



Food and Agriculture
Organization of the
United Nations



Global Soil Doctors Programme

A farmer-to-farmer training programme

Fertilizer

TRAINING AID MODULES

TRAINING AID



TITLE	Types of fertilizers
PURPOSE	Explaining to farmers the different kinds of existing fertilizers
TRAINING METHOD	This training can be given as a lecture, as a discussion or through demonstration(s).

MAIN POINTS	NOTES FOR THE TRAINER
<p>1. Organic fertilizers, derived from living organisms:</p> <ol style="list-style-type: none"> a. Manure b. Green manure c. Compost and crop residues d. Municipal waste <p>2. Bio-fertilizers:</p> <ol style="list-style-type: none"> a. Rizobhium b. Blue green algae c. Azolla d. Others <p>3. Inorganic (chemical, mineral, organic-synthetic)</p> <p>These are fertilizers derived from non-living organisms. They can either be single/ straight fertilizers or compound/ complex fertilizers.</p> <p>Some definitions to be used:</p> <p>Fertilizer (FAO, 2019): refers to a chemical or natural substance or material that is used to provide nutrients to plants, usually via application to the soil, but also to foliage or through water in rice systems, fertigation or hydroponics or aquaculture operations. Thus, multiple nutrient types and sources are considered and include: chemical and mineral fertilizers; organic fertilizers such as livestock manures and composts; and sources of recycled nutrients such as wastewater, sewage sludge, digestates and other processed wastes.</p> <p>Inorganic fertilizer (FAO, 2019): a nutrient-rich fertilizer produced industrially by chemical processes, mineral extraction or by mechanical grinding. Note that though urea is technically an organic material, it is referred to within this Fertilizer Code as an inorganic fertilizer.</p> <p>Organic fertilizer (FAO, 2019): a carbon-rich fertilizer derived from organic materials, including treated or untreated livestock manures, compost, vermicompost, sewage sludge and other organic materials or mixed materials used to supply nutrients</p>	<p>Discuss with farmers the local use of fertilizers.</p> <p>Mention the most common fertilizers.</p> <p>Show farmers different types of fertilizers (show samples).</p> <p>Discuss the different roles of fertilizers.</p> <p>Discuss the roles and differences between organic fertilizers, bio-fertilizers, mineral fertilizers or a combination of them.</p> <p>Discuss Integrated Soil Fertility Management (ISFM)</p>

References: FAO. 2019. *International Code of Conduct for the Sustainable Use and Management of Fertilizers*. Rome. (<http://www.fao.org/3/ca5253en/ca5253en.pdf>)

TITLE	Organic fertilizers
PURPOSE	Explaining what organic fertilizers are and providing farmers with basic knowledge on their use.
TRAINING METHOD	This training can be given as a lecture, as a discussion or through field visits.

MAIN POINTS	NOTES FOR THE TRAINER
<p>Animal manure (FAO, 2019): materials from livestock production operations used for fertilization purposes, including manure, urine, slurry, straw and other bedding materials.</p> <p>Compost (FAO, 2019): a mixture of decaying organic matter, as from leaves and manure, used to improve soil structure through the addition of carbon and provide nutrients.</p> <p>Green manure (FAO, 2019): plants that are grown in order to provide soil cover and to improve the physical, chemical, and biological characteristics of soil.</p> <p>Sewage sludge (FAO, 2019): solid materials removed from the wastewater stream originating from a public sewage system. May or may not be subject to additional treatment to reduce volume, pathogens, odors, and nutrient content.</p> <p>Crop residues: Residues from previous crop or other crops incorporated in the soil</p> <p>Mulch: Plant material that is kept on the soil (added to the soil) for soil or water conservation purposes.</p>	<p>It is important to emphasize that manure needs appropriate storage and quick incorporation into the soil (prior to sowing or planting).</p> <p>Explain the role of organic matter in the soil, C:N ratio etc. Effect of soil organic matter on soil properties (can use some of the posters for this, by demonstrating the link between soil organic matter and all the other soil properties)</p> <p>Some to mention: Soil fertility Soil erosion Water quality Soil moisture</p> <p>Poultry manure can be mentioned as an example of high content of N and P.</p> <p>Concentration of nutrients in organic fertilizers depends on: storage method/ kind of animal/ feed used/ crop material used.</p> <p>Why should they use organic fertilizers?</p> <ul style="list-style-type: none"> • Increase organic matter • Improve soil structure • Improve soil fertility • Increase nutrient efficiency • Balance the use of fertilizers • Inexpensive when they are available <p>Green manure: usually N-fixing crops are used. Give local examples. Show pictures or examples/ farm visits.</p>

