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GHANA

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FERTILIZER USE AND MANAGEMENT

The need for fertilizer usage

The use of fertilizer in Africa is indispensable to alleviate nutrients constraints and therefore stands central in ISFM practices for improved crop production.

However, sufficient mineral fertilizers not available at the right times during the year. The shortage is mainly attributable to high transaction costs and insufficiencies throughout the production.

Little fertilizer available is often not the correct type required for various crops, and farmers are unfamiliar with its correct usage. Fertilizer adulteration in several African countries discourages fertilizer investment by farmers.

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FERTILIZER USE AND MANAGEMENT

Amount of fertilizer produced and used in Africa

165 million ha of land in the SSA is cultivated and about 1.38 million tons of fertilizer per year are applied to cultivated lands during 2002 giving an average fertilizer consumption of 8.3 kg/ha.

This represents only 2% of worldwide demand (64.5 million MT) and is the lowest rate of fertilizer use in the world.

The SSA produces only 13% of its fertilizers, with the remainder being imported.

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FERTILIZER USE AND MANAGEMENT

Amount of fertilizer produced and used in Africa

In Africa fertilizer consumption of less than 5 kg/ha occurs in 55% of 38 countries. Five of these are landlocked, suggesting that factors other than inland transportation are affecting their paucity of fertilizer use.

Eight of those nations are engaged in, or have recently emerged from conflict, indicating that political instability is an important condition for fertilizer use.

The country with the greatest fertilizer consumption in 2004 had undergone economic collapse and is unlikely to retain its position some years later.

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FERTILIZER USE AND MANAGEMENT

Amount of fertilizer produced and used in Africa

Only five nations consume greater than 25 kg of fertilizer per ha.

Four of these nations are in Southern Africa and they operate under the influence of South Africa's economy.

Most fields receive less than the recommended fertilizer rates because of high prices due to removal of subsidies and insufficient marketing systems.

Most fertilizers are being applied to cash crops on larger farms.

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FERTILIZER USE AND MANAGEMENT

Amount of fertilizer produced and used in Africa

Fertilizer prices are often high compared to crop commodity prices and cost per unit nutrient can vary greatly.

There are price increases over the past decade.

The use of organic fertilizers such as animal manure, green manure and household refuse is less popular among farmers.

Raising fertilizer use from the current values in Africa to the African Fertilizer Summit (2006) recommendation (50 kg/ha) is therefore a daunting challenge.

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FERTILIZER USE AND MANAGEMENT

Amount of fertilizer produced and used in Africa

There is evidence of combined use of inorganic and organic fertilizers. A case study in Kenya showed that poorer farmers appear to make use of inorganic and organic resources.

Many of these farmers were influenced by a fertilizer programme. Better timing and placement of fertilizers during topdressing appeared to be promising entry point for improved targeting of fertilizers. Besides, majority of the households belong to local farmer organizations that encourage investment and improvement of market access and fairness. Most of the NGOs recommend the use of higher rates of fertilizers.

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FERTILIZER USE AND MANAGEMENT

Factors affecting the adoption and use of fertilizers by small-scale farmers

- Limited information available on the links between fertilizer use and soil management
- Women's poorer access to farm inputs, capital and credit requires better understanding before gender could be factored into ISFM recommendations
- Lack of consistency in fertilizer use data for different regions and nations
- Role and effectiveness of extension services vary between countries
- Farmers' weak response to extension is not characterized

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FERTILIZER USE AND MANAGEMENT

Factors affecting the adoption and use of fertilizers by small-scale farmers

- The wiliness of small-scale farmers in the investment of fertilizer is not understood.
- Socio-cultural beliefs have strong influence on farming practices
- Knowledge of farmers on maximum yields on different fields: could be used to set the maximum amounts of fertilizer to apply to each field type.
- Use of correct type of fertilizer is of paramount importance for efficient utilization.

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FERTILIZER USE AND MANAGEMENT

Availability, quality and utilization of mineral fertilizers

There is lack of agronomic information for the formulation of appropriate nutrient compositions by fertilizer manufactures and distributors. Crop nutrient requirements depend on the environment and change with time and intensifying crop production.

Ineffective linkages with experimental stations and lack of regular farmer surveys hamper this information.

Fertilizer quality loss due to poor storage and adulteration occurring during packaging are other constraints that discourage farmer investments in fertilizer.

