leveraging livelihood benefits from NUS through (agricultural) research: challenges, needs and opportunities

Theme 1 Resilience and Livelihoods
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Theme 1 Resilience and Livelihoods

a) Diversification for food security in Sub-Saharan Africa

This sub-theme will address the role of neglected and underutilized species (NUS) in resilient food production systems in Africa. Contributions will review practices and lessons learnt on how NUS are deployed by farmers to reduce biotic and abiotic risks, including adapting to climate change. Analyses of challenges, needs and opportunities for scaling up and mainstreaming these efforts for wider impact will also be included.

b) NUS for nutrition and health

The nutritional and health value of local crops. Many NUS species are known to be of very high nutritional value and to play a strategic role in sustainable food systems. Contributions to this theme will attempt to quantify such benefits.

1. Introduction/problem definition/definitions
   - Resilience
   - Livelihoods
2. (Bio)Diversity makes the world go round
3. Research: gaps, challenges, needs and opportunities

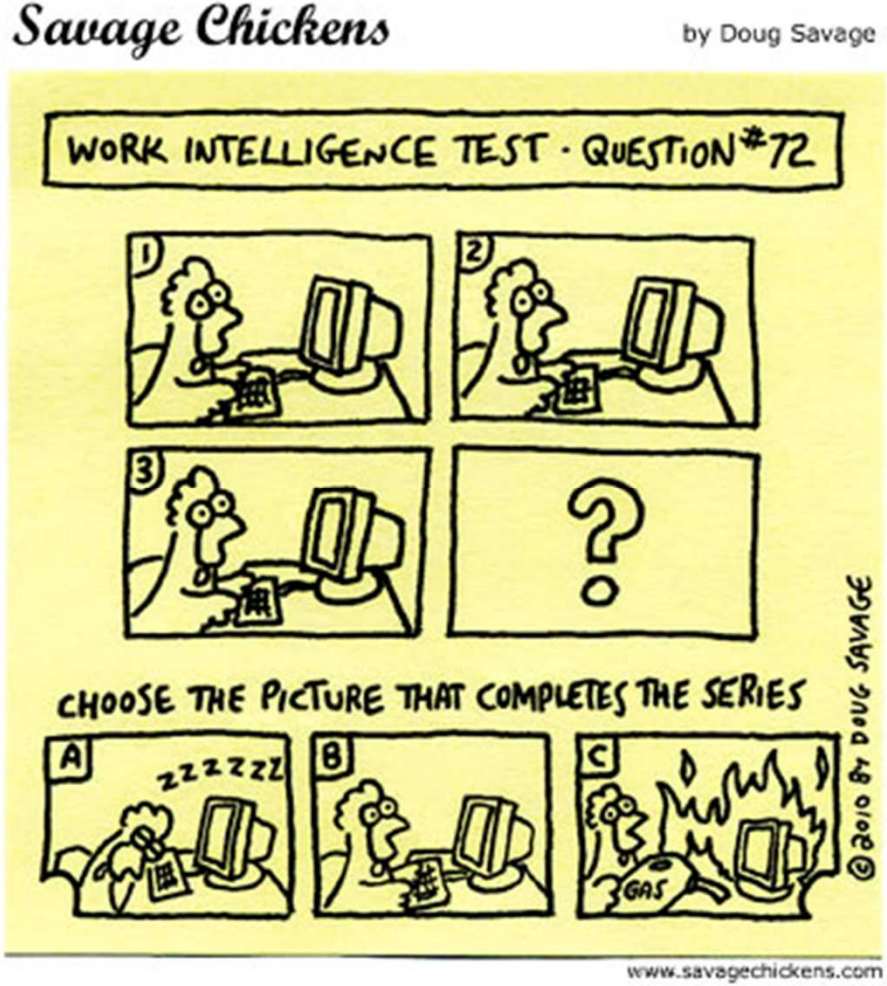
1. Introduction/problem definition/definitions
   - Resilience
   - Livelihoods
2. (Bio)Diversity makes the world go round
3. Research: gaps, challenges, needs and opportunities

… or: what kind of world do we envision ?..

.. a dull, monotonous, boring, repetitive, uniform, wearysome , tiresome, tedious, .. world ?..

.. a dull, monotonous, boring, repetitive, uniform, wearysome , tiresome, tedious, .. world ?..

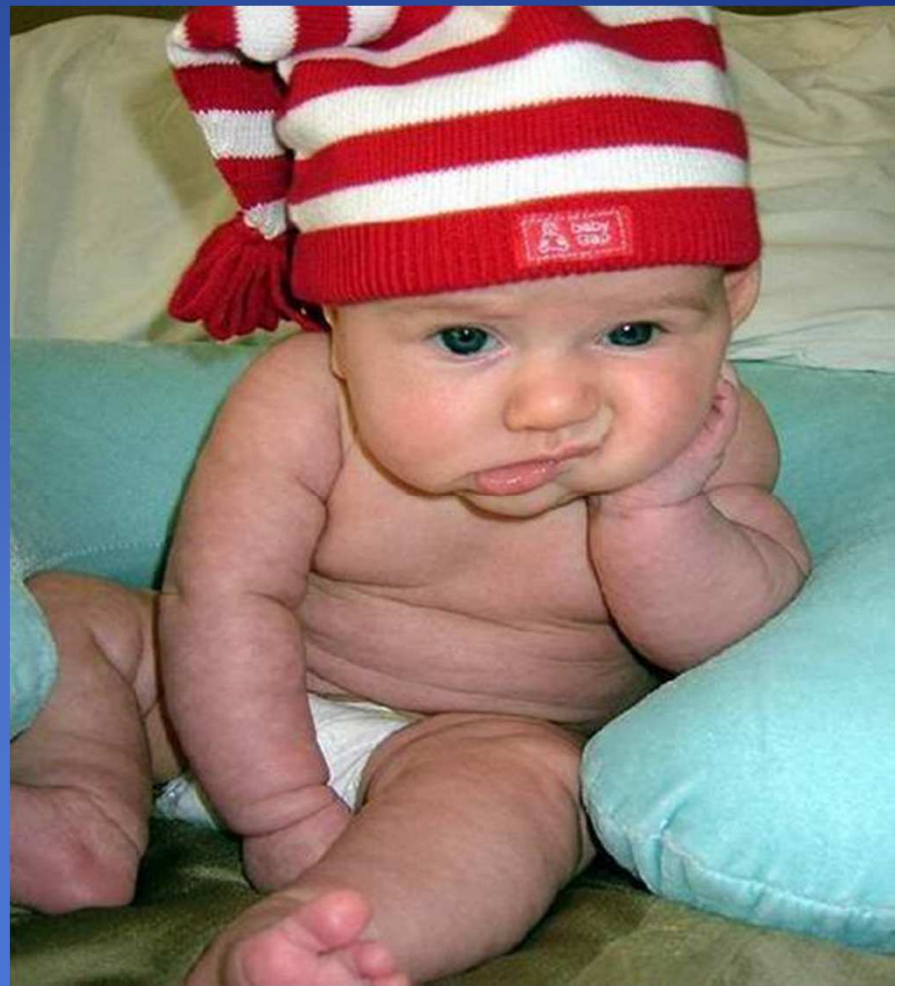
.. full of repetition ?...



.. a dull, monotonous, boring, repetitive, uniform, wearysome , tiresome, tedious, .. world ?..

.. full of repetition ?...

.. that wears you down ?...



.. that's leading to an unhealthy life ?..

.. promotes uniformity, monoculture,..?..

.. or, do you want to live in a resilient world …

.. or, do you want to live in a resilient world …

.. that is diverse, and well-equiped to confront difficulties, adversity,…

resilience… definitions…

1. the ability of a substance or object to spring back into shape; elasticity

2. the capacity to recover quickly from difficulties; toughness

resilience… against a background of globalisation in lifestyles…

globalization and changes in lifestyle, accompanied by standardization of diets and food cultures, are converting humankind's centuries-old culinary heritage based on biodiversity, into a mere curiosity

resilience … against a background of globalisation in lifestyles…

biodiversity-rich dishes, whose vitamins and micronutrients are strategic for nutritional security and for reducing the incidence of obesity and cardiovascular disease, are being replaced by foods rich in energy but poor in nutritional elements

the big three, maize, wheat and rice, represent a yearly production of ~ 3 x 600 mio t, or a total of ~1,800 mio t (one third used as feed)

comparative energy and protein content of some cereals, tubers, legumes and oilseeds (per 100 g)

Food	Energy *(kcal)*	Protein *(g)*
Maize, white	357	9.4
Rice, brown hulled	357	8.1
Fonio meal	343	10.5
Millets	345	10.4
Sorghum	345	10.7
Cowpeas	342	23.1
Beans *(Phaseolus spp.)*	336	23.0
Groundnuts	549	23.2
Sesame	558	17.9
Soybeans	405	33.7
Cassava flour	340	1.5
Cassava, fresh	153	0.7
Yam flour	317	3.5
Yam, fresh	104	2.0
Sweet potato	114	1.5
Taro	113	2.0
Plantain	128	1.0

Source: FAO/United States Department of Health. Education and Welfare, 1968.

resilience,… against a background of biodiversity loss…

over 60 % of the world's major ecosystem goods and services have been degraded or used unsustainably (MEA)

the demise of key ecosystems of the developing world include mangroves (35 % either lost or degraded), coral reefs (30 %) and tropical forests (30 %)

resilience,… against a background of biodiversity loss…

over the next 50 years, global biodiversity loss will accelerate, leading to the extinction of at least 500 of the 1,192 currently threatened bird species and 565 of the 1,137 mammal species

the remaining areas of relatively undisturbed ecosystems and species richness are mainly in tropical, developing regions

LDCs already account for 71 % of global water withdrawal, and their demand is expected to grow by 27 % in 2025

as a consequence…

for millions of people, particularly the poor, the current erosion of their food culture is dramatically reducing income opportunities and diet-related sustainability options

Global status of key ecosystem goods and services

Condition globally has been enhanced	Condition globally has been degraded	Condition globally is mixed
Crops	Capture fisheries	Timber
Livestock	Wild foods	Cotton, hemp, silk and other fiber crops
Aquaculture	Wood fuel	Water regulation
Global climate regulation	Genetic resources	Disease regulation
	Biochemicals, natural medicines and pharmaceuticals	Recreation and ecotourism
	Fresh water	
	Air quality regulation	
	Regional and local climate regulation	
	Erosion regulation	
	Water purification and waste treatment	
	Pest regulation	
	Pollination	
	Natural hazard regulation	
	Spiritual and religious values	
	Aesthetic values	

Source: Adapted from Millennium Ecosystem Assessment (2005, Table 1).

resilience … against a background of a globalising economy… (IUCN, 2010)

… the concept of **resilience** is highly **relevant to economics** in general and the Green Economy concept in particular

resilience of an economy is intimately **linked to its sustainability**

concept of resilience is most appropriately used to assess its **capacity to absorb shocks** without resulting in a change of state

from **an ecological perspective**, emphasis on the role of **biodiversity in sustaining ecosystem functions** (Hooper, 2005)…

resilience … against a background of a globalising economy… (IUCN, 2010)

… in an economic perspective, resilience allows to **analyze vulnerability and dependence of societies on their natural resources base**, and

the **capacity** that **local economies** have for ensuring that they are **resilient to disturbances** (e.g. climate change; market fluctuations, etc.) (WRI, 2008)…

resilience also highlights the **importance of anticipating potential thresholds** and **tipping points** for a global economy that is expanding within a finite biosphere is faced with (Rockström et al., 2009)…

resilience … against a background of a globalising economy...

