plants to establish/recuperate, and possibly long enough to produce seed for the next generation. Rabbits or other pests and fire may need to be controlled.

The first rule when feeding soil improvers and seeds to livestock would be to “do no harm” (to the animals, or the environment). Some of the materials suggested are untested, and some dosages suggested are speculative. Local veterinary advice should be sought. To entice stock to eat soil improvers/seeds, it may be necessary to add molasses or some other syrup, or sea salt, mixed together with warm water to fodder. A special fodder production area could grow especially palatable feed (a cut-and-carry system). Feeding may need to be supervised to ensure the feed is evenly distributed between individual animals. Another possibility for producing supplementary fodder is sprouted seeds of barley grass- see www.foddersolutions.org . Sprouted barley grass, mixed with seeds and soil improvers, could be thrown in a random pattern to livestock, which will cause excitement amongst the animals so that they disturb the soil surface as they run to the sprouted barley grass.

A soil test will indicate which soil improvers are needed, for both the stock and the soil, and in what quantities/proportions. Advice should be sought from local soil experts. Dung production should be about 80% of feed consumed, with most dung passed through from perhaps 24 to 48 hours later, but up to 96 hours. Defecation is likely to be 5 to 12 times per 24 hours, per animal. The quantity of dung produced could be as high as two tonnes dry matter per year for a stabled or yarded, 500 kg horse, but is more likely to be 1 tonne DM or less, per year, for cattle in less ideal conditions. Adult goats with supplementary feed in Nigeria produce 138 kg dry manure per year.

Soil Improvers

Biochar. Charcoal or biochar in soils is resistant to decay and can be considered a long-lasting form of organic matter. The porous surface area of biochar may promote the growth of beneficial soil life and hold water and nutrients. Since fast-growing plants produce more organic matter, some of it could be turned into a long-term bank of decay-resistant charred organic matter, while still leaving sufficient non-charred organic matter to feed soil life. Biochar (and burnt bone) could be produced in fuel-efficient cooking stoves, particularly in developing countries, as part of a cost-effective, synergistic system.

Activated charcoal is used for the treatment of humans and livestock in cases of poisoning, and for people, 60-100 grams is administered orally. A suitable dose might be around 2-8 g per kg of bodyweight, for livestock. Activated charcoal is not absorbed, so overdose is not a problem and all of it will pass through animals to the soil.

Charcoal can reduce livestock methane production. However, it should be remembered that greenhouse gases produced by animals (and humans) are derived from the environment, and are recycled back to the environment, with no net increase, and so are not the big problem they are made out to be.

For compacted, infertile soils, using a tractor initially to incorporate bulk quantities of industrially-produced biochar and other soil improvers may well be a worthwhile investment, to kick start the system. By comparison, the AID treatment is much more energy-efficient, but involves smaller quantities over more time.

Brown Coal dusts/powder. Powdered brown coal, with various names such as lignite, leonardite etc. Farmers in Australia have spread coal dust on their pastures, with reports of an increase in earthworms and dung beetles, and an improvement in the health of dairy cattle. Coal dust/powder fed to stock (at around 1-3g/kg) could provide a quick additional input of organic matter to soils, which should quickly form humus, and improve water holding capacity and cation exchange capacity. Researchers in North Dakota showed that humic acid improved sodic soils and that humic extracts from lignite increased the population of nitrogen-fixing bacteria. Therefore combining coal dust, nitrogen-fixing plant seeds and the relevant *Rhizobia* inoculant should work well.

Water plants and seaweeds. Nutrients lost from higher altitudes end up in water bodies, and therefore water plants. Water plants are usually high in nutrients, but may also be high in pollutants. Feeding water plants and/or seaweed to stock which then deposit manure at higher altitudes, would be an efficient recycling of nutrients and organic matter. These plants could be a major part of an animal's diet.

Rock dusts. These are finely ground/crushed rocks, also referred to as rock powders or rock flours. Limestone, dolomite, calcium phosphate, gypsum, sulphur and rock phosphate, have all been successfully fed to livestock, or applied to soils. Others include powders from basalt, scoria, zeolite, granite, and glacial deposits. Since glacial deposits are likely to be made up of a variety of rocks, containing a wide range of minerals, they may often be the best, followed by volcanic basalt and then granite dusts. In a trial in Australia, volcanic basalt dust increased soil pH in acidic soils, cation exchange capacity, available P, and exchangeable Ca, Mg, and K. Some of the more fertile soils in the world are derived from volcanic rocks; in Tanzania, wildebeest time their migration to feed on rich pastures growing on volcanic soils, high in calcium and phosphorus, needed for lactation. Rock dusts could be fed at perhaps 1-3g per kg bodyweight.

Instead of waiting for natural weathering processes to turn rocks into particles, adding rock dusts to soil could be viewed as a way of fast-tracking the formation of topsoil. Rock dusts should work even better if combined with organic coal dust/biochar/seaweed, and passed through an animal, with the addition of beneficial micro-organisms. It is thus becomes possible to "grow" new topsoil, or at least speed up the process.

Sulphur, or lime/dolomite could be fed to stock to adjust pH over time, and trace elements as needed. If sulphur is fed along with rock phosphate, the phosphate may be more available for plant use. If phosphate is fed with clays such as kaolin, the phosphorus may become unavailable.

Clay. Clay is a tried-and-tested positive addition to animal diets. Bentonite clay fed to cattle improves feed intake, conversion and absorption by 10 – 20%, resulting in superior growth rates. It could be that non-stop feeding of clay to animals may hinder absorption of nutrients, so it would be best to use it on and off. The same may apply to charcoal. Clay is commonly eaten by many animals to deal with plant toxins. Clay added to sandy soils increases water holding capacity and cation exchange capacity.

