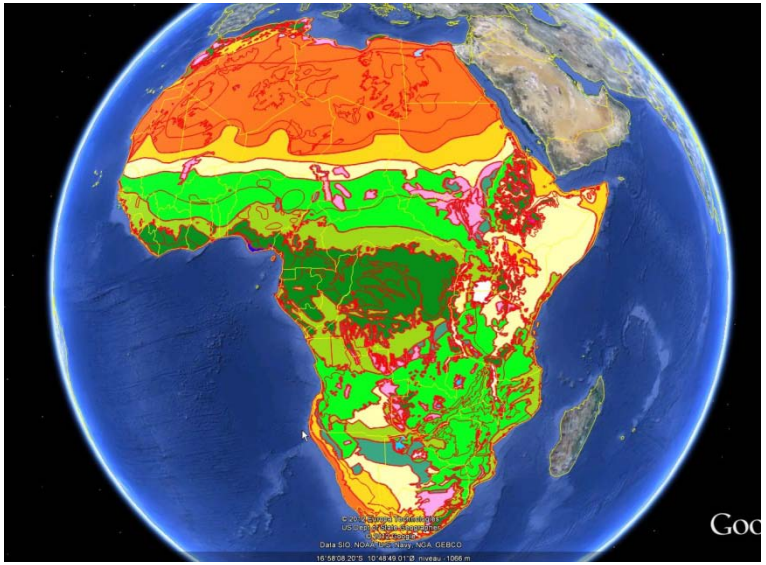
Strategies for landscape-scale restoration in the tropics

Restoring Forests in Africa: first you need old maps and nursery entrepreneurs

J.P.B. Lillesø, R. Kindt, P. van Breugel, L. Graudal, R. Jamnadass



Forest & Landscape Denmark - World Agroforestry Centre

(i) Two inter-related areas of relevance for restoration

Yale Workshop Description: **holistic design of locally appropriate** reforestation and restoration strategies that **scale-up project level successes to the larger landscape**, while promoting **sustainable livelihoods for smallholders**.

Our work revolves around two areas of relevance:

(i) Understanding of the natural variation across landscapes (ecosystems, ecological communities, species)

(ii) efficient mechanisms for distribution of quality planting material of indigenous (and exotic species) to smallholders

(i) Is a collaboration between Forest and Landscape Denmark, World Agroforestry Centre, and botanists in Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda, Zambia. It has been financed by The Rockefeller Foundation.

(ii) Is a collaboration between Forest and Landscape Denmark, World Agroforestry Centre, and National Tree Seed Centres across Eastern and Southern Africa. It is mainly financed by Danida.

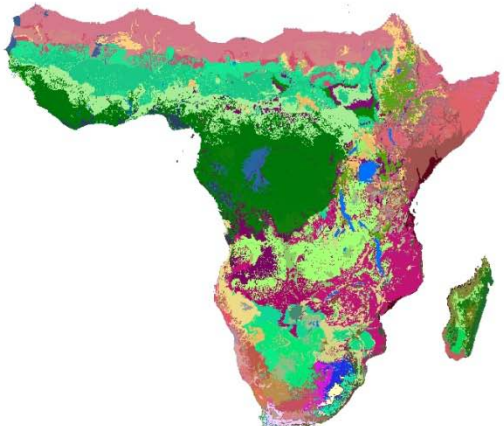
(1) Understanding of the natural variation across landscapes

A variety of **spatial frameworks** has been developed for the purpose of guiding conservation action internationally – biogeographic provinces, biomes/life zones, and ecoregions are the most prominent categories for delineating natural variation

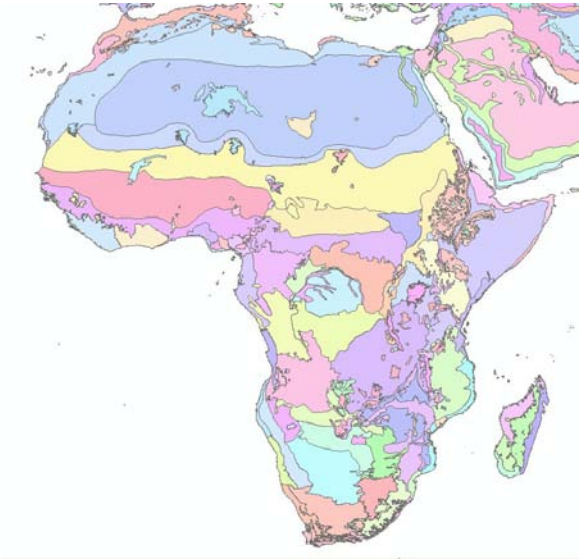
Considering Africa, South America and South East Asia – Africa has the most detailed mapped delineation of vegetation types – the UNESCO **vegetation map of Africa by Frank White (1983)**

Africa ecoregional classifications:
WWF- Ecoregions
NatureServe/USGS

both are simplifications of the White vegetation map combined with animal distributions and bioclimatic information



