Measuring and analysing agrobiodiversity

Toby Hodgkin

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Why quantify extent and distribution of agrobiodiversity?

- Conservation
  - In situ
  - Ex situ
- Use
  - Ecosystem function
  - Resilience and adaptation
  - Livelihoods and income
  - Production and productivity
- **Land use decisions**

What land use decisions are relevant to the extent and distribution of agrobiodiversity?

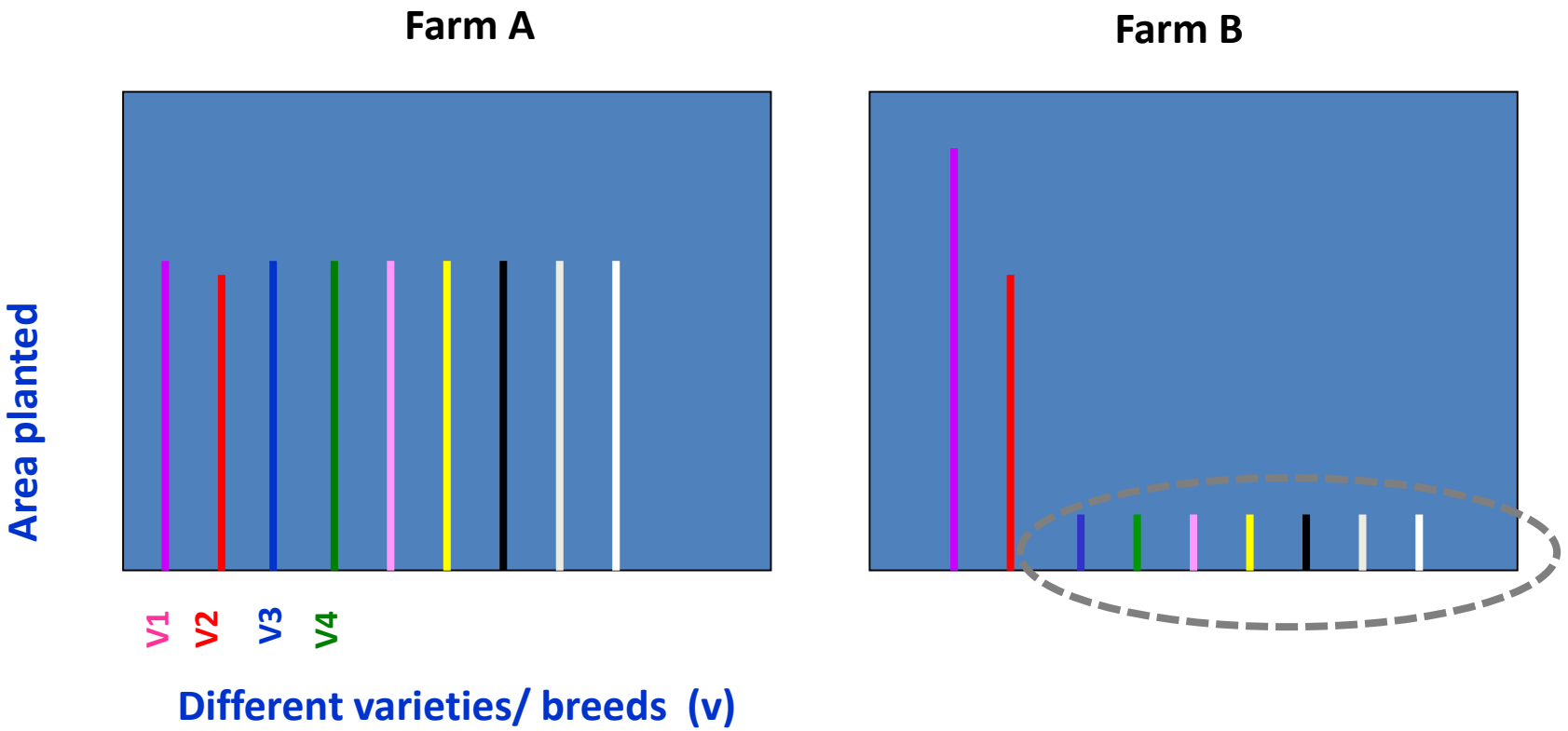
- Change from one land use to another
- Ownership
- Water management – e.g. drainage, irrigation
- Field size and location
- Agronomic practices (tillage, inputs)

Can these be placed along a sharing – sparing trajectory?

What data do we have relevant to this question?