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FERTILIZER USE AND MANAGEMENT

Availability, quality and utilization of mineral fertilizers

A major problem for effective utilization of fertilizer and ISFM practices in Africa has been inability to deliver appropriate recommendations (usually generalized) and accompanying inputs in the right form to smallholders.

There is the need to base guidelines for fertilizer use on the principles of ISFM, targeting dissemination programmes to the specific crop production problems faced by farmers.

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FERTILIZER USE AND MANAGEMENT

Steps required for sufficient availability of correct type of fertilizers to smallholders

- Better diagnosis of soil and plant constraints by rural planners
- Use of fertilizers must become nested within ISFM advice targeted to farmer's agro-ecological setting, production strategy and socio-economic conditions.
- Directing human and institutional capabilities toward finding solutions to soil constraints that make best use of farmers' limited resources and that balance the benefits of redirecting cash investment and labour.

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FERTILIZER USE AND MANAGEMENT

ISFM guidelines for integrated fertilizer use

- Optimize micro-dosing and top-dressing of nitrogen fertilizer and conduct campaigns to increase their use and effectiveness. Applying fertilizers in micro-dose amounts permits more precise and better time fertilizer placement, particularly in conjunction with water harvesting.
- Match different water conservation measures to specific dry land and soil conditions. Making good use of existing technologies to improve water availability and organic matter content. Technologies include water harvesting using *zai* planting pits, half-moon catchments, stone bunds and tied ridging.

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FERTILIZER USE AND MANAGEMENT

ISFM guidelines for integrated fertilizer use

- Better manage soil organic matter through ISFM. Approaches are (1) greater root biomass production (2) increasing crop residues for mulching, weed suppression and improved water infiltration and storage (3) improved fallow
- Promote legume-based ISFM practice for striga, pest, and disease management. Besides addition of N by legumes in cropping systems also controls striga, pests and diseases.
- Target returns per unit input not per unit area.

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FERTILIZER USE AND MANAGEMENT

Use of organic inputs

- They consist of livestock manures, crop residues, woodland litter, household organic refuse, composted plant materials, and any plant biomass. These can be obtained from the farm. In the urban areas industrial organic waste and sewage sludge can be obtained
- They have multiple functions in the soil ranging from the influence on nutrient availability to modification of the soil environment in which plants grow.

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FERTILIZER USE AND MANAGEMENT

Use of organic inputs

- Organic inputs derived from plant remains provide most of the essential nutrients but usually insufficient quantities
- They serve as energy source for microbes because they are rich in carbon
- They contribute soil organic matter (backbone of soil fertility) when they decompose
- They form complexes with soil minerals

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FERTILIZER USE AND MANAGEMENT

Organic inputs as source of nutrients

- The role of organic materials as nutrient sources is underpinned by the microbial decomposition of these materials into inorganic constituents
- The process involves the conversion of the nutrient elements in the unavailable organic form to the inorganic form; a process called mineralization
- It is during various stages of decomposition that SOM is formed. The amounts of SOM formed and quantities of nutrients released depend on the amounts and frequency of organic inputs applied to the soil

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FERTILIZER USE AND MANAGEMENT

Organic inputs as source of nutrients

SOM is a significant source of N, P and S in crop production. The quantities of these nutrients from SOM depends on the following:

- Quantity and frequency with which organic inputs are added to soil
- Quality of the organic resources
- The effect of soil type (e.g. texture & mineralogy) and environmental conditions (e.g. moisture & temperature)

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FERTILIZER USE AND MANAGEMENT

The role of SOM in soil fertility

- Supply of available forms of C to stimulate microbial activity and to contribute to SOM formation
- Regulation of rates and amounts of nutrients released for plant uptake
- Improvement of soil water infiltration rate and soil water holding capacity
- Increasing cation exchange capacity, or the soil's capacity to store nutrients
- Enhancing soil aggregation, improving soil structure, reducing bulk density and promoting good aeration.
- Binding of toxic elements in soils and minimizing impacts on growing plants.

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FERTILIZER USE AND MANAGEMENT

Advantages of organic inputs as fertilizers

- Provides essential plant nutrients
- Contribute directly towards the build-up of SOM and its associated benefits
- Nutrients are released slowly from organic resources compared with mineral fertilizers, hence, nutrient losses are therefore small.
- Organic inputs modify the soil environment, directly improving soil biological properties and often enhancing soil productivity.

