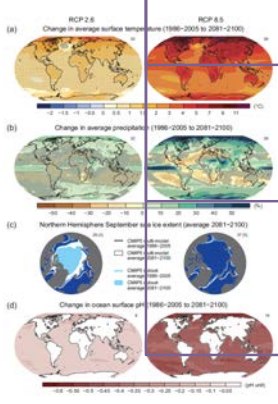
Agroecology and the design of resilient farming systems

Clara Ines Nicholls
President SOCLA
University of California, Berkeley
www.agroeco.org/socla

Signs of Climate Change (1981-2010)



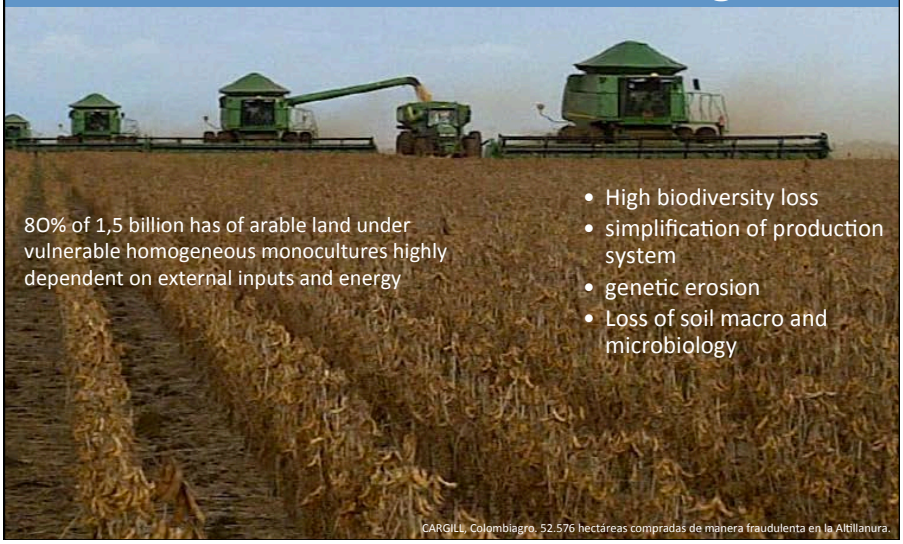
Temperature increase
- Medias: 0.5ºC
Mínimas: 0.45º C
Máximas: 0.25ºC

Increased extreme precipitation

Reduction of water balance .. Water stress

(Ocampo, 2012)

Intensive agricultural production: contributes to climate change

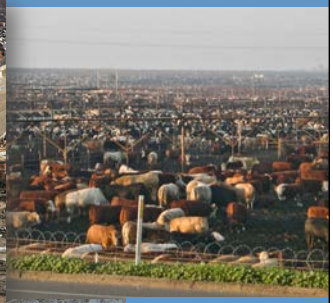


80% of 1,5 billion has of arable land under vulnerable homogeneous monocultures highly dependent on external inputs and energy

- High biodiversity loss
- simplification of production system
- genetic erosion
- Loss of soil macro and microbiology

CARGILL, Colombiagro. 52.576 hectáreas compradas de manera fraudulenta en la Altillanura.

Intensive animal production in Argentina



- High emission of Methane
- Low Animal welfa
- High cost energy

Expressions of Climate Change in Colombia

2008	2009	2010	2011
Fenómeno de El Niño		Niña	

Floods in southern Atlantico, Colombia , November 2010 (FEDEGAN)

Climate change is here to stay

The impacts of climate change will affect all **living organisms** that make up ecosystems, whether **natural** or **anthropogenic** them .

IPCC 2009, Álvarez A, 2009

The climatic changes can affect agricultural production ?

Drought in México

Death of cattle in Mexico

Occurrence of gullies in Paraná , Brazil

Effects of climate change on agricultural production

¿Are our agroecosystems in conditions to confront climatic extremes?

Genetic Vulnerability and Crop Diversity (NAS 1972)

- **Most modern agricultural systems are characterized by homogeneity and uniformity that may lead to higher yields but also to greater susceptibility to pathogens.**

- **Modern agricultural selection disturbs the natural balance in favor of variety uniformity over large areas, domintaed by varieties vulnerable to losses from epidemics and also climatic extremes**

Many small farmers adapt to climate change

- Statistics on effects of climate change on small farmers do not take into account the strategies that many small farmers have used over centuries to overcome climatic variability
- In fact many small farmers prepare and adapt for climate change using a variety of agroecological strategies

There is an urgent need to understand and support the adaptation of farmers to climate change.

Agroecological design less dependent on external inputs ,

↓

High energy efficiency of the production of food and feed .

↓

High Adaptation to the impacts of climate change and increased resilience.

↓

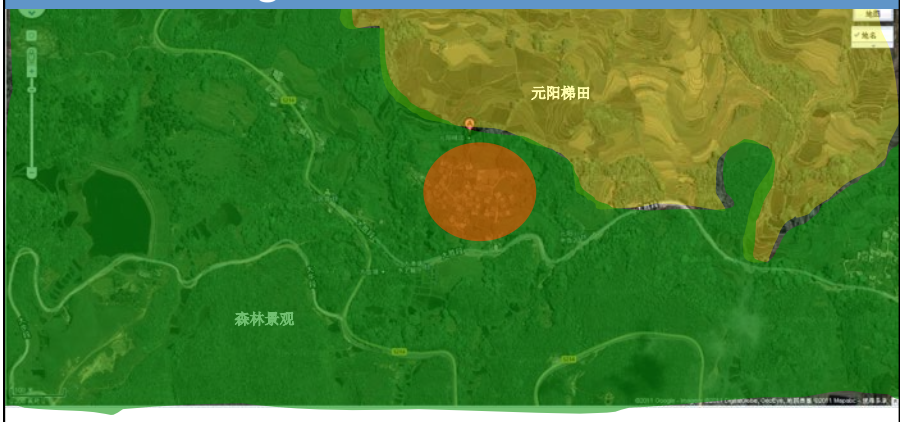
Reducing emissions of greenhouse gases (local and global environmental services) MITIGATION

