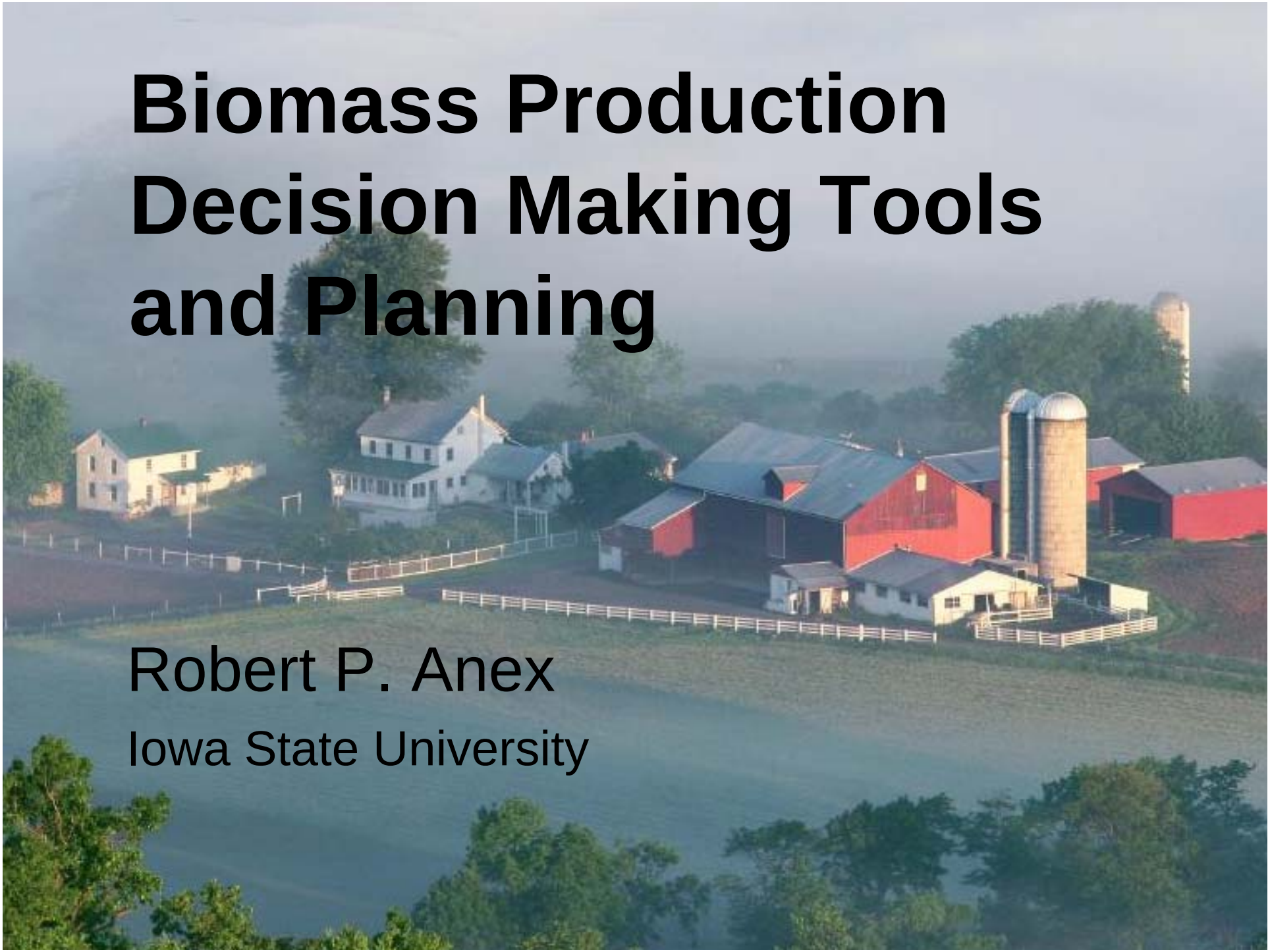


Biomass Production Decision Making Tools and Planning

Robert P. Anex

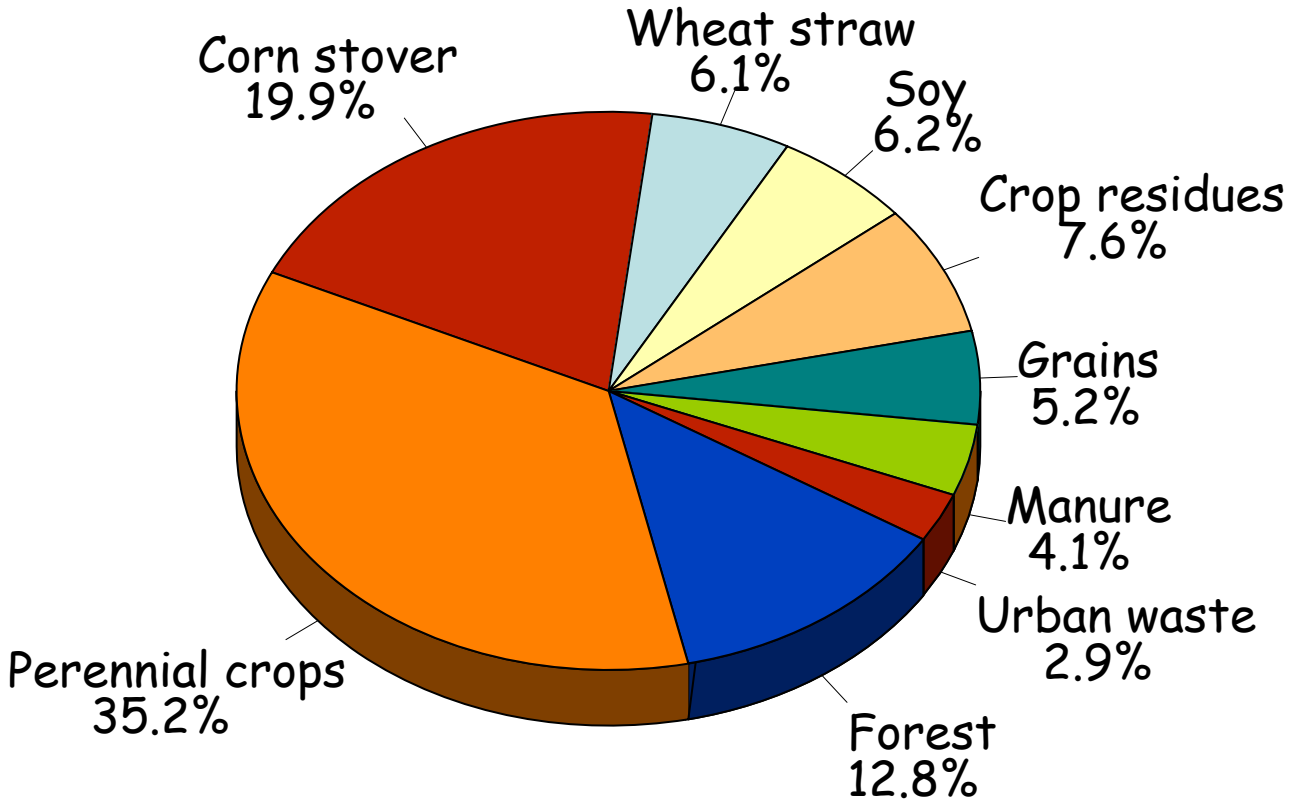
Iowa State University

U.S. Administration Biofuel Goals

- 35 billion gallons by 2017
- 60 billion gallons by 2030