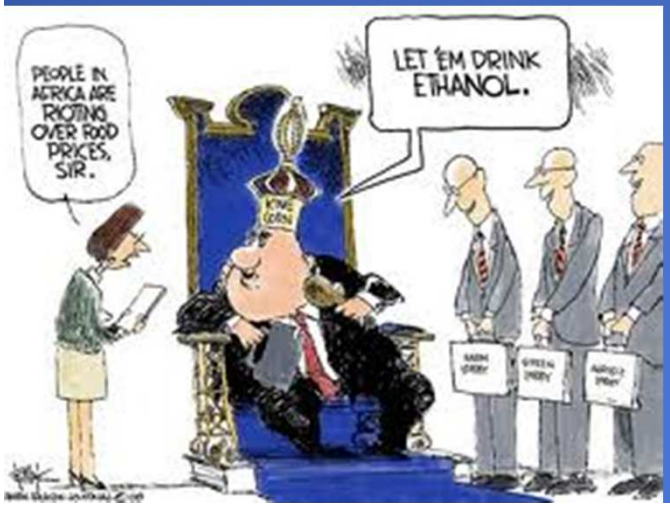
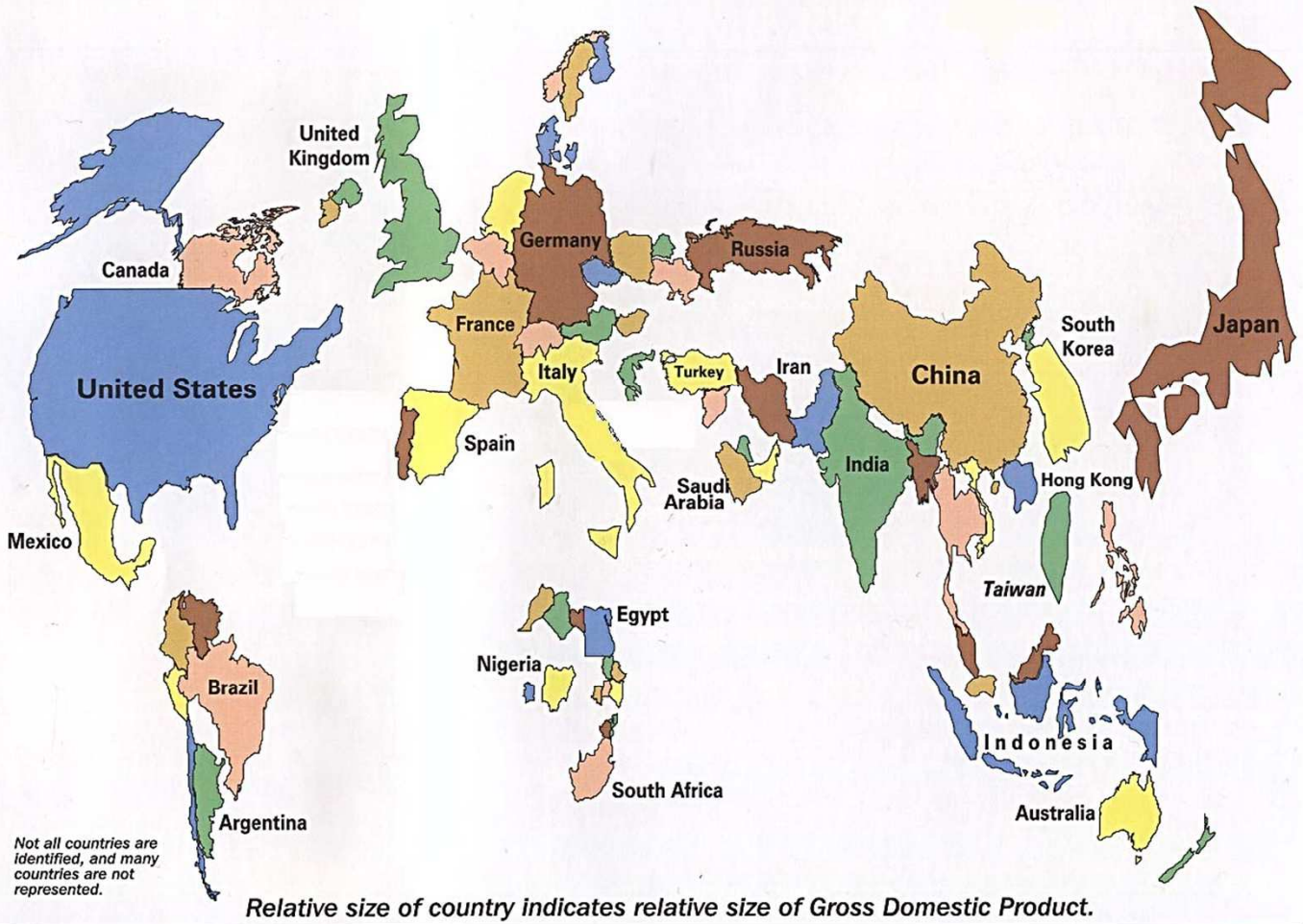


Figure 5. Market Size by Gross Domestic Product, 1995



Relative size of country indicates relative size of Gross Domestic Product.

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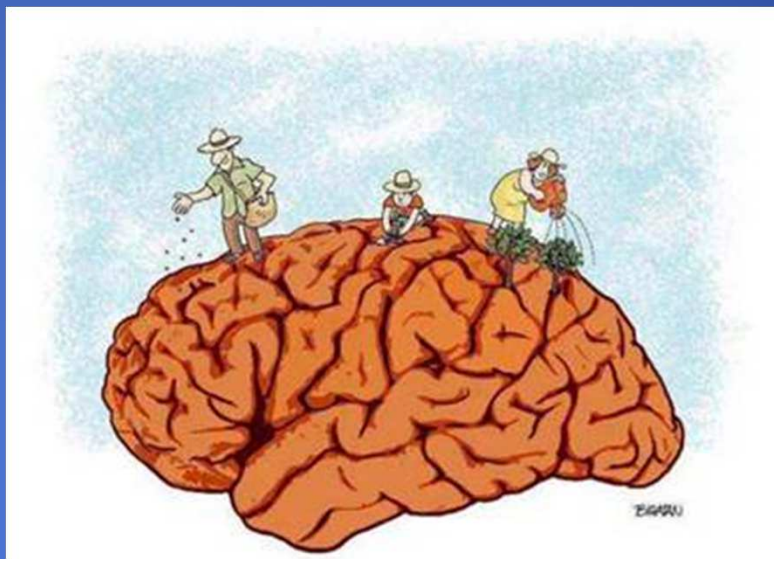
the role of NUS/biodiversity in building resilience – food for thought

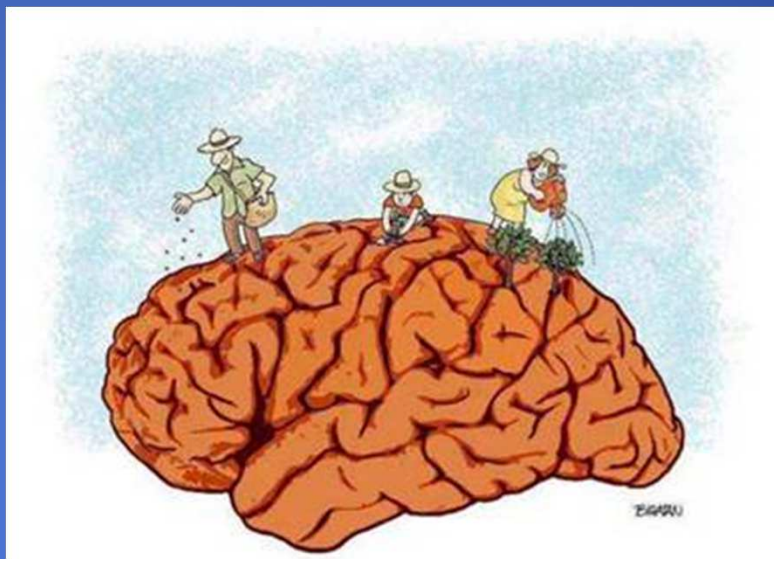
it is our contention that **NUS/(agro)biodiversity are key to** help **attain a more resilient production system c.q. livelihood** for resource- poor farmers, and people in general

through **provision of subsistence products and income**

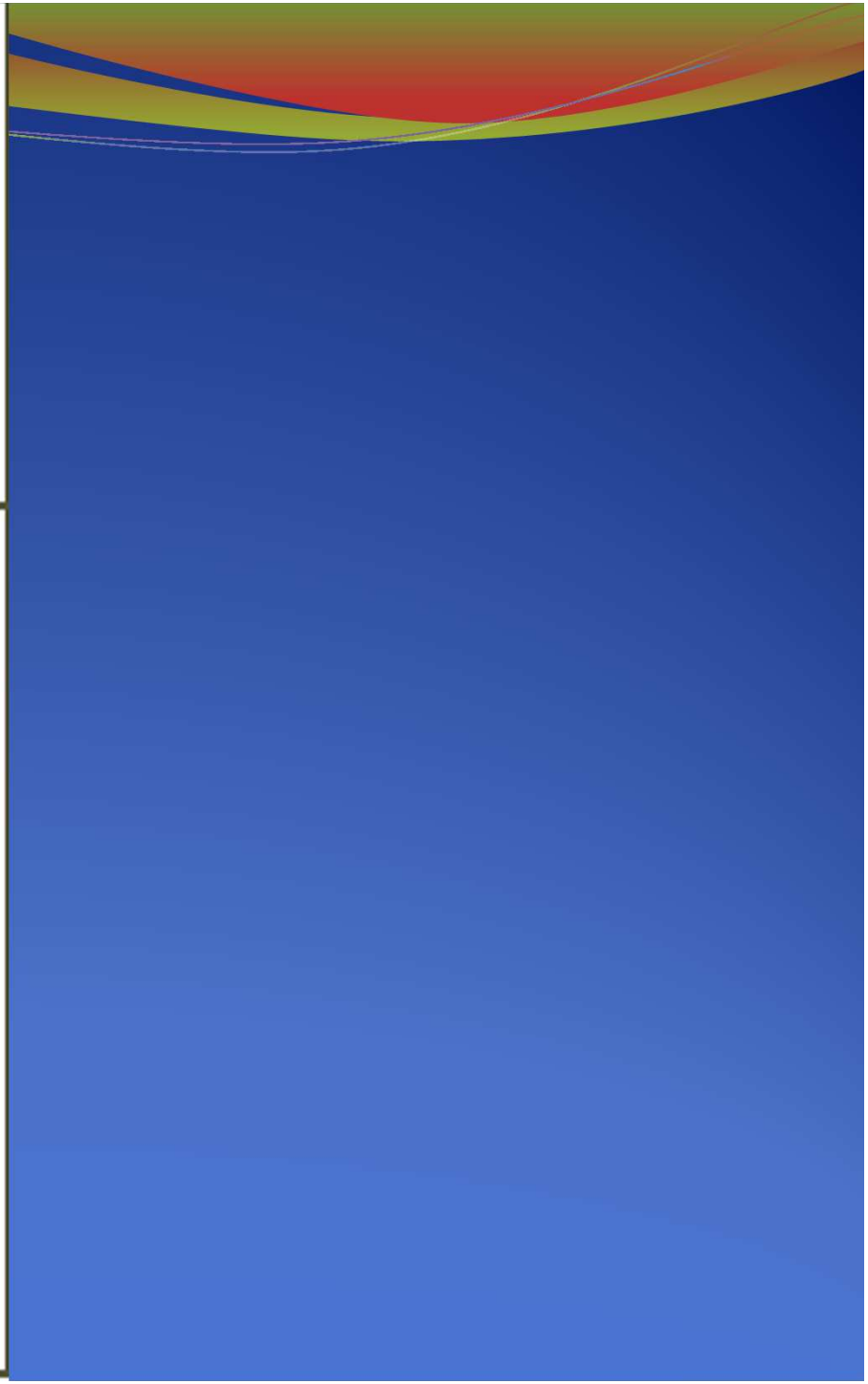


the role of NUS/biodiversity in building resilience – food for thought

more in general, NUS/biodiversity at three levels - ecosystems, the species they contain and the genetic diversity within species – can/should/must contribute to **increased food security** and **improved nutrition** (Toledo Burlingame/FAO), as essentials in **resilience build-up**



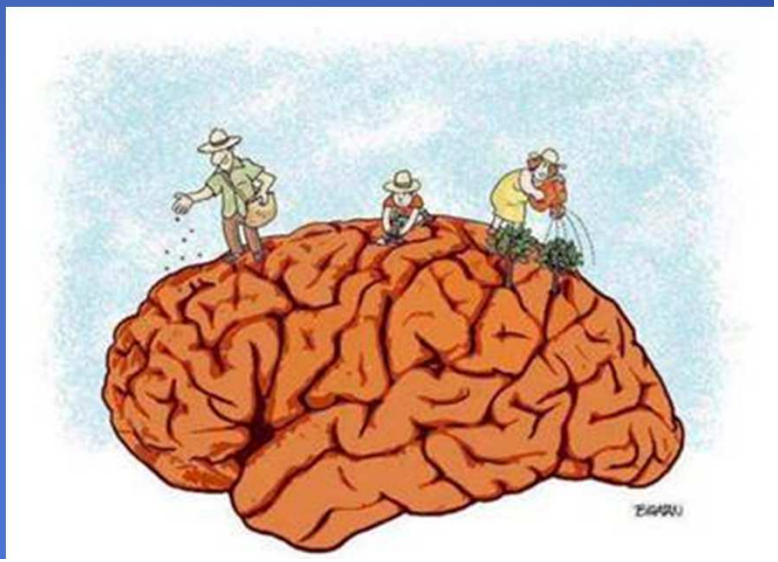
Provisioning Services	Cultural Services
▪ Food, Fiber and Fuel ▪ Genetic Resources ▪ Biochemicals ▪ Fresh Water	▪ Spiritual and religious values ▪ Knowledge system ▪ Education / inspiration ▪ Recreation and aesthetic value
Regulating Services	**Supporting Services**
▪ Invasion resistance ▪ Herbivory ▪ Pollination ▪ Seed dispersal ▪ Climate regulation ▪ Pest regulation ▪ Disease regulation ▪ Natural hazard protection ▪ Erosion regulation ▪ Water purification	▪ Primary production ▪ Provision of habitat ▪ Nutrient cycling ▪ Soil formation and retention ▪ Production of atmospheric oxygen ▪ Water cycling

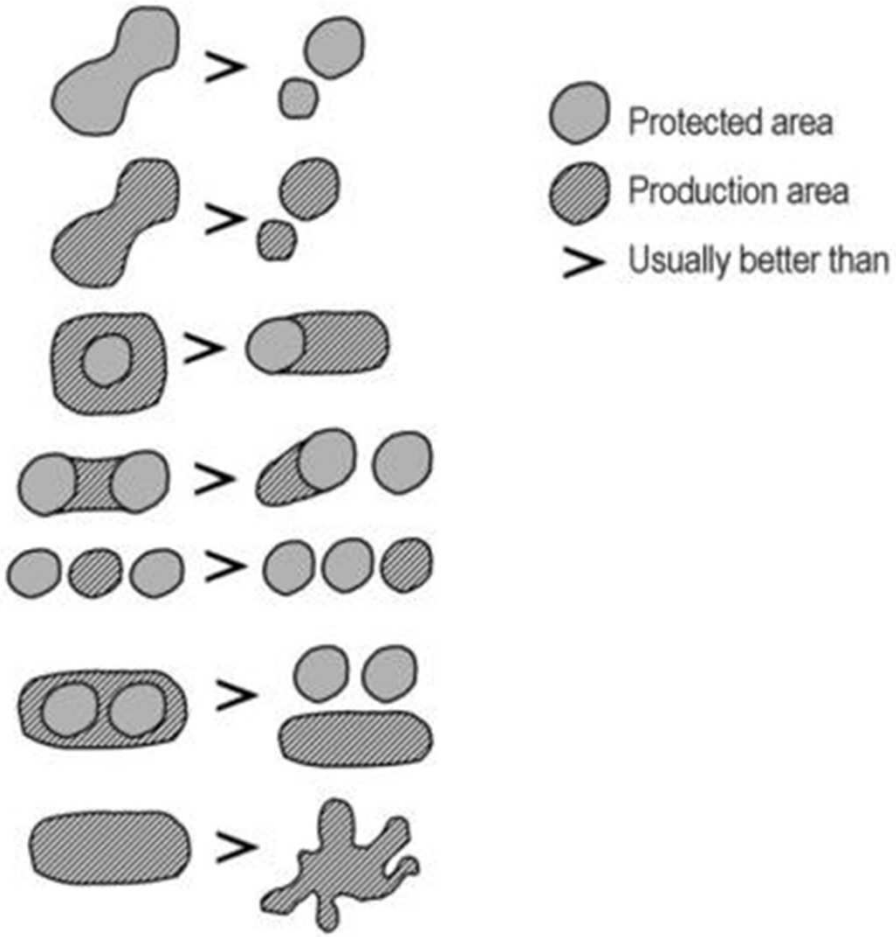


the role of NUS/biodiversity in building resilience – food for thought

agriculture often represents a significant threat to the preservation of biodiversity

however, **productive landscapes** can also **contribute** to the **conservation of (agro)biodiversity** (McNeely and Sherr, 2001)



