

Some keys for P management in sahelian regions in Africa  
proposed by M. Brossard (soil scientist, ORSTOM, France)

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Stangel P., et al.,

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M. Brossard  
ORSTOM c/o CPB-CNRS, BP 5 - F-54501 Vandœuvre-lès-Nancy Cédex - FRANCE  
Tél. (33) 83 51 08 60      Télécopie (33) 83 57 65 23

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The objective of this section is to give some considerations in order to improve P management in african regions where:

- (i) annual pluviometry is usually 200-750/850 mm;
- (ii) the agriculture is extremely extensive;
- (iii) there is a lack of infrastructures;
- (iv) population densities are growing in urban zones;
- (v) there is no environmental concerns, and,
- (vi) some years national food demand can prevail (food insecurity) and population observe a regular degradation of natural ressources during the last 20 years.

Many of the major P considerations were exposed at the SCOPE Regional Workshop in Kenya (1991) and general ways of reflexion were presented by ORSTOM (1990).

### The water

An agroclimatical zonation shows that the area is concern by pastoralism and precarious agriculture (rainfed crops) (Pieri, 1989). The climate is characterized by contrast between a dry season and a period having a high intensity pluviometric episodes during short times. All factors which permits a better water alimentation of crops will be benefic for phosphate nutrition. In the same time, encourage water infiltration in soil allows for a diminution of runoff and erosion risks (Hoogmoed, 1985; Casenave and Valentin, 1989), factors which induce phosphorus outputs for the agricultural systems. Roose (1981) shows that P loses by erosion in West Africa are 3 to 30 kg P ha<sup>-1</sup>year<sup>-1</sup> in relation with soil type and amount of eroded material.

### The soils

At low scale soils have a sandy to sand-clayey texture. They have a low organic matter contain (Boissezon, 1973; Jones, 1973; Feller et al., 1991). The clayey soils are observed in low parts of the watersheds. Soil total phosphorus reserves are low, 80 to 200 mg P kg soil<sup>-1</sup>, in surface layers (Roche et al., 1980; Boyer, 1982; Frossard et al.,

1992). The content of available phosphate assessed by isotopic techniques are low (Fardeau et al., 1983; Morel and Fardeau, 1987), and this observation is valid in soils with low and high P fixing capacity. But except clayey soils, the soils in this area have a low P fixing capacity (Frossard et al., 1992). In consequence it was shown that it is possible to increase the levels of available phosphate (Truong et al., 1978) by a minimal fertilization in order to maintain the P level upper than a critical level for plants (Fardeau and Frossard, 1991).

#### Management of organic matter

The estimation of the balance of organic matter in cultivated soils indicate that in south Sahara savannas the deficit is general. Erosion, runoff, and intensification practices increase this deficit (Pieri, 1989). Decrease of soil organic matter is about 30-40 % of the initial level after 3 years cultivation (Feller et al., 1991). These authors show also that the organic compartments concerned by this variation are the plant debris present in the soil and the fine silt fractions. There is a decrease of P soil reserve in relation to the OM contents decrease (Frossard et al., 1991), and a loss of a potential biological mobility of P (Frossard and Frossard, 1992; Feller et al., 1993). In general during dry season there is a high demand of straw for livestock alimentation and thatched roofs. Management of organic residues is a socio-economic problem. Restoration of soil organic matter reserve must be an objective, but this is a part of a global approach in the management of agricultural systems in a way of sustainability.

#### The P balance

There is a lack of information, but from a global point of view the balance of soil phosphorus is largely negative (Pieri, 1991). The annual average of the deficit is estimated onto 0-6 kg P ha<sup>-1</sup>year<sup>-1</sup>. Compared to the mean content of available phosphate evaluated by a bicarbonate extraction (1-10 mg P kg soil<sup>-1</sup>) a theoretical total consumption in fifteen years of the bioavailable soil P can be estimated (Pieri, 1991). Because the deficit of organic matter input and soil contents, and the low reserve of P in soils there is a need of P fertilizers in order to maintain a minimal crop productivity and minimizing the P decrease of the soils. This assumption is valuable in agricultural systems when the water is not the main constraint for plant growth. There is no information (?) about wastes. But in the approach future urban population increasing, there is a need for modernisation of cities, and alternatives to use of wastes must be tested and proposed.

It is possible to increase the soil phosphate fertility in this area. P fertilization has to be a state investment in order to improve the fertility and not only a technical procedure

which can be done by some farmers. The sources of rock phosphates are near (Lucas, 1991), but this fertilizers have to be use only in soils having a pH < 6. In fact, the principal constraint is the dryness which is a negative factor on the dissolution and desorption of phosphate from the solid phase to the soil solution.

Management of water must be done in terms of integrity of watersheds and not only in the potential zones to be developped as the lowland parts of the watershed. For example, after dryness the second factor is the relief which permits accumulation of water runoff, soil and vegetation are secondary in this case. But if there is a disposal of this accumulated water for irrigation, soils and relief becomes essential. Global perception at different scales of the milieu (IRAT, 1974; Boulet et al., 1982; Stoosnijder and Hoogmoed, 1984; Bertrand et al., 1985; Casenave and Valentin, 1989; Brabant, 1990; Fritsch, 1993) allows for a better definition and utilisation of environmental policies.

In terms of strategies solutions cannot be done as only technical alternatives. The economical and social changes during the last past 25 years modified the pastoralism practicies (ORSTOM, 1990). New rules in the space management have to be edicted and applied. Maintain and intensification of agricultural systems need the reevaluation of the farmers profits (Casenave and Valentin, 1989). For example the sale price of rice are lower than the cost production for a Diola farmer in Casamance (Boisgallais, 1993). But the principal problem after water deficiencies is the disponibility of land. One reaction to the demographic pressure is that farmers have a reflexe which conduce to occupe the virgin lands whithout any change in their agricultural practicies. This induce a dilution of time-work/unit surface, the use of marginal lands, and finaly soil degradation and decrease of yields (Pieri, 1989).

Finaly, P policies are just in this region a part of global policies which include social, environmental, agronomic, macro and microeconomic, and politic for new ways in development (ORSTOM, 1990).

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