Waste Not: Closing the Loop on Organics Wastes

Faculty collaborators:

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Global food ventures
MnDRIVE
Minnesota's Discovery, Research and InnoVation Economy

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The Problem with Food Waste

- At the retail and consumer levels, food waste amounts to 1,250 calories per person daily, 61% of what we actually eat!
- The value of wasted food in the U.S. is $160 billion per year – about $500 per person.
- Food waste comprises 21% of total municipal landfill waste.

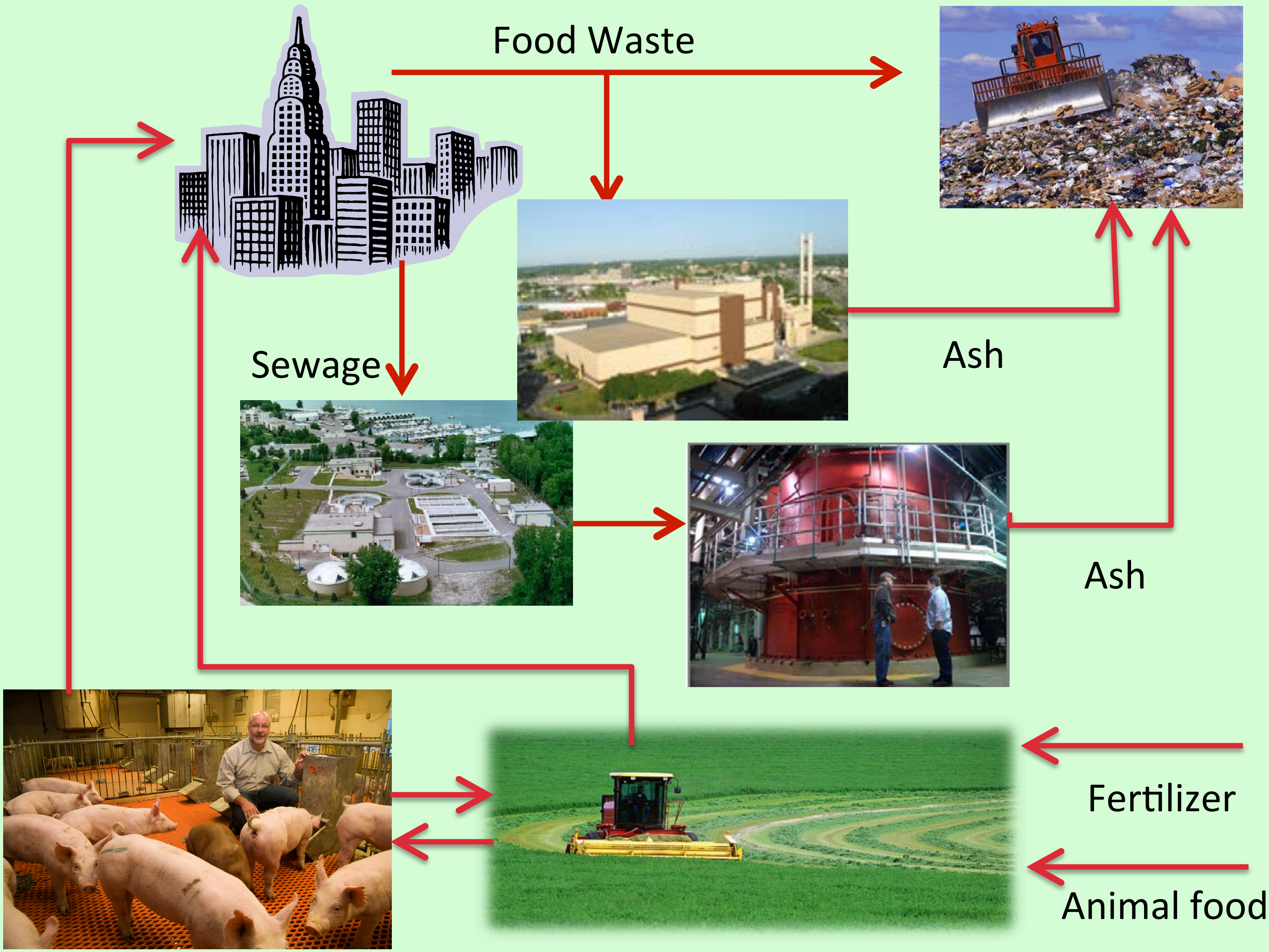
Environmental impacts of U.S. food waste

