Watershed-based Natural Resource Management in Small-scale Agriculture: Sloped Areas of the Andean Region

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Objectives

- Describe LTRA-3 research project
- Present and discuss main messages from research

Host-Country Partners

- **Ecuador:** INIAP—Victor Barrera; ECOCIENCIA
- SIGAGRO-MAG
- **Bolivia:** PROINPA—Ruben Botello
- PROMIC
- UMSS

US Partners

- Jeffrey Alwang Ag. and Applied Economics, Virginia Tech
- Darrell Bosch, Ag. and Applied Economics, Virginia Tech
- George W. Norton Ag. and Applied Economics, Virginia Tech
- Sarah Hamilton, International Development, Univ. of Denver
- Mary Leigh Wolfe, Bio. Systems Engineering, Virginia Tech.
- Brian Benham, Center for TMDL and Watershed Studies, Bio. Systems Engineering, Virginia Tech
- Conrad Heatwole, Bio. Systems Engineering, Virginia Tech
- Paul Backman, Plant Pathology and Biocontrol, Penn State
- Jonathan Lynch, Plant Nutrition, Penn State University
- Wills Flowers, Entomology and Biological Control, Florida A&M

Project Objectives

Generate and validate environmentally sustainable alternatives to improve production systems and enhance income generation

Create a means of evaluating the impacts of alternative actions, policies and interventions on income generation, and social and environmental conditions

Build local capacity to evaluate policy alternatives, and make and enforce decisions

Organizing Concept

The main organizing concept is an adaptive watershed management approach whereby local actors are brought together to identify objectives, participate in research, and make decisions based on research findings

