PRESERVING AND IMPROVING soil fertility

The fertility of a soil is its ability to deliver a productive service. Agro-ecology mobilises biological processes that support fertility, in order to reduce an agricultural system's dependency on nitrogen, phosphorus and water.

Improving soil fertility and helping farmers become less dependant on synthetic inputs requires an approach focused on agronomic principles and their implementation, such as good crop and root establishment, rules for driving agricultural machinery in fields, good crop residue and exogenous organic matter management, effective fertiliser application, complementarity of crops within the rotation and introduction of legumes. Innovative combinations are currently being studied. Up to now, biotechnological and genetic progress has been producing action levers with a relatively modest impact.

Preserving the soil's physical condition

Preservation of the soil's physical condition, which is partially linked to its biological condition, is sometimes neglected. And yet, it is the first and crucial step towards maintaining its fertility. It is achieved differently depending on the texture of the soil.

Capping is a risk specifically linked to silty or sandy-silty soils. Capped soils are more likely to lead to germination losses. Water, fertiliser and certain plant protection product (such as soil acting herbicides) inputs are less effective as it is difficult for them to penetrate into the soil and a large proportion may be lost through runoff or evaporation. The risk of capping is greater in soils with low organic matter content and low pH. It is also increased if the seed bed is too fine, the soil is left bare or irrigation is excessive. Conversely, if the organic matter is concentrated on the surface, it protects the top soil's structure and improves its stability. Lime spreading has the same effect.

Some degree of compaction is observed in many types of soils, whether they are silty or clayey. If a soil tends to be clayey, the use of lower pressure tyres and the shrink-swell capacity of clay are not enough to prevent or remedy compaction, because of increasingly heavy agricultural machinery, of climate change and of technological advances (mild winters, extended irrigation). This makes root establishment more difficult, especially for legumes for which the establishment phase is crucial. It results in delayed growth stages, nitrogen deficiency and greater vulnerability to bio-aggressors at the beginning of the cycle.

The weight of machines and their loads, as well as the water content of the soil as they pass on it are crucial in preventing compaction.

If necessary, field work and application dates can be moved by modifying rotations. The combination of those precautionary measures with appropriate tyres and regular surface mulching of incorporated organic residue, helps to maintain good soil structure and make the most of biological activity in the soil.

Soil coverage (choice of rotations and cover crops during the intercropping season, leaving crop residue on the ground), the right type of cultivation, field sizes and good field layout, are all effective measures to control water and wind erosion.

The inclusion of legumes in a cropping system helps to restrain nitrogen consumption and stimulate biological activity.

Towards nitrogen self-sufficient systems

A large number of action levers can be activated to obtain cropping systems that are less dependant on nitrogen inputs, as well as more efficient and more resilient. It is important to rank them, and to adjust them depending on the circumstances. The introduction of legumes in a system is the most powerful of them to reduce mineral nitrogen fertilisation and enhance soil fertility. This introduction can take different forms: pure leguminous crop in the rotation, combination of leguminous plant with another crop, introduction of cover crops (pure or in combination) or companion plants. Legumes do not require any nitrogen fertilisation. In addition, they help reduce nitrogen inputs by 20 to 60 kg N/ha, sometimes even more, for the following crop(s).

For the introduction of legumes in the rotation to be successful, their specific characteristics must be taken into account in the farming system and it must be combined with greater varietal and technical innovation. Good root establishment, linked to good physical and biological condition of the soil, must also be encouraged. Cropping systems under green cover, now that we have a better understanding of the conditions required to lead to their success, are capable of returning 30 to 50 kg N/ha per year, without altering the cash crops.

Finally, regular "upkeep" of the humus content of the soil (incorporation of crop residue and of the intercropping season cover, or exogenous inputs) helps to build organic matter stocks and feed crops. It is possible to reduce the amount of purchased synthetic fertiliser, by using organic by-products high in nitrogen (slurry, poultry manure, industrial or urban waste, etc.). The amount of available nitrogen is then potentially high, provided, however, that the logistics of supplying those organic products to the crops have been properly established. Those containing most carbon (composts) have a longer effect on organic matter stocks, and therefore on the amount of nitrogen that can be mineralised each year.

Selecting an appropriate form of fertiliser and appropriate application dates (growth stage and weather) helps to improve its effectiveness, sometimes quite significantly, in particular with calcareous soils. Although to a lesser extent, some additives (NBPT) also enhance the effectiveness of those nitrogen fertilisers most susceptible to ammonia volatilisation. It has not yet been possible to demonstrate the effectiveness of bio-stimulants in field conditions. Up to now, the varietal impact on nitrogen uptake has made very little difference to yield, but it must be taken into account for protein content.

Good root establishment has a major impact on phosphate uptake

Like for nitrogen, selecting the right form of fertiliser and using organic products to replace mineral fertilisers are useful options to make cropping systems less dependant on synthetic inputs. In the soil solution, phosphorus is not a mobile element. Good root establishment and progression of the root zone are therefore important to ensure proper uptake. New techniques are being studied to cope with the possible exhaustion of phosphate fertiliser resources in due course. They include improving the root volume of a crop through varietal selection, and discovering useful synergies between varieties and mycorrhiza, a type of soil fungus which, in symbiosis with roots, contributes to the supply of mineral nutrients to plants.

Regular "upkeep" of its humus content, especially during the intercropping season, enhances the soil's contribution to crop nutrition.

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EVERY DROP OF WATER MATTERS

Optimal utilisation of all water resources is a crucial issue.

Increasing water availability is the first step towards optimising the management of this resource. Any technique that helps to increase water availability in the soil must be implemented. Greater root depth increases water holding capacity and has by far the most significant impact. Covering the soil with mulch limits runoff and reduces evaporation in the early stages. Increasing the soil's organic matter content slightly improves water holding capacity, in particular in sandy or shallow soils. But this is a long process and can be costly. Finally, reducing waterlogging helps to increase water availability through better root establishment.

Improving the effectiveness of irrigation water

Applying water at the right time and in the right place ensures that water fully contributes to production. Management tools are an essential part of an agro-ecological approach. Their interpretation requires a good knowledge of cropping cycles and of the periods when water deficiency-induced stress presents a greater risk. Tensiometric probes and water balances are complementary tools to optimise irrigation in a given parcel and determine priorities between fields. Other significant action levers include the equipment chosen and its settings.

Choosing appropriate block plans and varieties

Block plans represent a major action lever for water management. Matching water availability and the estimated water requirements of the crops that will be established will help ensure productiveness and effectiveness of irrigation. This can mean choosing species which do not consume much water or that can efficiently utilise inputs. Varietal adaptation is the subject of several genetic research projects. Recent results with maize show it has a significant impact.