

**Harnessing the potential of remote sensing for  
tracking adoption of agricultural practices**

**Ground truth ... Or how to lie with maps?:**

**Glenn Hyman**

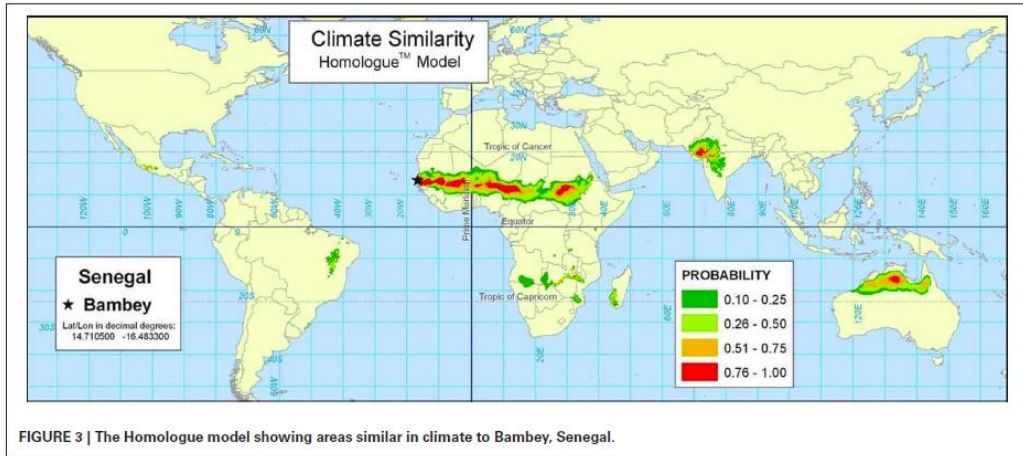
**International Center for Tropical Agriculture (CIAT)**

# Introduction

- Opportunities for using remote sensing to evaluate adoption and impact are expanding rapidly
- But huge challenges remain
- What are the developments or trends that are responding to these challenges?
- Ex-ante and ex-post impact assessment using remote sensing and spatial analysis

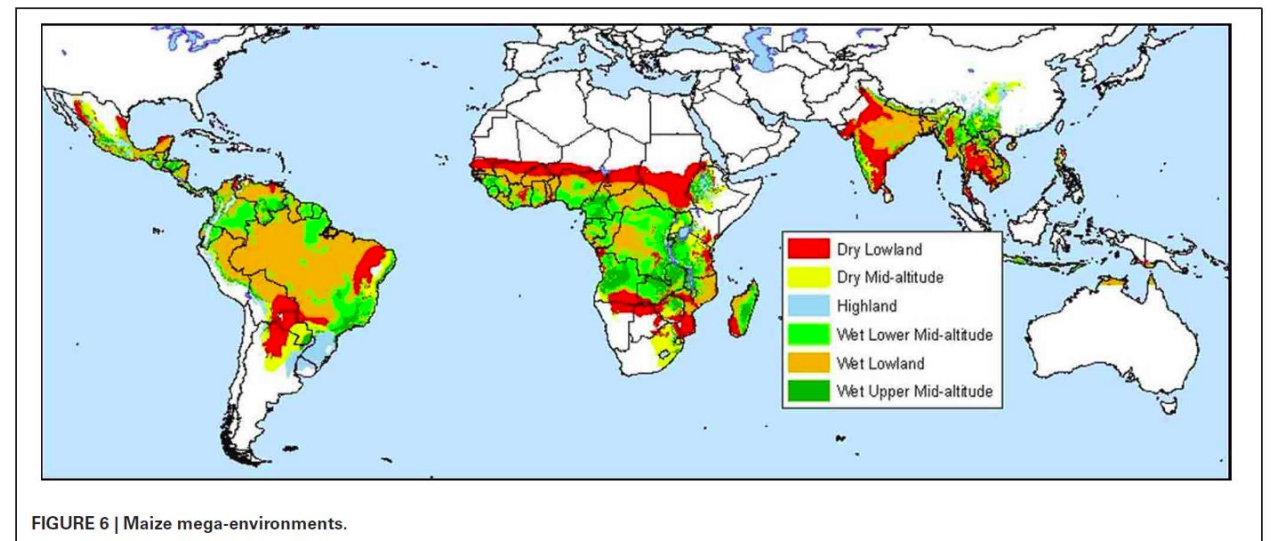
**Ex-ante remote sensing and GIS tools and methods for evaluating adoption and impact**

# Targeting genotypes: targeting uses spatial analysis with land cover or land use derived from remote sensing




Hyman, G., Hodson, D. and Jones, P., 2013. Spatial analysis to support geographic targeting of genotypes to environments. *Frontiers in physiology*,4.

Annicchiarico,P., Bellah, F., Hand Chai,T. (2006).Repeatable genotype x location interactions and its exploitation by conventional and GIS-based cultivar recommendation for durum wheat in Algeria. *Eur.J.Agron.* 24,



Global crop distribution models combine land use derived from remote sensing with production statistics and other spatial data


- SPAM
- Monfreda et al.,
- Many others



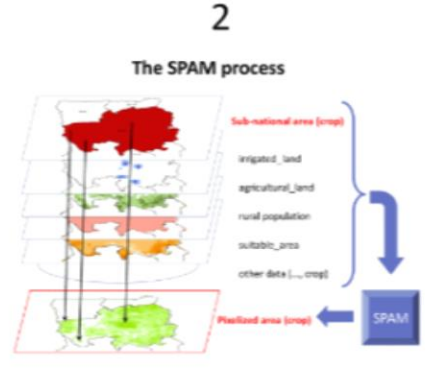
# IFPRI's Spatial Production Allocation Model (SPAM 2005)

Drawing on a variety of inputs, SPAM uses an entropy-based, data-fusion approach to 'plausibly' assess cropping system distribution and performance at a 'meso-gridded' scale of 5-minute globally, 30-seconds at country level (if data available).