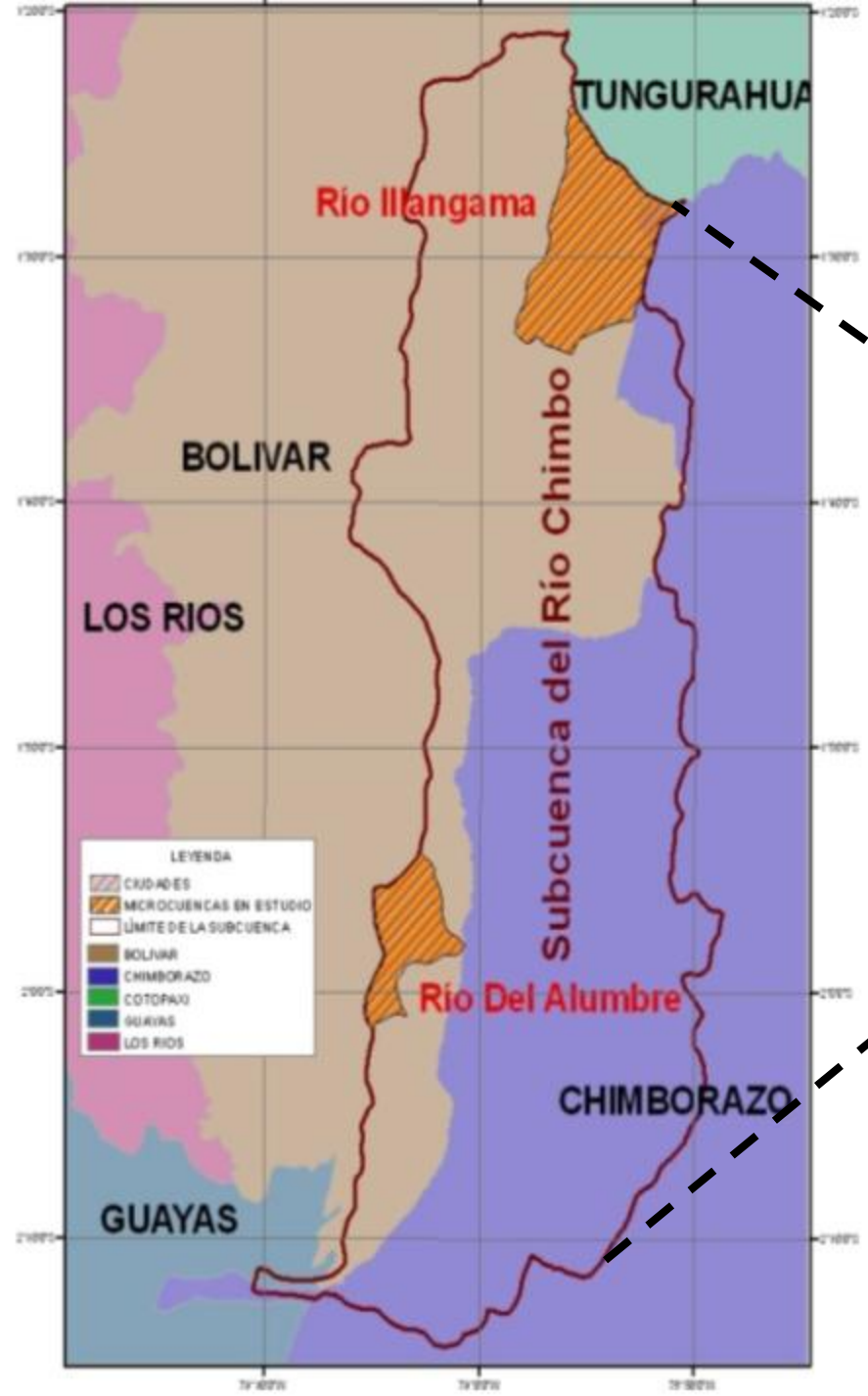
Research Activities

- Bio-physical research activities to identify potential solutions to constraints faced by farmers, including plant diseases, variety selection, feasibility of alternative crops (rotations), soil erosion and water management
- Social science research on the determinants of household livelihood strategies, profitability of livelihood alternatives, access to markets, costs and benefits of enhanced natural resource management, and institutional considerations affecting governance

Research Activities

- Tied together through physical and economic models of the watershed
- Model results are used in a participatory adaptive watershed planning process to inform local decision makers about the impacts and consequences of alternative land uses
- Project is engaged in an ongoing dialogue with local stakeholders to guide research activities and build ownership of research outputs

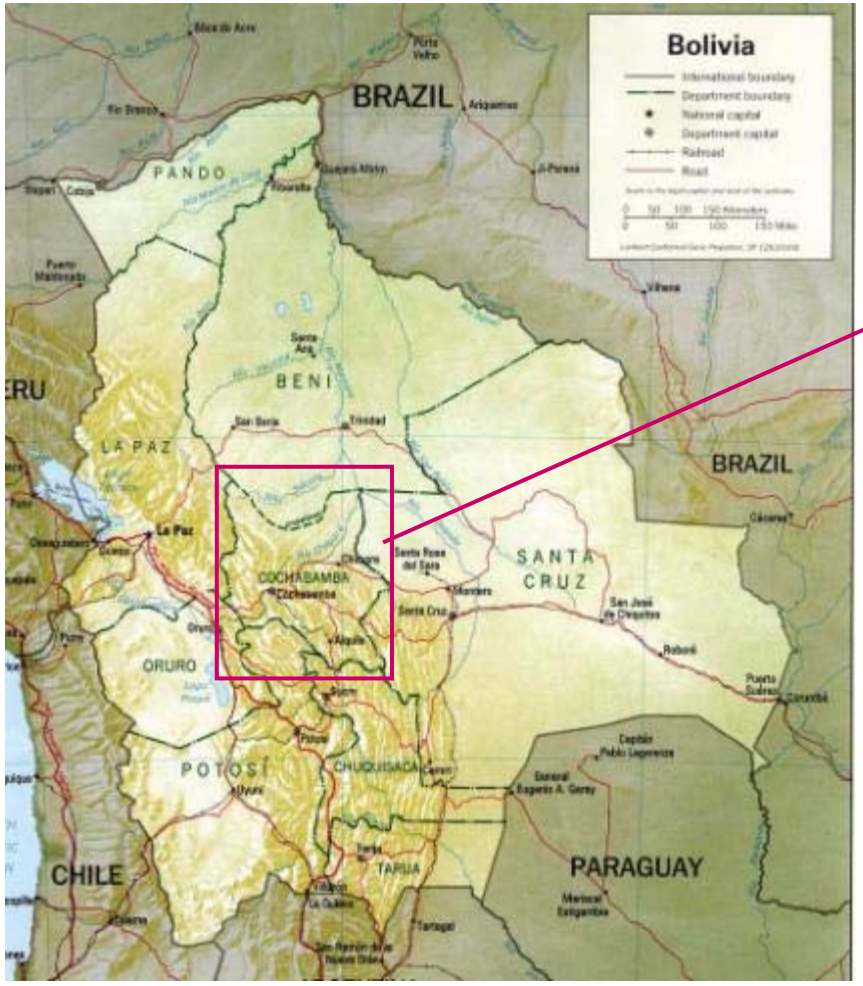
Sites: Chimbo, Ecuador & Tiraque, Bolivia

