Organic Fertilisers

Poor soil fertility and low soil nutrient contents are often a major constraint on increasing yields. Soils in Afghanistan have shown low levels of nitrogen and micronutrients deficiencies for iron, zinc, copper, and boron (USDA & UC Davis, 2013). Proper nutrient management is therefore crucial to recycle nutrients on-farm, improve available nutrients and crop yields.

Important nutrients

The three most important nutrients for plant growth are nitrogen (N), phosphorus (P, as P_2O_5) and potassium (K, as K_2O), mostly abbreviated to NPK. Other important macronutrients include calcium (Ca), magnesium (Mg) and sulphur (S). The main micronutrients are boron (B), copper (Cu), iron (Fe), chloride (Cl), manganese (Mn), molybdenum (Mo) and zinc (Zn), all of which are also necessary for plant growth, but in small quantities (ILEIA, 2010).

If one nutrient is missing or deficient, plant growth will be poor, even if the other nutrients are abundant. The deficiency of any one nutrient delays plant development. Once supply of that nutrient is no longer the limiting factor, there is no benefit to increasing its supply. Another element will then be in low supply and thus the limiting factor.

Nutrient deficiencies

Crops require different amounts of nutrients for optimal plant growth. For details of the nutrient requirements of various crops (wheat, potatoes, vegetables, fruit and nuts) please refer to the information provided by USDA & UC Davis, 2013 on: http://afghanag.ucdavis.edu/afghanag

If a crop does not receive enough nutrients, it will not grow properly, and one nutrient will also be the limiting factor. This kind of nutrient deficiency often becomes visible in the green parts of the plant, mainly in the leaves. It is important to detect major nutrient deficiencies so as to be able to react and tackle nutrient deficiencies in a timely fashion. These links show the nutrient deficiency symptoms of wheat, potatoes, fruit and vegetables.

Nutrient cycling

Nutrients occur naturally in the soil through rock weathering and decomposing plant residues, animal remains, soil minerals and soil microorganisms. Plant residues and animal manures decompose to soil organic matter. Their nutrients are then mineralised form the organic to an inorganic nutrient store (see Figure 1 on the next page). Plants take up nutrients through their roots. The presence of water enables plants to absorb nutrients, especially nitrogen. Thus **soil moisture** plays an important role in nutrient uptake. Available nutrients can also be lost, e.g. directly from the soil through erosion, runoff, leaching or volatilisation (evaporation). Nutrients can also be a source of **environmental contamination** when they reach lakes, rivers and groundwater (ILEIA, 2010).

The nutrients taken up by plants are removed with the harvest of crops or through animals grazing. Nutrient losses increase when crop residues or livestock manure are not returned to the soil, but nutrient inputs should always balance nutrient outputs so as to maintain soil nutrients and thus soil fertility. Soil fertility is the soil's ability to provide all essential nutrients in adequate quantities and in the proper balance for plant growth. This can be ensured by applying nutrients to the soil in the form of **organic fertilisers** (farmyard manure, compost, green manure) or as **chemical fertilisers**. Nitrogen can also be fixed to the soil through **nitrogen fixation**.

Crop rotation and diversification

The availability of soil nutrients can be improved by diversifying cropping systems. Crops require different amounts of the various nutrients, so a diversified system balances nutrient requirements. Crop rotation, intercropping and multi-layer systems are all sustainable ways of using different crops, shrubs and trees to optimise plant growth and improve soil nutrient cycles.