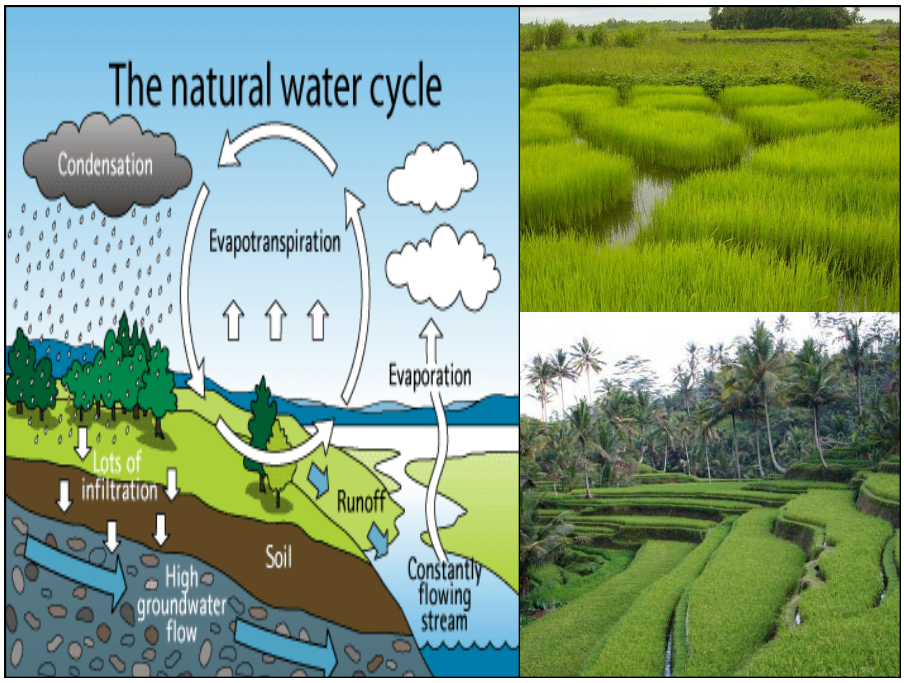
The landscape matrix influences the resiliency of farm fields

In Yuanyuang region in China, many farmers suffered severe droughts

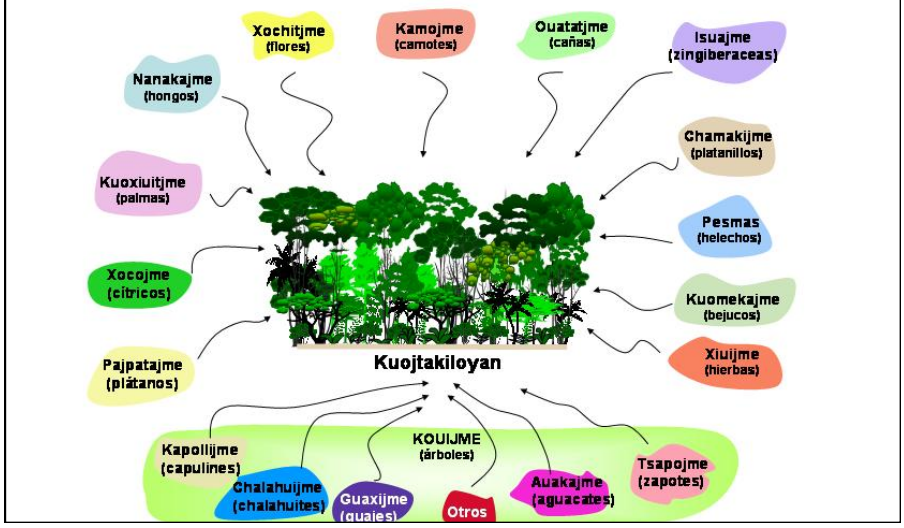
In Yuanyuang terraced region there was a totally different picture.

Traditional Landscape arrangement in agricultural watershed.

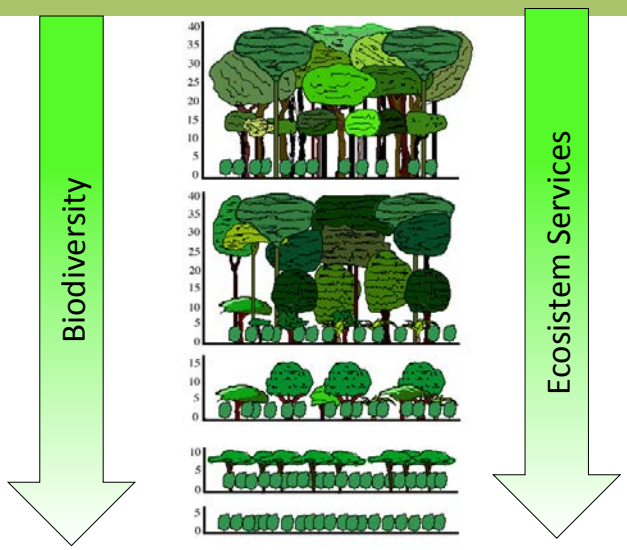




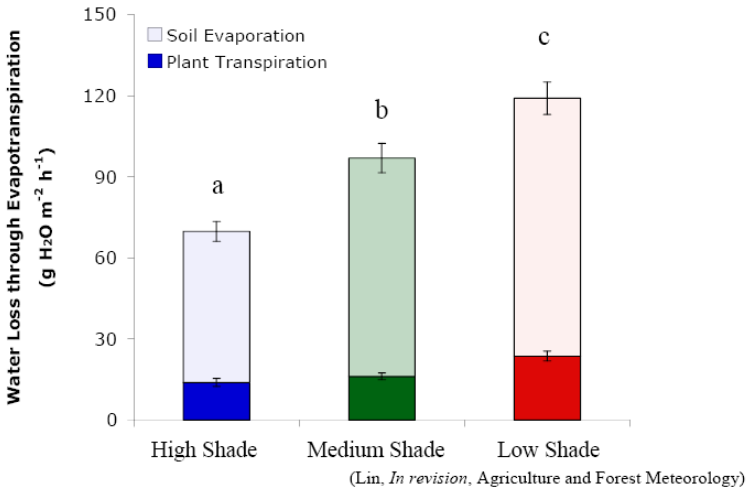
Traditional coffee systems (*Kuojtakiloyan)in Puebla contain more than 150 species/hectare*