Diversity Indices: A means to compare amounts and distribution of diversity across sites, time, crops, breeds

The concepts of richness and evenness



Richness = 9 (local varieties): A=B

Evenness (less dominance): A>B

Bioversity International

Partitioning diversity

- Global
- Community
- Farmer

Agrobiodiversity components

- Production sources or elements
- Useful wild plant and animal species
- Crops and varieties
- Animal (livestock) species and breeds
- Useful wild plant and animal species
- Perceived diversity (from SER study)
- Others…….

Production sources or types

- Field (irrigated, non-irrigated, permanent shifting)
- Pasture
- Animal yard
- Home garden
- Orchard
- Agroforest
- Bee keeping
- Fish (pond, lake, river)
- Forest
- Wetland
- Others (what?).....

Can be analysed by household (access/use) and spatially (landscape dimensions)

Useful wild plant and animal species

Here the classification will be different. What might be useful? What has been recorded?

- Species name
- Taxonomy (Kingdom, phylum, genera)
- Function (food, medicine, building, culture)
- Status (common, rare)
- Occurrence (forest, meadow, field margin etc)
- Part used (leaf, stem, root etc.)
- User (male, female, adult, child)
- Management practices and traditional knowledge

Crops

Best to start by treating each crop separately.

- Part used (root, leaf, seed)
- Useage (staple, vegetable, spice, fruit)
- Breeding system (self or out-pollinated, clonal)
- Seed source
- **Number of varieties (richness)**
- **Proportion of area on which each is grown (evenness)**