31% of cropland

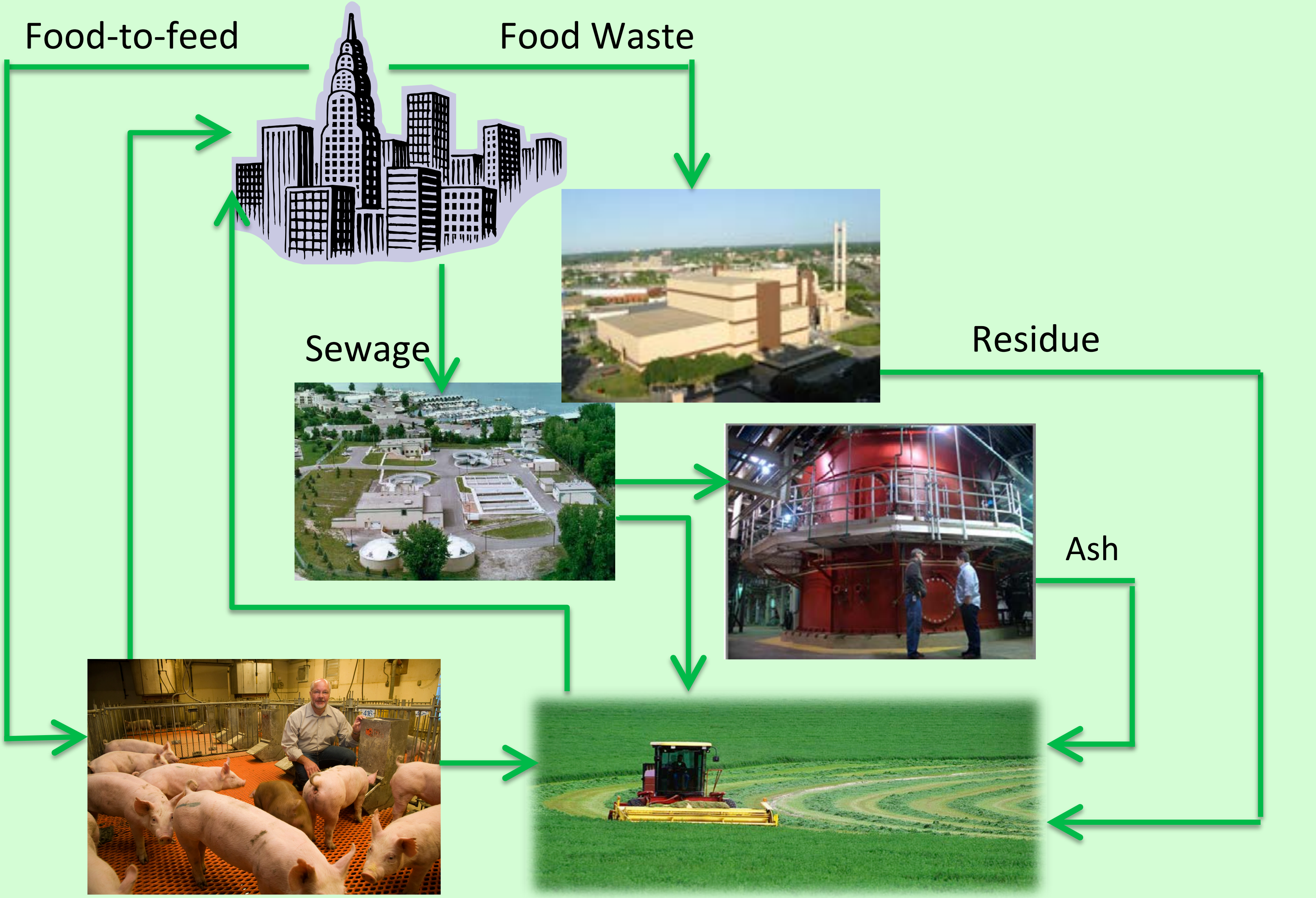
25% of water consumption

21% of landfill volume

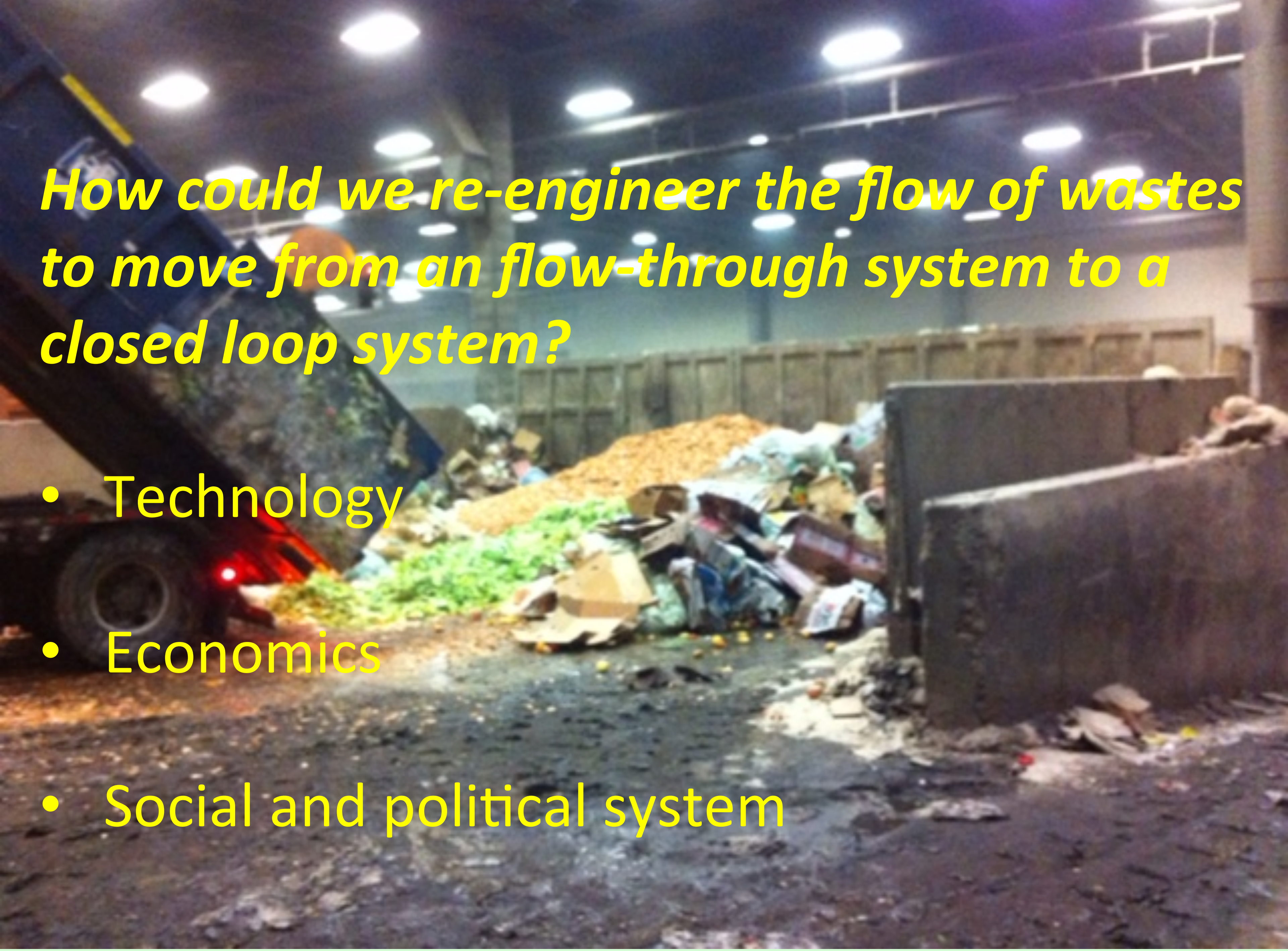
2% of energy consumption



Current: Flow-Through Organic Waste System

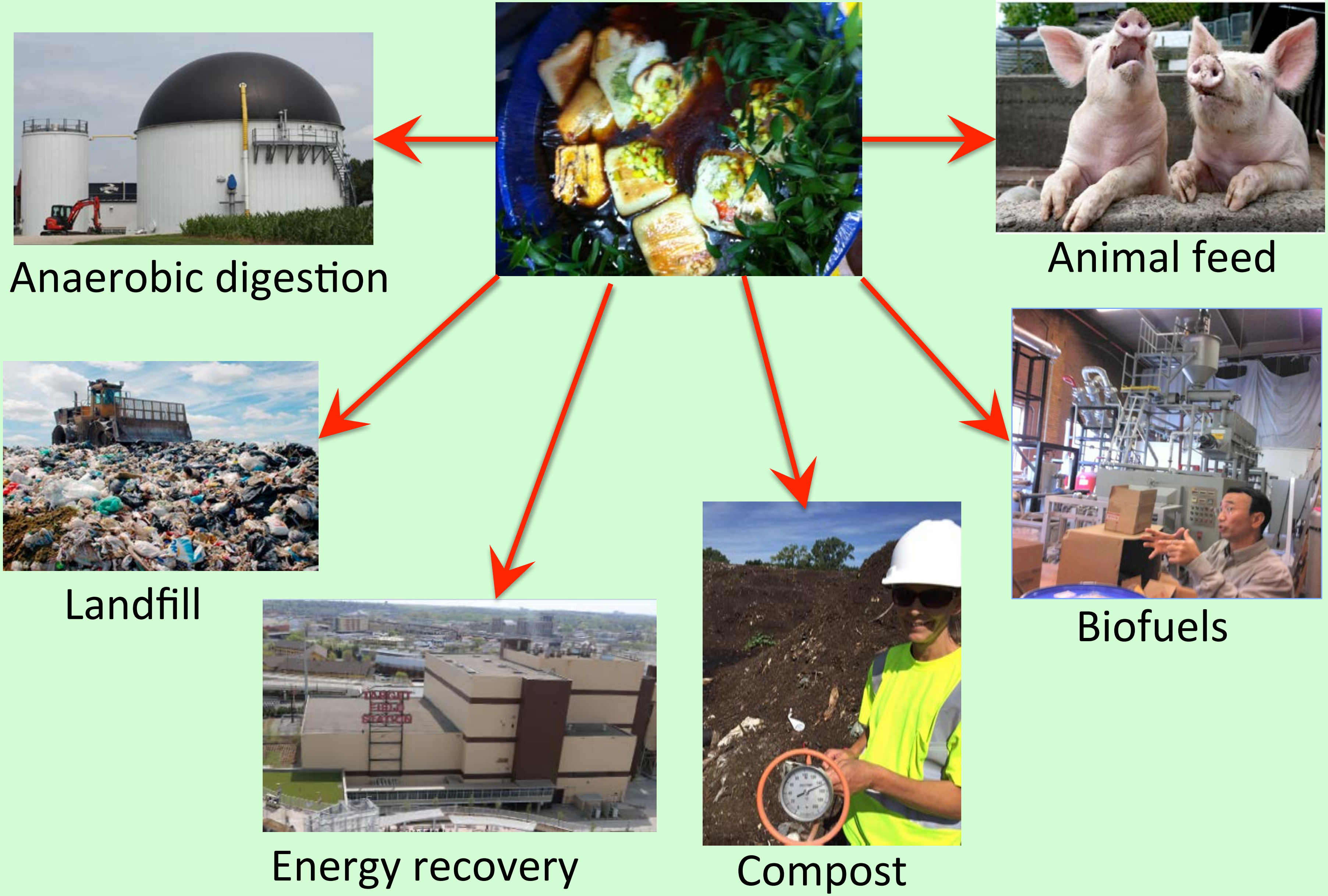


The Future: Closed Loop System



How could we re-engineer the flow of wastes to move from an flow-through system to a closed loop system?

- Technology
- Economics
- Social and political system



What is the highest and best use of food waste?