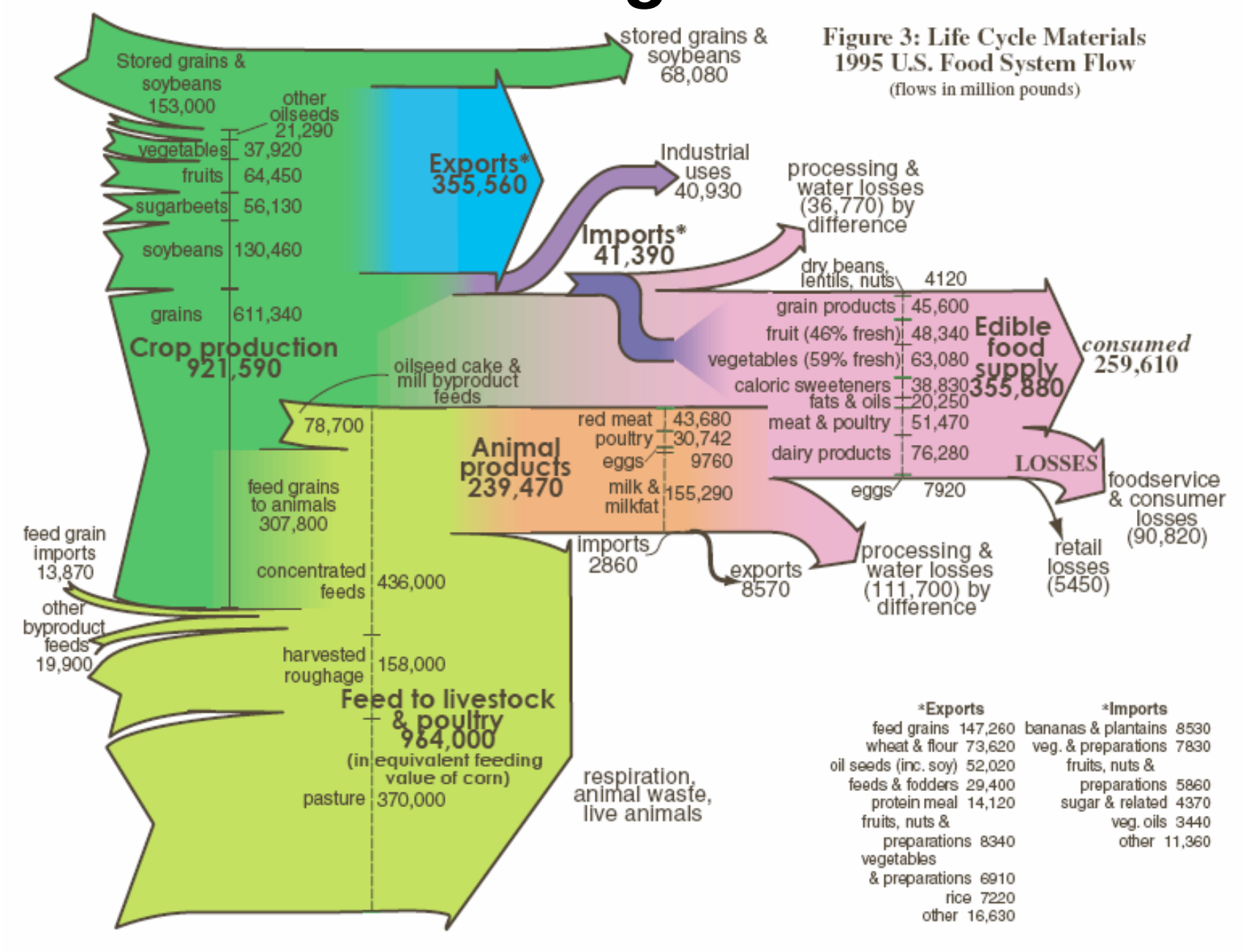
U.S. petroleum imports ≅ 181 billion gallons

US Biomass inventory = 1.3 billion tons



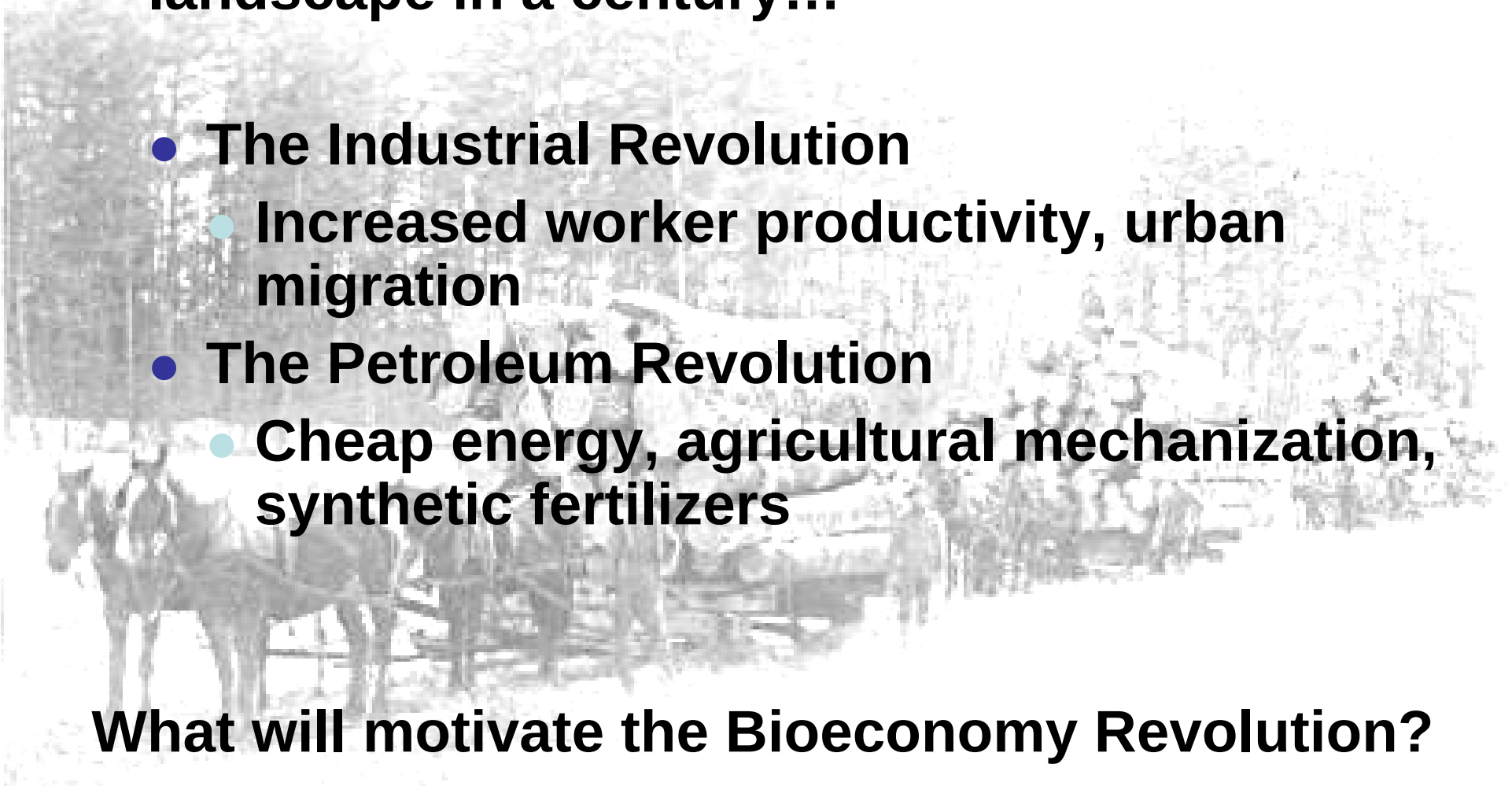
From: Billion Ton Vision, DOE & USDA 2005

What farmers grow now…



1 + Billion tons per year?