References: FAO. 2019. *International Code of Conduct for the Sustainable Use and Management of Fertilizers*. Rome. (<http://www.fao.org/3/ca5253en/ca5253en.pdf>)

TITLE	Biofertilizers
PURPOSE	Explaining what bio-fertilizers fertilizers are and providing farmers with basic knowledge on their use.
TRAINING METHOD	This training can be given as a lecture, as a discussion or through field visits.

MAIN POINTS	NOTES FOR THE TRAINER
<p>Biofertilizers (FAO, 2019): a broad term used for products containing living or dormant micro-organisms such as bacteria, fungi, actinomycetes and algae, alone or in combination, which on application help in fixing atmospheric nitrogen or solubilize/mobilize soil nutrients.</p> <p>Some examples that can be covered:</p> <ol style="list-style-type: none"> 1. Rhizobium (N fixation): <ol style="list-style-type: none"> a. Rhizobium production and storage b. Inoculation techniques c. Identification of nodulation (show/demonstrate) d. Effect on N fertilization 2. Blue Green Algae (N fixation – mostly in rice production): <ol style="list-style-type: none"> a. Production and storage b. Application practice c. Effect on N fertilization 3. Others: <ol style="list-style-type: none"> a. Not commercially utilized but existing in most soils b. P-solubilizing microorganisms (Vesicular Arbuscular Mycorrhizae or VAM) 	<p>Explain what biofertilizers are and give an example of biofertilizers used at the local level.</p> <p>Show images of different types of biofertilizers</p> <p>If available in the region, schedule a visit to a site that uses biofertilizers</p> <p>Discuss:</p> <ul style="list-style-type: none"> • Reasons for use of biofertilizers • Local practices • Role of legumes <p>Effect on subsequent crops</p> <p>Economics in the use of biofertilizers</p>

References: FAO. 2019. *International Code of Conduct for the Sustainable Use and Management of Fertilizers*. Rome. (<http://www.fao.org/3/ca5253en/ca5253en.pdf>)

TITLE	Mineral/ inorganic fertilizers
PURPOSE	Explaining what mineral/ inorganic fertilizers are and their nutrient content
TRAINING METHOD	This training can be given as a lecture or as a discussion

MAIN POINTS	NOTES FOR THE TRAINER
<p>See the definition in the “Types of fertilizers” training aid.</p> <p>1. Single fertilizers Contain ONE nutrient: N, P, K, S etc.</p> <ul style="list-style-type: none"> • Urea (46-0-0) • Triple superphosphate (0-46-0) • Potassium chloride (0-0-60) <p>2. Compound (mixed) fertilizers: NPK fertilizers, they usually contain 2 or 3 macronutrients.</p> <ul style="list-style-type: none"> • Diammonium phosphate (18-46-0) • Triple 15 (15-15-15) <p>3. Additional nutrients Some compound fertilizers also contain secondary and/or micronutrients</p> <p>Macronutrients: N, P and K Secondary nutrients: Ca, Mg and S Micronutrients or trace minerals: Zn, Cu, Fe, Mn, B, Mo, Cl, Ni.</p> <p>The nutrient content should ALWAYS be shown on the fertilizer bag. Discuss labelling and nutrient content.</p>	<p>List locally available brands and grades.</p> <p>Present/ show samples.</p> <p>Explain the differences between the different types of nutrients (macro, secondary and micronutrients).</p> <p>Have a discussion/ questioning session to ensure that all participants understand the principles behind nutrient contents.</p> <p>This training should go together with the one about the fertilizer specifications and legislation.</p>