Lunds/Byerleys
Grocery store

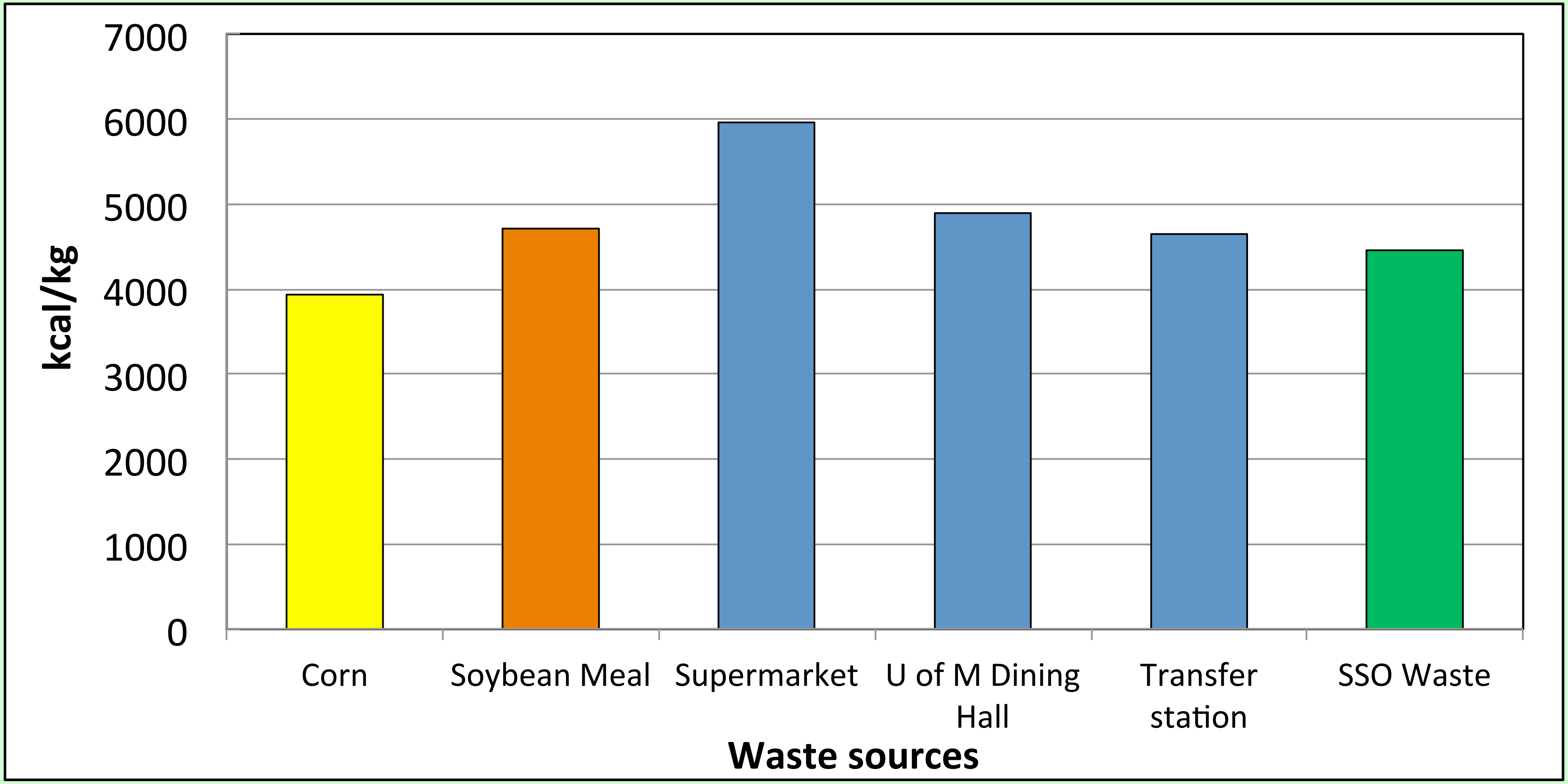
University of Minnesota
dining hall waste

Household source-
separated organics

Mixed organics waste,
transfer station

Some of our favorite organic wastes!

Which food wastes could become feedstocks for animal feed?



Caloric content of two conventional feedstocks and four source of urban organic wastes.

SSO = source separated organics, from Minneapolis, 83% food waste.

On a caloric basis, urban organic wastes compare well with corn and soybean meal!

Nutrients in three organic wastes, corn and soybean meal.

Data are based on dry weight	Super -market	Dining Hall	Transfer Station	Corn	Soybean Meal
No. samples	22	60	27	115	101
Metabolizable energy, kcal/kg	4,843	4,300	3,301	3,395	3,294
Crude protein, %	24	16	16	8.2	47.7
Ether extract, %	34	12	9.7	3.5	1.5
Neutral detergent fiber, %	16	8	26	9.1	8.2
Phosphorus, %	0.61	0.26	0.42	0.26	0.71
Shadow pricing, $/ton	300	240	300		

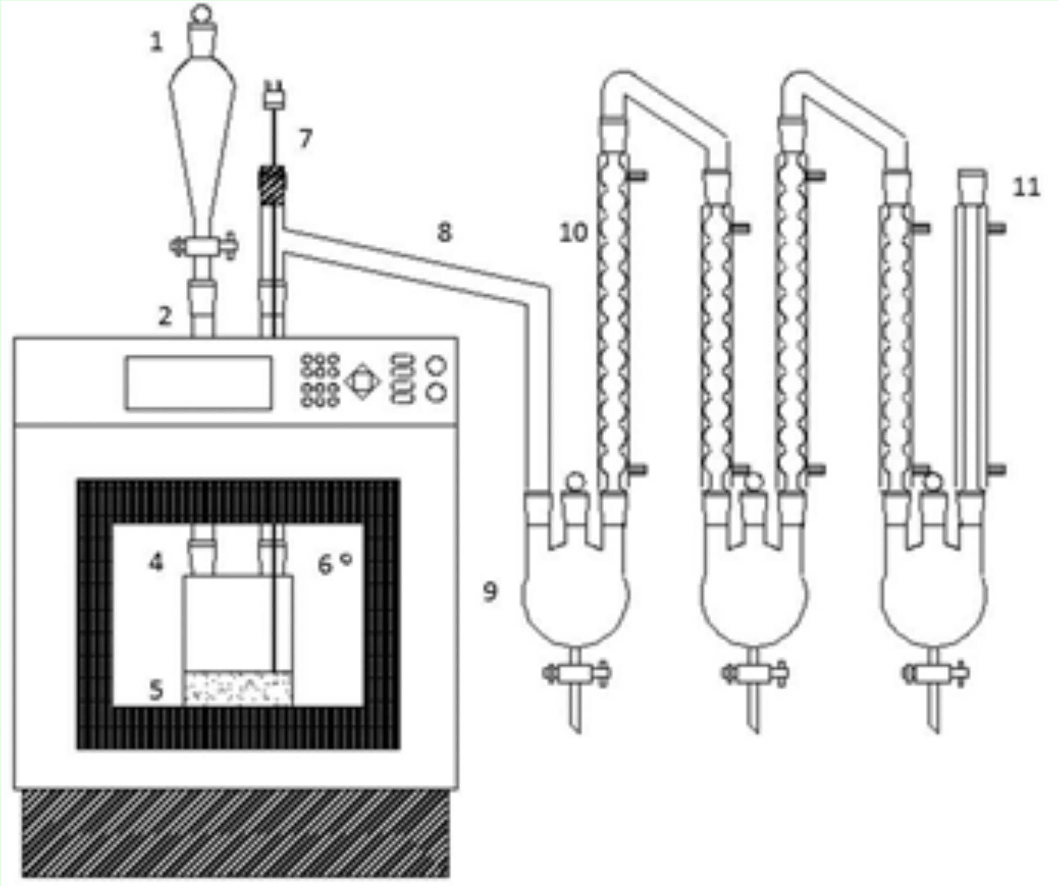
Shadow pricing of urban organic wastes is $240-300/ton.

