Society for Underutilized Legumes (SUL)

SUL
2020
Lecture Series

promoting pulses with pluses
Orphan Legumes and Global pandemic: insights to the need to rescue our cultural foods

Daniel B. Adewale, PhD
Department of Crop Science and Horticulture
Federal University Oye-Ekiti, Nigeria
+234 803 922 8085
d.adewale@gmail.com
President, Society for Underutilized Legumes
Fellow, African Plant Breeding Academy
Fellow, African Bioscience Challenge Fellowship
https://orcid.org/0000-0002-0249-8629
Presentation Outline

1. Introduction
2. The Legumes
3. Orphan crops
4. Orphan Legumes
5. Insights
6. Way forward
7. Research Gaps in orphan legumes
8. Conclusion
There is COVID-19, so........?

COVID-19 will expire soon
Malnutrition, poor health, hunger, and even starvation are still the world’s greatest challenges.
Introduction

“So in our pity to prevent the demise of the orphan crops (especially legumes), we formed the rescue team - SUL”

@ www.sulegumes.org

......promoting pulses with pluses
LEGUMES
Plate 1: Pictorial Legume Diversity
Nutritional benefit of Legumes

- Legumes are a crucial source of a variety of phytochemicals that are important for human health.
- These include protein, low GI (glycaemic index) carbohydrate, fibre, minerals, vitamins, carotenoids and polyphenols.
- Legumes contribute to reduced risk of mortality because of their benefits against major chronic diseases and their risk factors — including cardiovascular disease, diabetes, cancer, obesity and gut health.
- Increasing evidence suggests that legumes can act as prebiotics that potentially alter bowel flora, affecting production of gut hormones and consequently appetite.
- A legume-rich diet has food, health and nutrition benefits for humans and livestock alike (Foyer et al., 2016).
ORPHAN CROPS
Definitions

1. They are not extensively traded
2. They receive little attention from researchers
3. They are restricted to marginal environments
5. Their Breeding program lags behind major crops
6. Unconsidered in the agricultural mainstream and policies
7. Some of them have agronomic, genetic, economic and socio-cultural constraints
8. They are strongly linked to the cultural heritage of their places of origin
9. They are ecotypes, landraces or wild species
10. They are adapted to some specific agro-ecological niches
11. Their importance are not fully exploited
12. Cultivations are usually in small scale
13. Attending low production leads to poor or low availability of products
14. Their distribution, biology, cultivation, and use etc. are poorly documented.

Sources: Muhanji et al. (2011); Moe et al. (2012); Padulosi et al. (2013); Tumwet et al. (2014)
Definitions

Hence, they are significant in:
1. in improving food security
2. in providing means of health
3. in improving nutrition,
4. generating income,
5. maintaining ecosystem health
6. empowering the poor and marginalized,
7. promoting cultural diversity
8. food for livestocks
9. promising industrial products
10. climate smart crop
11. soil fertility enhancers
12. etc.

Sources: Muhanji et al. (2011); Moe et al.(2012); Padulosi et al. (2013); Tumwet et al. (2014)
Improvement of food and nutrition security (social benefits)

Biodiversity conservation and agro-ecosystems stability (Environmental benefits)

Income and Employment generation (Economic benefits)

Figure: Broad Significant potentials of Orphan crops
Why are Orphan crops threatened?

• Expansion of human population
• Habitat destruction, degradation, deforestation etc.
• Use of pesticide and herbicide
• Over-exploitation
• Introduction of exotic species
• Natural calamities
• Lack of or poor conservation programs
• Lack of or poor awareness of the importance of orphan crops
Challenge to Orphan crop Scientists

Why has Orphan crops remained orphan?