References: FAO. 2019. *International Code of Conduct for the Sustainable Use and Management of Fertilizers*. Rome. (<http://www.fao.org/3/ca5253en/ca5253en.pdf>)

TITLE	Fertilizer specifications and legislation
PURPOSE	Provide knowledge about fertilizer labelling and legislation
TRAINING METHOD	This training can be given as a lecture or as a discussion

MAIN POINTS	NOTES FOR THE TRAINER
<p>Explain the following responsibilities for fertilizer users:</p> <ul style="list-style-type: none"> *When and where possible, obtain fertilizers from officially recognized dealers and that are properly and clearly labelled. * Follow appropriate guidelines and instructions regarding the safe handling and use of fertilizers according to the labelling and other technical materials and advice from suitably recognized and qualified individuals providing the product. *Recycle and/or dispose of fertilizer containers as and where appropriate. *Contact the relevant authorities when the quality of the product does not correspond to the claims made on the label, or when they experience issues with the product. <p>Fertilizer specifications:</p> <ul style="list-style-type: none"> • Nutrient content (see training on nutrient content) • Chemical composition • Moisture content • Particle size range <p>National fertilizer legislation:</p> <ul style="list-style-type: none"> • Import and local production • Grades and blending • Distribution • Fake fertilizers • Others (see Fertilizer Code for relevant articles) <p>Penalties for deviation from stated values and conditions – if relevant</p>	<p>Go over the responsibility of all fertilizer users regarding fertilizer specifications and legislation.</p> <p>Have a group discussion to identify problem areas</p> <p>Include all fertilizers as per the definition above (all plant nutrients) as part of this training</p> <p>Explain and discuss the quality of fertilizers</p> <p>Show fertilizer bags and samples (Explain that re-bagged fertilizers should always follow the specifications as well)</p> <p>Talk about carriers and fillers etc.</p> <p>Mention any national or local law/ legislation related to fertilizers.</p> <p>Distribute and/or explain any fertilizer act, rules, regulations, Code of Conduct (such as the Fertilizer Code).</p>

References: FAO. 2019. *International Code of Conduct for the Sustainable Use and Management of Fertilizers*. Rome. (<http://www.fao.org/3/ca5253en/ca5253en.pdf>)

TITLE	Fertilizer specifications and legislation
PURPOSE	Provide knowledge about fertilizer labelling and legislation
TRAINING METHOD	This training can be given as a lecture or as a discussion

MAIN POINTS

Explain some responsibilities that fertilizer users have:

*Purchase or apply fertilizers that have evidence of appropriate and proper testing for composition, quality, and purity.

*Follow appropriate guidelines and regulations, as well as application and cumulative application limits for nutrients and maximum allowable concentrations for contaminants – provide them with these guidelines and regulations, and explain what they mean.

*Inform the relevant authorities when suspecting an issue with a fertilizer product – let them know who the relevant authorities are and provide them with their contact information

Soil contamination*: occurs when the concentration of a chemical or substance is higher than would occur naturally but is not necessarily causing harm.

Soil pollution*: refers to the presence of a chemical or substance out of place and/or present at higher than normal concentration that has adverse effects on non-target organisms.

Contaminant*: substance contained within fertilizers that is not a plant nutrient. May include, but is not limited to, heavy metals, pathogens and industrial by-products.

NOTES FOR THE TRAINER

Explain the issue of fertilizer composition, quality and purity.

Mention some of the issues that participants can have with fertilizers.

If there are any local examples related to this training, share them.

Mention issues of contamination, pollution and health issues associated with fertilizers. The “Soil Pollution” posters can be used for this exercise.