Production of biofuels

Fast Microwave Assisted Pyrolysis and Gasification (fMAP and fMAG)

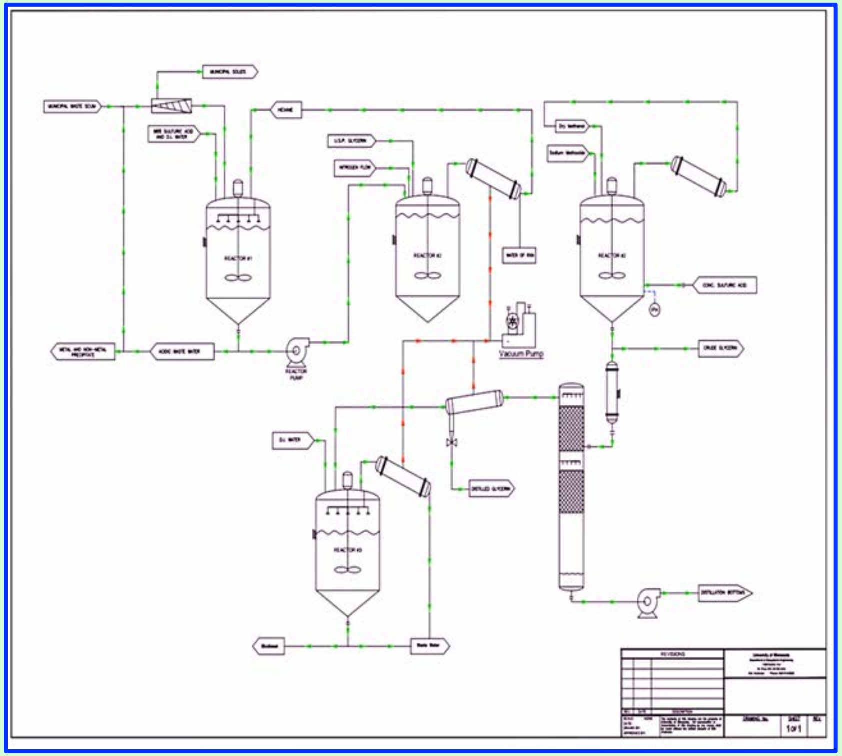
Organic substrate → gas + liquid fuel + char

Vary heating, distillation to control product



Examples of products produced by fMAP and fMAG from various organic wastes in the batch studies.

	Product	U of M Dining Hall	Household SSO	Grocery Store	Transfer station
fMAP, % of waste mass	Bio-oil	22.4	23.4	29.6	17.5
	Bio-char	35.8	35.32	43.8	54.8
	Gas	42	41	27	28
fMAG, % of waste mass	Total gas	61	56	69	59
	H_2	35	27	27	25
	CO	17	13	13	15
	CH_4	9.7	35	3.5	9.8
	CO	15	25	25	19

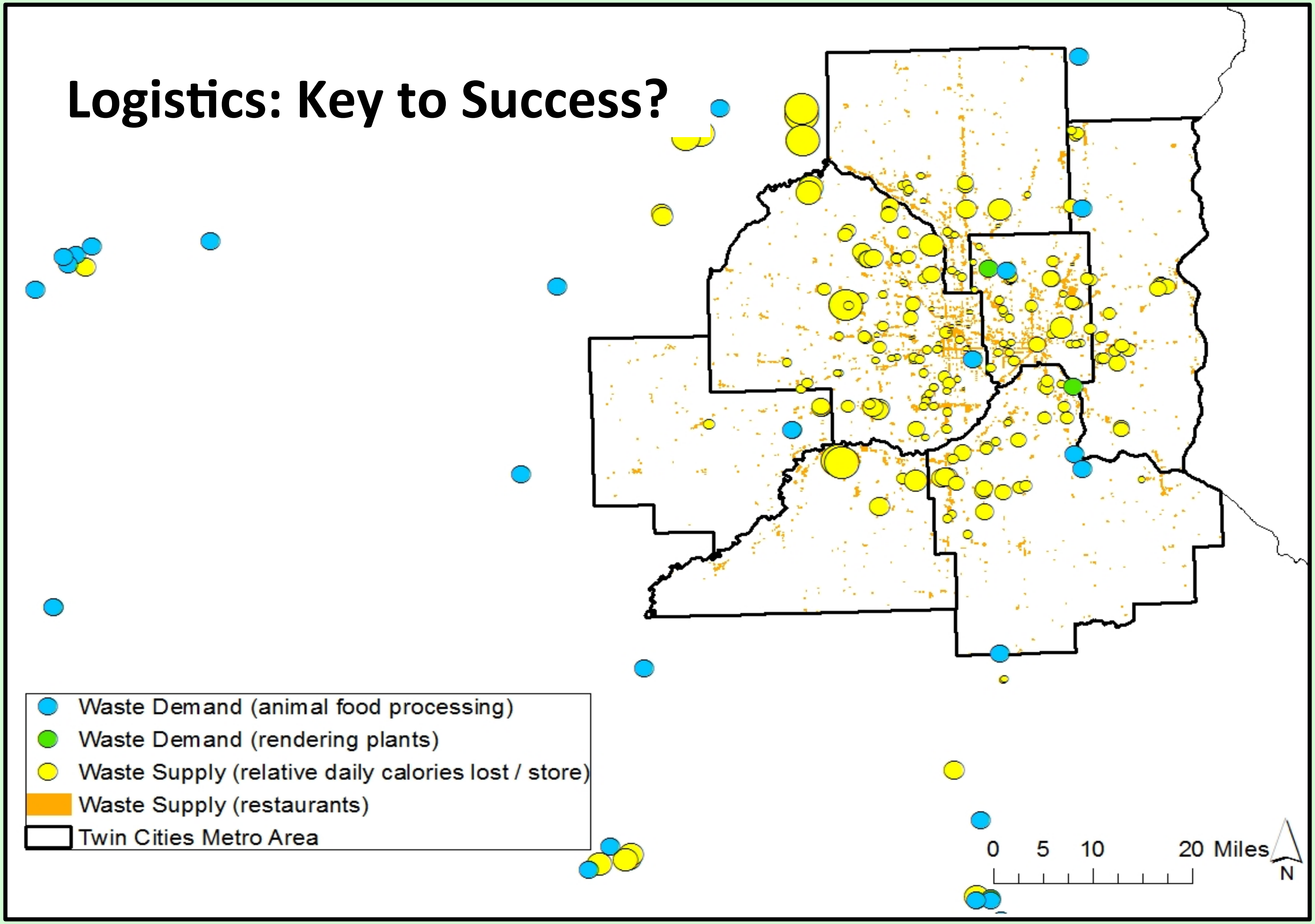


Wastes that produce high yields in batch studies move to pilot studies (above) and eventually to full-scale operations. The design at left is for producing biofuels from sewage plant scum.

Industry benchmark study for food wastes (Cascadia 2006).

Most food waste at restaurants, stores, and hotels is disposed.

Logistics: Key to Success?



We can now map the distribution of food waste calories from grocery stores and restaurants in relation to potential demand centers.

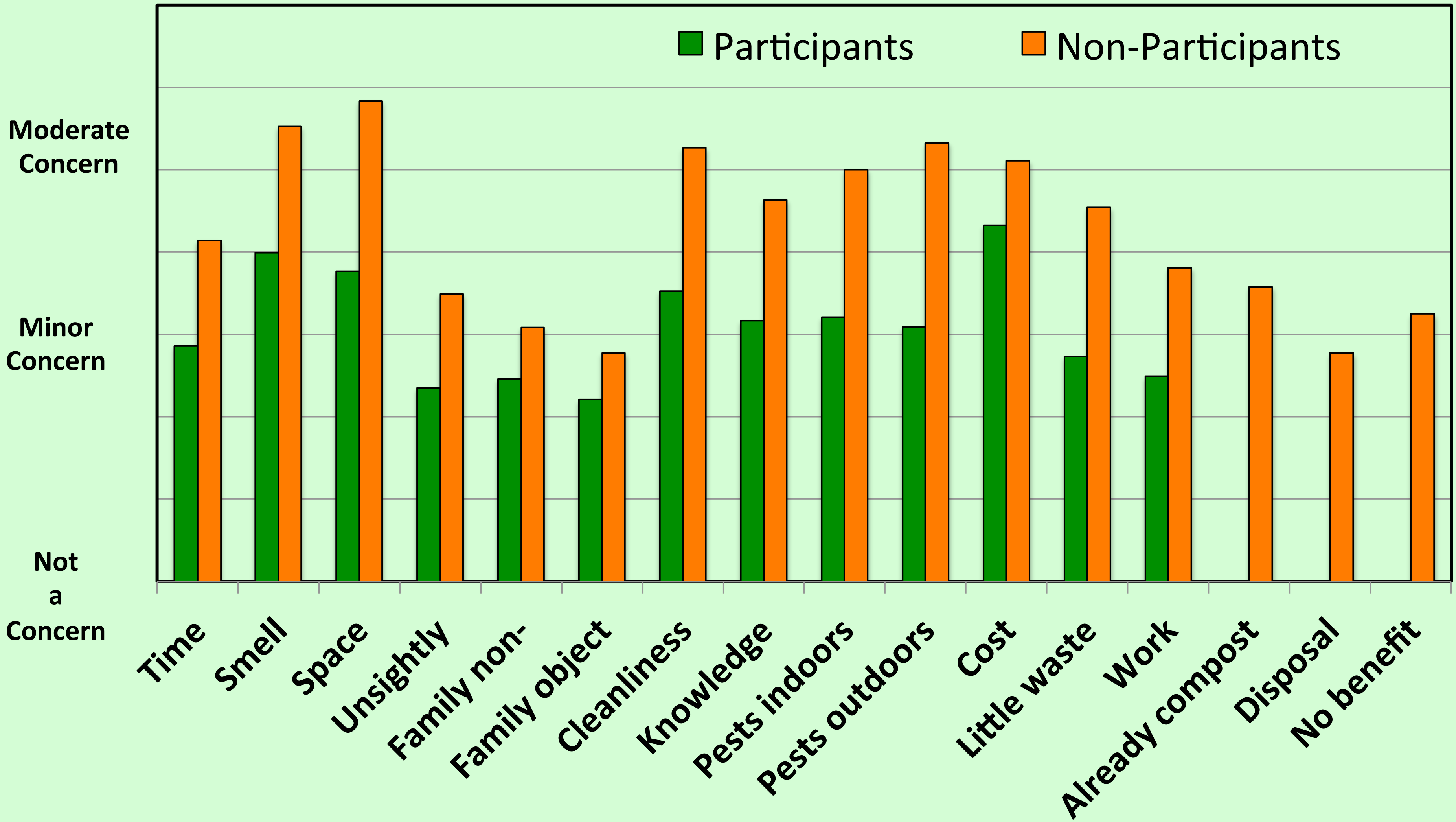
Evaluation of Collection of Source-Separated Organics
In Minneapolis

