

SOILS AND FERTILIZERS
MODULE 11
BULK BLENDING OF FERTILIZERS; FERTILIZER FORMULATION
LABELING OF FERTILIZERS AND LAWS

1. Terminology

Fertilizer - Any substance containing one or more recognized plant nutrients that is used for its plant nutrient content. Unprocessed animal and vegetable manures, marl, lime, limestone, wood ashes, and other products are exempt from this definition.

Fertilizer material - A fertilizer that either:

Contains important quantities of no more than one of the primary plant nutrients nitrogen (N), phosphoric acid (P_2O_5), and potash (K_2O), or

Has 85% or more of its plant nutrient content present in the form of a single chemical compound, or

Is derived from a plant or animal residue or by-product or natural material deposit that has been processed in such a way that its content of plant nutrients has not been materially changed except by purification and concentration.

Commercial fertilizer - Any substance containing one or more recognized plant nutrients that is designed for use or claimed to have value in promoting plant growth or that is designed for use or claimed to have value in controlling soil acidity or alkalinity (except non-manipulated animal and vegetable manures).

Mixed fertilizer - A fertilizer containing any combination or mixtures of commercial fertilizers designed for use or claimed to have value in promoting plant growth.

Complete fertilizer - Contains the three major plant nutrient elements: nitrogen, phosphorus, and potassium.

Fertilizer grade - The percentages in mixed fertilizer of total nitrogen (N), available phosphoric acid (P_2O_5), and the soluble potash (K_2O), stated in whole numbers in the same terms, order, and percentages as in the "guaranteed analysis" form (15-5-15, for example). Mixed fertilizer containing a total of 5% or less of total N, P_2O_5 , and K_2O may be guaranteed in other than whole percentages; however, a minimum guarantee shall be established by rule.

Fertilizer ratio - Refers to the relative percentages of N, P_2O_5 , and K_2O (a 15-5-15 has a 3-1-3 ratio).

Fertilizer formula - An expression of the quantity and analysis of the materials in a mixed fertilizer.

Filler - A “make-weight” material added to a mixed fertilizer or fertilizer material to make up the difference between the weight of the added ingredients required to supply the plant nutrients in a ton of a given analysis and 2000 lbs.

Granulation - The process of manufacturing fertilizer particles of reasonably uniform size and stability.

Acid-forming fertilizer - A fertilizer capable of increasing soil acidity, derived principally from the nitrification of ammonium salts by soil bacteria.

Basic fertilizer - A fertilizer capable of decreasing soil acidity.

Non-acid-forming, or “neutral” fertilizer - A fertilizer that is guaranteed to leave neither an acidic nor a basic residue in the soil.

Dry bulk blending - The process of mechanically mixing solid fertilizer materials.

Bulk fertilizer - A fertilizer distributed in a non-packaged form, usually in semi-trailers.

Clear liquid fertilizer - A fertilizer in which the N-P-K and other materials are completely dissolved.

Suspension fertilizer - A fertilizer in which some of the fertilizer materials are suspended as fine particles.

Fluid fertilizer - Clear or suspension liquid fertilizers.

Brand - Term, design, or trademark used in connection with one or several grades of commercial fertilizer.

Coning - The formation of a pyramidal pile or cone of dry bulk mixed fertilizer such as may occur while being loaded into a holding hopper or transport vehicle and cause separation and segregation of the fertilizer components.

Dealer - Any person, other than the manufacturer, who offers for sale, sells, barter, or otherwise supplies commercial fertilizer.

Deconing - Any accepted process employed by a manufacturer that will prevent or minimize coning.

Deficiency - The amount of nutrient found by analysis less than that guaranteed, which may result from lack of nutrient ingredients or from lack of uniformity.

Excess - The amount found by analysis over and above that guaranteed on the label.

Label - A display of written, printed, or graphic matter upon the immediate container of any commercial fertilizer or accompanying same when moved in bulk.

Manufacturer - A person engaged in the business of importing, preparing, mixing, blending, or manufacturing commercial fertilizer for sale, either to direct consumers or through other media of distribution.

Official sample - Any sample of commercial fertilizer taken by FDACS or its representative, in accordance with the provisions of the fertilizer law.