The most revolutionary transformation of the landscape in a century…



- **The Industrial Revolution**
  - **Increased worker productivity, urban migration**
- **The Petroleum Revolution**
  - **Cheap energy, agricultural mechanization, synthetic fertilizers**

What will motivate the Bioeconomy Revolution?

Biomass Planning Tools

- Biomass Supply and Logistics
  - Integrated Biomass Supply and Logistics (IBSAL) model.
    - Oak Ridge National Laboratory, S. Sokhansanj

- Life-cycle energy and emissions
  - Biofuel Energy Systems Simulator (BESS)
    - Corn grain-based ethanol systems
    - University of Nebraska, K. Cassman

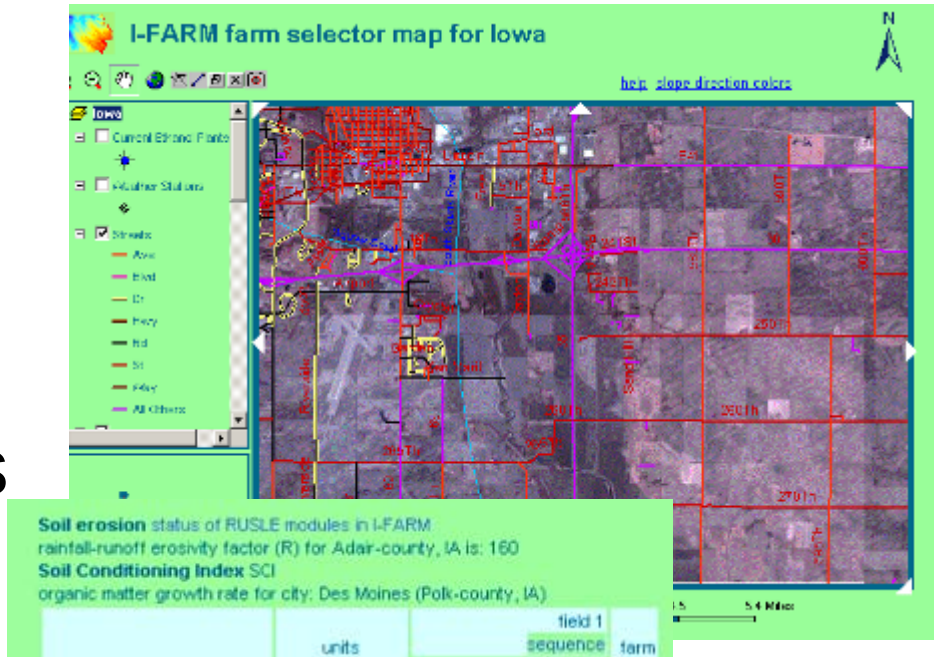
- Farm enterprise modeling
  - I-FARM
    - Iowa State University, Robert Anex
    - Pennsylvania State University, Tom Richard

Farmer decisions depend on…

- Experience – Tradition, training, technical assistance
- Ability – Time, labor, management
- Equipment – Owned, leased, contracted
- Profit – Income, expenses, subsidies
- Risk – weather, markets, insurance
- Environment – Recreation, sustainability, stewardship

The I-FARM decision tool

- Web-based
- GIS interface
- Menu driven
- Database algorithms
- Data transparency
- User adjustable
- Free



Soil erosion status of RUSLE modules in I-FARM
rainfall-runoff erosivity factor (R) for Adair-county, IA is: 160
Soil Conditioning Index SCI
organic matter growth rate for city: Des Moines (Polk-county, IA)

	units	field 1 sequence corn for grain	farm
field area			
soil name			
soil surface texture			
hill slope			
slope length			
tolerable soil loss (T)			
field specific soil loss (A)			
Soil Conditioning Index			

I-FARM - Microsoft Internet Explorer

Farm bottom line ($/year)

	Revenues	Expenses
Crops	374,410	324,588
Hired labor		7,080
Custom farming		9,726
Government payments*	44,795	
Bank loan payments		45,703
	419,205	**387,097**

http://i-farmtools.org

A brief tour…


i-farmtools.org
re-login home
user 1 logout
imperial/US system go
project: Tom
change colors, fonts, etc.
main menu
farm
run
report
save
retrieve
data
internal data
miscellaneous
on-line tutorials
info
tools
examples
FAQ
e-news
who is on-line?
feed back
simple form
evaluation form
I-FARM
integrated crop and livestock production
and biomass planning tool
Welcome Tom! You may start I-FARM now.
1. Review user settings
2 Click farm in main menu to enter your input or retrieve to load a
3. Remember to LOGOUT when you are done!

On-line tutorials

I-FARM tutorial and exercises

user 1: Tom

- Exercise 1. Whole farm simulation. Takes approx. 50-60 minutes; start.....
- Exercise 2. Integrated GIS-tool to identify farm fields and their properties. Takes approx. 30-40 minutes; start.....
- Exercise 3. Conventional and experimental corn stover harvest simulation. Takes approx. 50-60 minutes ; 'Under revision'

Analyze report pages and answer questions:

Go to report page '**crops**'.

1. How much corn stover (tons/year) is available for export/sales?
2. How much wheat straw (tons/year) is available for export/sales?
3. How much swithgrass (tons/year) is available for export/sales?