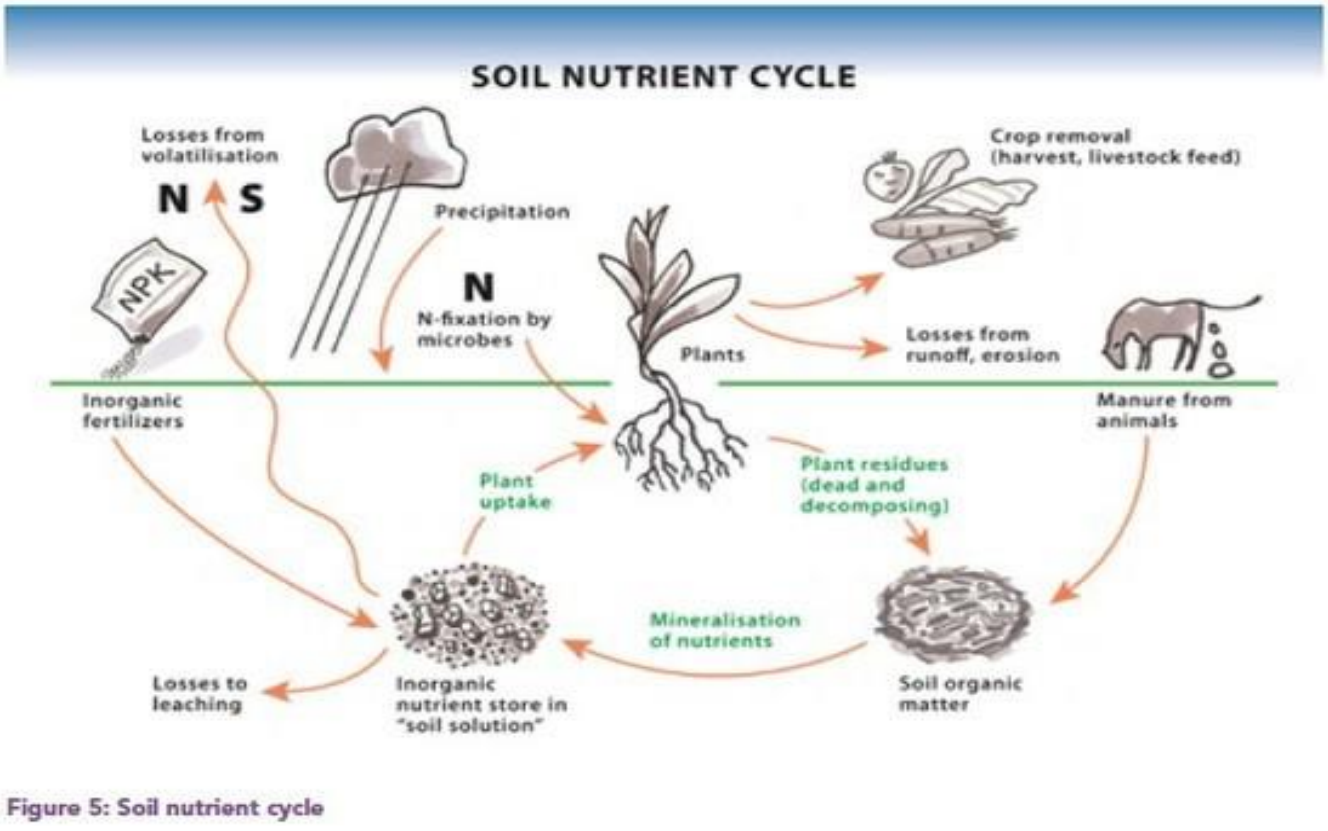

Figure 1: The soil nutrient cycle with nutrient sources and losses (ILEIA, 2010)

Organic and chemical fertilisers

Fertilisers need to be applied in agricultural production, as soil nutrients are depleted over time. Fertilisers can either be of an organic or a chemical origin. Chemical fertilisers are usually available in a soluble and inorganic form, which distinguishes them from organic fertilisers such as farmyard manure or compost. Organic fertilisers are mineralised by soil organisms to their inorganic form before being taken up by plants (see Figure 1). Chemical fertilisers can be taken up immediately after application and are therefore a faster-acting form of plant nutrition. Chemical fertilisers are therefore often referred to as “feeding the plant”, whereas organic fertilisers “feed the soil”, as they contribute substantially to increase soil organic matter. Table 1 shows the advantages and disadvantages of organic and chemical (inorganic) fertilisers.

Organic fertilisers are key in sustainable agriculture, and the use of chemical fertiliser must be limited to reduce the impact on human health and the environment. As most cropping systems in Afghanistan are mixed farming systems, farmyard manure is the country’s most important organic fertiliser.

