Sub-Global Assessment Network

Landscape diversity and ecosystem services in agricultural ecosystems: implications for farmer's income

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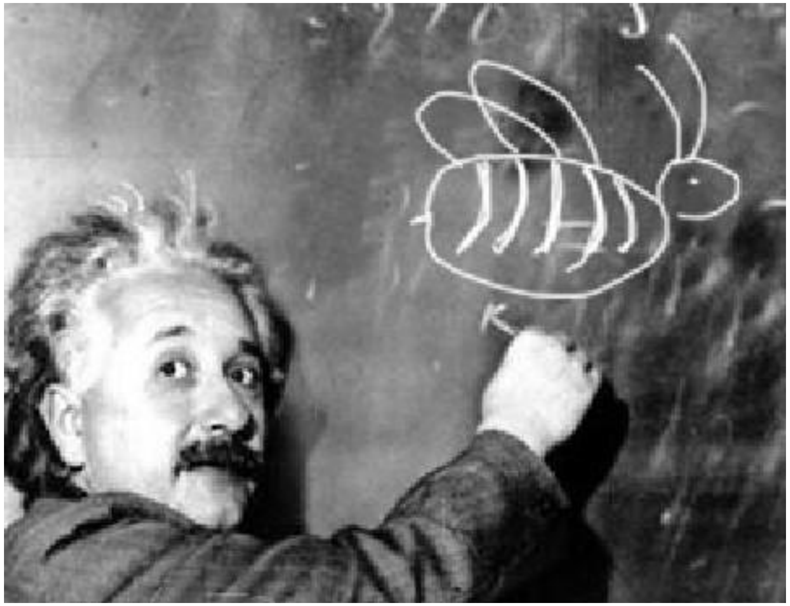
Sub-global Assessment Network Annual Meeting

26th-29th November 2012, Stellenbosch, South Africa

Something delivered by Albert Einstein



"If the bee disappears from the surface of the earth, man will have no more than four years to live"

- 80% of the flowerer need pollination by insects, among these, 85% are maintained by bee;
- If there are no bee, 40,000 kinds of plants will disappear from the Earth

Use of insecticides may do harm to the ecosystem service of pollination…

- Land use diversity can support ecosystem services of biological pest control and reduce the need for insecticides
- Empirical evidences have been collected in developed nations, but very limited information is available from developing countries



