

How forgotten beans can help fight malnutrition

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Overview

- Legumes as sustainable protein source
- Peas and chips from tuberous legumes
- A case of forgotten bean in Africa: African Yam Bean (AYB) in Nigeria and Ethiopia
 - Challenges in rehabilitating AYB
 - Understudied tuber formation in legumes
- Challenges in improving forgotten legumes

Legumes as sustainable and nutritious crops



CELEBRATING
#WorldPulsesDay



Food and Agriculture Organization of the United Nations | **SUSTAINABLE DEVELOPMENT GOALS**

10 February
World Pulses Day

Pulses for a sustainable future

World Pulses Day 2023
Building on the success of the International Year of Pulses (IYP) in 2016 implemented by FAO and recognising the potential of pulses to further achieve the 2030 Agenda for Sustainable Development, the United Nations General Assembly (UNGA) designated **10 February** as **World Pulses Day (WPD)**. This celebration provides a unique opportunity to raise public awareness about pulses and the fundamental role they play in the transformation of current agriculture into a more efficient, inclusive, resilient and sustainable agrifood systems for better production, better nutrition, a better environment, and a better life, leaving no one behind.

Soil health and restoration
Pulses are key to resilient farming systems. Not only do they contribute to soil fertility through atmospheric nitrogen fixation, including them in crop rotations can also help to restore poor and degraded soils. Cereals grown in rotation after pulses yield on average 1.5 tonnes more per hectare than those grown without pulses. This is equivalent to the effect of 100 kilograms of nitrogen fertiliser.

Food security and healthy nutrition
Pulses are a valuable and affordable source of plant protein as well as essential minerals and vitamins. Including pulses in agrifood systems therefore contributes to healthier, more nutritious and diverse diets and can help combat micronutrient deficiencies (Hidden Hunger).

Ecosystem services
Including pulses in agricultural systems can help to suppress pests, diseases and weeds. Agricultural systems that include pulses ensure a more efficient nutrient use as they require less

Nitrogen-fixing nodules: special structures on legume roots

- Symbiotic association with specific soil bacteria
- Can generate own nitrogen “fertilisers”