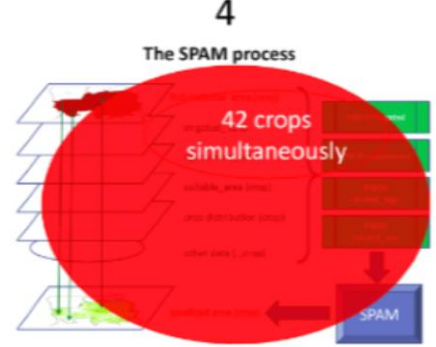
### 1 Path From Admin Units to Pixels



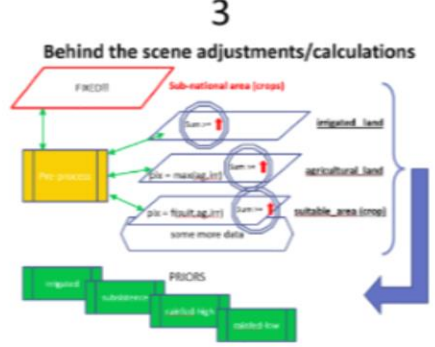
### 2 The SPAM process



### 4 The SPAM process



### 3 Behind the scene adjustments/calculations



#### Challenges

- Different sources -> 'contradictory' information
- Raster data not at same scale
- Sub-national data complete, at least level1, better level2
- Conform national crops -> FAO/SPAM crops
- Consistencies between layers - constraints met  $ag\_land \gg stats, irr \gg crop\_irr, suit\_land \gg ag\_land \gg stats$
- Cropping intensities & production systems shares consistent with data and model
- Validation of results

#### Opportunities

Driven by applications or user preferences:


- Accessibility for HUBZero community - move out of IFPRI 'enclosure'
- Include data at larger scale - 10x10 km -> 1x1 km
- Use most recent data - statistics, ag\_land, irrigation, distribution, administrative units
- Provide and use national/sub-national prices
- Change crop list - expand/reduce (suitabilities?)
- Proprietary suitability conditions (modify model)
- Reproducibility of results
- Teaching tool for GIS, modelling, GAMS
- Validation 'easier' at large scale, reduced area

#### Validation

- Validation process by other CGIAR centers (e.g. IRRI, CIAT, ILRI, CIP, CYMMIT). Each focuses on the mandate crops.
- Crop map view 'parties' by local experts and agronomists
- Crowd-sourcing on a dedicated website (mapSPAM.info)

#### SPAM crops

1	wheat
2	rice
3	maize
4	barley
5	pearl millet
6	finger millet
7	sorghum
8	other cereals
9	potato
10	sweet potato
11	peas
12	beans
13	other leguminosae
14	soya
15	oilseeds
16	coconut
17	oil palm
18	lupinus
19	other pulses
20	soybean
21	groundnut
22	sesame
23	oil palm
24	sunflower
25	rapeseed
26	sunflower
27	other oilseeds
28	sugarcane
29	sugar beet
30	cotton
31	coffee (blue beans)
32	coffee arabica
33	coffee robusta
34	teesta
35	tea
36	tobacco
37	banana
38	plantain
39	tropical fruits
40	temperate fruits
41	vegetables
42	rest of crops

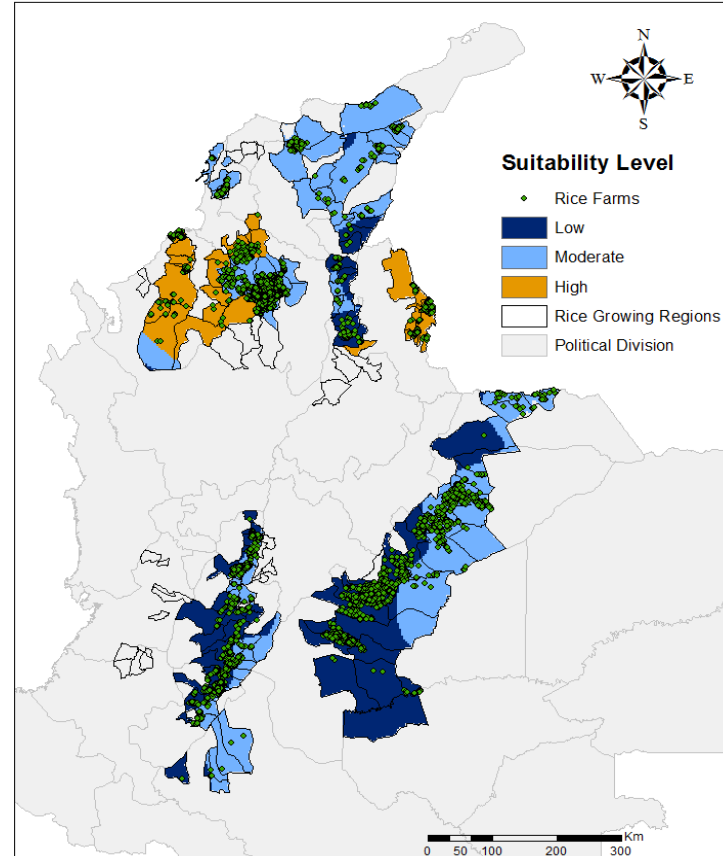
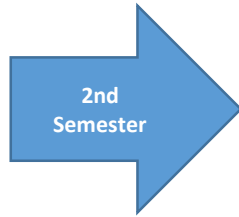
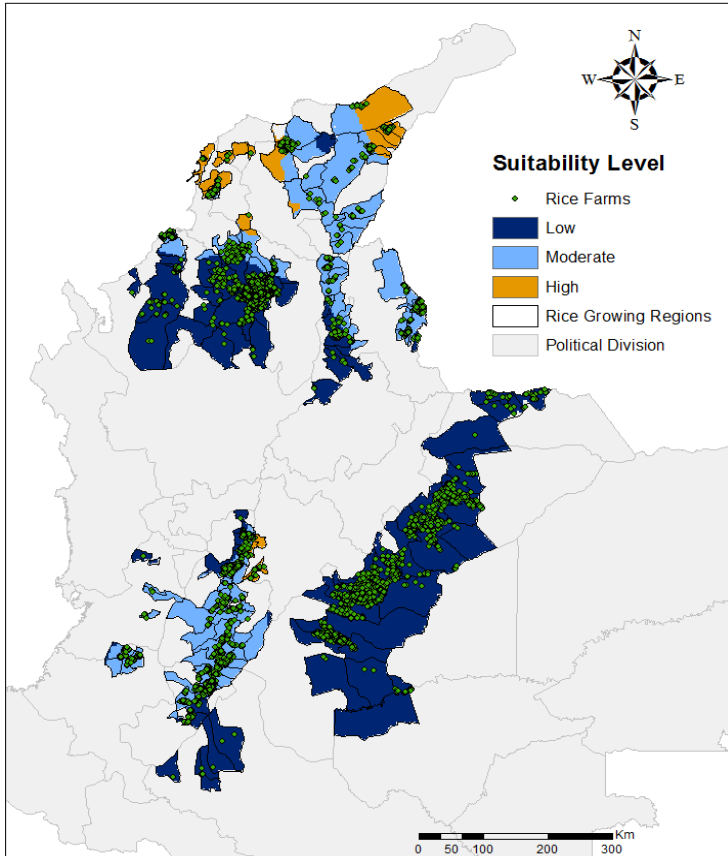
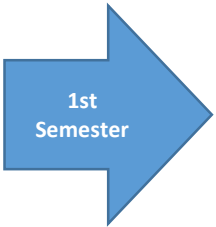