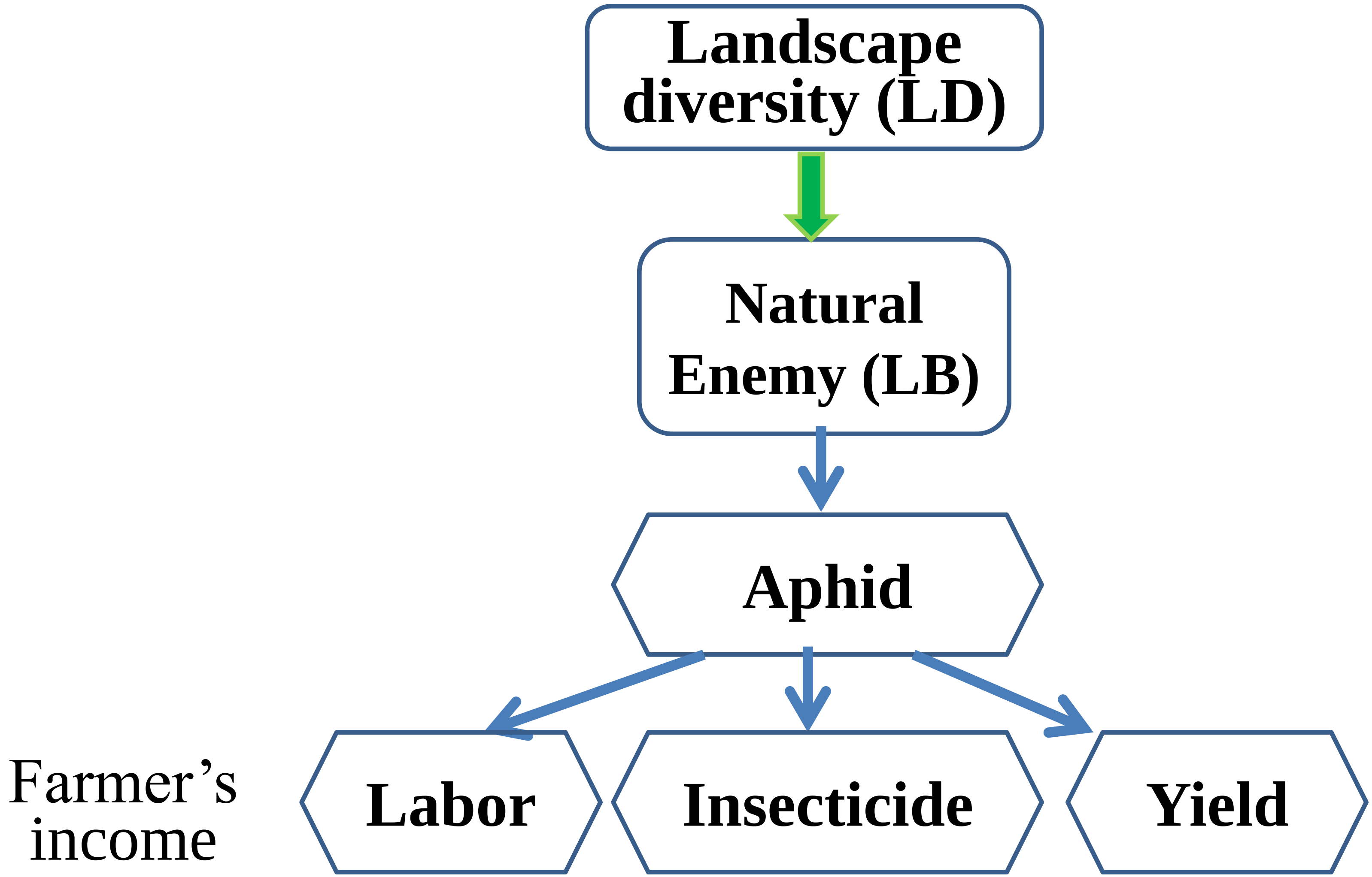
In addition,

- the existing literature on landscape diversity on biological control has exclusively focused on the regional extent, no any study is based on farm level;
- similarly, nearly all existing studies on the dynamics of natural enemy and pest has been examined in lab or controlled fields, no single study is conducted at actual farms…

Research objectives

- To understand the role of landscape diversity in biological control services through field experiments in cotton farm
- To explore the correlation between landscape diversity, pest control services, insecticide use, crop yield and income through an empirical study

Technical flow chat for the entire study



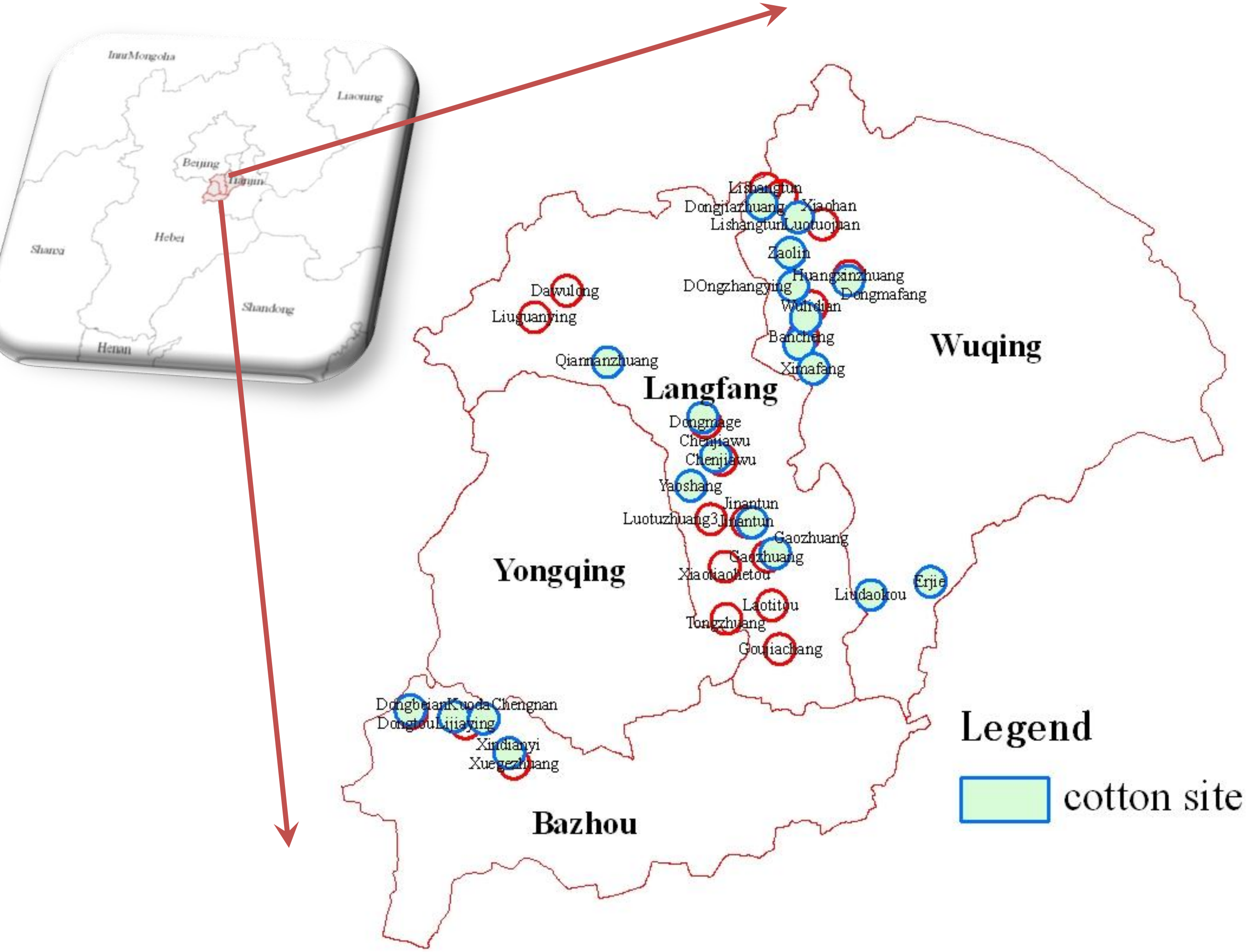
Study area and samplings

- 2 prefectures: Langfang and Wuqing

- 20 villages from 10 townships:
  - Ecological diversification
  - 2 villages from 1 township