Soybean nodule picture from ManitobaPlus

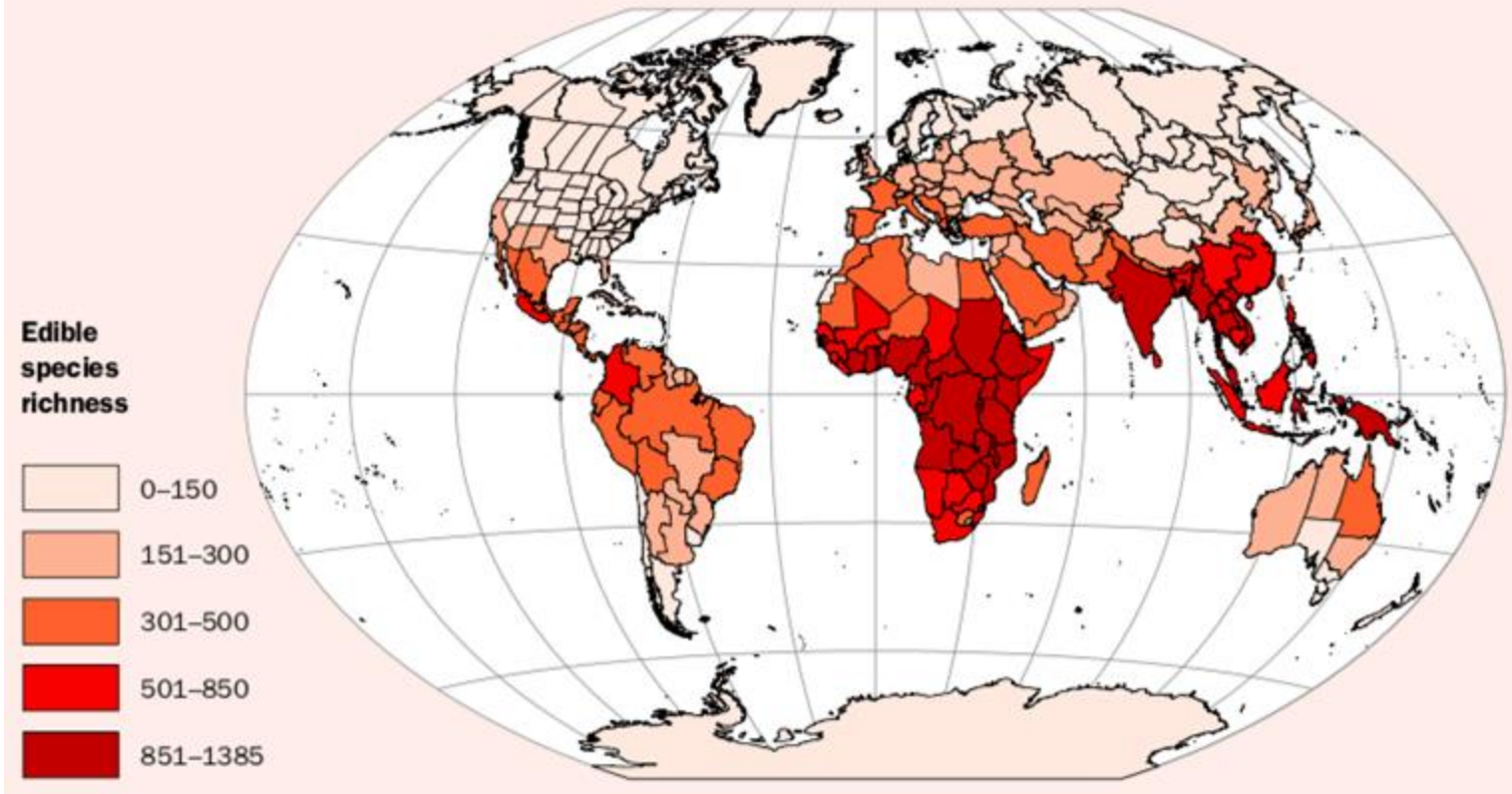


Medicago nodule picture from Wikimedia

Forgotten, neglected, underutilised, orphan legume crops

- **95%** of calories from **30 crop species** with half of calories supplied from maize, rice, wheat (Dwivedi et al, 2017, *Trends in Plant Sci*)
- **625** of 7039 edible species are **legume plants** (highest for any plant families)

FIGURE 3: The global species richness, by country or state, of 6,959 of the 7,039 edible plant species identified by the review team
The darker shading highlights locations where there is high abundance of edible plant species.



Tuberous legume species around the world

Hopniss
Apios americana



Earthnut pea
Lathyrus tuberosus



Kudzu
Pueraria sp.