You, Liangzhi, and Stanley Wood. "An entropy approach to spatial disaggregation of agricultural production." *Agricultural Systems* 90.1 (2006): 329-347.

<http://mapspam.info/methodology/>

# Finding the “sweet spot”

Where might alternate wetting and drying (AWD) systems be developed? Based on work from IRRI. Uses rainfall, temperature and radiation data from remote sensing



**Colombia -  
Suitability  
Maps:  
Current  
Scenario**

Conservation  
Agriculture?

Barrios et al.  
Manuscript in  
preparation

Suitability Level	Rice Farms Area (ha)	Area (%)
Low	131,216	63
Moderate	72,898	35
High	4,166	2


Suitability Level	Rice Farms Area (ha)	Area (%)
Low	120,254	60
Moderate	64,136	32
High	16,034	8



# Where could smallholders adopt water harvesting?

Monserrate, Fredy, et al. "Aumentando la resiliencia climática en el occidente de Honduras: explorando fuentes de agua para pequeños productores rurales." (2016).

Aumentando la Resiliencia Climática en el Occidente de Honduras: Explorando Fuentes de Agua para Pequeños Productores Rurales



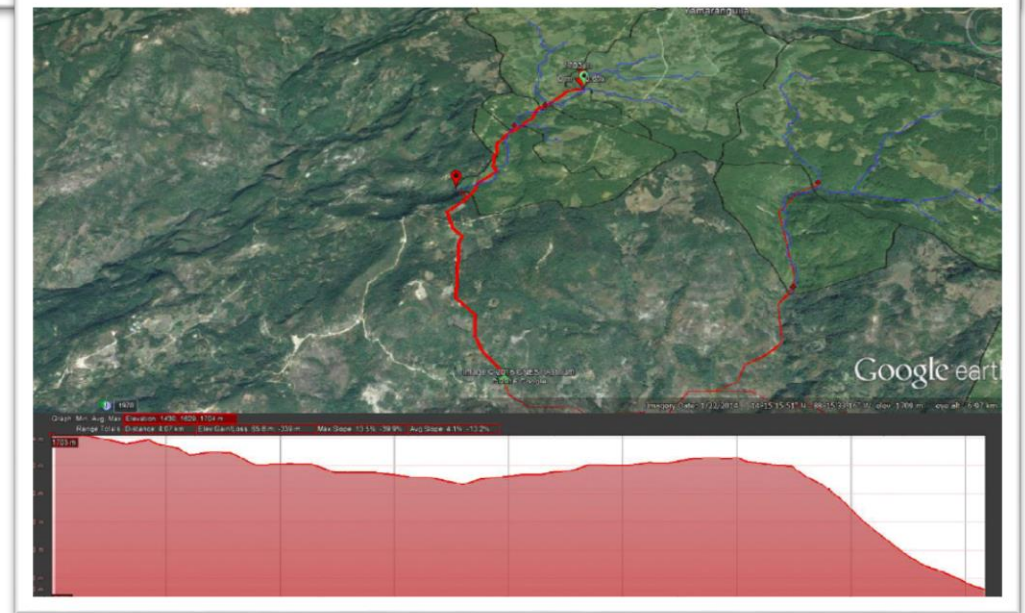
USAID DEL PUEBLO DE LOS ESTADOS UNIDOS DE AMÉRICA

CIAT Centro Internacional de Agricultura Tropical

ZAMORANO



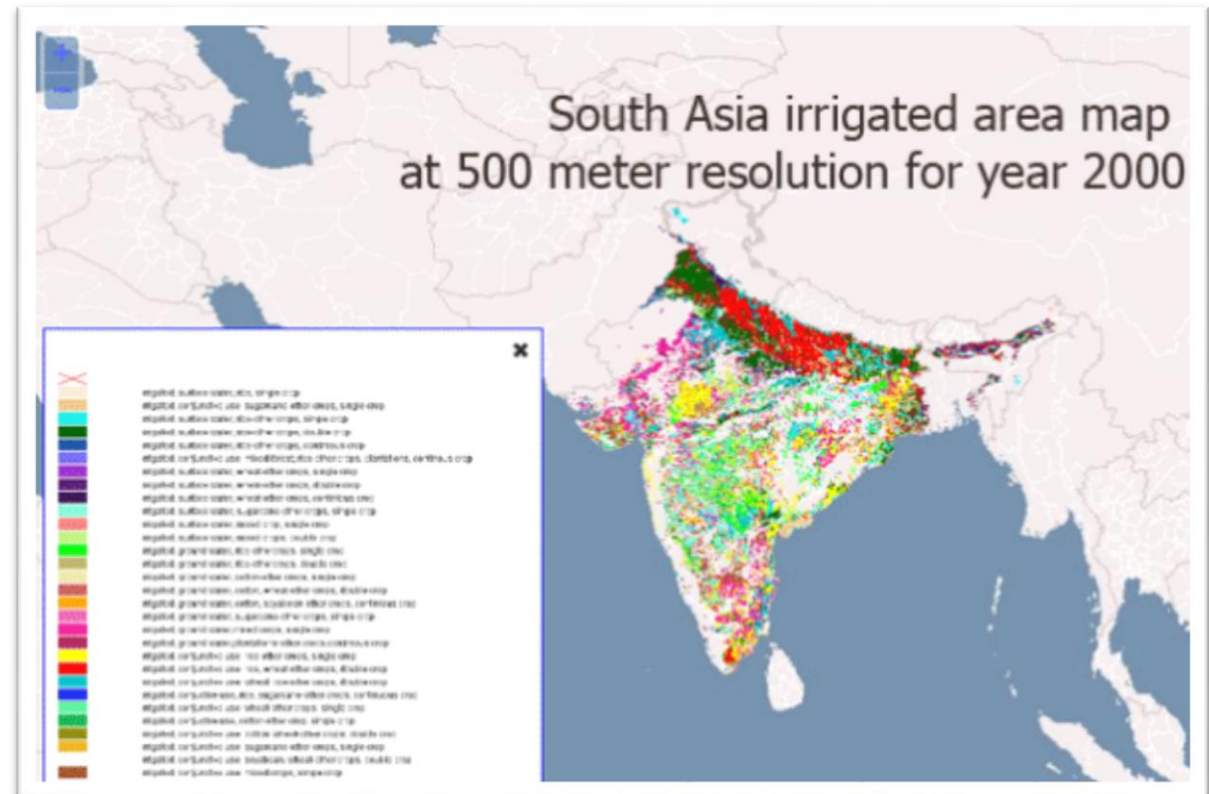
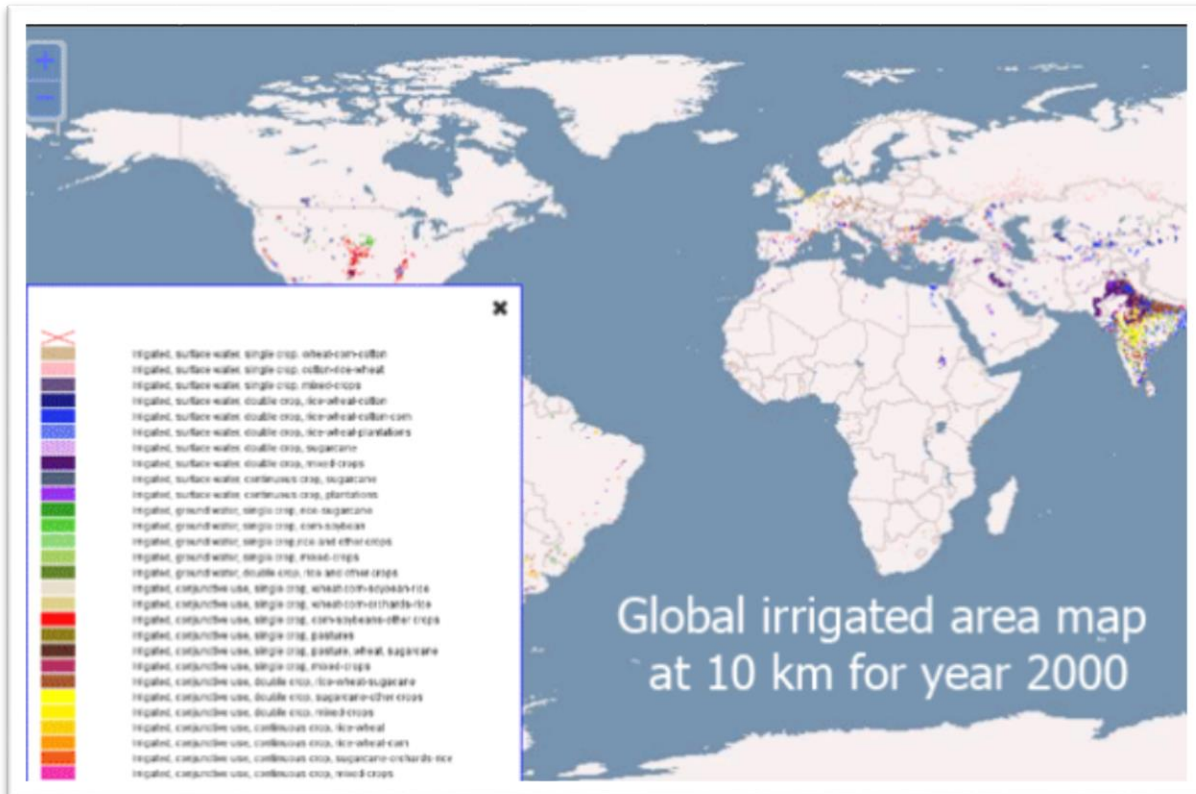
Reservorio de cosecha de agua lluvia para uso agrícola, Lempira, Honduras.



Ex-post remote sensing and GIS tools and methods for evaluating adoption and impact



# Irrigation



Thenkabail, Prasad S., et al. "Global irrigated area map (GIAM), derived from remote sensing, for the end of the last millennium." *International Journal of Remote Sensing* 30.14 (2009): 3679-3733.

