5. Agrominerals in greenhouses and plant nurseries.

Greenhouse production of vegetables and flowers, mainly for the overseas market, is developing rapidly in parts of sub-Saharan Africa. For the growth and packaging of plants and flowers the industry requires growth media and light-weight sterile packaging media. Tree nurseries are common in most countries, but the use of growing media other than soil is still very limited in sub-Saharan Africa. In the world there are millions of plants grown in shallow-drained container soils each year. Constructed growth media are used in containers and pots, on sportsfields and restricted landscapes, for example, on rooftop gardens, on courtyards, patios, etc.

Constructed growth media offer several advantages over conventional soil mixes: They are homogenous, disease- and insect-free and light weight. Fertilization and water use can be carefully controlled. Constructed growth media provide anchorage for plant roots, good aeration, and water-holding capacities, and the flow of fertilizers can be easily regulated. Among the common ingredients of soil-less mixtures are peat, perlite, and vermiculite. They can be used as soil amendments and growing media in greenhouse operations and tree nurseries. Growth media in greenhouses generally include mixes of lightweight bulky and sterile mineral materials like perlite, vermiculite and peat.

5.1 Perlite

Perlite is the term for unprocessed and processed forms of a volcanic glassy material. The 'crude' unprocessed perlite is a meta-stable, amorphous, silica-rich volcanic rock of rhyolitic to rhyodacitic composition, usually of Tertiary age or younger. The transparent light gray to glassy black rock has pearl-like lustre and exhibits numerous concentric cracks resembling an onion skin in appearance. Crude perlite is chemically inert, has a pH of about 7, a specific gravity of 2.2 to 2.4 g cm^{-3}, and contains 2-5% combined water. When the mineral is rapidly heated above 1000^{o} C in special furnaces, the rock melts and then expands up to 20 times its original volume by the vaporization of the trapped moisture. It is this mass of white, glassy foam that forms commercial 'perlite,' a porous, light-weight, sterile, physically stable silicate with good thermal insulation properties, and a neutral pH. Expanded perlite has a low bulk density (for example bulk density of coarse perlite is 0.1 g cm^{-3}) but has virtually no cation exchange properties. Perlite is a resilient rock material that does not deteriorate in potting mixes and soils.

Perlite has been used successfully in many applications as a component of various growing media for a variety of horticultural crops and flowers. In recent years it is increasingly being used in commercial plant growing and hydroponic operations, and in special perlite 'bag systems,' for example, for the production of tomatoes and cucumbers (Wilson 1985). Coarse 'horticultural perlite' is used as part of potting mixes for tree and horticultural plant seedlings. In these applications this resilient material is especially valued for its good aeration and drainage properties. In addition, finely ground white perlite powder sprinkled onto the surface of seedblocks aids early plant growth due to its high brightness and reflectance of light onto the underside of leaves of the growing seedlings.

Crude perlite has been described from a number of volcanic regions in sub-Saharan Africa, including Djibouti, Mozambique and South Africa. Only in South Africa is perlite commercially mined. There is however a great potential of finding perlites in other volcanic regions of Africa, including Ethiopia, Kenya, Tanzania, and other areas with young silica-rich volcanism, such as along the Western Rift, and on various volcanic islands in which obsidians and rhyolitic tuffs are reported.

5.2 Pumice

Pumice is a naturally occurring light-coloured, cellular, frothy, chemically inert and physically resilient volcanic rock, similar to the artificially expanded perlite. It forms as result of violent expansion of dissolved gases in a viscous, silicic-rich lava such as rhyolite or rhyodacite. It is found in large consolidated and unconsolidated deposits close to the volcanic vents from which it was ejected. Like

perlite, pumice has sealed internal pores, making it a very light-weight material. In fact, most pumice blocks can float on water.

Pumice resources are exploited for many purposes, mainly for the building industry, for the abrasive industry and the stonewashing of jeans, and only a minor amount is used for soil amending purposes (McMichael 1990). Pumice produced for horticultural purposes is won from unconsolidated deposits solely by crushing and sizing. Environmentally, the production of pumice is more 'friendly' than that of perlite or vermiculite as it does not require high-energy inputs for thermal expansion. Nature has already completed this process during the formation of pumice.

In many unconsolidated deposits sizing is the only processing technology required, thus making it a very inexpensive soil amendment and growth medium. Differences with perlite are mainly related to the range of pore sizes, shape and independent particle size. Investigations by Noland *et al.* (1992) showed that pumice has similar physico-chemical properties to those of perlite and can thus be used as an inexpensive substitute for perlite in greenhouses and plant nurseries.

Unconsolidated pumice deposits have been described in several countries in sub-Saharan Africa with Tertiary to younger silicic volcanism. Countries in which sizeable pumice deposits have been described include the countries along the Eastern and Western Rift; for example, Ethiopia, Djibouti, Kenya, Uganda, and Tanzania. It is not known whether pumice is used anywhere in sub-Saharan Africa for soil amending purposes or in container-based cropping systems, in greenhouses or in plant nurseries.

5.3 Vermiculite

In its crude form vermiculite is a laminar hydrated ferromagnesian sheet silicate mineral that resembles mica. It is found in various geological environments, the main occurrences being associated with surficially altered carbonatites and pyroxenites.

When subjected to high temperatures (> 900^{o} C), particles of vermiculite exfoliate by expanding at right angles to the cleavage of the mineral. The exfoliation of vermiculite is the result of mechanical separation of the layers by the rapid conversion of contained water to steam. It is this exfoliated low-density vermiculite that is known in the building and horticultural industry for its excellent properties of insulation and fire resistance, good absorption and cation exchange capacities. In greenhouse applications this light-weight mineral has good water retention and high cation exchange capacities (50-150 cmol kg^{-1}). Vermiculite is widely used in container mixes, but also for seed germination, transplanting of trees and other plants, as a carrier of pesticides and fertilizers, and in feed additives for poultry, cattle and other animals.

Vermiculites have been discovered in various geological environments in sub-Saharan Africa. Most potential vermiculite accumulations are found in surficially altered carbonatites and ultramafic bodies; for example, in Kenya, Malawi, South Africa, Uganda, Zimbabwe. To date, most of the vermiculite is exported from the above countries and little has been consumed locally.

5.4 Peat

Peat is a unique natural organic material that is found in marshes, bogs, swamp systems and low-lying coastal areas where organic matter has accumulated under reducing conditions. Peat deposits are found not only in the northern hemisphere, but also in vast areas of the tropics. Peat is valued for its physical and chemical properties. It has high water-holding capacities, high cation exchange capacities (100-150 cmol kg^{-1}), high porosity, low density and low heat conductivity. It has by itself only very low nutritional status but can be used as a fertilizer carrier. Other uses include peat as a clean media for oil spills, a filtering agent in sewage treatment plants, for chemical and pharmaceutical purposes and as an energy source.

In potting soils it is valued for its light weight, good aeration and water holding qualities. Northern peat commonly has a low pH and has been used as a medium in phospho-composting systems (Mathur *et al*. 1986). A high sulphur peat found in the coastal region of Sri Lanka has been selected as a low pH medium to enhance phosphate rock dissolution (Dahanayake *et al*. 1991).

Peat deposits in sub-Saharan Africa are found in high altitude swampy areas of Rwanda and Burundi, and in many low lying coastal swamp areas, for example, in Benin, Congo, Mauritania, Senegal.

There are serious environmental concerns related to the extraction of peat deposits in many parts of the world, because swamp areas are natural carbon sinks and wetlands of high ecological value.