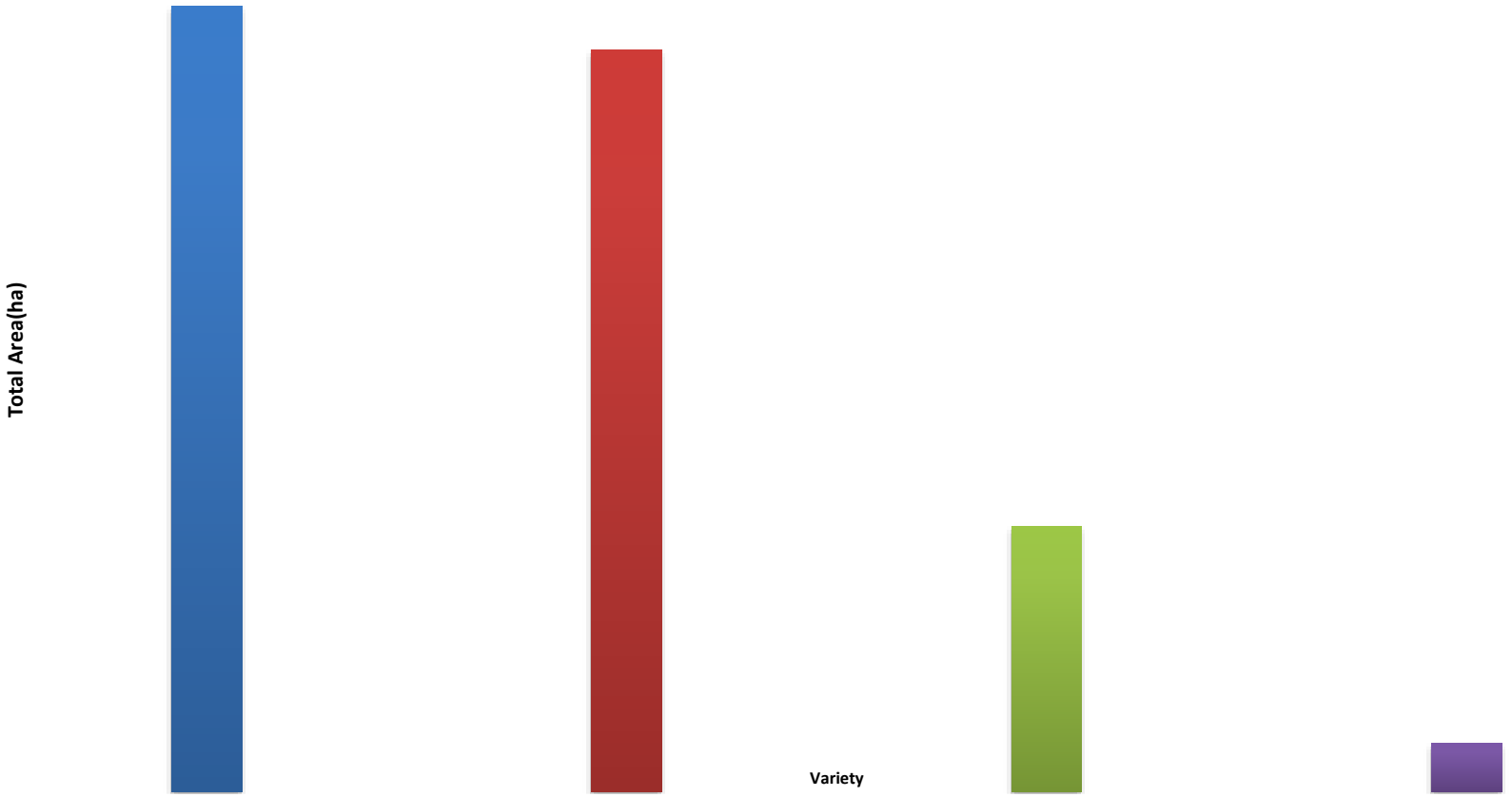
Animals

- Species
- Useage
- Management practices (transhumance, staic, intensive)
- Number of breeds (richness)
- Breed evenness (1- the sum of the square of the percent frequency of each breed)
- Population size
- **Effective population size** (Ne)

  Ne=4 (NmNf/Nm+Nf)

  where Nm is number of males and Nf is number of females

Evenness of common bean varieties in Sri Lanka



Analytical framework for Agrobiodiversity Indicators (developed with the GEF Secretariat)

Figures to be measured at project start, mid-term evaluation, and at final evaluation.

(1) Area coverage of traditional crop varieties and animal breeds (in hectares)

(2) Richness (number of) traditional crop varieties and animal breeds

(3) Evenness (relative areas/population size of) crop varieties and animal breeds

(x) Effective population size – Animals only

An example of richness and evenness

Farm	Area (ha)	Modern varieties growing on these farms	Proportion of farm with trad. varieties	Variety A	Var B	Var C	Var D	Var E	Number of varieties by farm (RICHNESS)	H (Simpson) (EVENESS)
1	10	xxx	0.5	1	0	0	0	0	1	0
2	8	xxx, yyy	0.2	0.2	0.8	0	0	0	2	0.32
3	8	xxx	0.3	0	0	1	0	0	1	0
4	6	zzz	0.4	1	0	0	0	0	1	0
5	5	xxx	0.3	0	0	0	1	0	1	0
6	3	None	1	0.2	0.2	0.2	0.2	0.2	5	0.8
7	3	None	1	0	0.5	0.3	0.1	0.1	4	0.64
11	3	xxx	0.7	0	0	0	0.5	0.5	2	0.5
Average	5.75	1	0.55	0.3	0.1875	0.1875	0.225	0.1	2.1	0.28
Total	46	3		Simpson	0.779		Divergence	0.64		

Computing the partition of variation in this example:

$$H_T = 1 - (0.3)^2 - (0.1875)^2 - (0.1875)^2 - (0.225)^2 - (0.1)^2 = 0.78$$

The Divergence or % of variation between farms = (0.78 – 0.28) / 0.78 = 64%

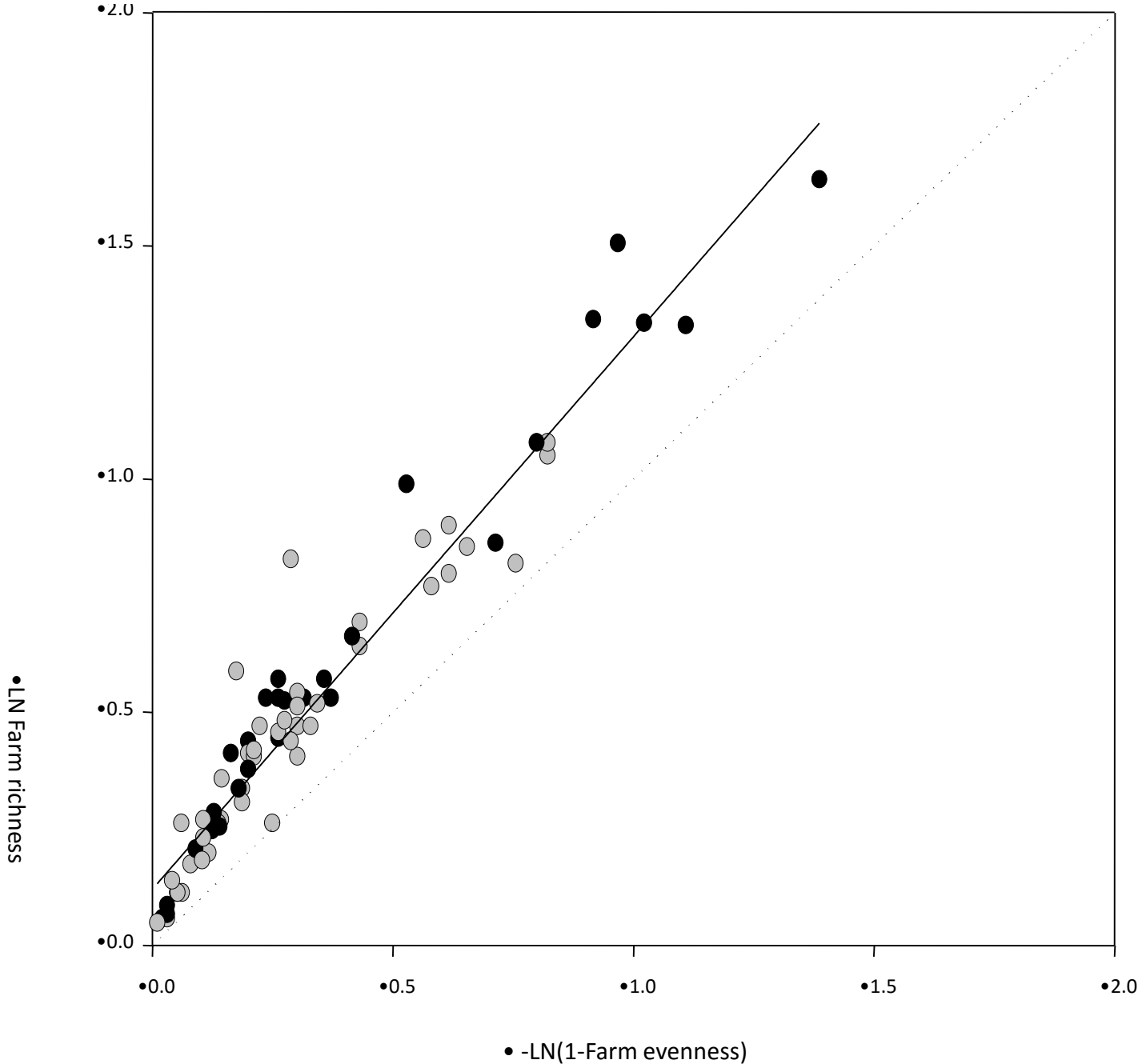
A log transform may be desirable when plotting relationships between richness and evenness

What can the analysis of richness and evenness tell us?