NatureServe
NatureServe/USGS Survey
Ecosystem Map Africa



WWF
WWFBinaryitem6603 (1).zip

(i) Understanding of the natural variation across landscapes

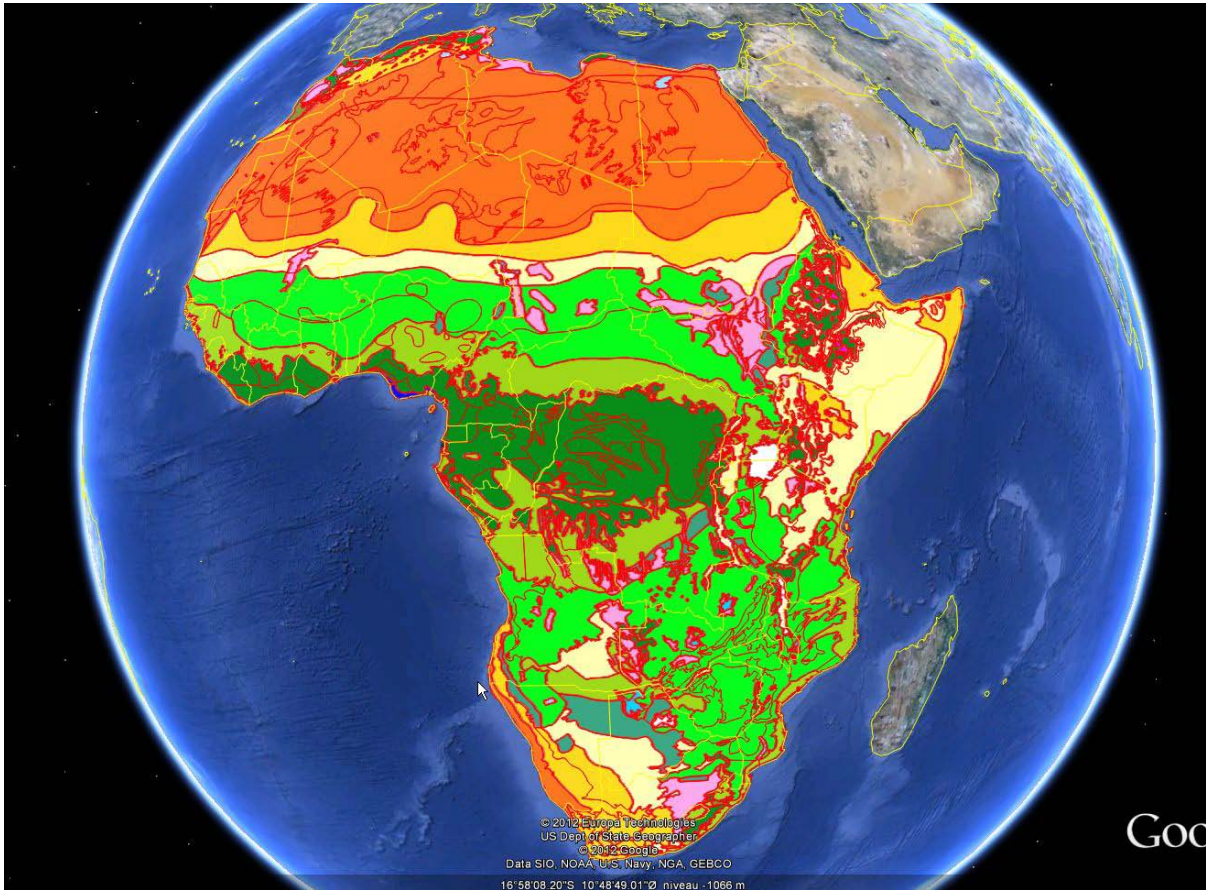
We have taken the opposite approach of WWF and NatureServe by deconstructing the White map into its more detailed parts => more well defined mapping units!

This was possible because at the end of the colonial era and during first decades of the new independent nations quite intense botanical mapping was carried out

Many of these maps were made on the basis of transects documenting empirically the distribution of species and communities

The aim of the reconnaissance surveys was to produce an overview of the natural resources for agriculture available in the countries:

The White vegetation map is based on a large number of smaller maps



(i) Understanding of the natural variation across landscapes

So why do we think that a higher resolution is important?

If a map should be of importance for **field implementation** – it needs to include interpretation of vegetation dynamics and species distributions

We highlight two aspects here:

(i) Because of our bottom-up approach we could compile tree species occurrences in vegetation types => we can thus compile **tree species distributions** for the whole area

(ii) We map whole landscapes as ”**Potential Natural Vegetation”**

=>interpretation of community dynamics becomes publicly available and can be disputed and tested.

For other **ecoregion maps** - managers of restoration projects and tree planters must make their own guesses based on **recommendations that cannot be located in the field**

(i) Understanding of the natural variation across landscapes

The central concept "Potential Natural Vegetation" (PNV) in the VECEA map can be seen as the pivot around which a whole range of contested assumptions circle.

Climax vs. individual adaptation; successional processes; equilibrium vs. non-equilibrium, alternative stable states, niche-assembly vs. stochastic neutral communities, etc.

Potential natural vegetation has been defined as the vegetation structure that would become established if all successional sequences were completed without interference by man under the present climatic and edaphic conditions, including those created by man (van der Maarel, 2005 - similar to Tüxen, 1956).