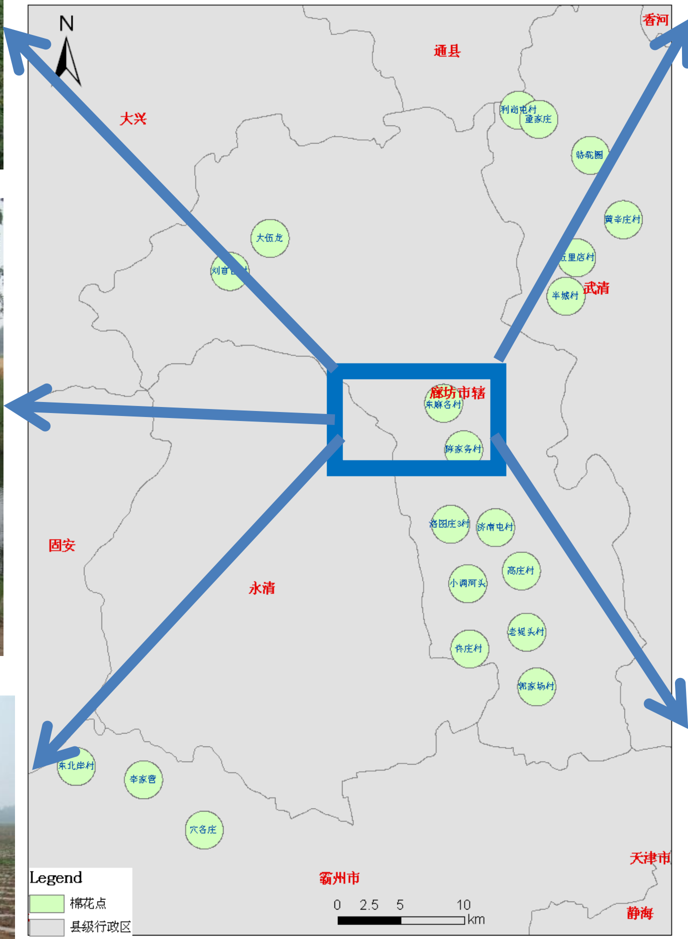
- 312 households:
  - Interview 15-25 households each villages
  - Divide then into 4 groups based on number of pesticide application in previous years

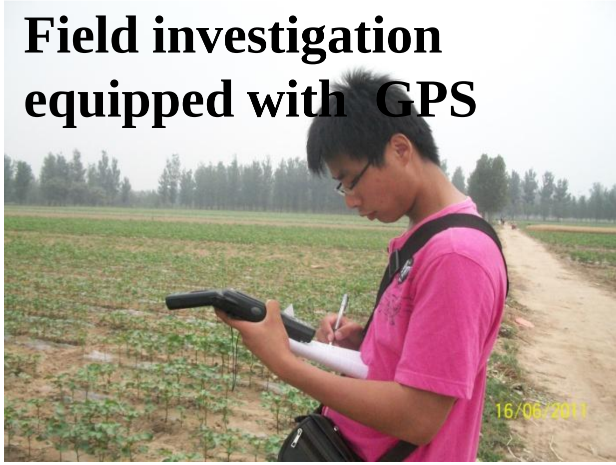
Household surveys



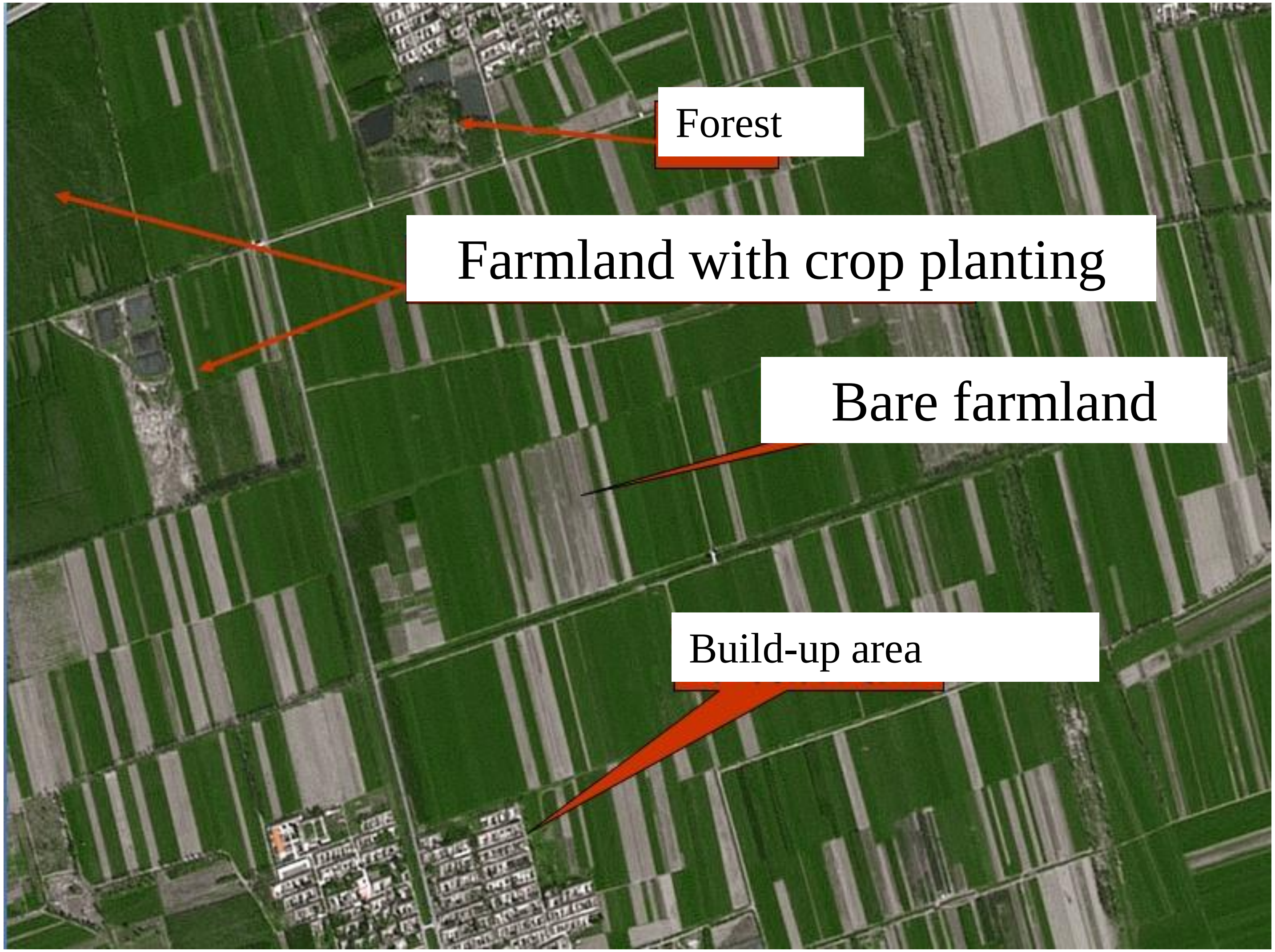
- **Langfang**
  - **Anci**
  - **Guangyang**
  - **Bazhou**
- **Tianjin**
  - **Wuqing**

