Sustainable Land Management in Northern Namibia:

Opportunities to Integrate Local and Scientific Knowledge Based on an Understanding of Land Use Potential

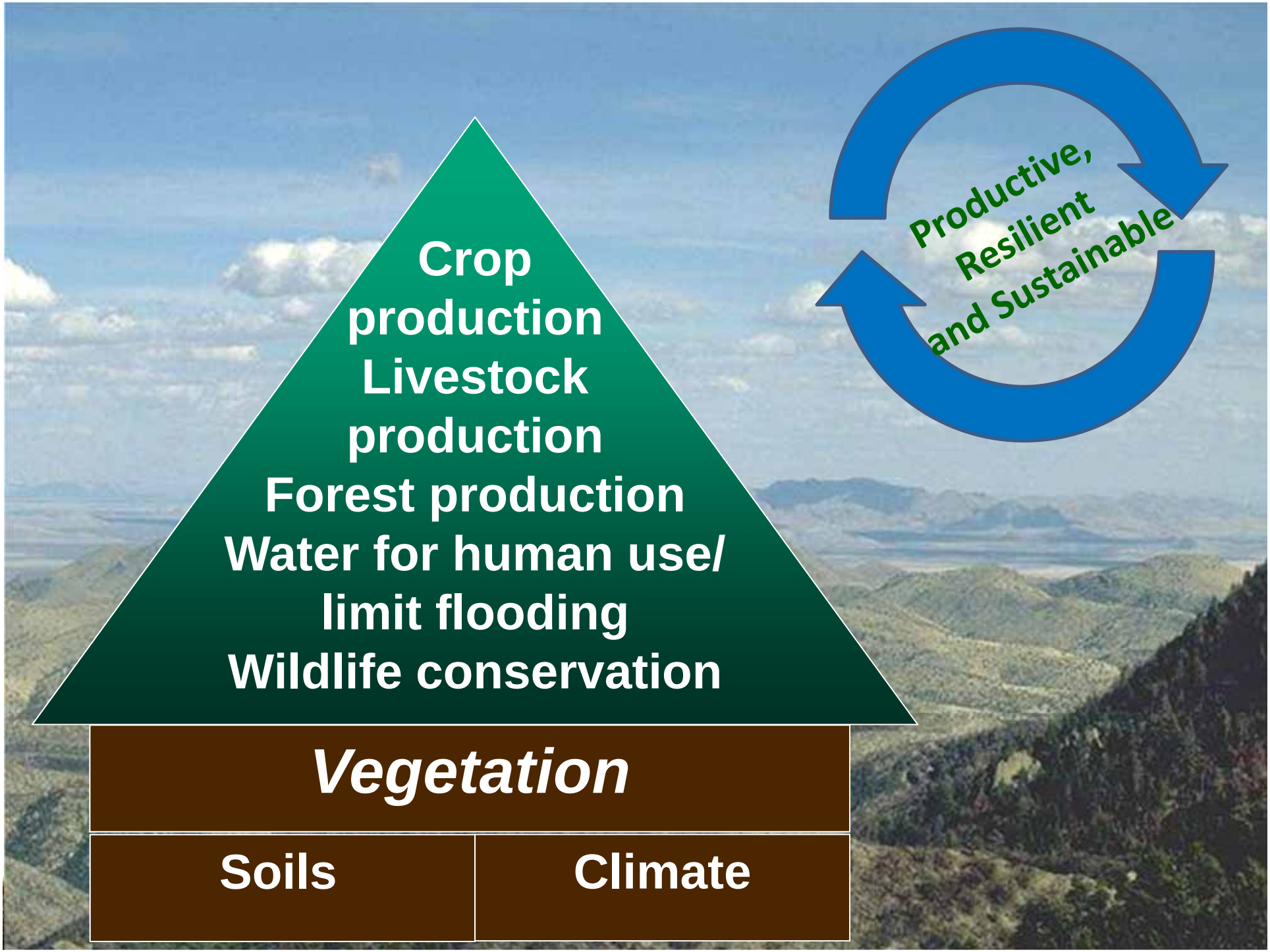
Polytechnic of Namibia
Windhoek, Namibia
23 May, 2012

Jeff Herrick
Jornada Experimental Range
Agricultural Research Service
US Dept. of Agriculture (USDA)
Las Cruces, NM USA

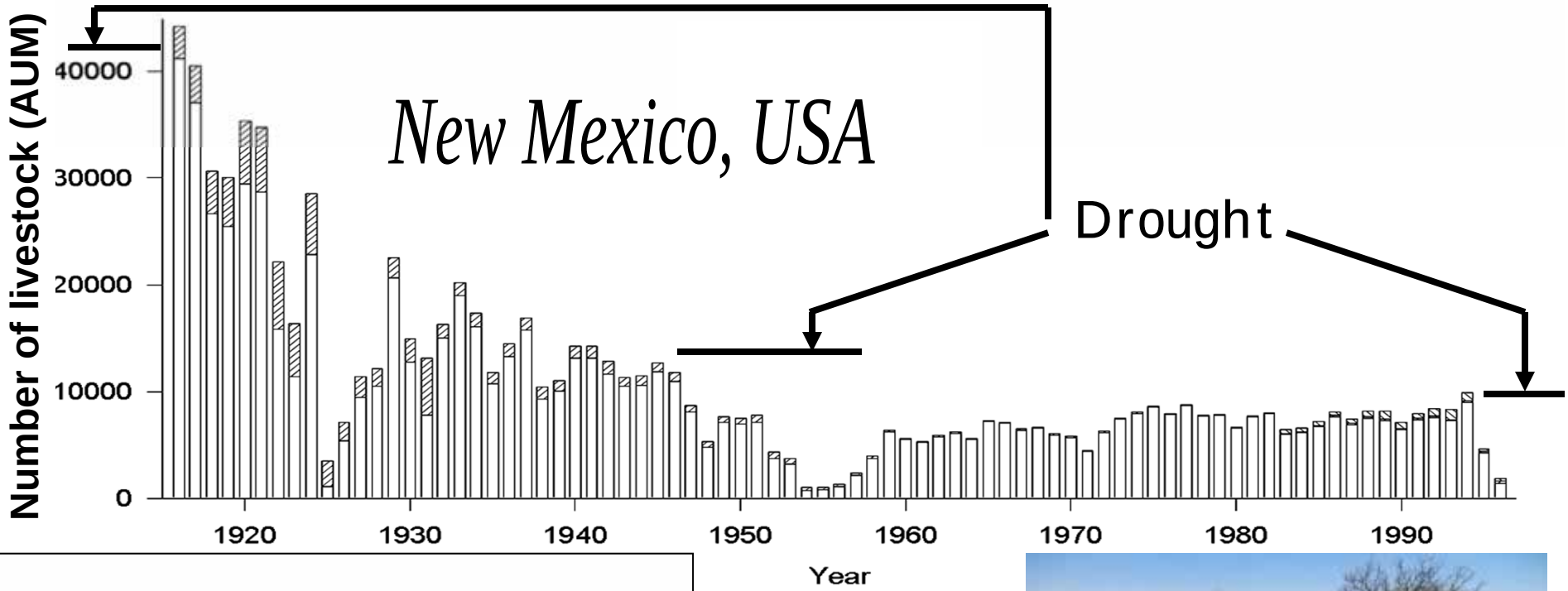
1. US experience: 1880's and 1930's
2. Global challenge
3. (Parts of) northern Namibia at a tipping point?
4. Elements of a (local to global) solution
   - Integrating and sharing scientific and local knowledge
   - Land Potential Knowledge System

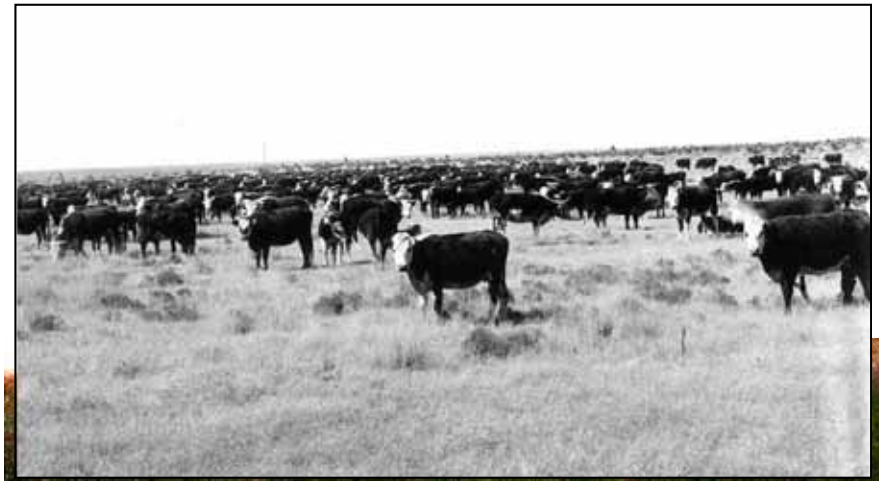

2-9 September, 2011
14-22 January, 2012


How can rangelands on resettlement farms be improved? (production and condition)
NAMIBIA RANGELAND FORUM
9 SEPTEMBER 2011
CHARD T. KAMUKUENJANDJE


Crop production
Livestock production
Forest production
Water for human use/ limit flooding
Wildlife conservation
Vegetation
Soils
Climate
Productive, Resilient and Sustainable

Southwest US Experience: 1880's-present (Kunene climate)



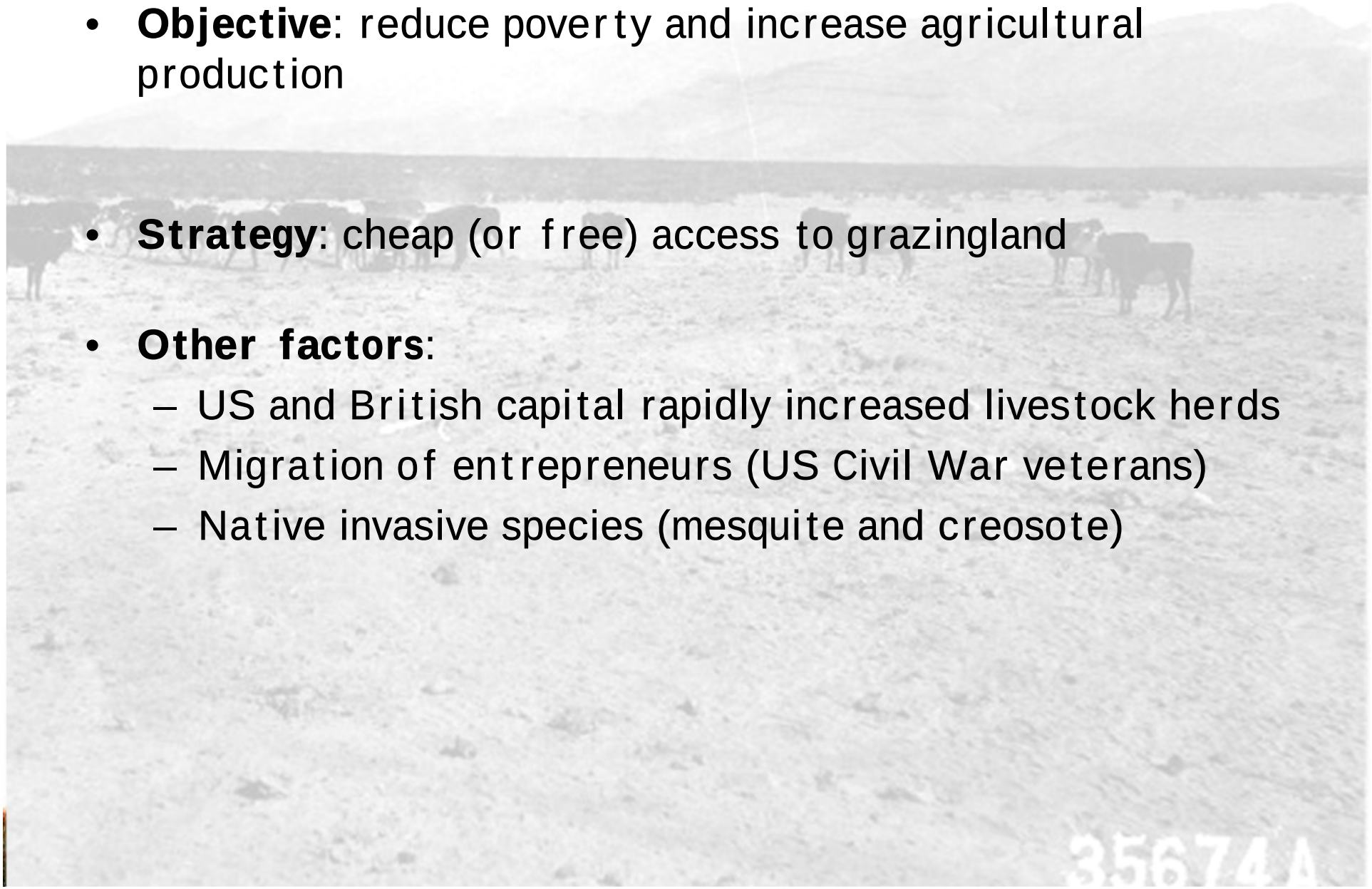


Southwest US Land Management 1880-1934

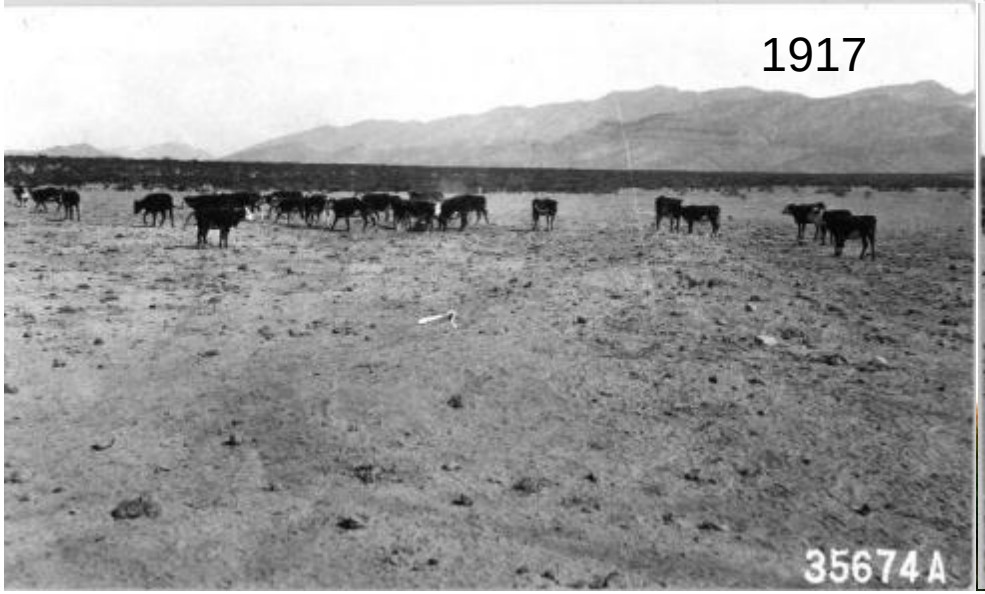
- **Objective**: reduce poverty and increase agricultural production

- **Strategy**: cheap (or free) access to grazingland

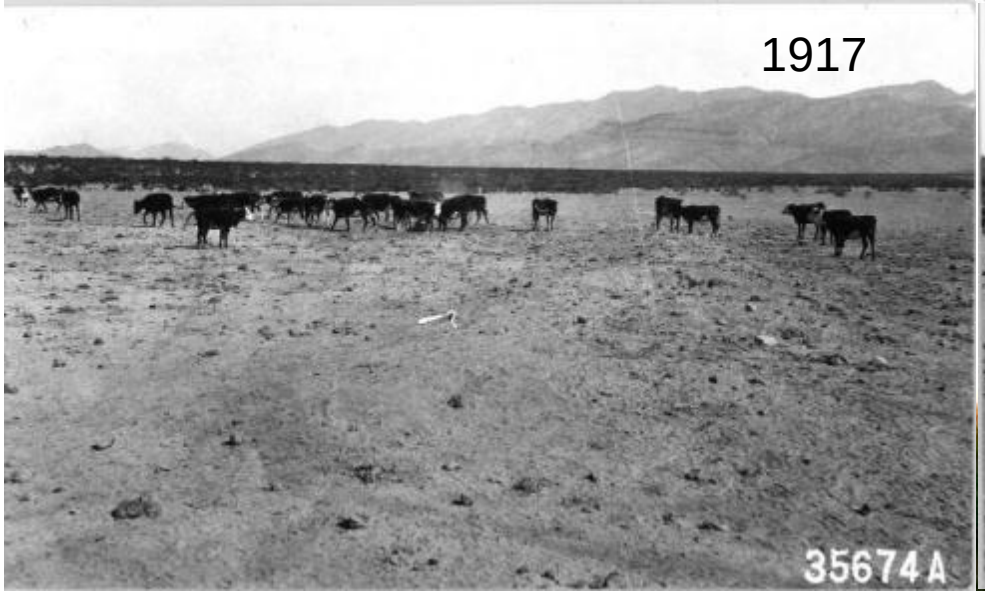
- **Other factors**:
  - US and British capital rapidly increased livestock herds
  - Migration of entrepreneurs (US Civil War veterans)
  - Native invasive species (mesquite and creosote)



Result: overgrazing + drought = grass mortality. Invasive shrubs now dominate.