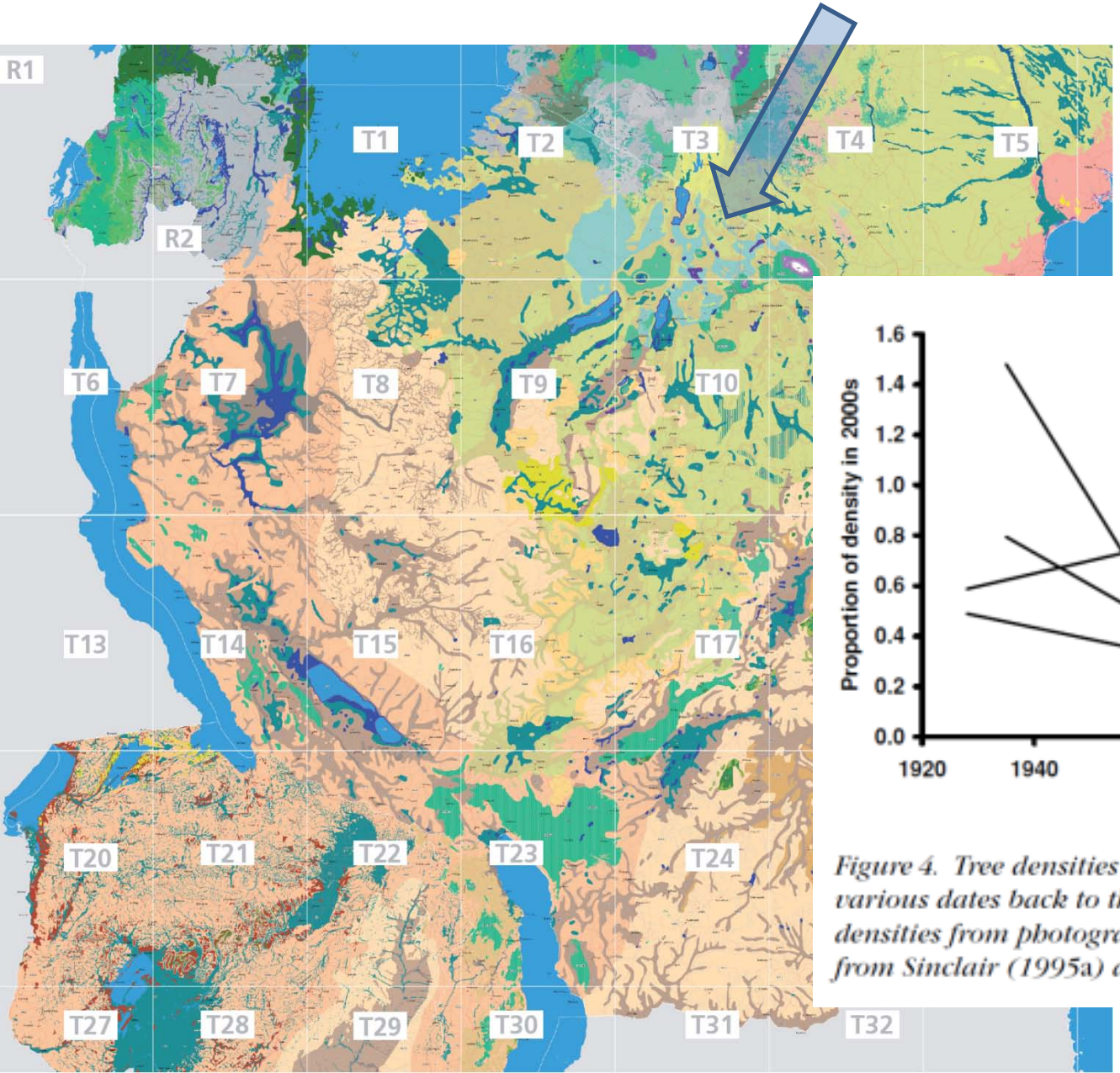
While it is indisputable that plants are not randomly distributed geographically and in time, there is an ongoing debate about at what scale patterns can be discerned and whether plant species form assemblies that follow similar distribution patterns.

There is no avoiding it!

Either the map puts it up front for discussion and interpretation
or
implementers will interpret it when implementing projects in the field!

(i) Understanding of the natural variation across landscapes

An example - Multiple Stable States in Serengeti - Mara (Tanzania/Kenya)



Change in tree densities over time
Grassland<->woodland

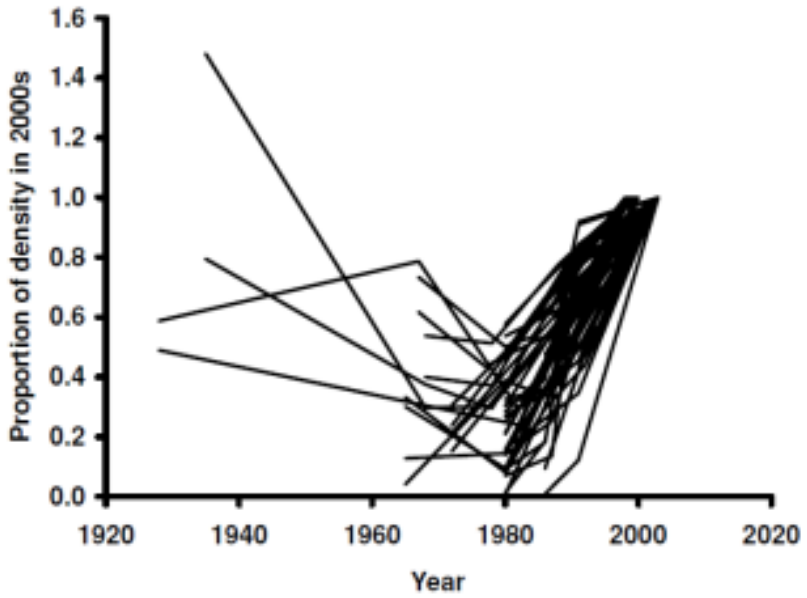
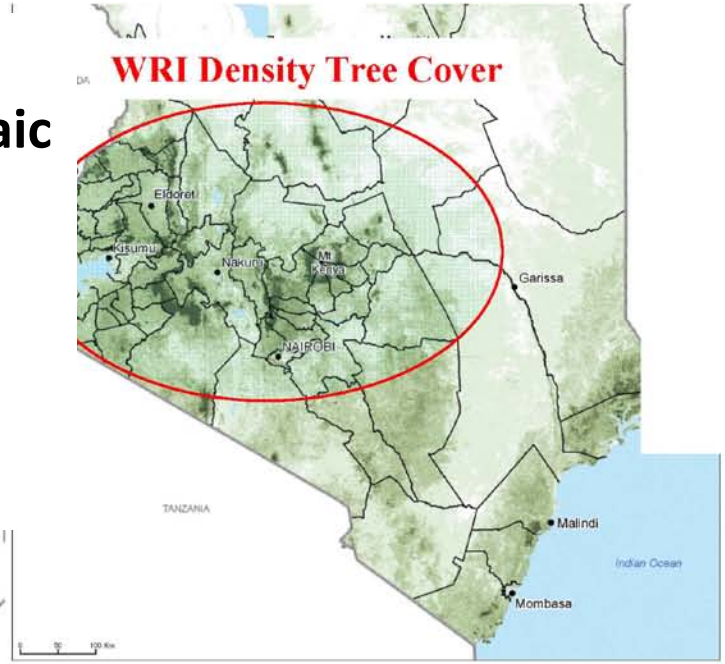