Field survey





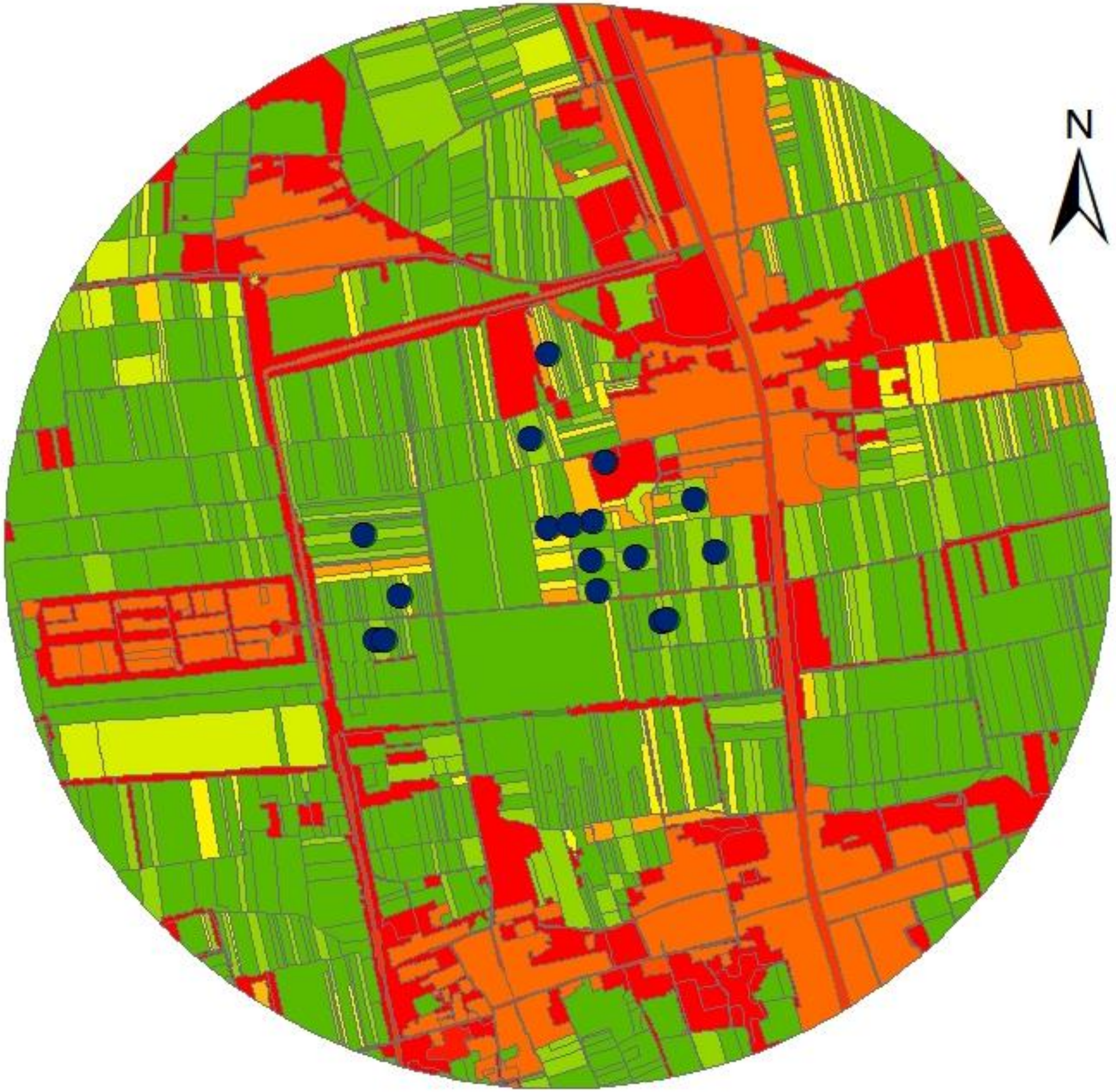
Identification of crop patterns



Crop-specific land use classification system(three levels, 34 kinds)

