Jobs, Jobs, Jobs, and the Bioeconomy

Invited Presentation
Conference on Transition to a Bioeconomy:
Environmental and Rural Development Impacts

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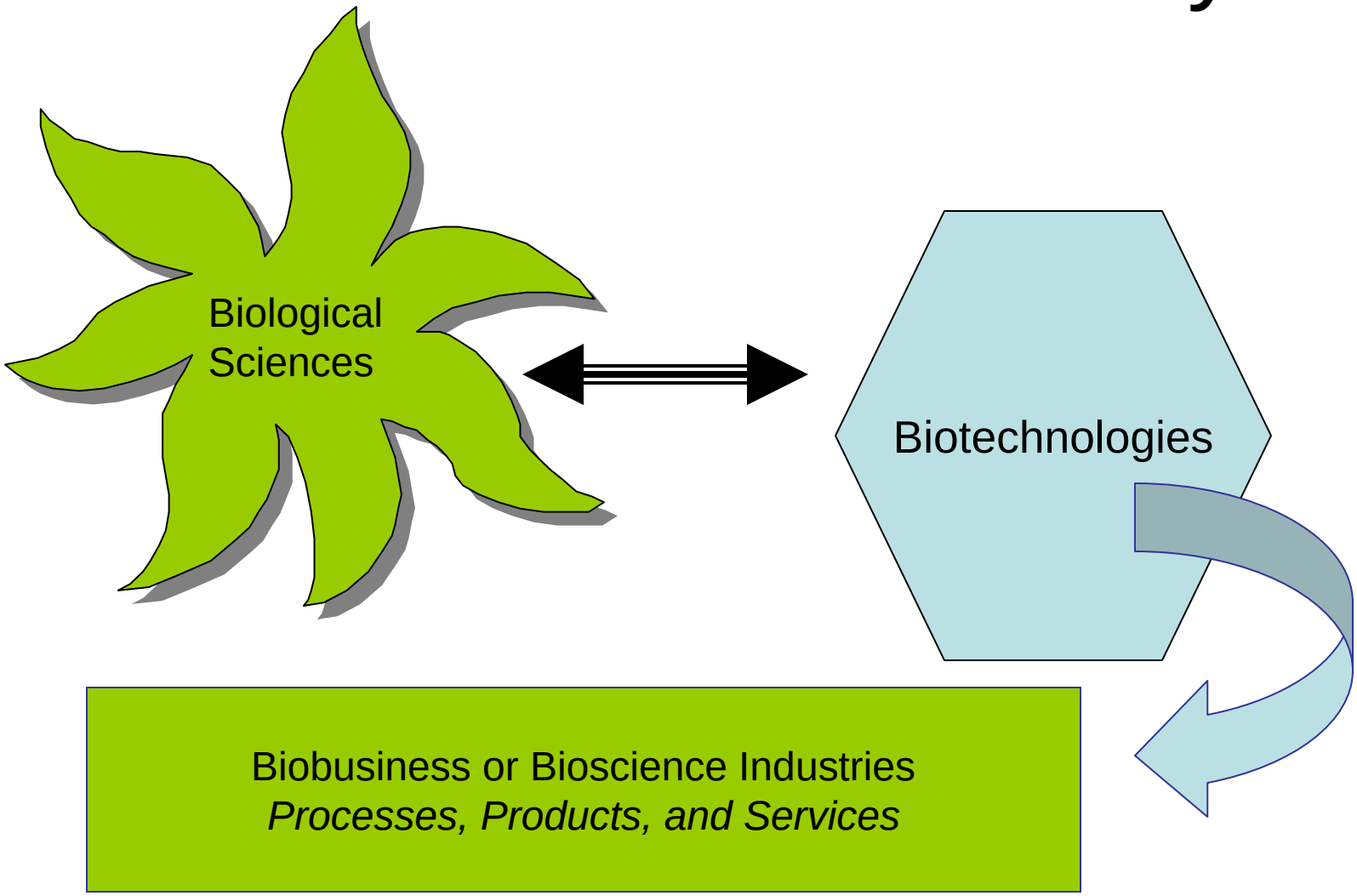
The Buzz