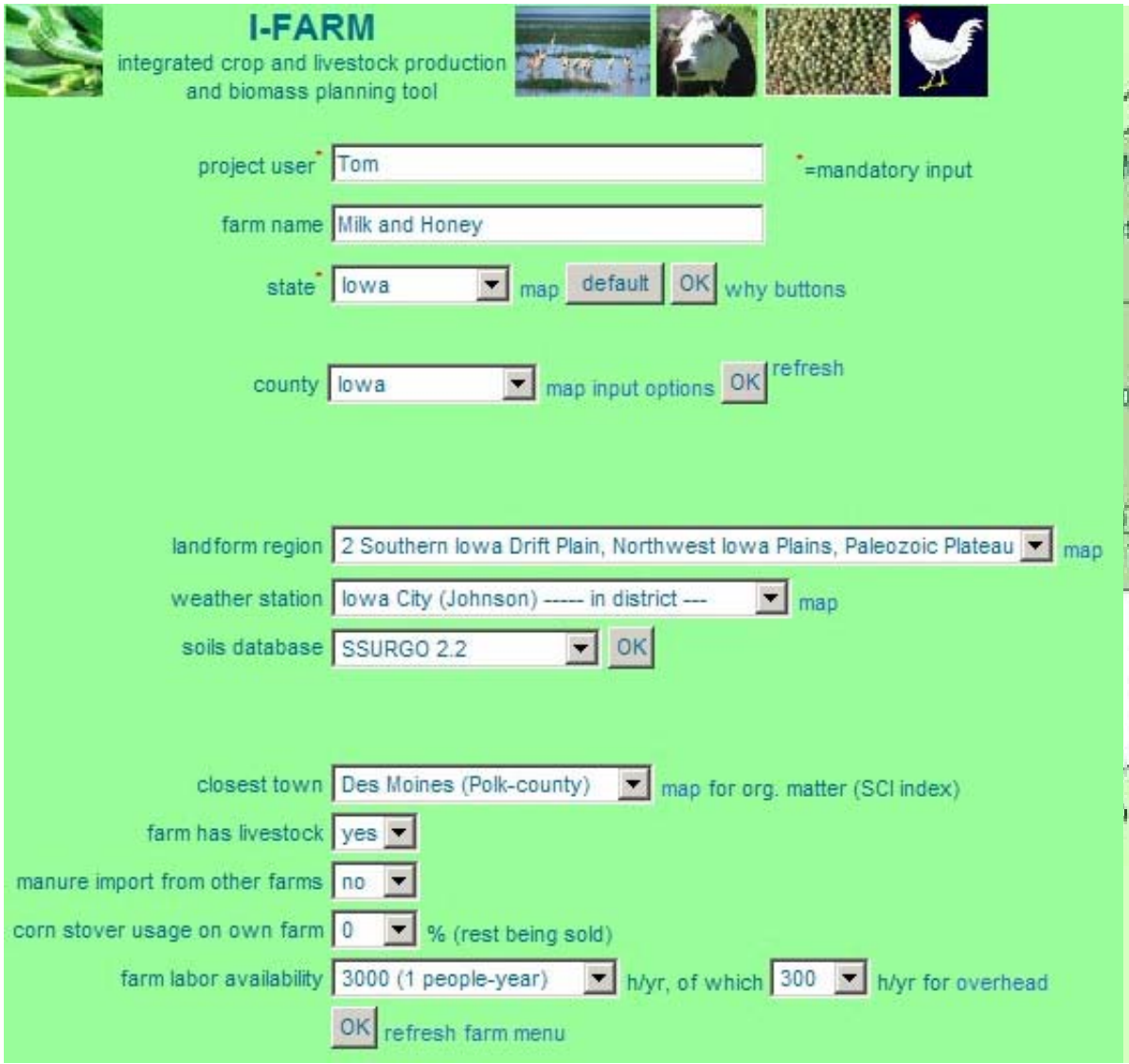
Go to report page '**fertilizers & manure**'.

4. How many pounds of nitrogen are applied per year on this farm in the form of chemical fertilizer?
5. How many pounds of nitrogen are applied per year on this farm in the form of swine manure?

Go to report page '**nutrients and aerial emission**', and display the nutrient balance for field 1, where corn stover is harvested. Notice that we tried to balance for N, P, and K. Use the calculator from Start/Programs/Accessories

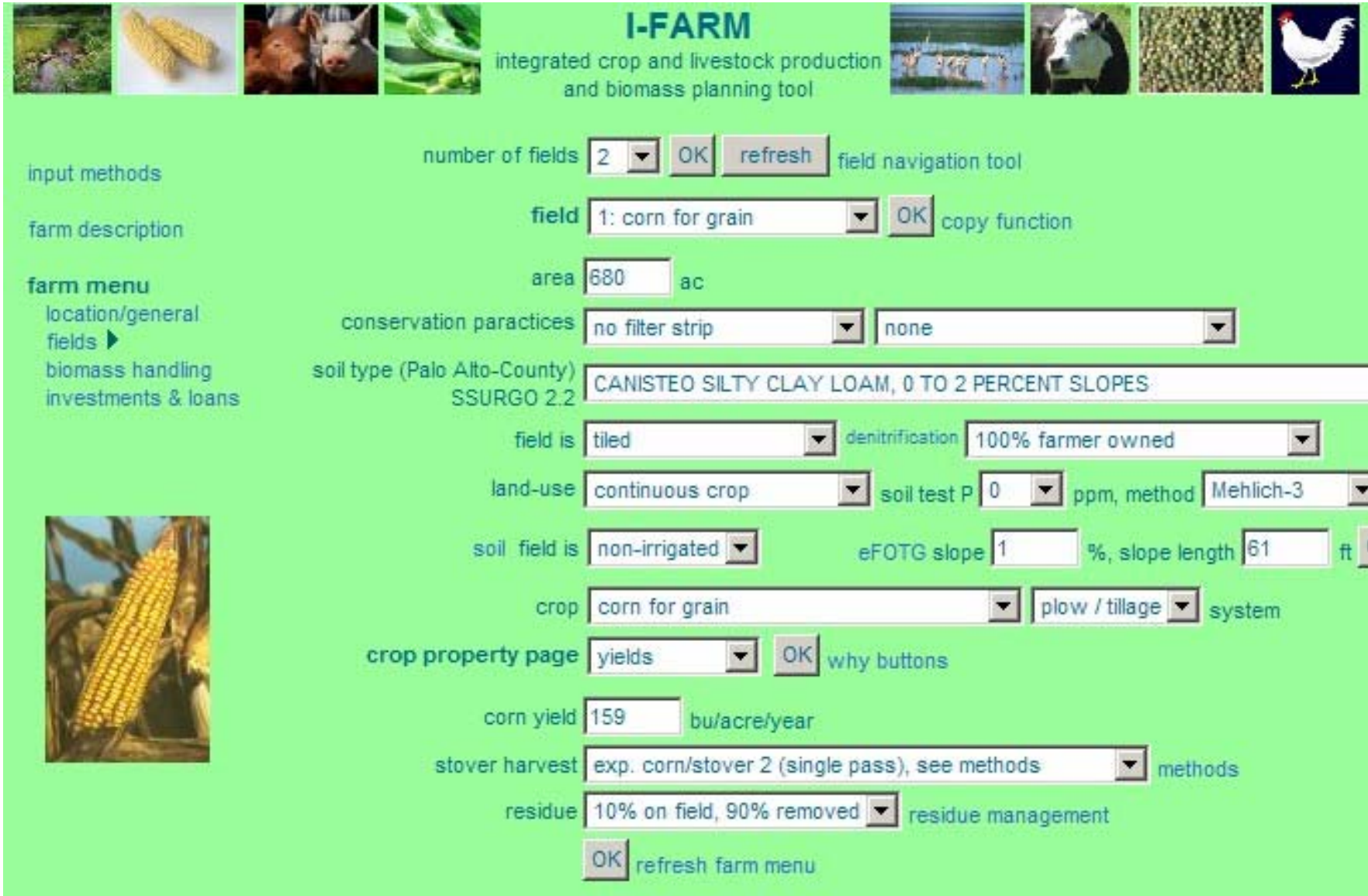
6. What is the annual export of N from field 1 (lbs/yr)?
7. What is the residue removal fraction (N_residue devided by N_total) of the total N exported from field 1?
8. What is the ammonia emission fraction (sum of two N_NH3's devided by N-total) of the total N exported from field 1?