Winged bean
Psophocarpus tetragonolobus



Ahipa
Pachyrhizus ahipa



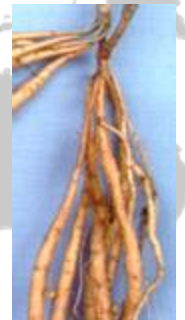
Jicama
Pachyrhizus erosus



African Yam Bean
Sphenostylis stenocarpa



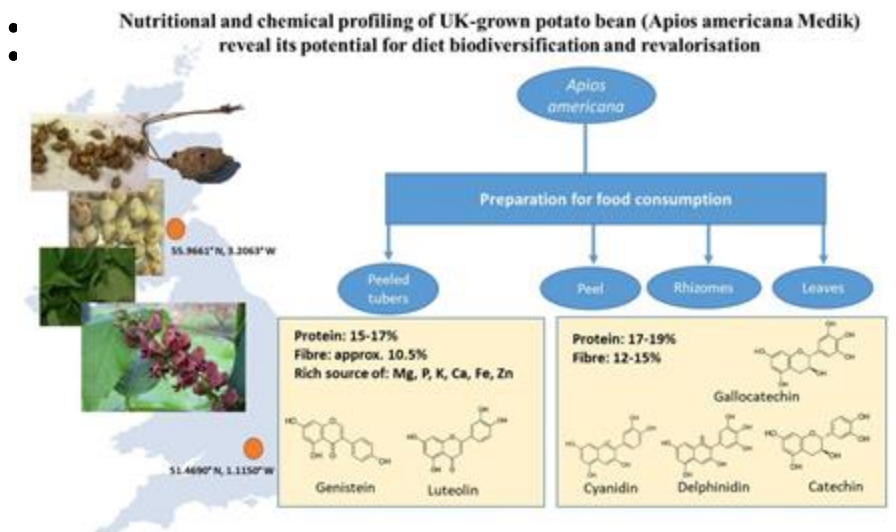
Zombi pea
Vigna vexillata



Bush carrot
Vigna lanceolata

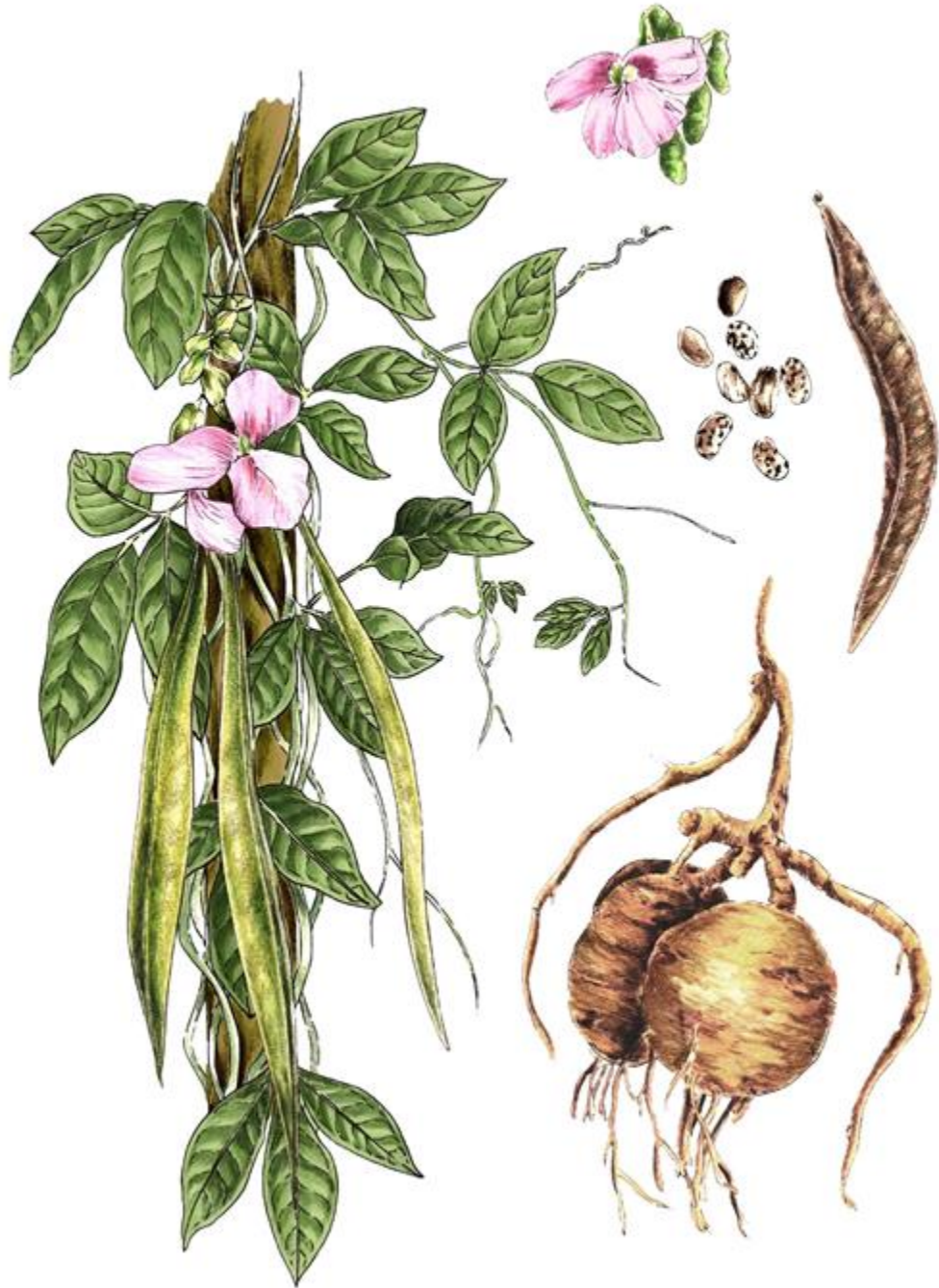
Peas and chips on one plant

- Sustainable protein in beans and tubers
- Tubers can be consumed raw – high amount of resistant starch (low GI)
- Highest amount of protein for tuber crops
- At least two species have edible leaves, flowers, beans, tubers
- Potato bean or hopniss (*Apios americana*): future UK crop for sustainable source of dietary protein and fibers?



African Yam Bean

Sphenostylis stenocarpa



- High protein in beans and tubers - alleviate malnourishment in Nigerian Civil War (1967-1970) (Nwokolo, 1996)
- Higher seed yield per unit land with up to 3000 kg/ha
- Drought-resistant
- Nitrogen-fixing nodules – enrich soil with nitrogen, good for intercropping
- Grown by old farmers – acreage is declining

Challenges in rehabilitating AYB as a sustainable protein crop



Rehabilitation of AYB in Nigeria

- Long cooking time for beans
- Short shelf life of tuber (tuber shrinks 2-3 days after harvest)
- Relatively small tuber size
- Requires staking
- Inconsistent tuber production – unknown environmental factor(s) and genetics
- Outcrossing species – requires huge effort to “clean” the lines