Loss of Biodiversity/ Vulnerability



Microclimate variability: Evaporative loss

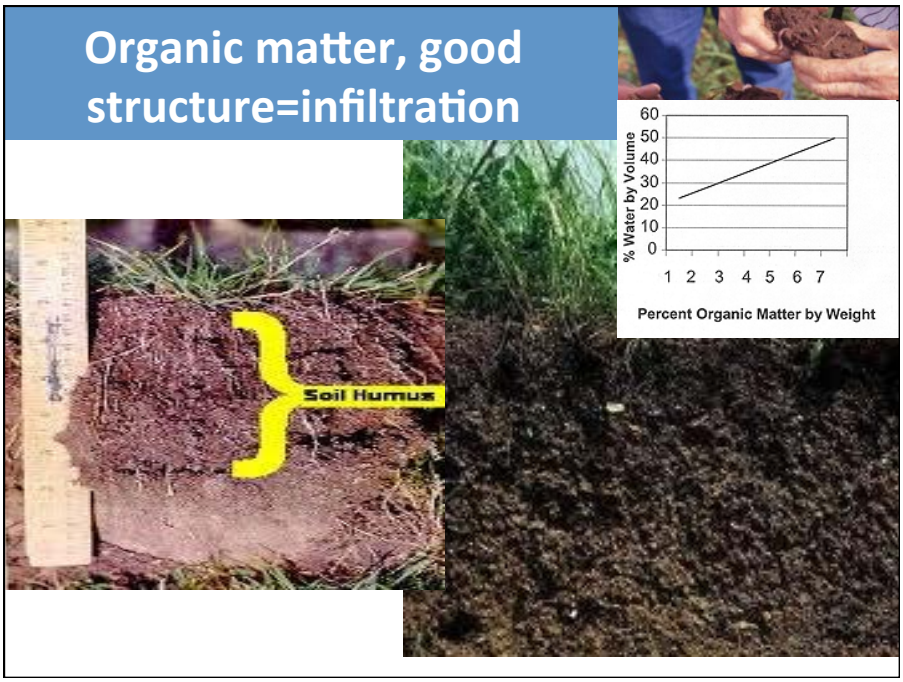


(Lin, *In revision*, Agriculture and Forest Meteorology)

WARU-WARUS Cuzco-Puno, Peru

Orillado system in south of Ecuador

Organic matter, good structure=infiltration



ZAI : Managing soil moisture

Tenerife: Managing soil moisture, Canarias Islands, Spain

Mana-vai Esstern Island -CHILE

Local genetic diversity is key to adapt to climate change but its potential is greater with agroecological strategies

En PARAIBA resgate y valorizacion del conocimento de las famílias campesinas

COMPARISON OF PRODUCTIVITY OF NATIVE VARIETIES AND BURLOG VARIETIES OF WHEAT

	Native variety	Borlaug variety
Yield Kg/ha	3291	4690
Water Demand	12" 5.3 cm	36" 16 cm
Fertilizer Demand	47.3	88.5
Productivity with respect to water use (kg/ha/cm)	620.94	293.1
Productivity with respect to fertilizer use (kg/ha/kg)	69.5	52.99


Maiz de cajete

Water harvesting, Paraiba, Brasil

Water harvesting, Mexico

Water harvesting at the landscape level Mexico

RESILIENCY

resistance to shock and capcity to recover after the shock.

propensity of a system to maintain its organizational structure and productivity after a perturbation. This perturbation or shock can consist of frequent stressful events, cumulative or unpredictable.

SOCIOECOLOGICAL RESILIENCY

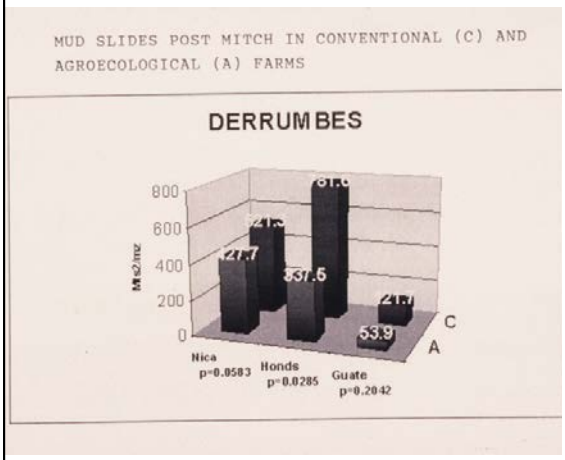
A resilient agroecosystem is able to still produce food after suffering the effects of a storm, hurricane or drought, or given a sudden increase in the cost of petroleum or external input scarcity

Evidence I (Huracan Mitch-Central America)

- In Central America, diverse farms with soil conservation practices :
  - mulch, living
  - dead barriers,
  - terraces, etc

  resisted more the imapct of hurricane Mitch in 1998 than farms managed under monoculture (Holt-Gimenez 2002).