Input farm site and characteristics



GIS Interface

Crop management and yield



Databases and references

data in I-FARM
crops
- yields, 2002 Census
- yields, residues
- nutrients in 3 harvested crops
- nitrogen fixation legumes

reference - Windows Internet Explorer

http://www.i-farmtools.org/i-farm/reference.asp?id=19

Shinners, K.V., B.N. Binversie, and P. Savoie, 2003. Harvest and storage of wet and dry corn stover as a biomass feedstock, Paper Number 036088. American Society of Agricultural Engineers. Annual International Meeting, Las Vegas, 23 pp, download .

close window

Done | Internet | 100%

storage method	storage time (months)	dry matter loss (%)
outdoors, unprotected on ground	12	25

- atmospheric N-deposition
- generated weather data
- precipitation
- rainstorm intensity

miscellaneous
- topographic factors (erosion)
- ethanol plants

Whole farm production

I-FARM simulation report yearly balance go

crops, forages, and bioethanol go

for farm show

grains, forages, silage, stover, straw								
	unit	produced	removed	consumed	used	loss	import	export
corn (grain)	bu	108,120						108,120 to bio-refinery*
corn stover (dm)	Ton	3,027	2,725			255		2,470

*Bioethanol production as a result of this farm		
Expected bioethanol from the **dry-grind grain to bioethanol plant** (at a conversion rate of 2.8 gallons of bioethanol per bu of corn grain)	302,736	gal/year

Crop revenue

Economic analysis ($/year)

price list and references for crops, livestock, and manure; custom rates

crop revenues	method
corn	324,360
corn stover	123,503

* fuel, repairs, utilities, veterinary, hired machinery, marketing, breeding fees, accounting, bedding

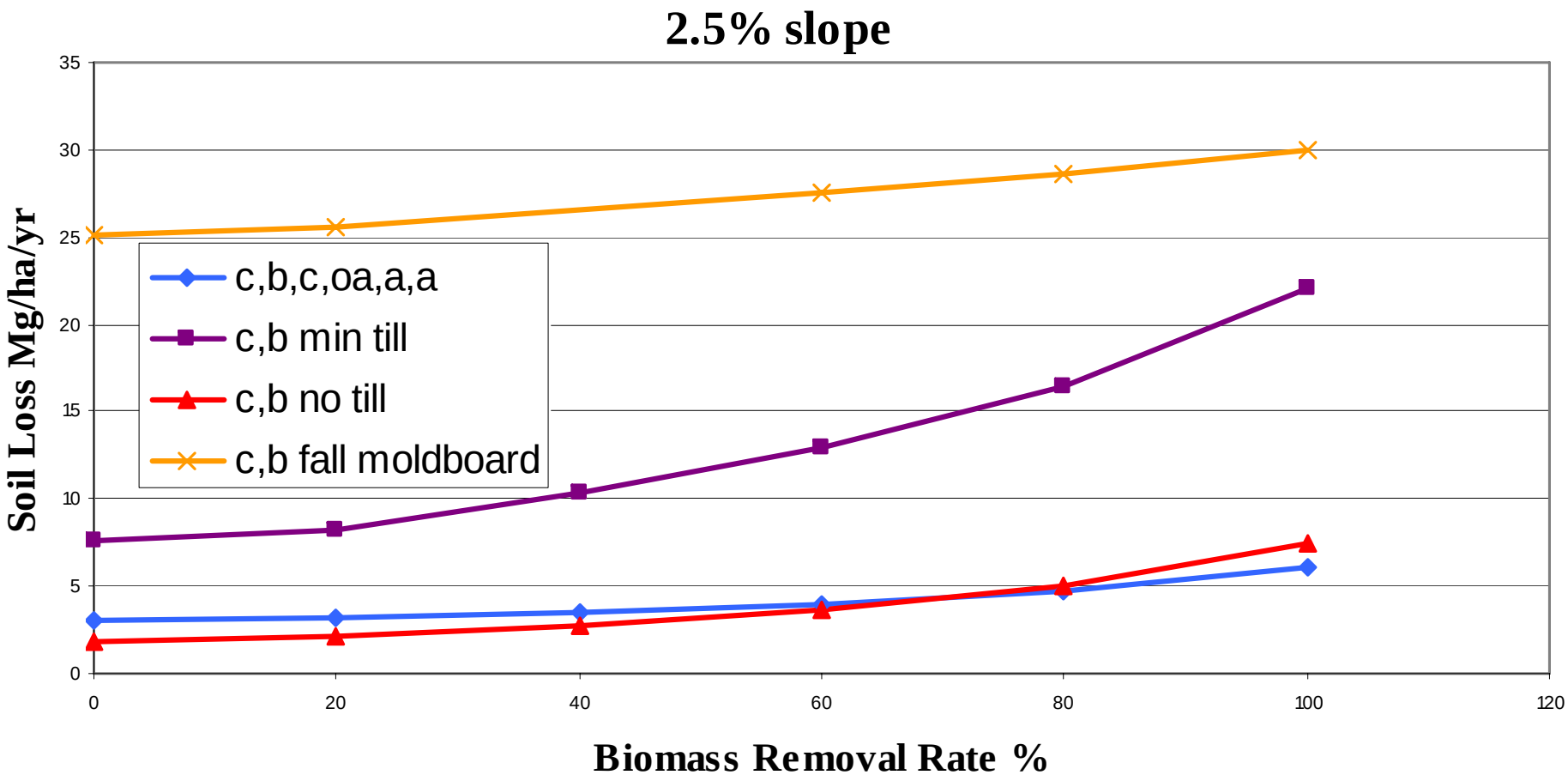
Farm nutrient balance

Nutrient balance field **1**, 680 acres corn for grain (lbs/year) excl. run-off, leaching/percolation, mineralization and immobilization	import or available for plant growth			export or unavailable for plant growth		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
chemical fertilizer applied	176201	28458	93550			
crop harvested				77864	17728	20828
removed crop residues				60487	10898	73020
crop N volatilization during senescence (NH_3 emission)				15167		
atmospheric N deposition (from NADP database)	4238					
soil-N denitrification (15% of N-input, N_2 & N_2O aerial emissions) (basis)				27066		
totals	**180439**	**28458**	**93550**	**180583**	**28627**	**93848**

nutrient balance summary	
nitrogen deficit	144 (= 0 lbs/acre/year)
phosphate deficit	169 (= 0 lbs/acre/year)
potassium oxide deficit	298 (= 0 lbs/acre/year)