• Lack of clear research goals
• Limited funding directed at NUS and
• Journal apathy toward publishing work on NUS.
• Lack of interest from emerging researchers.
• Lack of interest from established researchers.
• Poor understanding of NUS within the NUS community
• Inability to articulate a roadmap for NUS’ promotion
ORPHAN LEGUMES
Some domesticated underutilized legumes

- Mungbean (*Vigna radiata*),
- Adzuki bean (*V. angularis*),
- Ricebean (*V. umbellata*),
- Lupin (*Lupinus mutabilis*),
- Bambara groundnut (*Vigna subterranea*),
- Jack bean (*Canavalia ensiformis*),
- Grasspea (*Lathyrus sativus*),
- Lablab (*Lablab purpureus*),
- Pigeon pea (*Cajanus cajan*),
- African yam vean (*Sphenostylis stenocarpa*),
- Kersting’s groundnut (*Macrotyloma geocarpum*)
- etc............
<table>
<thead>
<tr>
<th>S/N</th>
<th>Legume species</th>
<th>Edible parts</th>
<th>Distributions in Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Sphenostylis spps</em></td>
<td>Seed and tubers</td>
<td>East/Central/West Africa</td>
</tr>
<tr>
<td>2</td>
<td><em>Tylosema esculentum</em></td>
<td>Seed and tubers</td>
<td>Southern Africa</td>
</tr>
<tr>
<td>3</td>
<td><em>Tylosema fassoglense</em></td>
<td>Seed and tubers</td>
<td>Southern Africa</td>
</tr>
<tr>
<td>4</td>
<td><em>Bauhinia petersiana</em></td>
<td>Seed</td>
<td>Southern Africa</td>
</tr>
<tr>
<td>5</td>
<td><em>Vigna lobatifolia</em></td>
<td>Tuber</td>
<td>Southern Africa</td>
</tr>
<tr>
<td>6</td>
<td><em>Vigna fischeri</em></td>
<td>Tuber</td>
<td>East/Central Africa</td>
</tr>
<tr>
<td>7</td>
<td><em>Vigna ambacensis</em></td>
<td>Tuber</td>
<td>Tropical Africa</td>
</tr>
<tr>
<td>8</td>
<td><em>Vigna reticulata</em></td>
<td>Tuber</td>
<td>Tropical Africa</td>
</tr>
<tr>
<td>9</td>
<td><em>Vigna vexillata</em></td>
<td>Tuber</td>
<td>Tropical Africa</td>
</tr>
<tr>
<td>10</td>
<td><em>Mucunna pruriens</em></td>
<td>Seed</td>
<td>West Africa</td>
</tr>
<tr>
<td>11</td>
<td><em>Mucuna sloanei</em></td>
<td>Seed</td>
<td>West Africa</td>
</tr>
<tr>
<td>12</td>
<td><em>Dioclea reflexa</em></td>
<td>Seed</td>
<td>West Africa</td>
</tr>
</tbody>
</table>

Source: Dakora (1996)
Ten curtains
African yam bean
*Sphenostylis stenocarpa*
(Hochst ex. A. Rich) Harms

Native to West/Central Africa.
It is the yam bean for Africa
Highly nutritious tuberous legume.
Winged beans (*Psophocarpus tetragonolobus*)

**Other names:**
Goa bean, four-angled bean, four-cornered bean, manila bean, princess bean, Cigarrillas, Asparagus bean, Dragon bean

It grows abundantly in the hot, humid equatorial countries of South and Southeast Asia for the pulse. It produces tubers too
BENEFITS OF WINGED BEANS

- Low In Calories
- High In Protein
- Vitamins And Minerals
- Contains Healthy Fats
- Prevents Premature Skin
- Promotes Skin Elasticity
- Supports Immunity
- Prevents Birth Defect
- Healthy Teeth And Nails
- Protect From Anemia
- Prevent DNA Damage
- Lifts Mood
Lima beans (*Phaseolus lunatus*)

Other names:
- Butter bean
- Sieva bean
- Double bean
- Madagascar bean

Grown for its edible seeds.
Bambara groundnut (Vigna subterranean)

The name originates from Bambara, a district on the upper Niger near Timbuktu.

Traditionally, was cultivated, mainly by women, in semi- and arid regions.

It has been produced mainly for the sustenance of families locally.