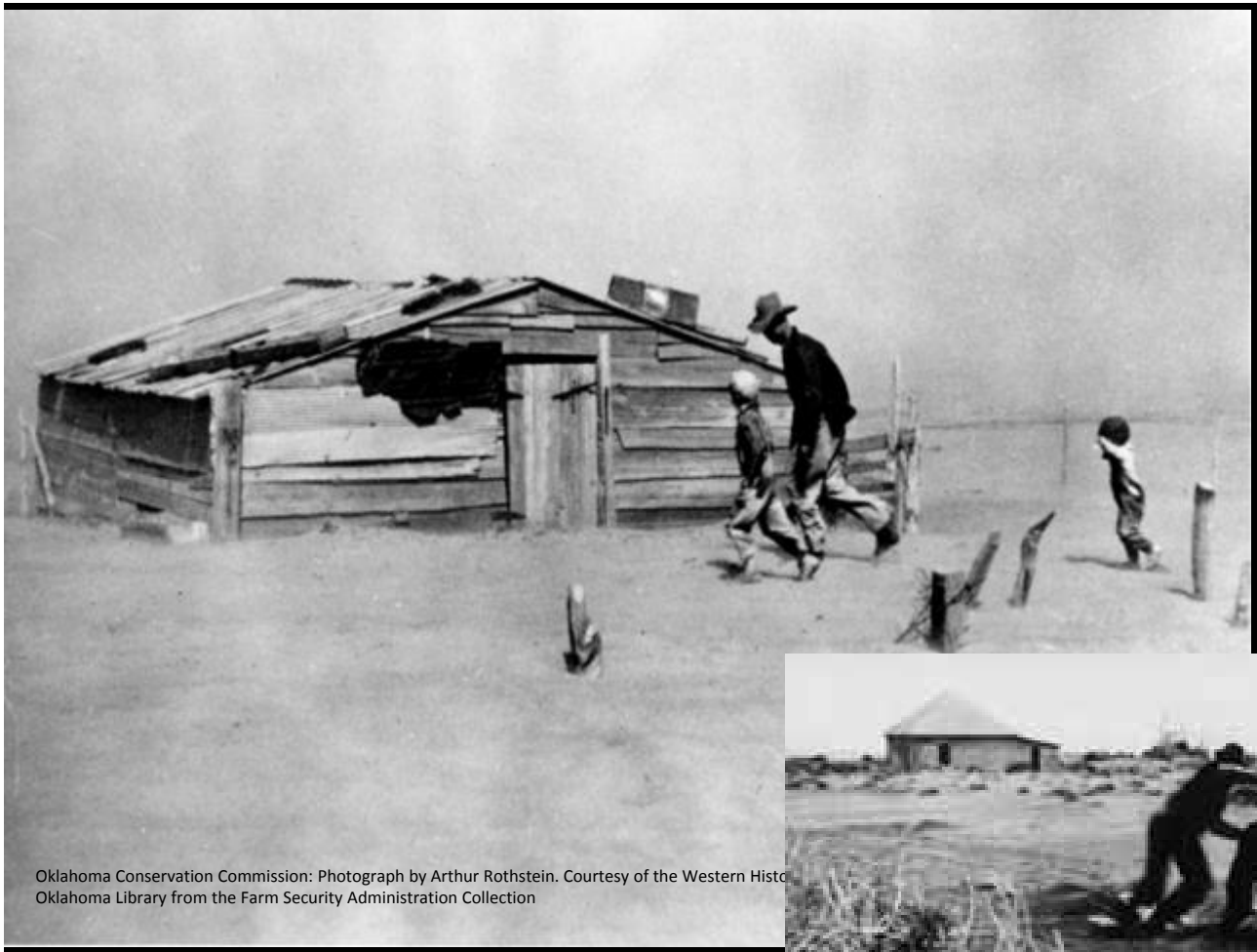
Ecologists' role: documented degradation, recommended preventive measures (too late -- Wooton publishes "The Range Problem in New Mexico" in 1908)



US Experience 1930's: "The Crime of the Century"

(Quote and photo June 1910 near Newell SD by A.C. Dillman, USDA) (from K.D. Kephardt, SDSU)

US Experience 1930's "Dust Bowl"



Oklahoma Conservation Commission: Photograph by Arthur Rothstein. Courtesy of the Western Histo
Oklahoma Library from the Farm Security Administration Collection

US National Archives

1. US experience: 1880's and 1930's
2. ***Global challenge***
3. (Parts of) northern Namibia at a tipping point?
4. Elements of a (local to global) solution
   - Integrating and sharing scientific and local knowledge
   - Land Potential Knowledge System

Global Challenge

"… we will need the equivalent of two planets by 2030 to meet our annual demands… " (WWF Living Planet Report 2012)

… but this is based on 'business as usual' production systems and land use patterns…

Wall Street Journal – January 2011

WSJ Jan 18 2011 pC9

With high grain prices and global production shortages, U.S. farmers are expected to plant every available acre this spring. Here, harvesting corn in Marshall, Mo., in September.

Farmers Pressed to Plant

By Ian Berry

U.S. farmers are expected to plant every spare acre they can yet still may be unable to replenish low grain supplies.

Analysts estimate farmers come spring must sow an additional 10 million acres—the largest U.S planting in a decade—to maintain adequate supplies of crops from corn to oats. The U.S. Department of Agriculture last week forecast supplies as a percentage of usage would fall to 15-year lows for corn and more than 40-year lows for soybeans. The agency also cut its forecast for some exporters such as Argentina and Australia.

Farmers have an incentive to sow as many acres as they can. The supply outlook has pushed crop prices to multiyear highs, with corn trading at about $6.40 a bushel and soybeans trading at more than $14 a bushel.

Some analysts expect the strong prices will ease demand somewhat, yet ramping up planting will be critical to ease global-supply concerns.

To reach the 327 million acres of planted cropland that is being talked about, farmers will need favorable weather to sow the maximum amount of acreage and increase "double cropping," or the planting of an acre twice in the same year. Prices also may need to climb further to give farmers an incentive to plant marginal lands.

"I can't come up with a solution of where all these acres are going to come from, unless we start putting hay acres under plow," said Dan Basse, president of Chicago research firm AgResource, meaning acres currently used to grow hay would have to be cultivated for crops like corn or soybeans.

Yet grain prices are "screaming" for more acres, which will push farmers to convert pastures used for animal grazing to cropland and consider planting even in questionable weather conditions, Iowa State University agricultural economist Chad Hart said.

He said North and South Dakota have roughly three million acres that could be put into production. Another three million acres are available in a region from southern Illinois to Arkansas.

In the meantime, a pullback in demand could help ease concerns over end-of-season inventories. Meat producers are likely to cut back on grain usage as high prices cut into margins. Export demand could weaken as well. Yet demand from producers of corn-based ethanol is expected to remain high as crude-oil prices above $90 a barrel drive more blending of the fuel additive than required under federal mandate.

"…grain prices are 'screaming' for more acres which will push farmers to convert pasture used for grazing animals to cropland and consider planting in questionable weather conditions…"

New York Times – April, 2011

High Prices Sow Seeds of Erosion

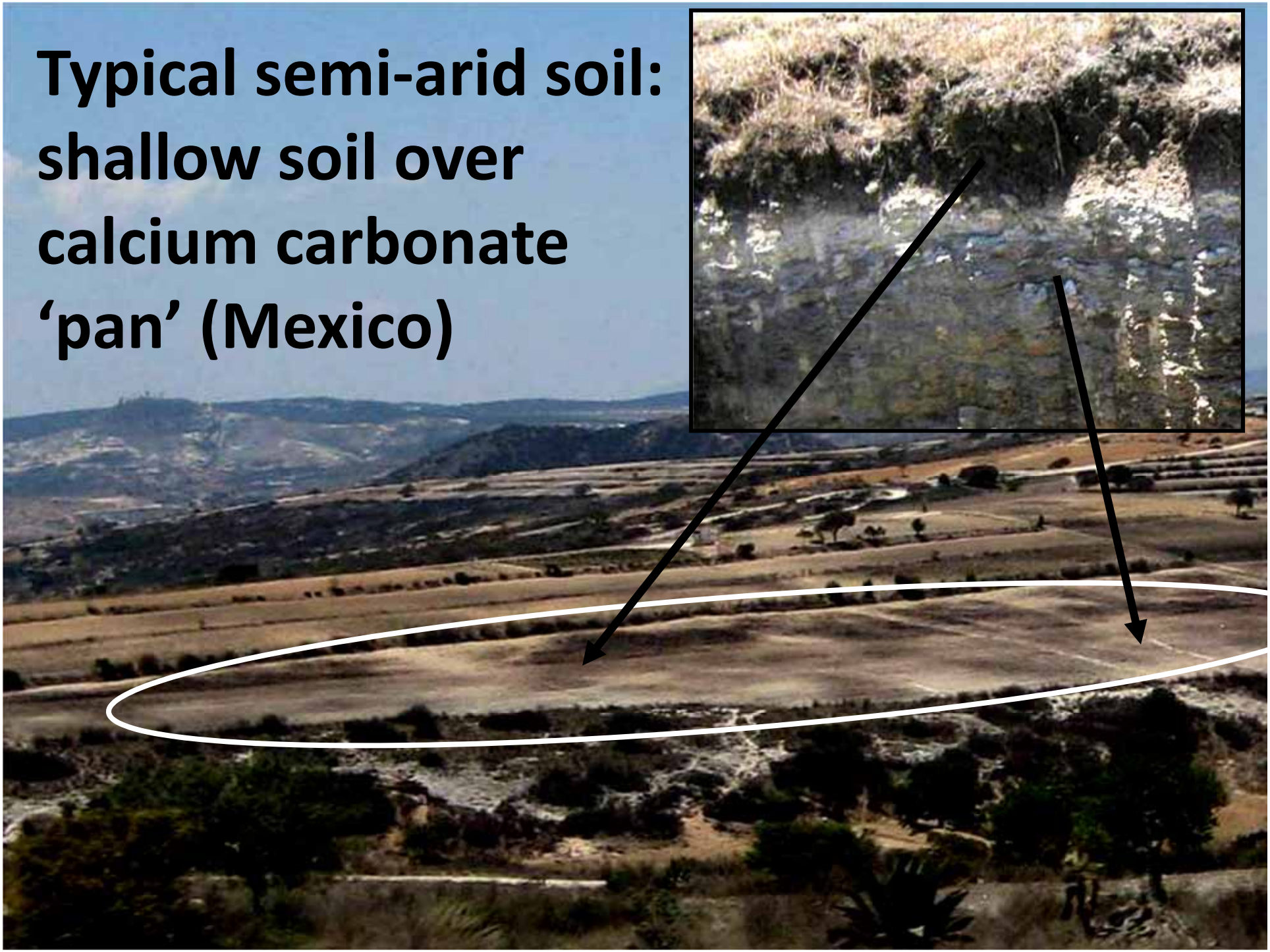
When prices for corn and soybeans surged last fall, Bill Hammitt, a farmer in the fertile hill country of western Iowa, began to see the bulldozers come out, clearing steep hillsides of trees and pastureland to make way for more acres of the state's staple crops. Now, as spring planting begins, with the chance of drenching rains, Mr. Hammitt worries that such steep ground is at high risk for soil erosion…

http://www.nyttimes.com/2011/04/13/business/13erosion.html

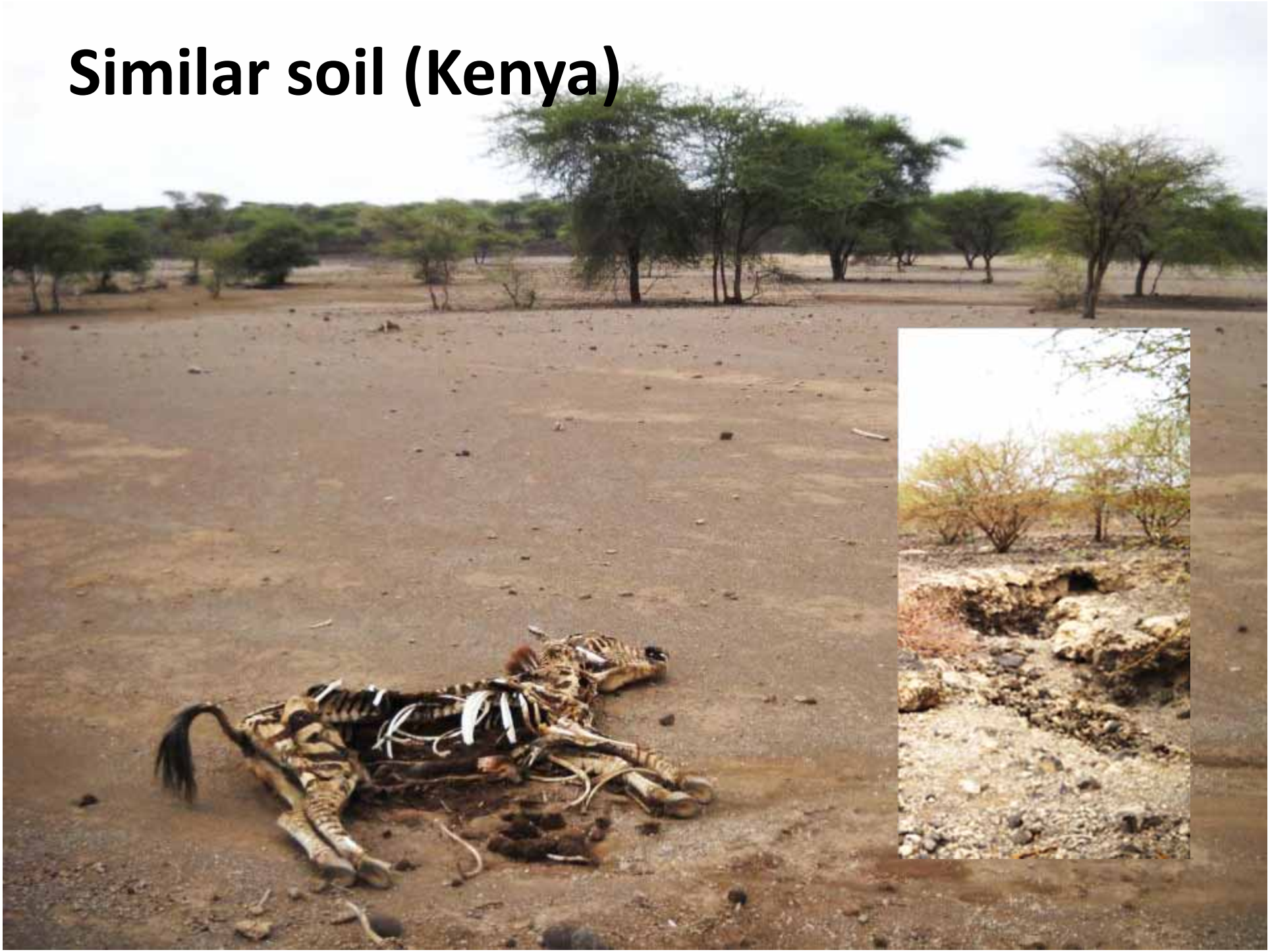
Global Challenge

Drylands, including northern Namibia, are often at greater risk of degradation due to frequent drought, leaving soil exposed to erosion, intense storms *even without climate change,* and poor inherent soil quality

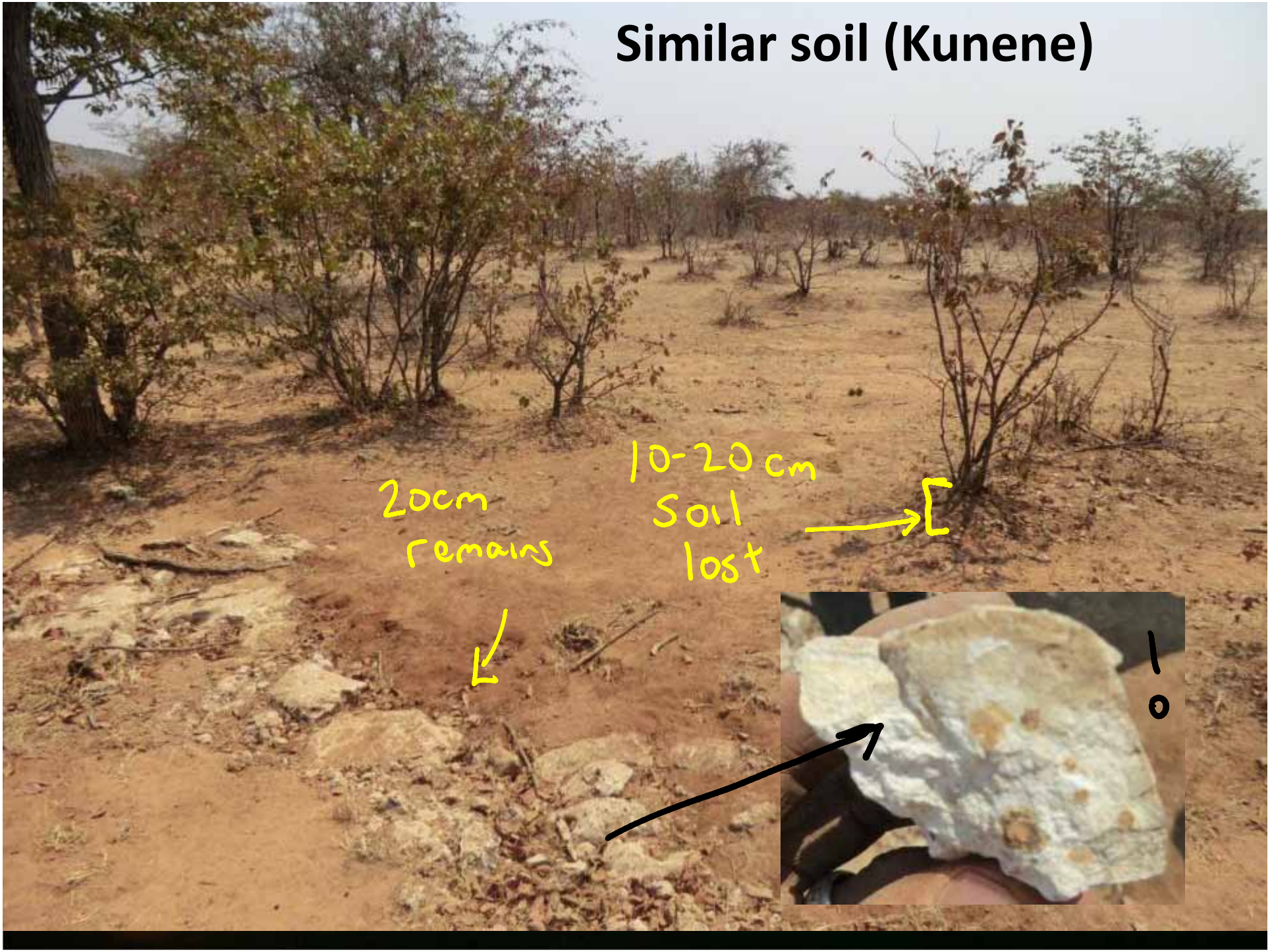
Typical semi-arid soil: shallow soil over calcium carbonate 'pan' (Mexico)



