Sustainable agriculture for the future

October | Oktober 2026

No 162

Agri About

www.agriabout.com

Building Resilient Farms

Healthy Soils, Smart Management and Sustainable Growth

The Plant's Secret Pantry

Ancient Seeds for a Drier Future

No water, no crops

Healthy Soils, Resilient Vineyards

Breërivier-Landbouvereniging: 'n Eeu van groei en trots

The Plant's Secret Pantry:
How Starch Keeps Plants Alive

Mkateko Chauke, Gugulethu Zuma-Netshiukhwi, Mpho Mafa & Yanga Mhlom
Agricultural Research Counci
University of the Free State I

Plants are remarkable organisms. Every day they capture sunlight, water and carbon dioxide to produce the sugars that fuel growth through the process of photosynthesis. Yet photosynthesis can only occur when sunlight is available. What, then, keeps plants alive during the night, periods of drought, or other times when their ability to produce food is limited?

The answer lies in starch, a vital energy reserve often described as the plant's "secret pantry". During the day, plants convert part of the sugar produced through photosynthesis into starch and store it for later use. This stored energy sustains essential life processes when photosynthesis cannot take place, ensuring continued growth, development and survival.

Why Plants Store Starch

Unlike animals, which store excess energy as glycogen or fat, plants primarily store energy in the form of starch. Starch is insoluble in water, compact and highly efficient for long-term storage. Large quantities can be accumulated without disrupting normal cellular processes.

Different plant organs store starch according to their biological function:

- Roots such as cassava and sweet potato store starch to support survival and regrowth.
- Tubers such as potatoes and amadumbe serve as major long-term energy reserves.
- Seeds including maize, wheat and legumes store starch to nourish the embryo during germination.
- Stems and rhizomes such as ginger, turmeric and sugarcane also act as storage organs for future growth.

These reserves are later broken down into sugars that support root and shoot development, flowering, fruit production and survival during unfavourable environmental conditions.

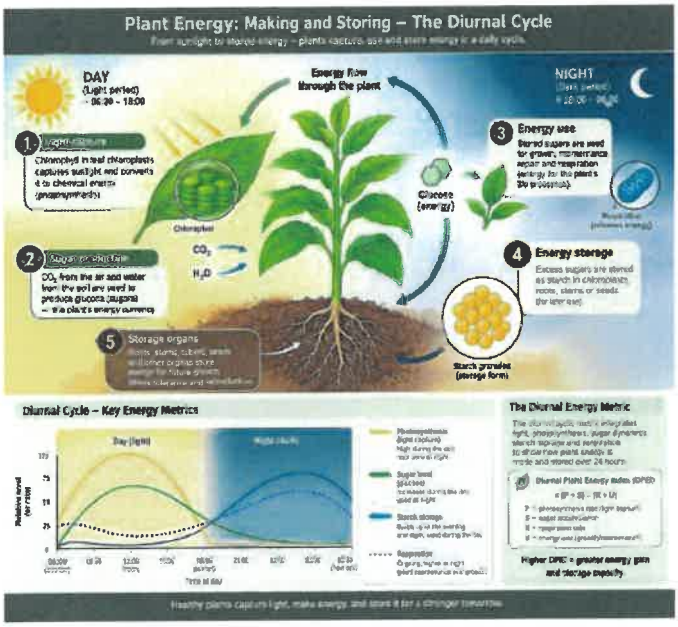

Figure 1: Plants produce sugars through photosynthesis and store excess energy as starch, creating a reserve that can be used when photosynthesis stops.

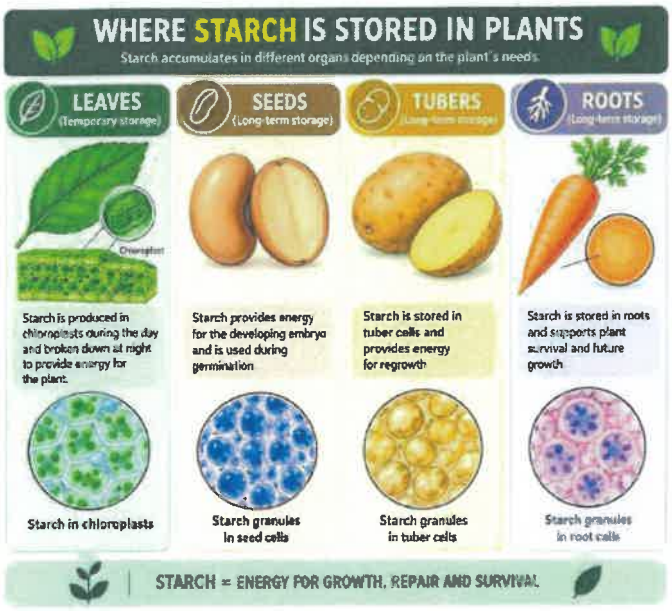

Figure 2: Major storage organs where plants accumulate starch reserves for future growth, reproduction and survival.