1. Household survey of Minneapolis SSO participants (350) and non-participants (350). Survey posted at wastenot.umn.edu

2. Policy actor interviews
3. (n =20)

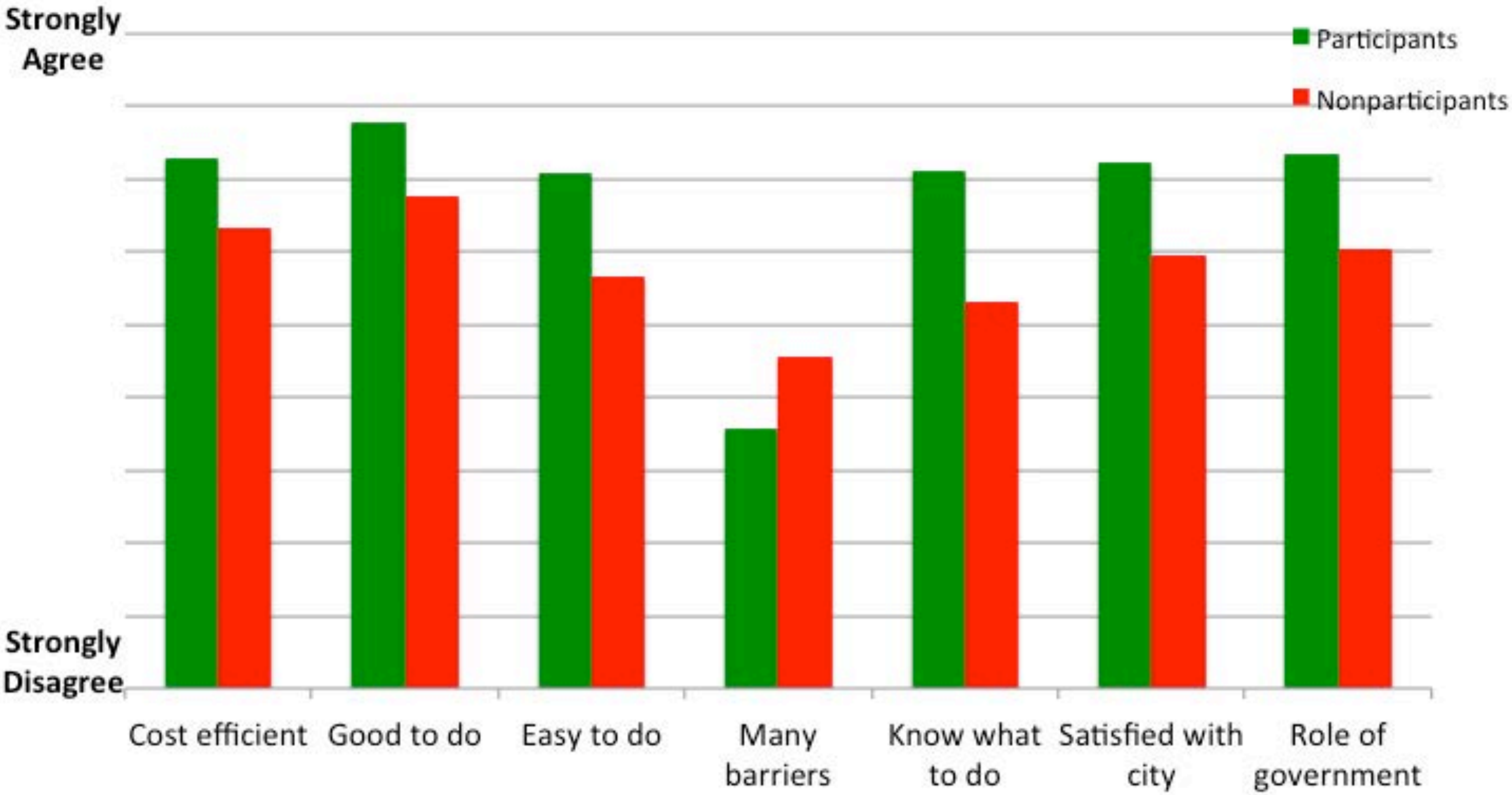
Household Survey: Results

Biggest concerns are practical



Waste Management Innovation

Attitudes: Biggest Differences are Specific to Organics Recycling



Other differences between participants and non-participants:

Willingness to Pay

- Participants willing to pay $2
- Non-participants willing to pay $1.75

Age

- Participants are largely middle aged (31-65) with children
- Non-participants older (65+), more even distribution

Similarities between participants and non-participants:

Motivators

Both groups would recycle more given:

