Ref: "Fertilizer Manual", United Nations Industrial Development Organization (UNIDO) & International Fertilizer Development Center (IFDC).

Why use fertilizer?

Use of fertilizers is needed for all types of long-term crop production in order to achieve yield levels which make the effort of cropping worthwhile

- The purpose of fertilizer use, especially for higher yields, is identical in temperate and tropical climates:

- supplement the natural soil nutrient supply in order to satisfy the demand of crops with a high yield potential

- compensate for the nutrients lost by the removal of plant products or by leaching, etc

- improve unfavorable or to maintain good soil conditions for cropping

- economic returns have increased due to more effective production

Fertilizer specifications

- Need to contract between buyer and seller to fulfill the agreement
- Nutrients contents and concentrations
- Nutrients chemical composition
- Moisture Content
- Particle size distribution
- Physical condition
- Solubility and /or availability
- Conditioner
- Special limitations pertaining to phytotoxic production, byproducts or additives
- Packing details
- Methodology used to quantifying or qualityfing items 1 through 9

Soil fertility and its improvement

The term "soil fertility" comprises a complex of properties which should be optimized as far as possible

Components of soil fertility

- Soil depth
- Soil structure
- Soil reaction
- Content of nutrients in different degrees of availability
- Storage capacity for soluble nutrients from the soil and fertilizers
- Humus content and quality
- Quantity and activity of soil organisms as agents of transformation processes
- Content of detrimental or toxic substances, either naturally occurring or man-made (e.g. from pollution)

A *highly productive soil* with high fertility (natural or improved) should has the following characteristics

- mobilizes soil nutrients from the reserves;
- transforms fertilizer nutrients into easily available forms;
- stores water-soluble nutrients in easily available forms, thus preventing leaching;
- offers the plants a balanced nutrient supply, due to its self-regulating system;
- stores and supplies sufficient water;
- maintains good soil aeration for the oxygen requirements of roots;
- does not 'fix' nutrients, i.e. convert them into unavailable form

Ways of making use of soil fertility in farming:

- exploitation i.e. farming without any added fertilizer (e.g. in shifting cultivation)

- utilization of as many components of soil fertility as possible without compensation and yet without negative yield effects (e.g. by applying only moderate amounts of fertilizer N and P)

- maintenance and improvement of soil fertility to assure consistent high yields (e.g. by compensating for losses due to removal and by soil amendments to improve fertility)

Soil reaction and liming

For soils to be highly productive, pH should be kept in optimum range (5.5-6.5)

Values under pH 4.5-5.0 can be very damaging to plants ("soil acidity syndrome") by causing nutrient deficiencies (of P, Mg, etc.) and toxicities (of Al, Fe, Mn)

Liming should be employed to raise the pH to at least about 5.5

pH range of 5.5-6.5 is satisfactory for moderate yields of most crops

Ref: "Fertilizer Manual", United Nations Industrial Development Organization (UNIDO) & International Fertilizer Development Center (IFDC).

Diagnosis of Fertilizer Requirements

Methods of diagnosis

Optical

Plant observation:

- extent of deviation from full green color;
- identifiable deficiency symptoms;
- growth difference compared with plots without fertilizer

Chemical

Soil testing:

- content of available nutrients as a basis for fertilizer requirements;
- pH, salinity, etc

Plant testing:

- spot tests, e.g. on the leaf, or with extracts;
- plant analysis, using nutrient contents as a basis for estimating additional requirements

Types of Mineral Fertilizers

Method of production:

- "natural" (as found in nature or only slightly processed);
- synthetic (manufactured by industrial processes).

Number of nutrients:

- single-nutrient or straight fertilizers (whether for major, secondary or micro nutrients);
- multinutrient (multiple nutrient) or compound fertilizers, with 2, 3 or more nutrients:

Type of combination:

- mixed fertilizers, i.e. either a physical mixture of two or more single-nutrient or multinutrient fertilizers (for granular products this may comprise a mixture of separate granules of the individual ingredients, or granules each containing these ingredients);

- complex fertilizers, in which two or more of the nutrients are chemically combined (e.g. nitrophosphates, ammonium phosphates)

Physical condition:

- solid (crystalline, powdered, prilled or granular) of various size ranges;
- liquid (solutions and suspensions);
- gaseous (liquid under pressure, e.g. ammonia)

Mode of action:

- quick-acting (water-soluble and immediately available);
- slow-acting (transformation into soluble form required)

Types of N Fertilizers

Ammonium fertilizers:
- ammonia (80 % N), ammonium sulphate (21 % N), ammonium bicarbonate (17 % N), all moderately quick acting. Uptake by plants can be retarded by addition of nitrification inhibitors, e.g. dicyandiamide (DCD)

Nitrate fertilizers:
- calcium nitrate (16 % N), sodium nitrate (16 % N), Chilean nitrate, all quick-acting

Ammonium nitrate fertilizers:
- ammonium nitrate (about 34 % N), calcium ammonium nitrate which is a combination of ammonium nitrate and calcium carbonate (21-27 % N), ammonium sulphate nitrate (26-30 % N)

Amide fertilizers:
- urea (45-46 % N), calcium cyanamide (20 % N).