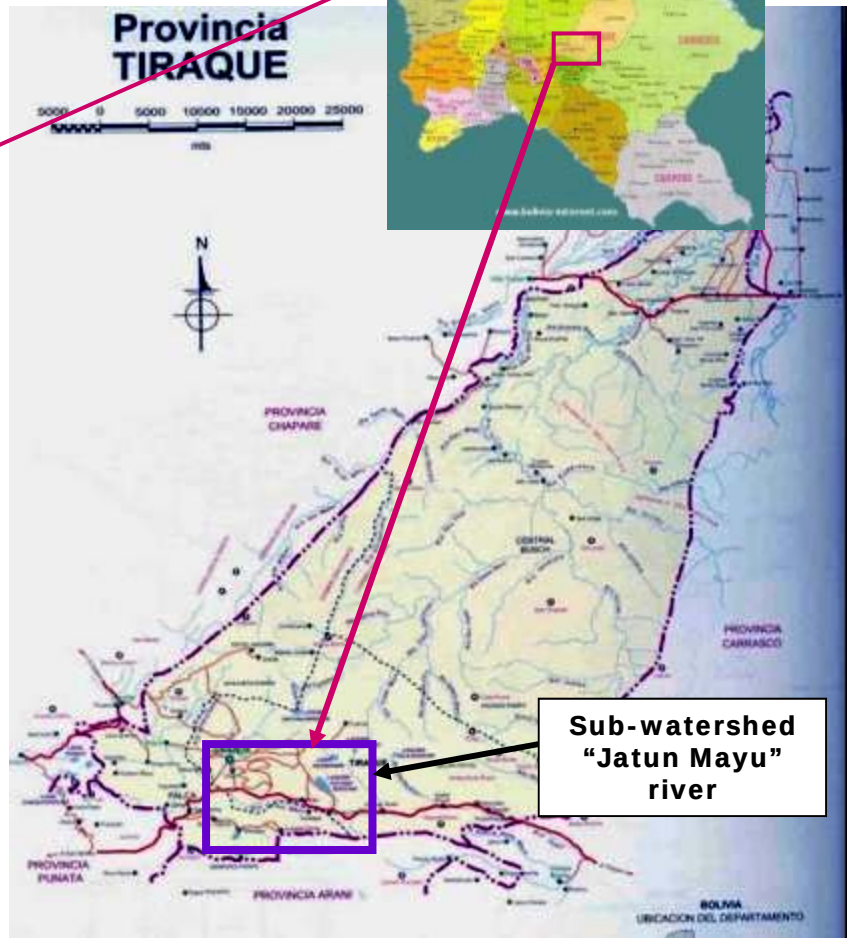

TUNGURAHUA
Río Illangama
BOLIVAR
LOS RIOS
Subcuenca del Río Chimbo
Río Del Alumbre
CHIMBORAZO
GUAYAS
LEYENDA
CIUDADES
MICROCUENCAS EN ESTUDIO
LÍMITE DE LA SUBCUENCA
BOLIVAR
CHIMBORAZO
COTOPAXI
GUAYAS
LOS RIOS


COLOMBIA
QUITO
ECUADOR
Guayaquil
PERU
Legend:
Principal Cities
INAMHI Meteorological Stations
INIAP Agricultural Experiment Stations
Rivers
Province Boundaries
0
65
130
260
Kilometer