- JOBS
  - The biosciences employed 1.3 million people in the U.S. in 2006 and generated an additional 6.2 million jobs.
- HIGH WAGES
  - The average annual wage of U.S. bioscience workers was $71,000 in 2006 compared to $42,000 for the total private sector.
- SCIENTIFIC BREAKTHROUGHS
  - More than 82,000 bioscience-related patents were awarded between 2002 and 2007 in the U.S.
- GROWTH
  - Employment in the biosciences grew 5.7 percent since 2001, compared with 3.1 percent in the overall private sector.

Bioeconomy Jobs and Rural Development

- THE PUZZLE.
  - What is the bioeconomy?
- THE RURAL ROLE.
  - Where are the bioeconomy jobs?
- THE IMPLICATIONS.
  - What about rural development?

What is the Bioeconomy?



Biotechnology

The use of biological processes to solve problems or make useful products.

4000–2000 B.C.E.

• Biotechnology is first used to leaven bread and ferment beer with yeast (Egypt).

• Production of cheese and fermentation of wine begin (Sumeria,China and Egypt).

500 B.C.E.

• The first antibiotic is put to use: moldy soybean curds to treat boils (China).

100

• Powdered chrysanthemums are the first insecticide (China).

1870–1890

• Using Darwin's theory, plant breeders crossbreed cotton, developing hundreds of varieties with superior qualities.

• Farmers first add nitrogen-fixing bacteria to fields to improve yields.

• American botanist William James Beal produces first experimental corn hybrid in the laboratory.

1919

• The word biotechnology is first used in print.

Source: *Guide to Biotechnology 2008*

Modern Biotechnology

The use of cellular and biomolecular processes to solve problems or make useful products.

1953

• *Nature* publishes Watson and Crick's manuscript describing the double helical structure of DNA, beginning modern genetics.

1961

• USDA registers the first biopesticide: Bacillus thuringiensis, or Bt.

1976

• Recombinant DNA pioneer Herbert Boyer co-founds Genentech, the first company based on the technology.

1980

• The U.S. Supreme Court approves the principle of patenting organisms, allowing Exxon to patent an oil-eating microorganism.

1982

• FDA approves the first biotech drug: human insulin produced in genetically modified bacteria, developed by Genentech and Eli Lilly.

•The first recombinant DNA vaccine for livestock is developed.

1990

• The first insect-protected biotech corn is produced: Bt corn.

Source: *Guide to Biotechnology 2008*

Bioscience Industries and Biobusiness

Biotechnology is a collection of technologies that capitalize on the attributes of cells, such as their Mfg capabilities, and put biological molecules, such as DNA and proteins, to work for us.

The biosciences are a diverse group of industries that apply knowledge of the way plants, animals, and humans function.

The biosciences are a unique industry cluster, constantly changing to incorporate research and scientific discoveries.

Biobusiness is economic activity devoted to the development or commercialization of bioscience or bioscience-related technologies, products, or services.

A Color Guide to the Bioeconomy

Green. Agri-Bio Technology

Agriculture and food.

White. Bio-Industrial Technology

Industrial fields such as biomaterials, bioprocessing, bioenergy, bio-based chemicals, food ingredients and bioremediation.