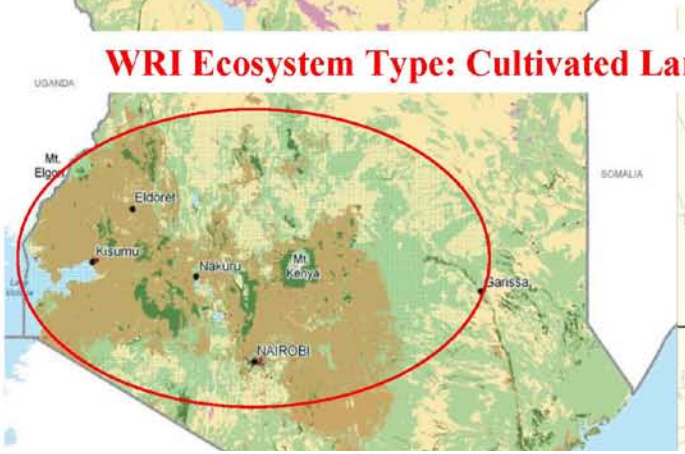
Figure 4. Tree densities based on photographs taken at various dates back to the 1920s relative to tree densities from photographs taken in the 2000s. Data from Sinclair (1995a) and A.R.E.S. (unpublished).

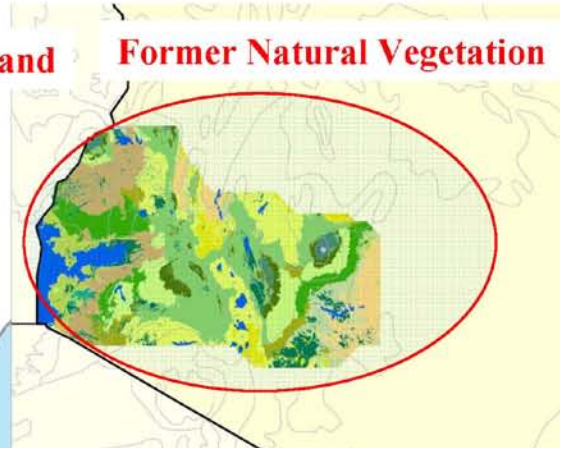
(i) Understanding of the natural variation across landscapes

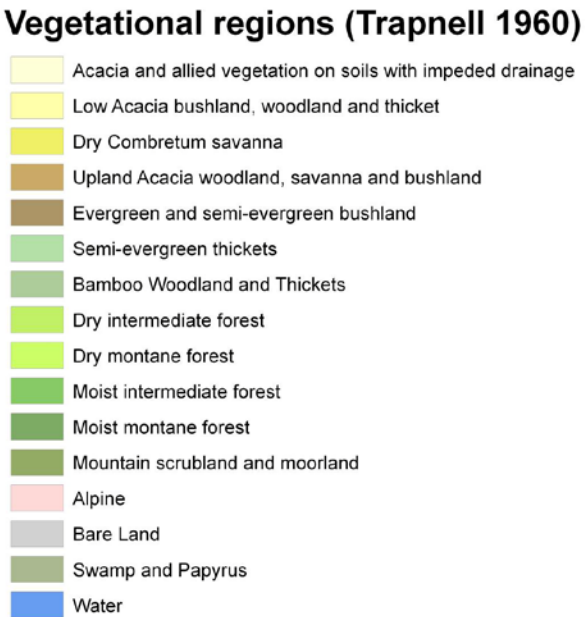
Cover versus content

Cultivated land is not just cultivated land – it is a mosaic of PNVs with very different environments for growing trees









Sources: World Resources institute: Atlas of Kenya
Kindt et al – The Trapnell PNV map of SW Kenya

(i) Understanding of the natural variation across landscapes

The **PNV maps offers a tool** that can be utilised in **analysing the pattern and processes** in landscapes including the biotic and abiotic interrelationships that govern these ecosystem aspects. As such it complements and can be used as an input to modelling of ecosystems and individual species.

VECEA has just been completed last month and in 2012 we will write a series of scientic papers to discuss and demonstrate use of the map

We have documented the map and the process of making it in 7 volumes available on
http://sl.life.ku.dk/English/outreach_publications/computerbased_tools/vegetation_climate_change_eastern_africa.aspx

- Volume 1, Introduction of VECEA and individual country maps
- Volumes 2 to 5 descriptions of potential natural vegetation types,
  including lists of "useful tree species" by vegetation type
  Vol. 2: forests. Vol. 3:Woodland. Vol. 4: Bushland and thicket. Vol. 5: Other vegetation types
- Volume 6 gives details about the process that we followed in making the VECEA map.
- Volume 7: Modelling the distribution of potential natural vegetation types for six potential future climates.

VECEA map is available on **GoogleEarth** by accessing a kmz file on the web site

(ii) efficient mechanisms for distribution of quality planting material of indigenous (and exotic species) to smallholders

And now to something almost different!