Table 1: Advantages and disadvantages of organic and chemical fertilisers

Chemical fertilisers		Organic fertilisers	
Advantages	Disadvantages	Advantages	Disadvantages
• Act fast • Specific and known nutrient composition • Easy application	• High costs • Water contamination • Health hazards • Loss in biodiversity • Contribution to Green House Gases (GGH)	• Recycling of farm material • Cheap • Multiple nutrient composition • Improve soil organic matter • Improve the soil in the long-term	• Labour-intensive • Knowledge-intensive • Transport

Farmyard manure

Farmyard manure is the best organic fertiliser available in mixed farming systems. Farmyard manure should be collected and recycled back into agricultural production to close nutrient cycles and improve soil fertility.
The amount of farmyard manure produced depends on which animals are being kept on the farm. Farm animal excrement contains up to 90% of the nutrients that the animals have taken up with their fodder. It is a multiple-nutrient fertiliser that contains nutrients such as NPK as well as Mg, Ca and many micronutrients. Manure is therefore a cheap and efficient fertiliser. Cattle manure is better than donkey and horse manure, while goat and sheep manure is considered better than cattle manure. Chicken manure is considered the best of all, as it is nitrogen-rich (ICIMOD, 2008). The following aspects have to be considered with regard to manure:

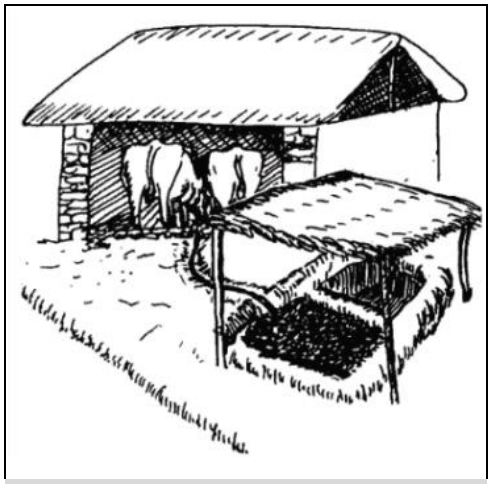

Figure 2: Farmyard manure and urine collection in a stable (ICIMOD, 2008)

Collection: Manure is best collected mixed with litter such as straw or other plant residues. They absorb nutrients that would otherwise be lost. A high proportion of litter generates more solid manure, whereas water mixed with little litter results in more liquid manure (slurry). The best option for absorption is chopped and mashed straw. Manure collection is easiest to perform when animals are kept in stables. However, dried dung collection from grazing lands is also important.

Storage: There are different possibilities for storing manure. Manure is either stored directly in the stable, or outside the stable in heaps or pits (see Figure 3). One simple rule is to avoid sun, wind, rain and stagnant water. Roof cover or a tree can provide good protection. It is also preferable to choose a site on a slight slope, which allows the liquid manure to flow out and be caught in a slurry pit. The best base is compressed soil (clay) or concrete.

Sheep, goat or horse/donkey dung has to be watered down or urine can be poured on it. White threads or points indicate overly dry storage conditions; a yellow-green colour is a sign for overly wet manure. When correctly stored, manure has an even brown-to-black colour. Manure should not be stored for too long: most manure is mature in about four months (Forster, 2001).

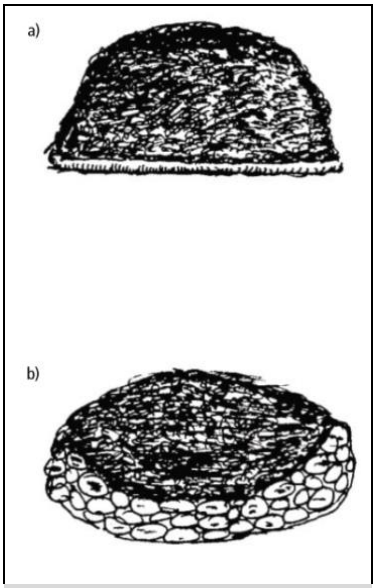

Figure 3: Store manure in a) heaps and b) pits (ICIMOD, 2008)

Composting: Farmyard manure can be composted to reduce the spread of weed seeds and pest and diseases via the manure. During composting the manure heap or pit should be kept warm and moist to enhance the process (see *AGR2B Sustainable Soil Management*).