Bolivia

Departament of Cochabamba





Five big messages

- Institutions
- Participation
- Watershed modeling
- Risk
- Linkages

Message 1: Institutions matter

- National agricultural research systems & local institutions
  - Research capacity
  - Linkages to local governments and other institutions
  - Both institutions (INIAP and PROINPA) have strong capacity, credibility in field and linkages to private sector
- Assistance to achieve food security should work through and strengthen existing institutions

Message 2: Participation is important, but not all participation is equal

- "New" and "improved"—has term lost its meaning?
- Review of watershed management programs in Andean Region: all used participatory methods, but with big differences in effectiveness
- Engaged participation and learning
  - Trust (in competency and motives)
  - Bring something to the table: alternatives
  - Participatory learning

Example: Soil erosion trials

- Soil loss & management
- Participation: identifying the problem, establishing trials, measuring outcomes
- Hands on: see the dirt and see the yields
- Uptake technologieshave been taken up

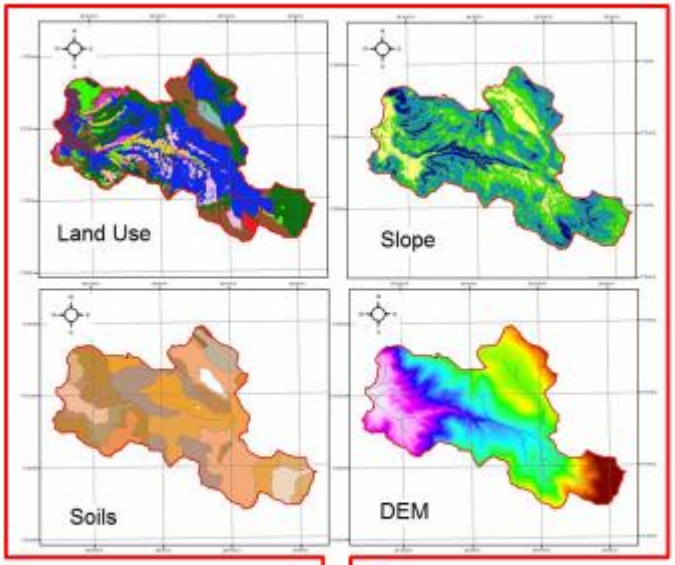
Contour cultivation and ground-cover, Alumbre

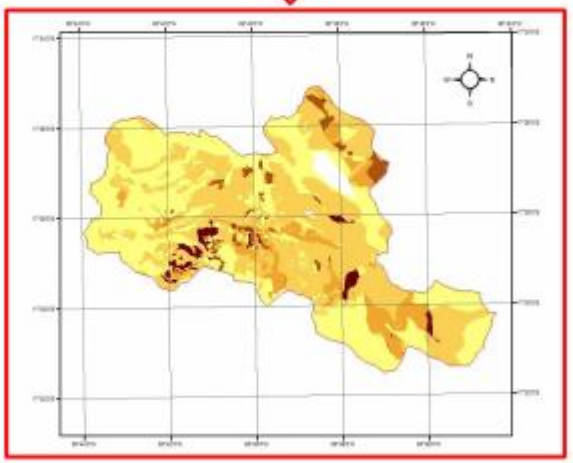
Cultivation in belts: Illangama

Message 3: Watershed modeling: more than we could chew?