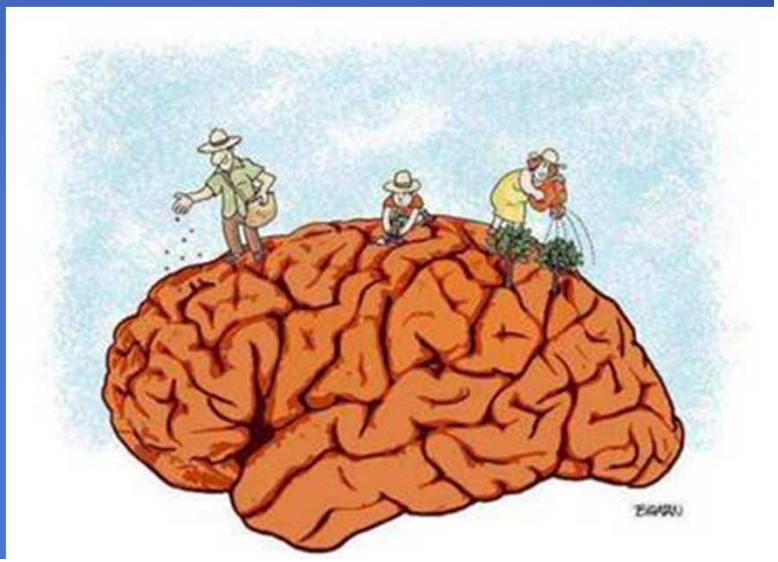


configurations of protected and production forest that favour biodiversity

the role of NUS/biodiversity in building resilience – food for thought

.. the place of the agricultural sector in a green economy inevitably involves a consideration of global markets and supply chains

.. it also needs to be framed within the broader context of **rural development**…



the role of NUS/biodiversity in building resilience – food for thought

.. good reads

IUCN's Green Economy Guidebook

(http://cmsdata.iucn.org/downloads/tpa5_guidebook_august_2010.pdf)…

and

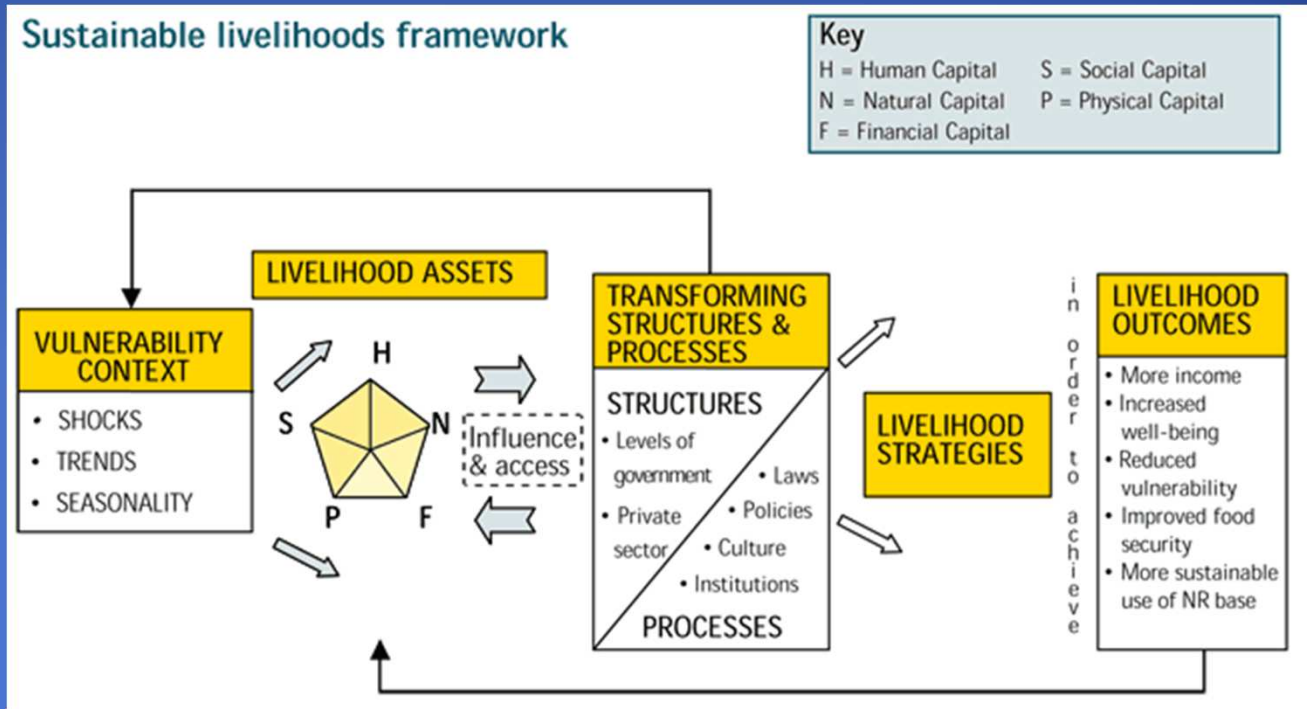
Forest managament, biodiversity and livelihoods

(http://www.cbd.int/development/doc/cbd-good-practice-guide-forestry-booklet-web-en.pdf)…

1. Introduction/problem definition/definitions
   - Resilience
   - Livelihoods
2. (Bio)Diversity makes the world go round
3. Research: gaps, challenges, needs and opportunities

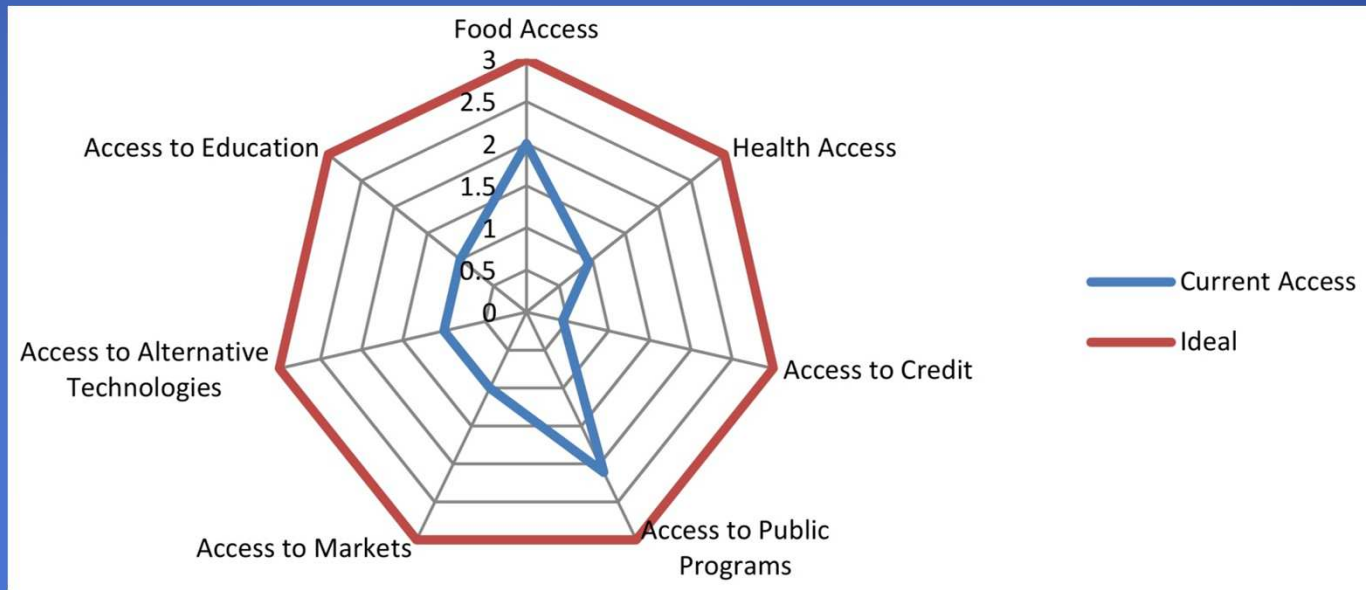
livelihoods…

means of securing the basic necessities - food, water, shelter and clothing - of life



livelihoods…

capabilities, assets and activities needed for a means of living **sustainable** when they can cope with and recover from shocks and stresses, maintain or enhance their capabilities and assets and provide sustainable opportunities for the next generation



NUS/(agro)biodiversity can provide goods and services such as

- organic and locally grown food and ´health´products
- organic and natural personal care products
- green and sustainable building
- Energy-efficient applicances
- socially responsible investing
- natural household products (paper goods and cleaning products)
- complementary, alternative and preventive medicine (naturopathy, Chinese medicine, etc.)
- fair trade products
- …

NUS/(agro)biodiversity can (adapted from Thrupp, 1997)

- increase productivity, food security, and economic returns
- reduce pressure of agriculture on fragile areas, forests and endangered species
- make farming systems more stable, robust, and sustainabl
- contribute to sound pest and disease management
- conserve soil and increase natural soil fertility and health
- contribute to sustainable intensification

NUS/(agro)biodiversity can (adapted from Thrupp, 1997):

- diversify products and income opportunities
- reduce or spread risks to individuals and nations
- help maximize effective use of resources and the environment
- reduce dependency on external inputs
- improve human nutrition and provide sources of medicine and vitamins, and
- conserve ecosystem structure and stability of species diversity.

distinctive features of **NUS/(agro)biodiversity**, compared to other components of biodiversity (FAO):

- NUS/(agro)biodiversity: actively managed by male and female farmers
- many components of NUS/(agro)biodiversity would not survive without this human interference; local knowledge and culture are integral parts of NUS/(agro)biodiversity management
- many economically important agricultural systems are based on 'alien' crop or livestock species introduced from elsewhere (for example, horticultural production systems or Friesian cows in Africa) - this creates a high degree of interdependence between countries for the genetic resources on which our food systems are based

distinctive features of **NUS/(agro(biodiversity**, compared to other components of biodiversity (FAO):

- as regards crop diversity, **diversity within species** is at least as important as **diversity between species**;
- because of the degree of human management, **conservation of NUS/agrobiodiversity** in production systems is inherently linked to **sustainable use** - preservation through establishing protected areas is less relevant (also see Raebild *et al.*, 2011); and
- in industrial-type agricultural systems, much crop diversity is now held *ex situ* in gene banks or breeders' materials rather than on-farm.

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NUS/(agro)biodiversity provides

