Briefing Note

Resource-Saving Fertiliser Use

Background

World population growth and changing consumption patterns, along with limited capacity to expand arable land and pasture, require the intensification of agriculture. There is much potential for such intensification in the developing countries: the soils are often nutrient-poor as a result of both natural conditions (climate, geology) and human activity, while at the same time use of external inputs is limited. One way of improving land productivity is to provide better plant nutrition, for which both organic and inorganic fertilisers are available options.

Organic fertilisers are derived from waste matter of plant, animal or human origin. They can be applied to agricultural land either directly or in the form of compost. Harvest residues which remain on the arable land as well as green manure can also increase the nutrient content of the soil. The use of organic fertilisers depends on the adequate production and availability of biomass. The advantage of organic fertilisers is that most are available either free of charge or at low cost. They help nutrients to remain in the agricultural production system. However, the gathering, storage and application of organic materials are usually labour-intensive tasks, requiring the availability of sufficient workers. Also, competition can arise over the use of organic substances (for fodder or fuel) and land (where green manure is used).

Inorganic fertilisers are manufactured sometimes from synthetic and sometimes from natural resources. They are faster-acting than organic fertilisers as a large proportion of the nutrients is directly available to the plants. As they require limited manual labour and are in some cases quite affordable, inorganic fertilisers are enjoying increasing popularity around the world compared to more labour-intensive organic fertilisers. Partially as a result of infrastructure gaps, however, inorganic fertiliser use in many developing countries is still uneconomic. For instance, transport costs account for 32 per cent of the price of fertiliser price in Mali, almost three times as much as in Thailand (11 per cent). The costs of nitrogen (N) fertilisers in particular depend heavily on the price of oil and can fluctuate accordingly. At the same time the resources needed to manufacture some inorganic fertilisers are limited; current estimates show that sources of phosphate will be depleted in about 350 years and of potassium in 600 years (Reller & Graedel 2009). As the most significant deposits are found in just a few places around the world (e. g. potassium is produced in only 12 countries), they are susceptible to sharp price fluctuations, e. g. for political reasons. Prices also change as result of the balance of supply and demand.

There is international agreement that nutrient levels in the soils of developing countries need to be raised. Inorganic fertiliser use is in many cases too low. For instance, sub-Saharan Africa uses an average of 9 kg/ha, Latin America 73 kg/ha, East and Southeast Asia 135 kg/ha: as a comparison, industrialised nations use more than 206 kg/ha (CAADP, 2003). Both organic and inorganic fertilisers have a beneficial effect on soil properties and/or **plant nutri-**

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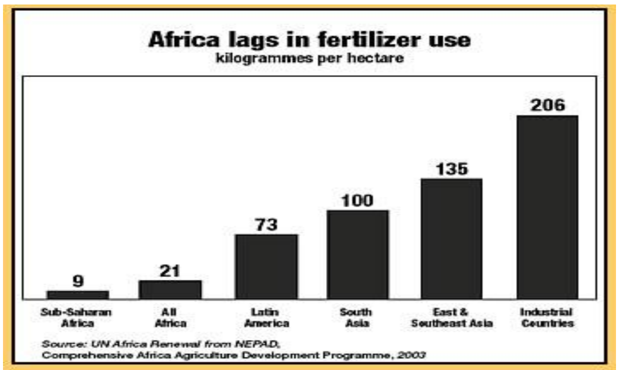
tion. Apart from providing nutrients, organic substances improve soil structure, reduce erosion, help to retain moisture and increase the soil's nutrient storage capacity. Because of the ready availability of nutrients, inorganic fertilisers are well-suited to a targeted plant nutrition plan. However, their use (particularly N-fertilisers) causes soil acidification, which makes liming necessary.

Although the use of fertiliser (both organic and inorganic) is predominantly beneficial in terms of plant nutrition, the incorrect use of inorganic fertilisers – especially those containing nitrogen (N) – can impact negatively on the environment (water, climate). When applied in excess, nutrients are washed out by rainfall into **surface and groundwater**, contaminating these with potentially harmful substances (e. g. nitrates, phosphates). It is estimated that half the nitrogen from inorganic fertilisers is currently being lost. With respect to organic fertilisation, it is difficult to make the nutrients available at precisely the right time because they are released only gradually; here too leaching does occur.