- The amount of diversity in a system
- Patterns of species or variety distribution
- Species or varieties at risk
- The extent to which individual farmers do their own thing (divergence)

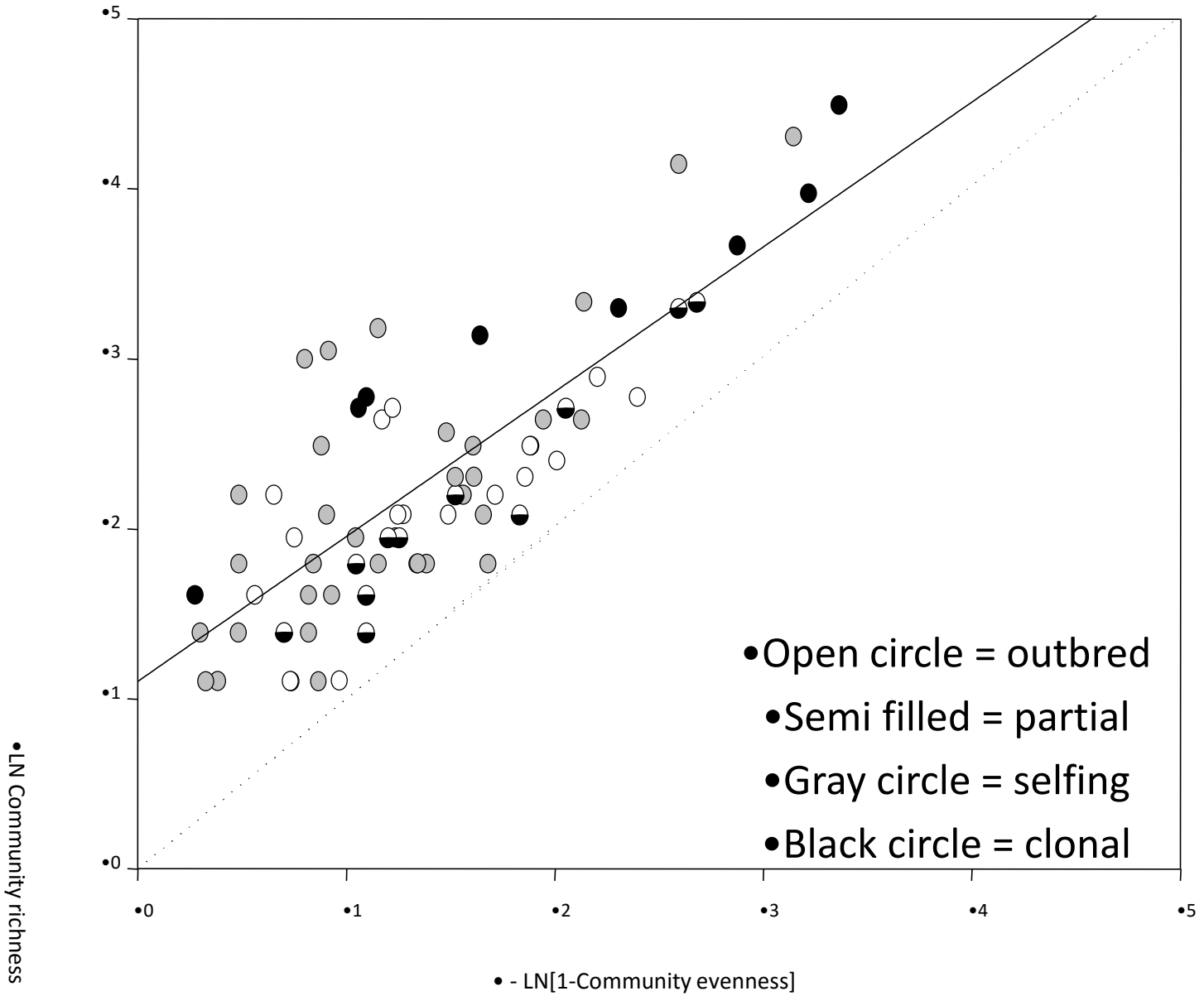
We can link richness and evenness to other characteristics and find out more.