food

- seeds and nuts
- fruits
- leaves, roots,…
- edible palm products
- mushrooms

feed

NUS

- Food

1. Seeds and nuts

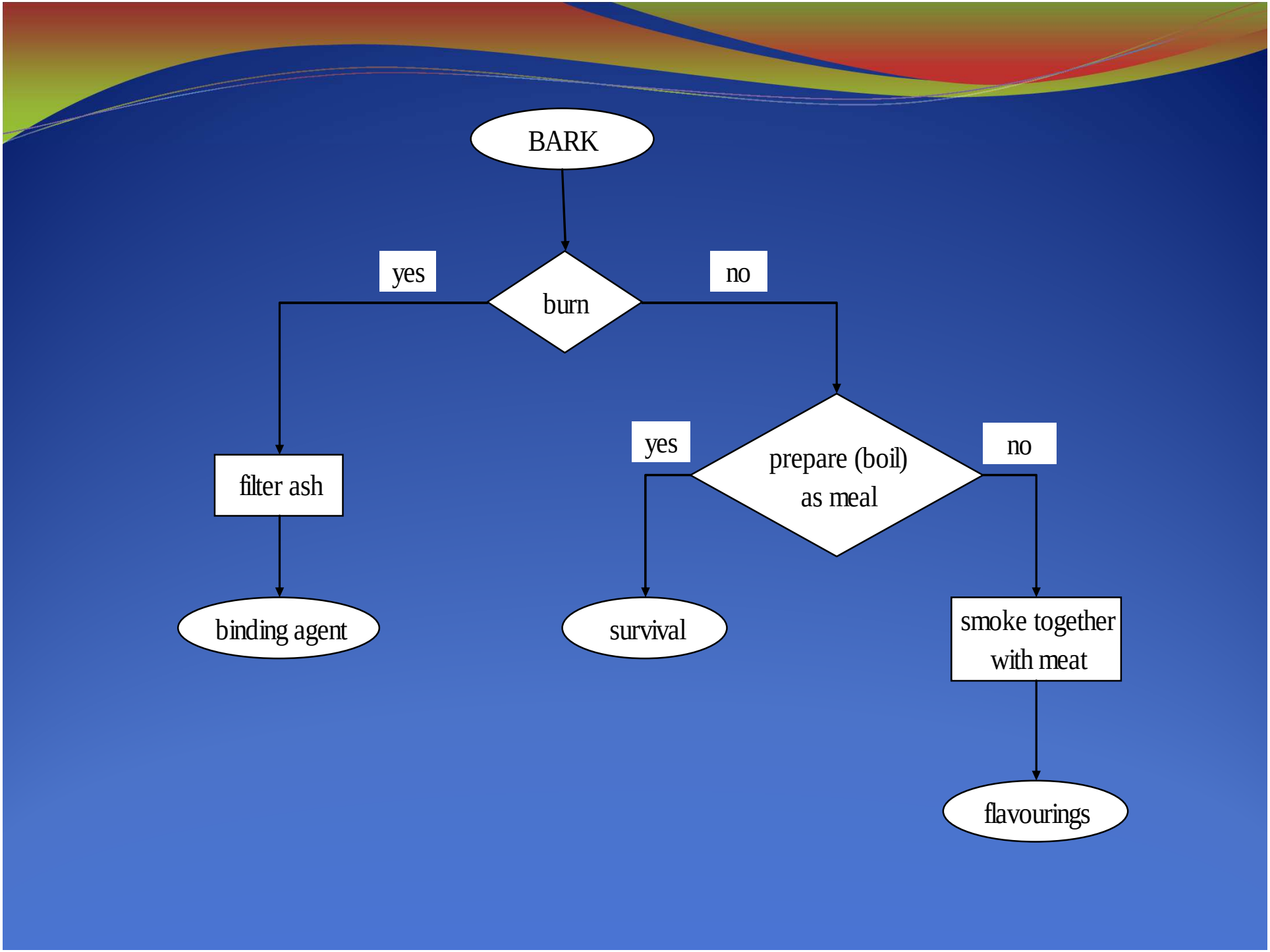
Argania spinosa

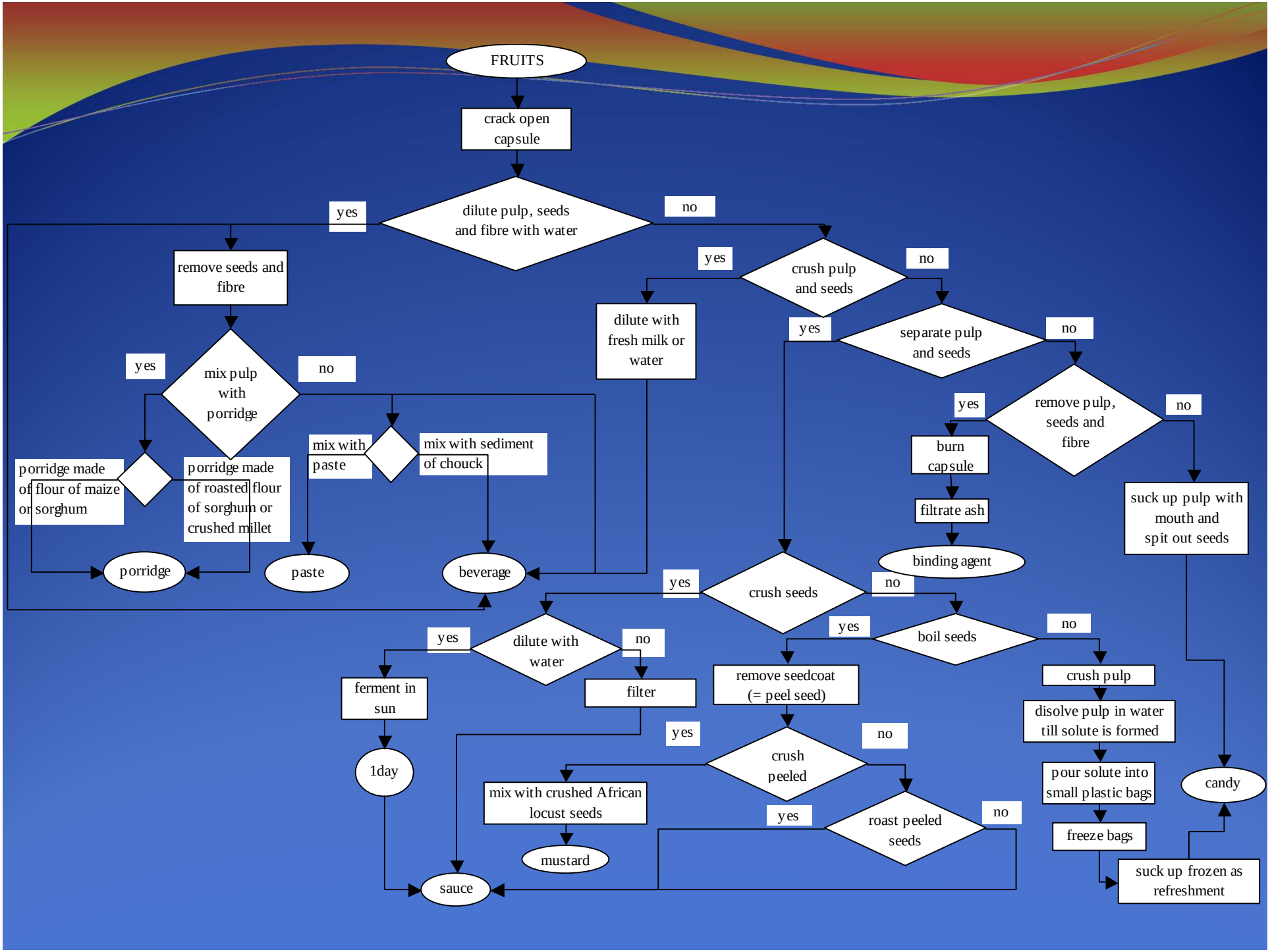
Pistacia spp.

Ceratonia siliqua

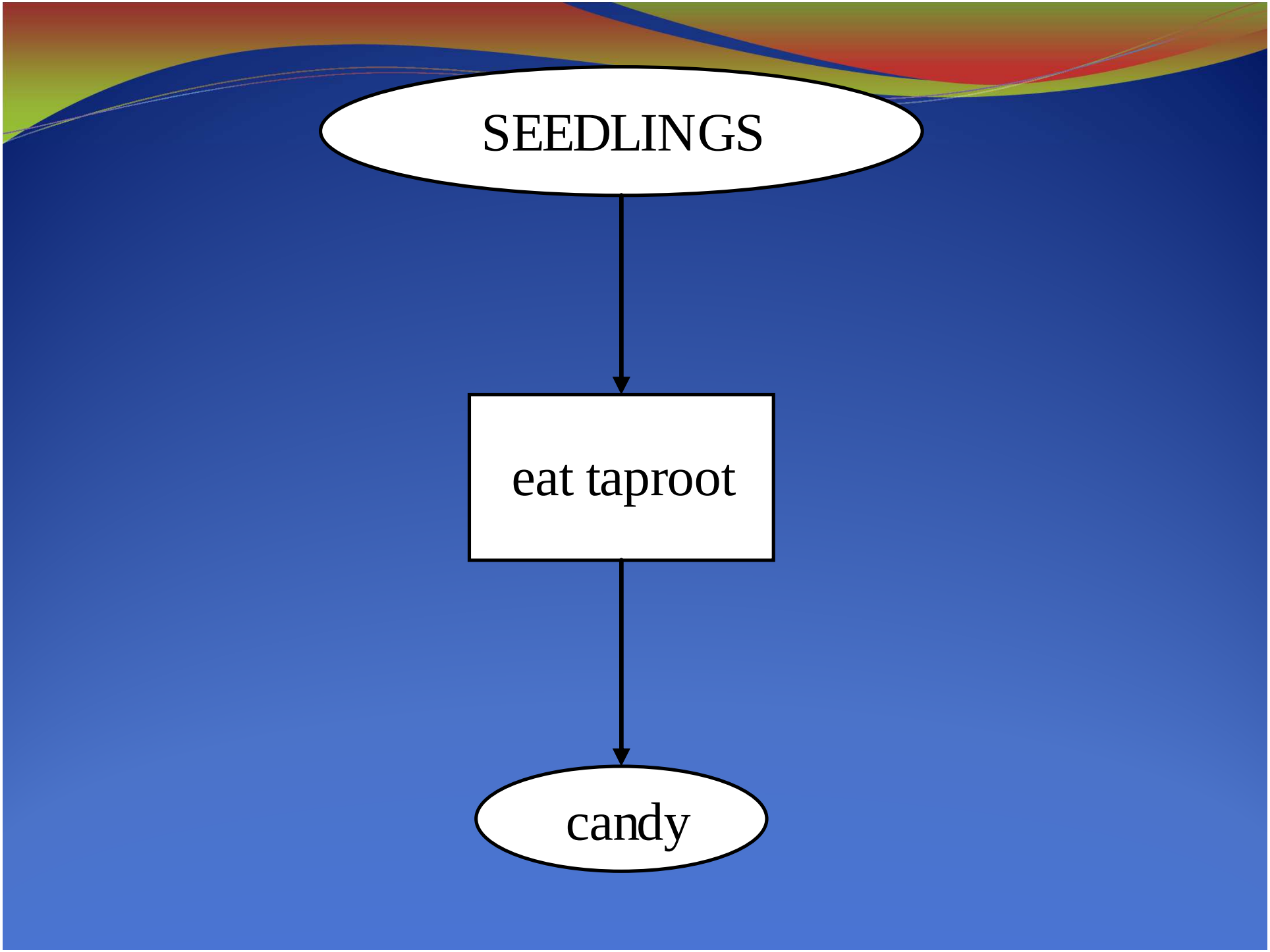
Vitellaria parodoxa (karité)

Baobab – trunk…


BARK
burn
yes
no
filter ash
binding agent
prepare (boil)
as meal
yes
no
survival
smoke together
with meat
flavourings


FRUITS
crack open capsule
dilute pulp, seeds and fibre with water
yes
no
remove seeds and fibre
mix pulp with porridge
yes
no
porridge made of flour of maize or sorghum
porridge made of roasted flour of sorghum or crushed millet
porridge
mix with paste
mix with sediment of chouck
paste
beverage
crush pulp and seeds
yes
no
dilute with fresh milk or water
separate pulp and seeds
yes
no
remove pulp, seeds and fibre
yes
no
burn capsule
filtrate ash
binding agent
suck up pulp with mouth and spit out seeds
crush seeds
yes
no
dilute with water
yes
no
ferment in sun
1day
filter
boil seeds
yes
no
remove seedcoat (= peel seed)
crush peeled
yes
no
mix with crushed African locust seeds
mustard
roast peeled seeds
yes
no
sauce
crush pulp
disolve pulp in water till solute is formed
pour solute into small plastic bags
freeze bags
suck up frozen as refreshment
candy


Baobab - seedling


SEEDLINGS
eat taproot
candy

Baobab-sap


LES VERTUS CACHEES DU BAOBAB :
Adansonia digitata.
SIROP PUR FRUIT DE BAOBAB
Riche en sucres naturels, en protéines, en acides organiques, en vitamines et en sels minéraux. Indiqué contre la fatigue, la diarrhée, l'ulcère et l'hémorroïde.
Produit et conditionné par :
l'Etablissement ALISAH (Alimentation pour la Santé Humaine)
01-BP 2759 COTONOU
Agréé sous le n°187ATL DANA
SIROP PUR FRUIT DE BAOBAB
Riche en sucres naturels, en protéines, en acides organiques, en vitamines et en sels minéraux. Indiqué contre la fatigue, la diarrhée, l'ulcère et l'hémorroïde.
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LES VERTUS CACHEES DU BAOBAB
Adansonia digitata.

NUS

- Food

2. Fruits:

Balanites aegyptiaca

Ziziphus mauritiana

Parinari macrophylla

NUS

- Food

Saba senegalensis

2. Fruits (next):

Adansonia digitata

Parkia biglobosa

NUS

- Food

3. Leaves, roots,…:

Adansonia digitata

NUS

4. Edible palm products:

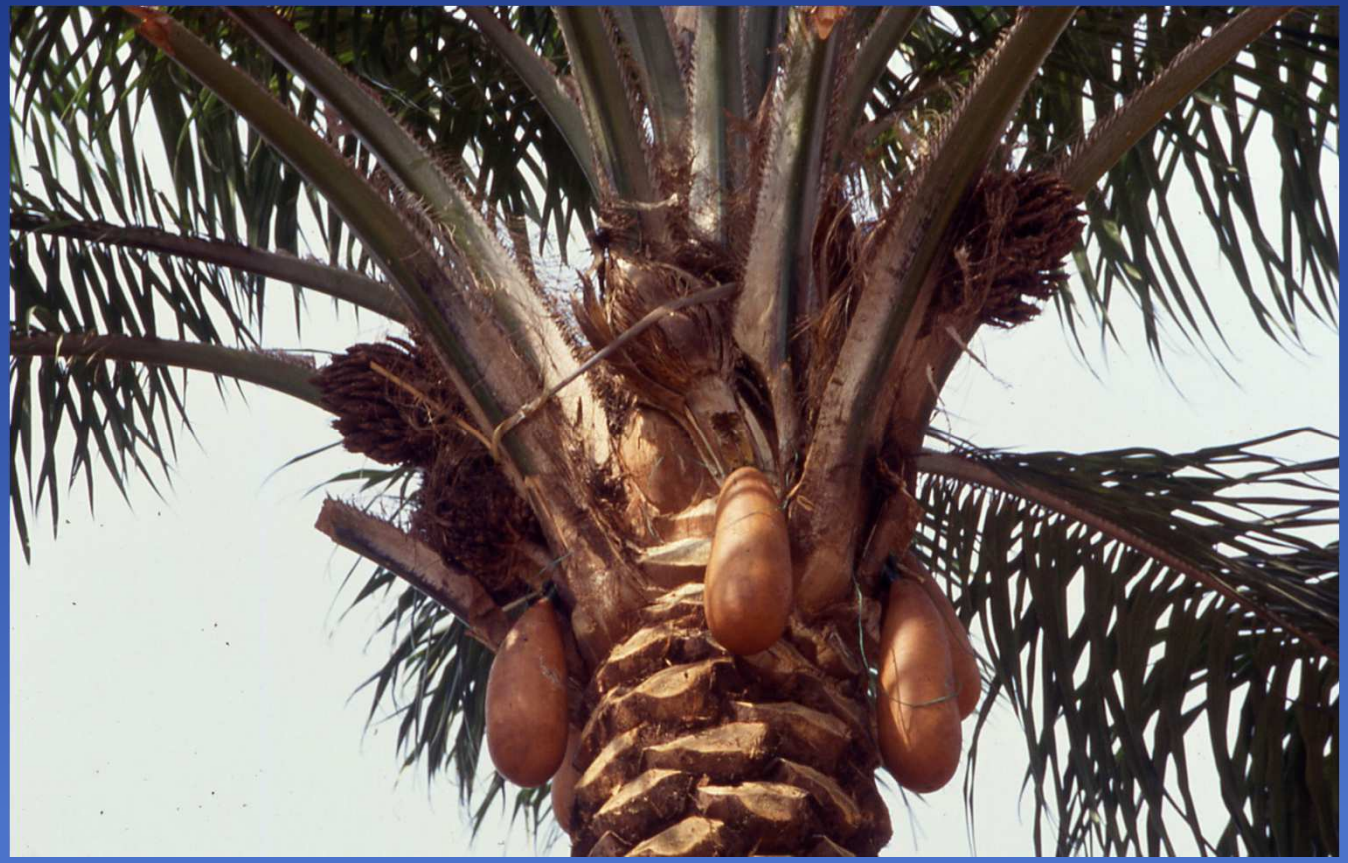
Elaeis guineensis (edible fruits, oil, shoots, palm wine)