- Free indoor bins
- Lower waste collection bill

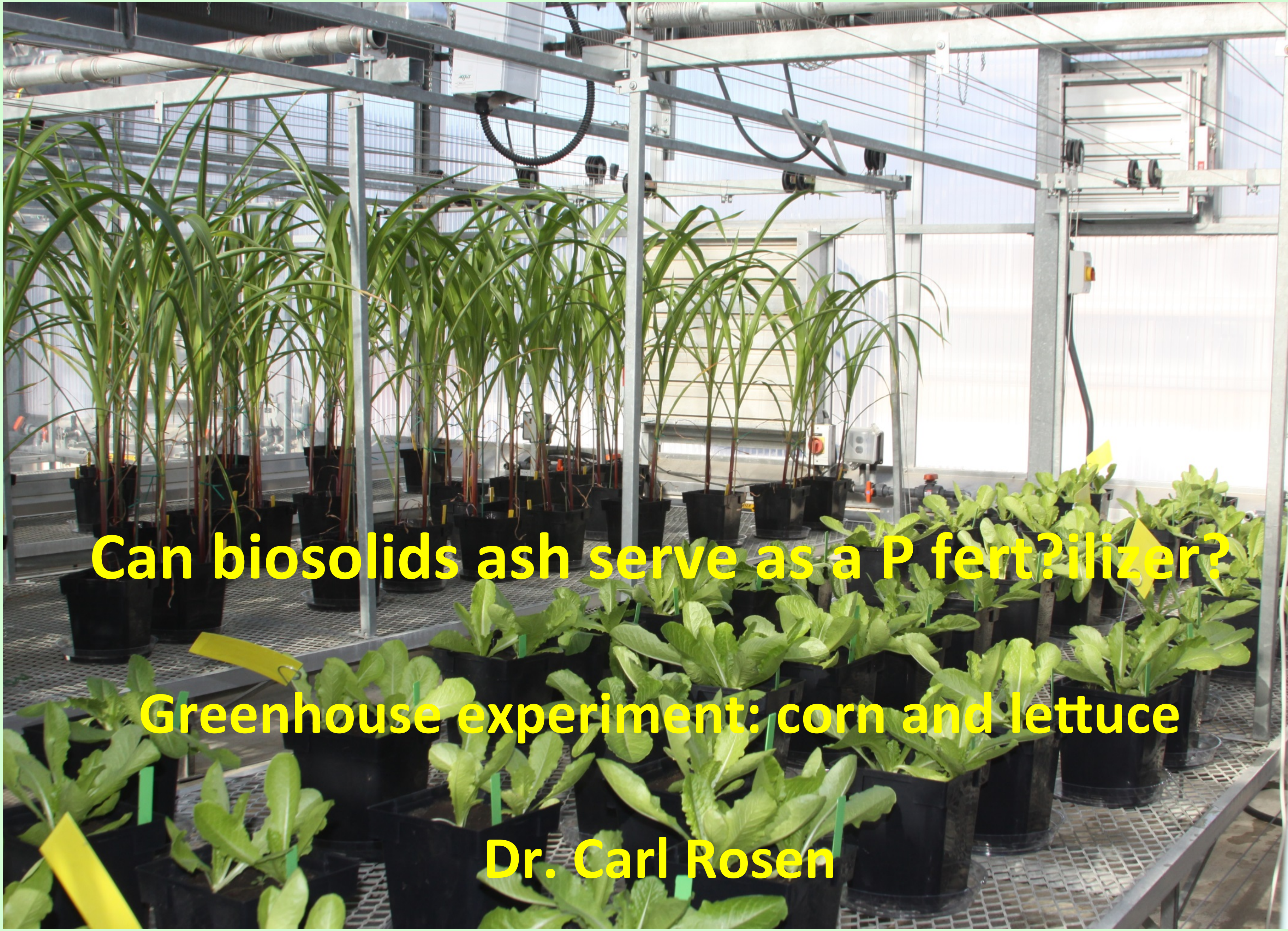
Information sources

Both groups look to:

- City website
- Mailers

Key findings from policy actor interviews (n = 20)

- Governance innovation and policy reform is necessary to "close the loop" on organic wastes
- Public policy strategies must reflect the important role of the private sector
  - In open systems, public-private collaboration is key
  - In organized systems, government able to play a leading role
- For organics recycling programs to be viable in the long term, public participation must increase

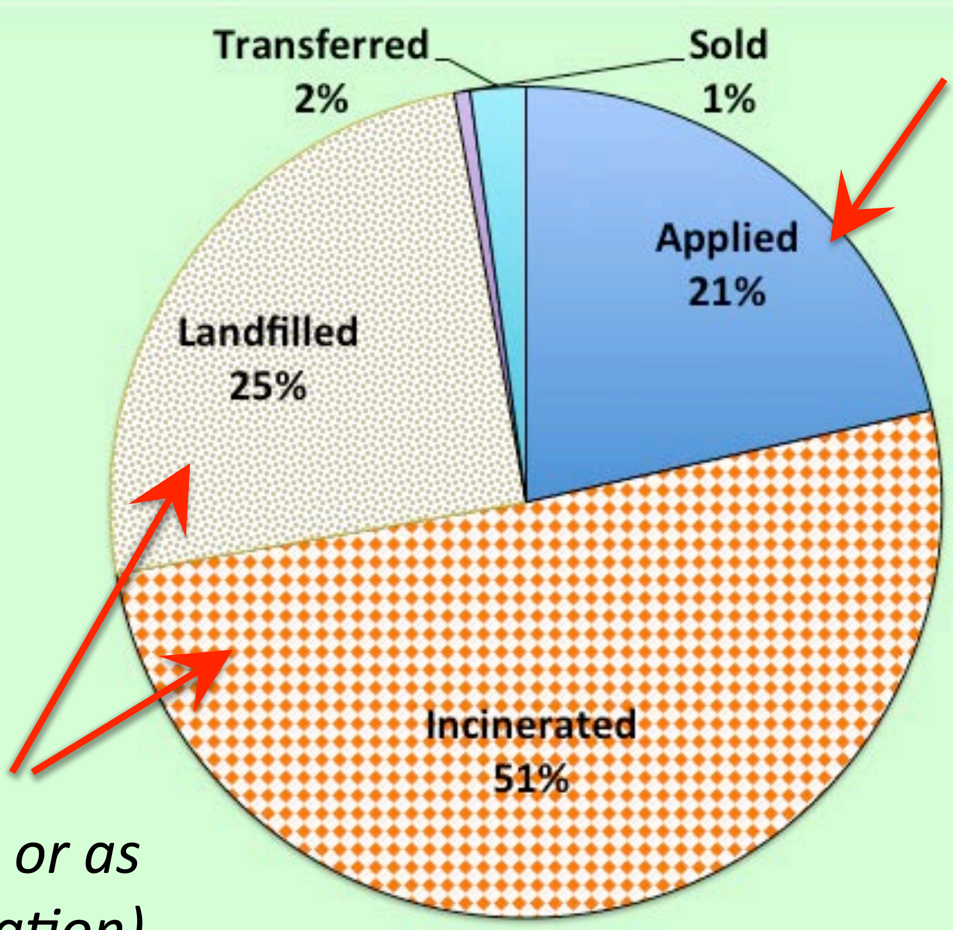


Can biosolids ash serve as a P fert?ilizer?

Greenhouse experiment: corn and lettuce

Dr. Carl Rosen

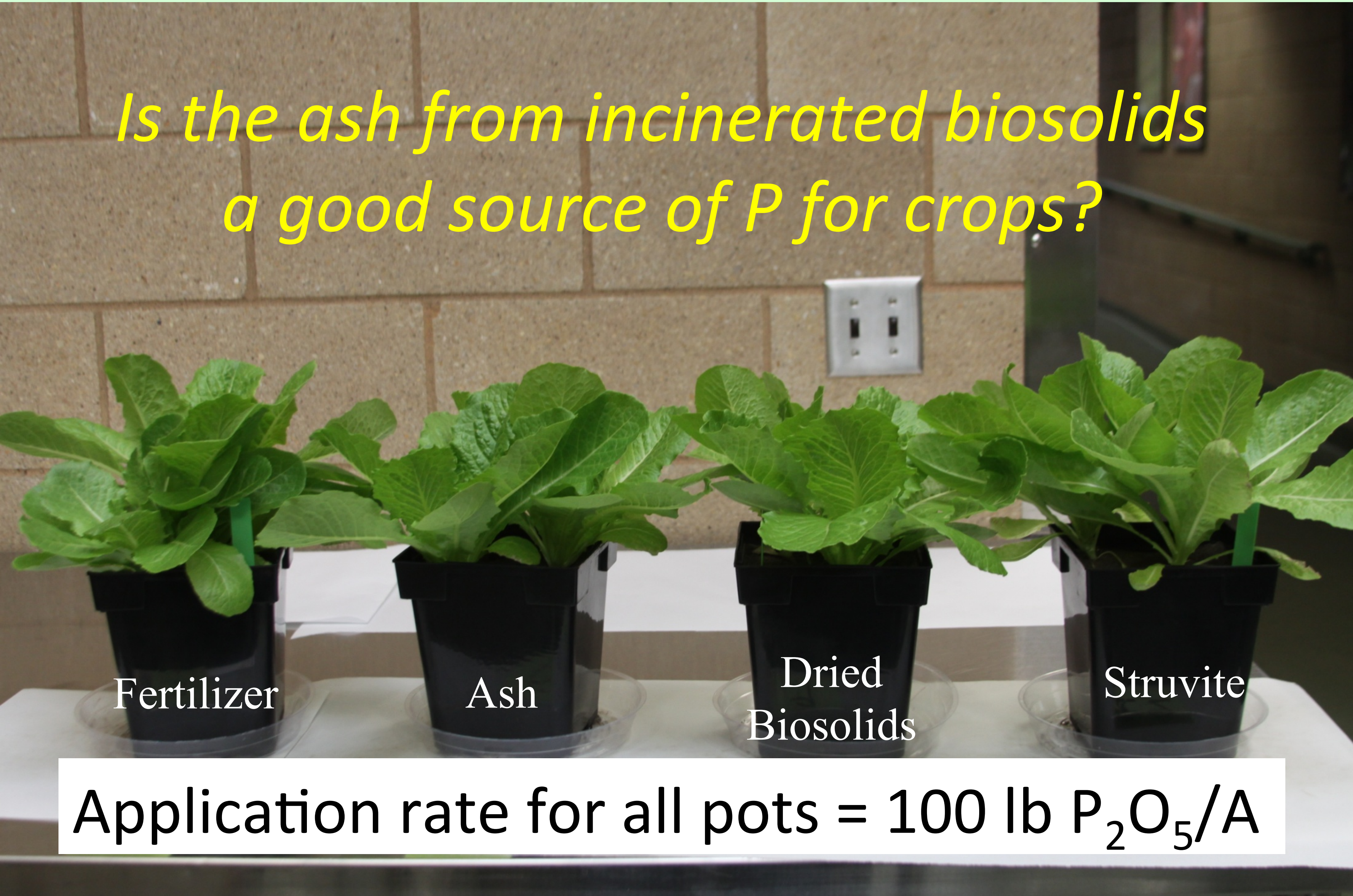
Biosolids Recycling in Minnesota



Only about one-fourth is applied to land.