Solutions containing more than one form of N:
- urea ammonium nitrate solution (28-32 % N)

Slow release fertilizers:
- either derivatives of urea with N in large molecules, or granular water-soluble N fertilizers encased in thin plastic film, but slow or very slow-acting according to type of coating; partly including a quick-acting component.
- or other means of slow release, e.g. sulphur coated urea (SCU)

Multinutrient fertilizers containing N
- nitrophosphate= NP (20-23 % N, 20-23 % P_2O_5)
- monoammonium phosphate = MAP (11 % N, 52 % P_2O_5)
- diammonium phosphate = DAP (18 % N, 46 % P_2O_5)
- liquid ammonium polyphosphates (e.g. 12 % N, 40 % P_2O_5);
- NK;
- NPK

Types of P fertilizers

(P2O5 content refers to 'available' portion, except for rock phosphate where it means total content)

Water-soluble types (quick-acting):
- single superphosphate (18-20 % P2O5);
- triple superphosphate (45 % P2O5)

Partly water-soluble types (quick- and slow-acting):
- partly acidulated phosphate (23-26 % P2O5, at least one-third water-soluble)

Slow-acting types:
- dicalcium phosphate (citrate-soluble);
- basic slag (citric acid-soluble)

Very slow-acting types:
- rock phosphate (finely-powdered soft type, e.g. 30 % P2O5), with reactivity indicated by formic acid-solubility;
permitted minimum is about one-half of total P2O5 content)
Multinutrient fertilizers containing P:
- NP
- PK (mixtures very commonly used);
- NPK (may contain about one-third or more water-soluble P for quick supply and two-thirds slow acting P for continuous supply)

Potash fertilizers

These are mainly derived from geological saline deposits. Although low-grade, unrefined materials can be used directly, most fertilizer use is now in the form of higher-concentration products, all of which are water-soluble and quick-acting:

- potassium chloride, or muriate of potash (40-60 % K2O), the lower grades providing Na in addition to K2O, with or without Mg;

- potassium sulphate (50 % K2O), for Cl-sensitive crops (e.g.potatoes, tobacco);

- potassium magnesium sulphate, also known as sulphate of potash magnesia or Patentkali (e.g. 40 % K2O, 6 % Mg).

Organic fertilizers inclusive manures

Important criteria for organic fertilizers are:

- By-products of once living organisms
- Nutrients released over a longer period of time.
- Lower amounts of nutrients
- Need to be broken down by soil microorganisms
- Warm temperature, moist conditions, O2
- dry matter content
- C/N ratio is high
- contents of substances detrimental to plant growth or product quality (heavy metals in particular should be below established critical limits)

Types of organic fertilizers inclusive manures

1. Naturally occurring material, e.g. peat

Farm wastes*:*

- crop residues (straw, leaves, etc.)
- animal manures (farmyard manure, liquid manure, slurry)
- compost (mixture of decomposed plant residues etc.)
- green manures (leguminous or other crops incorporated into the soil)

Residues from processing of plant products, e.g.:

- fibres (from paper industry) and pressed cakes (from oilseeds)

- wood materials (bark, sawdust; lignin from paper industry)
- molasses (from sugar industry)

Residues from processing of animal products, e.g.:

- blood-, horn- and bone-meal
- leather dust, etc.

Town wastes:

- composted household refuse
- sewage sludge

Soil inoculants (e.g. living micro-organisms)

2. Processed organic wastes (require mechanical and chemical preparation)

They must be dried, ground, mixed, granulated, neutralized complemented by the addition of particular nutrients, and free of pathogenic germs

Effects of organic materials on plant growth (via the soil)

Improvement of physical soil properties, either directly or by activating living organisms in the soil;

- better soil structure as a result of soil loosening
- better water-holding capacity and soil aeration;
- surface protection by mulch layer

Influence on chemical properties:

- sorption of nutrients by humic acids;
- supply of nutrients from decomposition of humus and from dissolving action on soil minerals:
- fixation of nutrients in organic complexes (mainly a negative influence for a shorter or longer period);
- effects of growth regulators produced in soil (e.g. growth inhibitors accumulating in monocultures, and antibiotics protecting against some bacterial diseases)

Some Processed Organic Fertilizers

1. **Blood meal**
2. **Bone meal**
3. **Fish emulsion**
4. **Kelp**

Corn gluten meal

It carries a warning to allow 1 to 4 months of decomposition in the soil prior to seeding.

Allelopathic properties will inhibit the germination of seeds. However, there is no danger to established or transplanted plants. This product is also marketed as a pre-emergent weed control for annual grasses in bluegrass lawns.

- Typical NPK analysis 9-0-0
- Release time 1-4 months
- Very high nitrogen
- Germination inhibitor, some are GMOs
- Application:20-40 pounds per 1000 square feet

Bone meal

A well-known source of phosphorus, bone meal is steam processed and widely available at feed stores and in garden centers. If purchased at feed stores, P is expressed on the label as elemental phosphorus and is 2.3 times higher than numbers shown on garden center labels for phosphate (i.e. – 12% phosphate is the same as 27% phosphorus). **However, recent CSU research has shown that P from bone meal is only available to plants in soils that have a pH below 7.0**

- Typical NPK analysis 3-15-0
- Release time 1–4 months
- Highly plant available form of phosphorus
- Cost
- Application Till in 10 pounds per 100 square feet