Borassus aethiopum (sweet sugarrich sap, palm wine, fruits)

Elaeis guineensis – palm wine (destructive)

Elaeis guineensis – palm wine (non-destructive)

Elaeis guineensis – palm wine (calebashes)



Elaeis guineensis – palm wine (implements)

Elaeis guineensis – palm wine (the proof of the pudding…)

NUS

- Food

5. Mushrooms:

miombo: Central Africa,…

mushrooms

Oyster mushroom grown on wild grass

Oyster mushroom grown on cereal crop residues

mushrooms

Ganoderma lucidum

→ Nutriceutical therapy for HIV/AIDS

Terfezia pfeilii

→ Kalahari truffle mushroom

NUS

- Feed

Acacia

Prosopis

… but also Atriplex

… NUS/(agro)biodiversity can also be a source of income and/or employment

- bamboo
- rosin and turpentine/resins and gums (broadleaved species)
- tannins
- tasar silk
- gum arabic
- medicinal, dyes, aromatics, and other economic plants
- raw material for paper
- others: cork…

- NUS providing employment or cash income
  - bamboo: southern Africa and Asia;
  - rosin and turpentine/resins and gums (broadleaved species): *Sterculia setigera* (gum for cooking), *Ficus* spp. (idem), *Pinus* spp.;

Acacia spp. (gum Arabic)

NUS

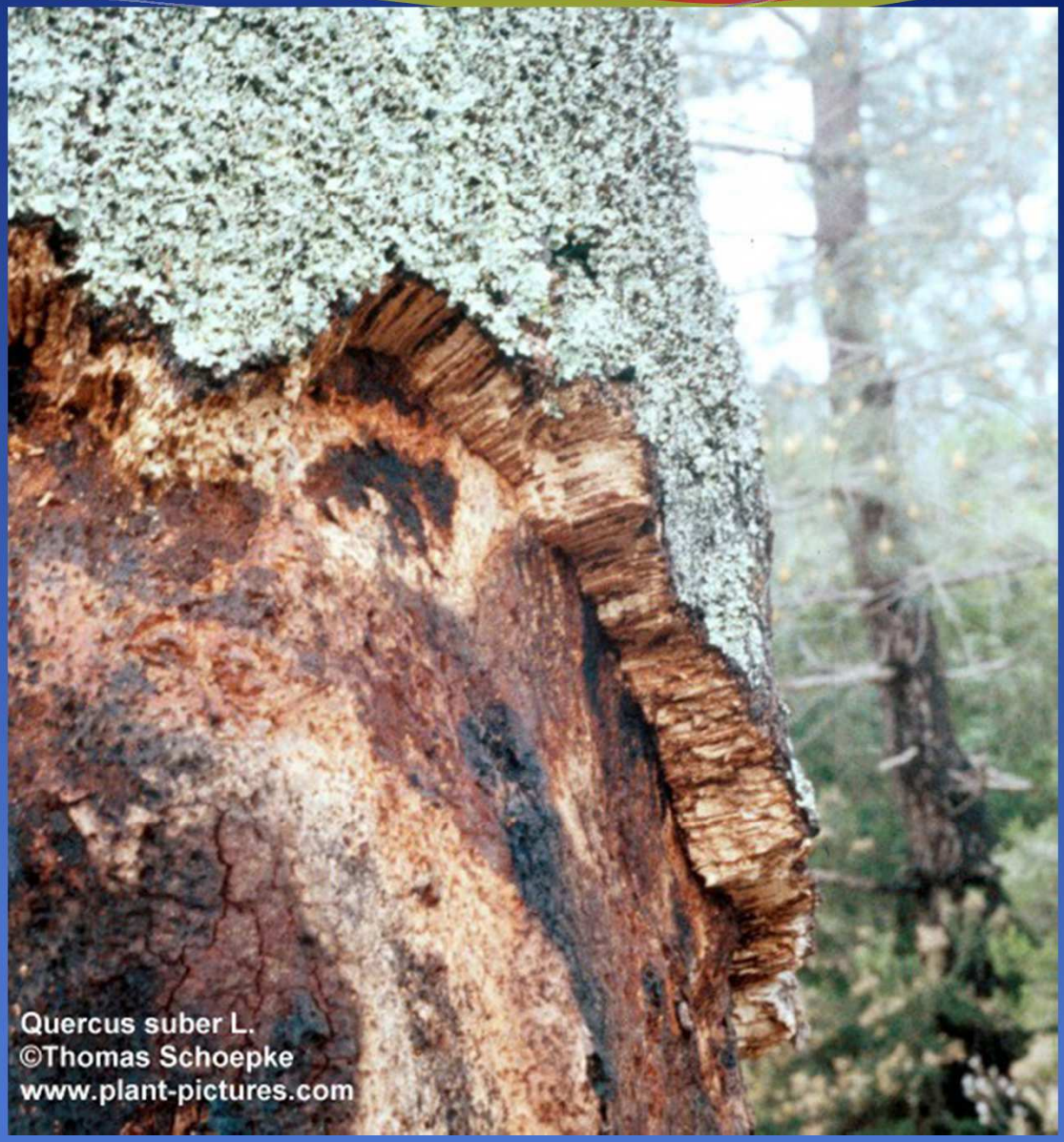
- NUS providing employment or cash income (continued)
  - (bark) tannin: *Acacia* spp. (*A. nilotica*), *Rhizophora* and *Avicennia* spp. (mangrove species), *Quercus* spp.;
  - tasar silk (sericulture): produced by *Antheraea* spp. feeding on *Terminalia tomentosa, T. arjuna, Ziziphus mauritiana;*

Tasar silk (center) produced by *Antheraea* spp. (left: larvae; right: adult)

NUS

- NUS providing employment or cash income (continued)
  - gum arabic (medicine, textile, food, paints/ink): *Acacia senegal* and *A. laeta*;
  - medicinal, dyes, aromatics, and other economic plants: ...;
  - raw material for paper: grasses; and
  - others: *Quercus suber* (cork)

Natural dyes



Quercus suber

NUS/(agro)biodiversity can increase land productivity through diversification

- honey and beeswax
- *Acacia senegal*
- …

NUS

- NUS increasing land productivity by (by-)product diversification
  - honey and beeswax: honeycomb (honey + beeswax) – beekeeping is well-suited to developing countries, requiring little capitalisation, and making virtually no demands on natural resources; may be carried out in conjunction with subsistence and modern agriculture (any scale of operation) – is an integral part of an agricultural management system

NUS

- NUS increasing land productivity by product diversification (continued)
  - *Acacia senegal*: gum arabic, fodder, fuelwood, poles, tannin, N-fixing well-suited for integration in agroforestry systems;
  - *Vetiveria zizanioides,…* : soil fixation, aromatics; and
  - others: *Sesbania* spp.,…

Vetiveria zizanioides

Other plant products not from forests…

Aloe spp.

Euphorbia tirucalli

aesthetics...

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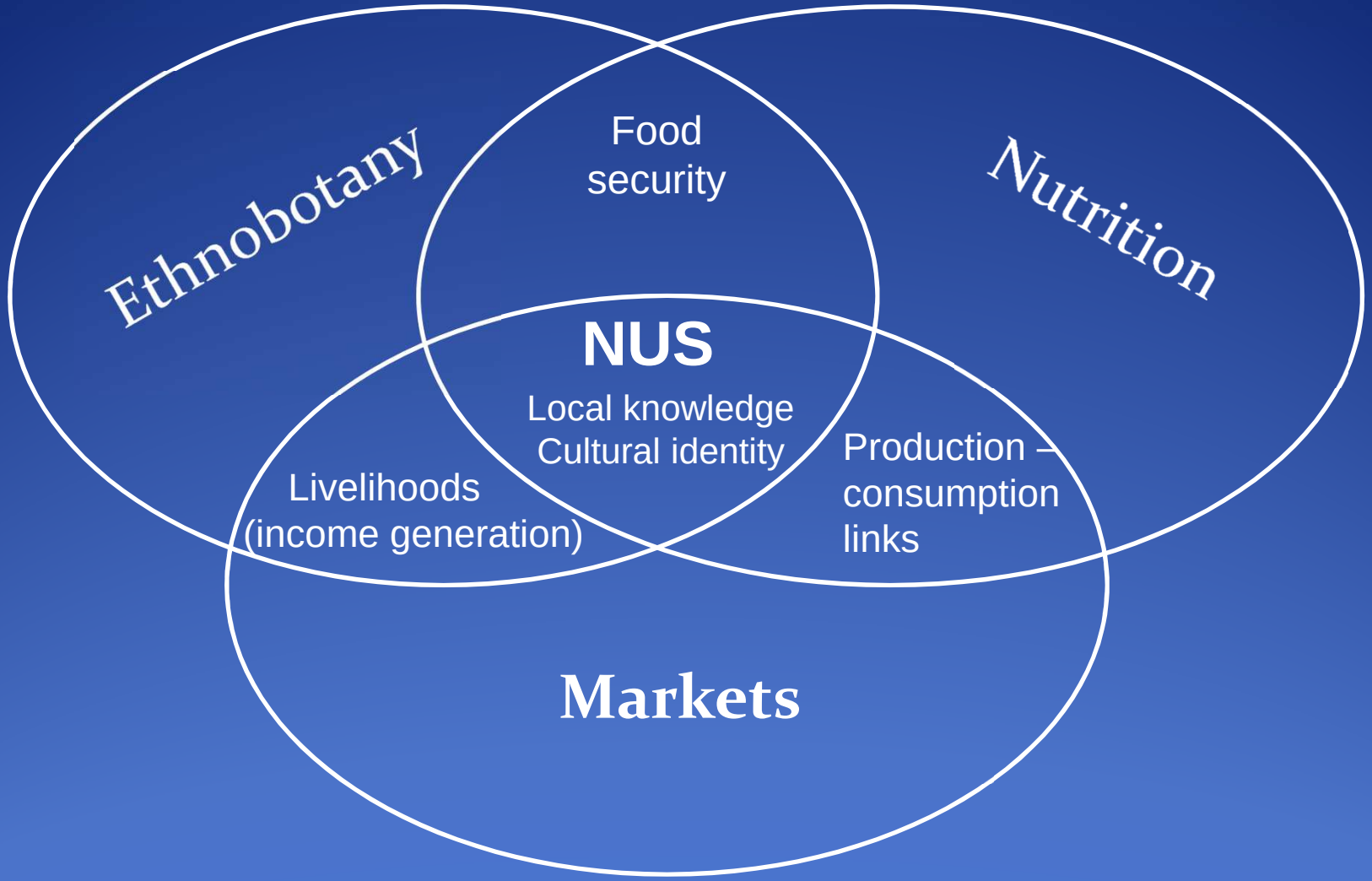
gaps, challenges, needs…

- ethnobotanical
- ethnomedicinal
- ethnoveterinary
- …

info

multidisciplinary R&D approach with edible NUS focus



gaps, challenges, needs…

- wild (plant/animal) species and intraspecies biodiversity have key roles in global food security
- different varieties/ecotypes/accessions/… have (statistically) different active compounds and nutrient contents
- acquiring biochemical/nutrient data on existing biodiversity is a prerequisite for development of new crops/speculations
- formal biochamistry/nutrient content data need to be among criteria in cultivar development/promotion

gaps, challenges, needs…

- active compound/nutrient data for NUS and cultivars need to be systematically generated, centrally compiled and widely disseminated
- biodiversity questions and/or prompts need to be included in food consumption surveys
- acquiring nutrient data and intake data for varieties/types/… is essential in order to understand the impact of biodiversity on food security

NUS and food

India's food habits are well-documented, but local ingredients little known for their nutrient content and diversity….

gaps

level of knowledge usually limits itself to:

Global Exotic **Functional Foods**		
Region	**Food**	**Functionality and Traditional Use**
Asia	Shiitake, (*Lentinus edodes*)other medicinal mushrooms properties.	A medicinal mushroom used in traditional Chinese medicine (TCM). Also popular as a food item in the U.S., research supports shiitake medicinal benefits including anti-tumor [3] Other medicinal mushrooms used as food include reishi and maitake.
	Sea Buckthorn (*Hippophae rhamnoides*)	Used for centuries in Europe and Asia, it exhibits a range of pharmacological activities: anti-inflammatory, antimicrobial, analgesic, and tissue-regeneration. Its fruits are nutritionally rich, and although primarily used in Europe in jams and jellies, they are gaining popularity for their medicinal uses.[5]
South America	Maca (*Lepidium meyenii*)	An Andean root crop used as a food staple in areas of Peru, it is also valued for its vitality and stamina-building benefits. Has recently gained attention for research supporting its aphrodisiac qualities.
	Guarana (*Paullinea cupana*)	IIt produces a red fruit high in caffeine content. Brazilians consume guarana popularly as a drink, and it is valued for its energy-giving properties. Today, guarana may be found in functional drink formulations and in dietary supplements for similar reasons.
Africa	Rooibos (*Aspalathus linearis*)	Used in South Africa and recently marketed in Europe and the U.S. as herbal tea. It has a unique flavor, is high in nutritional content, and claims to have numerous medicinal benefits, some of which may be due to its antioxidant content.[7] Recent research at Rutgers confirms the antioxidant activity.
	Honeybush (*Cyclopia* spp.)	A native South African tea plant that is becoming popular for some of its functional benefits, such as promoting relaxation and gently relieving constipation. Recent work also shows this tea plant to exhibit antioxidant activity.
India	Garcinia (*Garcinia cambogia*)	Its fruit rind is used in traditional recipes in Indian and Ayervedic cooking. Popular in the U.S. for its use in weight loss due to its content of hydroxycitrate (HCA).
Europe	Hawthorn (*Crataegus laevigata*)	With fruit that look like tiny apples, it has a long history of use in foods, and for its therapeutic use in many ailments. Clinical studies support its heart-health promoting properties. Enjoys popularity as a dietary supplement in the U.S. and Europe.[8]

Source: Kerry Hughes, EthnoPharm 4,5,6,7 See references at end of article.

challenges/problems

- poor knowledge base
- limited policy makers' attention
- poor capacity to promote NUS
- limited number of NUS genebanks, and limited number of germplasm accessions present therein
- limited seed supply (services)
- poor image
- poor marketing/value chains

Opportunities

- (pre-supposed) nutritional/biochemical value
- diversification potential
- high adaptation level
- self-reliance appeal
- strenghtening of local cultural values and self-esteem
- health
- flavouring….

opportunities (in detail)

NUS can help guarantee/improve household food security

- particularly important in diversifying/strenghtening cropping strategies and consumption patterns of poor people
- provide a varied diet, often rich in minerals and vitamins including vitamin A, iron and calcium

opportunities

nutrition-based arguments, however, are not always the most persuasive

- need for more material concerns such as economic benefits, convenience and palatability
- returns to labour in the production of NUS must be seen to be advantageous compared with farming of traditional/cash crops if their production is to be promoted

opportunities

NUS broaden the livelihood/food base

- some 50,000 food plant species are known to exist worldwide,
- humanity uses no more than 200
- provide 95 % of food energy
- in view of the food scarcity in many developing countries, these proportions are not only insufficient, the situation is also ecologically and nutritionally dangerous

it is high time to rediscover forgotten and neglected food plants/NUS, and to broaden the food base using significantly more of the available resource

opportunities

enhance diets and nutritional status

- traditional legumes, oilseeds, fruits and vegetables add taste and flavour to the diet, improve palatability and help to balance protein, vitamin and mineral intakes
- vegetables and fruits supply provitamin A, vitamin C, iron, calcium and many other micronutrients.
- in Africa, ~80 % of vitamin A and > 1/3 of vitamin C are supplied by traditional food plants (see ex. of baobab *infra*)
- nuts and oilseeds: good sources of protein and energy, valuable supplements in children's diets and useful in preparing snack foods

opportunities

improve HH food security

- seasonal food scarcity/tiding-over period accentuates severity and incidence of malnutrition
  - rural people grow traditional food plants near their homes using available family labour to see them through the so-called hungry season
  - many of these plants are drought-resistant, can be grown without expensive inputs and have good storage qualities.; e.g. cassava

need for: inventory; pheno/genotypic characterisation, including ecophysiological profiling

Crop wild relatives hotspots
the chili pepper (*Capsicum* spp.) case

Mapping intra-specific diversity the case of cherimoya (*Annona cherimola*)

Photo courtesy: X. Scheldeman

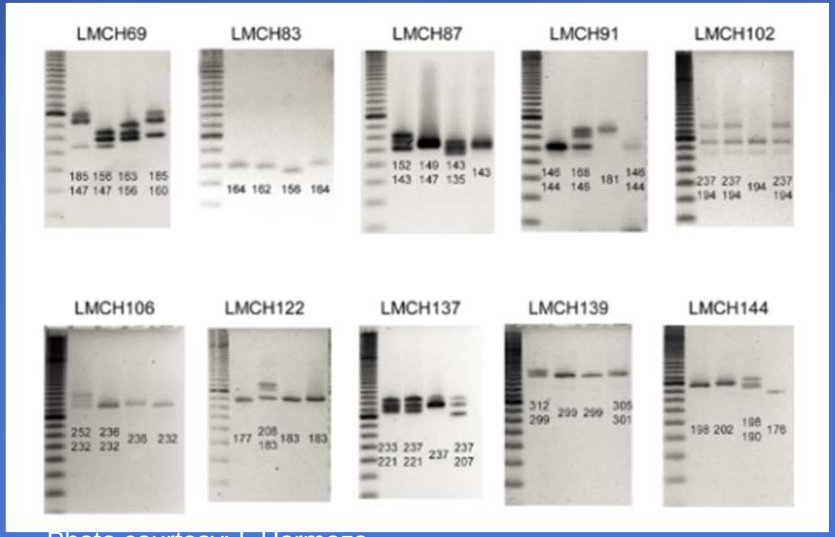
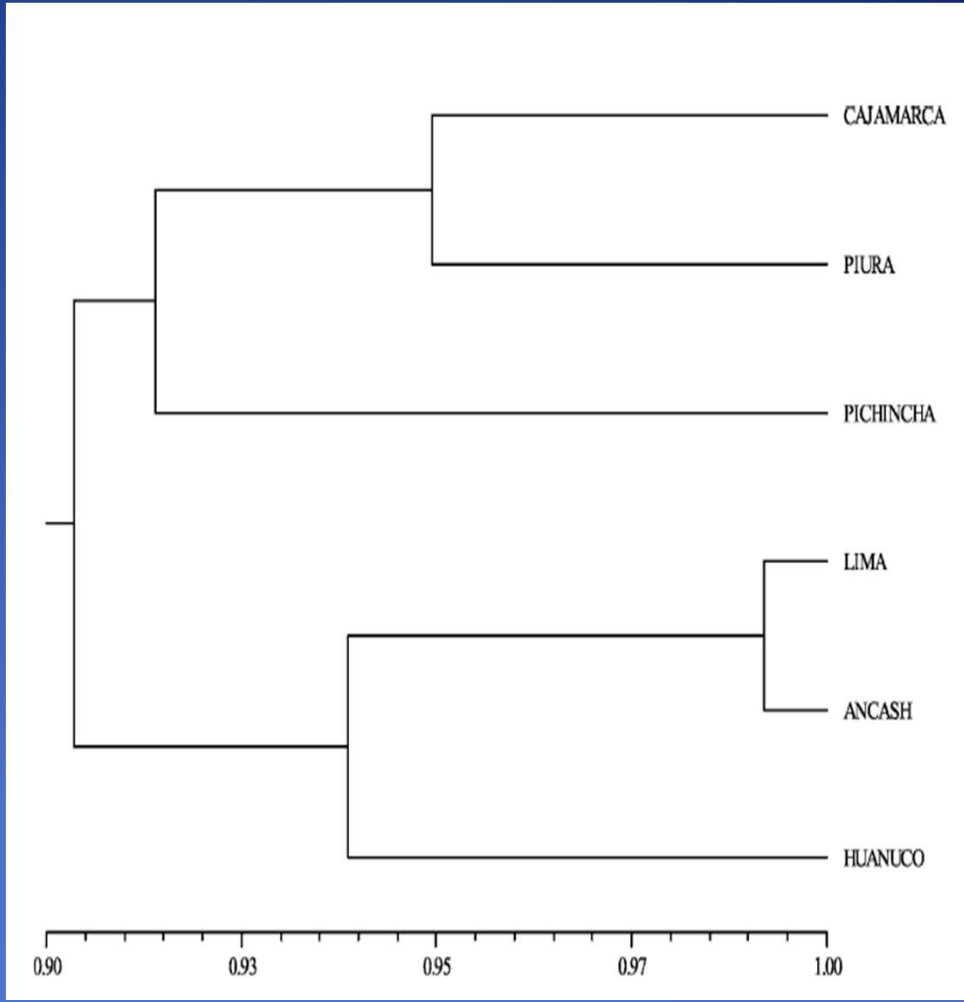
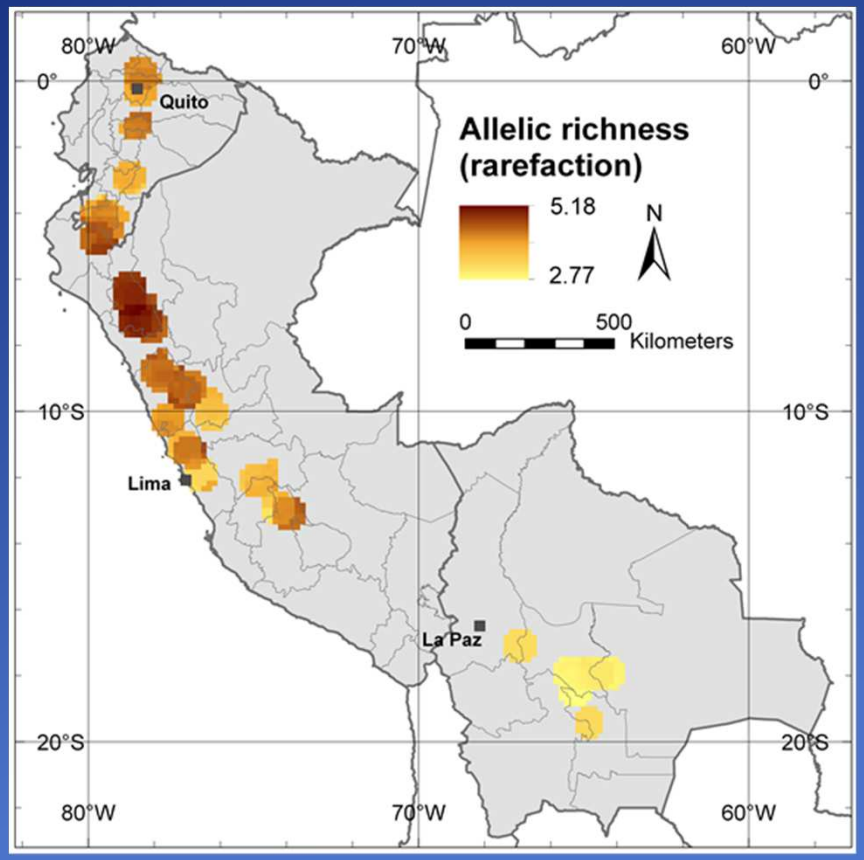


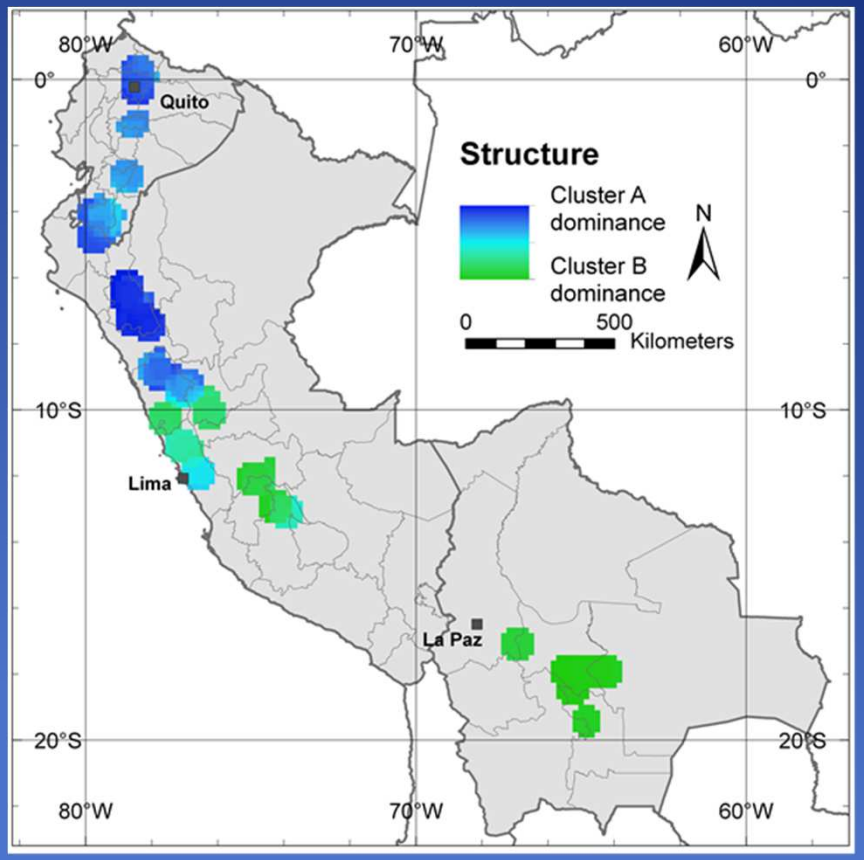
Photo courtesy: I. Hormaza



Escribano et al. 2007

Mapping intra-specific diversity
the case of cherimoya (*Annona cherimola*)





opportunities

increase crop productivity, conserve soil and increase soil fertility

- grown as rotation crops between successive main crops: reduce build-up of pests and diseases
- interplanted, may act as an ecological barrier to disease
- as ground cover, traditional food plants also help to prevent soil erosion, reduce evaporation and suppress weed growth
- as green manure and ploughed in, traditional plants can increase soil organic matter and improve soil structure
- leguminous species fix atmospheric N, enriching the soil for the following /nearby crops/plants

opportunities

increase HH and national income

producers - mainly women -increase their families' own consumption and generate income by selling the surplus in local markets

thus: more varieties of NUS available to consumers at lower cost

income used for improving nutrition and welfare of their children

opportunities

increase HH and national income/import substitution

- many food-deficit countries are forced to import large quantities of food to meet local production shortfalls
- foods based on domestically produced traditional food plants will stimulate increased consumption of, and demand for, these foods (several examples but also: NERICA !...)

opportunities

processing and changes in food systems…

- in a traditional subsistence economy (with mutual support and security) high/obvious appeal of traditional food crops
- changing to a cash economy and purchase of processed food alters the food system
- roles change, and with them the type and amount of foods grown for domestic and/or social use, and for sale
- changes, however slight, may disrupt daily household routines
- domestic processing of traditional grains is labour-intensive: when time is short, women prefer wheat bread, rice or maize which are easier to process


Thank You!