# Kayawa, Nigeria

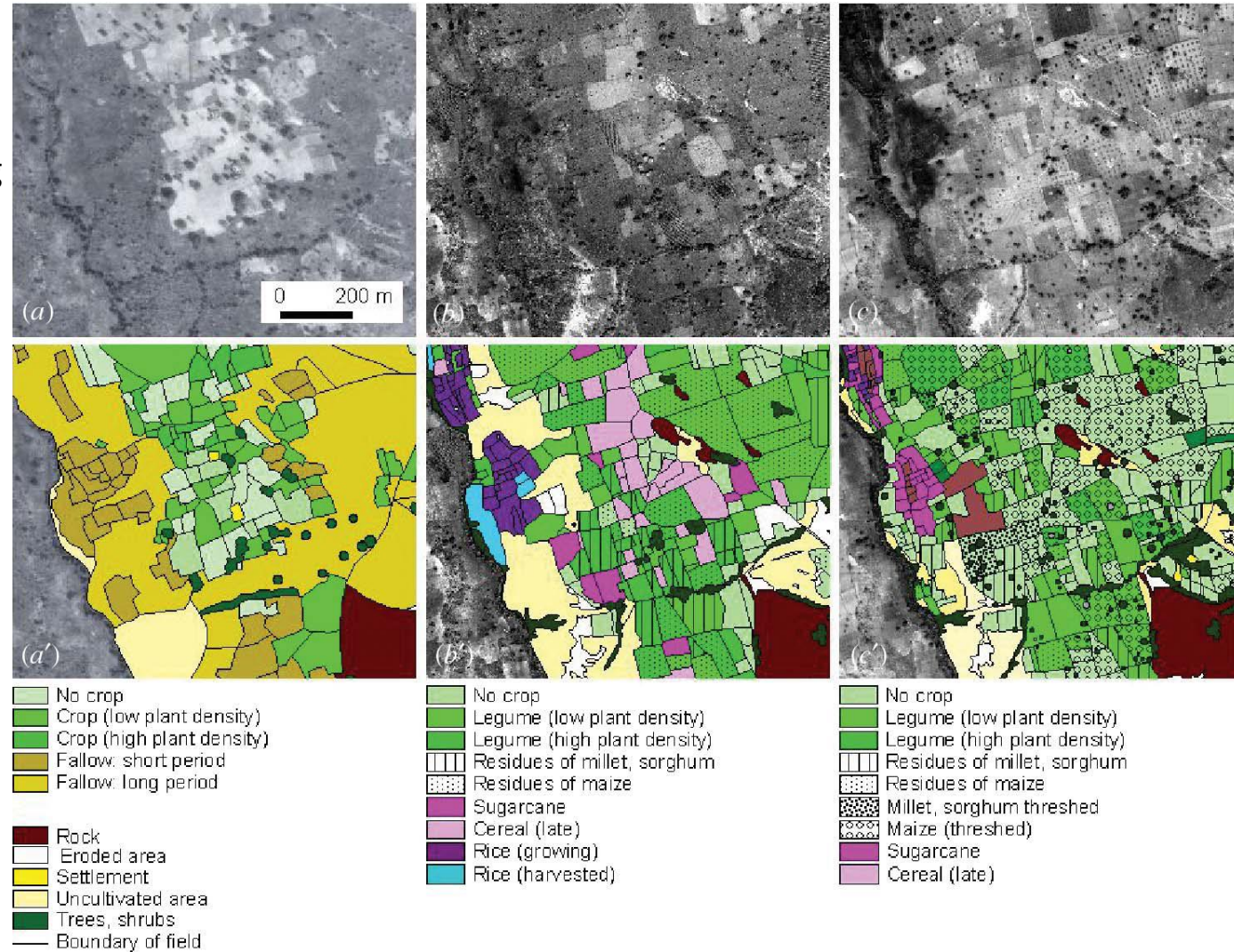
## Natural resource monitoring-soil erosion

LULC using remote sensing data  
)

a) Aerial photograph  
(3 December 1962)

b) IKONOS  
(2 September 2000)

c) QuickBird  
(29 December 2006)



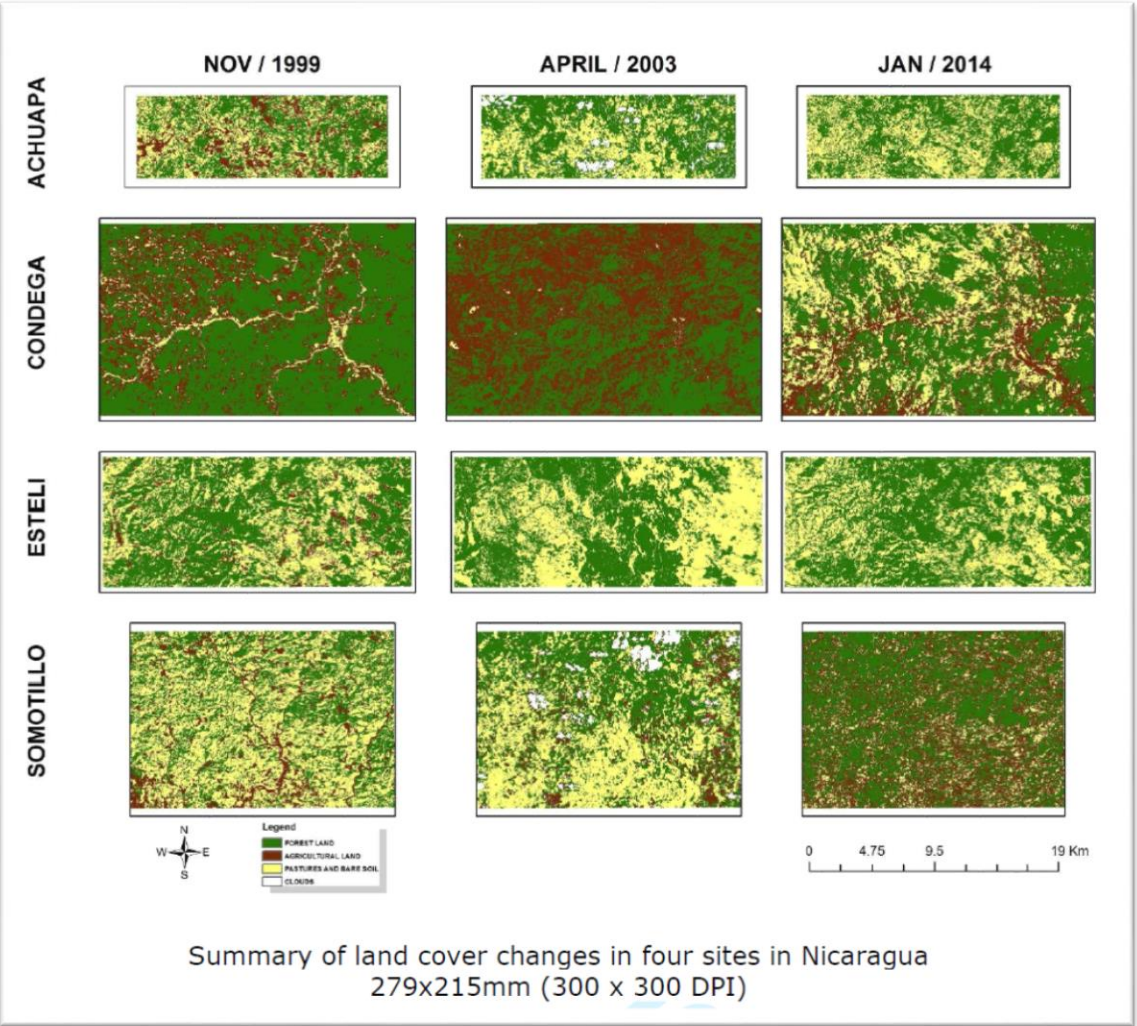
Junge, B., et al. 2011. Use of remote sensing and GIS for improved natural resources management: case study from different agroecological zones of West Africa. *International Journal of Remote Sensing*. 31:23,6115-6141.