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FERTILIZER USE AND MANAGEMENT

Disadvantages of organic inputs as fertilizers

- Major disadvantage is the relatively low nutrient contents, hence, they are needed in large quantities to meet the demand of crops
- Farmers usually give priority to feeding some organic inputs (crop residues) to their livestock
- On-farm handling of organic inputs requires substantial investments in labour for transport and field application
- Organic inputs can increase the activity of insect pests and other harmful soil organisms which will attract extra cost to control diseases and pests.

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FERTILIZER USE AND MANAGEMENT

Fertilizer materials: **Nitrogen fertilizers**

- The most common N fertilizer is urea but compound NPKs are often used as a source of N for basal fertilizer application
- Other N fertilizers include anhydrous ammonia, calcium ammonium nitrate, ammonium nitrate and ammonium sulphate
- Nitrate (NO_3^-) and ammonium (NH_4^+) are the major N sources released from N fertilizers and available for plant uptake.
- Nitrate is easily leached out of the root zone

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FERTILIZER USE AND MANAGEMENT

Fertilizer materials: P fertilizers

- All P fertilizers are derived from mineral phosphate ore rocks of either sedimentary or igneous origin
- Phosphate rock (PR) of sedimentary origin is generally more reactive than the igneous origin
- PRs are highly variable in both P content and P availability

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FERTILIZER USE AND MANAGEMENT

Fertilizer materials: **Drawbacks to the use of PR for direct application**

- PRs have relatively low P content compared with manufactured ones, which increases cost of transport and labour for application
- Difficult to handle and apply because they must be made in the powder form (except Minjingu PR, available in a pelleted form)
- The soil must be sufficiently acid (pH < 5.5) to solubilize the PR
- The rate of release of P from PR may be too slow to satisfy crop demand, hence, good for P source for tree crops and long term purpose

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FERTILIZER USE AND MANAGEMENT

Fertilizer materials: K fertilizers

- All K fertilizers are manufactured from very large deposits of water-soluble K minerals that have accumulated as a result of the evaporation of shallow seas or natural lakes over geological time.
- The most widely used K salts in agriculture to produce K fertilizers are double salts that also contain significant quantities of Mg and S.
- The most commonly available K fertilizers are KCl and K_2SO_4.
- K_2SO_4 is usually more costly than KCl but is more suitable for use on high-value crops where sugar content is important (pinneapples, sugar cane, fruit crops).

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FERTILIZER USE AND MANAGEMENT

Fertilizer materials: Multinutrient fertilizers

- **Complex multinutrient fertilizers (CMFs):** Are designed for use in horticulture where high-grade fertilizers are required. Costly to use in small-scale farming in SSA

- **Compound fertilizers(CFs):** Are manufactured by mixing straight fertilizers to produce granulated products. They are less costly produced than CMFs.

- **Bulk blend fertilizers (BBFs)**: Are prepared by physically mixing different fertilizers to achieve a specific nutrient composition.

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FERTILIZER USE AND MANAGEMENT

Soil amendments

Lime:

•Liming materials are used to increase pH in acidic soils. In some very acidic soils, Al and Mn toxicity is prevented and P and Mb availability is increased following lime application. Liming also increases Ca and Mg contents that play important role in improvement of soil physical properties. It also improves some microbiological processes such as nitrification and N_2 fixation.

•Commonly used liming materials are limestone ($CaCO_3$), calcium oxide (CaO), calcium hydroxide ($Ca(OH)_2$), dolomite ($CaMg(CO_3)_2$).

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FERTILIZER USE AND MANAGEMENT

Soil amendments

Gypsum:

- Gypsum ($CaSO_4.2H_2O$) is a mineral that occurs as a natural deposit in semi-arid and arid regions.
- It is used to rehabilitate sodic soils that have, by definition, a very high percentage of sodium on the cation exchange complex.
- It is also used to correct Ca deficiency in crops.

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FERTILIZER USE AND MANAGEMENT

Fertilizer use efficiency (FUE)

- **Agronomic efficiency (AE):** It is the proportion of nutrients that are taken up by a crop to produce grain.

- **Recovery fraction (RF)**: The proportion of nutrient taken up by a crop when a kilogram of such nutrient is applied.

- **Internal use efficiency (IUE)**: This is the additional yield obtained for each additional kilogram of nutrient is taken up by a crop.

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FERTILIZER USE AND MANAGEMENT

The '4Rs' for effective fertilizer use

- Right fertilizer product
- Right fertilizer rate
- Right time for fertilizer application
- Right placement of basal fertilizer (broadcasting, banding, spot application, deep placement).