(ii) efficient mechanisms for distribution of quality planting material of indigenous (and exotic species) to smallholders

Restoration of landscapes inside and outside of protected areas require **cost efficient networks** for **distribution of seeds and seedlings** and **sources of seed that are suitable to the planting sites**

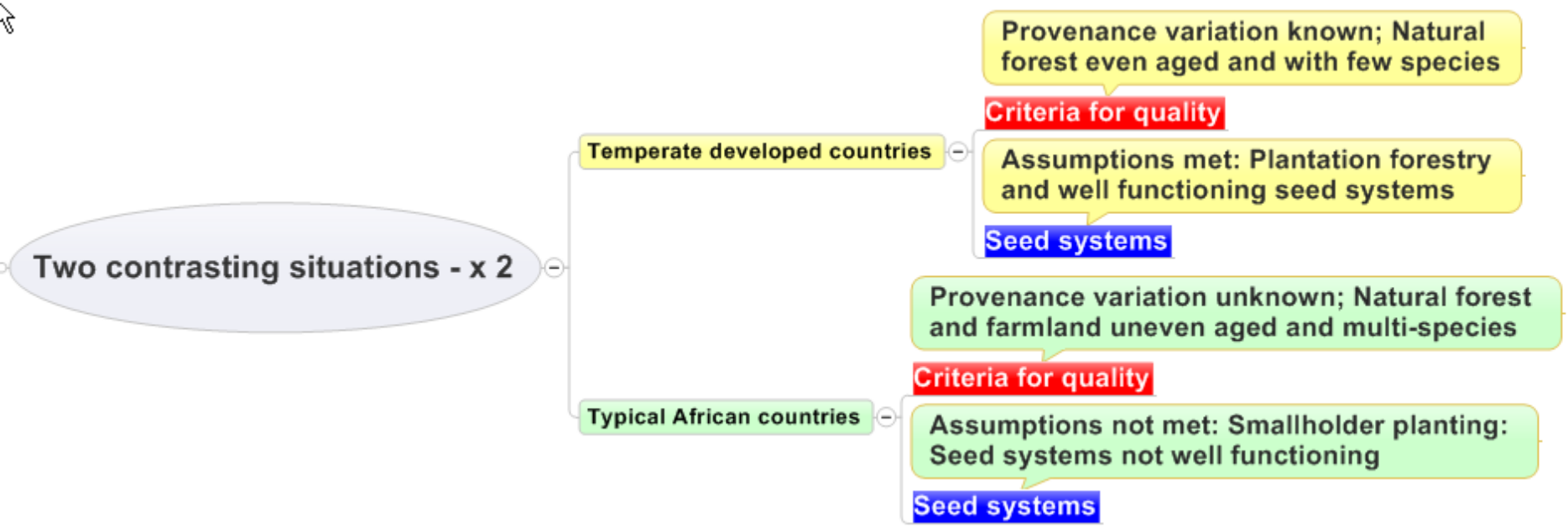
We highlight two areas that we find important:

- **How would one argue that a source (for an indigenous African tree species) is adapted to the planting site?**

- **How would one set up a cost efficient network to distribute quality (adapted) seed?**

Assumptions of the OECD classification of seed sources – most relevant in Africa

Differences between temperate developed countries and tropical developing countries



A more detailed classification system (than OECD) would beneficial in two areas:

1. More precise genetic criteria for characterising seed actually collected
2. Better identification of constraints in organisation of collection and distribution

How would one argue that a source (for an indigenous African tree species) is adapted to the planting site?

Definition (OECD, 2011): For a species or sub-species, the Region of Provenance is the area or group of areas subject to sufficiently uniform ecological conditions in which stands showing similar phenotypic or genetic characters are found.

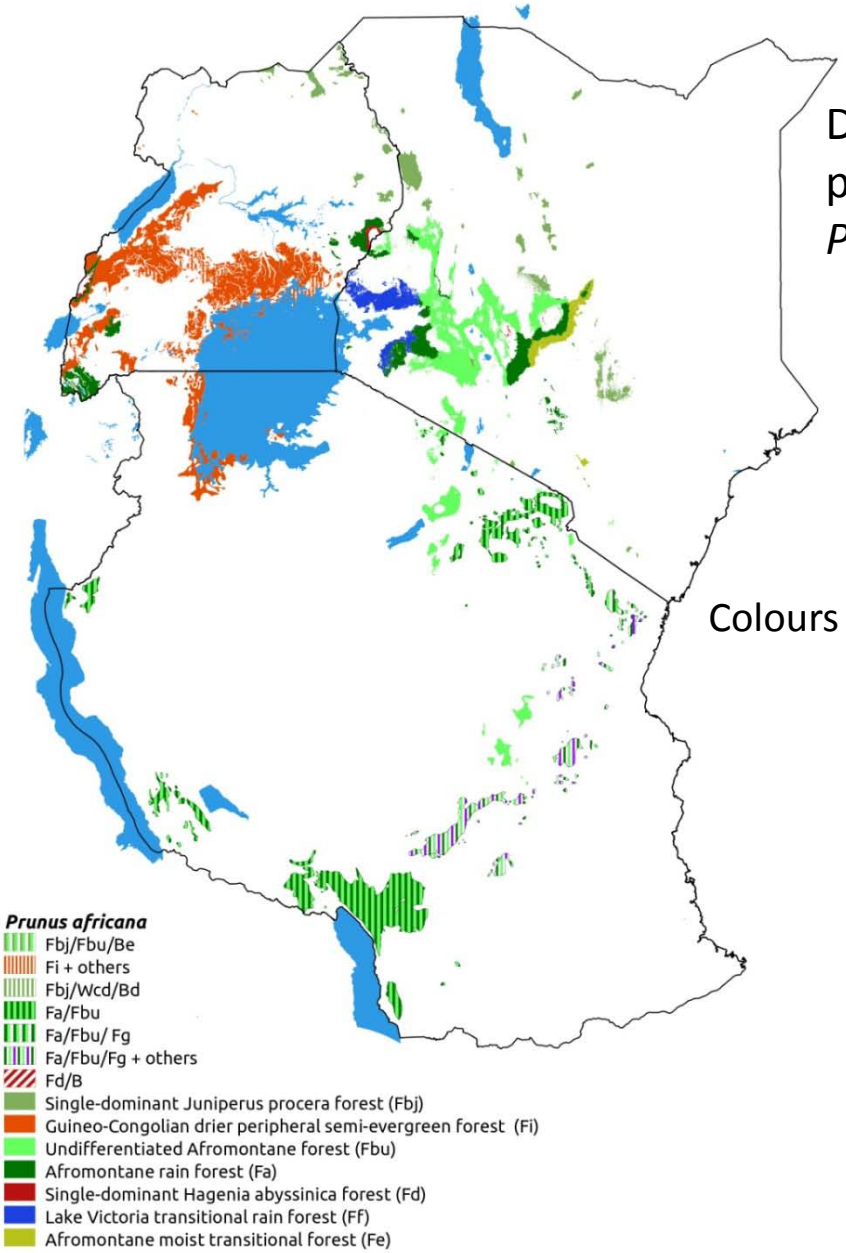
Nothing is known of GxE for practically all the African useful species.