Farmland 10		**Forest 20**	**Grassland 30**	**Water area 40**	**Build-up area 50**	**Unused land 60**
Cereals11	wheat 111	poplar 21	weed 31	River 41		
	millet 112	apple 22	clover 32	*lake 42	building52	
maize12		peach 23	other 39	pond 43	roads53	
cotton13		pear tree 24		canal 44	other59	
Beans14	soybean/ Black beans 141	vines 25		other 49		
	Vigna radiata 142	pomegranate 26				
		other29				
Vegetables15	peas \ lentil 151					
	tomato152					
	eggplant 153					
	potato154					
	Cruciferae (Chinese radish/ cilantro/ cabbage/Chinese cabbages/broccoli)155					
	*colza 156					
	*chrysanthemum coronarium 157					
	other159					
greenhouse16						
Sweet potato17						
Peanut18						
other19						

Field experiments within village: with a radius of 1500 m



Calculation of Shanon diversity index

- Shannon-Weaver diversity index

$$H = -\sum_{k=1}^{n} P_k \ln(P_k)$$

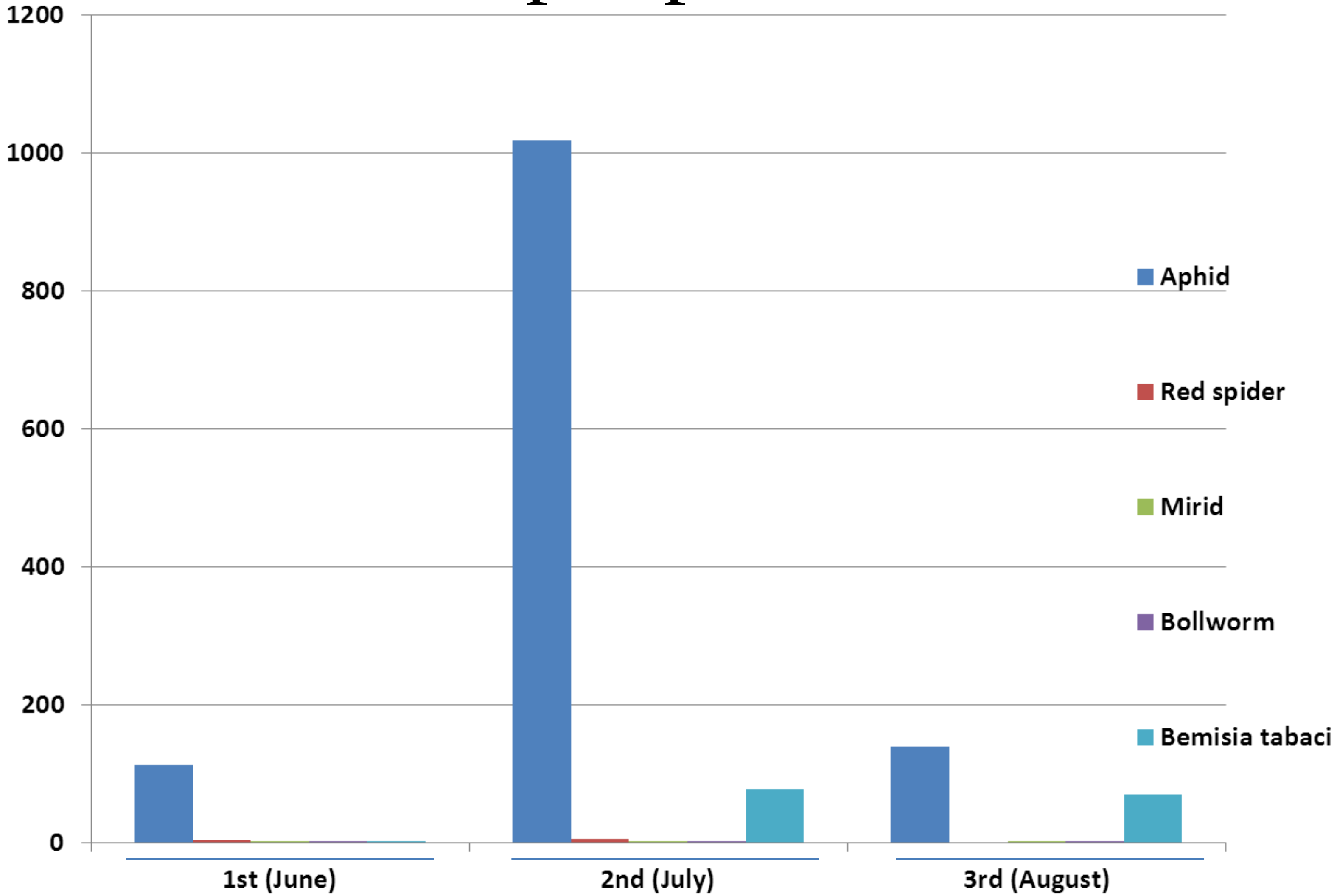
where P_k is the proportion of the landscape occupied by land use class k and n is the number of land use classes.