Organic - A material containing carbon and one or more elements, other than hydrogen and oxygen, essential for plant growth. When the term "organic" is used on the label, it shall be qualified as either "synthetic organic" or "natural organic," with the percentage of each specified. When the term "organic" is used, it must be clearly indicated that it refers only to the nitrogen or other applicable portion of the fertilizer.

"Natural organic" is a byproduct from processing of animal or vegetable substances that contain sufficient plant nutrients to be of value as fertilizers.

"Synthetic organic" is a material that is manufactured chemically (by synthesis) from its elements or other chemicals, as contrasted to those found ready-made in nature.

Percent - Indicates percentage by weight.

Primary plant nutrient - Any form of nitrogen, phosphoric acid, or potash, or any combination of these substances.

Registrant - The person who registers commercial fertilizer under the provisions of the fertilizer law.

Secondary plant nutrient - Any element or substance useful as plant nutrient other than the primary plant nutrients.

Slow or controlled-release fertilizer - A fertilizer containing a plant nutrient in a form that delays its availability for plant uptake and use after application, or which extends its availability to the plant significantly longer than a reference "rapidly available nutrient fertilizer," like ammonium nitrate or urea, ammonium phosphate, or potassium chloride. When slow or controlled-release nutrient is claimed or advertised, the guarantee for such a nutrient shall be shown as a footnote and shall be expressed as percent of actual nutrient. When a slowly released nutrient is less than 15% of the guarantee for either total nitrogen, available phosphoric acid, or soluble potash, as appropriate, the label shall bear no reference to such designations.

Specialty fertilizer - Commercial fertilizer in packages sold or offered for sale for home use.

Tolerance - The variation authorized by law or regulation from the guaranteed analysis.

Unit of plant nutrient -1% of a ton, or 20 lbs.

Water insoluble nitrogen - Nitrogen not soluble in water. All organic nitrogen soluble in water shall be classified as "water-soluble organic nitrogen." However, soluble organic nitrogen derived from urea may be classified either as "urea nitrogen" or "water-soluble organic nitrogen," at the option of the registrant. Nitrogen in the nitrate or ammoniacal forms shall be so classified.

Association of American Plant Food Control Officials - An organization of officers and their deputies charged by law with regulating the sale of fertilizers, and of research workers employed by state or federal agencies engaged in the investigation of fertilizers. Its object is to promote uniform and effective legislation, definitions, and rulings, and to enforce the laws relating to the control of sale and distribution of fertilizers and fertilizer materials.

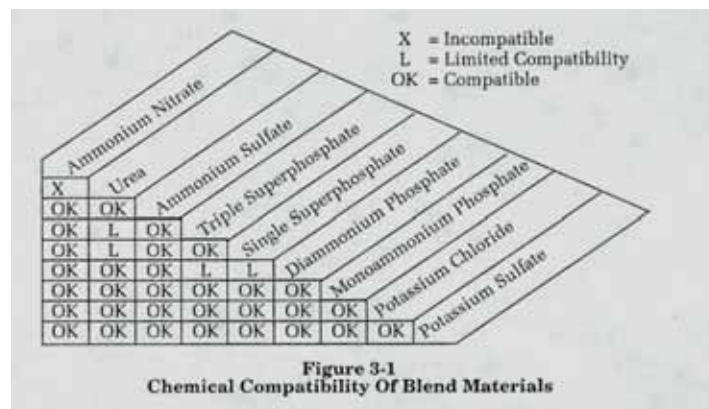
2. General

- a. In 1992, 21 million tons of fertilizer mixtures were produced in the USA; The average analysis was 11.0% N, 11.6% P₂O₅, and 14.3% K₂O. In 1955, this ratio was 5.2-5.2-9.0; In 1964 it was 7.7-6.6-10.5; In 1973 it was 10.3-8.3-10.6.
- b. Advantages of higher-analysis blends: Lower cost per unit of plant nutrients, lower transportation costs, less storage space required, less labor in handling, increased speed of application in the field because of fewer stops.
- c. Solution and suspension fertilizers have gained in popularity compared with dry fertilizers because they can be applied very uniformly with herbicides.