We suggest focus should be on potential GXE interactions - **seed application zones/planting zones -** different seed sources should be used at different sites (due to GXE).

Immediate term focus: **Avoiding failures**
Longer term: **Understanding GXE for individual species**

We propose that it is possible to delineate individual potential planting zone for hundreds of useful African Tree species. These planting zones can be turned into immediate recommendation for use of surces.

How would one argue that a source (for an indigenous African tree species) is adapted to the planting site?



Delineation of provenance areas – based on potential distribution areas
Prunus africana (Kenya, Tanzania, Uganda)

Colours denote vegetation types=different environments

How would one set up a cost efficient network to distribute quality (adapted) seed?

Learning from crop sed systems
History of support to smallholders

Crop seed

- General consensus that efficient input supply systems to smallholders are lacking (World Bank)
- Gates/Rockefeller has financed AGRA mainly to assist smallholder farmers
- Seed systems is an essential part of AGRA
- Making good seeds available through small dealers networks is an essential part of AGRA

Tree seed

- Tree seed systems are characterised by severe paucity of sources in natural vegetation
- Instead majority of seeds are sourced from trees in farmland (suboptimal quality)
- Permanent networks of nurseries are not supported by NGOs and governments
- Instead NGOs create competing nurseries handing out free seedlings
- Making good seeds available is currently not an essential part of smallholder projects in Africa

Substantial re-organisation of the sector is required for input supply to function efficiently

How would one set up a cost efficient network to distribute quality (adapted) seed?

Why more dynamics in crop seed systems?

For **crop seed** there are relatively **clear definitions** of the entities and links in the breeding, production, and distribution cycle.

(i) the earliest generations of a variety are referred to as **breeding seed**,
(ii) the generations of seed used by seed producers are termed **foundation seed**; and
(iii) the seed purchased by farmers is **commercial seed**.

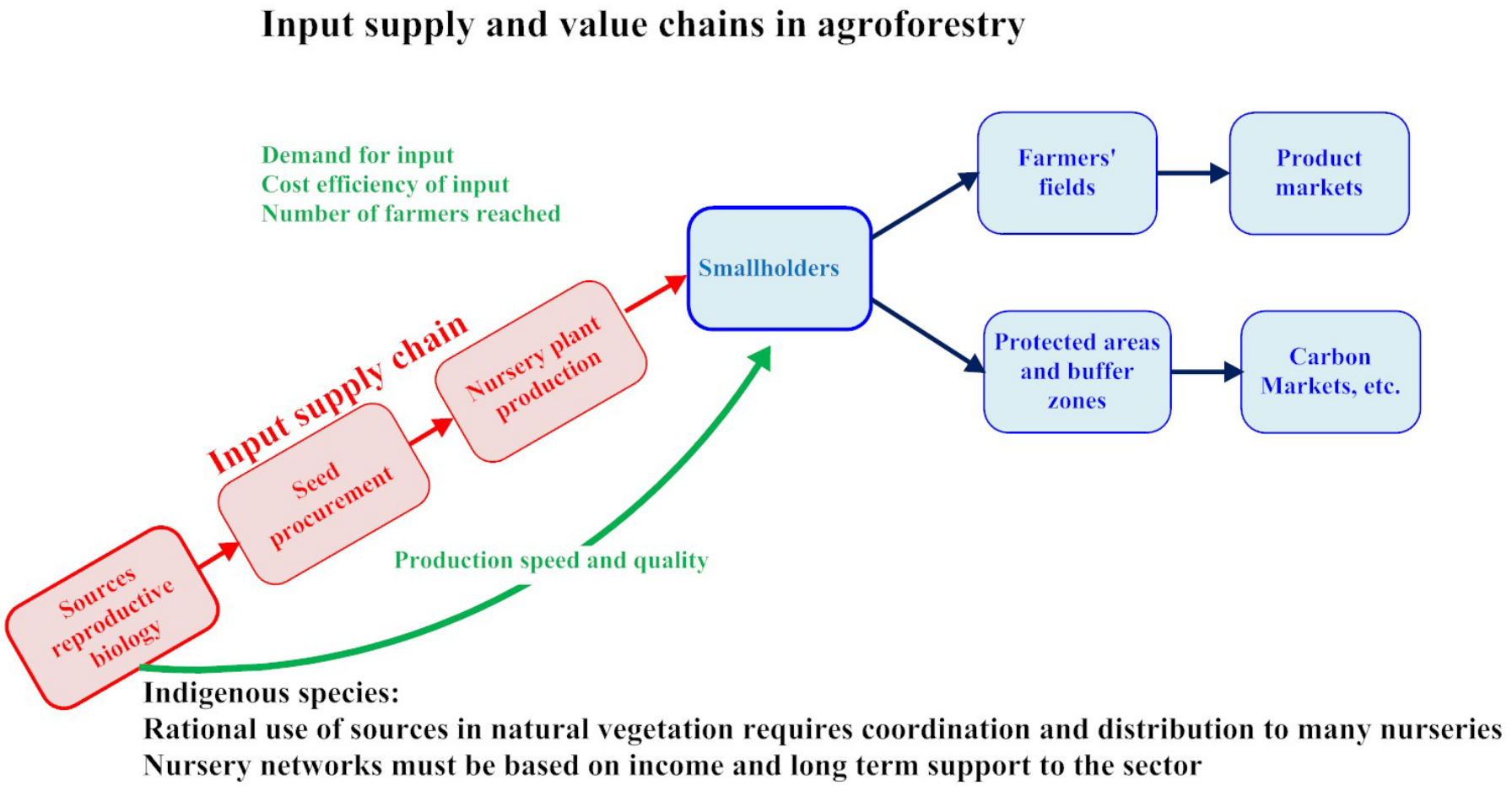
Consequently, the **roles of the different actors in the system can be defined clearly** and interventions determined accordingly

