

GUIDE

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Metric and Other International Units for Agriculture

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By the time 1980 rolls around, Missouri corn yields should average more than 6,300 kilograms per hectare. Fuel economy for intermediate size cars should be approaching 8.5 kilometers per liter. And the United States will be well on its way to adopting the International System of Units or, as it is more commonly referred to, the metric system.

The International System of Units was formally adopted by the countries of the world in 1960. This system has six standard units from which all measurements can be derived. These six units are:

- meter (m):** Standard unit of length first defined by the French government nearly 200 years ago. Even though the United States retained the English system (inches, feet, yards) of length, we have used the international standard meter to derive these units since 1889.
- kilogram (Kg):** Unit of mass (weight) originally defined as the weight of 1,000 cubic centimeters of pure water.
- second (s):** Standard unit of time already in use in the United States.
- degree Kelvin:** Measure of temperature. The Kelvin degree is the same size as a degree on the Celsius or Centigrade scale which is used in most countries of the world.
- ampere (amp):** Standardized measure of electric current flow already used in the U.S.
- candela (cd):** Measure of light intensity.

All other units of measurement used in the world today can be derived from these six basic standards. For example, speed is distance per unit time and has as its basic unit meters per second.

Distance and mass (weight) units in the International System use the decimal (base 10) system of accumulation. The English system has no consistent base unit; that is, 12 inches = 1 foot, 3 feet = 1 yard, 5,280 feet = 1 mile. Because of this, the metric system is considerably easier to learn and use than is the English system.

Regular multiples and divisions of metric units are identified by attaching prefixes to the basic element name. A listing of these prefixes is contained in Table 1. Using this table, we can find that a kilometer is 1,000 meters and that a milligram is 1/1,000 of a gram.

Your Farm and the Metric System

Only three parts of the International System of Units will have a major effect on your farm operation. They are temperature, length, and mass (weight). However, these three will, singly or in combination, influence almost every operation on the farm, from purchasing fertilizer to marketing livestock.

Table 2 presents a series of conversion factors for translating English units into the metric system and vice versa. Tables of this type will help you make the transition to metric. However, in the long run, you should strive to "think metric" rather than always convert units into the metric system.

Here are some of the changes you will be confronted with when the metric system comes to your farm.

Length (distance)

The basic unit will be the meter, which is a little longer than a conventional yardstick. Things which are longer than a meter and less than 500 meters will probably be specified in meters. A 40 foot by 200 foot building will become a 12.2 meter by 61 meter building. A 1/4-mile long corn field will become a 1,609-meter long field.

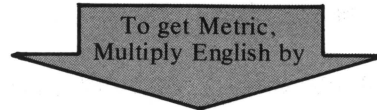
The term kilometer (1 kilometer = 1,000 meters) will replace the mile as a measure of longer distances. The distance from Kansas City to St. Louis will change from 250 miles to 402 kilometers. The odometers on your truck and car will read in kilometers instead of miles.

Measurements that we currently specify in inches will be changed to centimeters. It takes approximately 2.5 centimet-

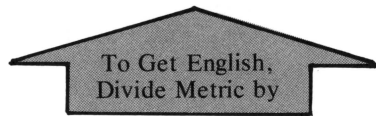
Table 1. Prefixes Used to Designate Multiples and Divisions in the Metric System.

Prefix	Symbol	Multiple
mega-	M	1,000,000
kilo-	K	1,000
hecto-	h	100
deka-	da	10
deci-	d	1/10
centi-	c	1/100
milli-	m	1/1,000
micro-	μ	1/1,000,000

Table 2. Conversion Factors



inches (in)	2.54	centimeters (cm)
feet (ft)	.3	meters (m)
miles (mi)	1.61	kilometers (km)
square inches (in ²)	6.45	square centimeters (cm ²)
square feet (ft ²)	.09	square meters (m ²)
square yards (yd ²)	.81	square meters (m ²)
acres (A)	.39	hectares (ha)
cubic inches (in ³)	16.39	cubic centimeters (cc) or milliliters (mL)
cubic feet (ft ³)	.028	cubic meters (m ³)
cubic yards (yd ³)	.76	cubic meters (m ³)
pounds per square inch (psi)	6.89	kilopascals (kPa)
ounces (oz)	28.4	grams (g)
pounds (lb)	454.0	grams (g)
tons (2,000 lb)	.91	tonnes (t)
BTU	1.05	kilojoules (kJ)



To convert from Fahrenheit to Celsius, use the following equation:
 $^{\circ}\text{C} = (^{\circ}\text{Fahrenheit} - 32) \times .56$

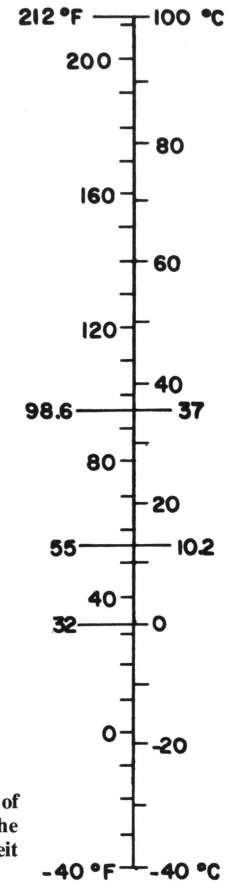


Figure 1. Graphic comparison of selected points on the Celsius and Fahrenheit temperature scales.

ers to equal 1 inch. A 2 x 4 board will be 5.08 x 10.16 cm and a 30-inch row spacing will be a 76.2 cm spacing. Incidentally, when the metric system becomes official, other standards will probably change to provide some further simplification. For example, the standard 2 x 4 will probably become a 4 x 8 cm or 4 x 9 cm board and will be sold by the cubic meter rather than board feet.