Building Starch from Sunlight

Starch production begins in the chloroplasts, where the Calvin cycle converts atmospheric carbon dioxide into simple carbon compounds during photosynthesis. Through a series of biochemical reactions, these compounds are transformed into glucose-based molecules that serve as the building blocks of starch.

Specialised enzymes assemble these molecules into two major starch components:

- **Amylose**, which consists of long linear chains.
- **Amylopectin**, which forms a highly branched structure.

Together they create starch granules, the compact energy stores that accumulate in leaves, seeds, roots and tubers. While starch in leaves is typically used within a daily cycle, starch stored in seeds and underground organs can remain available for much longer periods, supporting future growth and reproduction.

A Plant's Internal Timekeeper

One of the most fascinating aspects of starch storage is the way plants manage their reserves during the night. Researchers have discovered that plants regulate starch consumption with extraordinary precision.

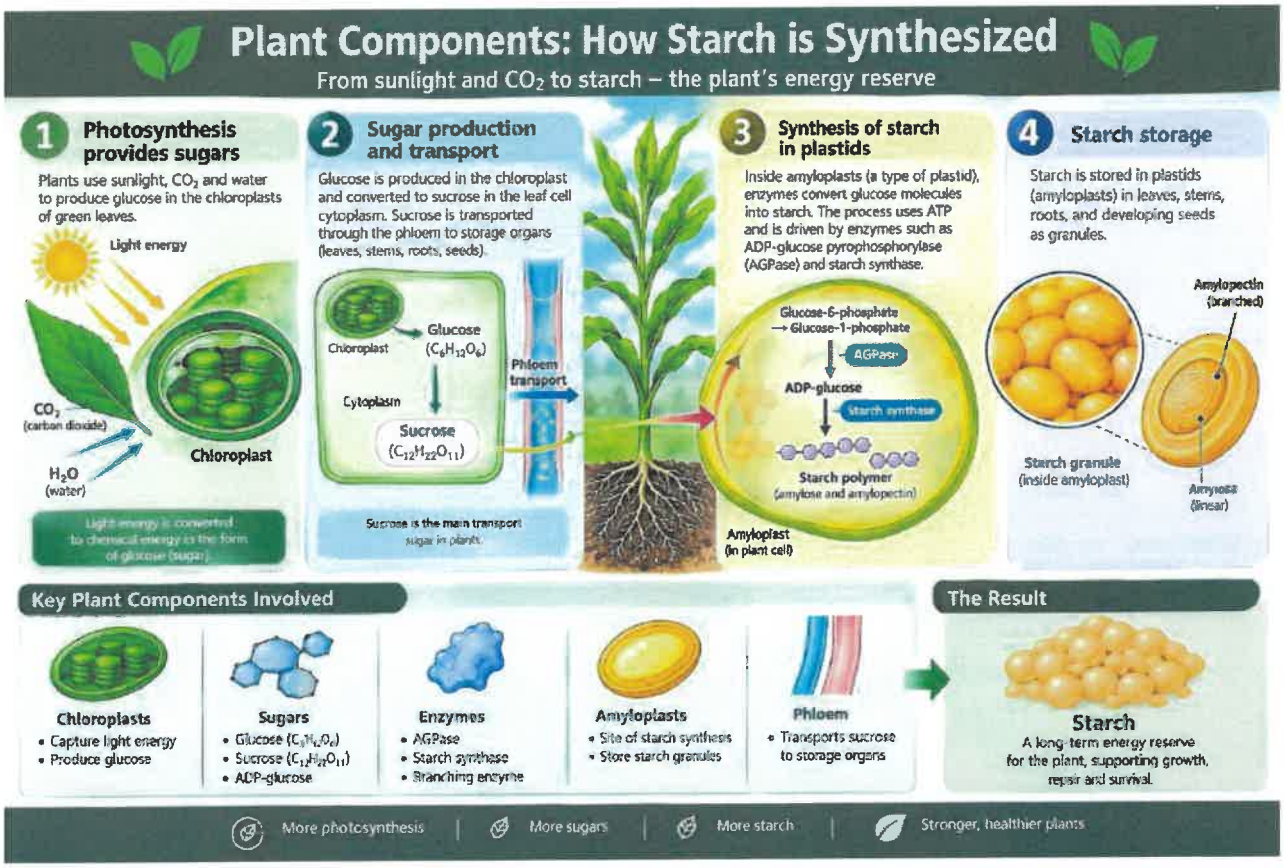

Figure 3: Starch biosynthesis in plants. Sugars produced during photosynthesis are converted into the starch molecules amylose and amylopectin and stored as energy reserves in plant tissues.