Evidence I (Huracan Mitch-Central America)



Although damage was significant throughout, agroecologically managed farms conserved more soil and vegetational cover, suffered less erosion, mud-slides

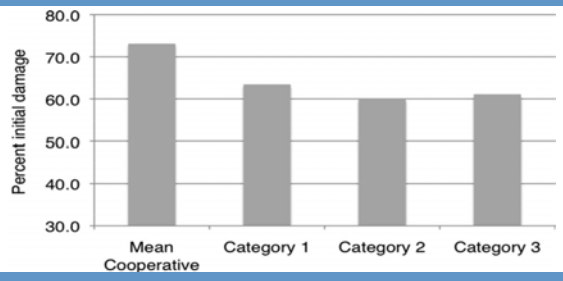
Evidencia II (Huracan Ike-Cuba)

- Areas under industrial monoculture suffered more damage and exhibited less recovery than diversified farms.
- After the hurricane average loss in diversified farms was about 50% compared to 90-100% in monocultures
- Productive recovery was about 80 - 90%,and was noticeable 40 days after the hurricane

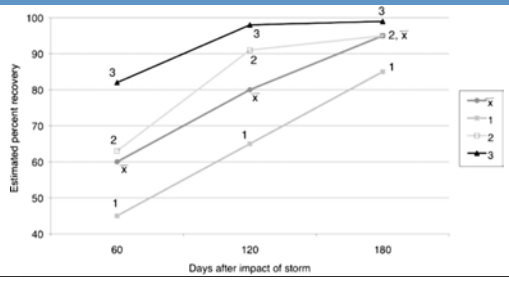
Evidencia II (Huracan Ike-Cuba)

Areas under industrial monoculture suffered more damage and exhibited less recovery than diversified farms.
After the hurricane average loss in diversified farms was about 50% compared to 90-100% in monocultures
Productive recovery was about 80 - 90%,and was noticeable 40 days after the hurricane

After the hurricane average loss in diversified farms was about 50% compared to 90-100% in monocultures in Sancti Spırius,Cuba,

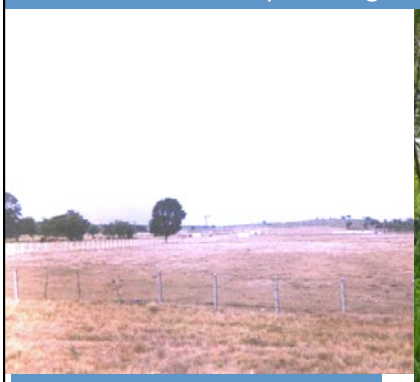


Productive recovery was about 80 - 90%,and was noticeable 40 days after the hurricane

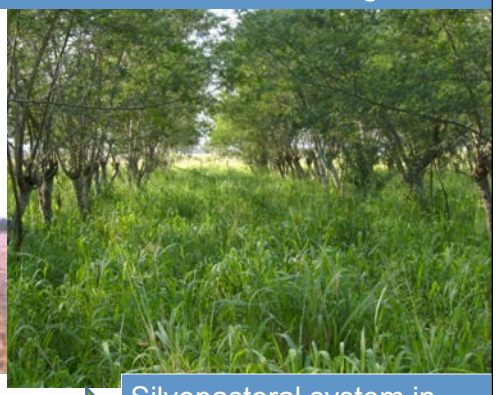


Livestock facing a marked deficit of biomass during extended dry periods.

The combined benefits of Silvopastoral systems:
water regulation, favorable microclimate, biodiversity, and carbon stocks in these ISS, provide greater resilience to climate change.



Pasture status under severe drought



Silvopastoral system in the same study area and time of year.

Lands degraded by cotton monoculture

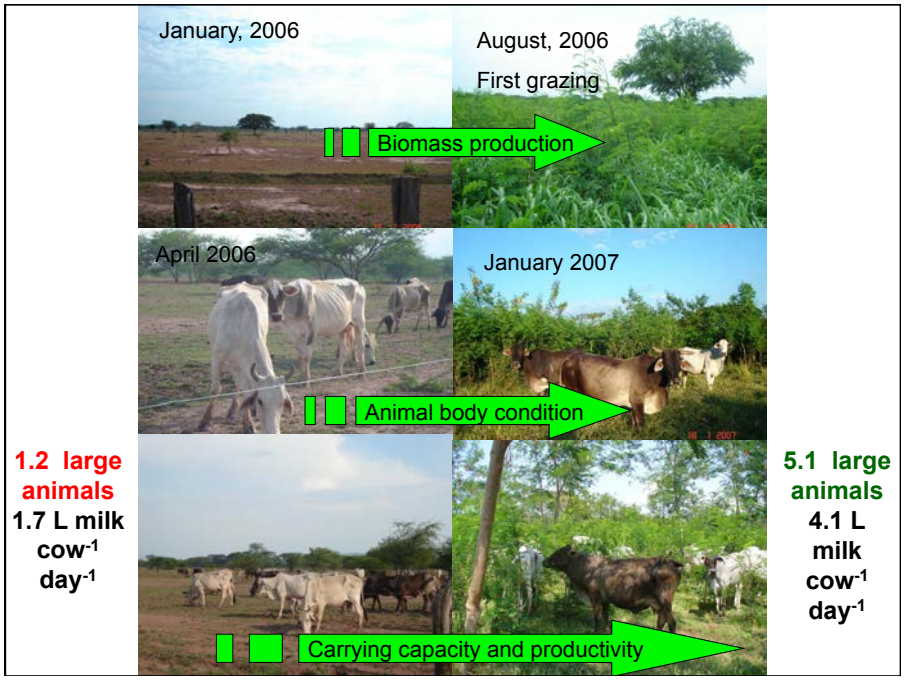
Rehabilitation with silvopastoral systems

Cesar river valley, Colombia

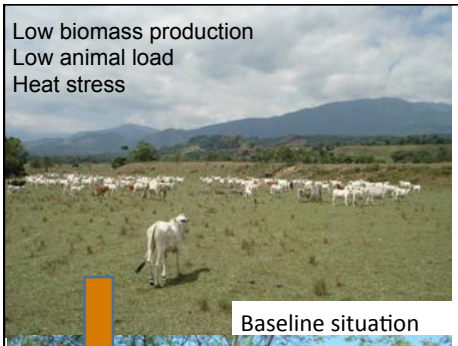
Caribbean region

Rainfall: 1000-1200 mm

Monomodal regime, few rain events


January, 2006
August, 2006
First grazing
Biomass production
April 2006
January 2007
Animal body condition
1.2 large animals
1.7 L milk cow-1 day-1
5.1 large animals
4.1 L milk cow-1 day-1
Carrying capacity and productivity


A win-win situation
The productive advantages that make SPS attractive for landowners ultimately originate from the environmental benefits they provide.