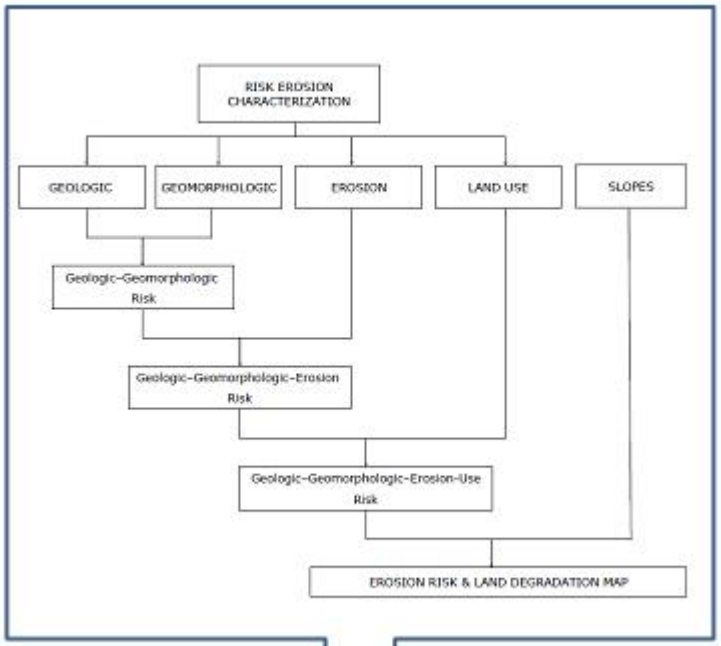
- Data hungry models: SWAT and GLEAMS
  - High tech and inappropriate?
- Provides structure to data collection & analysis
- Capacity building
- Validation of alternative methods

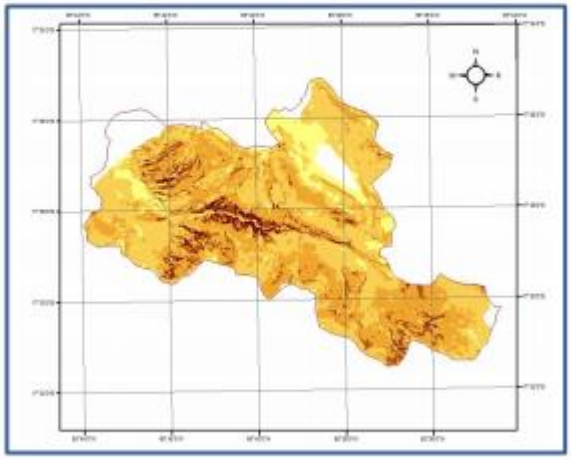
Sediment yield prediction by SWAT





PROMIC's risk assessment approach (Vargas et al., 2007)





CONCLUSIONS

- PROMIC's approach and SWAT produce similar erosion risk assessment
- PROMIC's more qualitative approach is suitable for general erosion risk assessment

Message 4: Focus on risk

- Intrinsic and instrumental impacts of risk
- Food security and intrinsic value
- Instrumental impacts on agriculture
  - Market choice
  - Variety choice
  - Production efficiency
- Risk management and long-term food security

Example: Efficiency and risk

1. Estimate KGMHLBC model:

   The stochastic production frontier and the inefficiency model are estimated jointly:

$$\ln y_i = \ln f(x_i;\beta) + v_i + u_i$$

$$u_i = \gamma' z_i + \varepsilon_i$$

2. Estimate technical efficiency (TE) scores and map scores based on field and household locations

Main findings

- Technical efficiency scores

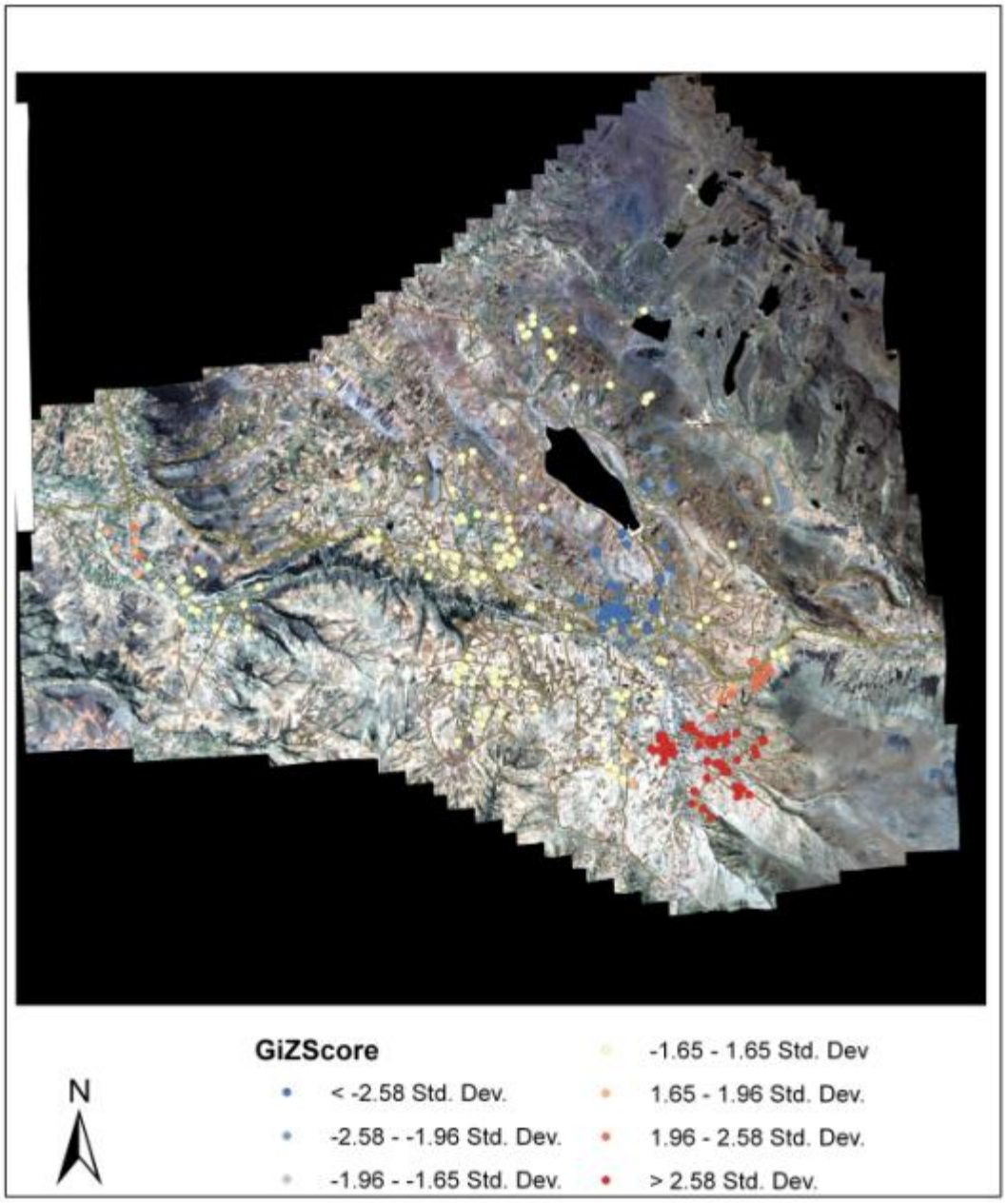
Mean	Stan. deviation	Minimum	Maximum
52.56 %	21.78	4.47%	97.05%

- Test for spatial autocorrelation

	N	**Z-Score**	**Meaning**	**Basis**
For each field	287	5.37	Clustered	Field location
Averaged the household level	123	-0.19	Random	Household location

→ Fields located near each other have similar level of efficiency where households located nearby have uncorrelated averaged efficiency scores.