required fertilizer (expenses) to meet crop nutrient balance

Soil Erosion



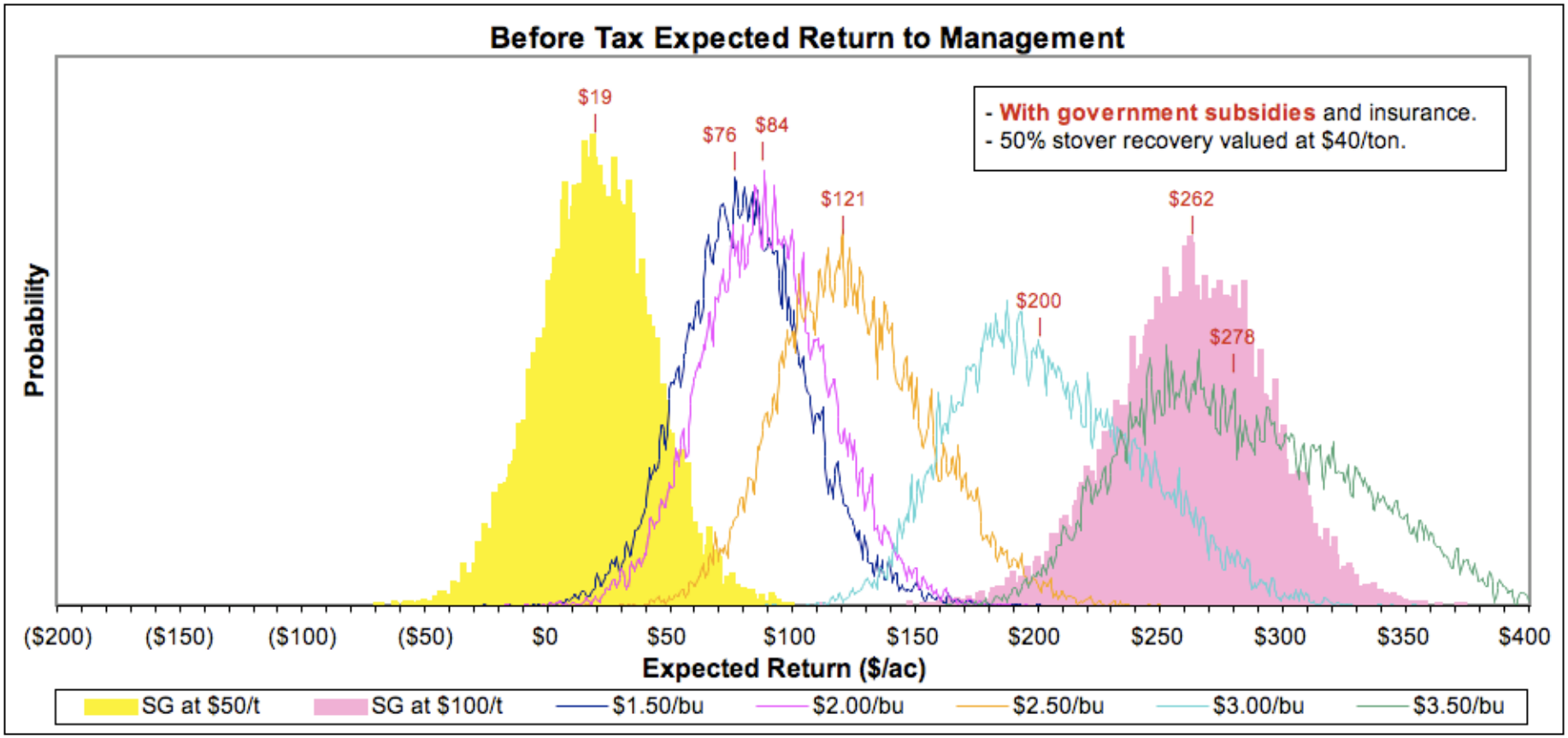
Soil Erosion

Soil erosion status of RUSLE modules in I-FARM
rainfall-runoff erosivity factor (R) for Palo Alto-county, IA is: 137
Soil Conditioning Index SCI
organic matter growth rate for city: Clarinda (palo_alto-county, IA)

	units	field 1 sequence corn for grain	farm
field area	acres	680	680
soil name		CANISTEO SILTY CLAY LOAM, 0 TO 2 PERCENT SLOPES	
soil surface texture		clay loam	
hill slope	percent	1.0	
slope length	feet	61	
tolerable soil loss (T)	tons/acre/year	5.00	
field specific soil loss (A)	**tons/acre/year**	**1.49**	
Soil Conditioning Index		**0.01**	
total soil loss	tons/year	1,012	1,012

v1.187

Government crop programs



Government Payments

Government payments, Farm Bill 2002, see ERS farm policy web site price list

program			corn	soybeans	oats	wheat	
DP	direct payments (limit $40,000/year)	payment rate ($/bu)	0.28	0.44	0.024	0.52	
		base yield (bu/acre/year)*	159	47	58	53	
		base acres*	680	0	0	0	
CCP	counter cyclical income support payments (limit $65,000/year)	target price ($/bu)	2.63	5.80	1.44	3.92	
		loan rate ($/bu)	1.95	5.00	1.33	2.75	
		national market price ($/bu)	3.00	6.80	1.90	1.90	
LDP	loan deficiency payments (limit $75,000/year)	actual market price ($/bu)	3.00	6.80	1.90	1.90	
CSP	conservation security program						0
CRP	conservation reserve program statistics						0

* based on historical data of the years 1998 through 2001

limit ON calculate

program		corn	soybeans	oats	wheat	total
DP	payment acres (85% of base acres)	578	0	0	0	
	DP payments ($/year)	25,733	0	0	0	25,733
						---------- +
	government payments ($/year)					25,733

Labor, services, loans, etc.

hired labor	
420 hours/year, $10.00/hour	4,200

custom farming expenses	
fertilization	4,760

government payments calculator 25,733 per year

bank loans for investments in	invest-ment ($)	loan amount ($)	term (yrs)	interest rate (%)	constant payment (principal & interest) ($/yr)
land	1,700,000	0	30	5.9	0
machines, power units	436,550	327,413	20	5.9	28,314
machines, implements	191,300	143,475	15	5.9	14,676
	2,327,850	**470,888**			