# Slash and mulch agroforestry systems (Quesungual) in Central America



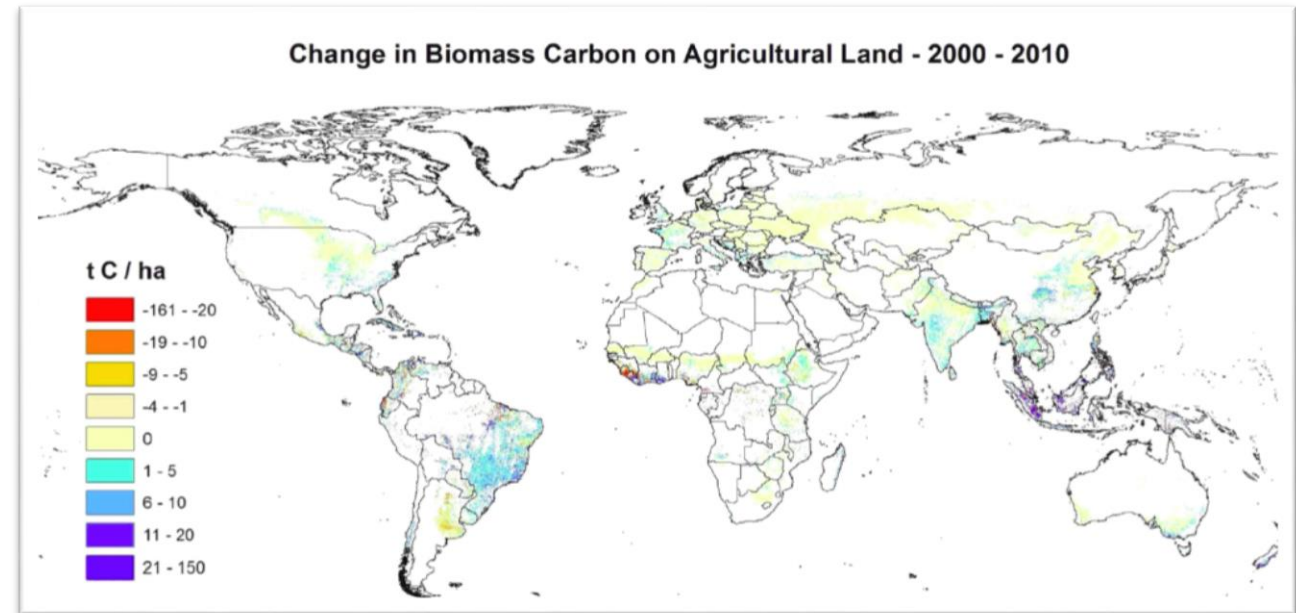
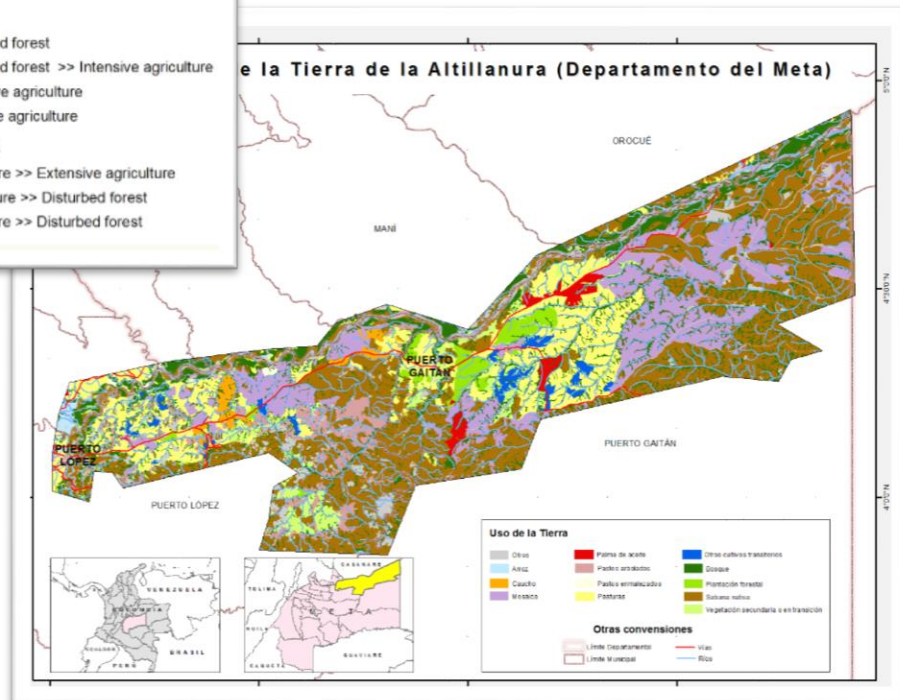
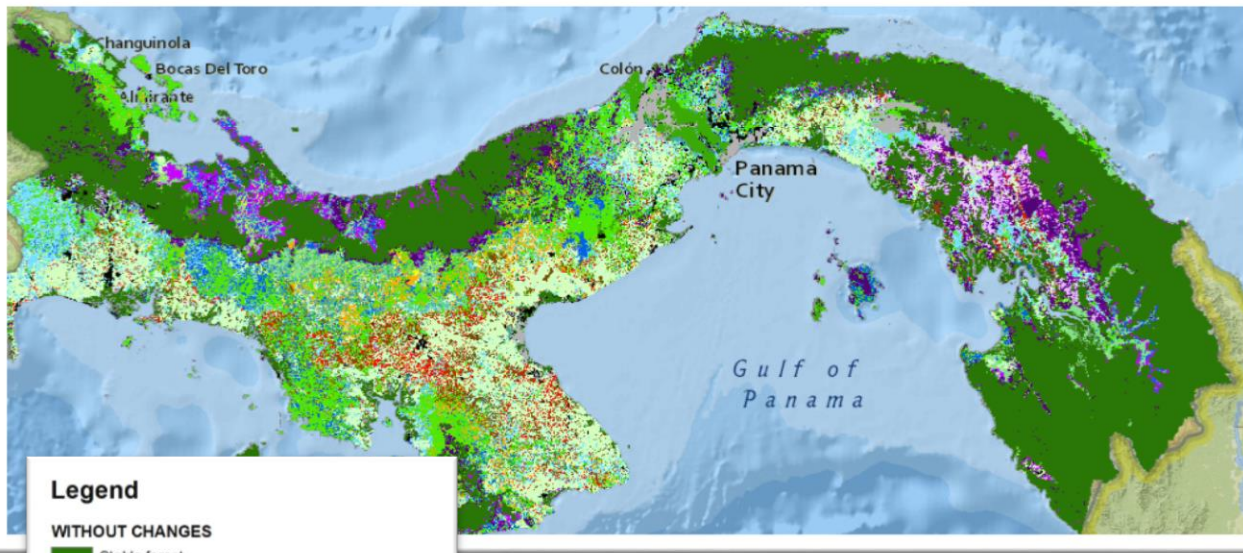
Example of the Quesungual slash and mulch agroforestry system  
162x122mm (220 x 220 DPI)