It is called a balanced meal.
Kesting Groundnut *Macrotyloma geocarpum* (Harms) Marechal

Formerly *Kestingiella geocarpa*

A major food legume displaced by groundnut (*Arachis hypogea*)

It is almost extinct in Africa.
Hyacinth bean (Dolichos lablab or Lablab purpurea)

- Has more resemblance to Lima bean
- Displays beautiful pinkish-purple blossom flowers
- Produces interesting reddish-purple pods
- Pod almost same in size as lima bean pods.
- It is a perennial tropical Africa bean
- It is important food
Jack bean (*Canavalia ensiformis*)

Very important as animal fodder and human nutrition
Sword bean (*Canavalia gladiata* (Jacq.) DC.)

*Canavalia gladiata* and *C. ensiformis* are very close species. They were distinguished in Floras but genetic assessment failed to show differences between them (Bosch, 2004).
Morama bean (*Tylosema esculentum*)

An undomesticated legume also called **Gemsbok bean**

It is a perennial legume

Native to arid areas of southern Africa.

Has prostrate or trailing growing habit

Vines could be 3 metres

Has forked tendrils that facilitate climbing.

Seeds are large brownish-black in colour.
Dioclea reflexa Hook f. Flore de Guyane

It is a wild undomesticated legume species

The plant is harvested from the wild for local use as a food, medicine and source of materials.

Seed have wider potential use in human food

A source of an effective larvicide.
**Mucuna sloanei** Fawcett & Rendle [family Leguminosae-Papilionoideae]

An undomesticated climbing legume up to 6–8 m high

Found in savanna woodland, deciduous forest and secondary jungle

Common in Guinea-Bissau to West Cameroons and Fernando Po etc.

Widespread in the African tropics.
Insights

• African indigenous agricultural knowledge and local foods of Africa are endangered.
• A considerable number of local food crops have been displaced.
• Some nutritionally important wild food plants still remain undomesticated.
• Knowledge of food and medicinal uses of some crops are eroding.
• Process of displacement of indigenous food crops species still continues.

Leading to:

• Marginalization of indigenous domesticated crop species
• None consideration of the undomesticated species
• Uniquely rich tuberous legumes (*Vigna lobatifolia*, *V. vexillata* and *Sphenostylis stenocarpa*) have no relevance beside introduced tubers.
• Protein-rich indigenous African tuber legumes are hardly known outside.
Insights

**Soil properties**

• Nodulated legumes have been used by indigenous peoples in Africa for centuries, their full potential has never been realized.

• All indigenous African legumes nodulates and fix nitrogen, with varying degrees of effectiveness, using a range of bacterial symbionts (Sprent et al., 2010).

• ....the tendency in agriculture and forestry to use exotic species....... ignores the potential of the native species, which are arguably better adapted to their environment (Sprent et al., 2010).

**Nutrition**

• Malnutrition and disease are closely associated

• Poor nutrition causes nearly half (45%) of deaths in children under five, which accounts for about 3.1 million children each year (FAO, 2014).

• **Grain legumes form only a minor part of most current human diets** (Foyer et al., 2016).
Way Forward
The Lock-in Situation

• A lock-in situation arises when institutions and role players in decision making continue with a conventional approach, despite that it is no longer leading to desired outcomes (Pahl-Wostl, 2009).

Globally:
• About 80,000 plant species are used for food and fiber as well as industrial and medical purposes (Kermali et al., 1997). The number of edible plant species reported in the literature varies; however, about 10,000 appears to be a realistic number (Kunkel, 1984; Wiersema et al., 1999).

Nigeria:
• Out of more than 5,000 plant species available in Nigeria, less than 20 are currently developed and used for food and as industrial raw materials (Ogunwusi and Ibrahim, 2016).

Crop Diversification is the way forward

• “Food and nutrition security” exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” [FAO, WFP, IFAD, 2012].
Assemblage of germplasm

PGR Evaluation for potentials and diversity

Understanding of the floral structure

Initiate a simple breeding and propagation program

Harness the economic importance details and promote awareness

*FIGURE 1:* A schematic procedure to rescue genetic resources of orphan crops
FIGURE 2: A schematic illustration for research, development and innovation (RDI) strategy for promoting underutilized crops in South Africa.