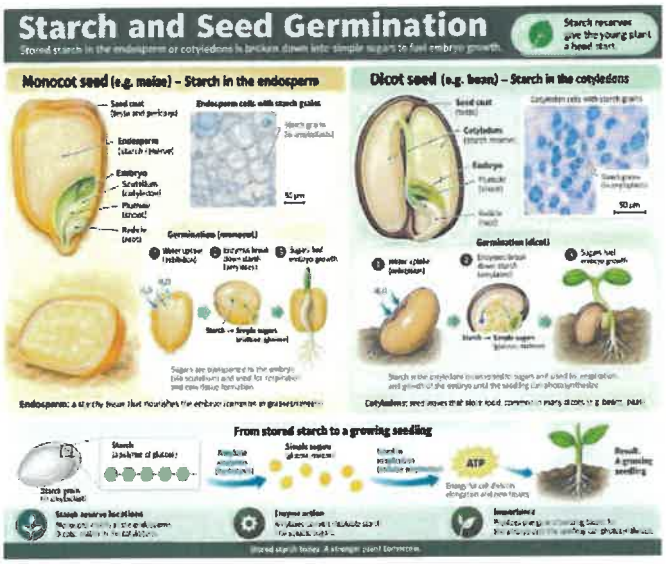

Figure 5: During germination, starch reserves stored in seeds are converted into sugars that power early seedling growth.

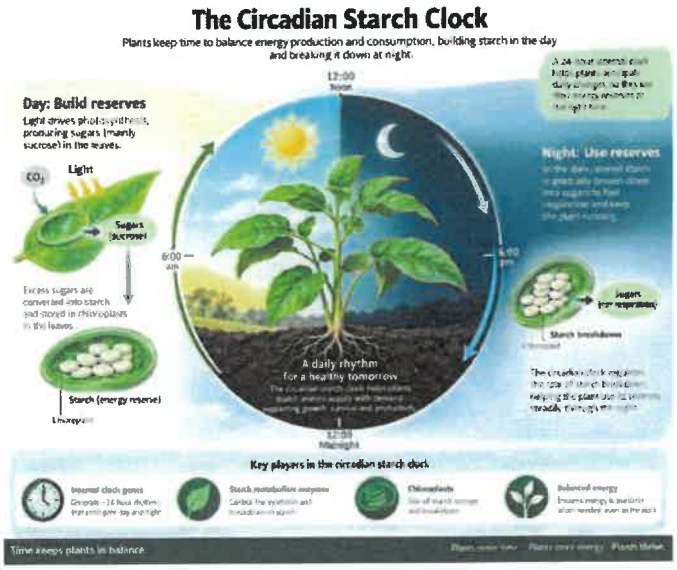

Figure 4: The circadian "starch clock" regulates how stored starch is used throughout the night so that reserves last until dawn.

As darkness falls, plants calculate how much stored starch is available and adjust the rate at which it is used so that supplies last until dawn. This process is controlled by an internal circadian clock that effectively enables plants to "budget" their energy throughout the night.

This biological timekeeping system prevents plants from exhausting their energy stores before sunrise while also avoiding unnecessary starch accumulation. It allows plants to balance growth and survival under constantly changing environmental conditions.

The Role of Starch in Seed Germination

Before seedlings develop leaves and begin photosynthesis, they depend entirely on stored food reserves. Starch acts as the seed's first source of energy.

When a seed absorbs water, enzymes become active and begin breaking down starch into simple sugars such as glucose and maltose. These sugars fuel cell division, root emergence and shoot growth, allowing the young plant to establish itself successfully.

Once the first leaves develop and photosynthesis begins, the seedling gradually becomes independent of these stored reserves. Healthy starch reserves therefore play a critical role in successful germination, vigorous seedling establishment and ultimately strong crop performance.

Starch as an Emergency Reserve During Stress

Starch is not only important for growth. It also serves as an emergency reserve during environmental stress.

When plants experience drought, salinity or extreme temperatures, photosynthesis often becomes restricted. Under these conditions, plants begin converting stored starch into soluble sugars, including glucose, fructose and sucrose.

These sugars perform several important functions:

- They provide energy when photosynthesis is reduced.
- They help cells retain water and maintain turgor pressure.
- They protect proteins and cell membranes from damage.
- They support stress response mechanisms within the plant.

During drought, this starch-to-sugar conversion can mean the difference between survival and death. Once favourable conditions return, plants rebuild their starch reserves and resume normal growth. This dynamic process is a key factor in plant resilience and adaptation.