For tree seed a sources is at the same time breeding seed, foundation seed; and commercial seed.

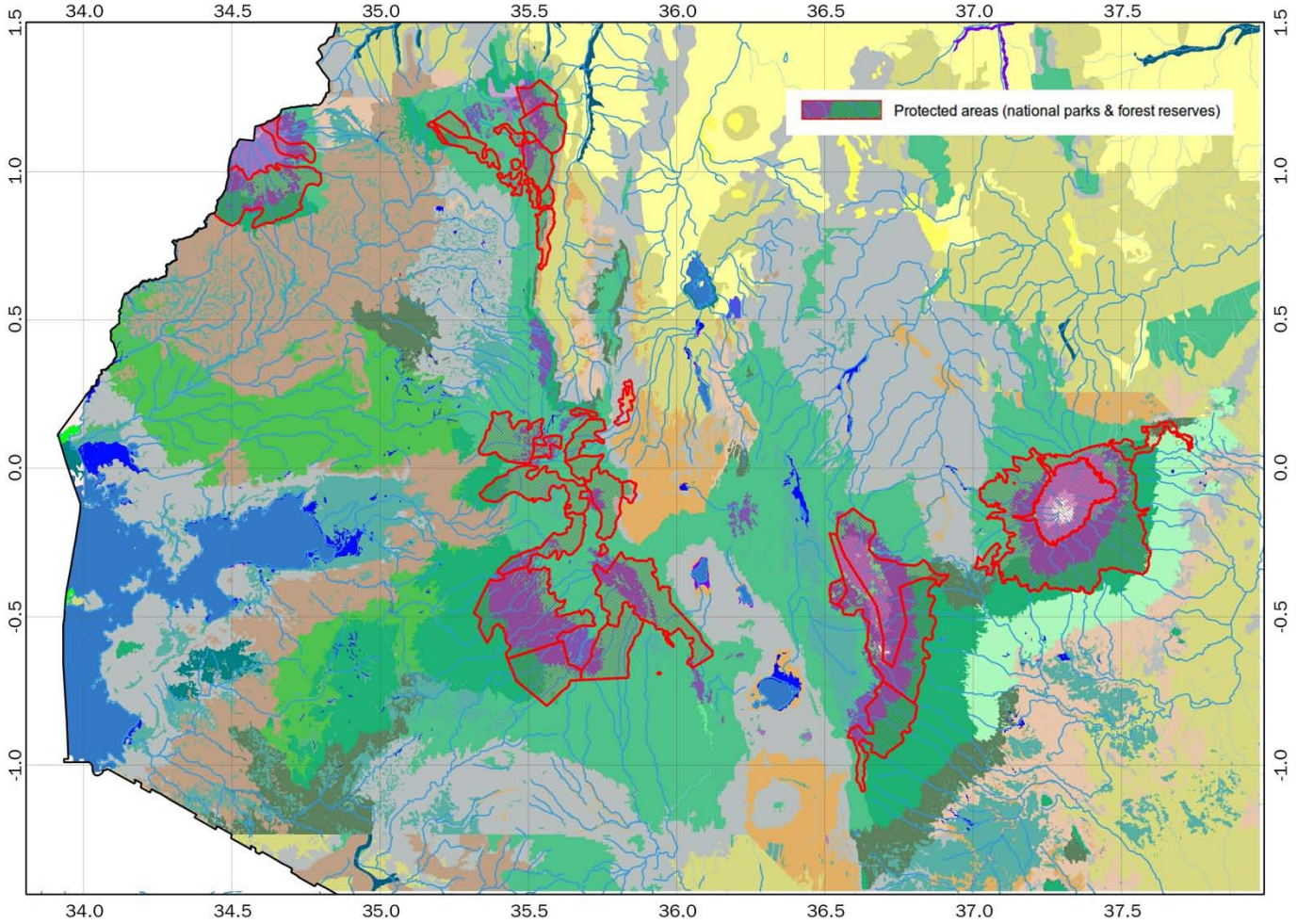
For **tree seed** –in contrast to crop seed - there is **generally no defined point** at which public and large private institutions can breed new materials and then hand this foundation seed over to smaller enterprises for the production and distribution of commercial material.