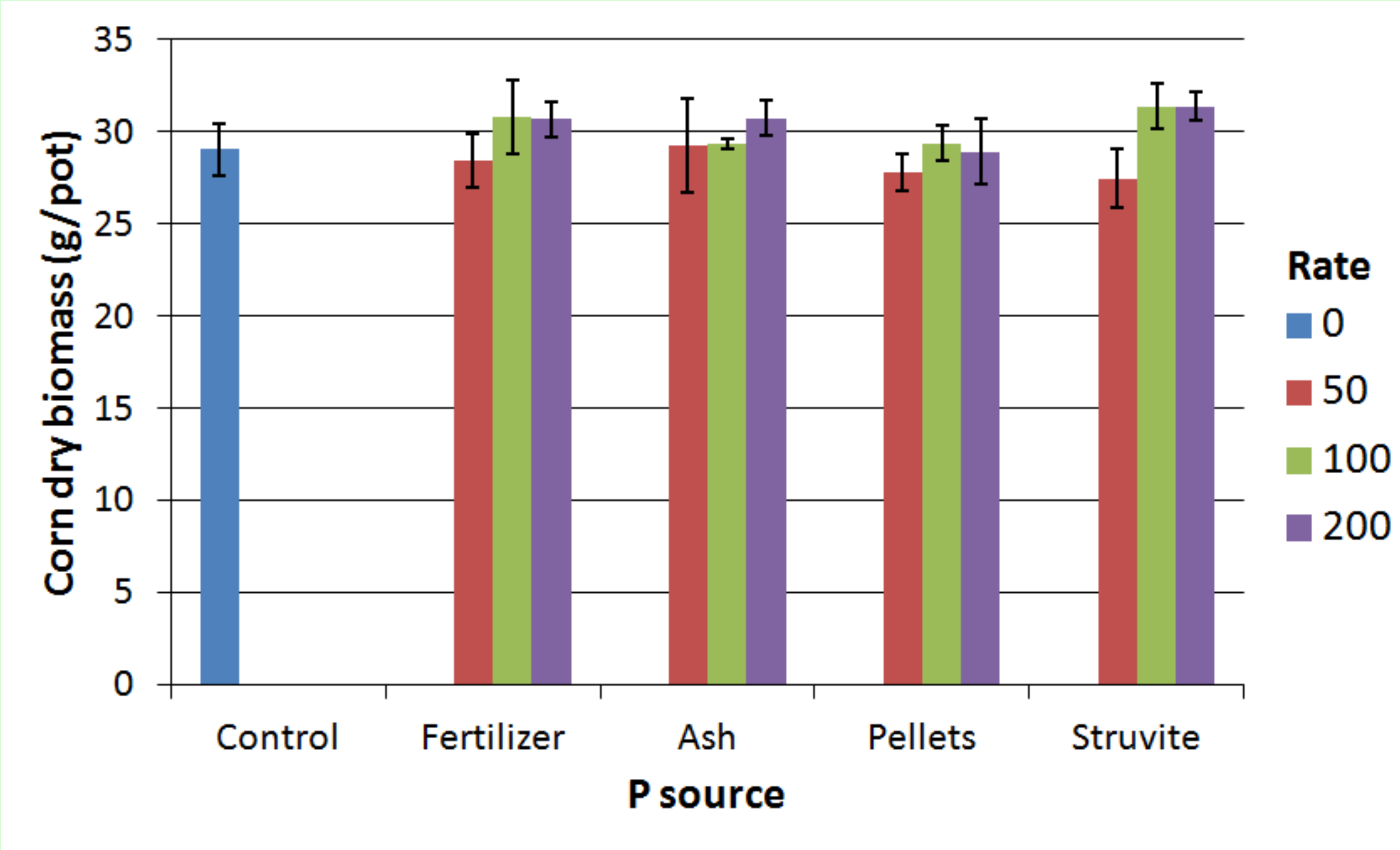
Three-fourths is landfilled directly or as ash (after incineration).

Is the ash from incinerated biosolids a good source of P for crops?



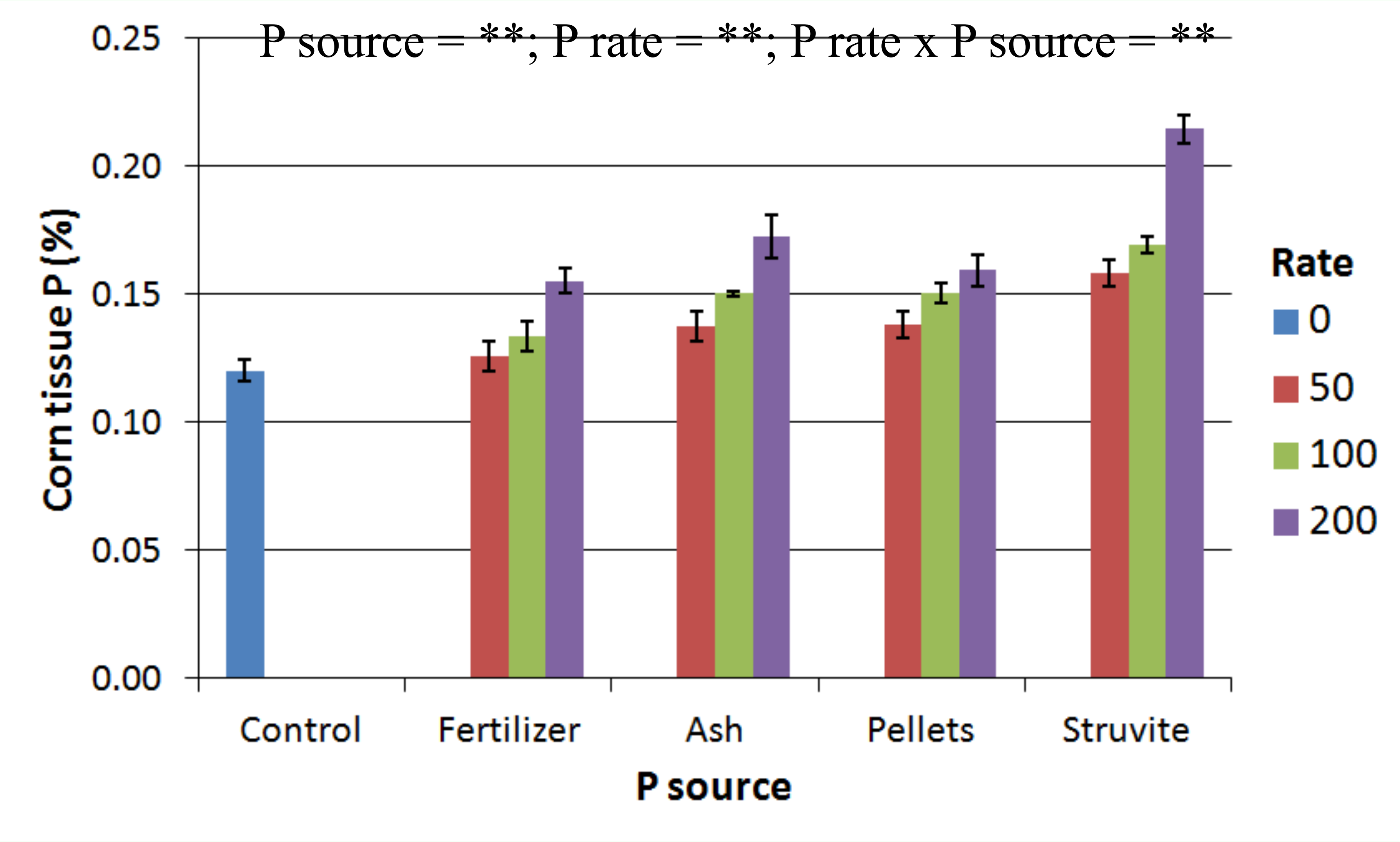
Application rate for all pots = 100 lb P_2O_5/A