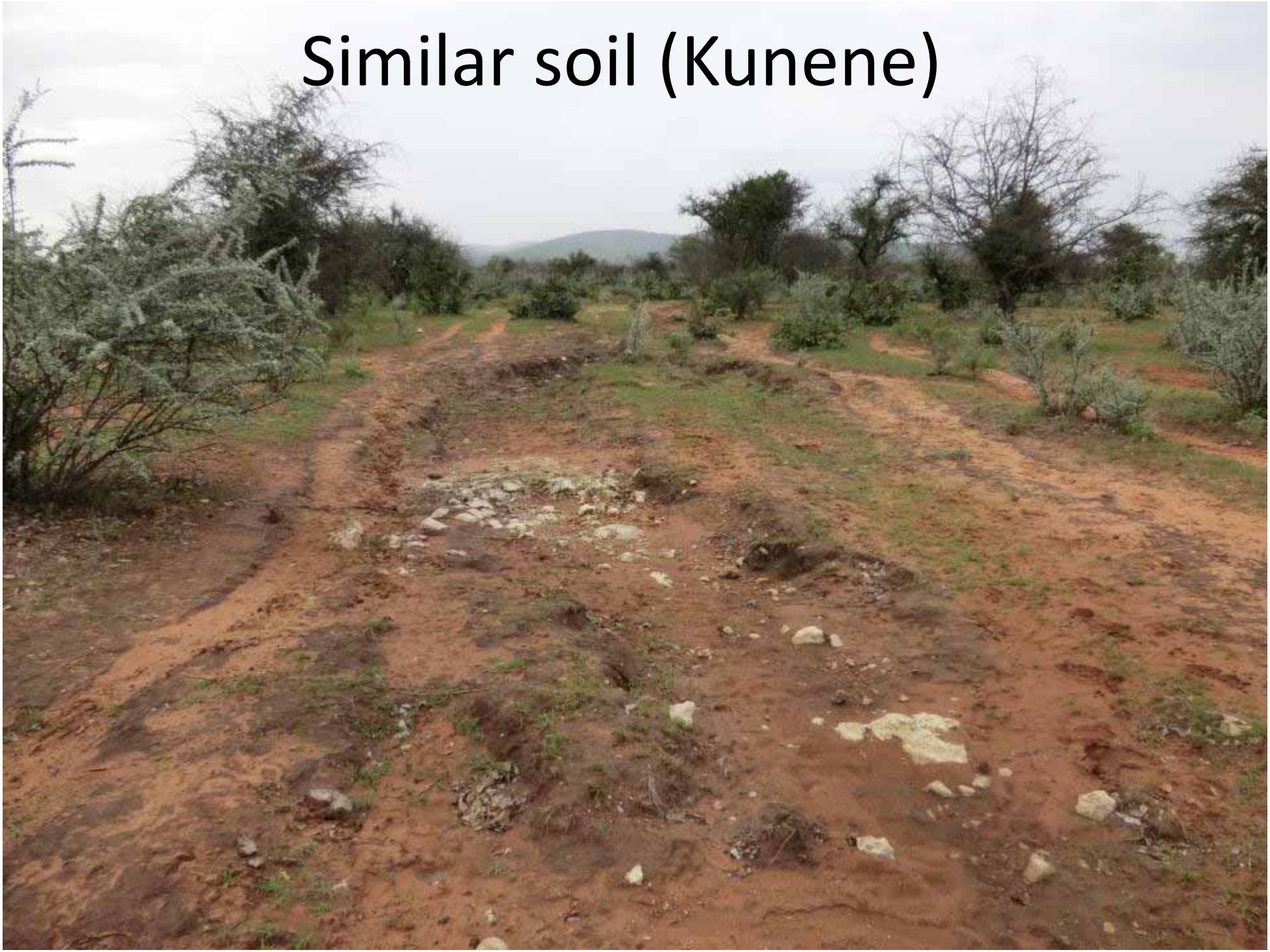
Similar soil (Kenya)

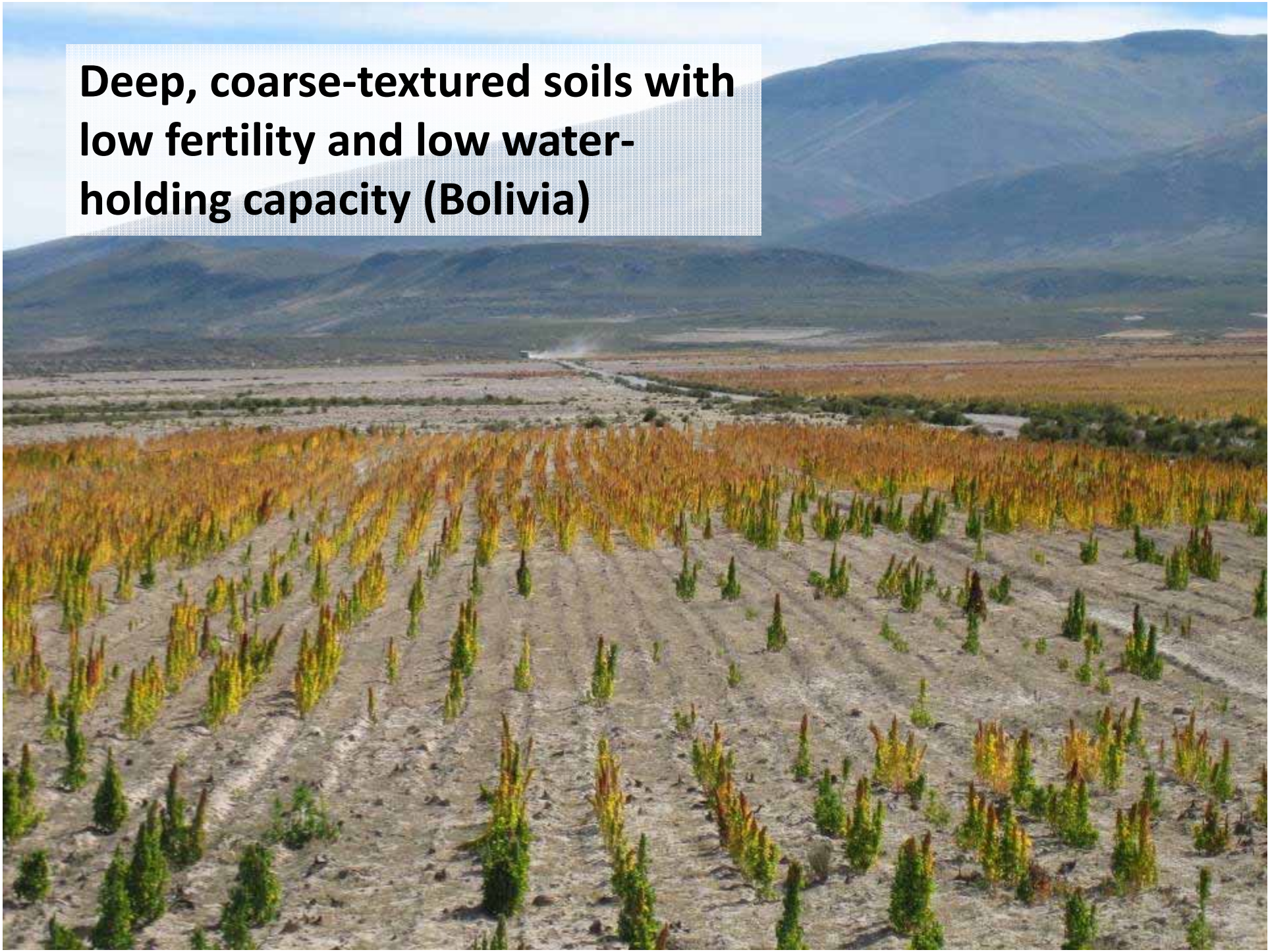


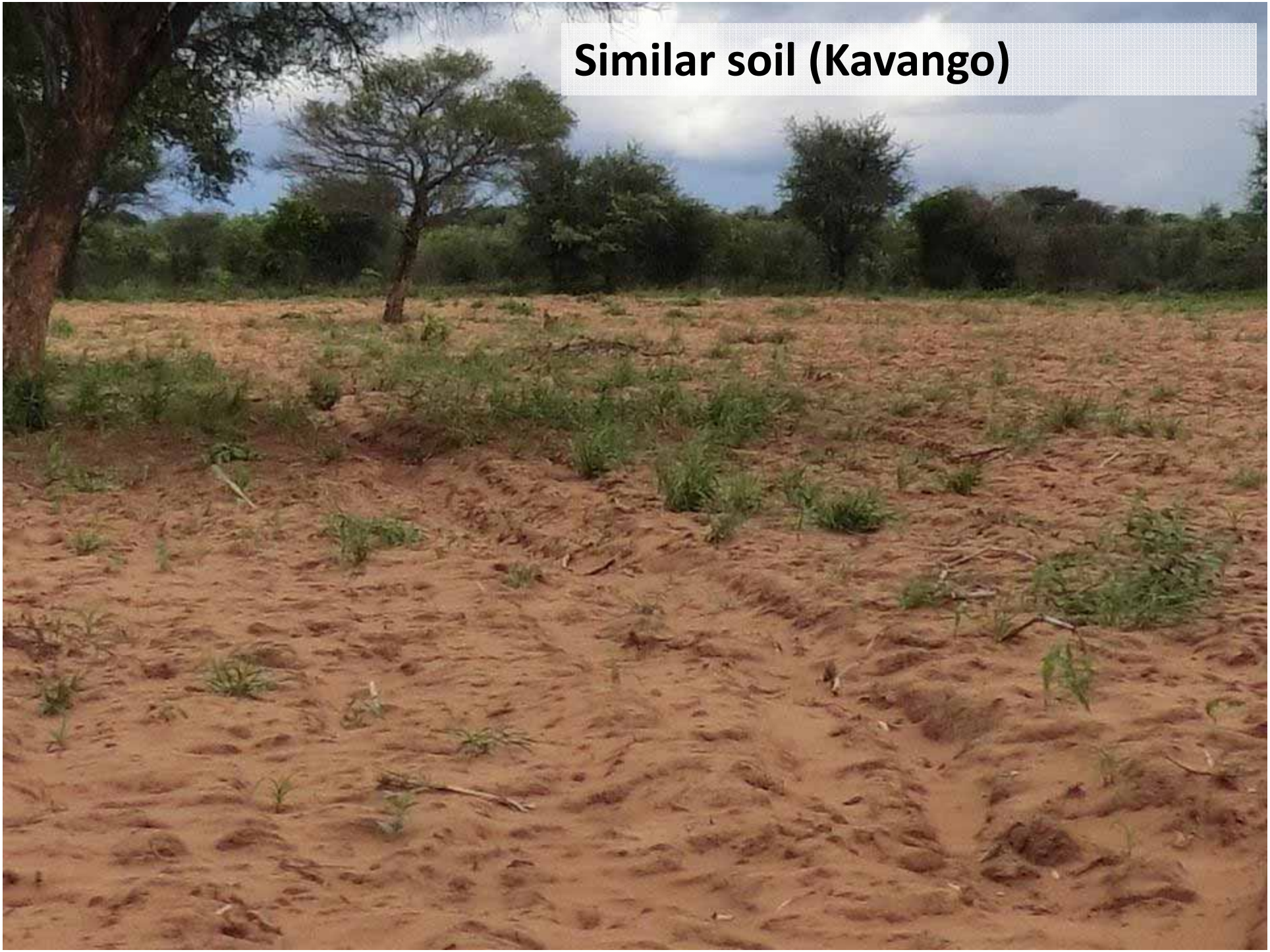
Similar soil (Kunene)

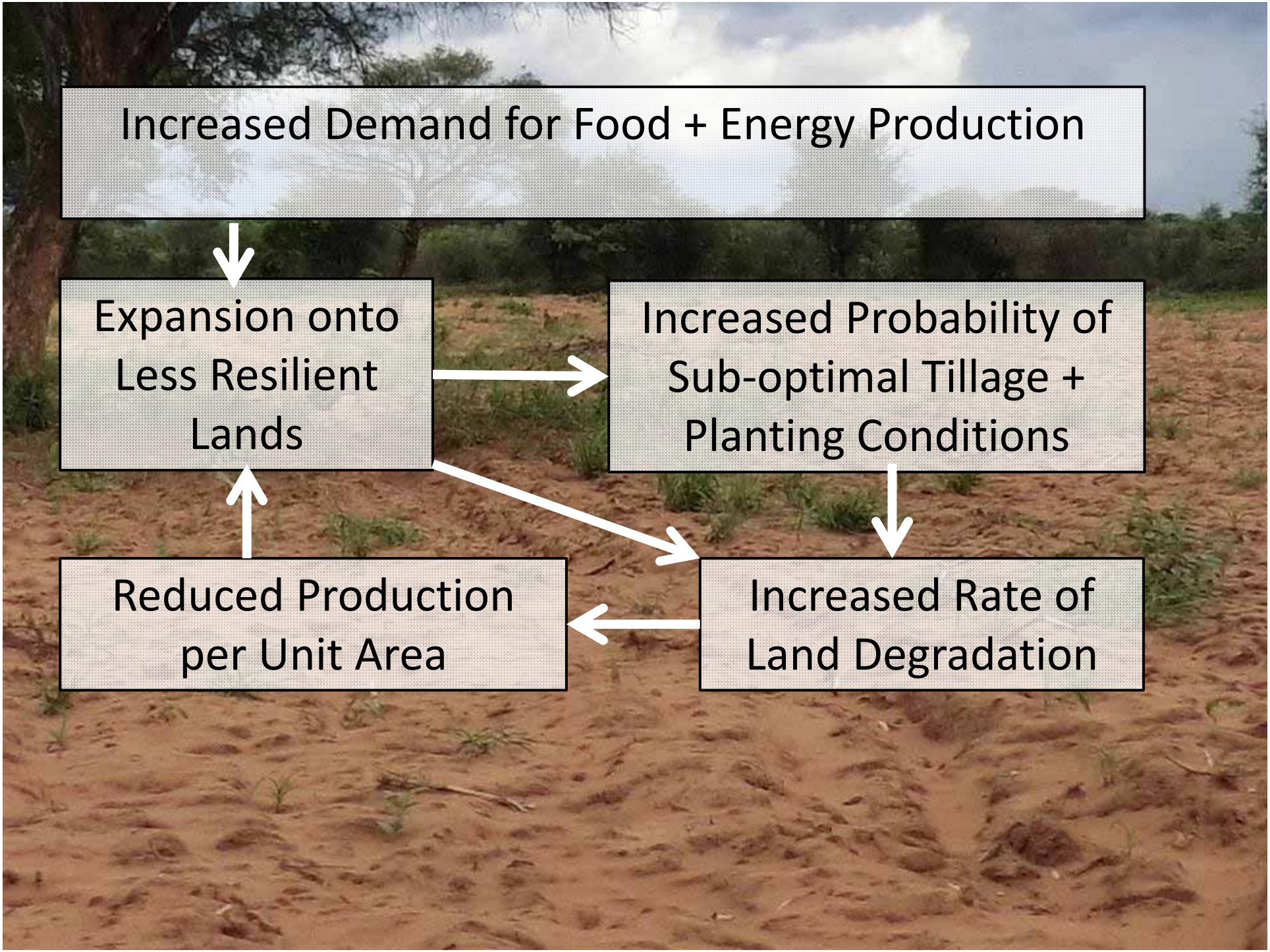


Similar soil (Kunene)



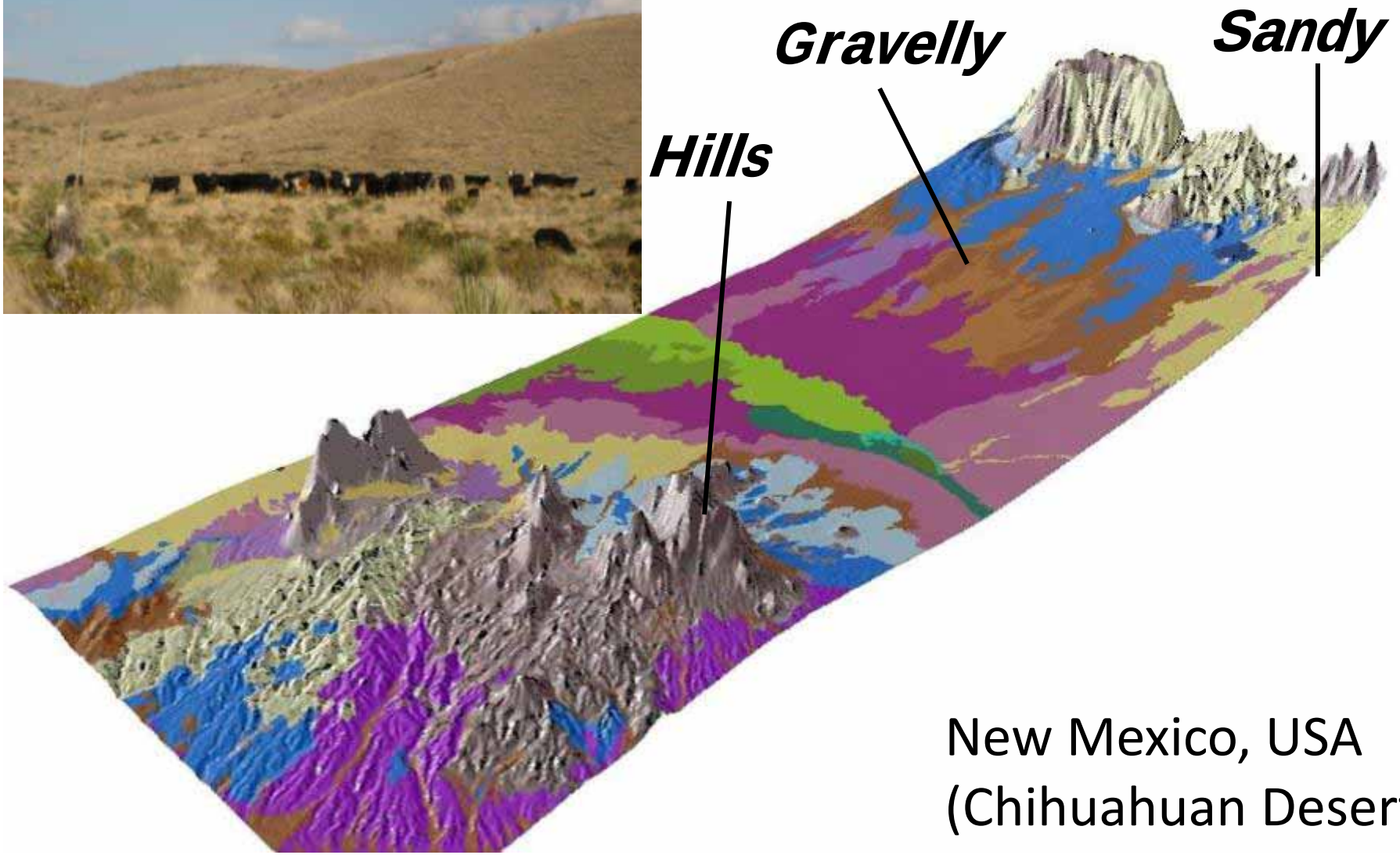

Deep, coarse-textured soils with low fertility and low water-holding capacity (Bolivia)