3. Bulk blending

- a. This mode of fertilizer marketing originated in the USA in the early 1950s.
- b. The desirable qualities of bulk-blended fertilizer include:
 - i. Granular and free-flowing.
 - ii. Components are present in the right plant nutrient proportions and are mixed to a high degree of homogeneity.
 - iii. High degree of non-segregation during handling and spreading.
 - iv. Analysis of any reasonable sample reflects the guaranteed plant nutrient concentrations.
 - v. Non-dusty and reasonably non-hygroscopic.
- c. There are about 5000 bulk-blending plants in the USA. Advantages of bulk blending include:
 - i. Bulk blending facilities have relatively low investment costs.
 - ii. Material cost for blends is usually low.
 - iii. Plant operation is relatively easy and requires a minimum of trained personnel.
 - iv. Maintenance of the plant is easy and costs are low.

- v. It is possible to supply farmers with a prescription mixture (a “custom blend”) that closely fits their plant nutrient requirements.
- d. In most bulk-blending plants, the following steps occur:
 - i. Raw materials arrive in rail cars and are off-loaded into bins for storage.
 - ii. A blend is prepared by removing the materials from storage, mixing them, and conveying the mixture to a transport truck for bulk transport, or to a bagging machine.
 - iii. The mixer most frequently used is the concrete-type rotary mixer.
 - iv. Materials are usually removed from storage by front-end loaders and weighed in hopper scales mounted above an elevator or conveyor.
- e. The raw materials most frequently used in bulk blending are:
 - i. Monoammonium and diammonium phosphates (MAP and DAP).
 - ii. Concentrated superphosphate (CSP).
 - iii. Ammonium nitrate.
 - iv. Urea.
 - v. Potassium chloride.
 - vi. Ammonium sulfate.
- f. The ingredients used must be chemically compatible:



- g. Particle size distribution is the main consideration in production of non-segregating blends. Segregation usually occurs by allowing materials to cone when they are discharged into a pile, hopper, or applicator; usually, the fine materials collect in the center of the pile and the larger materials at the outer edges of the pile; can use hopper dividers or a flexible spout to avoid coning.
4. Fluid mixed fertilizers
- a. The two major types of fluid fertilizers are **solutions** and **suspensions**; solutions are free of solids and clear enough to see through; suspensions are of higher concentration and have small crystals of plant nutrients suspended by a gelling clay, such as attapulgite or sodium bentonite, in saturated fertilizer solutions.
 - b. N-P-K fluid mixed fertilizers are used in starter solutions and foliar sprays, as water-soluble fertilizers for injection into irrigation systems, and for direct soil application.

- c. There are about 3200 fluid-mix plants in the USA. Advantages of clear liquid fertilizers include:
 - i. Easy to transport, handle, and apply.
 - ii. Can be applied uniformly and accurately.
 - iii. Can be applied with pesticides.
 - iv. Can be added to irrigation water.
 - v. No problems with dusts, fumes, hygroscopicity, or caking.
 - vi. Can be applied foliar.
- d. Disadvantages of clear liquid fertilizers:
 - i. Materials used must be water soluble, which limits the choices.
 - ii. Liquid fertilizers are less concentrated than solids (lower analysis). Thus, shipping cost increases.
 - iii. Low temperatures may cause crystals to form and "salt out."
 - iv. Specialized equipment is needed for storage and transport.
- e. Major pre-blended solution fertilizers:
 - i. Ammonium polyphosphate (10-34-0)
 - ii. Superphosphoric acid (0-68-0)
 - iii. Urea-ammonium nitrate (32-0-0)
 - iv. Potassium chloride
- f. The N-P-K or N-K solution fertilizers used for fertigation in Florida are made by dissolving dry materials in water in a large plastic tank with agitation. The dry fertilizers usually must be added in a specific order according to a pre-determined "recipe" in order for the blend to come out right.
- g. Advantages of suspension fertilizers over solutions:
 - i. Cost is lower because less pure materials can be used to produce suspensions.
 - ii. Higher analysis grades can be produced (especially with K).
 - iii. Higher concentrations of micronutrients can usually be suspended than can be dissolved.
 - iv. Powdered herbicides and insecticides not normally soluble in solution fertilizers can be suspended and uniformly distributed throughout the mixture.