APPLAUSE!

our meta-analysis shows.. (Penafiel et al, 2011)

in general, locally available foods were found to be important sources of energy, micronutrients, and dietary diversification in the diet of rural and forest communities living in highly biodiverse ecosystems

current evidence shows local food biodiversity as an important contributor to nutritious diets

findings are, however, limited to populations living in highly biodiverse areas

research on the contribution of biodiversity to diets of industrialized and urban settings needs more attention

more studies/instruments are needed that would measure the dietary contribution of local biodiversity

role of biodiversity…

underutilized crops have traditionally been used for food, fibre, fodder, oil, and as medicine

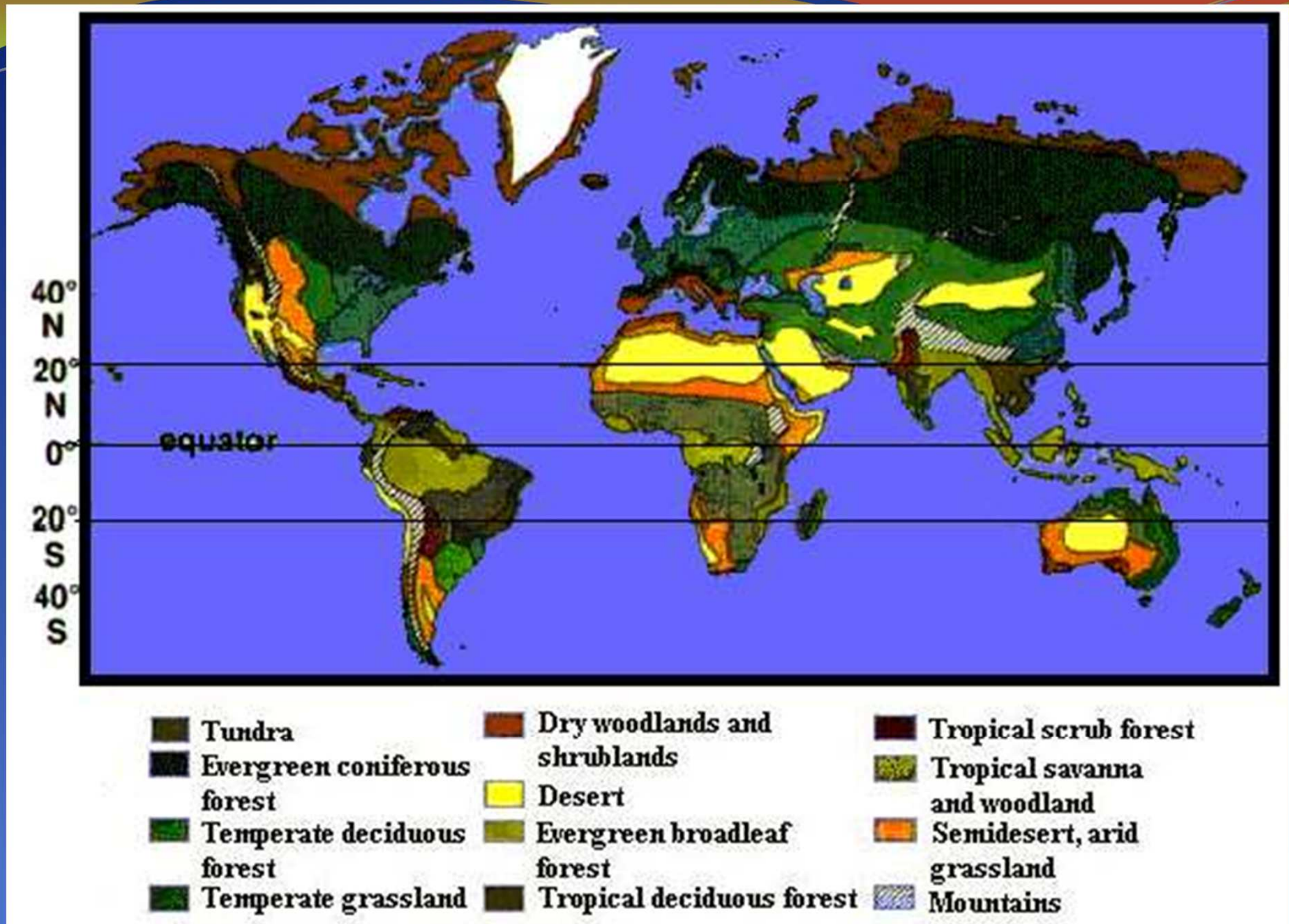
however, based on our own field research, it is our contention that… their potential contribution to food security, nutrition, health, income generation, and ecosystem services for the well-being of mankind is still largely **under-documented and under-exploited**

and/but also that

actual **use is probably over-rated** and might be **under pressure** from westernised food habits

→ the DRCongo case…

NUS from Africa – an overview



Distribution of the world's major biomes

- Africa as centre of origin of traditional (and well-known) food and non-food crops

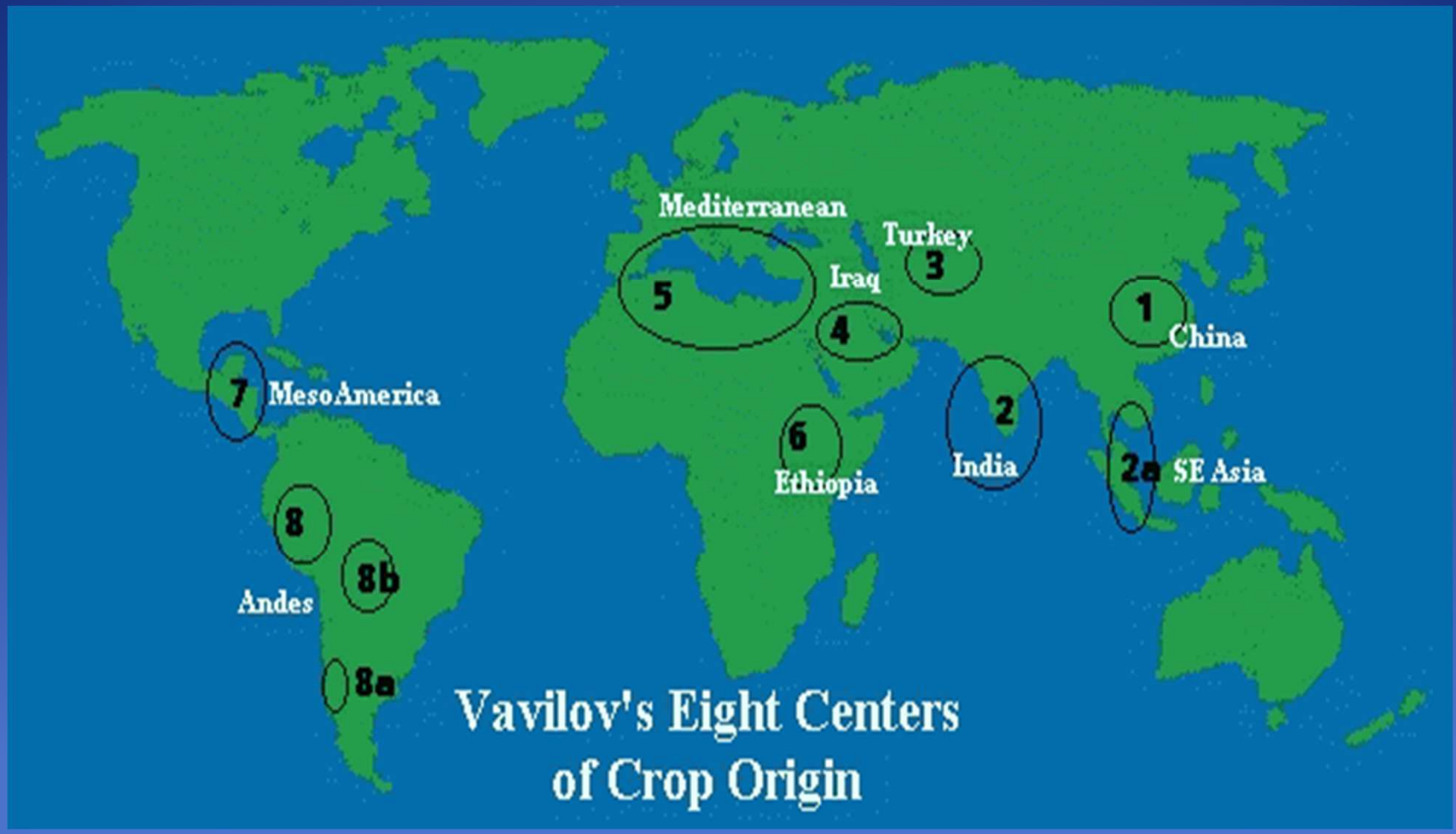
Pennisetum glaucum
(millet)

Sorghum bicolor

Coffea spp.
(robusta/arabica)

Dioscorea spp.
(yam)

Africa center: pearl millet, Guinea millet, African rice, sorghum, cowpea, Bambara groundnut, yam, oil palm, watermelon, okra,…

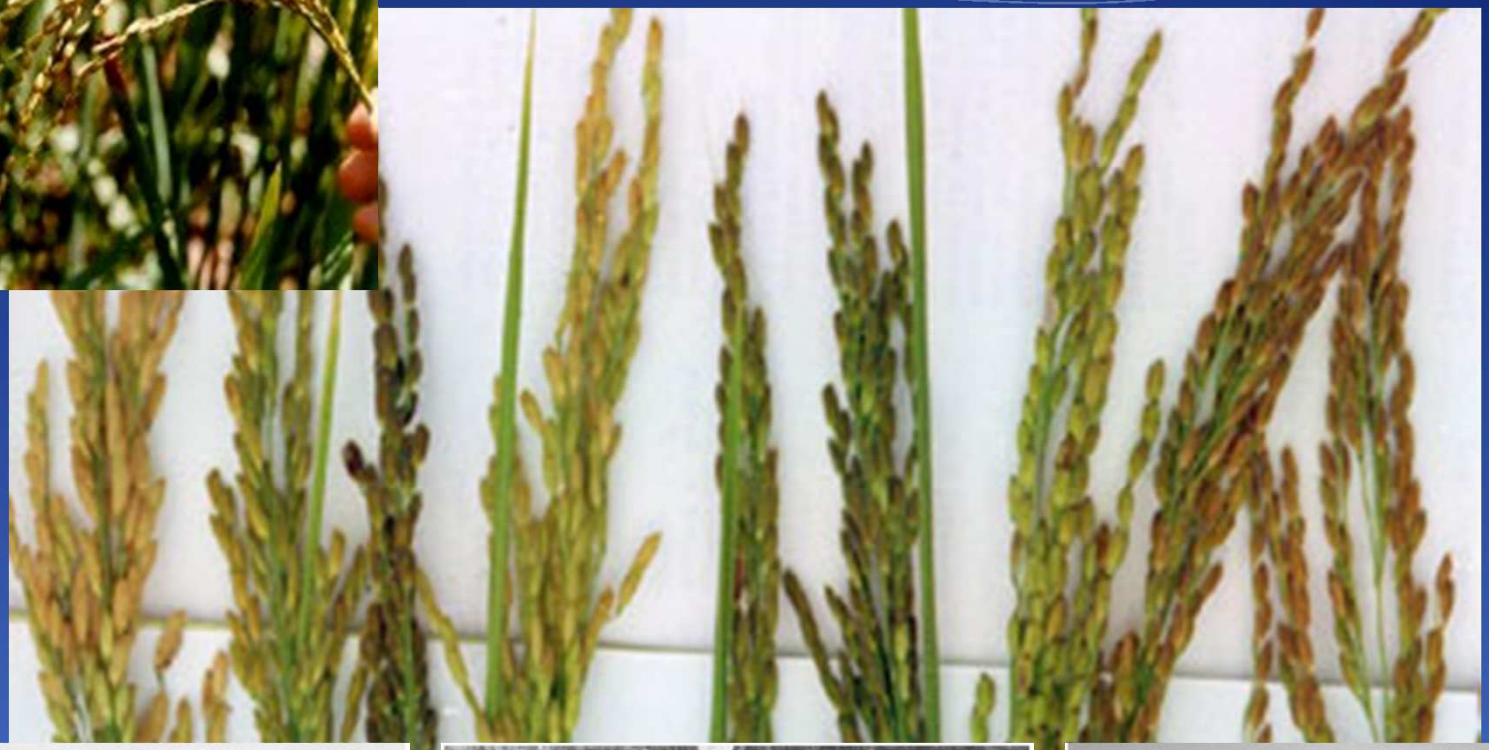


Coffea spp.

Dioscorea spp.

Gossypium spp.