The International Code of Conduct for the Sustainable Use and Management of Fertilizers (FAO, 2019) tackles soil contamination, soil pollution and contaminants within fertilizers. Refer to the Fertilizer Code regarding how to farmers can tackle these issues.

TITLE	Fertilizer recommendations (inorganic)
PURPOSE	Background information on inorganic fertilizer recommendations and the factors that affect these recommendations
TRAINING METHOD	This training can be given as a lecture, discussion, exercises.

MAIN POINTS	NOTES FOR THE TRAINER
<p>Factors linked to fertilizer recommendations:</p> <ul style="list-style-type: none"> • Cropping system • Nutrient status and soil fertility • Other inputs such as water • Soil and plant analysis • Expected yield • Availability of suitable grades, organic and/or biofertilizers • Price of crop and fertilizers • Awareness of limiting factors • Farm management • Local demonstrations and trials <p>Fertilizer recommendations should be targeting both the crop to be grown as well as the cropping system!</p> <p>Standard NPK ratios versus crop and field specific demand versus other systems such as traditional practice.</p> <p>Proper input recommendations are based on many factors such as climate, soil fertility, farming system and farm management. The importance of each factor can change over the years and with the farmers.</p> <p>Efficient use of some nutrients: some key points to remember if recommendations are given.</p> <p>Nitrogen (N):</p> <ul style="list-style-type: none"> • Use soil analysis reports • Apply N in splits • Give controlled irrigations • Mix topdressed N into the soil • Correct any other nutrient deficiencies • Account for other nutrient sources (manures) and biological N fixation 	<p>Discuss: Misuse, overuse and underuse of fertilizers. The International Code of Conduct for the Sustainable Use and Management of Fertilizers can be used with locally relevant articles are shared and discussed with the participants.</p> <p>Discuss: Nutrient replacement strategy Soil as buffer</p> <p>The recommendation factors determining the correct nutrient factors include all of the ones on the left, except other inputs (water), expected yield, and awareness of limiting factors.</p> <p>The recommendation factors determining the correct dosage include all of the ones mentioned on the left.</p> <p>Recommendations of grades (ratios) and doses for the same crop can change, due to changes in soil fertility, high yielding varieties, supply of other inputs, improved farm management, and fertilizer and crop prices.</p> <p>Discuss: Use of straight fertilizers versus compound fertilizers.</p> <p>Have a discussion/ questioning session to ensure that all participants understand the principles behind nutrient contents.</p> <p>If available, discuss results from local trials and demonstrations.</p>

References: FAO. 2019. *International Code of Conduct for the Sustainable Use and Management of Fertilizers*. Rome. (<http://www.fao.org/3/ca5253en/ca5253en.pdf>)

TITLE	Fertilizer Recommendations (inorganic)
PURPOSE	Background information on inorganic fertilizer recommendations and the factors that affect these recommendations
TRAINING METHOD	This training can be given as a lecture, discussion, exercises.

MAIN POINTS	NOTES FOR THE TRAINER
<p>Potash (K₂O):</p> <ul style="list-style-type: none"> • Use soil test reports • Base K-doses on soil texture • Match K with N • Split K in sandy/ high rainfall areas • Account for other sources (manure) • Correct any other nutrient deficiencies <p>Sulphur (S):</p> <ul style="list-style-type: none"> • Use soil and plant analysis reports • Watch for deficiencies in light soils • Some crops need more S than others: pulses, oilseeds, crucifers. • Account for S in irrigation water • Correct any other nutrient deficiencies <p>Zinc (Zn):</p> <ul style="list-style-type: none"> • Know Zn status of soil/ use soil test reports • Apply Zn on rotation basis • Favour basal soil application • Safeguard against P-Zn interactions (high levels of P render Zn unavailable for plant uptake) 	

References: FAO. 2019. *International Code of Conduct for the Sustainable Use and Management of Fertilizers*. Rome. (<http://www.fao.org/3/ca5253en/ca5253en.pdf>)

TITLE	Application methods (for mineral fertilizers)
PURPOSE	Explaining the most commonly used fertilizer application methods
TRAINING METHOD	This training can be given as a lecture, discussion or as a field visit showcasing these methods.