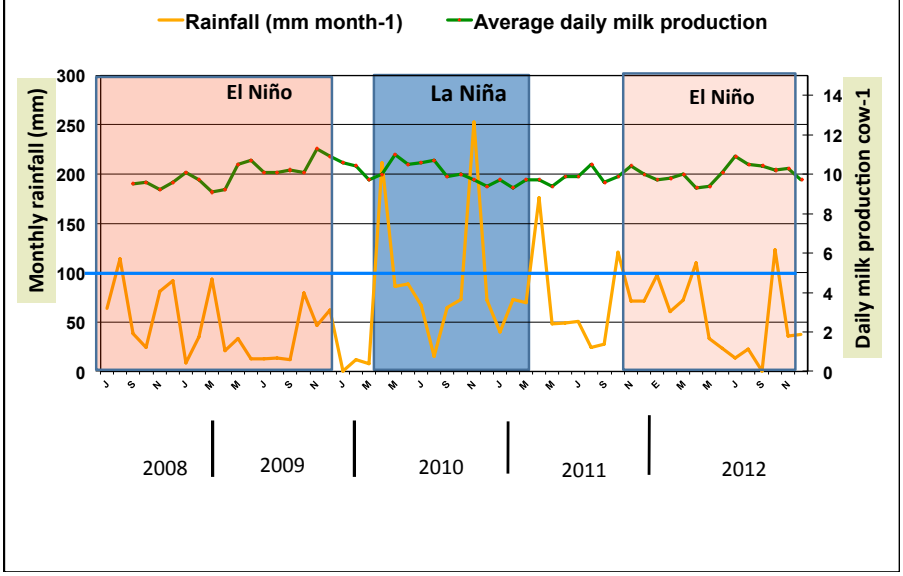
Cubarral, Meta

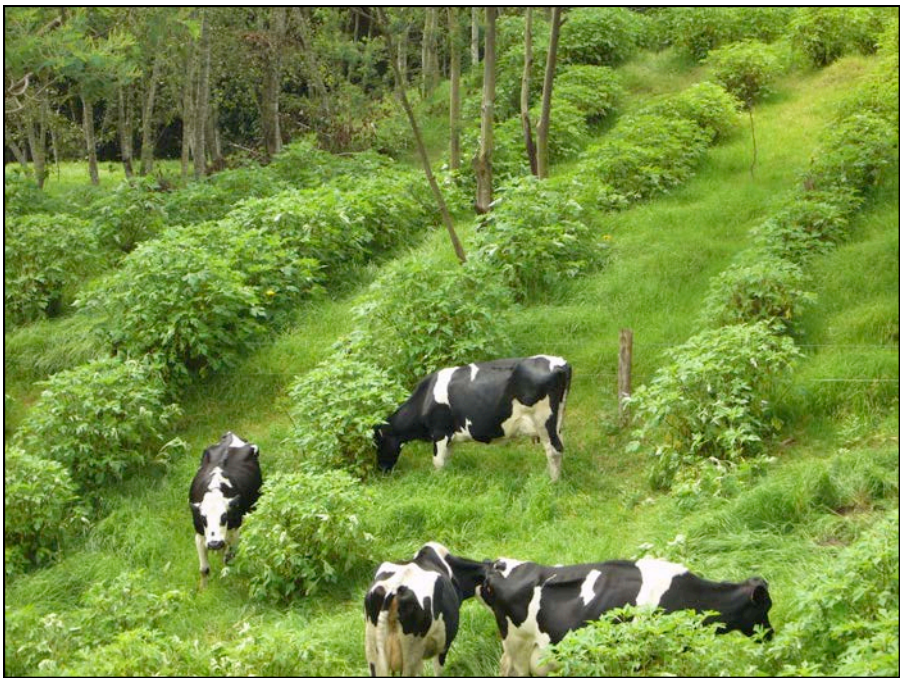
Andean foothills

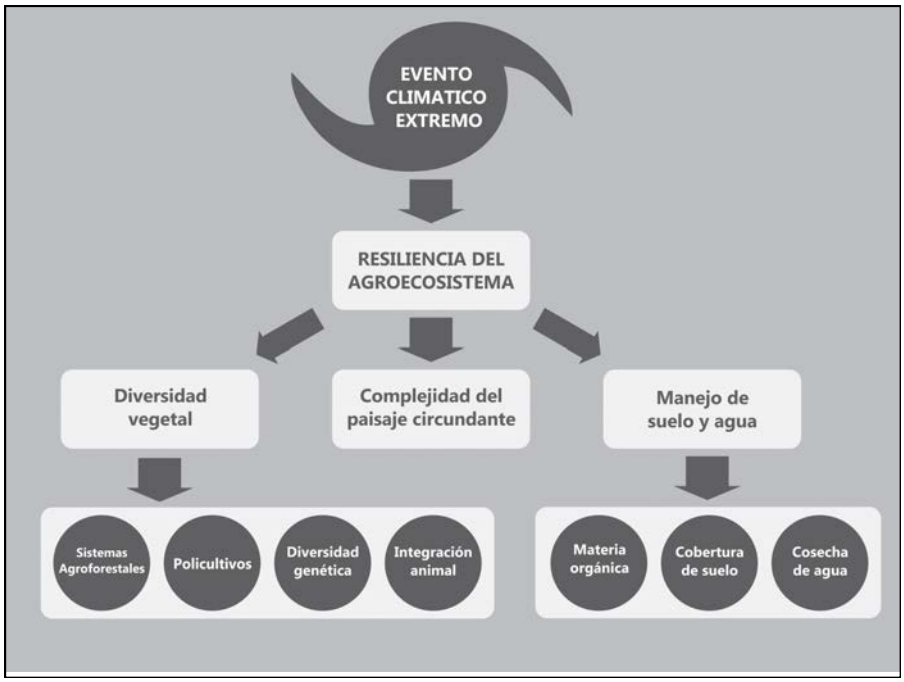
Rainfall > 3000 mm

Silvopastoral systems and resilience

Milk production at El Hatico farm (2008-2012)