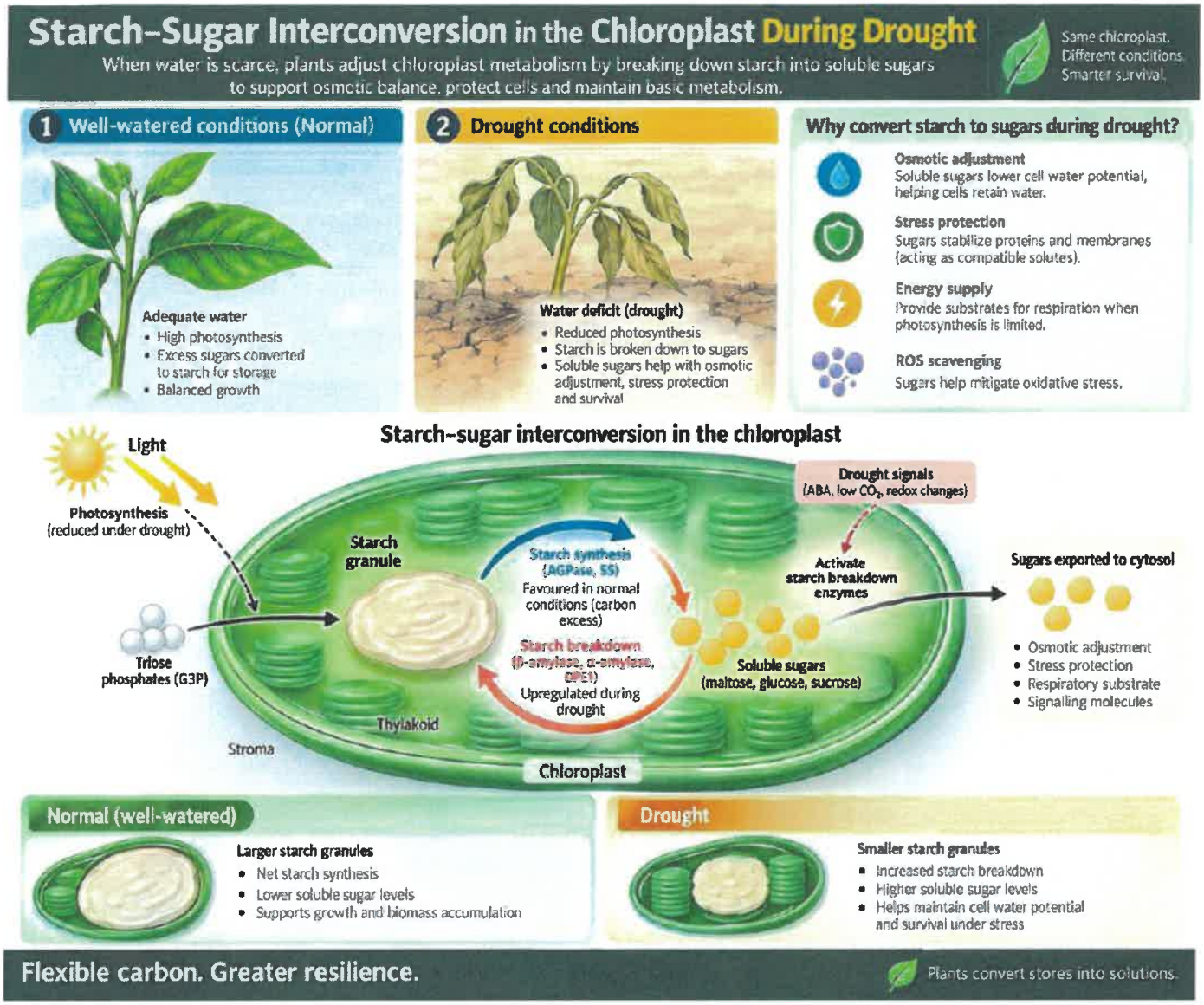

Figure 6: During drought stress, stored starch is converted into soluble sugars that help plants maintain energy supplies and protect cellular structures until conditions improve.

The Future of Crop Improvement

Understanding how plants produce, store and use starch has important implications for agriculture. Starch-rich crops such as maize, wheat, potatoes and cassava form the dietary foundation for much of the world's population. Improving the efficiency of starch production and utilisation can enhance crop productivity, food security and resilience to climate-related stresses.

Today, plant breeders and agricultural scientists are using conventional breeding techniques, biotechnology and genetic engineering to develop crop varieties with improved starch metabolism. These advances may help farmers maintain production in increasingly challenging environments while supporting sustainable agricultural systems for future generations.

Conclusion

Although largely hidden from view, starch is one of the most important substances in plant life. It fuels growth, sustains plants through the night, supports seed germination and provides a vital buffer against environmental stress. As researchers continue to unlock the secrets of plant starch storage and utilisation, this humble carbohydrate is proving to be a cornerstone of crop productivity, resilience and global food security.