Oryza glaberrima

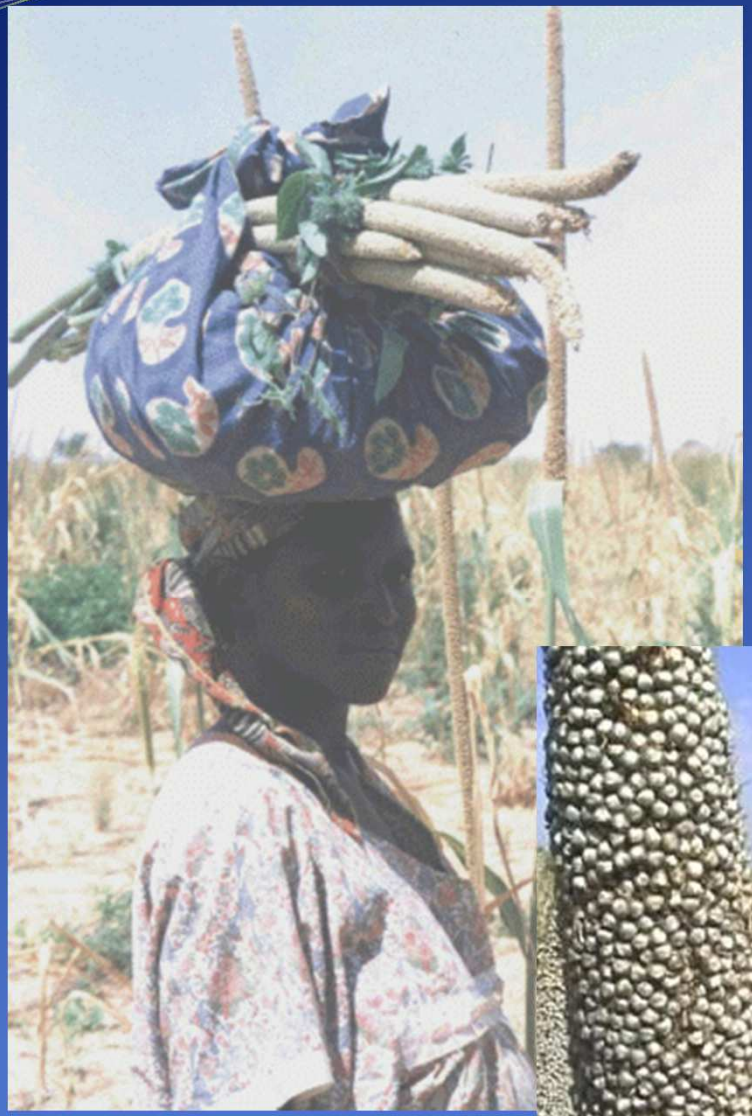


Men preparing the rice fields

Women transplanting rice seedlings

Women harvesting rice

Pennisetum spp.



Ricinus communis

Sorghum bicolor

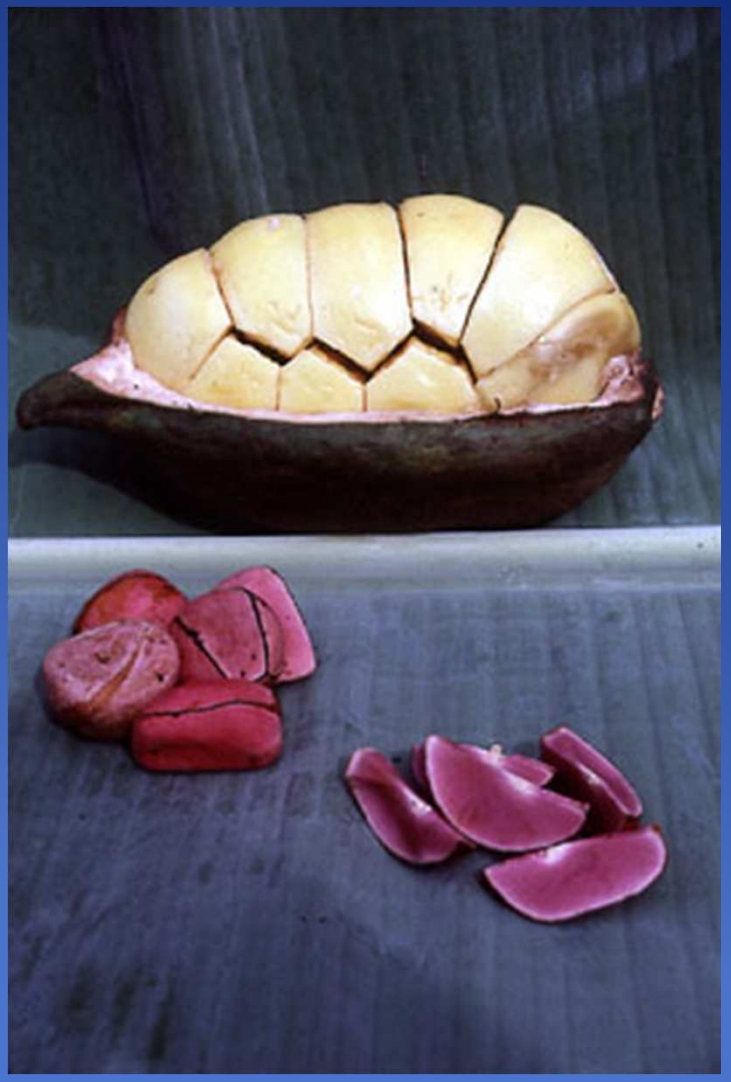
Vigna unguiculata

Cajanus cajan

Cajanus cajan

Cola nitida

Cola nitida



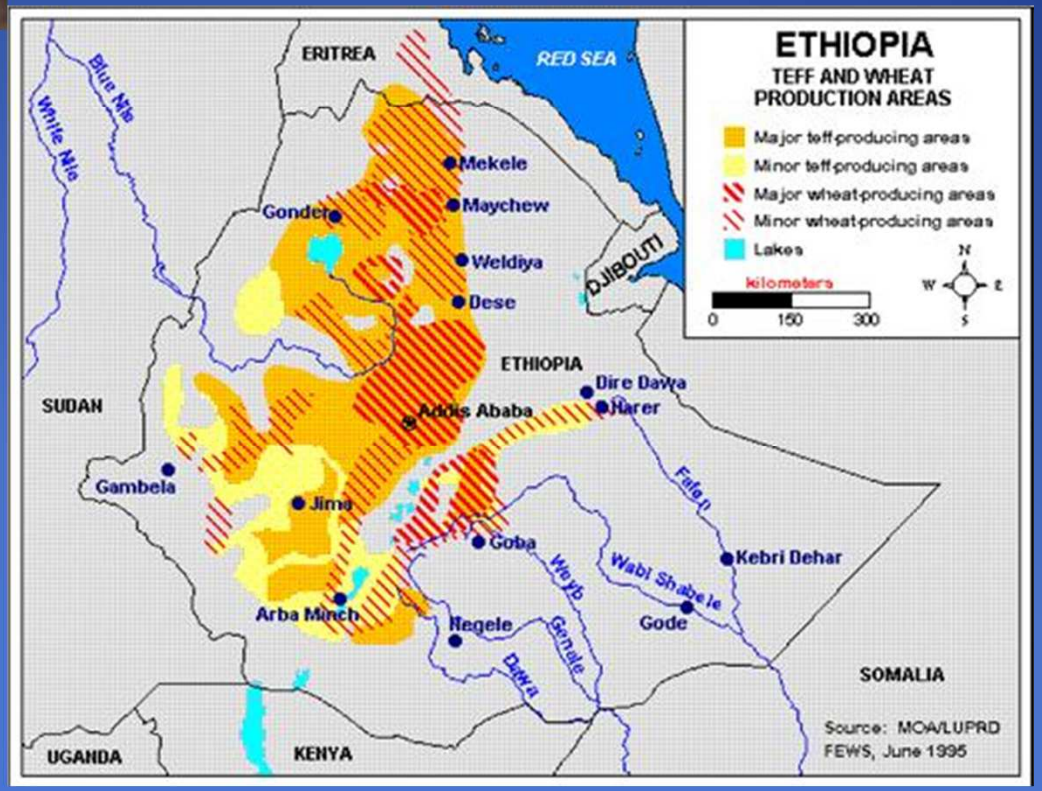
Cucumis spp.

Digitaria exilis

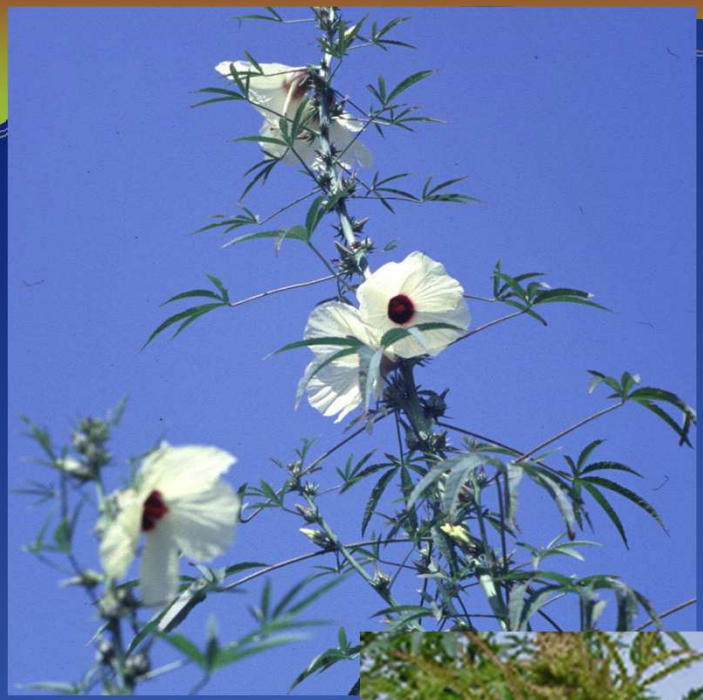
Elaeis guineensis

Eleusine coracana

Eragrostis tef



Hibiscus cannabinus



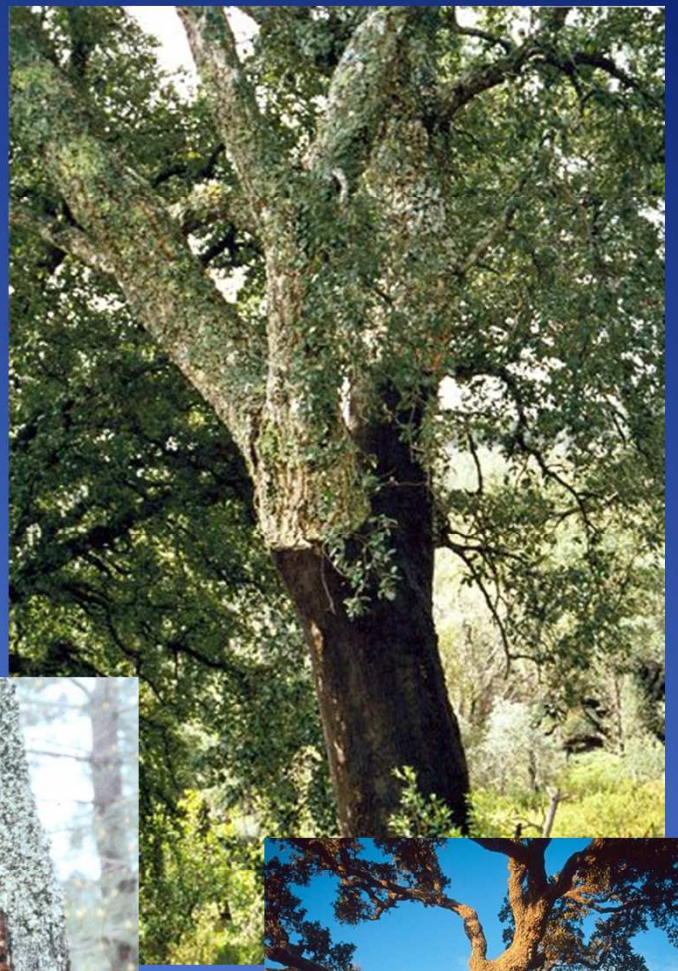
Hibiscus sabdariffa

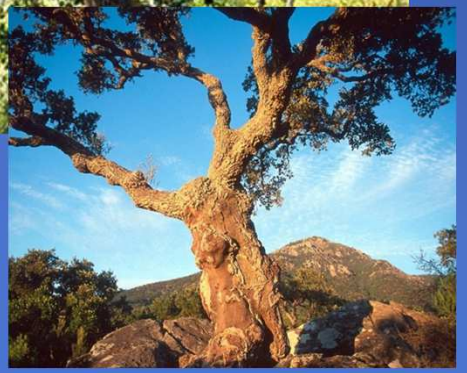
Lablab purpureus

Lagenaria siceraria

Prunus africana

Quercus suber



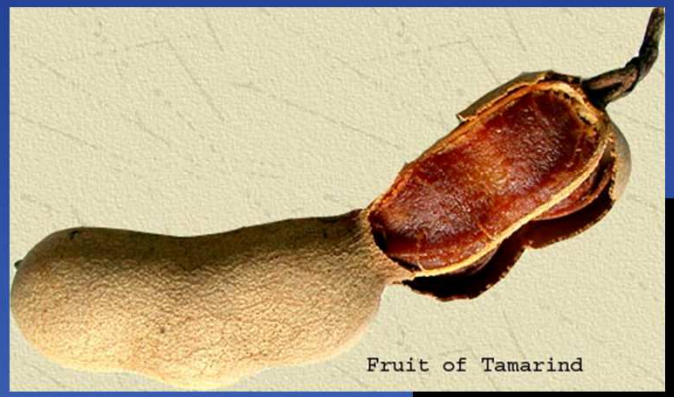


Ricinodendron heudelotii

Solanum aethiopicum

Guizotia abyssinica

Tamarindus indica



Xylopia aethiopica

1. Nut cracking

2.
Roasing/cooking

3. Grinding

4. Homogenisation of pasta

5. Pasta balls

6. End product