Still smaller distance measurements will be specified in millimeters. We already use millimeters to specify spark plug sizes. Nuts and bolts and the tools to handle them will be sized in millimeters. If you have a tractor or an automobile which was built in a foreign country, you probably have already had some experience with metric measurements on nuts and bolts.

Area

Area is the product of length and width. Building materials such as roofing, plywood, sheathing, and sheet plastic, which are now sold by the square foot, will be sold by the square meter. One square meter contains 10.76 square feet.

Land will be measured in hectares instead of acres. One hectare is the amount of land contained in a square area which has a length of one hectometer (100 meters). It takes approximately 2.5 acres to make one hectare. This means a 250 acre farm will become a 100 hectare farm.

Volume

Volume is the product of length, width, and height or depth. The basic unit of volume in the metric system is the liter (L). A liter is equivalent to one cubic decimeter (1,000

cubic centimeters).

Bulky items such as gravel and concrete which are sold on a volume basis will be measured in cubic meters. It takes approximately 1.3 cubic yards to make one cubic meter. Motor oil, milk, insecticides, and fuel will be measured and sold by the liter. A liter is equivalent to slightly more than one quart. Engine displacement will be measured in liters, or in some cases cubic centimeters, which is merely 1,000 times the liter value.

Medicines and other items handled in small amounts will be measured in cubic centimeters (milliliters). Many of these items have already been changed to the metric system. The metric system does not have volumetric measures such as the peck, bushel, or gallon.

Pressure

Pressure is defined as force per unit area. The most common unit in the English system is the pound per square inch (psi). Pressure in the metric system will be defined as pascals. One pascal (Pa) is defined as one newton (N) per square meter. A newton equals mass in kilograms divided by 32.2.

Mass (weight)

The basic unit of metric weight is the gram. The gram was originally defined as the weight of one cubic centimeter of pure water. It takes approximately 454 grams to equal one pound.

Items which were specified in pounds in the English system will be measured in kilograms in the metric system.

Table 3. Metric Weights of Some Materials Found on the Farm

Material and Unit	Weight (kilograms)
1 bushel wheat	27.2
1 bushel corn	25.4
1 bushel oats	14.5
1 cu ft baled hay	5.5
1 cu ft concrete	68.0
1 cu ft gravel	56.7
1 cu ft white oak	20.9
1 cu ft steel	222.0

(One kilogram = 2.2 lbs.) Included in this category will be livestock, field crops, and milk sales.

Larger masses may be specified in 1,000 kilogram units called tonnes. (One tonne = 2,200 lbs.) Feed, fertilizer, and limestone will probably be handled in these larger units.

Small items such as trace elements and some medicines will be measured in milligrams or even micrograms.

Temperature

Conversion to the International System of Units will also result in the adoption of the Celsius (Centigrade) temperature scale instead of the Fahrenheit system. The Celsius scale has as its basis a 100-degree interval between the freezing point and the boiling point of water. Zero degrees (0°) Celsius represents the freezing point (32° on the Fahrenheit scale) and 100°C is equivalent to 212°F. A conversion formula may be found in Table 2. Figure 1 provides a graphic comparison of the two scales.

Energy

One additional change which will come about as a result of conversion to international units is energy measurement. The metric system measures energy in terms of joules instead of British Thermal Units (BTU) of the English system. There is approximately one kilojoule in one BTU.

Preferred Units

In the metric system, you can combine units and multipliers to arrive at different terms for the same physical

quantities. For example, 1 kilogram = 1,000 grams = .001 tonne. In order to avoid some confusion, the following uses are suggested.

To Quantify	Use
vehicle acceleration	meters per second squared (m/s ²)
engine speed or shaft rotation	revolutions per minute (r/min)
land measurement	hectare (ha)
torque	newton meter (N.m)
heat energy	kilojoule (kJ)
machine energy usage	kilowatt hour (kw.h)
drawbar pull	newton (N)
vibration frequency	hertz (Hz)
row spacing	millimeters or centimeters
row length	meters (m)
rated vehicle loads	kilograms (kg)
crop yield or fertilizer application rates	kilogram per hectare (kg/ha)
soil density	kilogram per cubic meter (kg/m ³)
engine power	kilowatt (kw)
tire pressure or hydraulic pressure	kilopascal (kPa)
surface speed	kilometers per hour (km/h)
fuel capacity or sales	liter (L)
fuel consumption	liters per hour (L/h)
machine width	millimeters or centimeters
pesticide application rate	liters per hectare (L/ha)



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