5. Labeling of fertilizers and laws

- a. The Florida Fertilizer Label:
 - i. Requirements are stringent for labeling; they are set by the state of Florida; established because Florida is known as a "junk fertilizer" state.
 - ii. See separate handout "The Florida Fertilizer Label."
- b. Comments regarding labeling: **Nitrogen**
 - i. There are many different types of nitrogen; they are classified into four categories:
 - (1) nitrate-N
 - (2) ammoniacal-N
 - (3) water soluble organic-N
 - (4) water insoluble-N

The first three are important because they identify the amount of readily-leachable N; in Florida, all four types must be identified; their percentages must add up to the "Total N" percentage.

- ii. Urea is regarded as 100% water soluble synthetic organic N, and fits under the third category as listed above.
 - iii. If the label indicates 100% synthetic organic N, then it is all urea nitrogen and all falls under the third category; won't pay a premium price for this material as one would if it was natural organic N.
 - iv. If the label indicates 100% natural organic N, then the source would most likely be something like sewage sludge (slow-release N); this material will be more expensive.
- c. Comments regarding labeling: **Phosphorus**
- i. In the analysis, e.g. a 10-10-10, the P content is expressed as %P₂O₅; the labeling expresses it as "available phosphoric acid"; neither of these two materials is actually in the blend; the P materials in the blend will most likely be OSP, CSP, MAP, or DAP.
 - ii. "Available phosphoric acid" is the water soluble plus citric acid soluble phosphorus; the soil solution is normally a weak acid, in which the citric acid soluble materials are readily made available for plant use.
- d. Comments regarding labeling: **Potassium**
- i. Potassium is expressed as %K₂O in the analysis, although there is no actual K₂O in the blend.
 - ii. The actual form of potassium in the fertilizer is the potassium ion K⁺.
- e. Comments regarding labeling: **Other**
- i. According to the law, primary nutrients cannot be marketed unless the N-P-K percentages add up to 16%; if they add up to less than 16%, a special permit is needed; thus, an 8-2-8 or a 6-6-6 is O.K., but an 8-0-6 is not O.K.
 - ii. All fertilizer materials are subject to random inspection; fertilizer companies all pay a fee of \$0.50 per ton marketed to support the inspections.
 - iii. Deficiency tolerances are based on the guaranteed percentage:

Fertilizer N analysis	Tolerance
0 to 4%	0.2%
4.1 to 6%	0.3%
6.1 to 8%	0.4%
8.1 to 11%	0.5%
11.1 to 30%	0.6%
Greater than 30%	0.75%

Fertilizer P ₂ O ₅ analysis	Tolerance
0 to 10%	0.4%
10.1 to 25%	0.5%
Greater than 25%	0.75%

Fertilizer K ₂ O analysis	Tolerance
0 to 2%	0.2%
2.1 to 3%	0.3%
3.1 to 4%	0.4%
4.1 to 8%	0.5%
8.1 to 20%	0.6%
Greater than 20%	1.0%

For example, if a guaranteed 6-6-6 analyzed 5.7-4.5-6.5, the N and K would pass, but the P would be classified as deficient; the company would be charged a penalty equaling three times the commercial value of the deficiency found.

If it was a ton of 6-6-6 that was 1.5% deficient in P_2O_5 as above, the deficiency would be 1.5 units, or 30 lbs, of P_2O_5 ; the commercial value per unit of P_2O_5 is \$3.15; thus, the penalty would be: 1.5 units x \$3.15 x 3 = \$14.18.

Another example: If a guaranteed 12-12-12 analyzed 11.5-11.5-11.5, it is still legal, but a 11-11.5-11.5 would be classified as deficient in nitrogen and charged a 1% deficiency.

- iv. Fertilizers are difficult to mix exactly; every prill or granule will not be the same size; transporting tends to separate particles, with the smaller ones going toward the bottom of the container; this makes fertilizer blends difficult to assess correctly; if the blend is accurate but has segregated and the sample analysis shows a deficiency, the manufacturer still has to pay the penalty.
- v. If the label on a tobacco fertilizer guarantees a chloride content, a penalty is assessed if the material contains an excess of Cl of more than 25% of the guarantee; the penalty in this case would be 100% of the commercial value of the fertilizer; in brands other than tobacco brands, the penalties for excess Cl are one-eighth of that listed above.