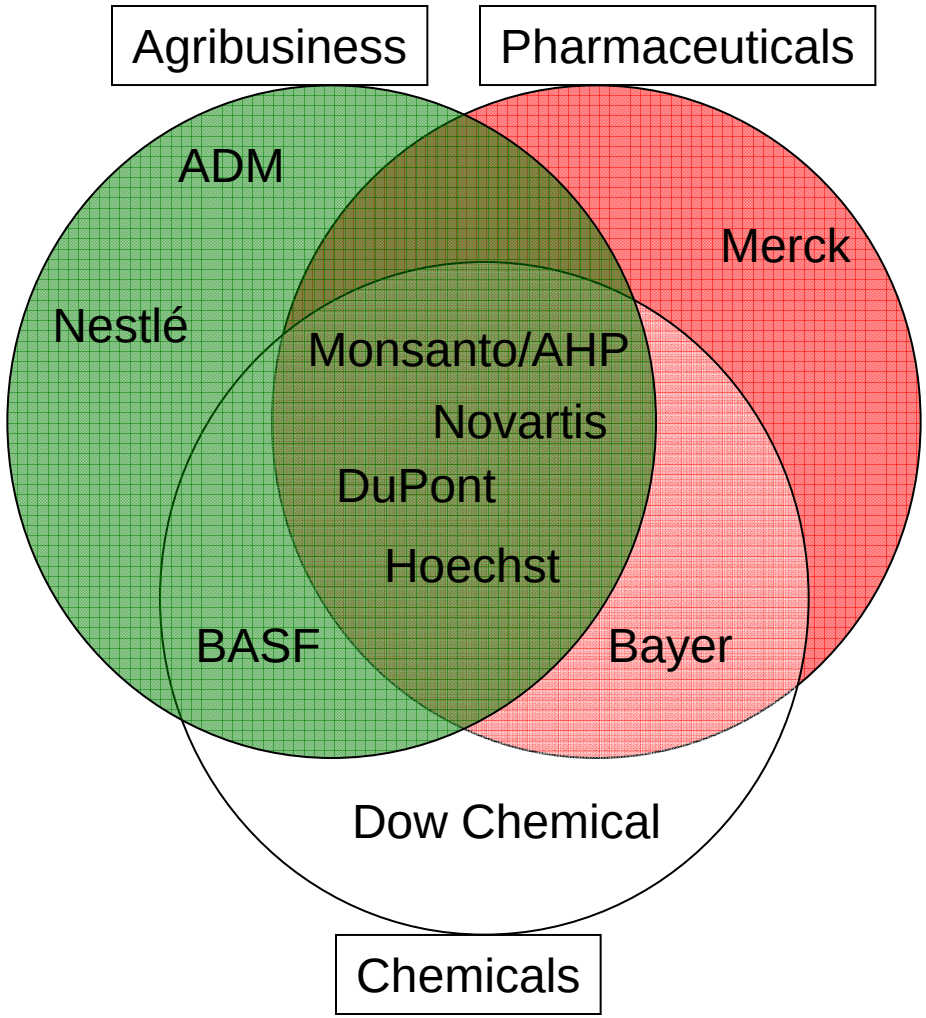
Red. Medical Technology

Human and animal health, including medical devices, pharmaceuticals and complex medical technology systems.

Blue. Aquatic Technology

Aquaculture, biotechnology-enhanced environmental remediation, and other water-related bioscience-based economic activities.

Industries Are Being Restructured



Source: Enriquez, *Science* 1998

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Battelle and BioBusiness Alliance Definitions, A Summary

				Est. by number of emp		
Color	BioBusiness Category	US Jobs 2006	Wage	Total	1000+	100+
Black	Research and Development	615,400	$93,751	14,799	76	1,078
Red	Medical Devices	388,300	57,601	12,995	43	776
Red	Pharmaceuticals	249,743	83,538	1,886	37	438
Red	Med and Diag Laboratories	228,067	49,451	12,063	22	337
Black	*{analytical labs, equipment}*	131,584	53,167	6,628	4	210
Green	*{fertilizers, ag. chemicals}*	99,461	67,606	1,605	6	220
Green	Agri-bio and Bio-Ind Tech	78,750	49,745	2,593	3	139