Summary of land cover changes in four sites in Nicaragua  
279x215mm (300 x 300 DPI)



Remote sensing can identify agroforestry, but adoption is difficult to determine



ZOMER, Robert J., et al. Global Tree Cover and Biomass Carbon on Agricultural Land: The contribution of agroforestry to global and national carbon budgets. *Scientific Reports*, 2016, vol. 6.







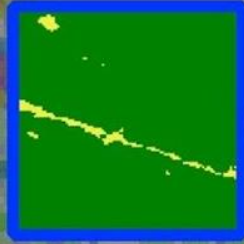
# Patterns derived from remote sensing in the Amazon

%Pattern participation by ADM level 1  
Western Amazon

1:637,000



Diffuse



Linear



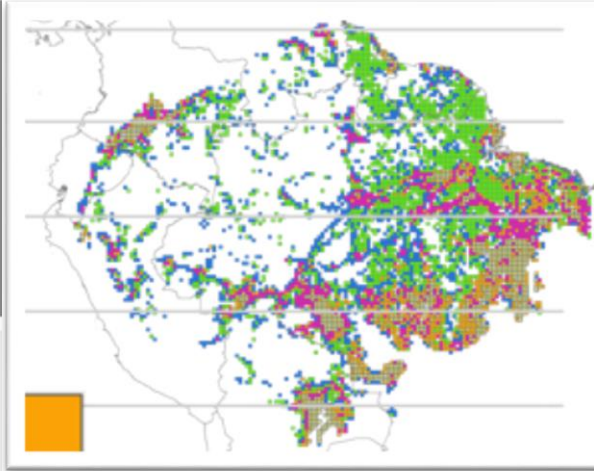
Geometric



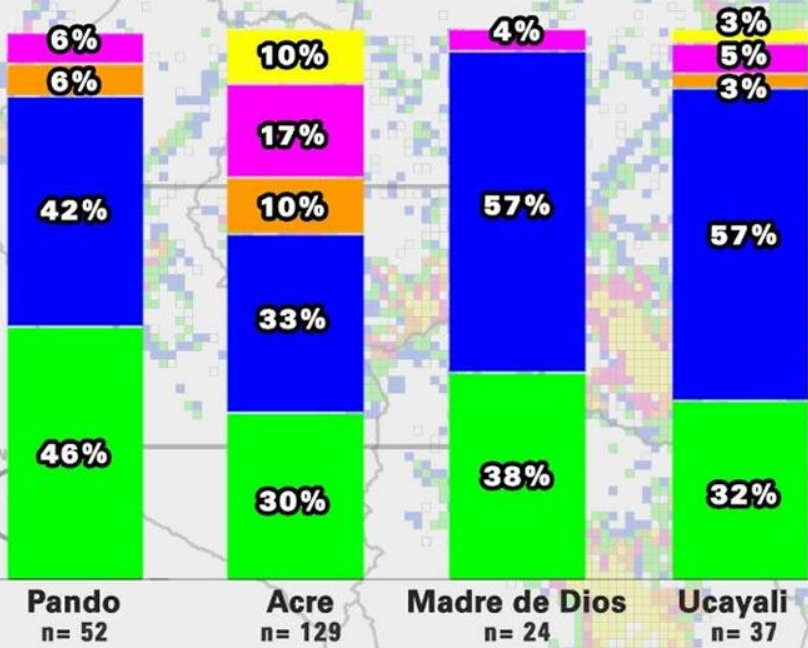
Fishbone



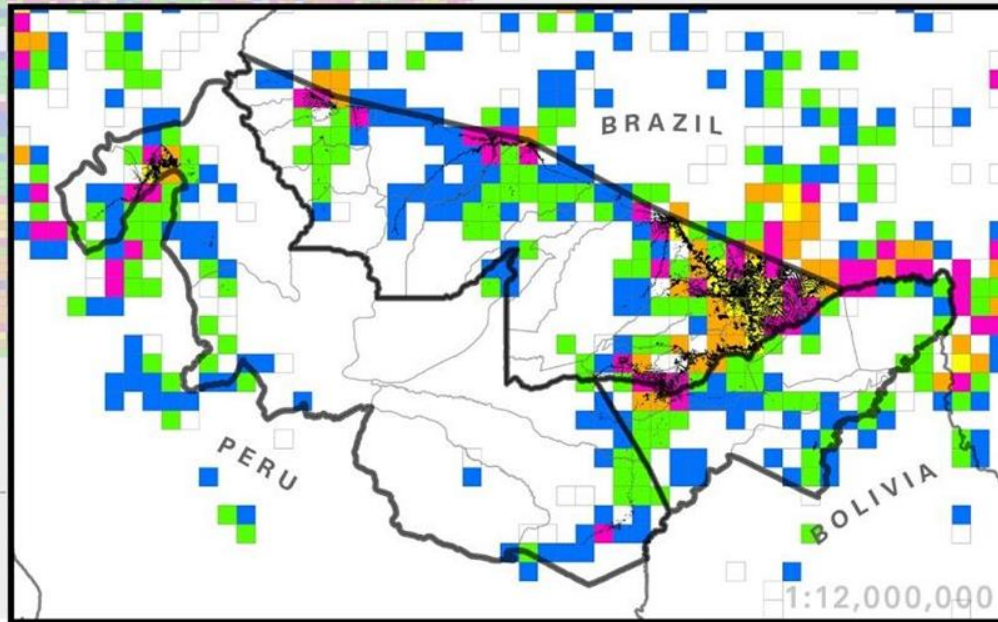
Consolidated



Landscape metrics aggregated by 25km<sup>2</sup> cells



