FACT SHEET

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What is sustainable potassium management and why do we need it?

Potassium (K) is the third of the indispensable macronutrients required for all life, alongside nitrogen (N) and phosphorus (P). All three of these macronutrients play a fundamental role in our food production. However, around one fifth of all agricultural soils face severe potassium deficiency. Whilst we know that potassium is critical to maintaining healthy ecosystems and supporting global food production, there is still more that we need to discover about potassium supply, consumption and pollution risk.

Potassium is the eighth most abundant element in the Earth's crust and the second most abundant nutrient after nitrogen. Despite this, potassium is not always available in a form that can be used by plants. Bacteria are an important part of helping increase the availability of potassium.

Potassium fertilizers are used to supplement soil nutrients and support crop production. However, there is inequity in access to and availability of potassium fertilizer. This is a serious concern for nutrition and health. Insufficient potassium in the soil poses a threat to global food production and the achievement of Sustainable Development Goal 1: Zero Hunger.

The solutions for sustainable management of potassium include:

- Understanding the soil to optimize the use of potassium fertilizer,
- Reducing potassium demand through reducing food waste and adapting diets,
- Identifying new deposits,
- Considering alternative sources, such as organic sources, and
- Use of nutrient recovery technologies.

What is potassium?

Potassium is a soft alkali metal. On its own it is unstable, reacting easily with air and water and so in nature it tends to occur combined with oxygen or different minerals. There is no gaseous form of potassium.

What do we use it for?

In 2021, 45 million tonnes of potassium were used globally. Approximately 95% of this was used in agricultural fertilizers, representing a US$15 billion dollar industry and accounting for around 20-25% of total fertilizer consumption. Potassium can be formulated into a combined Nitrogen, Phosphorus and Potassium (NPK) fertilizer, or used as a standalone potassium-specific fertilizer, such as potassium chloride.

Like other nutrients (i.e., nitrogen and phosphorus) potassium is an important limiting factor for plant growth and deficiency can threaten food security.

Potassium is required in large amounts for growing crops. Plants with enough potassium cope better with adverse conditions such as drought, frost damage, insect and disease attacks.

Latest figures show that global demand for potassium increased at an annual rate of 2.4% between 2015 and 2020, driven by the growing need for food production and biofuels.

Potassium has other uses, including serving as an additive in animal feed, food additives, in the beer brewing process, water softeners, de-icing solutions, in glass and textile manufacture, pharmaceuticals and explosives. Historically saltpeter (KNO_3) was used in gunpowder.

Where can potassium be found?

Traditionally potassium was extracted from wood ash, which was then crystalized in pots to extract the potassium, hence the name 'potash'. Today potash is also used to describe mined potassium salts, which are mostly mined as potassium chloride (KCl).

Although potassium can be found in small concentrations in many different types of rock, there are some rocks with high concentrations. These formed in saltwater lagoons hundred of millions of years ago. They make up the larger, more commercially viable potassium reserves that are mined today for agricultural fertilizers.

The current extractable global reserves of mineral potassium occur in a handful of countries, predominantly in the northern hemisphere with around half of these reserves found in Canada alone. The reserves of potassium that can be mined for producing potassium based fertilizers are believed to be sufficient to meet the projected demand for centuries. It is estimated that in 2025 69 million tonnes of potassium will be produced, which is over 50% more than the expected demand in 2025. Despite there being adequate reserves, the fact that these are in only a few geographic locations presents logistical challenges in getting this resource to where it is needed, resulting in inequity in its access and availability.

Useful quantities of potassium also occur in some ocean algae, like kelp. Kelp can yield between 3 and 10% available potassium, which can be processed and used as a liquid fertilizer.

Potassium can often be found in soils, but only a small proportion of this is available to plants. The availability and uptake of potassium is affected by soil moisture, oxygen levels and soil temperature. Since potassium is soluble it does not remain for long in the soil and is easily leached out. The characteristics of this nutrient are important to understand in fertilizer application to ensure it is applied at the right time and at the right dose and avoid unnecessary economic costs to the farmer.