The BioBusiness Alliance of Minnesota

Battelle
The Business of Innovation

The Bioeconomy, 2006

			Est. by number of emp		
Color	Jobs 2006	Wage	Total	1000+	100+
Red	866,110	$62,934	26,944	102	1,551
Black	746,984	86,602	21,427	80	1,288
Green	178,211	59,714	4,198	9	359
Total	1,791,305	$72,483	52,569	191	3,198

Entire private non-farm sector:
120 million jobs, $40,206 average wage

The Red Bioeconomy

Industry	US Jobs 2006	Wage	Est. by number of emp Total	1000+	100+
Pharmaceutical Preparation Mfg	163,198	$81,409	959	22	269
Medical Labs	139,027	47,878	5,277	20	236
Surgical Appliance and Supplies Mfg	104,873	53,361	1,924	11	217
Surgical and Medical Instrument Mfg	100,499	60,671	1,269	14	245
Diagnostic Imaging Centers	89,040	51,908	6,786	2	101
Electromedical Apparatus Mfg	56,377	77,169	602	9	123
Dental Labs	47,088	34,706	7,261	1	34
Biological Product Mfg	33,220	93,587	323	6	54
In-Vitro Diagnostic Substance Mfg	26,971	80,095	246	5	60
Medicinal and Botanical Mfg	26,354	87,580	358	4	55
Ophthalmic Goods Mfg	24,302	52,362	591	4	46
Laboratory Apparatus and Furniture Mfg	21,703	51,343	415	1	52
Irradiation Apparatus Mfg	17,908	90,632	170	3	26
Dental Equipment and Supplies Mfg	15,550	43,622	763	0	33

Black Biotechnology

Industry	US Jobs 2006	Wage	Est. by number of emp Total	1000+	100+
R&D in the Physical, Engineering, and Life Sciences	615,400	$93,751	14,799	76	1,078
Testing Laboratories	100,139	47,687	6,063	2	139
Analytical Laboratory Instruments	31,445	70,618	565	2	71