Challenges in rehabilitating AYB as a sustainable protein crop



Rehabilitation of AYB in Ethiopia

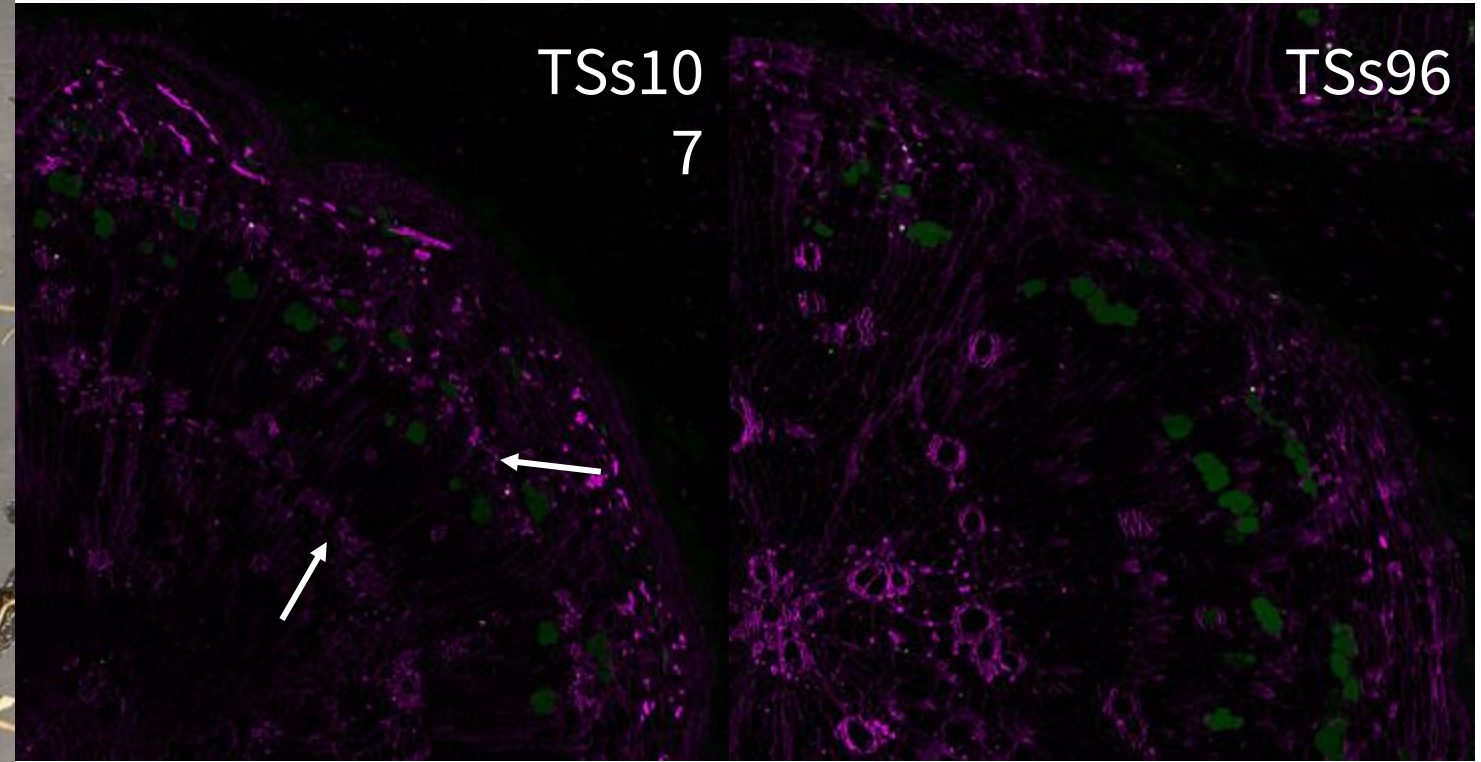
- Lack of information on the current status of AYB in the country
 - Used to be present in Ethiopia
- Disease affecting seed production
 - *Colletotrichum sp.* causing pod blight disease
 - Infection reduces during dry seasons – AYB relies on tubers for pod production
- Only relying on agronomic practices to reduce infection

What we've learned...

- Recognised for its nutritional properties
- Potential to become commercial legume crop beyond security crop
- Ideal traits for crop improvement:
 - Stable **tuber** production
 - Bigger and more **tubers**
 - Shorter cooking time for the beans



Tuber formation in AYB is different to other known tuber crops



Challenges in improving forgotten legumes

- Lack of dedicated physiological studies
- Nutritional properties have not been fully explored
- Dependent on slow conventional breeding
- Most legumes are recalcitrant:
 - Not amenable to transformation
 - Difficult or almost impossible to regenerate after gene-editing or transformation
- **Solution:** Novel and accessible technology to improve legume regeneration and transformation

Conclusion

- Forgotten beans can contribute to a resilient food system
- Tuberos legumes as sustainable sources of nutrition (protein and carbohydrates)
- Challenges in rehabilitating and improving forgotten beans:
 - Lack of studies
 - Different physiology to known crops
 - Difficult transformation
 - Slow breeding process

Thank you

AYB project in Nigeria

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AYB project in Ethiopia

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Tuberous legume project

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