Effect of P source on Corn Dry Weight

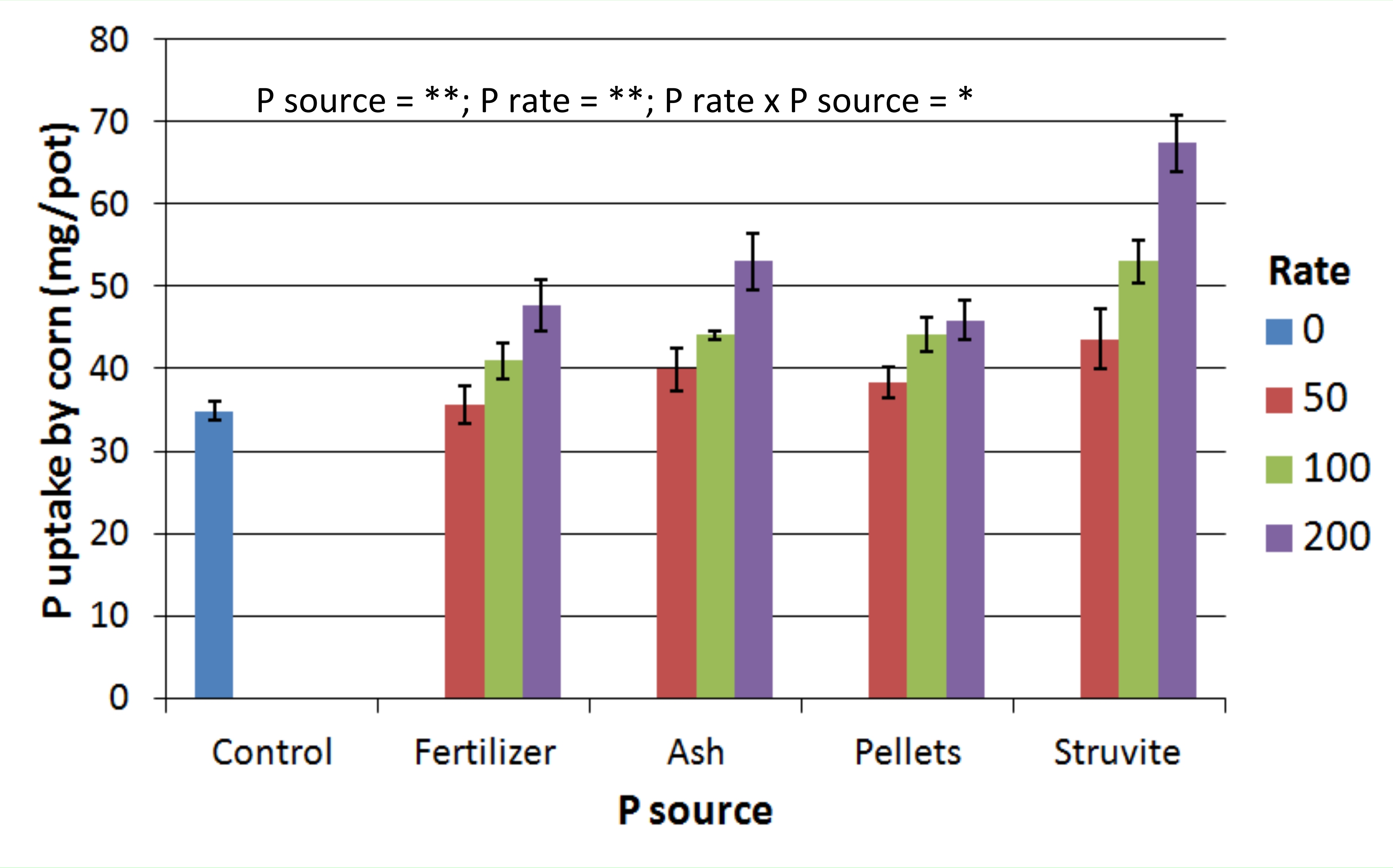


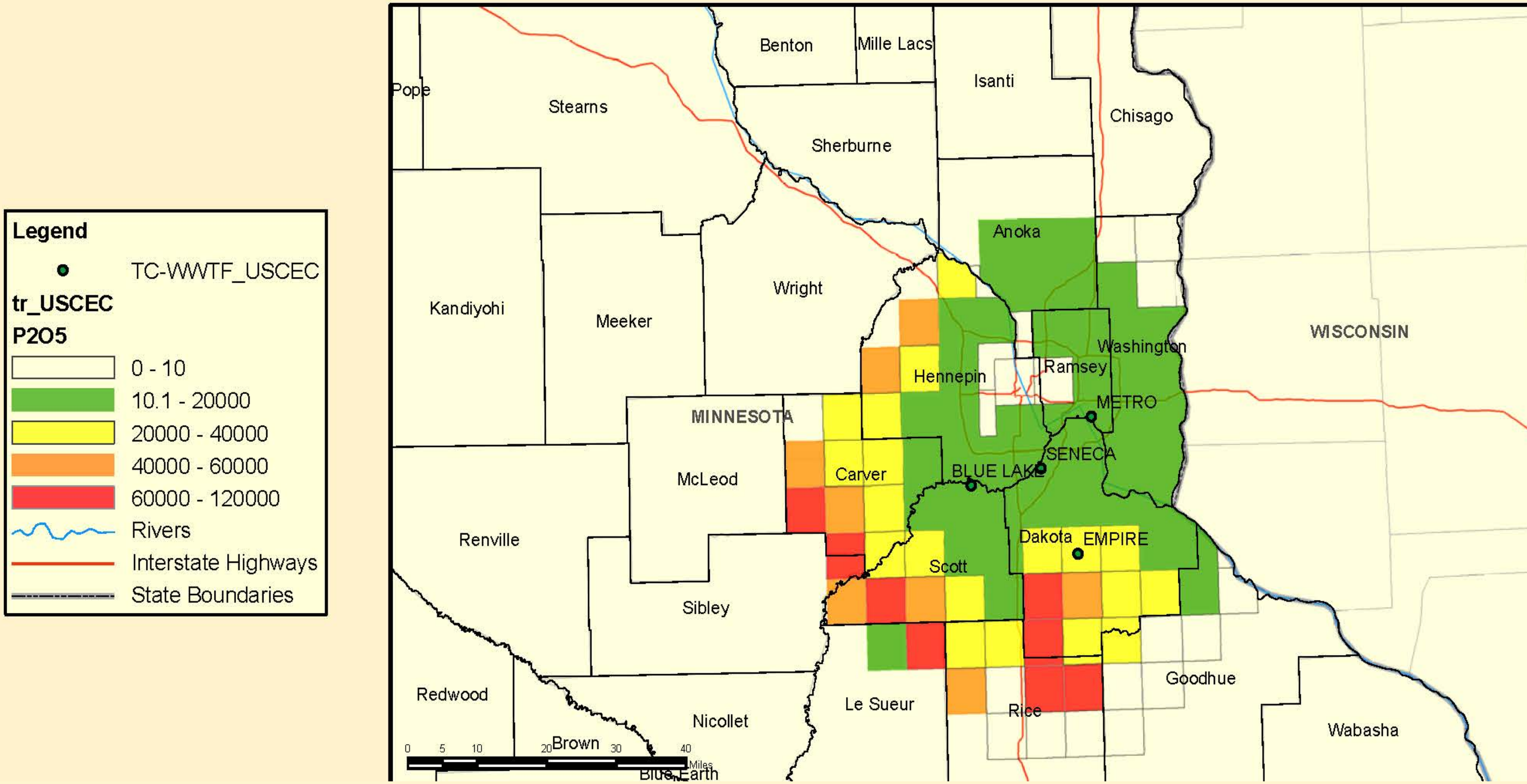
P source = NS; P rate = **; P rate x P source = NS

Effect of P Source on Corn Tissue P



Phosphorus Uptake by Corn as Affected by P Rate and P Source





Economically optimized distribution of biosolids (ash or dried) on farmland based on P

Spreading biosolids produced by the Metro Region would be economical because of abundant peri-urban cropland.

SUMMARY

- There are multiple potential benefits to re-engineering our organic waste system
  - Decrease cost of disposal
  - Generate value from products
- Creating knowledge about waste utilization potential (highest and best use) will create value
- Modifying waste infrastructure may facilitate broader utilization of organic wastes.
- Re-engineering also involves social and political system.

Value of Recycling Food Waste to Minnesotans

For farmers:

Urban food waste → animal feed

Urban biosolids → crop fertilizer

Possibly lower (or at least more stable) prices

For cities:

Avoided landfill costs

Added value for "highest and best uses" for food wastes

For all:

Lower environmental impacts from our food system.