2. Agrominerals and farming.

With the exception of nitrogen, all plant nutrient resources for farming systems are of geological provenance. In natural systems, nitrogen is 'harvested' from the air by legumes or through N-fixing organisms and recycled in the soil. Other nutrients critical for plant growth, like P and K, Ca, Mg, S and micronutrients are supplied by geological resources – rocks. Weathering of these rocks, as well as organic inputs, atmospheric deposition, and re-sedimentation of soil materials eroded from upper slopes, supplies most of the nutrients essential for plant growth.

Under natural climatic conditions the physical breakup, chemical weathering and release rate of nutrients from minerals is not fast enough to provide nutrients for annual crop production. In the past, soils were given rest periods to recover and naturally replenish after periods of cultivation and harvesting. But these fallow periods have been shortened in recent years or even abandoned due to increasing pressure on the land base. These days, the soil is given no rest. Continuous cultivation, however, requires continuous replenishment of soil nutrients. It has been widely recognized that the removal of nutrients from soils through repeated harvesting, leaching, gaseous and losses and runoff and erosion is too high to retain enough soil nutrients in the soil for sustained crop production. The result is that soils are 'mined.' Van der Pol (1992), Stoorvogel *et al.* (1993), Smaling *et al.* (1993, 1997), and Smaling (1995) presented nutrient balances of the cultivated land base in various parts of sub-Saharan Africa. The calculations of nutrient 'stocks' and 'flows' indicate that sub-Saharan Africa is losing 4.4 million tonnes of N, 500,000 tonnes of P, and 3 million tonnes of K every year through nutrient depletion.

To correct the imbalance between soil nutrient exports and imports it is necessary to replenish nutrients that have been removed or lost. If not replenished, soil fertility will decrease and result in continuous loss of capacity to support plant growth. This will have dire consequences and lead to increased food insecurity and poverty.

To sustain crop production, soils need replenishment of nutrients through inputs such as manures, water-soluble fertilizers or some other alternative inputs. Although most smallholder farmers in Africa appreciate the value of water-soluble fertilizers, they can rarely afford them. Often, if fertilizers are available, farmers are unable to apply them at recommended rates and at the appropriate time. Fertilizer imports have been hampered in many parts of the developing world by the scarcity of foreign exchange, political problems, civil wars, transport problems, and other challenges. In addition, farmers often get low prices for their agricultural products, leaving them with little or no incentive to increase crop production.

In many parts of Africa, farmers depend on local resources and natural processes to replenish soil fertility, and instead of spending their savings on expensive, mainly imported water-soluble fertilizers, they resort to alternative ways of accessing vital plant nutrient resources. They utilize organic materials like manure and plant material, for example. In parts of sub-Saharan Africa, replenishment strategies for nitrogen have been successful though improved fallow and crop-fallow rotation practices (Sanchez *et al.* 1997; Sanchez and Jama 2000). But these organic resources generally have low nutrient contents, especially phosphorus, and they are bulky. To substantially increase the inflow of new nutrients other than the ones provided by organic matter, farmers could add locally available agromineral resources. Some agrominerals occur naturally in concentrations and forms that can be used as alternative fertilizers or soil amendments. 'Reactive' sedimentary phosphate rock (PR), potash, gypsum, dolomite, limestone, and various other minerals fall in this category. In other cases, mineral resources do not occur in a form that is directly available to crops and must be modified physically, chemically and biologically to become effective nutrient sources for soils and crops. For other agromineral resources, such as ground silicate rocks, large quantities of rock material are needed to be agronomically effective (Roschnik *et al.* 1967; Gillman 1980; Gillman *et al.* 2000; Harley and Gilkes 2000).

Due to substantial cuts in external aid and fertilizer subsidies, many developing countries rely more and more on their own nutrient resources and it is important to know the indigenous agromineral resources available to support a viable and sustainable rural agricultural economy.

The development process must be viewed as a long-term goal. Short- and medium-term solutions like the import of fertilizers can have positive short-term impacts on food security, but this is only a partial solution to national independence from foreign agricultural inputs. The disruption of fertilizer supplies by economic, political and other pressures can seriously impede the development and livelihood of rural inhabitants. It is therefore imperative to live and work within these limitations and not proceed as if these constraints do not exist (Pride and van Straaten 1993).