- True diversity index

$$H' = \exp(H)$$

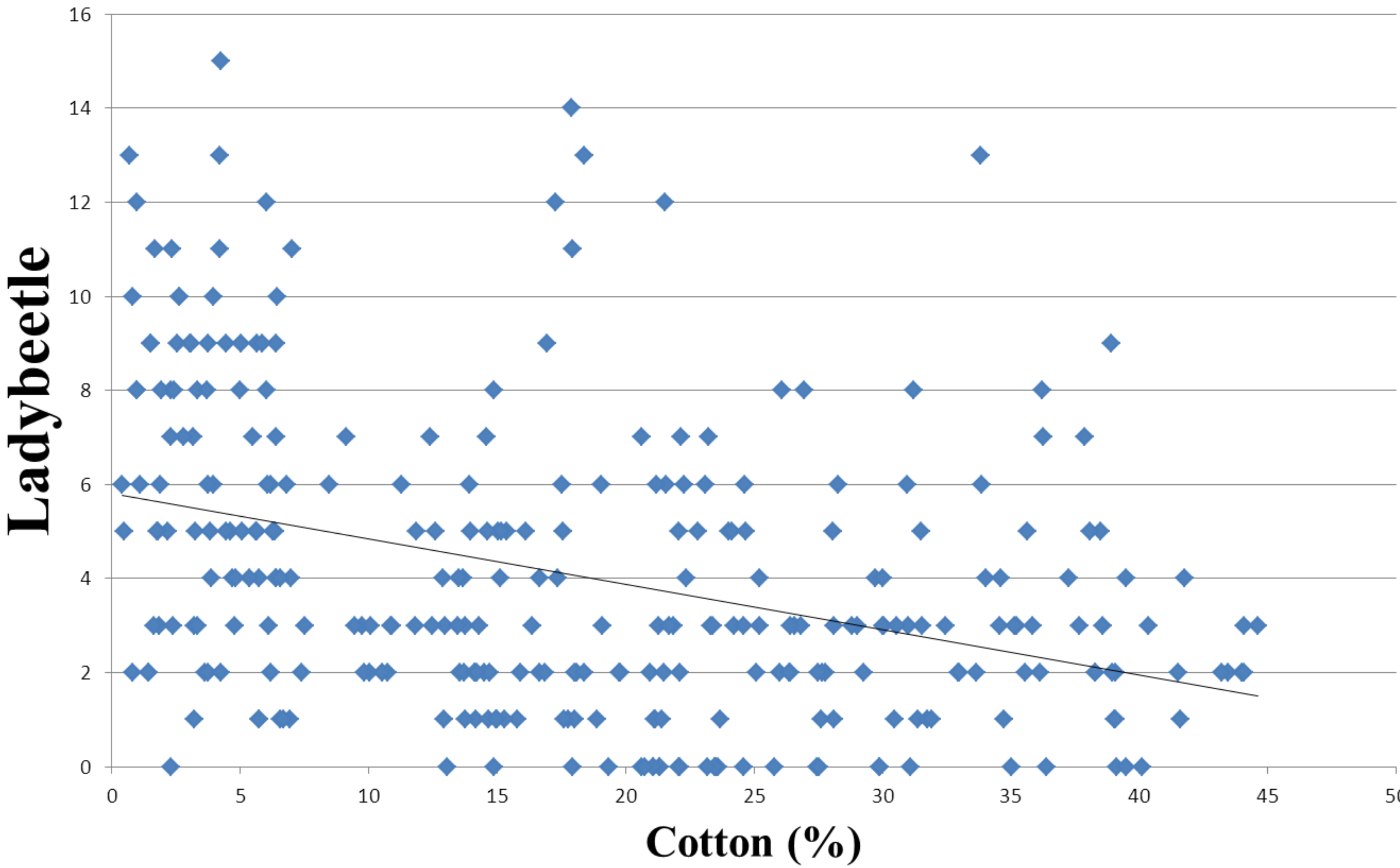
where H is Shannon-weaver diversity index