What is the purpose of potassium?

For humans and animals

In animals, including humans, potassium, sodium, magnesium and calcium act as an electrolyte essential to all metabolic activity. Potassium helps the body function in a number of different ways. It helps regulate hydration and how nutrients move in and out of cells. It maintains nerve impulses, heartbeat and muscle activity. Humans must consume between 1–5 grams of potassium per day, which can come from many plant-based foods, particularly fruit and pulses. One cup of orange juice provides around 10% what an adult needs per day. A potassium deficiency can affect blood pressure and kidney function with serious health consequences.

For plants

In plants, potassium has two roles:

1. activating the enzymes needed to produce sugar and proteins, for metabolism
2. controlling osmosis – the movement of water through the plant's cells to ensure healthy root systems.

Potassium can improve the size, colour and sugar content of fruiting plants, carrots, onions and sweet potatoes, and with the addition of potassium fertilizer, plant production can increase by 10%.

What is the issue?

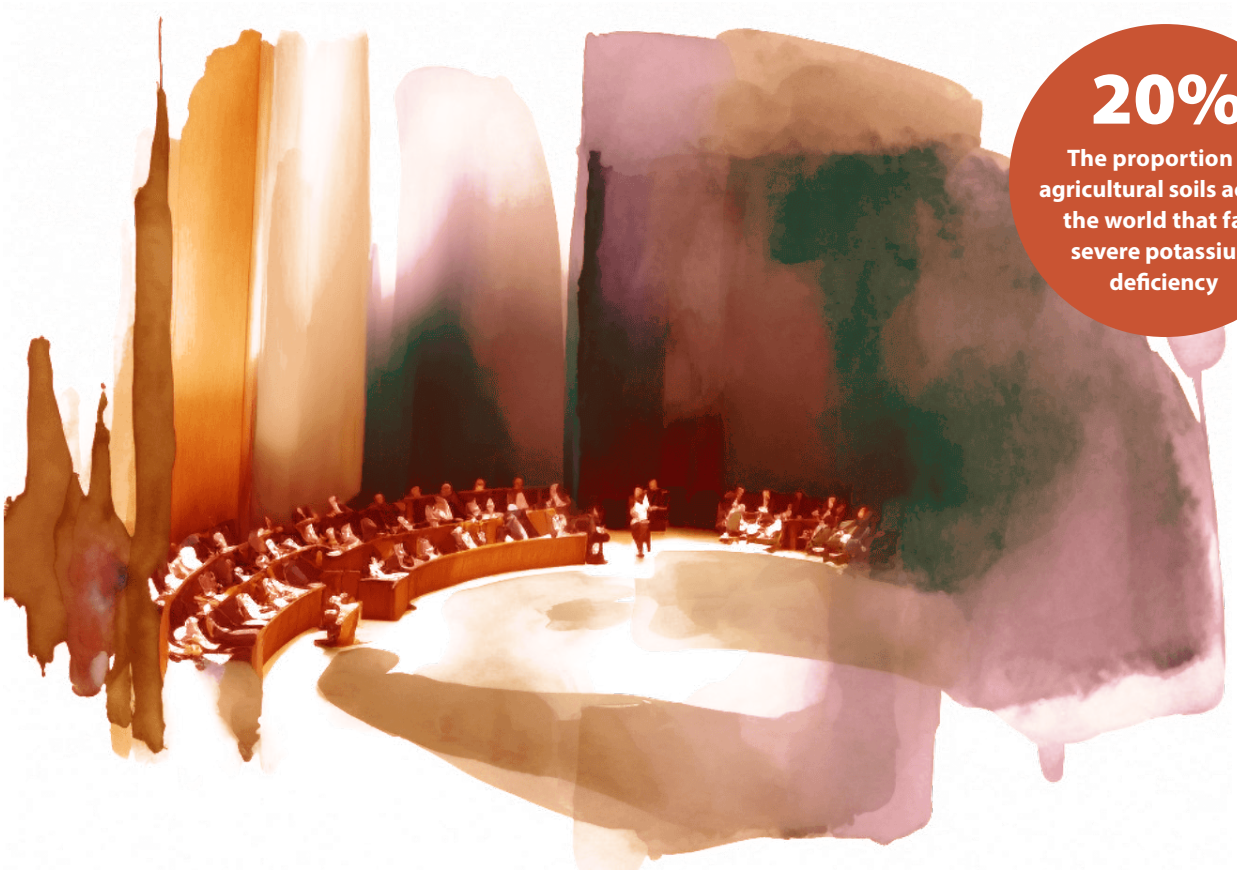
The environmental impacts of using potassium fertilizers on soils, water and air are not well understood, but we do know that potassium can be lost to the environment through erosion, leaching, burning and harvesting of crops. Unlike phosphorus and nitrogen, no specific environmental concerns have been identified from losses of excess potassium, although overfertilizing could result in unnecessary costs for the farmer.