Hot Spot Analysis for technical efficiency scores based on field locations



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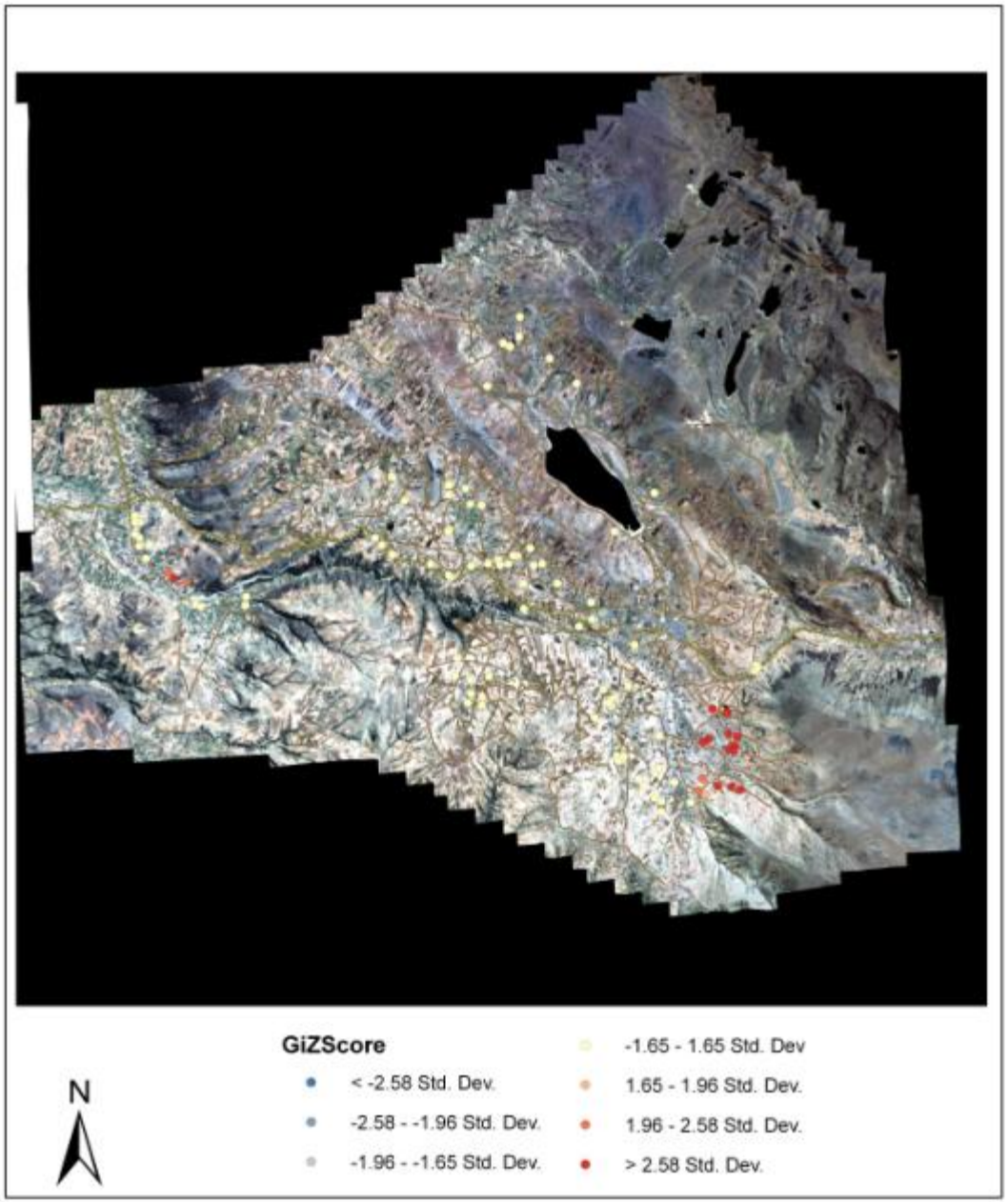


Main findings

- Important clusters of low and high technical efficiency scores are found when the analysis is performed at the field-level
- These clusters are practically inexistent when analysis is performed based on the household locations

Conclusion

- Variability in efficiency due to environmental factors and exposure to risk
- Having fields in different locations and managed differently is a diversification strategy used to mitigate risk
- Inefficient fields are clustered in highly vulnerable areas=>instrumental impact of risk

Message 5: Forward and backward: beyond farming

- Livelihood focus has proven to be useful
  - Obstacles to adoption?
  - Risk management
  - Economic mosaic
- Forward linkages: value chains and increased returns
  - Need to support producer organizations
  - Be supportive of formal membership among women
- Looking backward:
  - Bio-products, soil amendments
  - Sanitary seeds, grafting
  - Potential for cottage industries with strong linkages and positive environmental impacts