Average number of pest per 25 plants per plot



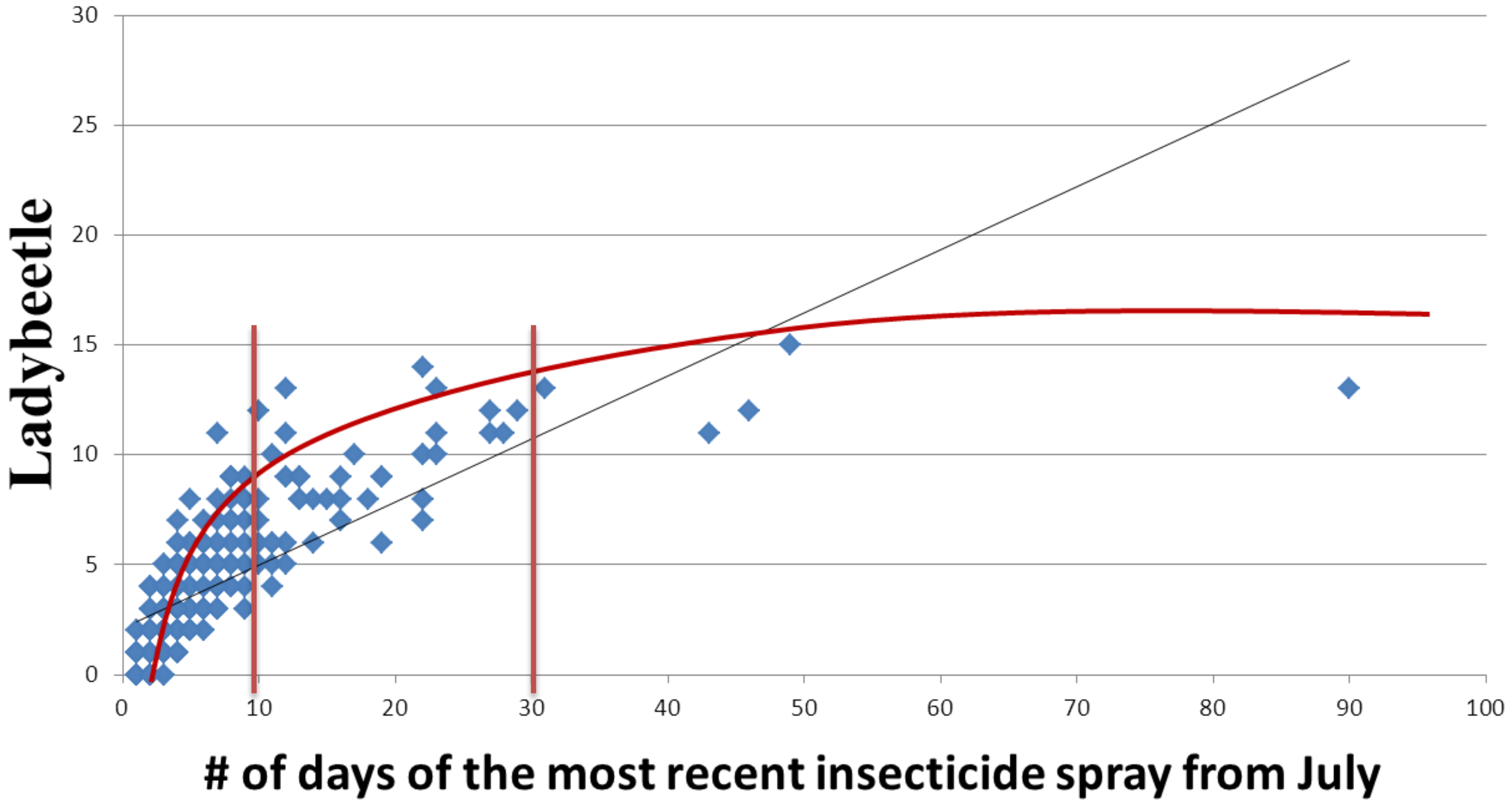
Rural survey by CCAP, 2011

Relationship between LD and Ladybeetle (LB) based on hh/plot data in July



Rural survey by CCAP, 2011

Relationships between ladybeetle and others in July



Rural survey by CCAP, 2011

Specifications of Models

$$\mathbf{LB_{it} = f(LD_{it}, D_{id}, Z_{i(j<t)})}$$

LD_{it}: Landscape diversity of hh *i* (or plot *i*) with R radius

D_{id}: Days from the most recent insecticide spray for household *i*

$Z_{i(j<t)}$: Insecticide use before time j (j<t), kg/ha or times of spray

$$\mathbf{AD_{it} = f(\ LB_{it}, D_{id}, Z_{i(j<t)})}$$

AD_{it}: # of aphid at time *t* ; LB is predicted value from (1)

$LB_{it} = f(LD_{it}, D_{id}, Z_{i(j<t)})$

	Ladybeetle	Ladybeetle
Maze (%)	0.065^{***}	0.068^{***}
Cotton (%)	-0.016^{**}	-0.011
Tree (%)	0.005	0.011
Other crops (%)	-0.048^{***}	-0.044^{***}
Grassland (%)	0.103^{*}	0.088^{*}
Water (%)	0.035	0.060^{*}
$\mathrm{Ln}(D_{id})$	3.012^{***}	2.827^{***}
$Z_{i(j<1)}$ in kg/ha	-0.005	
$Z_{i(1<j<2)}$ in kg/ha	-0.026^{***}	
$Z_{i(j<1)}$ in times		-0.054
$Z_{i(1<j<2)}$ in times		-0.306^{***}
N	302	302

Rural survey by CCAP, 2011

Specifications of Model

$\mathbf{Y_i = f(X_i, H_i)*G(Z_i; LB_i)}$, *i* indexes for plot or hh

Y: yield, kg/ha

X: a vector of major input per ha, including

fertilizer (kg/ha), labor (days/ha), other input (yuan/ha)

$G(Z_i)$: damage control function (0, 1)

Z_i : total insecticide use (kg/ha or yuan/ha)