Burnt bone. This is reported to have a very high phosphorus content of up to 35% phosphoric acid equivalent, compared with unburnt bone at 21%, and unburnt bone may not decompose and release its phosphorus for hundreds of years. Bones from mammals, fish, poultry etc. could be burnt and crushed into a powder and fed to livestock, and would be sterile and disease-free, although it is illegal to feed bone to livestock that will be eaten by humans in some countries (it can spread anthrax, botulism and mad cow disease). A suitable dose might be 1g per kg of bodyweight of the animal. Seek veterinary advice. It may be better and less risky to feed burnt bone to earthworms (which should further increase phosphorus availability), and use the vermicompost to grow fodder. Burnt bone may be available from the sugar industry.

Ash. Ash usually has high levels of potassium and calcium. Ash should normally be helpful to make acid soils more alkaline, especially if lime or dolomite is not available or expensive. In Brazil, adding 5 tonnes per hectare of ash from burnt bark (4.7% Ca and 1.4% Mg) to a 6 year old *Eucalyptus grandis* plantation growing in a sandy soil, increased stem volume from 38 to 86 cubic metres! Elephants, chimpanzees and domestic stock have all been observed eating ash. A suitable dose for animals might be 1-3g per kg of bodyweight.

Beneficial micro-organisms. Mycorrhizal fungi grow in a symbiotic relationship with plants, nourished by carbohydrate from plant roots. Their spreading hyphae represent a major proportion of the carbon in soils, improving soil structure and ultimately forming humus. Mycorrhizal fungi generally increase the surface area of contact between roots and soil and change the root architecture, thus improving nutrient (especially phosphorus) and water uptake, resulting in improved growth and drought tolerance. Plants may grow 10-20% faster, or even more.

Mammals appear to be effective dispersal agents of mycorrhizal fungi. Research in Australia found spores in 57% of dung samples from 12 out of 17 small mammal species. Inoculation experiments showed that spores colonised the roots of host-plant seedlings.

It is a common practice to coat seeds of legumes with nitrogen-fixing bacteria, with major economic benefits. The cost of using inoculants is two to three dollars per hectare, compared to over $100 to get the same results, using nitrogen fertilizer for example.

The spores of beneficial micro-organisms could be mixed into fodder along with appropriate seeds (and possibly deficient trace elements, coal dust and molasses), and fed to animals to disperse them. Spores might find refuge in coal dust, (or clay or biochar), and survive better in manure piles, and possibly provide more successful inoculation of seeds and soils. Earthworms are also known to disperse micro-organisms.

Another possibility would be to feed spores of probiotics to stock. This may improve digestion and growth rates, and be beneficial in soils (e.g. *Lactobacillus subtilis* and brewer's yeast), providing a dual benefit for a single cost.

Chemical fertilizers. Urea is commonly used, and mono and diammonium phosphate provide both nitrogen and phosphorus to stock, and then to soils. It may be beneficial to the establishment of legumes if small quantities of molybdenum, cobalt, iron, calcium and superphosphate are added along with *Rhizobium* inoculants. Since high applications of some acidic or "salty" fertilizers may be detrimental to some beneficial micro-organisms it would be better to feed them separately to different animals, or at different times, or at low rates. Dosage could be .1-1g per kg of bodyweight.

Seeds. Feeding seeds to livestock can increase species diversity in pasture or forests/grassy woodlands, or add improved varieties, and is called interseeding. The effective establishment of nitrogen-fixing *Acacia* and *Prosopis* trees by ungulate dung dispersal has been observed on four continents. Seedlings may establish better if grazing is down to ground level, especially if weed control is part of the program, and if there is high animal impact on soil crusts. While seed germination in dung piles can be spectacularly successful, direct-seeding by any means tends to be a hit-and-miss affair, and may require repeated treatments.

Dispersing seeds utilising animals is likely to work best with large numbers of small seeds, perhaps particularly seeds of nitrogen-fixing legumes, through large animals. Legume seeds commonly have a hard seed coat which may require hot water or acid pre-treatment. There may or may not be improved germination, but seedlings should grow well in a pile of "improved" dung, which includes appropriate beneficial micro-organisms and nutrients. Seeds could be up to perhaps 50% of the feed, by volume, with molasses. Some seeds could be fed as whole fruit or pods.

The AID plus seeds treatment – a synergistic and holistic system

The AID plus seeds treatment provides a cost-effective method to establish windbreaks, rows of fodder trees/shrubs, grasslands and forests. Over time, and with repeated treatments, the AID plus seeds treatment and planned grazing should improve almost any soil. Improved dung and high-biomass, deep-rooted plants should produce synergistic soil improvements. Combined with tunnelling and dispersal by dung beetles, and the action of earthworms making nutrients more available, treated soils should have greatly increased carbon/organic matter, increased fertility, reduced nutrient losses from volatilisation and leaching, increased cation exchange capacity, improved structure with better water infiltration and water holding capacity, improved aeration and drainage, reduced bulk density with easier root penetrability, more soil life and activity, faster nutrient cycling, and reduced erosion problems. All this combines to increase animal and plant growth, and perhaps even increase precipitation, producing outstanding results for minimal costs, in a relatively simple and low-tech system.

For more information:

Engel, Cindy. 2002. Wild health. How animals keep themselves well and what we can learn from them. Weidenfeld and Nicolson. ISBN 0 297 64684 2.

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