Landrace richness and evenness at the farm level

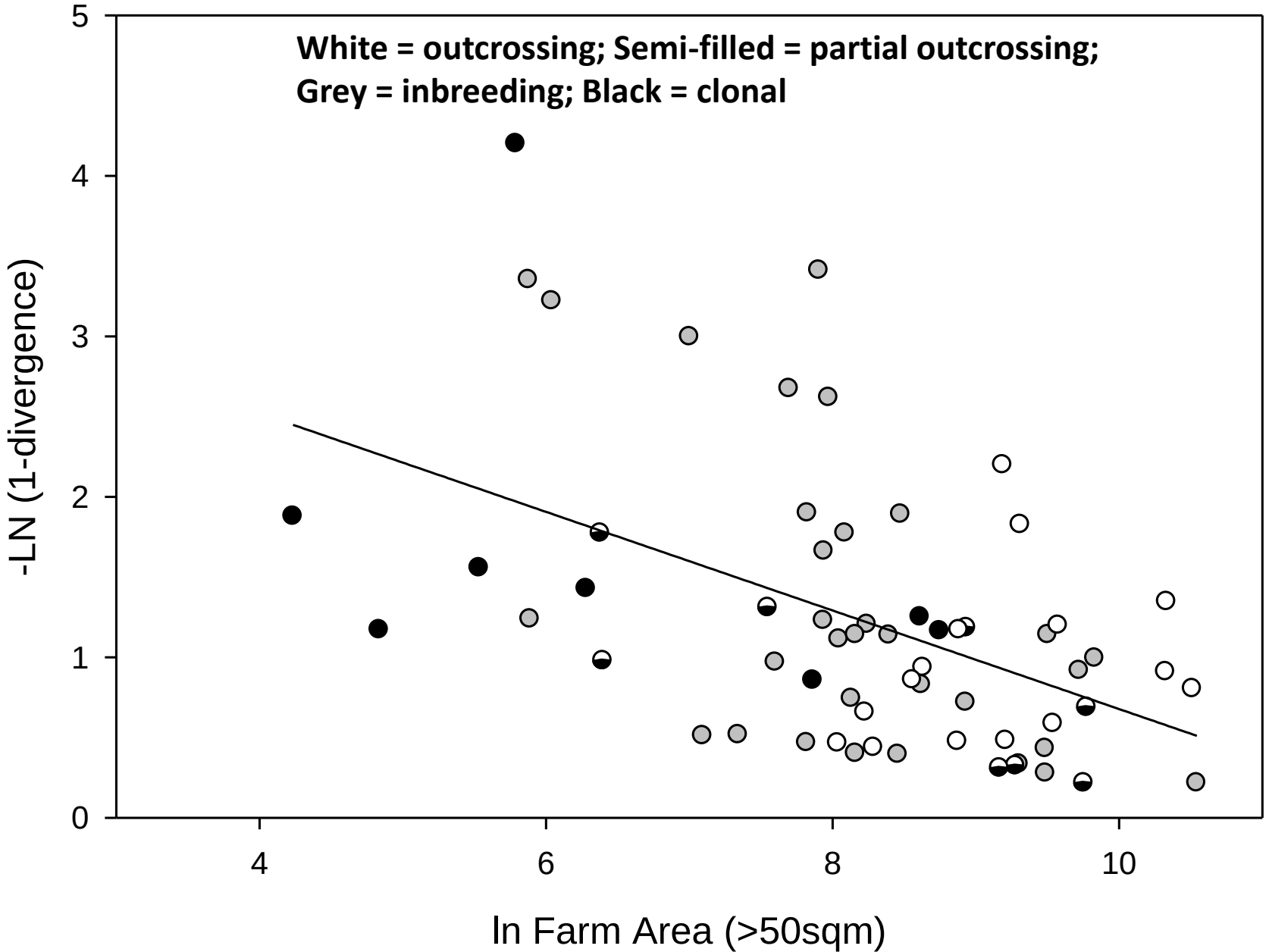


- Black circle = staples
- Gray circle = pulses, vegetables, etc

Landrace richness and evenness at the community level



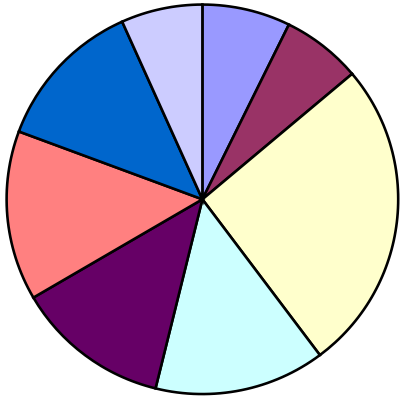
Relationship between farm area and divergence- plot one line the field crops

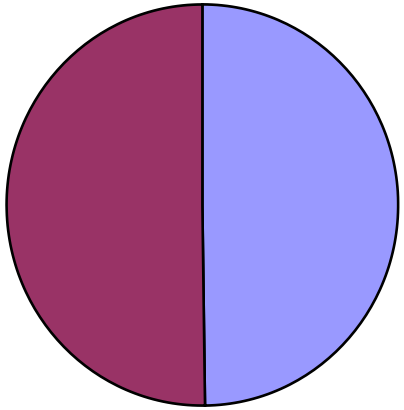


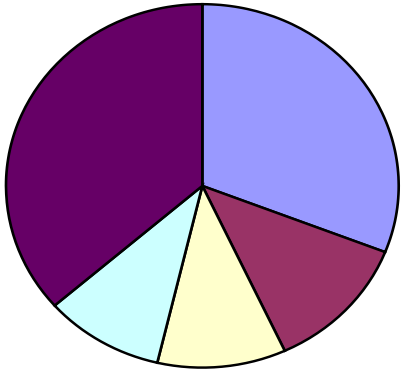
Rare vs. Common -- Rice varieties grown in Kaski, Nepal