Green Biotechnology

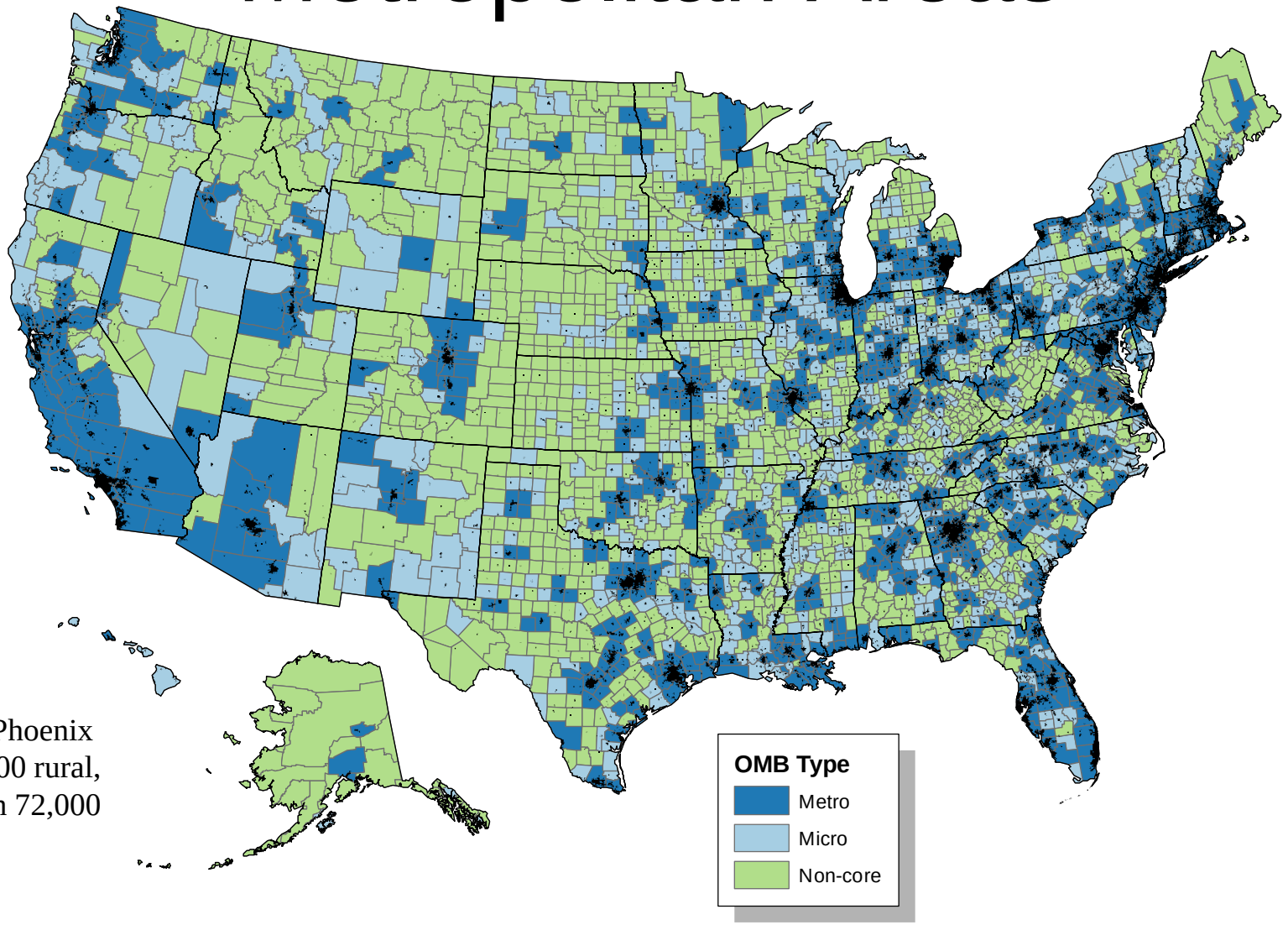
Industry	Jobs 2006	Wage	Est. by number of emp Total	1000+	100+
Misc. Basic Organic Chemical Mfg	69,713	$74,339	677	5	160
Wineries	29,926	42,503	1,791	1	48
Breweries	26,008	56,623	382	2	37
Pesticide, Other Ag Chemical Mfg	11,179	50,378	264	0	27
Wet Corn Milling	8,875	59,780	65	0	26
Fertilizer (Mixing Only) Mfg	8,851	38,755	476	0	8
Soybean Processing	6,492	42,496	111	0	15
Phosphatic Fertilizer Mfg	6,141	65,056	43	1	15
Ethyl Alcohol Mfg	4,262	49,955	187	0	6
Nitrogenous Fertilizer Mfg	3,577	66,006	145	0	10
Other Oilseed Processing	1,813	44,280	42	0	3
Cellulosic Organic Fiber Mfg	1,374	53,301	15	0	4

Where is the Bioeconomy?

What is the rural role?