Source: Mabhaudhi et al., 2017
implement, monitor and refine strategy

develop an up-grading strategy

assess opportunities/identify entry points

map/analyse selected NUS-VC

select NUS to promote

promoting VCD for NUS

Figure 3: Value chain development (VCD) for orphan crop
Some Research GAPS

- Much diversity work already done (on AYB and Bambara nut).....how far has the diversity of other legumes been harnessed?
- What problems has the diversity study addressed?
- How much variation creation work is ongoing? –
- Has Mutation, crossbreeding etc... started on your side?..
- Please note: The captured variation may not be able to provide solutions to some of the problems identified
- Pollen/stigma receptivity synchrony needs to be investigated
- Poor knowledge on flowering synchrony and photoperiodic sensitivity
- Genetic estimates and understanding of gene action on traits is lacking in most orphan crops
Some Research GAPS

• Poor documentation of some of the genetic resources at collection
• Low quantity of available genetic resources for distribution
• Proportion of diversity capture for orphan crops is still low
• Informative cultural rudiments on orphan crops may be facing out
• Basic research protocol to guide applied research into orphan crops are lacking
• Seed and planting propagules storage behavior of orphan crops
• Seed health of orphan crops needs to be understood
• Descriptors development and updating of the recent for orphan crops is needed.
• Mapping population and trait development is yet fully commence in majority of the minor crops
Conclusion
straightening the two major terms

**Neglected** species:
- are those grown primarily in their centers of origin or centers of diversity by traditional farmers, where they are still important for the subsistence of local communities. Some species may be globally distributed, but tend to occupy special niches in the local economy and in local production and consumption systems. While these crops continue to be maintained by socio-cultural preferences and local use practices, they remain inadequately characterized, and neglected by research and conservation.

**Underutilized** species:
- were once more widely grown but are falling into disuse due to various agronomic, genetic, economic and cultural factors (**CONSTRAINTS**). Farmers may find these species less **COMPETITIVE** than other crop species in the same agricultural environment. Consumers may be influenced by **CHANGING** food culture, **CHALLENGES** of processing and availability. The eco-geographic decline of these species may erode their genetic base thus restricting future development options.

**…..genetic resources are always in danger**

*Source: IPGRI Strategy 1998*
Some puzzling questions

• Have we identified all possible utility that orphan crops has to offer?
• What is the quantitative index of the genetic erosion on each of these crop?
• How fast can we move to harness still available traditional information and germplasm from the traditional curators before the earth push them out?
• Hmm!!!, but do we have means to speed up our mission of rescue germplasm and traditionally valuable facts?
• Are there some crops you used to know and you can’t find available again?
• How close are you to the nature?
• Do you know how close to extinction are some phylotaxa?
• Do you have an idea on how to woo funding for orphan crop research?
• How sure are we that we’ll be able catch up with the moving bus.......indigenous plant erosion?
1. Orphan crops are not: ‘poor man’s food’.
2. Deliberate focus on research, teaching, policymaking, trading and farming NUS.
3. Increase research focus on many NUS; their adaptive qualities and links with nutrition, health and livelihoods.
4. Formalized *ex situ* global NUS conservation programmes.
5. Creation of full range participatory partnering to promote NUS conservation.
6. Upgrading NUS market chains and development of market valued products.
7. Thinking out of your box: woo research collaboration for novelty, promote conservation for sustainability and evolve new and winsome products from field to the table.
8. We can turn all the constraints to opportunity

**To attain future food and nutrition security, the globe requires a paradigm shift from the current lock-in situation.**
Acknowledgement

• My family
• My friends
• My students and Mentees
• – the visible
• - the unreachables
• - the frequents and the visitors
• - the online types
• - etc.
• www.google.com – For most of the images
Thanks for your attention
Some References


Some References