How would one set up a cost efficient network to distribute quality (adapted) seed?

A systems look at Smallholder planting



See also Lillesø et al. 2011. Innovation in input supply systems in smallholder agroforestry: seed sources, supply chains and support systems. Agroforestry Systems 83:347-359.



- Afromontane rain forest
- Undifferentiated Afromontane forest
- Single-dominant Hagenia abyssinica forest
- Afromontane moist transitional montane forest
- Lake Victoria transitional rain forest
- Afromontane dry transitional montane forest
- Somalia-Masai Acacia-Commiphora deciduous bushland and thicket
- Evergreen and semi-evergreen bushland and thicket
- Desert
- Climatic grasslands
- Somalia-Masai semi-desert grassland and shrubland
- Biotic savanna
- Moist combretum savanna
- Dry combretum savanna
- Balanites wooded grassland
- Afroalpine vegetation
- Afromontane bamboo
- Montane Ericaceous belt
- Freshwater swamp
- Halophytic vegetation
- Edaphic grassland on drainage-impeded or seasonally flooded soils
- Edaphic wooded grassland on drainage-impeded or seasonally flooded soils
- Riverine wooded vegetation
- Sand
- Water bodies
- Afromontane desert

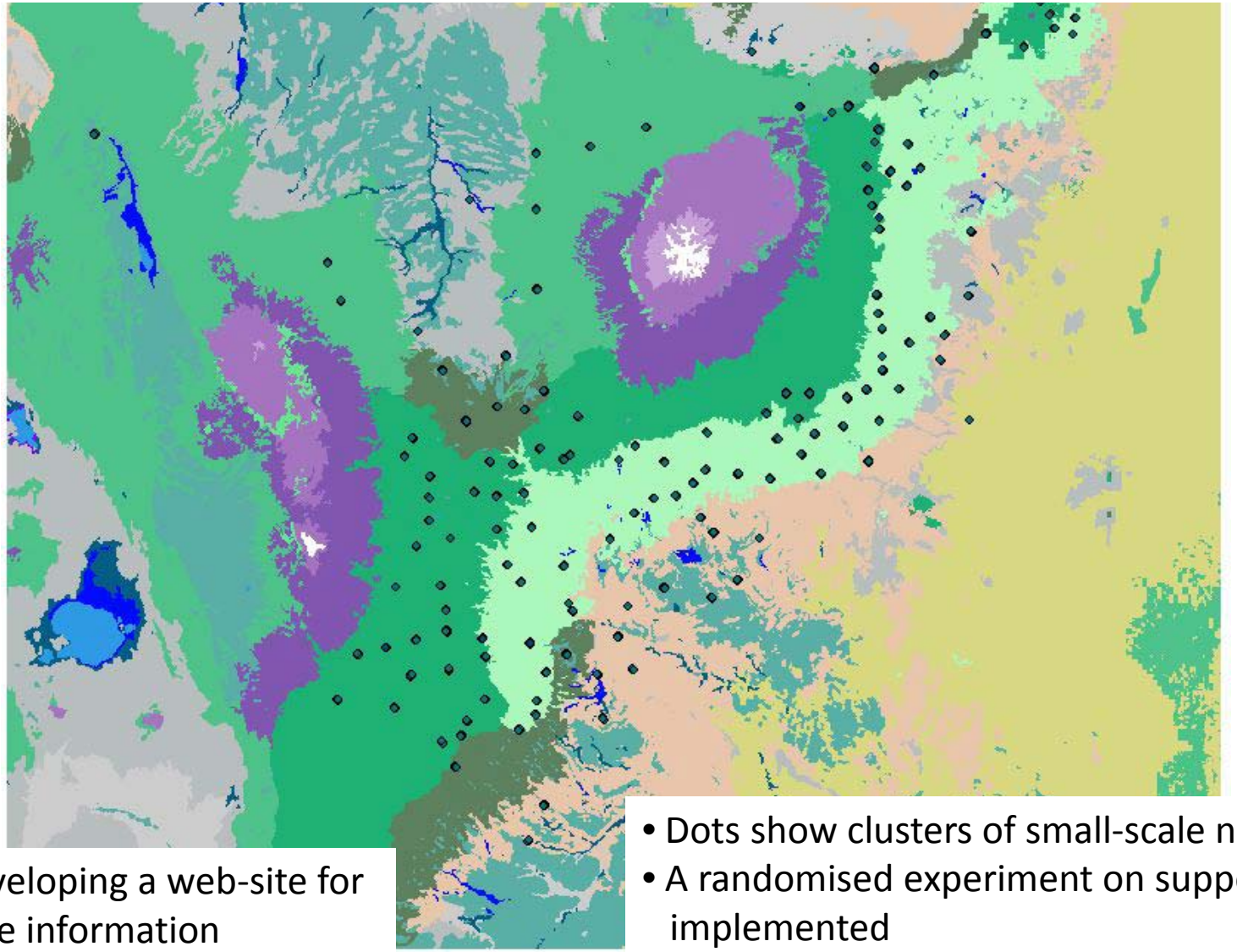
Suggestions for a reform:

Re-arrange roles of:

Government (National tree seed centres, Forestry): make information and sources available

NGOs: Provide support to smallholder planters and advise to entrepreneurs

Small-scale entrepreneurs: should have enabling environment to make money on quality



We are developing a web-site for seed source information

- Dots show clusters of small-scale nurseries
- A randomised experiment on support will be implemented