EVENTO CLIMATICO EXTREMO
RESILIENCIA DEL AGROECOSISTEMA
Diversidad vegetal
Complejidad del paisaje circundante
Manejo de suelo y agua
Sistemas Agroforestales
Policultivos
Diversidad genética
Integración animal
Materia orgánica
Cobertura de suelo
Cosecha de agua

TALLER DE LA PARCELA FELIZ

Describir Categorías y Indicadores

Paisaje

- **Composición del Territorio**
  - Bosques y predios en descanso y con otros cultivos.
  - Sin bosques pero sí otros predios en descanso y con otros cultivos.
  - Al rededor hay el mismo cultivo que el cultivo que tiene el predio ahora y en la misma temporada.
- **Vegetación y Barreras Vivas al Rededor de los Predios**
  - Árboles que se usan para muchas cosas: leña, madera, forraje, sombra y frutos.
  - Árboles grandes que no son buenos para los cultivos.
  - Sin árboles ni arbustos o barreras vivas.

Describir Categorías y Indicadores

Manejo de Parcelas

- **Rotación de Cultivos**
  - Rotan los cultivos año con año. Además, dejan descansar la tierra, dependiendo del tipo de suelo.
  - Rotan maíz-trigo u otro cultivo pero no incluyen las leguminosas y no dejan descansar la tierra.
  - Sin rotación o descanso: el mismo cultivo año tras año.
- **Tipos de Semilla**
  - Variedades violentas de trigo; maíz de cajete; trébol blanco; y chicharro.
  - Variedades violentas de maíz de temporal. Variedades menos violentas de trigo; calabaza, y haba.
  - Variedades menos violentas que se tarden mas de maíz de temporal. Frijol.