Urban and Rural Areas

Metropolitan Areas



Phoenix
154,000 rural,
Tucson 72,000

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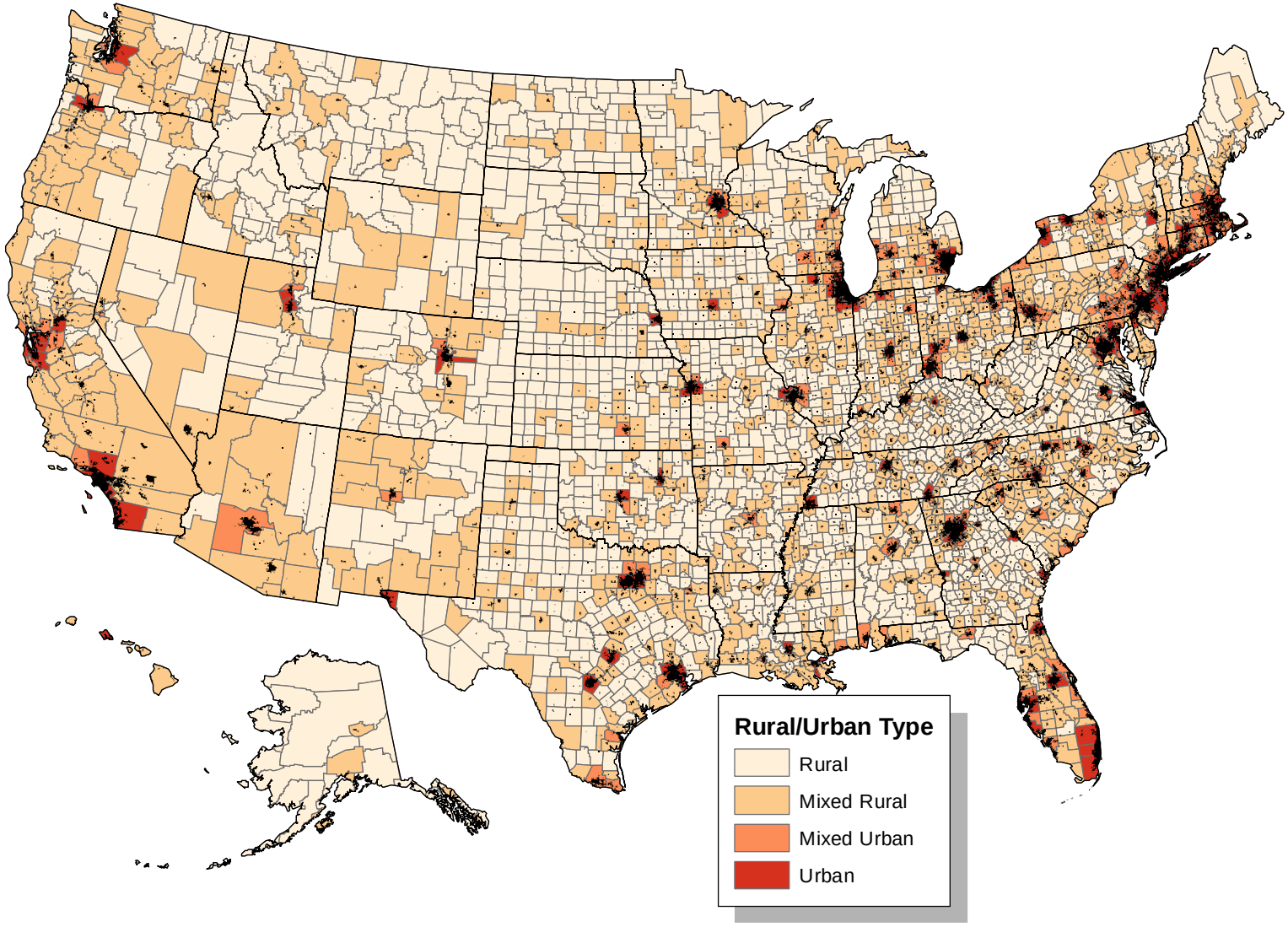
Rural-Urban Character



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The Rural Bioeconomy Share--Underrepresentation

			Establishments by No. Emp.		
County Type	Jobs	Share	Total	100+	1000+
Metro	1,665,045	93%	47,261	2,973	179
Non-metro	124,914	7%	5,263	222	12
Urban	1,132,843	63%	28,166	2,010	135
Mixed Urban	249,281	14%	8,035	428	22
Mixed Rural	358,053	20%	14,044	660	30
Rural	49,782	3%	2,279	97	4

Population shares
Non-metro 17%, Rural co. 10%, Mixed rural 31%
Mixed urban14%, urban 45%