Mining potassium can generate millions of tonnes of waste, which includes sodium chloride salts that can leach and contaminate soils and fresh water, impacting biodiversity. It also results in the emission of methane, carbon dioxide, and nitrous oxides, which are all potent greenhouse gasses.

Globally around one-fifth of agricultural soils face severe potassium deficiency. Potassium deficiency can be caused by not fertilizing at the recommended application rates and can threaten food security. In the case of the Mediterranean Basin a negative potassium balance is caused by the need to increase food production with increasingly arid conditions and declining potassium. In such cases potassium fertilizer is the limiting factor for food production.

Inequity of access is the primary cause of under-fertilization. This issue arises from highly volatile prices, geopolitical factors, a lack of local sources, and the high costs associated with imports and transportation – challenges that disproportionately affect farmers in developing countries. Limited access to potassium fertilizer is particularly concerning. Despite Africa hosting 25% of the world's potential croplands, the continent accounts for only 1.7% of global potassium fertilizer consumption.

The effects of climate change on the potassium cycle remain unknown. However, understanding its implications for potassium availability and plant uptake is crucial for meeting future food production demands. This is especially significant for arid and semi-arid regions, where extreme weather conditions are expected to become more frequent.



20%

The proportion of agricultural soils across the world that face severe potassium deficiency

What are the solutions for sustainable potassium management?

There is a growing recognition of the importance of potassium and an urgent need to enhance our understanding of its biogeochemical cycle. Currently, no national or international policies or regulations address the sustainable management of potassium in agriculture. However, the following four key actions could help pave the way for sustainable potassium management.

Reduce dependence on mineral potassium fertilizers

- Promote the use of organic fertilizers.
- Transition to small scale closed cycle agricultural production, where fertilizer nutrients are produced from farm wastes using manure, crop residue and compost. For example at harvest rice straw contains around 15 kg potassium per tonne and wheat straw around 10 kg potassium per tonne.
- Use soil testing to better understand and improve soil health.

- Increase targeted use where there are potassium deficiencies and use the 4 Rs of nutrient management – the right source, right rate, right time and right place.
- Changes in consumer behaviour – such as choosing a more plant-based diet and reducing food waste can help to reduce how much fertilizer is needed in the first place.

Promote principles of circularity

- Potassium is not widely recovered or recycled. Adopting a circular approach could enhance efficiency in the use and recycling of potassium. Policies that support circular principles should be a priority.
- Whilst there are rather low quantities of potassium in wastewater fractions, there are a few existing examples of nutrient recovery technologies that produce potassium outputs:
  - Recovering potassium chloride from fly ash produced from municipal waste;
  - A nitrogen-potassium fertilizer solution produced from liquid manure and water treatment effluent that can be used for hydroponics.

Invest in identifying new sources of potash

- Expand conventional sources of mined potassium, including searching for potash deposits in the global south to increase accessibility.
- Explore low-grade but indigenous potassium bearing minerals as locally accessible alternatives to high cost imported potassium fertilizers.

Other potential solutions

- Increase the availability of potassium that is already in the soil by using microorganisms to activate it so it can be used by plants.