Definir a los Indicadores

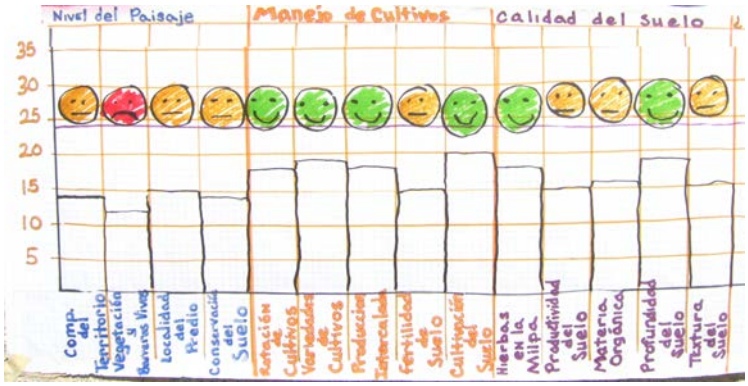
Escalas

Escalas

Categorías y Indicadores

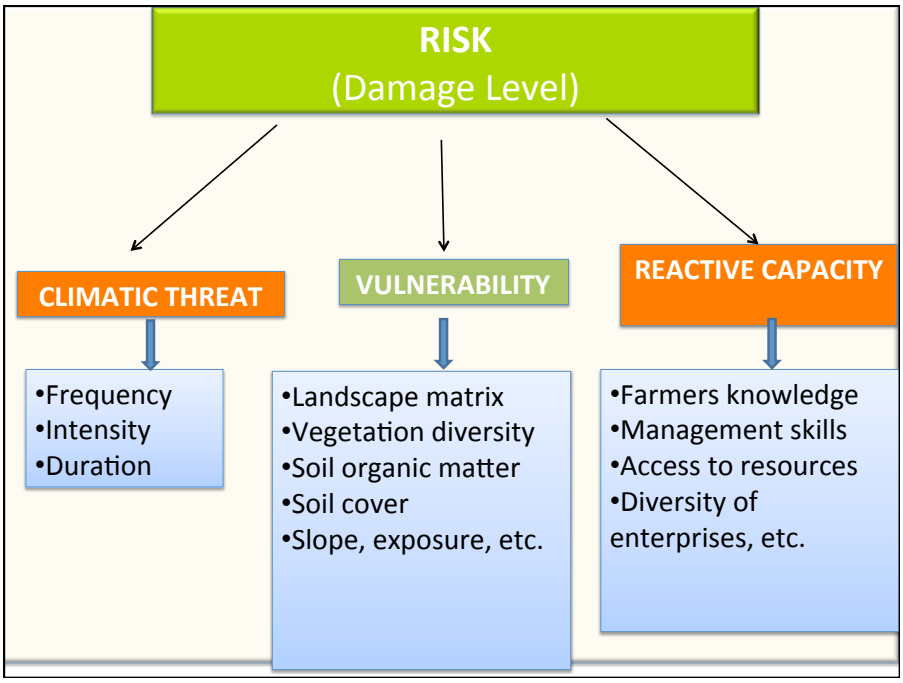
Nivel del Paisaje

Dibujar Gráficas

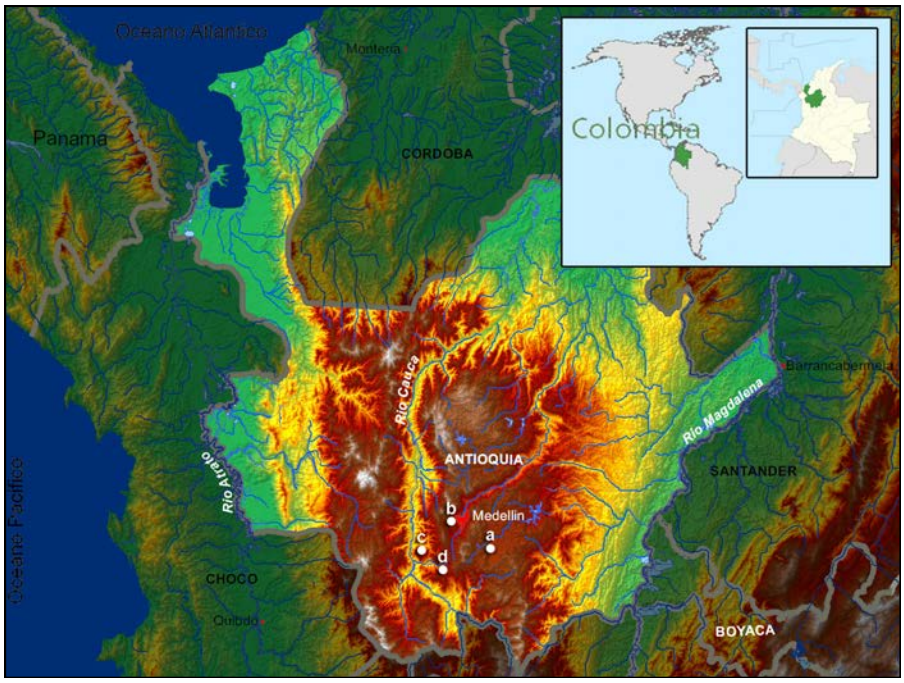


Methodology Campesino a Campesino

Farmer to Farmer



$$\text{RISK} = \frac{\text{Threat} + \text{Vulnerability}}{\text{Reactive Capacity and Recovery}}$$




El Jardin (a)
San Cristóbal


La rosita (c)
San Cristobal

Physical Vulnerability

Conventional Management (c)

		Cocondo "Pasture"	Santa Ana (Fredonia)	La Rosita (San Cristóbal)
		VULNERABILITY LEVEL		
1. SLOPE	Slope	47,7	60,62	8,00%
2. DIVERSITY LANDSCAPE	Diversity Landscape	Low Risk	Medium Risk	Medium Risk
3. SOIL´S EROSION SUSCEPTIBILITY	Infiltration	Moderate (66 min)	Fast (0,5 min)	Fast (4 min)
	Soil Structure	High density	Low Density	Medium Density
	Compaction	Medium Risk	Low Risk	Low Risk
	Erosion signs	Low Risk	Medium Risk	Low Risk

Agroecological Management (a)

		Renaser (El Carmen)	El Jardín (San Cristóbal)	La Subienda (San Cristóbal)	Cocondo (Titiribi)
		VULNERABILITY LEVEL			
1. SLOPE	Slope	2,68%	22,90%	8,20%	58,68
2. DIVERSITY LANDSCAPE	Diversity Landscape	Medium Risk	Medium Risk	Medium Risk	Low Risk
3. SOIL´S EROSION SUSCEPTIBILITY	Infiltration	Fast (5,16 min)	Fast (9 min)	Fast (6 min)	Fast (2,8 min)
	Soil Structure	Low Density	Medium Density	Medium Density	Low Density
	Compaction	Low Risk	Low Risk	Low Risk	Low Risk
	Erosion signs	Low Risk	Low Risk	Low Risk	Low Risk

Response capacity

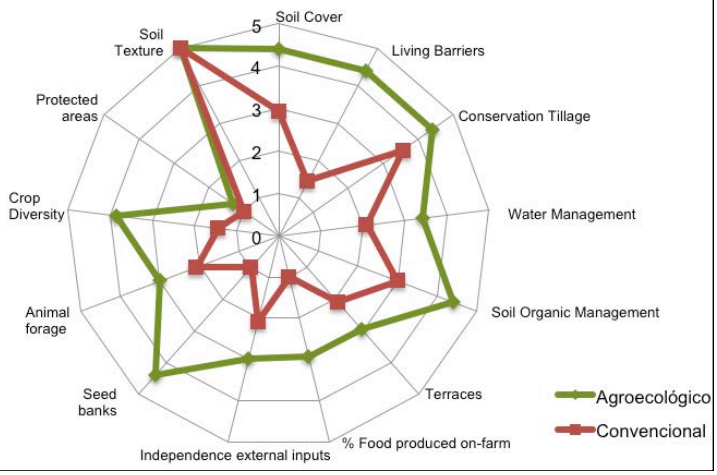
Conventional Management (c)

PRACTICAS DE CONSERVACION DE SUELOS	y barreras vivas, barreras Rompevientos)	< 10%	10 - 50 %	< 10%
	Labranza de Conservación	10 - 50 %	> 50%	10 - 50 %
	Prácticas de Manejo Hidrológico	Medio	Bajo	Medio
	Practicas para aumentar Materia Orgánica	Medio (1 a 2)	Medio (1 a 2)	Medio (1 a 2)
	Terrazas y semiterrazas (Curvas de nivel, multiestratos)	Ninguna	Medio	Medio
	Autoconsumo (% de alimentos producidos en la finca)	Bajo (<20)	Bajo (<20)	Bajo (<20)
	Autosuficiencia de insumos externos	10 - 50%	> 50%	10 - 50%
	Banco de Semillas	BAJO	BAJO	BAJO
	Alimentación Animal	10 - 50%	10 - 50%	> 50 %
	Asociación de Cultivos	Bajo (monocultivo)	Medio (=2)	Bajo (monocultivo)
	Áreas protegidas dentro de la finca	< 10 %	< 10 %	< 10 %
	Estimación de la textura de suelo	Franco - Limoso	Franco - Limoso	Franco - Arenoso

Agroecological Management (a)