calculate farm income

One bottom line

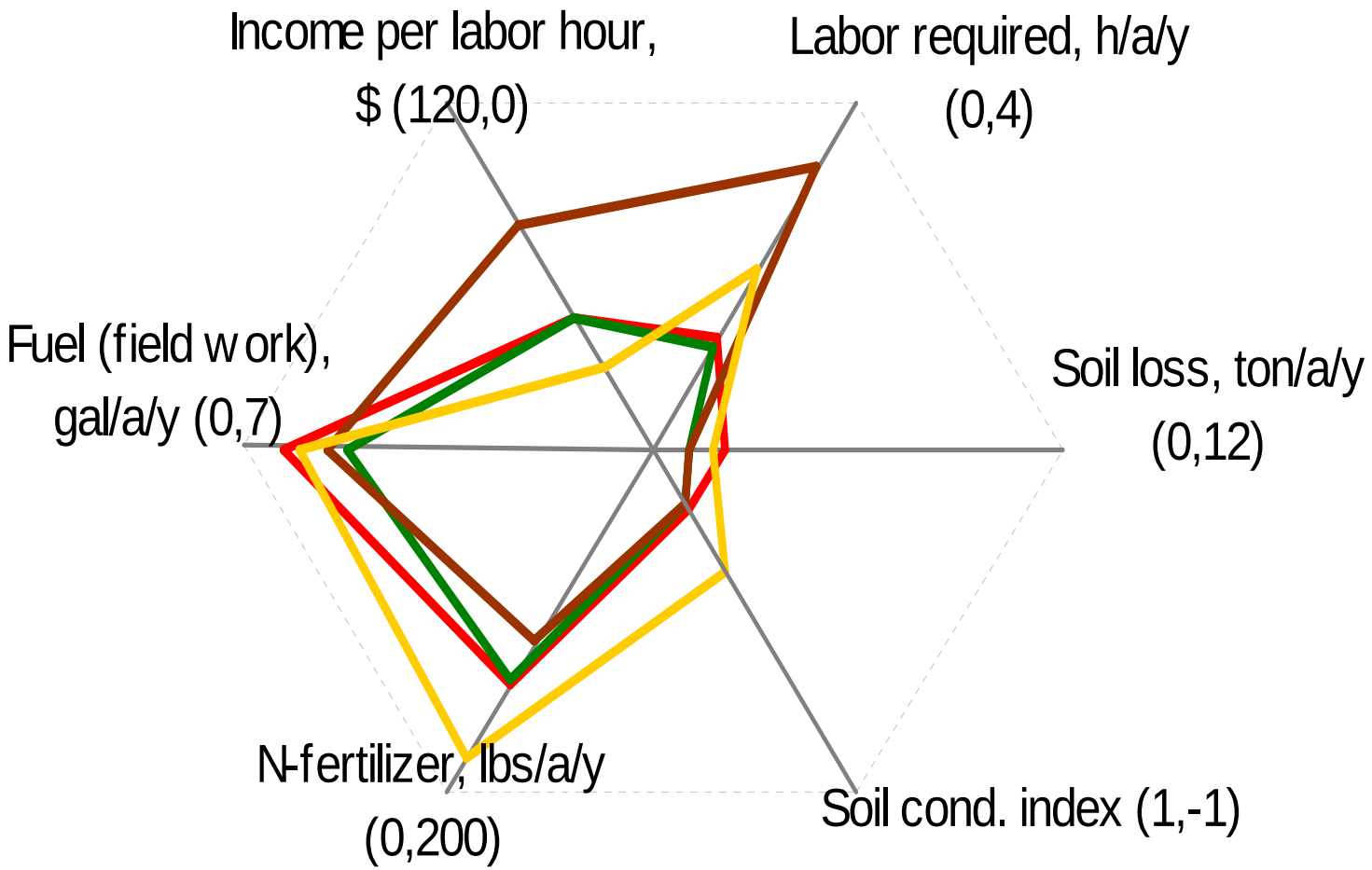
Farm bottom line (S/year)

	Revenues	Expenses
Crops	447,863	266,944
Hired labor		4,200
Custom farming		4,760
Government payments*	25,733	
Bank loan payments		42,990
	473,596	**318,894**

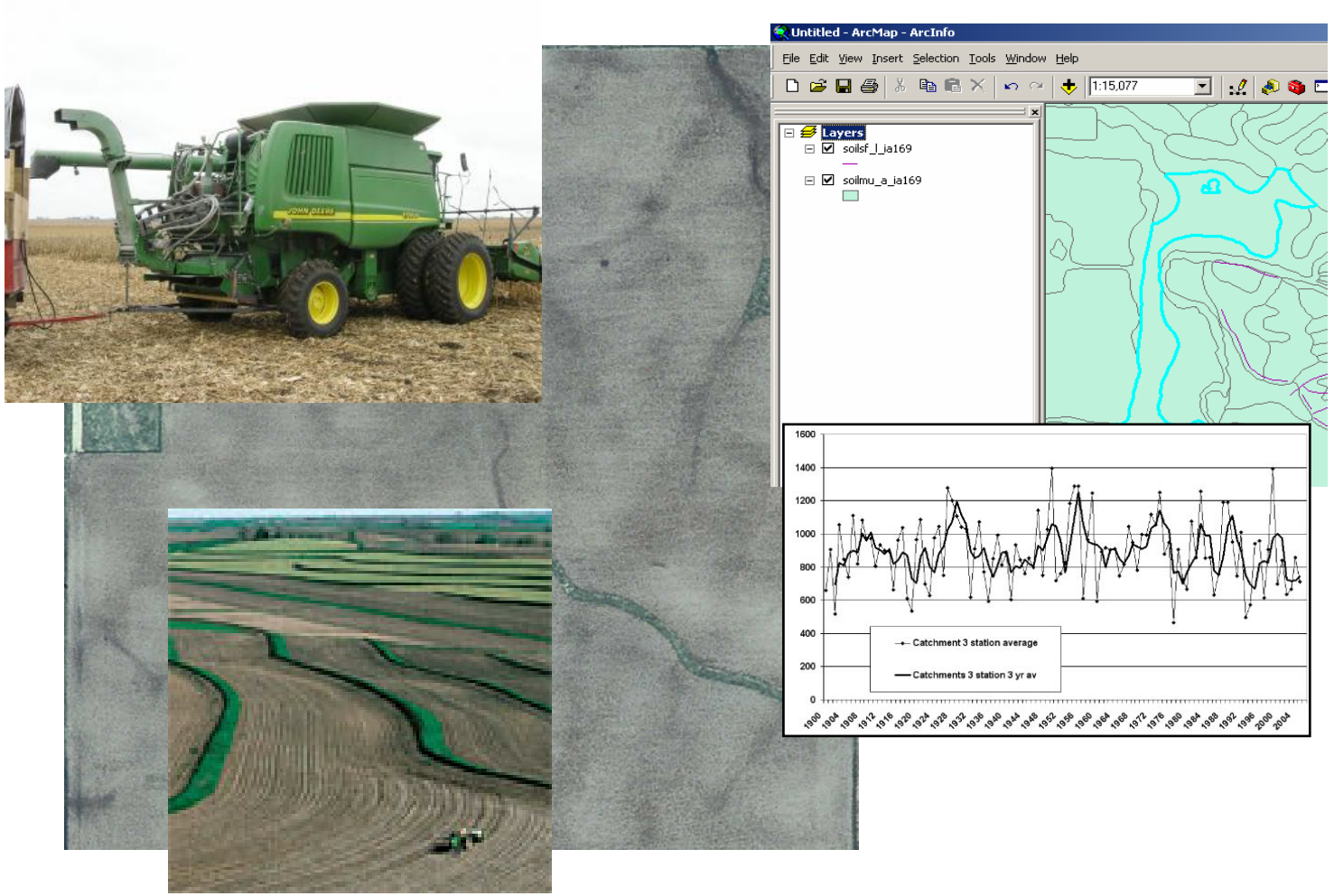
Net farm income (before taxes) **154,702** (or 152.03/h or 227.50/acre/year)