Similar soil (Kavango)


Increased Demand for Food + Energy Production
Expansion onto Less Resilient Lands
Increased Probability of Sub-optimal Tillage + Planting Conditions
Reduced Production per Unit Area
Increased Rate of Land Degradation

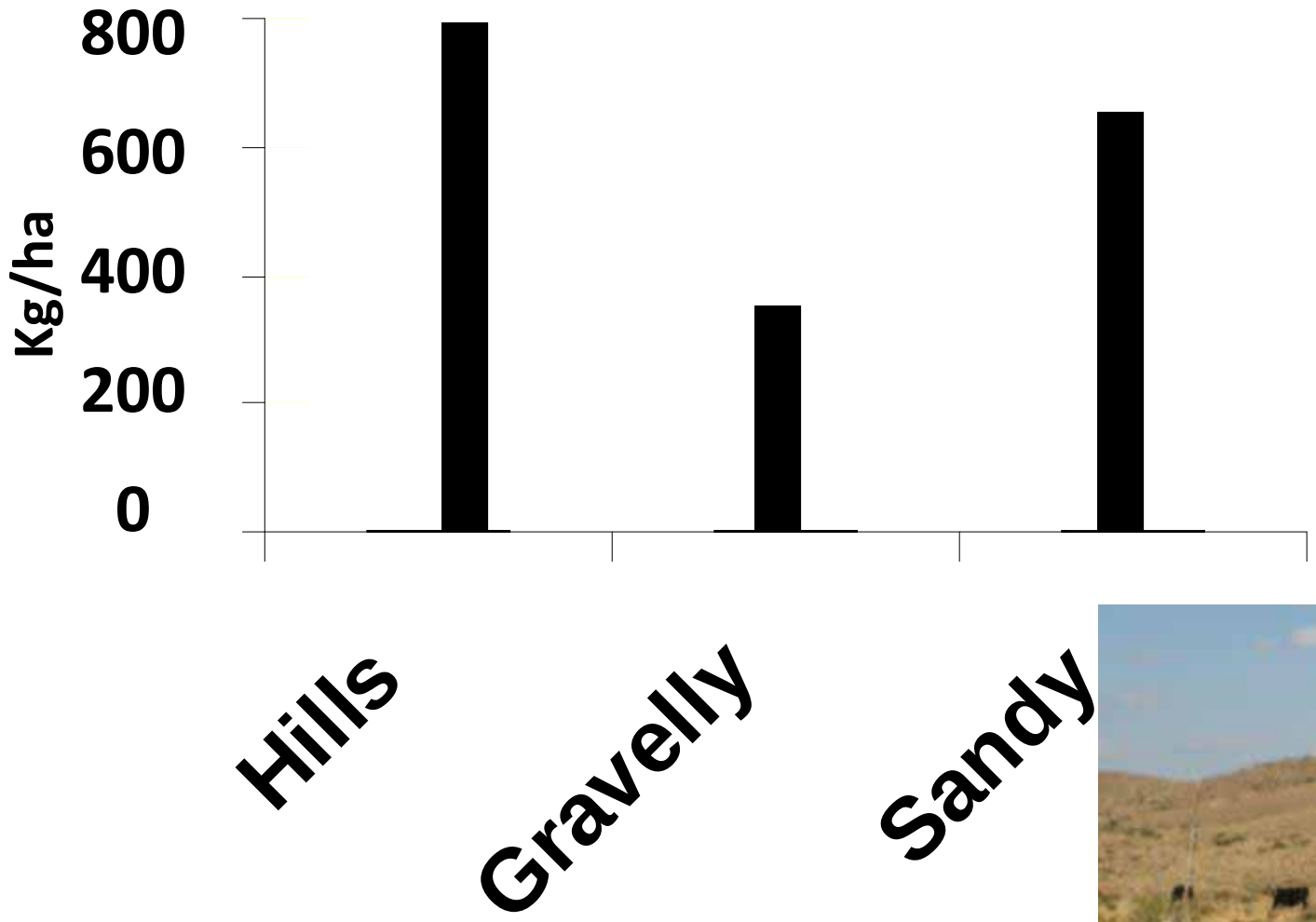
What is land potential? The potential of the land to support particular types and amounts of plant production, and to resist and recover from degradation.

Land classification based on the land's *potential*: soils + climate



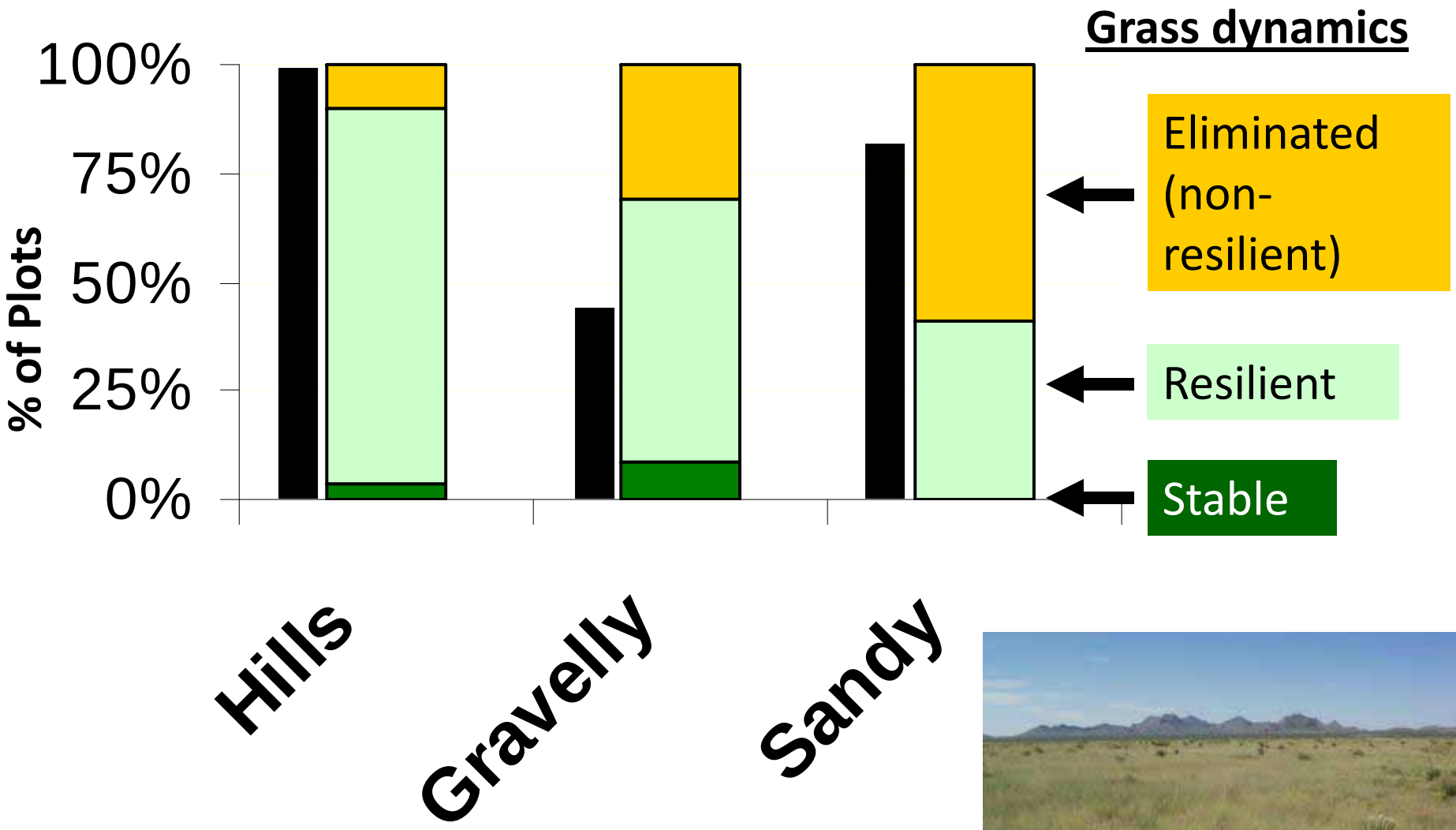
New Mexico, USA
(Chihuahuan Desert)

Soils affect potential grass (forage) production



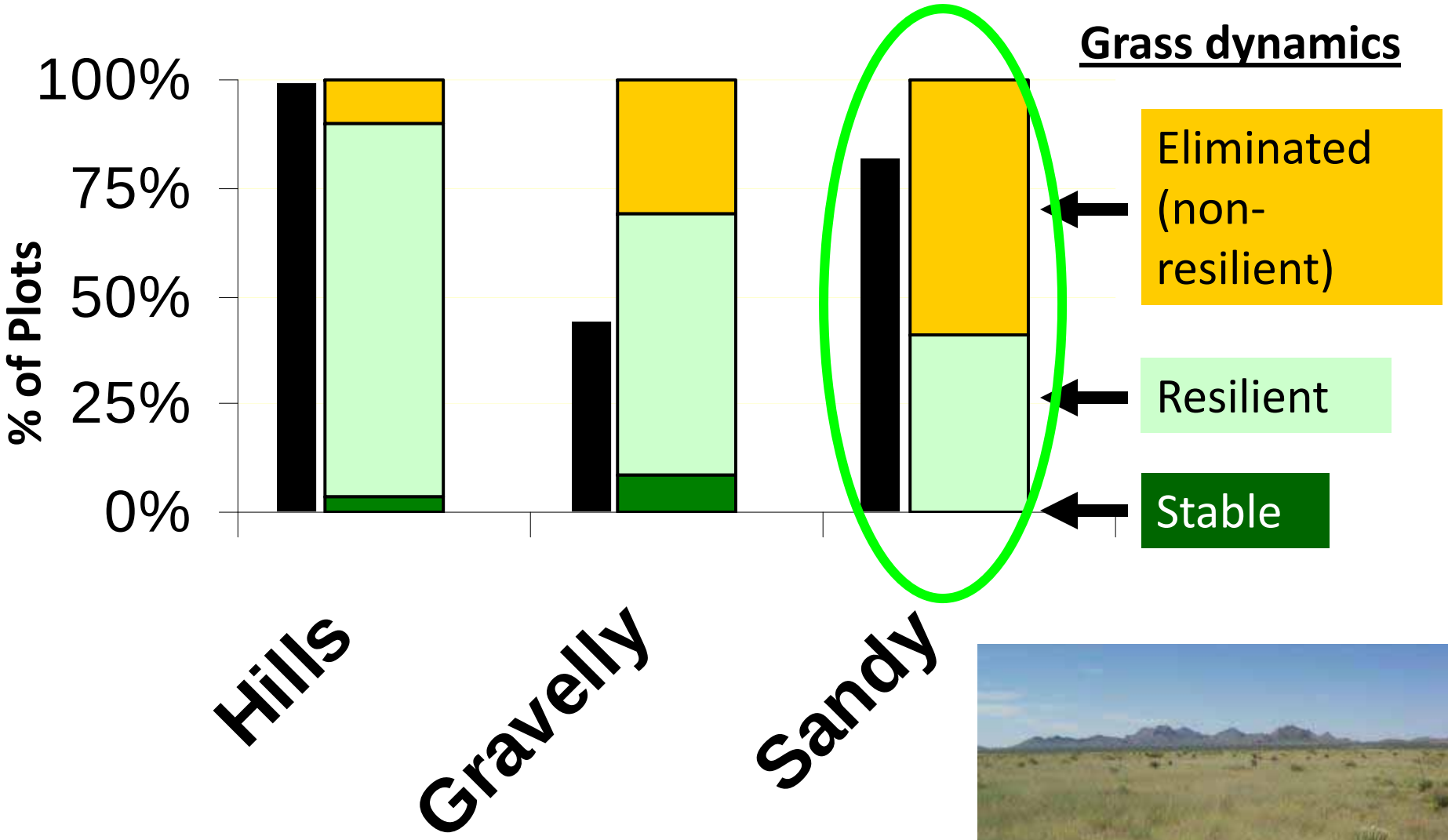
B. Bestelmeyer/BLM data, 123 plots (1970-2003)

Soils affect grass (forage) resilience



B. Bestelmeyer/BLM data, 123 plots (1970-2003)

Soils affect grass (forage) resilience



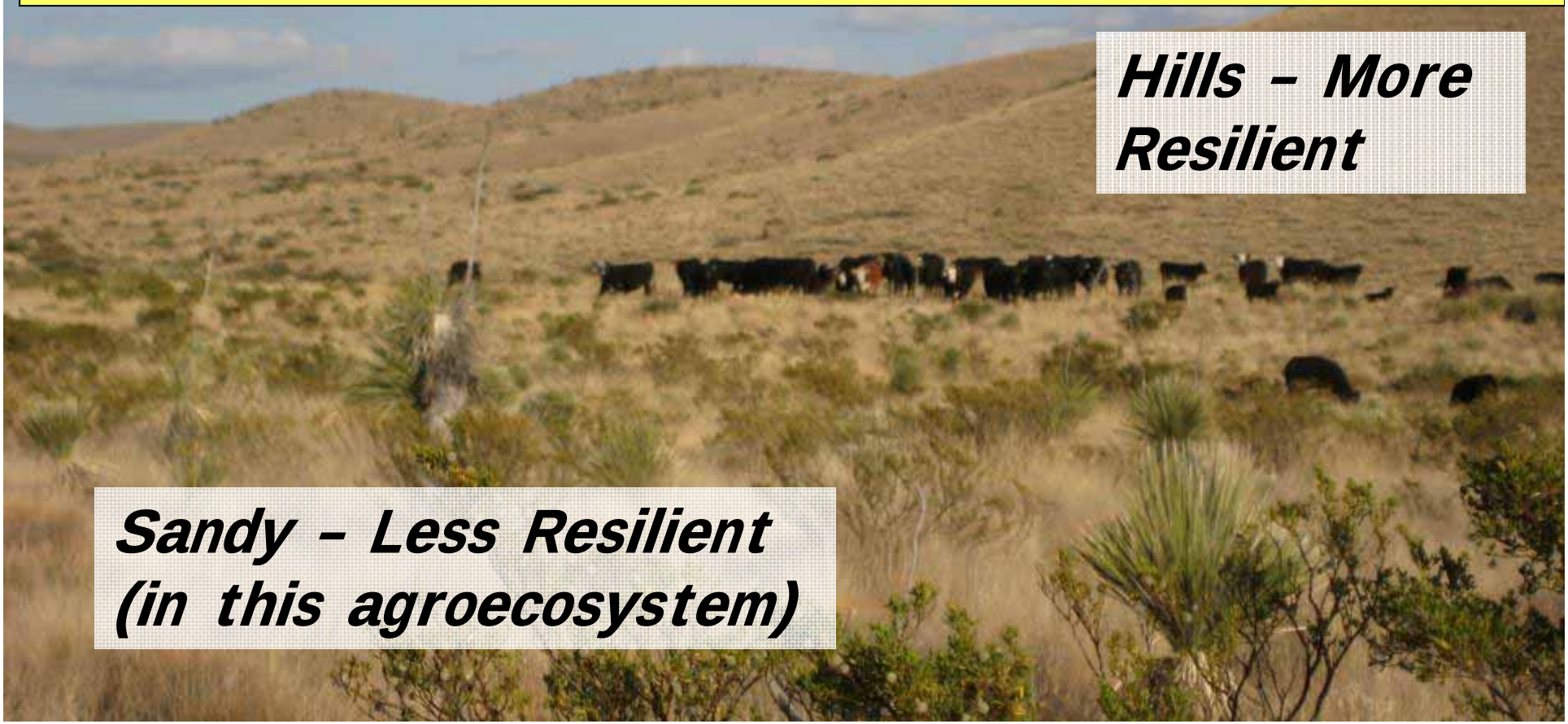
B. Bestelmeyer/BLM data, 123 plots (1970-2003)