With respect to **climate,** the use of inorganic fertilisers is particularly risky. Increased application of nitrogen fertilisers and a lack of oxygen in the soil help to release concentrations of nitrous oxide (N_2O), a greenhouse gas some 300 times more potent than CO_2 (IPCC, WWF). Also of concern is the large amount of energy required to manufacture inorganic fertiliser, especially those containing nitrogen (Haber-Bosch process). Greenhouse gases (especially ammonia) can also escape from organic fertilisers during storage and application. On the other hand, organic fertilisers store carbon in the soil (carbon sequestration). Soils currently store 1,500 gigatonnes of carbon, making them the second-largest carbon reservoir in the world, following the oceans.



Source: UN Africa Renewal from NEPAD, Comprehensive African Agriculture Development Programme, 2003

GIZ's position

In view of the rising demand for agricultural products and the need for sustainable resource use, GIZ recommends growing crops which are suited to the specific location and using both organic and inorganic fertilisers. The aim is to use an economic approach to improve plant nutrition in developing countries and at the same time to avoid any negative impact on the environment. This will help to develop agriculture and ensure food security. GIZ therefore supports the following:

1. **Organic and inorganic fertiliser use should be on an 'as needed' basis and environmentally sound.**

The potentially negative impact of fertilisation on the environment calls for efficient fertiliser use which burdens the soil, water and climate as little as possible. All fertilisation strategies should be based on the use of organic fertilisers. The aim is to achieve as far as possible a closed nutrient cycle on the individual farm and/or in the particular region (nutrient recycling). Steps must be taken to avoid the over-application of fertilisers and resultant runoff of nutrients which can occur when concentrated amounts are applied over limited areas. Organic substances are quickly depleted, especially in tropical soils. Depending on the given natural conditions, best practices (such as planting seeds in Zai pits, growing catch crops, a sensible crop rotation system, intercropping or reduced tillage) can retain or even improve the properties of the soil. With climate change in particular in mind, this will increase soil carbon stocks and reduce emissions of climate-damaging gases. Nutrient loss should be if possible minimised through year-round plant cover.

To complement organic fertiliser use, inorganic fertilisers should be used in accordance with the actual needs of the plants. This will replace the specific nutrients in the system which are removed when crops are harvested and which cannot be replaced by organic fertilisers or green manure. Nutrient-poor soils in particular need inorganic fertilisers to achieve significant yield increases, because they produce too little biomass for organic fertilisation. GIZ supports the target-oriented and correct use of inorganic fertilisers. Target-oriented and correct means that there should be no over-application and that no effort should be made to build soil fertility to a predefined general level. For reasons of cost and the environment the objective cannot be to attain a worldwide soil nutrient level equivalent to that of the industrialised countries today. Rather, the need for fertilisation should be kept to a minimum by planting crops to suit the location and by increasing efficiency. Any irrigation must be adapted to the nutrient content of the water and soil in order to prevent salination. In view of the limited resources available, especially of phosphorus (P) and potassium (K), inorganic fertilisers should be used primarily to produce food.

2. Fertiliser strategies must be economical.

As most organic fertilisers do not have to be purchased, they can reduce farmers' dependency on fluctuating market prices for inorganic fertilisers. However, a great deal of manual labour is needed to gather, store and apply them: when this is included in the calculation inorganic fertilisers can in fact prove more affordable. Different fertilisation strategies may be economic for different locations. Where possible, the longer-term environmental costs should be included in any calculations of economic efficiency; these may indicate a need for state intervention (payment for environmental services, nitrogen tax, etc.). Expanding the infrastructure could make both organic and inorganic fertilisers more affordable in the developing countries.