Black Bioeconomy—Strongly Urban

		Rural			Mixed Rural				
Industry	Jobs	Total	Non-metro	Metro	Total	Non-metro	Metro	Mixed Urban	Urban
Testing Laboratories	100,139	3	2	1	23	6	17	16	58
R&D in the Sciences	615,400	1	1	0	13	2	11	12	74
Analy Lab Instruments	31,445	0	0	0	20	2	18	15	65

Population shares
Non-metro 17%,
Rural co. 10%, Mixed rural 31%
Mixed urban14%, urban 45%

Red Bioeconomy

		Rural			Mixed Rural				
Industry	Jobs	Tot	Non-Met	Met	Total	Non-Met	Met	Mixed Urban	Urban
Lab Apparatus	21,703	8	6	1	29	15	15	20	42
Medical Instrument	100,499	5	2	3	22	7	15	15	59
Surgical Supplies	104,873	4	3	1	32	12	19	14	50
Pharmaceutical Prep	163,198	4	3	1	16	4	12	11	68
Medicinal and Botanic	26,354	3	3	1	14	2	12	15	67
Dental Labs	47,088	2	2	0	23	5	18	16	58
Biological Product	33,220	2	2	0	33	15	19	30	35
Ophthalmic Goods	24,302	1	1	0	11	2	9	16	72
Electromedical App	56,377	1	1	0	10	2	9	14	74
Dental Equipment	15,550	1	1	0	26	6	20	12	61
Diagnostic Imaging	89,040	1	1	0	21	4	17	17	62
In-Vitro Diagnostic	26,971	1	0	1	8	1	7	5	86
Medical Laboratories	139,027	1	1	0	15	2	13	13	72
Irradiation Apparatus	17,908	0	0	0	3	1	3	36	60

Green Bioeconomy

Industry	Jobs	Rural			Mixed Rural			Mixed Urban	Urban
		Total	Non-Met	Met	Total	Non-Met	Met		
Cellulosic Organic Fiber	1,374	58	14	44	15	0	15	18	10
Ethyl Alcohol	4,262	45	39	6	43	22	21	3	8
Soybean Processing	6,492	24	20	5	63	24	38	3	10
Phosphatic Fertilizer	6,141	19	18	1	61	23	38	3	17
Nitrogenous Fertilizer	3,577	18	17	0	67	27	39	6	10
Fertilizer (Mixing Only)	8,851	14	11	2	57	21	35	12	18
Pesticide, Other Ag Chem	11,179	13	11	3	45	18	27	7	35
Other Oilseed Processing	1,813	10	9	1	41	16	25	6	43
All Other Basic Organic Chem	69,713	7	6	1	32	9	23	24	37
Wet Corn Milling	8,875	7	4	3	67	38	29	4	22
Wineries	29,926	6	5	1	77	8	69	6	11
Breweries	26,008	2	2	0	26	3	23	16	55

The Implications

What about rural development?

Conclusions

- Identifying the bioeconomy with federal statistics is difficult
  - Establishments assigned to industry by major product
  - Biotechnologies are often processes, not products
  - A product can be produced with or without modern biotechnologies, e.g., milk and corn

Conclusions

- The Green bioeconomy is relatively small, but the most rurally oriented.
- The Green bioeconomy shows the least job growth.
- Biotechnology has not and might not translate into jobs, jobs, jobs for rural places.

Change 1998-2006	
Black	345,094
Green	-26,580
Red	129,915

Many Rural Areas Do Well in the Bioeconomy

- 50 mixed rural counties have more than 1,000 extra bioeconomy jobs
- 126 mixed rural counties have more than 500 extra bioeconomy jobs
  - Extra jobs is a measure of economic specialization relative to county population
- 59 rural counties have more than 150 extra bioeconomy jobs

Intriguing Research Questions

- The location and nature of rural bioeconomic centers
- The determinants and consequences of that specialization
- The cloning of well paying rural jobs