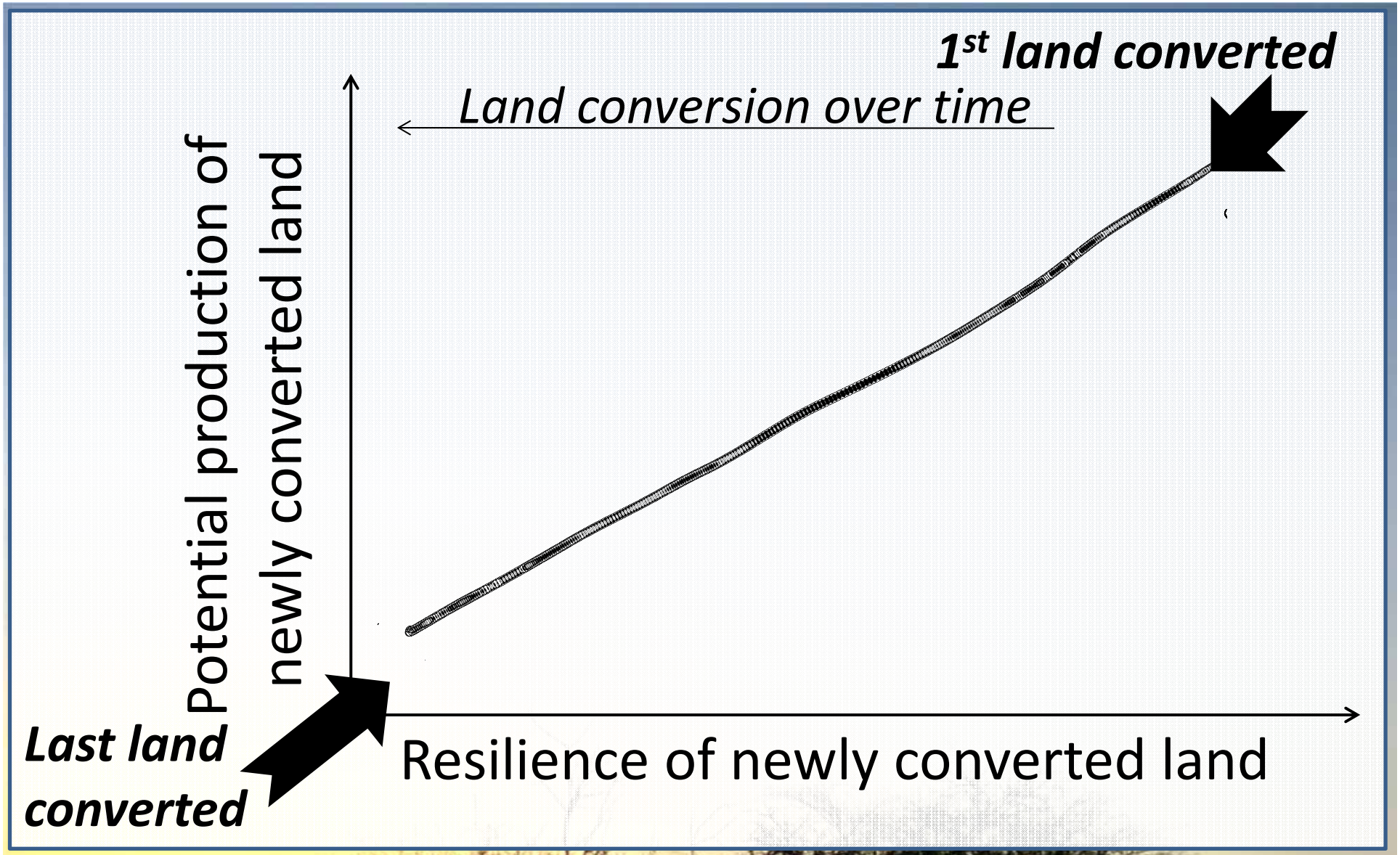
Land use plan for Chihuahuan Desert grasslands: drought

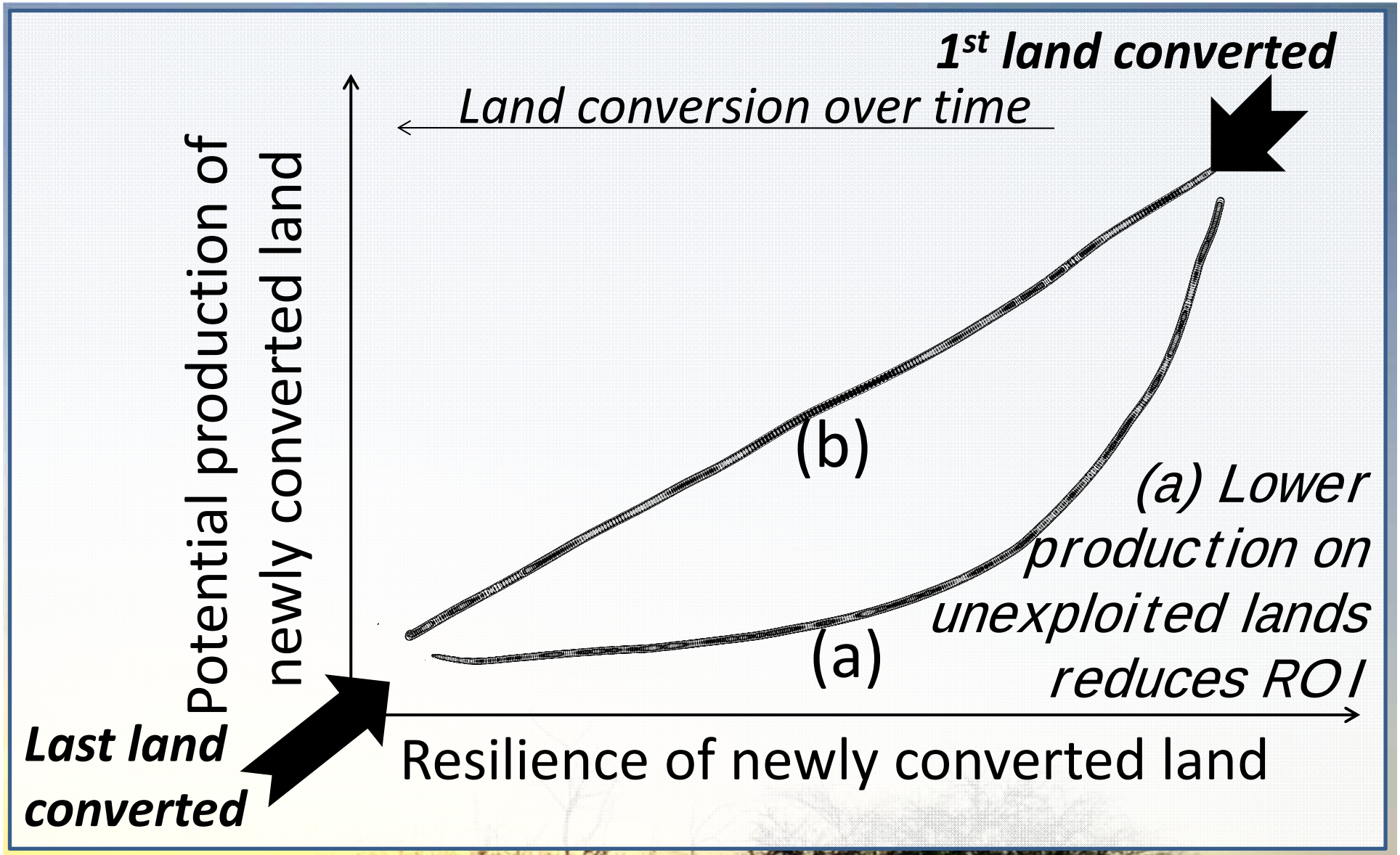
-Remove livestock early in drought

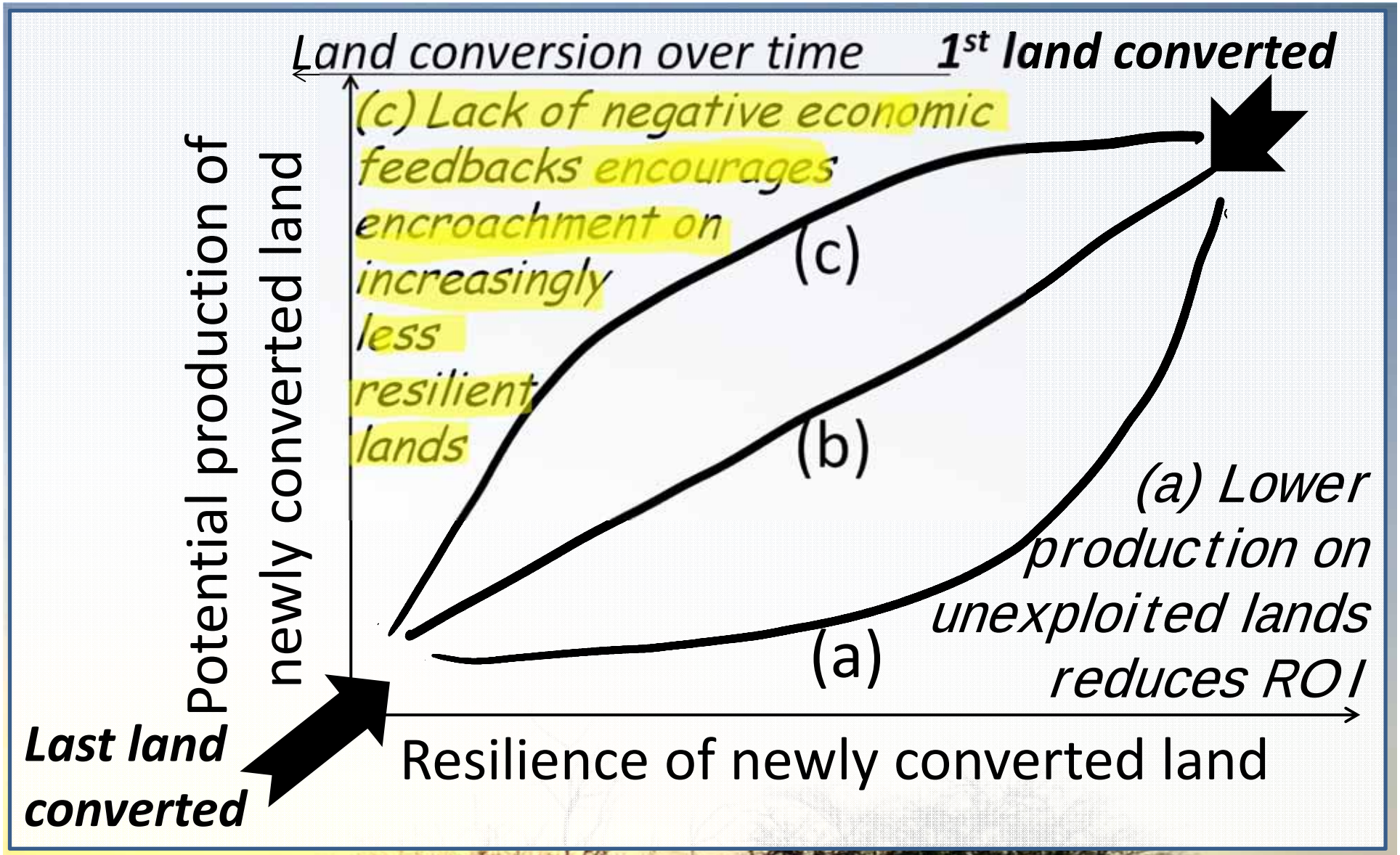
-Minimize pressure on highly erodible sandy soils, especially during early drought recovery period

-Control shrubs



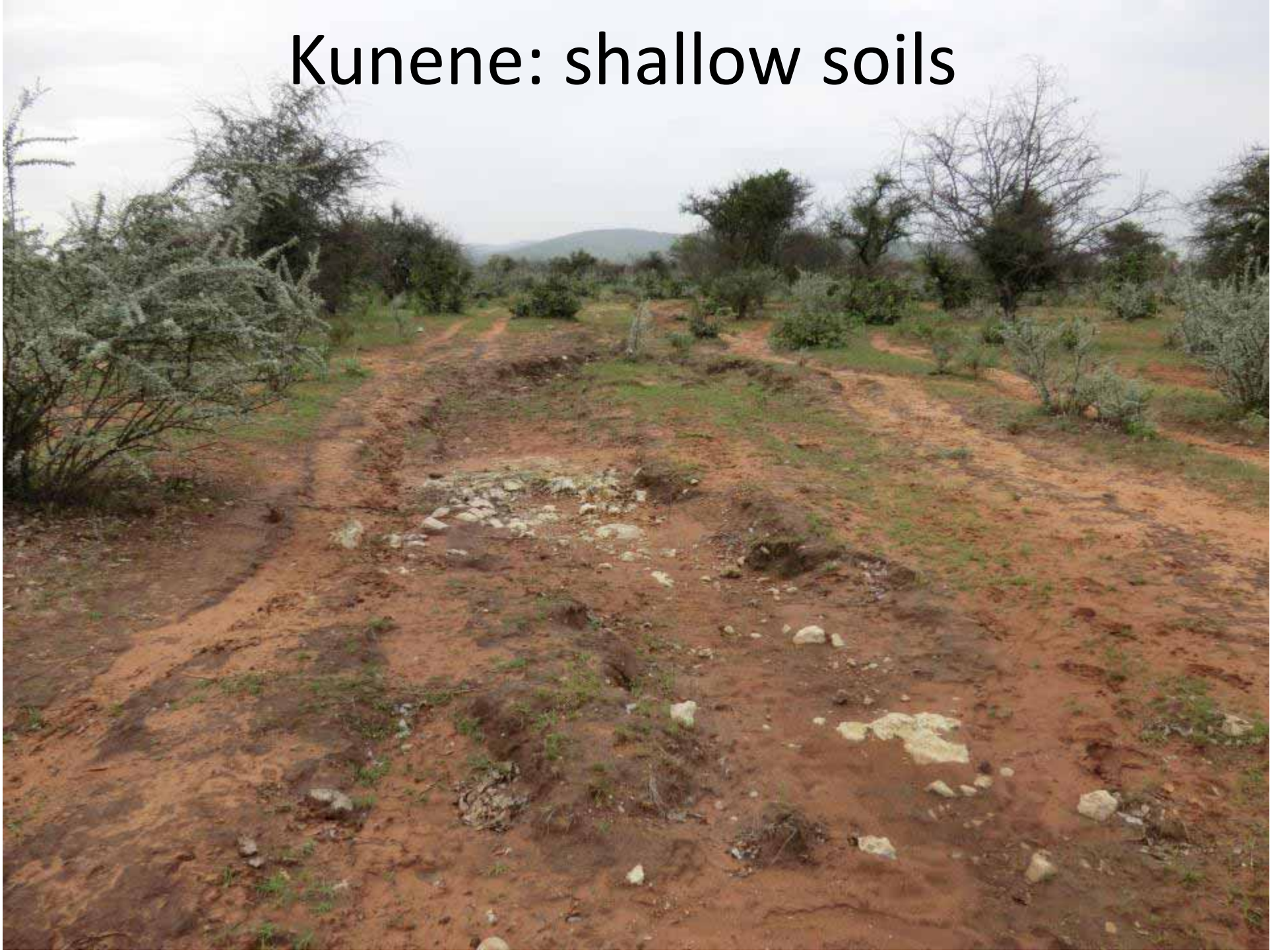

1st land converted
Land conversion over time
Potential production of newly converted land
Last land converted
Resilience of newly converted land


1st land converted
Land conversion over time
Potential production of newly converted land
(b)
(a)
(a) Lower production on unexploited lands reduces ROI
Last land converted
Resilience of newly converted land

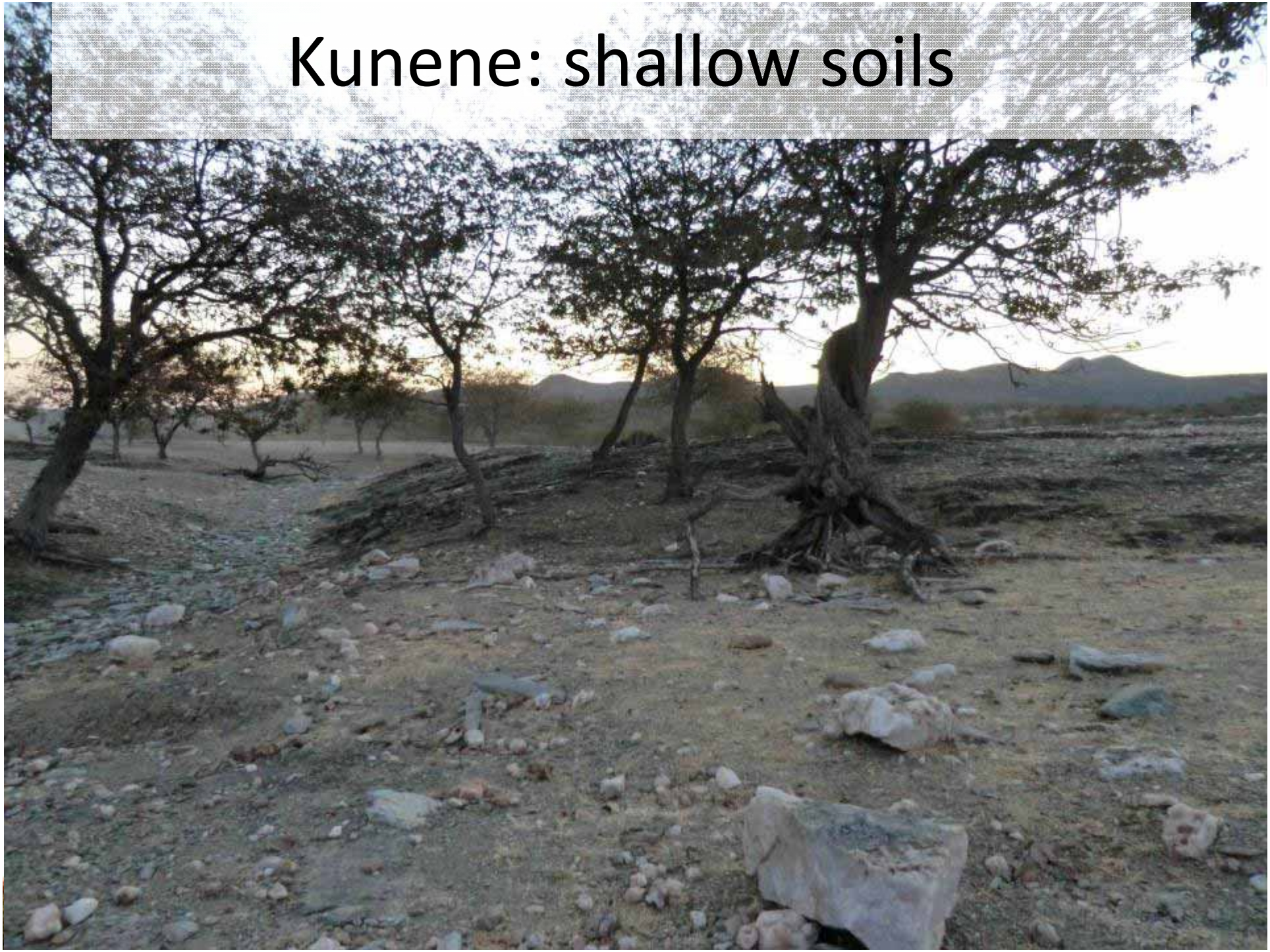

Land conversion over time
1st land converted
(c) Lack of negative economic feedbacks encourages encroachment on increasingly less resilient lands
(c)
(b)
(a)
(a) Lower production on unexploited lands reduces ROI
Potential production of newly converted land
Last land converted
Resilience of newly converted land