1:28,000,000

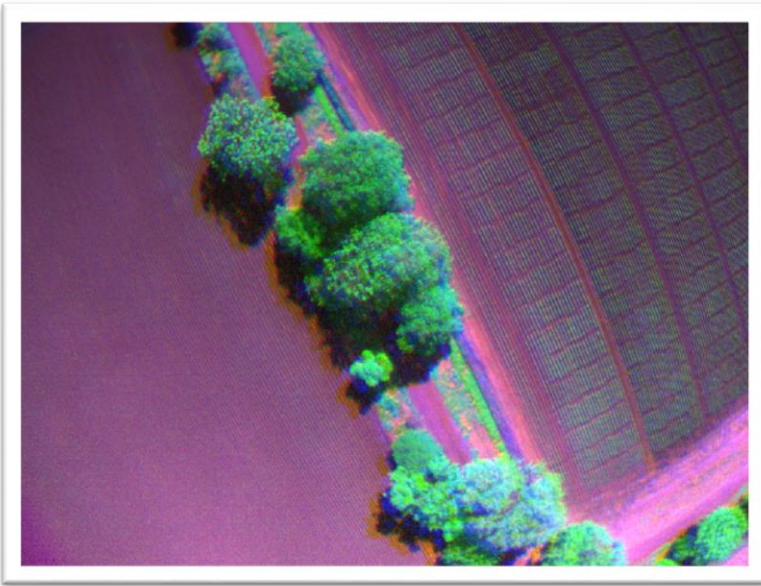


- Finding: Consolidated pattern in Acre (BR) may indicate forest loss due to commercial agriculture -





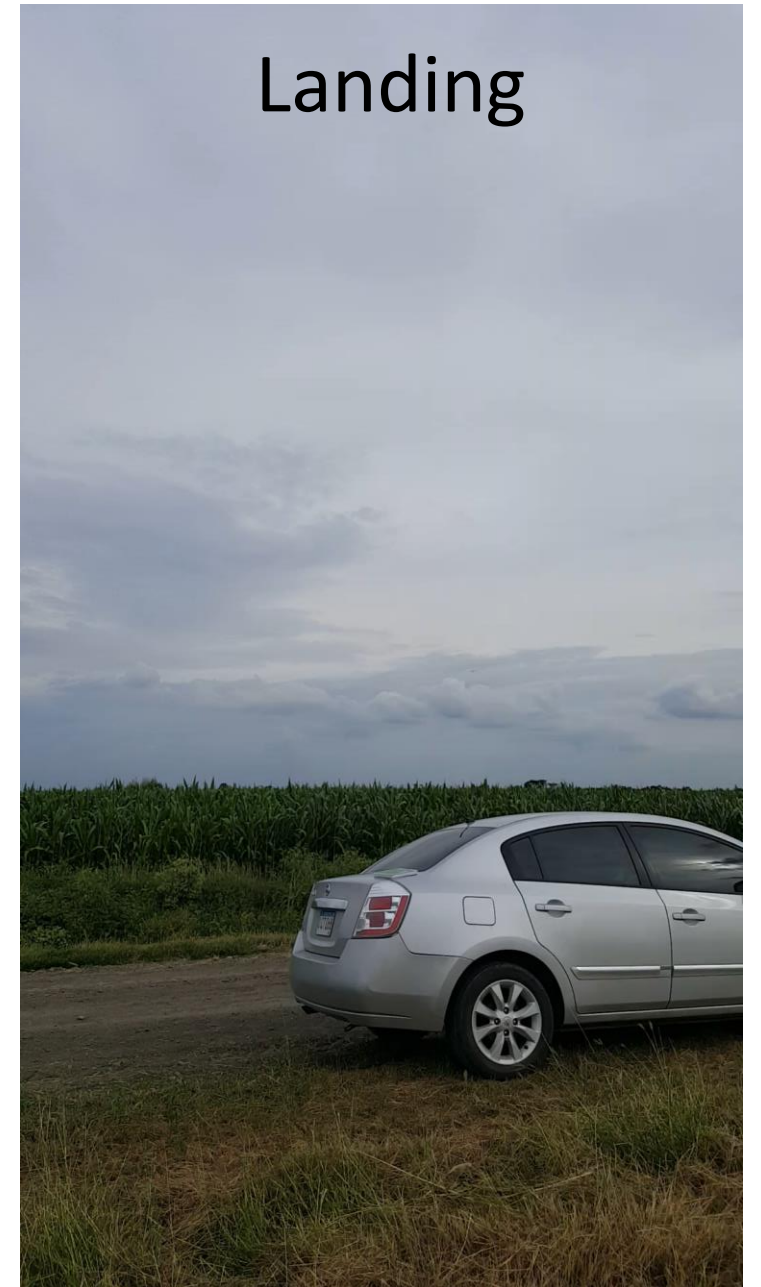
# Drones



## Takeoff



## Landing



# Other efforts and applications of RS for analysis of adoption

- No-till agriculture
- Residue and cover crop analysis
- Crowdsourcing (e.g. Geo-wiki)

# Summary

- Irrigation, conservation agriculture, no-till agriculture, crop rotations, AWD are key applications
- Drones
- Very high resolution imagery
- Image analysis cannot capture the human intention part of the patterns that we see on the ground (e.g. Agroforestry)
- Crowdsourcing
- Combining image analysis with field survey



Thank you....