*Government payments 25.29/h or 16.6% of farm income

Comparative analysis



Under Development …
Biomass production risk management



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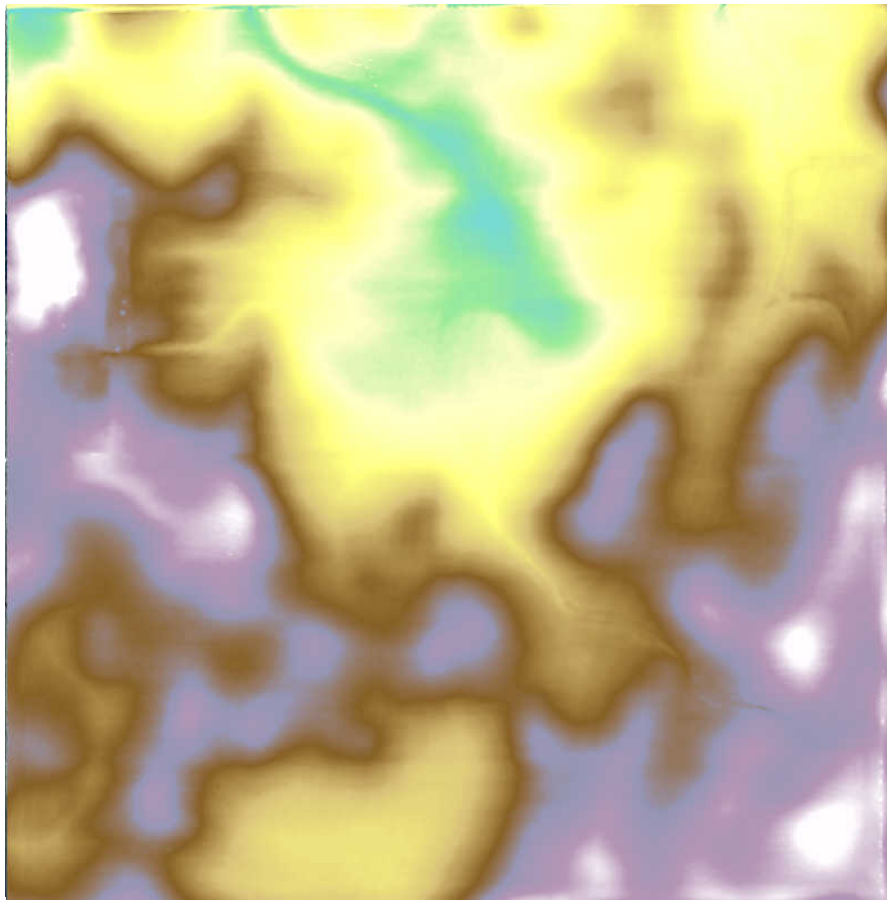
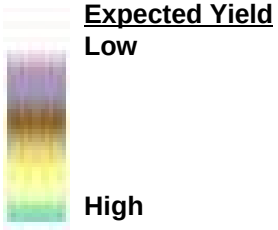


Spatially-explicit prediction of stochastic performance.

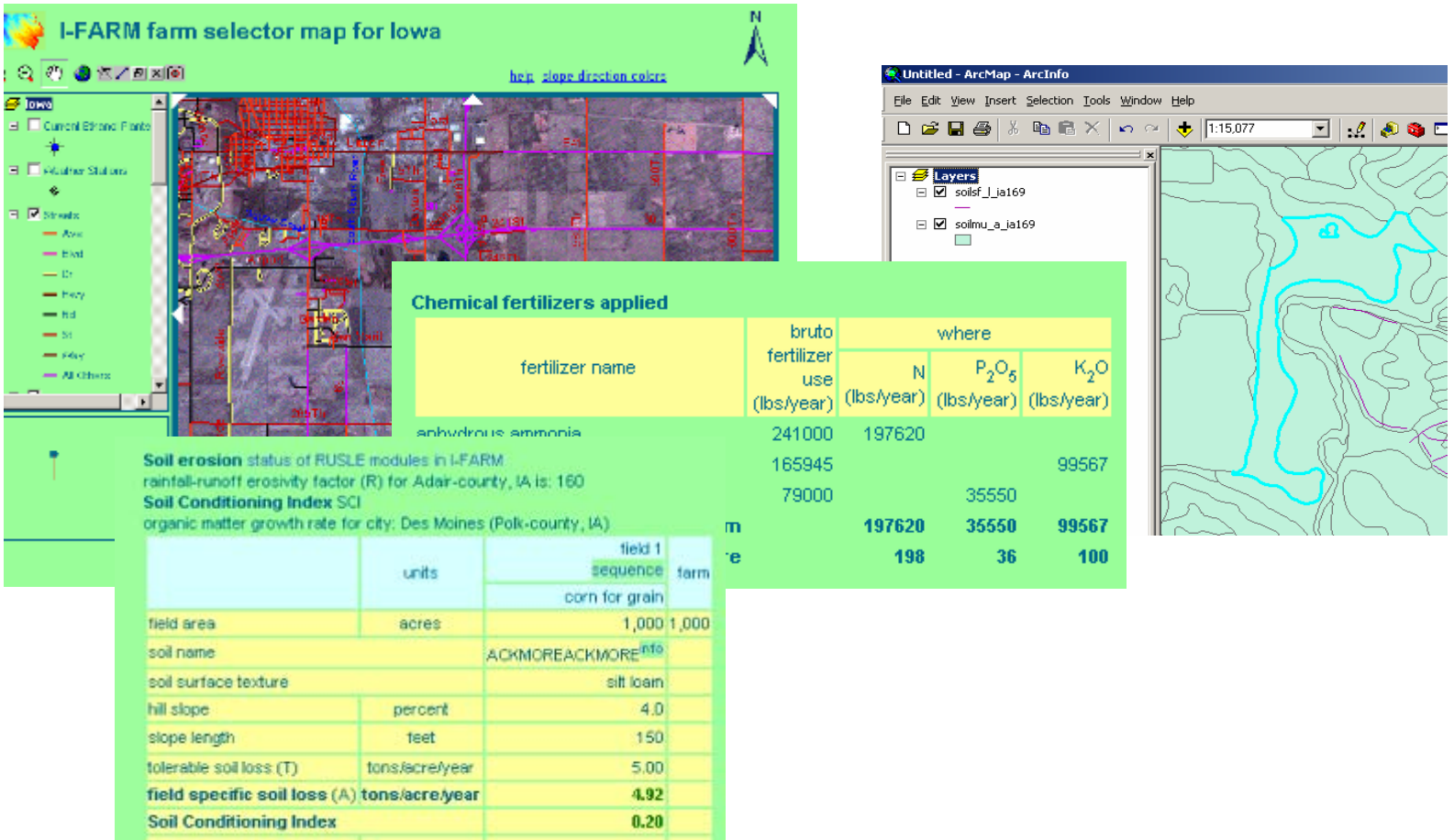
For example:

- yield
- return
- soil loss



Large-scale biofuel production will require dramatic changes in the agricultural system

New tools are needed to allow land managers and policy makers to “reimagine” an agricultural system that meets food, feed and fuel needs in an economically and environmentally sustainable way.


I-FARM farm selector map for Iowa
N
Untitled - ArcMap - ArcInfo
File Edit View Insert Selection Tools Window Help
1:15,077
Layers
soilsf_l_ia169
soilmu_a_ia169
Chemical fertilizers applied
fertilizer name
bruto fertilizer use (lbs/year)
where
N (lbs/year)
P2O5 (lbs/year)
K2O (lbs/year)
anhydrous ammonia 241000 197620
165945 99567
79000 35550
197620 35550 99567
198 36 100
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organic matter growth rate for city: Des Moines (Polk-county, IA)
units
field 1 sequence
corn for grain
farm
field area acres 1,000 1,000
soil name ACKMOREACKMORE info
soil surface texture silt loam
hill slope percent 4.0
slope length feet 150
tolerable soil loss (T) tons/acre/year 5.00
field specific soil loss (A) tons/acre/year 4.92
Soil Conditioning Index 0.20