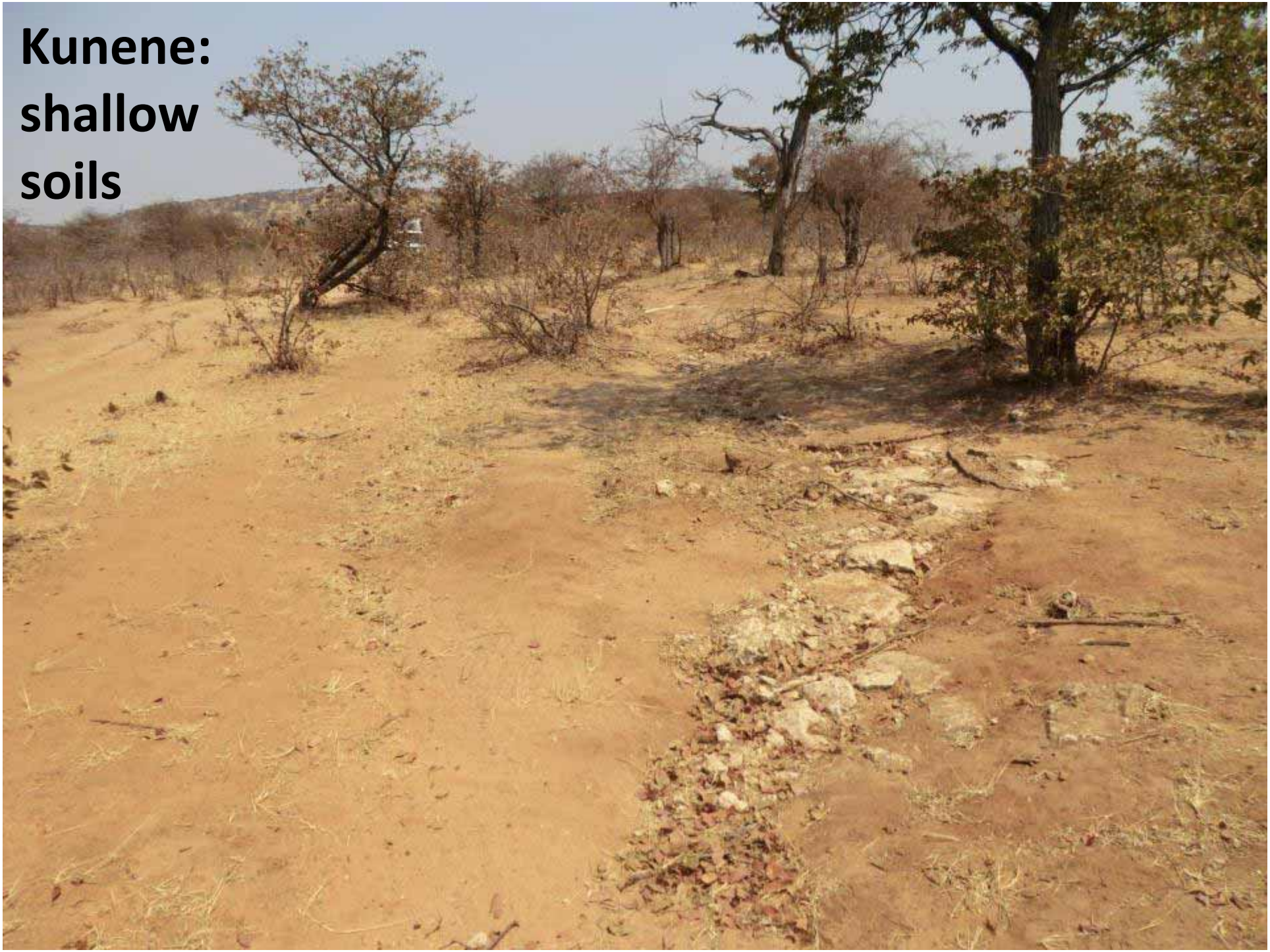
1. US experience: 1880's and 1930's
2. Global challenge
3. ***(Parts of) northern Namibia at a tipping point?***
4. Elements of a (local to global) solution
   - Integrating and sharing scientific and local knowledge
   - Land Potential Knowledge System

Kunene: shallow soils

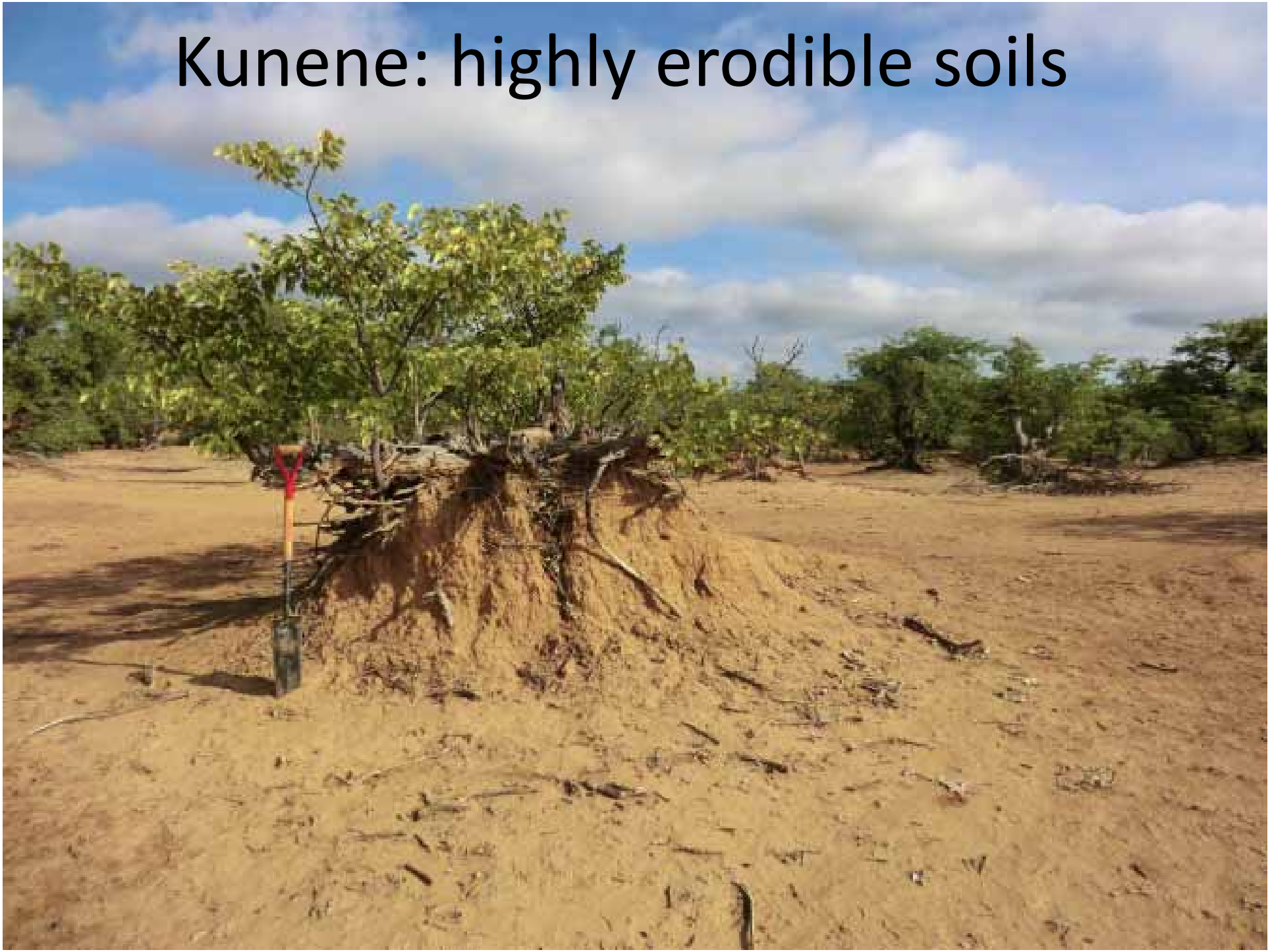


Kunene: shallow soils

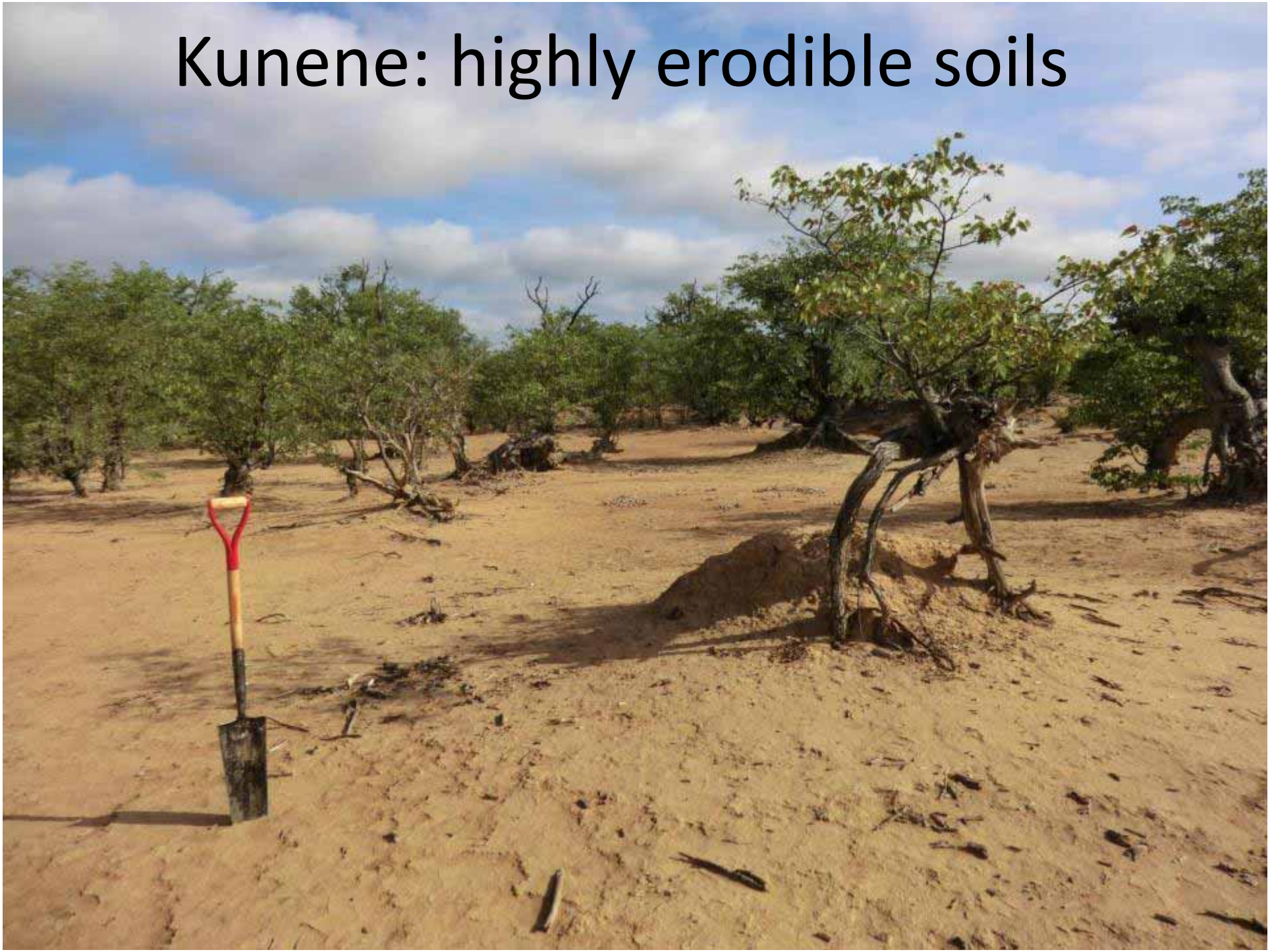



Kunene:
shallow
soils

Kunene: highly erodible soils



Kunene: highly erodible soils

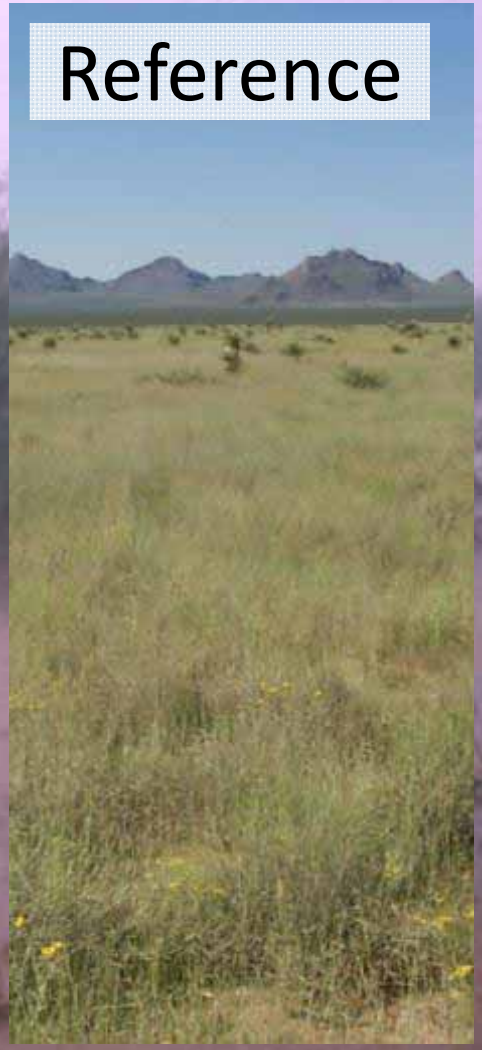


Kunene: shallow, highly erodible soils


CIMG0885 35 years ago was perennial grass.MOV

Potential for similar soil in SW US -- 250mm ppt, flat, loamy sand over sandy loam:

- **Plant community**: grassland, ~600 kg/ha
- **Hydrology**: no runoff
- **Soil**: weak intact A horizon, no erosion



Kavango: low fertility, erodible soils

Kunene: erodible soils with shallow chemistry/texture change

Kunene: erodible soils with shallow chemistry/texture change

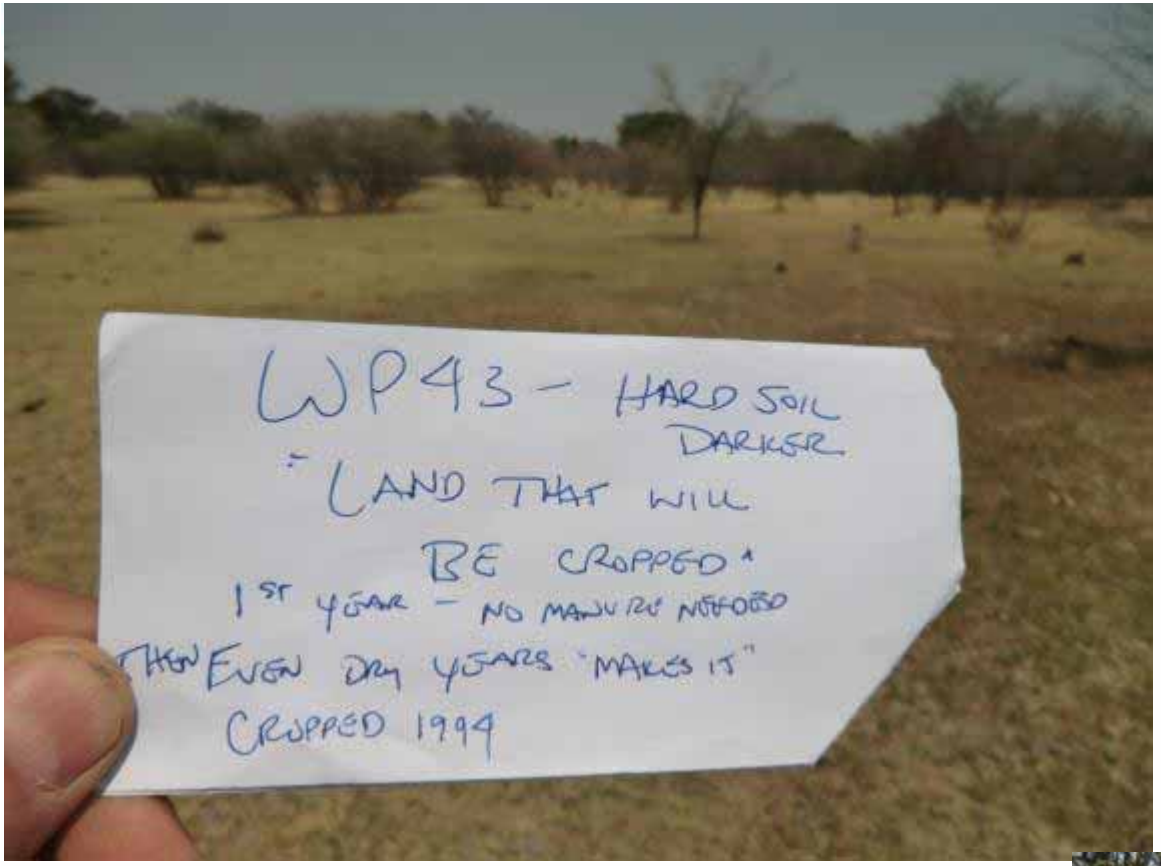
Kavango: high fertility, resilient soil

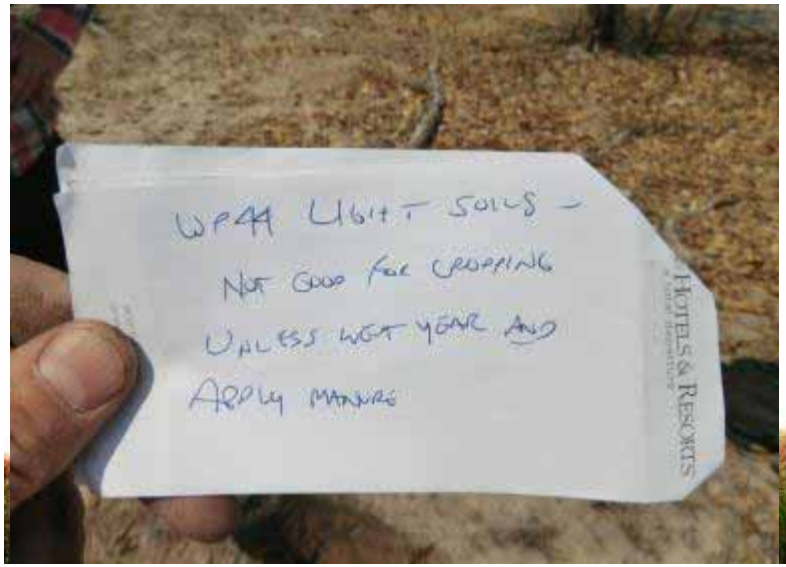
Kunene soil: ???