3. Farmers and agricultural advisers must be systematically trained in fertiliser use.

Applying the right amount of fertiliser at the right time requires appropriate knowledge in order to avoid ecological damage and ensure efficiency. Especially in the case of inorganic fertilisers, incorrect quantities are frequently applied, sometimes without consideration of the nutrient needs of the crops. For example, many farmers are unaware that different quantities of fertiliser are required depending on the climate, natural nutrient content in the root zone, rooting depth and intensity, water and air balance, and growth stage of the crop. Furthermore, the main nutrients are not always the limiting factor. Where there is a zinc deficiency, for example, fertilisation with N and P will produce no additional yield but will simply be a waste of money. Even after fertilisation several factors influence the absorption of nutrients by the plant (e. g. activity of soil biota, physical and chemical properties of the soil). Each type of crop also has its own nutrient needs, which should be taken into account when seed is selected. Service providers and farmers must be qualified to determine the availability of nutrients or – even better – the nutrient needs of the soil and to assess the right time for fertilisation. They must also be trained in the use of up-to-date fertilisation methods. Any approaches which involve the wide distribution and marketing of 'cheap' inorganic fertilisers (e. g. urea), but not the provision of advice to farmers, should be rejected.

4. Temporary financial promotion of inorganic fertilisers should be considered in some cases.

In nutrient-poor and degraded locations it can make sense to provide financial support for the use of inorganic fertilisers. Promotion is usually worthwhile if the costs of subsidisation are lower than the long-term gains from increased productivity. Conditions and types of financial support are explored in more detail in the Briefing Note: 'Subsidising Agricultural Inputs'.

Action required

To ensure that 9 billion people have enough to eat in 2050 it is imperative to increase and optimise the use of organic and inorganic fertilisers in developing countries. For this reason the following action is required:

1. Fertilisation must be made more efficient through technical innovation.

Fertilisation must be more precise, and the need for fertilisers must be reduced (e. g. fertigation: the application of fertiliser through a sprinkler or drop irrigation system; slow-release fertilisers for less mobile nutrients). This also increases affordability, especially when considered in the light of rising prices for oil and commodities. Methods of ascertaining the amount of nutrient required and/or the plant nutrition status must be improved and adapted to the financial situation and knowledge of users, including those in developing countries. Methods of storing and using fertilisers, especially organic ones, need to be improved and adapted to local circumstances in order to increase their affordability and thus their attractiveness.

2. Fertiliser use must become more environmentally sound and climate-friendly.

To keep the need for fertilisers to a minimum, crop-growing must be appropriate to the location. Fertiliser use must become more precise, to prevent an oversupply of nutrients (eutrophication) as well as the acidification and salination of soil and water systems. Also, compensation liming should be carried out regularly as needed. Quality controls should be put in place to prevent heavy-metal contamination of soils. Targeted, needs-based fertilisation leads to a reduction in greenhouse gas emissions. The enhanced use of organic fertilisers is also important in terms of climate protection. Storing organic material in the soil (soil carbon sink) can decrease concentrations of greenhouse gases in the atmosphere. Potential ways of incorporating this environmental service into the trade in emissions certificates should be investigated. Emissions-reducing processes of storing and applying both organic and inorganic fertilisers should be developed and implemented. Integrated approaches combining the use of organic and inorganic fertilisers should make the plant nutrient recycling system as comprehensive as possible.

3. More advice on fertiliser use should be made available.

Many farmers already possess (traditional) knowledge on how to maintain soil fertility. It is important to retain this knowledge and at the same time expand awareness of modern technologies and the use of inorganic fertilisers. Local (state or private) advisory systems have an important part to

play here. To prevent the random use of cheap standard products, all fertilisers should be provided in packaging marked with usage instructions. Incentives should be created for businesses in the private sector to consider the environment when marketing their products and to set up appropriate advisory services.

4. **Access to high-quality inorganic fertilisers must be improved.**

In many cases inorganic fertilisers are unaffordable for small-scale farmers, although they are indispensable for yield increases of any significance. Access to such fertilisers should be simplified using microcredit systems and, in some cases, using subsidies (see Briefing Note: 'Subsidising Agricultural Inputs'). In addition, infrastructure and trading systems must be expanded so that farmers from inaccessible regions also gain access to affordable fertilisers.

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