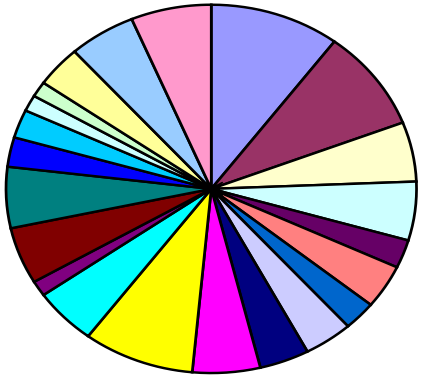
Large areas

Small areas









many households

few households

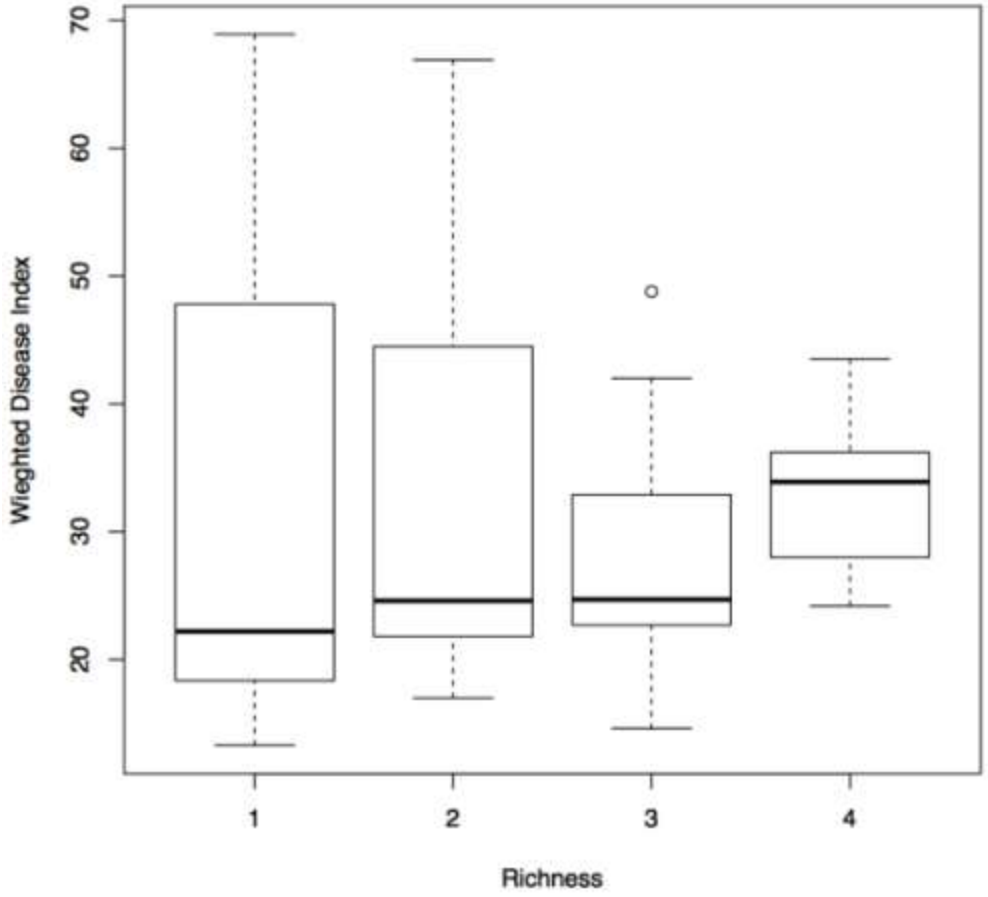
Rana et al., 2000

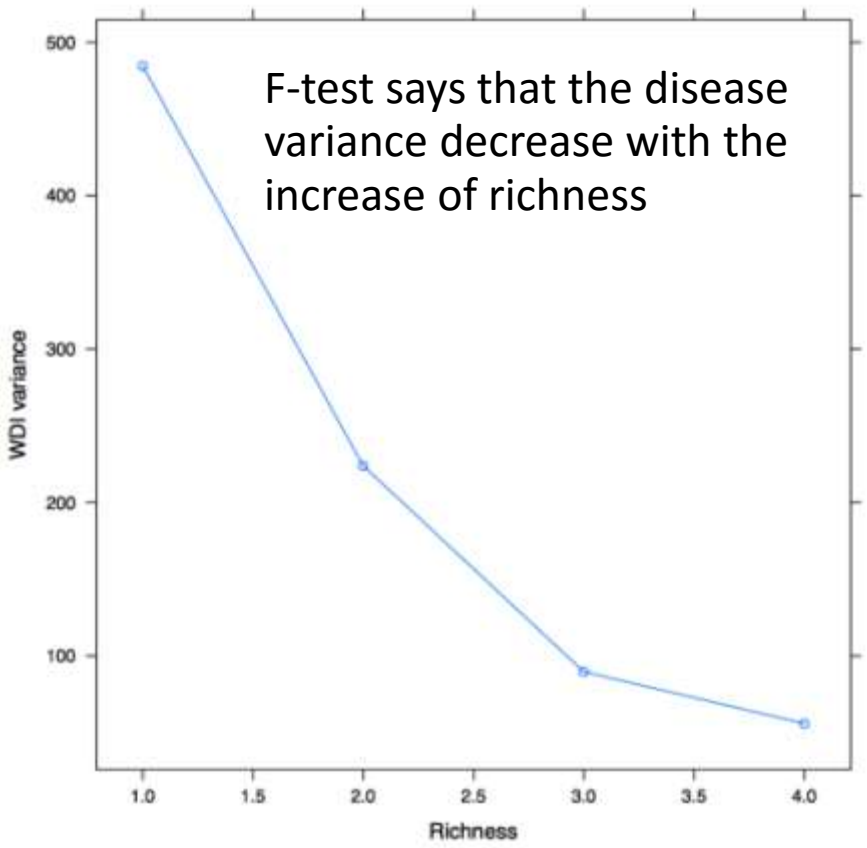
Seed maintenance and exchange

Country and crop	Self saved	Exchange	Local market	Formal sector
Nepal - rice	44	54	0	2
Yucatan - maize	54	44	n.d.	17
Morocco – local wheat	76	6	18	0