1. US experience: 1880's and 1930's
2. Global challenge
3. (Parts of) northern Namibia at a tipping point?
4. ***Elements of a (local to global) solution***
   - ***Integrating and sharing scientific and local knowledge***
   - Land Potential Knowledge System

Using local and scientific knowledge to predict and avoid degradation thresholds and develop sustainable management systems

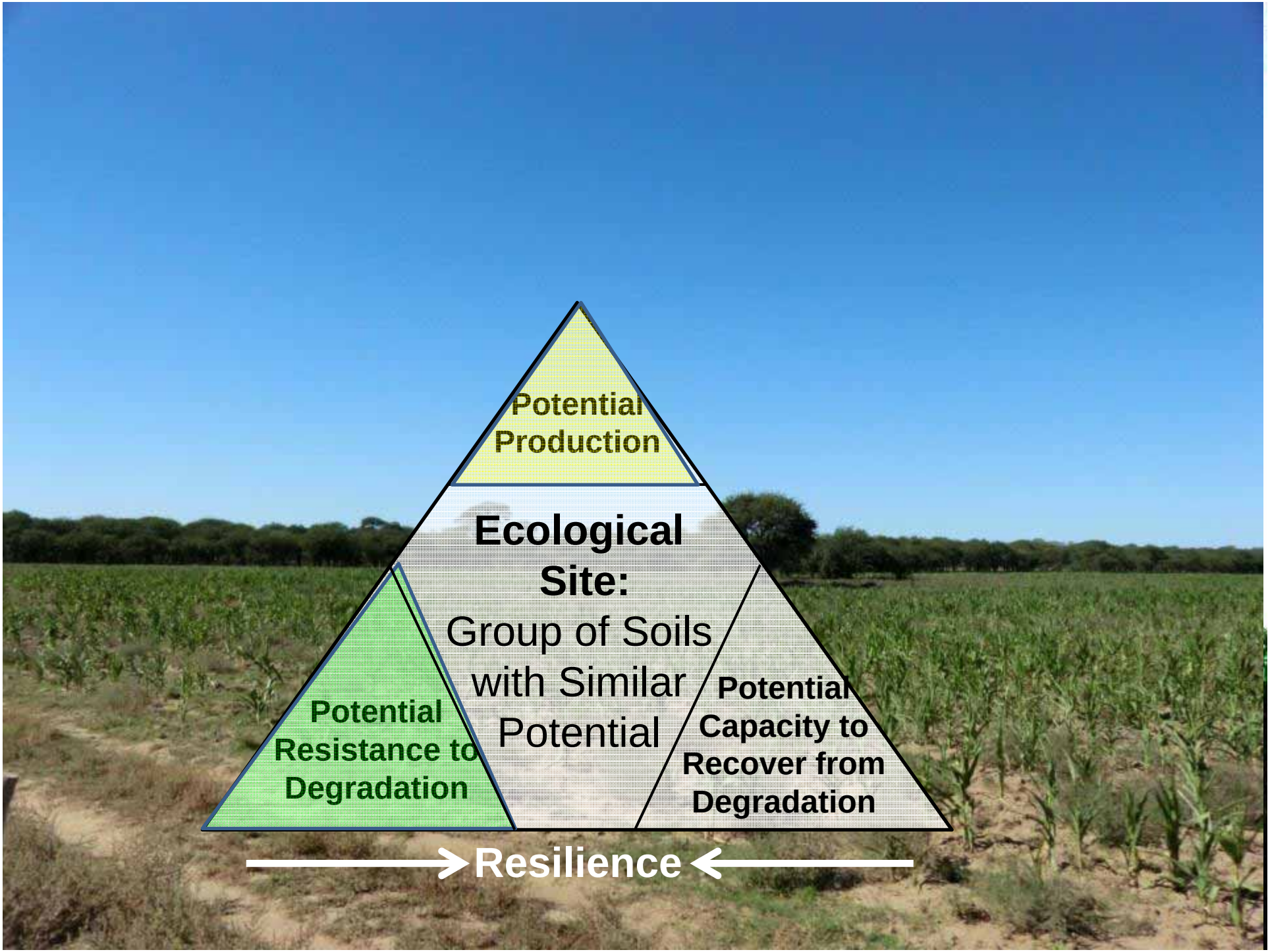
- Fertility thresholds in Kavango
- Salinity/hydrology/fertility thresholds in Omusati, Oshana, Oshikoto?
- Erosion thresholds in Kunene


WP43 - HARD SOIL
DARKER
"LAND THAT WILL
BE CROPPED"
1ST YEAR - NO MANURE NEEDED
THEN EVEN DRY YEARS "MAKES IT"
CROPPED 1994

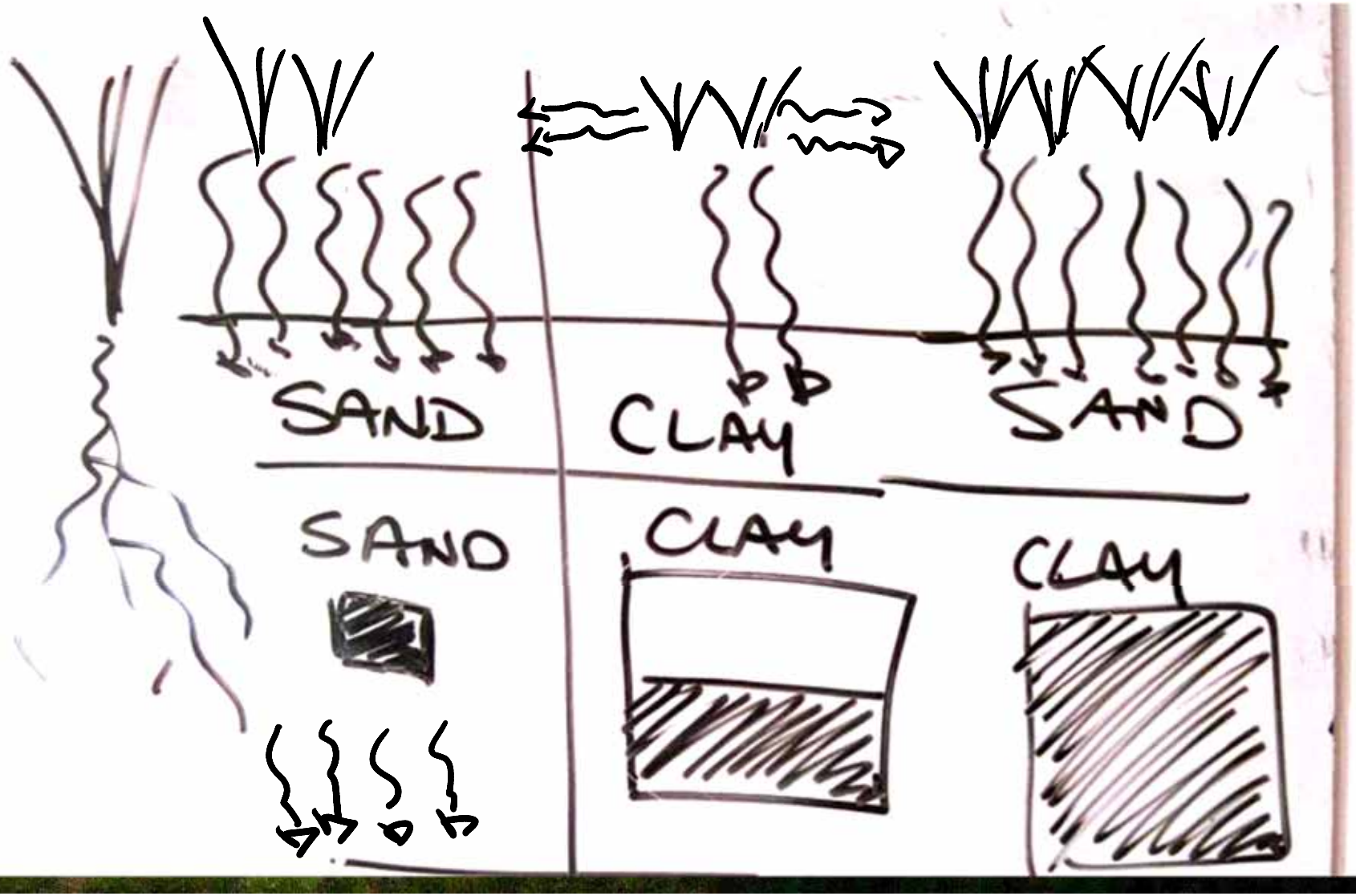

WP44 LIGHT SOILS -
NOT GOOD FOR CROPPING
UNLESS WET YEAR AND
APPLY MANURE
HOTELS & RESORTS

1. US experience: 1880's and 1930's
2. Global challenge
3. (Parts of) northern Namibia at a tipping point?
4. Elements of a (local to global) solution
   - Integrating and sharing scientific and local knowledge
   - ***Land Potential Knowledge System***

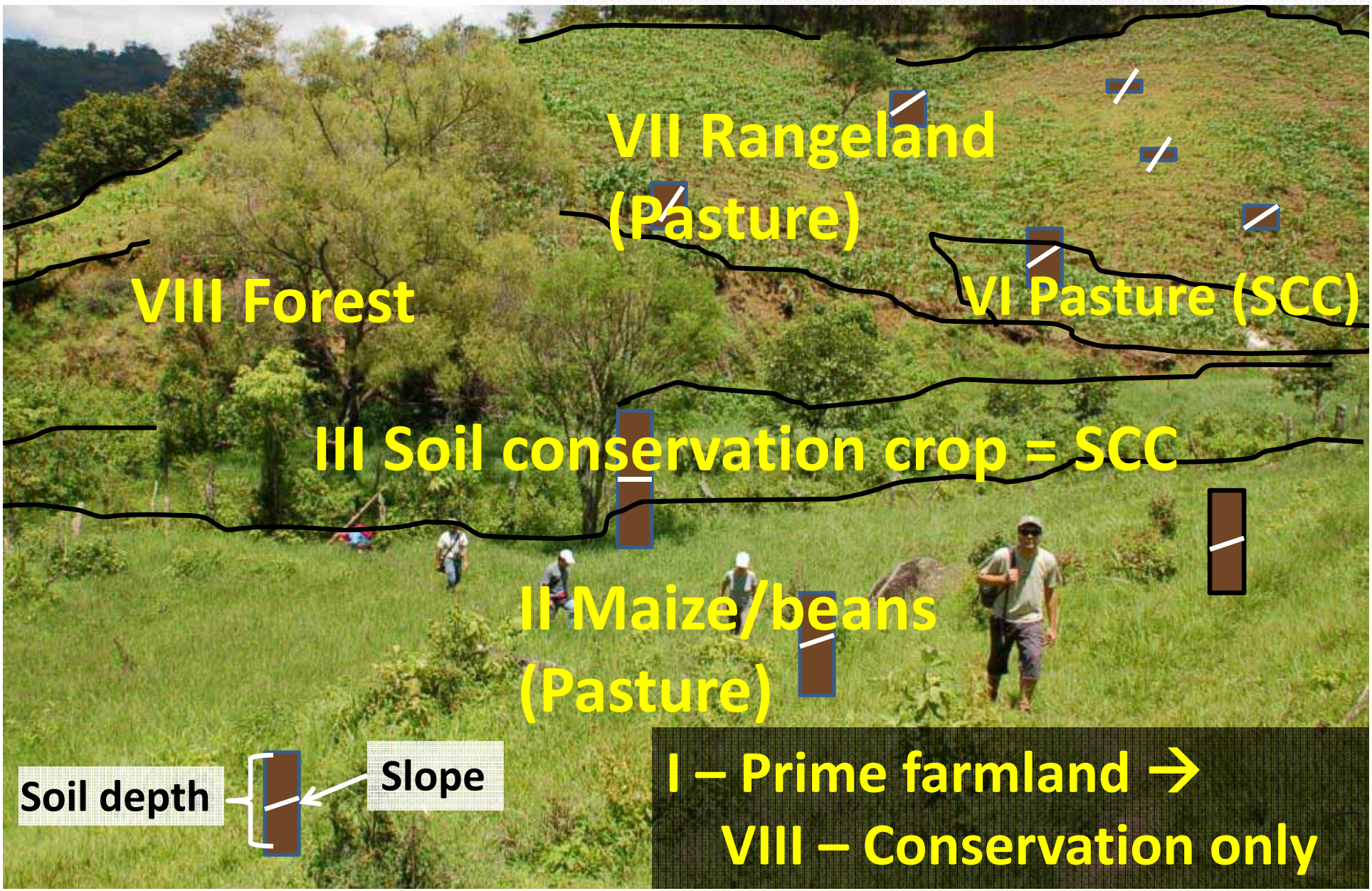
What is land potential? The potential of the land to support particular types and amounts of plant production, and to resist and recover from degradation.

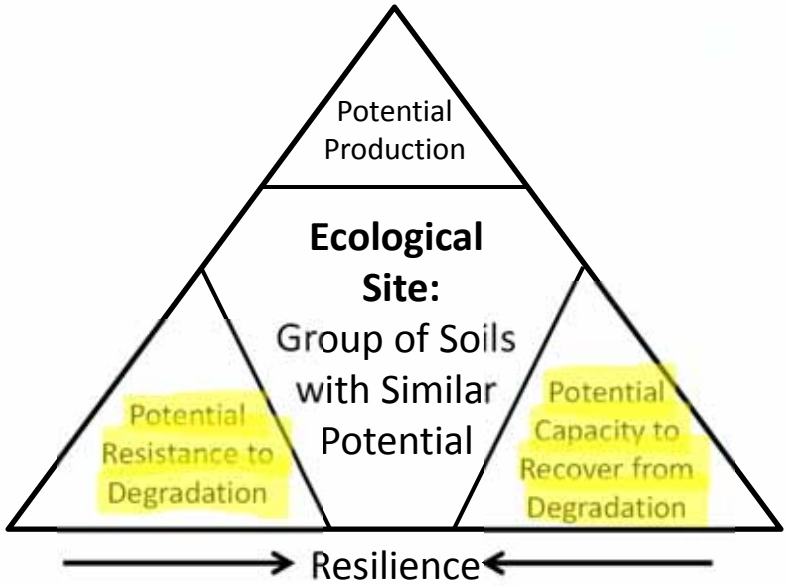

Potential Production
Ecological Site:
Group of Soils with Similar Potential
Potential Resistance to Degradation
Potential Capacity to Recover from Degradation
Resilience

LPKS based on potential production (based on soil profile characteristics) + resilience



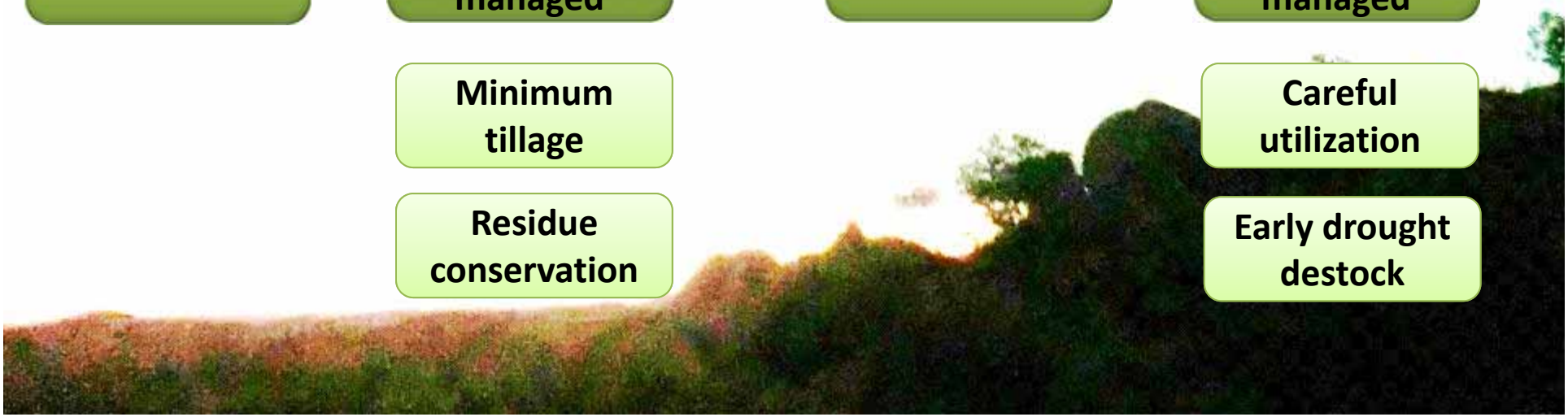
Existing systems (FAO AEZ and USDA LCC) don't include resilience