MAIN POINTS	NOTES FOR THE TRAINER
<ol style="list-style-type: none"> 1. Broadcasting Uniform distribution and preferably incorporated into the soil before or after sowing/planting 2. Row or band placement Under or beside the seeds/ seedlings 3. Side dressing Placing in rows beside the plants (used for maize) 4. Top dressing Broadcasting after crop appearance 5. Foliar application N and micronutrient on standing crop 6. Fertigation *The application of a plant nutrient, soil amendment, or reclaimed water from food processing and wastewater treatment facilities with irrigation water. 7. Other 	<p>Discuss and give examples of:</p> <ul style="list-style-type: none"> • Loss of nitrogen to the environment; soil, water, air (volatilization, leaching, denitrification and run off) • Loss of P and K (through fixation and leaching) • Damage and stress on seeds and plants • Fertilizer grade and dose • Timing of application • Reasons for split application • Availability of fertilizers • Crop specific application techniques <p>4 R nutrient stewardship Integrated Soil Fertility Management</p> <p>Give some examples of local and recommended application methods</p>

References: FAO. 2019. *International Code of Conduct for the Sustainable Use and Management of Fertilizers*. Rome. (<http://www.fao.org/3/ca5253en/ca5253en.pdf>)

TITLE	Storage, handling and transport of inorganic fertilizers
PURPOSE	Providing knowledge on proper storage, handling and transport of inorganic fertilizers
TRAINING METHOD	This training can be given as a lecture, discussion, demonstrations or as a field visit showcasing these methods.

MAIN POINTS	NOTES FOR THE TRAINER
<p>1. Storage requirement</p> <ul style="list-style-type: none"> • Adequate size and hard floor • Clean and dry • Fertilizers are protected against any dust or dirt • Good ventilation • Away from the rain or from direct sun exposure • Fertilizers should be separated from any other products <p>2. Handling</p> <ul style="list-style-type: none"> • Section storage by grades • Maximum of 2 to 3 meter high for 50 kg bags • Separate stack from floor (on wooden pallets) • Stack bags criss-cross • Leave half a meter space around each stack • Prevent slippage • No hooks • If repacking or rebagging, appropriate bags should be used <p>3. Transport</p> <ul style="list-style-type: none"> • Proper placement on trucks • Cover against rain and sun 	<p>Fertilizers should be stored in good ventilated rooms, protected from sunlight and rain. Good separation between different grades and hard floor are needed, the fertilizers should be stored on top of wooden pallets to facilitate transport</p> <p>If fertilizers are placed outside, they should be protected by a cover</p> <p>Discuss good quality of fertilizers:</p> <ul style="list-style-type: none"> • Nutrient content • Moisture level (should be acceptable) • Good physical structure such as hardness and particle size • Weight (needs to be checked) <p>Discuss how to avoid:</p> <ul style="list-style-type: none"> • Caking or hardening of fertilizers • Humidity, leakage or seepage • Damaged bags • Sharp objects in stores on lorries <p>Note: Urea absorbs moisture more easily than ammonium phosphate</p> <p>Quality of bags and fertilizers often differ from brand to brand</p> <p>Brainstorm/have group discussion and experience sharing on the topic</p>

References: FAO. 2019. *International Code of Conduct for the Sustainable Use and Management of Fertilizers*. Rome. (<http://www.fao.org/3/ca5253en/ca5253en.pdf>)



The Global Soil Partnership (GSP) is a globally recognized mechanism established in 2012. Our mission is to position soils in the Global Agenda through collective action. Our key objectives are to promote Sustainable Soil Management (SSM) and improve soil governance to guarantee healthy and productive soils, and support the provision of essential ecosystem services towards food security and improved nutrition, climate change adaptation and mitigation, and sustainable development.

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