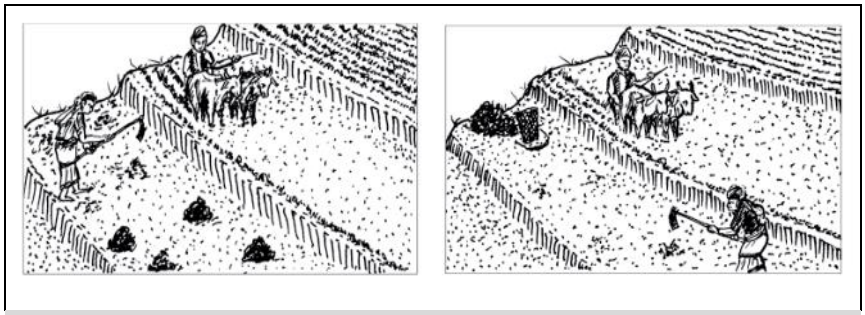

Figure 4: Incorporation of manure into the soil (ICIMOD, 2008)

Application: The dry manure is carried to the field where it is incorporated into the soil. It is important to carry the manure to the field on the day it is worked into the soil so as to avoid losses through on-field evaporation. Figure 4, on the following page, shows two methods for applying manure, either by distributing manure in small heaps or as one big heap at the edge of the field.

Urine: Animal urine is a very good source of nitrogen, because 60% of the nitrogen excreted is found in urine and only 40% in manure. As few as two cattle can save the cash equivalent of purchasing about 100kg of urea per year. Urine can be applied directly as liquid fertiliser (ICIMOD, 2008). Urine collection should be promoted in Afghanistan to tackle soil nitrogen deficiencies. Urine is best collected in a urine pit inside the stable.

Other organic fertilisers

Besides farmyard manure and urine there are several other organic fertilisers which feed the soil and help to improve soil nutrients (FiBL, 2011), such as green manure and compost (see *AGR2 Sustainable Soil Management*). Others are:

Liquid manures: These can be made using fresh plant material (plant tea), compost (compost tea) or fresh animal manure (manure tea). Manure tea and plant tea are both rapid sources of nitrogen, while compost tea is a more nutritionally balanced liquid fertiliser.

Plant tea: Fresh, green material is soaked in water for several days or weeks to undergo fermentation. Nutrient- or nitrogen-rich material should be used.

Ashes: The ashes of burnt organic material are often also used as organic fertiliser. Ash provides a rapid supply of phosphorus; however burning organic material also includes a loss of other nutrients and thus has severe long-term consequences.

Human faeces and urine: Human faeces and urine can also be used as an organic fertiliser. Using human faeces in agricultural production does demand special attention to hygiene and sanitation, however, and requires an additional treatment stage.

Nitrogen fixation

Nitrogen fixation is the process by which nitrogen is naturally added to the soil. We distinguish between nitrogen-fixing **soil bacteria**, which fix nitrogen from the air directly to the soil, and nitrogen-fixing bacteria in legume root nodules. These symbiotic bacteria are called rhizobia and fix nitrogen from the air to the root nodules. When the plant dies, the fixed nitrogen is released into the soil, and can then be taken up by plants.
A cropping system that includes legumes is therefore advantageous in terms of nitrogen supply. Legumes can be incorporated into the cropping system as intercrops, relay crops, improved fallow or as part of an agroforestry system (leguminous trees). Legumes integrated into cropping systems for their ability to fix nitrogen are referred to as green manures (see *AGR2B Sustainable Soil Management*).

Further reading and references

- FibL, 2011: African Organic Training Manual. Module 2: Soil Fertility Management. Available at: http://www.organic-africa.net/1311.html?&L=0
- Forster, D., 2001: Compost Production: Ways to Improve. Rural Advisory and Development Centre RADC, Jalal Abad Oblast, Kyrgyzstan.
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This publication has been made possible through financial support of Swiss Agency for Development and Cooperation SDC. The content, however, is the sole responsibility of HELVETAS Swiss Intercooperation.

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