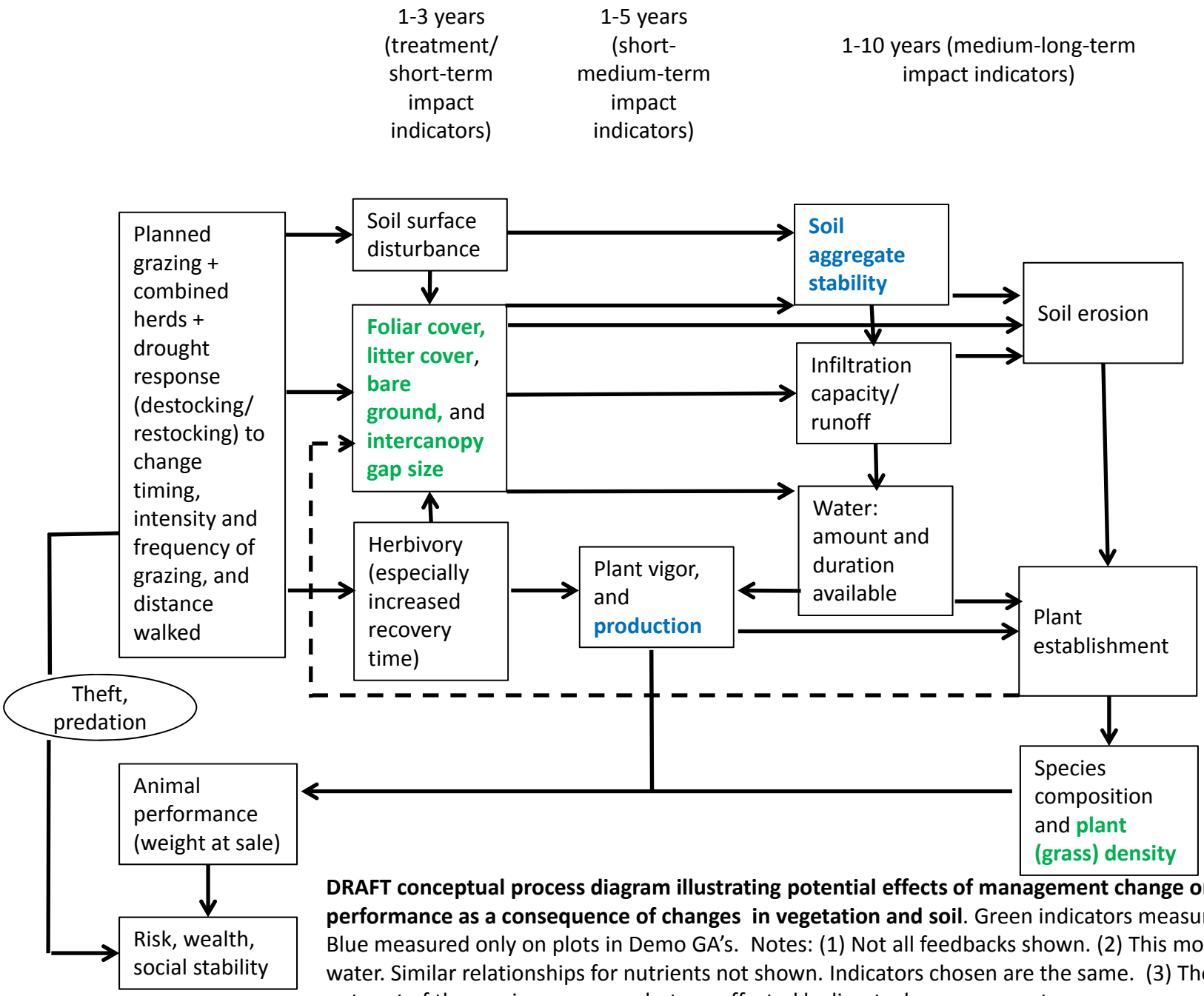




High resilience soils → **Low resilience soils**

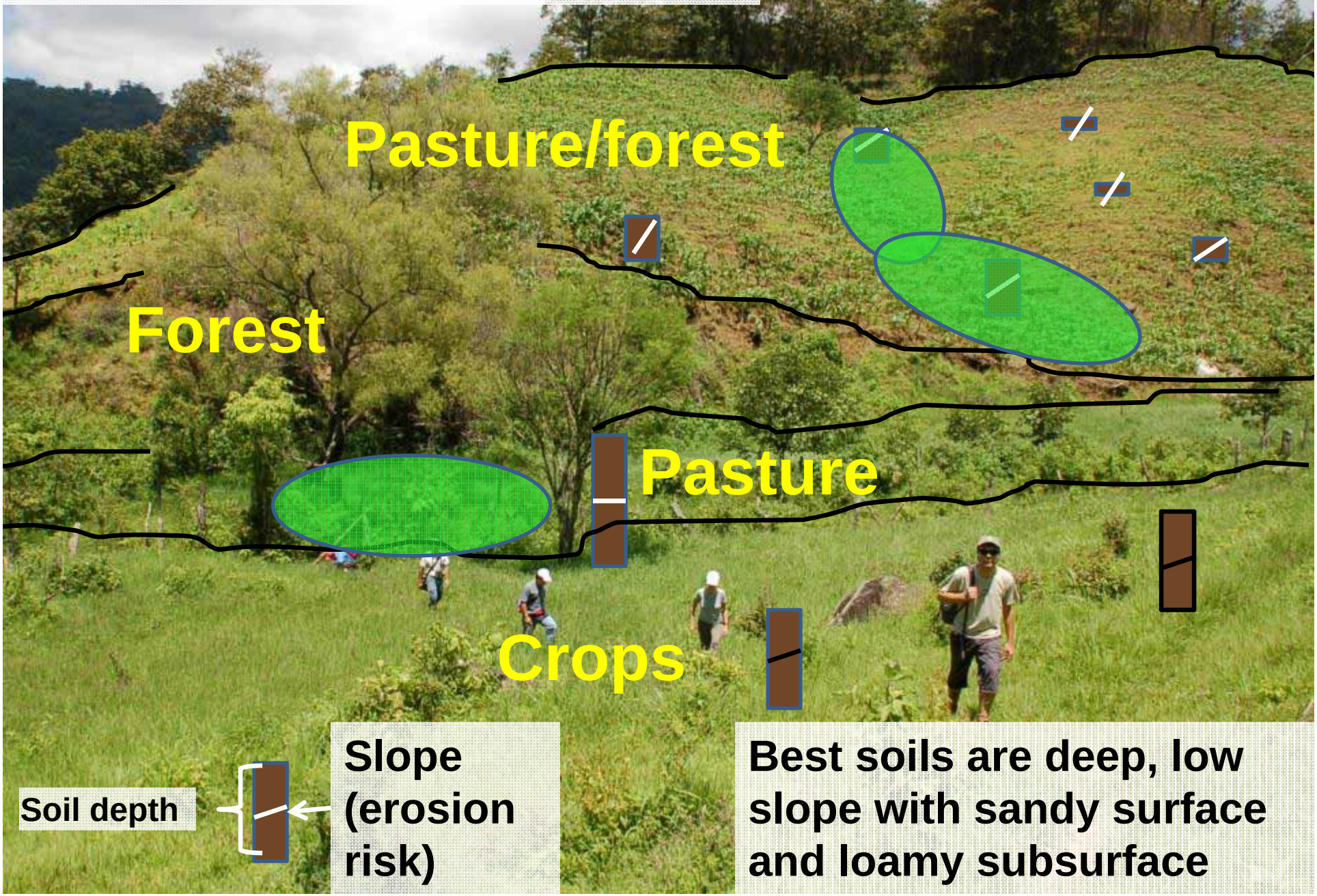
High resilience soils		Low resilience soils	
Crop	**Crop: conservatively managed**	**Livestock**	**Livestock: conservatively managed**
	Minimum tillage		**Careful utilization**
	Residue conservation		**Early drought destock**





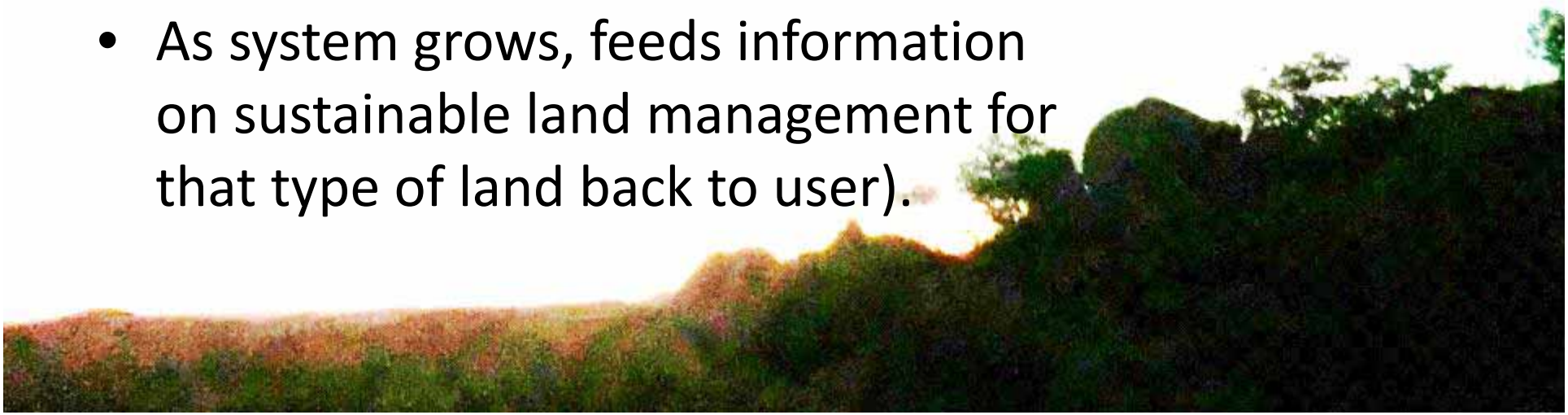
DRAFT conceptual process diagram illustrating potential effects of management change on animal performance as a consequence of changes in vegetation and soil. Green indicators measured on all plots. Blue measured only on plots in Demo GA's. Notes: (1) Not all feedbacks shown. (2) This model focuses on water. Similar relationships for nutrients not shown. Indicators chosen are the same. (3) Theft/predation are not part of the grazing response, but are affected by livestock management.

Land Use Plan (with resilience)



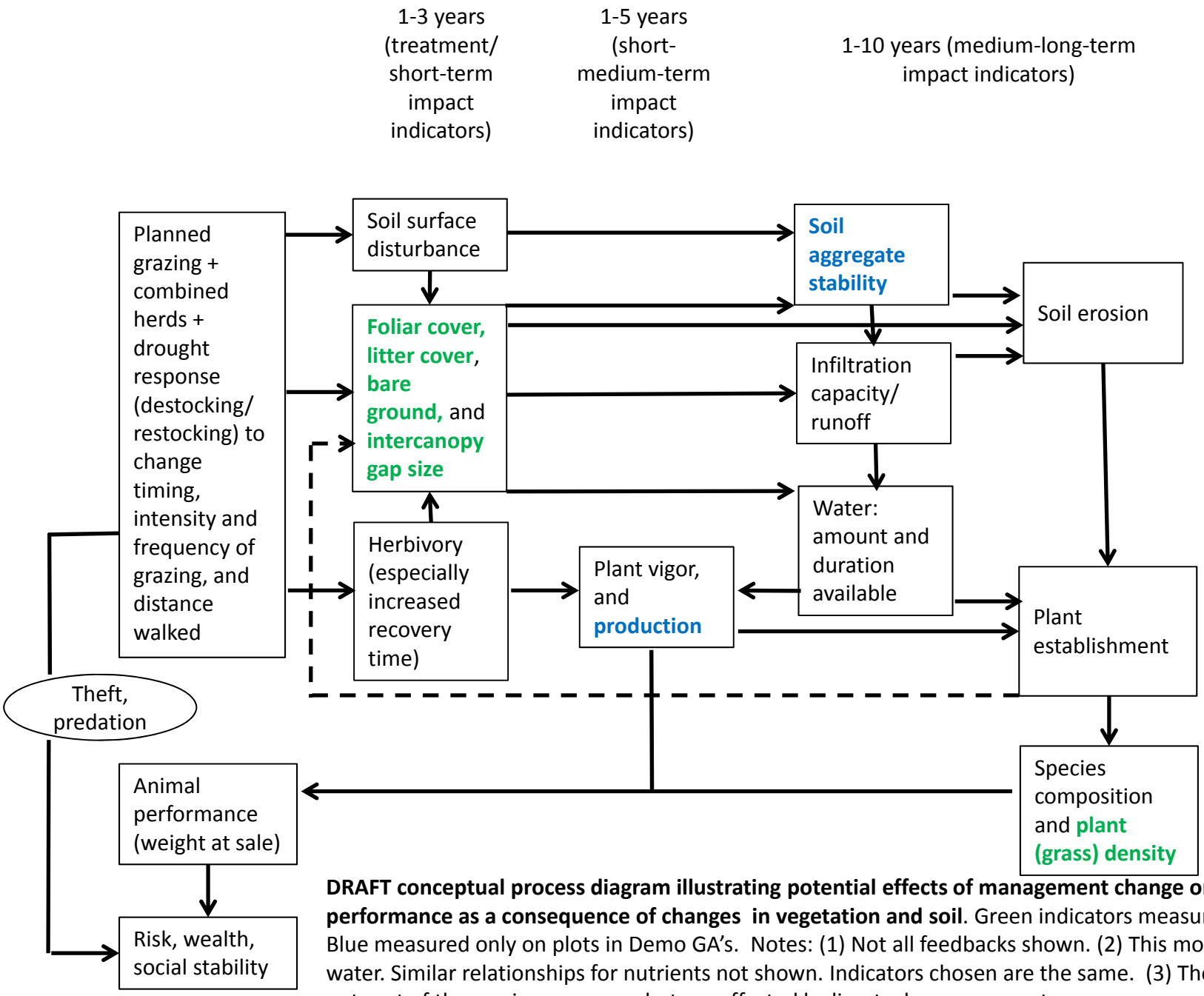
Land Potential Knowledge System: Implementation

- Data collected using gps-enabled camera phones + shovel in course of daily work
- Supplemented with targeted, intensive sites (e.g. for soil salinity)
- Fed into central database with knowledge system (matching soil, topography)
- As system grows, feeds information on sustainable land management for that type of land back to user).



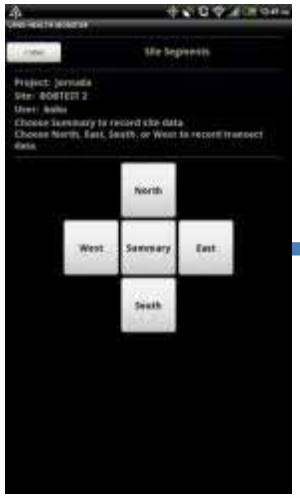
Why LPKS?

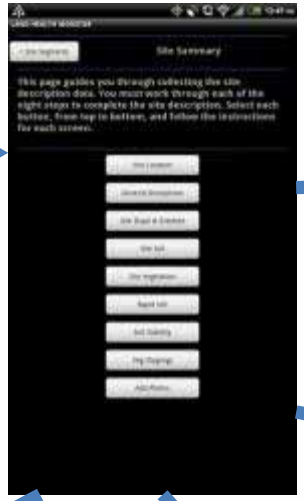
- ***Increased productivity and sustainability***
- ***Improved targeting*** of investments in food security, watershed management and natural resource conservation
- ***Reduced flooding*** and ***increase perennial stream flow*** by focusing efforts to increase infiltration on areas with the greatest potential for significant improvement.
- ***Reduced siltation*** of dams by focusing erosion control efforts on critical areas.
- Increased probability of ***success of management and restoration*** efforts by focusing efforts on area most likely to respond.
- Provide a method for assessing risk of treatment options based on the ability of a site to respond to various alternative treatments.
- Provide a standard to judge the ***effectiveness of management*** and other treatment actions.
- Increase the utility and cost-effectiveness of ***monitoring***.
- Improve ability to focus ***market development*** on those areas with a greater potential to sustain increased agricultural production.
- Collect and store ***local knowledge*** about land management in a way that it can be easily accessed and used by future generations.



DRAFT conceptual process diagram illustrating potential effects of management change on animal performance as a consequence of changes in vegetation and soil. Green indicators measured on all plots. Blue measured only on plots in Demo GA's. Notes: (1) Not all feedbacks shown. (2) This model focuses on water. Similar relationships for nutrients not shown. Indicators chosen are the same. (3) Theft/predation are not part of the grazing response, but are affected by livestock management.

Example: Android App for MCA CBRLM Project (May 2012)





LKPS: Next Steps

- Funding
- Database, knowledge system and field app development
- Pilot implementation
- Full implementation
- Refinement

Thank you…

All Participants

Ms. Akwenye
MCA

Dr. Tjivikua
Polytechnic of Namibia

Jeff Herrick
jherrick@nmsu.edu - jornada.nmsu.edu – landscapetoolbox.org
Jornada Experimental Range ~ Agricultural Research Service ~ US Dept. of Agriculture (USDA)
Las Cruces, NM USA

References

- Herrick, J.E., J.W. Van Zee, K.M. Havstad, L. M. Burkett and W.G. Whitford. 2005. Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems. USDA-ARS Jornada Experimental Range, Las Cruces, NM. Distributed by University of Arizona Press.
- Pellant, M., P. Shaver, D. Pyke and J.E. Herrick. 2005. Interpreting Indicators of Rangeland Health, Version 4. Interagency Technical Reference 1734-6. Bureau of Land Management, Denver, Colorado.
- Herrick, J. E., B. T. Bestelmeyer, S. Archer, A. Tugel, and J. R. Brown. 2006. An integrated framework for science-based arid land management. *Journal of Arid Environments* 65: 319-335.
- Herrick, J.E. and J. Sarukhan. 2007. A strategy for ecology in an era of globalization. *Frontiers in Ecology and the Environment* 5: 172-181. http://www.frontiersinecology.org/specialissue/articles/herrick.pdf
- Herrick, J.E., V.C. Lessard, K.E. Spaeth, P.L. Shaver, R.S. Dayton, D.A. Pyke, L. Jolley, J.J. Goebel. 2010. National ecosystem assessments supported by local and scientific knowledge. *Frontiers in Ecology and the Environment* 8: 403-408. doi: 10.1890/100017.
- Riginos, C. and Herrick, J.E. 2010. *Monitoring Rangeland Health: A Guide for Pastoralists and Other Land Managers in Eastern Africa, Version II*. Nairobi, Kenya: ELMT-USAID/East Africa. http://www.mpala.org/Monitoring_Guide.pdf