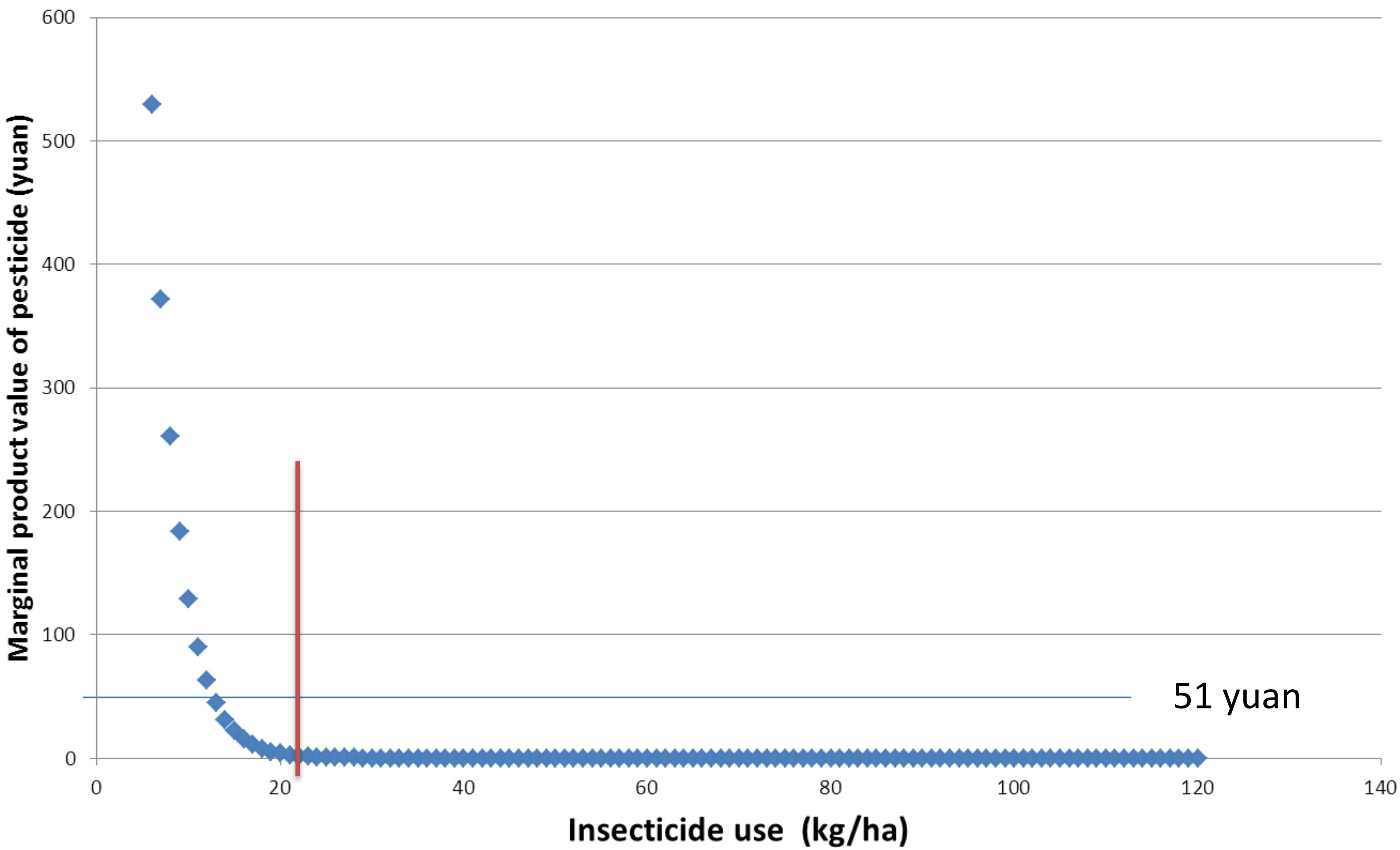
LB_i: average number of ladybeetle in t=1, 2 and 3

Insecticide use, ladybeetle and cotton yield

		Ln Yield (kg/ha)	
	Amount of pesticide use (kg/ha)	Cobb-Douglas function	Damage control function
Perception of Yield loss (%)	-0.931***		
Square of risk aversion	0.011***		
Price of pesticide (yuan/kg)	-0.034*		
Gender	0.898	-0.045	-0.054
Age (year)	-0.044	0.050	0.040
Education (year)	0.144	0.038**	0.032
Distance (m)	0.001	-0.022*	-0.026**
Farm size (ha)	-4.121	0.093***	0.095***
Fertilizer (kg/ha)		0.017	0.014
Labor (Hours/ha)		0.097***	0.093***
Other inputs (yuan/ha)		0.020	0.020
Insecticide use (kg/ha)			0.354***
Ladybeetle number	-0.537**		0.146*

Rural survey by CCAP, 2011

Marginal value of insecticide use



Average use of insecticide: 23 kg/ha

Concluding remarks

- Our empirical study indicates biological control is significant (statistically) and substantial in crop production
  - Average use of insecticide: 23 kg/ha
  - Insecticides use to lose of the control function: 0.4
  - Ladybeetle numbers to pesticides uses: -0.5
- It measures the connection between land use diversity and pest pressure and insecticide use in China
  - Test the hypothesized relationship in smallholder-based cropping systems with intensive pesticide use.
  - Link the ecological relationship to human welfare

Concluding Remarks

- The impacts of biological control (ladybeetle) on farmers' income are through 3 major channels:
  - Yield; insecticide use; and saving labor input
- Policy implications:
  - Appropriate land use pattern can contribute to ES, farmers' income and poverty reduction
  - Raising NE (e.g., ladybeetle) could be profitable and potential industry to develop if an appropriate NE market could be developed

In some sense,

“Do not ignore the existence of those insects. They looks ugly but they help our us a lot……”

- we need to offer the inhabitance to natural enermies and to diversify our land uses,
- and optimize our land use practices and management

Thanks for your attention!

For more information, please visit:
http://www.ccap.org.cn/espa.html