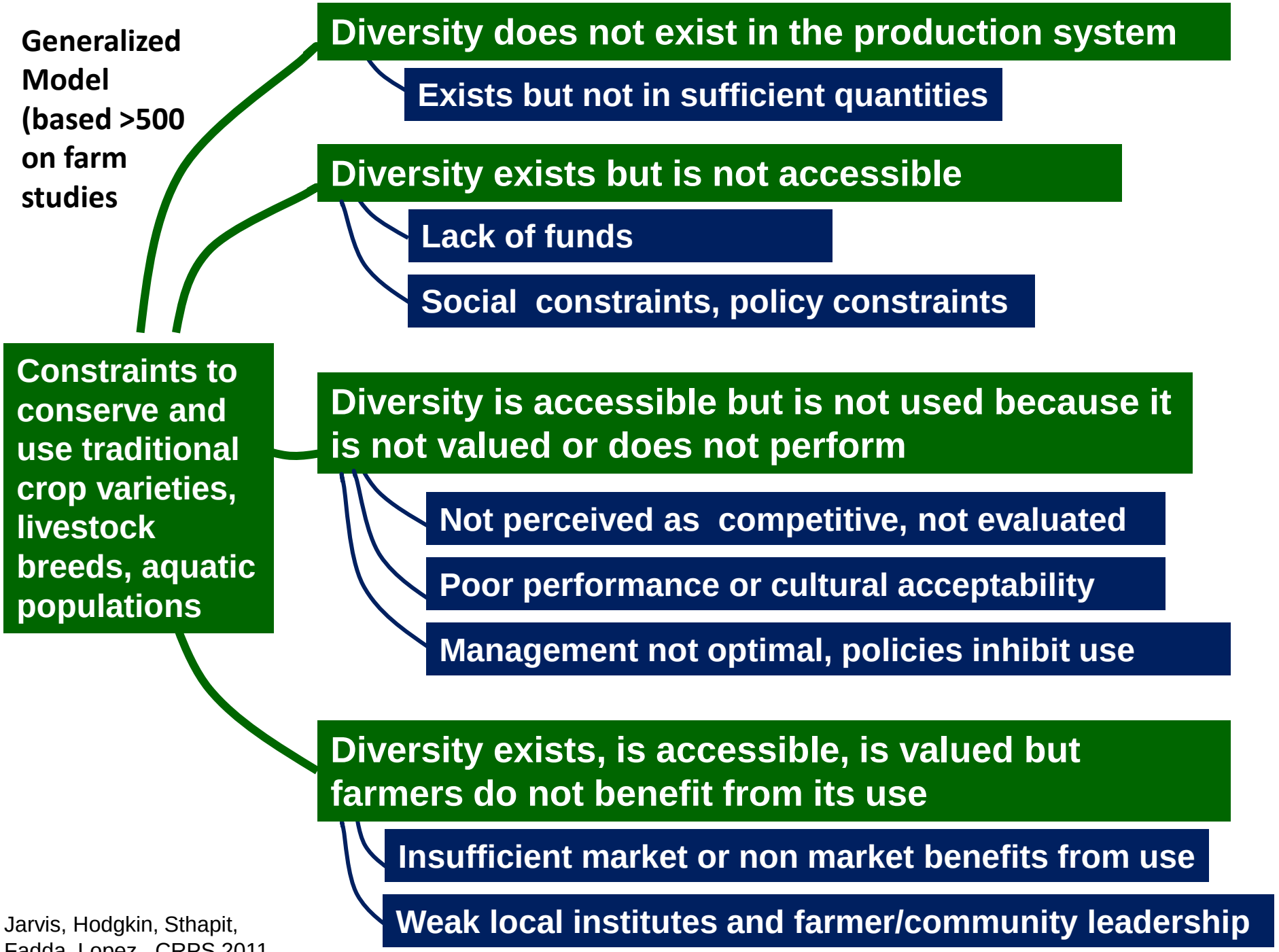
Relationships Richness/disease

Maize from Sichuan





F-test says that the disease variance decrease with the increase of richness



Jarvis, Hodgkin, Sthapit, Fadda, Lopez, CRPS 2011