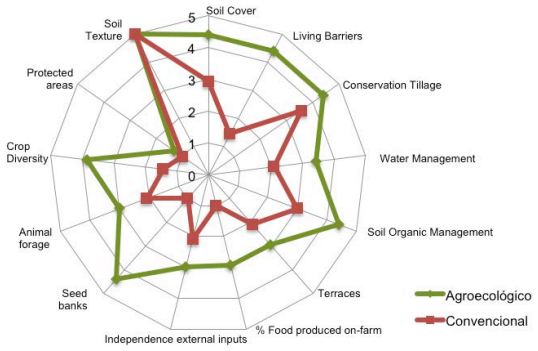
		CAPACIDAD DE RESPUESTA Y RECUPERACIÓN			
PRACTICAS DE CONSERVACION DE SUELOS	Cobertura vegetal (viva o muerta)	> 50%	> 50%	10 - 50 %	> 50%
	Barreras de Vegetación (Cercas y barreras vivas, barreras Rompevientos)	> 50%	> 50%	10 - 50 %	> 50%
	Labranza de Conservación	> 50%	> 50%	10 - 50 %	> 50%
	Prácticas de Manejo Hidrológico	Medio	Medio	Medio	Alto
	Praticas para aumentar Materia Organica	Alto (>3)	Alto (> 3)	Alto (> 3)	Medio (1 a 2)
	Terrazas y semiterrazas (Curvas de nivel, multiestratos)	Alto (curvas de nivel)	Alto (Curvas de nivel)	Ninguna	Alto (Multiestrato)
	Autoconsumo (% de alimentos producidos en la finca)	Alto (> 60%)	Alto (> 60%)	Medio (20 - 60%)	Bajo (<20)
	Autosuficiencia de insumos externos	10 - 50%	10 - 50%	10 - 50%	10 - 50%
	Banco de Semillas	ALTO	ALTO	MEDIO	ALTO
	Alimentación Animal	10 - 50%	10 - 50%	10 - 50%	10 - 50%
	Asociación de Cultivos	Alto (> 2)	Medio (= 2)	Medio (=2)	Alto (> 2)
	Áreas protegidas dentro de la finca	< 10 %	> 30 %	< 10 %	< 10 %
	Estimación de la textura de suelo	Franco - Limoso	Franco - Limoso	Franco	Franco – Limoso

Indicators of Response Capacity



Indicators of Response Capacity

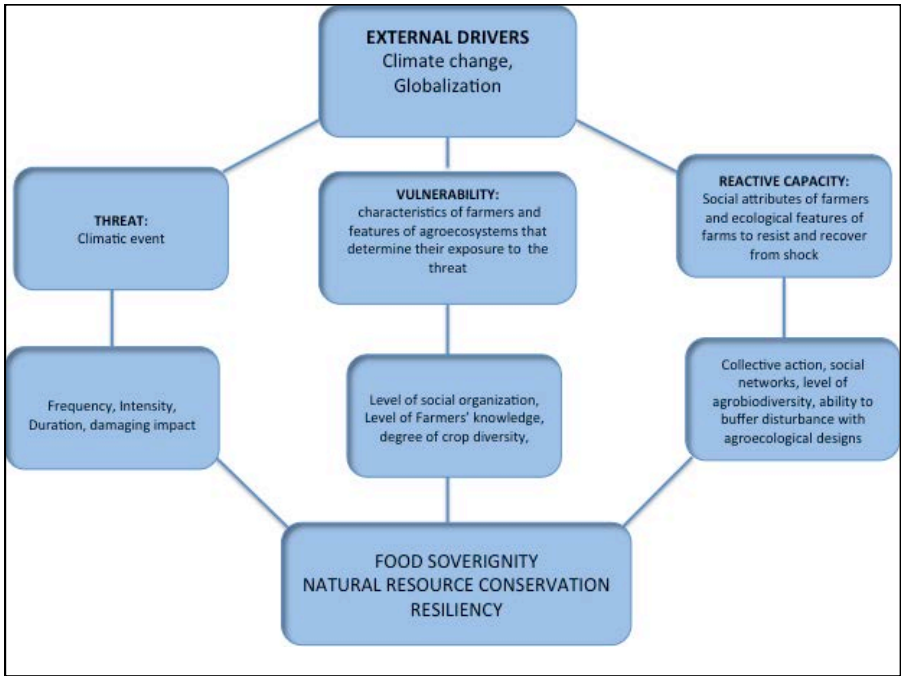
	Agroecológical Farms (a)	Conventional Farm (c)	(a – c)	((a – c)/c)*100 (%)
Soil Cover	4,40	2,92	1,48	50,50
Living Barriers	4,40	1,44	2,96	205,12
Conservation Tillage	4,40	3,56	0,84	23,72
Water Management	3,41	2,08	1,33	63,87
Soil Organic Management	4,40	3,00	1,40	46,69
Terraces (Contour line, multiestrata system)	2,94	2,08	0,86	41,48
% Food produced on-farm	2,94	1,00	1,94	194,28
Independence from external inputs	3,00	2,08	0,92	44,22
Seed banks	4,40	1,00	3,40	340,06
Animal forage	3,00	2,08	0,92	44,22
Crop Diversity	3,87	1,44	2,43	168,54
Protected areas within farm	1,32	1,00	0,32	31,61
Soil Texture	5,00	5,00	0,00	0,00
General average	**3,48**	**1,95**	**1,45**	**96,48**



Estimacion de riesgo

Risk assessment

	Vulnerability	Response Capacity	Risk index
Agroecological farms			
Renaser (El Carmen)	0,408	3,926	**0,103**
El Jardín (San Cristóbal)	1,127	4,108	**0,274**
La Subienda (San Cristóbal)	0,782	2,740	**0,285**
Cocondo (Titiribi)	1,176	3,335	**0,352**
Conventional farms			
Cocondo (Pasture)	2,038	1,954	**1,042**
Santa Ana (Fredonia)	1,775	2,212	**0,802**
La Rosita (San Cristóbal)	0,782	1,726	**0,453**


EXTERNAL DRIVERS
Climate change, Globalization
THREAT:
Climatic event
VULNERABILITY:
characteristics of farmers and features of agroecosystems that determine their exposure to the threat
REACTIVE CAPACITY:
Social attributes of farmers and ecological features of farms to resist and recover from shock
Frequency, Intensity, Duration, damaging impact
Level of social organization, Level of Farmers' knowledge, degree of crop diversity,
Collective action, social networks, level of agrobiodiversity, ability to buffer disturbance with agroecological designs
FOOD SOVERIGNITY
NATURAL RESOURCE CONSERVATION
RESILIENCY


AGROECOLOGICAL TERRITORIES


Thank you!!!
Pintando el Futuro
Una Indicación Geográfica para
el Salame de Colonia Caroya