A fifth 'right' for fertilizer use in SSA

- Consider the 'opportunity cost' of fertilizer and make sure that scarce fertilizer resources are delivered to the part of the cropping system that delivers the maximum economic benefit to the farmer.

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FERTILIZER USE AND MANAGEMENT

Fertilizer use and the environment

- Care must be taken to avoid the negative effects that accompany excessive fertilizer; e.g. water pollution and eutrophication. Such negative effects can be avoided by applying fertilizer best management practices to use fertilizers effectively.
- Over-use of mineral fertilizers is not major concern in SSA. The most significant environmental issue is related to soil fertility and soil degradation, due to insufficient use of mineral fertilizer and organic inputs.

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FERTILIZER USE AND MANAGEMENT

Minimizing losses of added nutrients

- Controlling water and wind erosion
- Minimizing or reducing leaching
- Controlling or minimizing gaseous losses through denitrification and volatilization.
- Crop residue managements

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FERTILIZER USE AND MANAGEMENT

Use of improved germplasm

- Genetic yield potential (genetically stable with high potential yield)
- Pest and disease resistance
- Nutrient use efficiency (higher agronomic efficiency compared with 'local varieties'.
- Availability and quality of planting materials
- Finding and selecting improved germplasm (have information on the variety, assess for desirable traits, and tested in the intended environment)

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FERTILIZER USE AND MANAGEMENT

Harnessing the benefits of N_2-fixing legumes

- Components of a successful N_2-fixing symbiosis (legume genotype, rhizobium strains used for inoculation or found in the soil, and the environment i.e. pH, temperature, etc.)
- The need for inoculation with rhizobia
- Legume contribution to soil fertility (grain legumes 300 kgN/ha in a season, tree legumes 600 kgN/ha in a season)

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FERTILIZER USE AND MANAGEMENT

Use of arbuscular mycorrhizal fungi(AMF) inoculants

- Commercially prepared AMF inoculants are available on the market
- They enhance nutrient and water uptake, reduce pest and disease damage, and improve soil structure
- AMF inoculation works best in low fertile soils, especially containing low P because AMF hyphae improve root access to P and other nutrients such as Zn that are beyond the depletion zone surrounding the crop’s roots.

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FERTILIZER USE AND MANAGEMENT

Other soil fertility management practices

- Soil acidity correction
- Correction of micronutrient deficiencies
- Breaking hardpans
- Water harvesting
- Erosion control
- Land preparation
- Planting date

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FERTILIZER USE AND MANAGEMENT

Other soil fertility management practices

- Spacing
- Planting practices
- Weeding
- Pest and disease management
- Intercropping

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FERTILIZER USE AND MANAGEMENT

Conservation agriculture (CA)

Conservation agriculture is underpinned by three basic principles:

- Soil disturbance is minimized by reduced or zero-tillage
- The soil is kept covered with organic materials
- Crop rotations/associations are used

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FERTILIZER USE AND MANAGEMENT

Organic agriculture

- Organic agriculture, low-input agriculture and evergreen agriculture emphasize on organic resources to provide nutrients to sustain soil fertility and produce economic yields of crops.
- ISFM advocates the use of mineral fertilizers in combination with organic resources because research has shown that their combined use provide greater benefits than the sole use of their organic resources or mineral fertilizer.

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FERTILIZER USE AND MANAGEMENT

Adaptiveness of interventions

The adoption of all practices is governed by the following:

- The fit of technical performance (P) at the field scale
- Opportunities and trade-offs (T) at the farm and village scale, and
- Farming systems context (C) at the regional scale
- Interactions between P, T and C (PTC)

Adoption = Performance + Trade-offs + Context + PTC

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FERTILIZER USE AND MANAGEMENT

Economics

- Soil capital is the farmer's most important asset which the farmer spends more other inputs to maintain his/her output if the soil capital declines.
- The farmer combines soil capital with variable inputs like labour, seeds, fertilizer and organic inputs in order to produce output of a particular crop for food, income or raw material for other production processes.
- Properties of soil capital include nutrient content, organic matter, moisture and living organisms. It is therefore important maintaining these properties.
- Without ISFM, soil capital in the form of nutrients, organic matter, etc. declines and maintenance of soil capital can yield greater profit.

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Material based mainly in:

Fairhurst, T. (ed.) (2012) Handbook for Integrated Soil Fertility Management. Africa Soil Health Consortium, Nairobi. Accessible from this link

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EDULINK

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