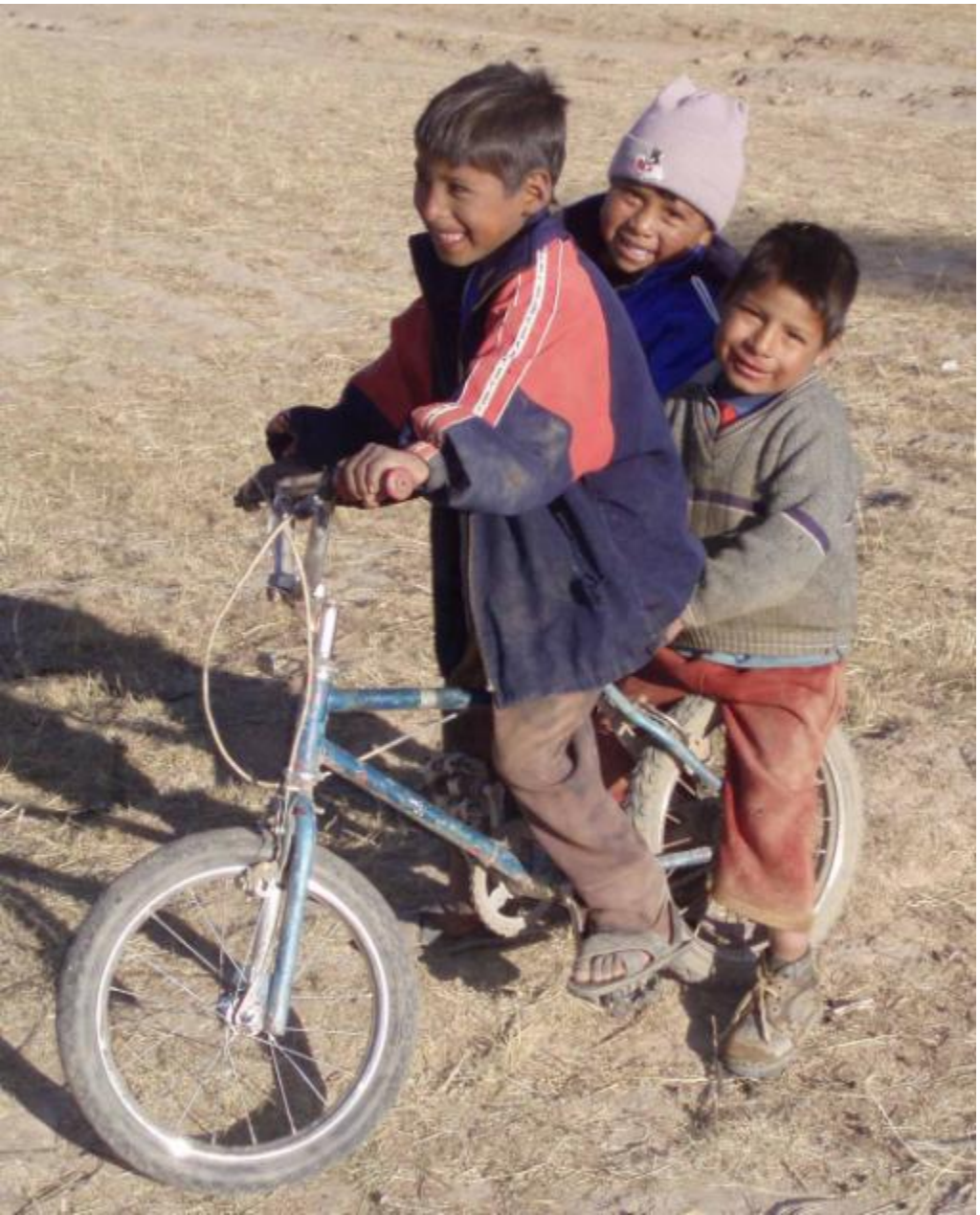
Agricultural Alternatives: Bolivia.
Alleviate pest constraints to annual crops

Study of isolation of endophyte bacteria in faba beans and potato in process

Plant pathogenic nematodes controlled through "bio-fumigation"

Conclusions

- Research results provide more details
- Impacts are highest where several forces collide:
  - Strong institutions and linkages to study areas
  - Sequenced participation
  - Science brings something to the table
  - Fits with livelihoods
- Soil conservation in upper Chimbo in Ecuador



THANK YOU