Nutrient Management in Organic Production

ORGANIC PRODUCTION

- Tradition
- Philosophy
- Science

Characteristics of Organic Production

- Reliance on on-farm nutrient sources, fewer purchased inputs
- Holistic- emphasis on soil building, soil health, crop rotation, nutrient recycling
- Requires natural rather than manufactured nutrient sources
- Essentially all manufactured or synthetic fertilizers and pesticides are prohibited

Characteristics of Organic Production

- Genetically altered or engineered species prohibited
- Materials containing chlorides, nitrates, highly-soluble phosphates are usually prohibited
- Sewage sludge prohibited – concern with metals in sludge

Organic Certification

- Largely by organic growers organizations
- USDA National Organic Program
  - Standardize production, certification, labeling
  - Assure consumers of consistent standards in growing and labeling
- Effect of history and tradition

Organic Production

- Extent of organic food production (USA)
  - < 2% of total sales
  - $ 9 billion in 2002
  - $ 2 billion in 1992
  - 20% annual growth in decade

DETERMINING NUTRIENT NEEDS

- Soil testing
- Nutrient deficiency symptoms
- Plant analysis

Organic certification – General requirements (OCIA)

- Fields or farms certified organic if:
  - No use of unacceptable materials for three years prior to first certifiable harvest
  - Full application of OCIA standards for one year before first organic harvest

Organic certification – General requirements (OCIA)

- Fields or farms certified organic if:
  - Inspection in the final year of conversion to organic.
  - At least three years of information on production methods and materials and an outline of farm management strategies must be provided (audit trail).

Required practices for organic certification

- Soil building program
  - Enhance organic matter
  - Encourage soil health
- Crop rotations
- Soil testing usually not mandatory
  - Testing recommended for problem solving

Soil Organic Matter

- Most Wisconsin soils = 1-5%
- Organic soils = 20-50+ %
- About 2-3% of OM decomposes annually

BENEFICIAL EFECTS OF CROP ROTATIONS

- Nitrogen from previous legumes
- “Rotation effect” not related to N
  - Soil physical properties
  - Reduced disease and insects
  - Crop residue effects
- Effects on nitrogen cycling

Required practices for organic certification

- Management to control weeds, pests, diseases
  - Resistant varieties
  - Inter-cropping
  - Maintain soil health
- Generate audit trail
  - Sources, amounts of off-farm inputs
  - Date, place of harvest
  - Steps between harvest and sale

Soils and Plants – Authorized Methods and Materials (Organic Matter)

- Manure
  - Sources and management documented
  - Amounts of organic materials brought onto farm limited
  - Manure additions cannot exceed farm's generation potential

Soils and Plants – Authorized Methods and Materials (Organic Matter)

- Manure
  - Composted or uncomposted manures
  - Free of contaminants if off-farm
  - Fresh manure/uncomposted
    - Apply to perennials, crops not for human consumption
    - Apply at least four months before crop harvest
    - Apply to warm soil (10^{o} C)

Soils and Plants – Authorized Methods and Materials (Organic Matter)

- Green manures, crop residues, peatmoss, straw, seaweed, similar materials
- Composted food and forestry by-products
- Sewage sludge, septic waste prohibited

Soils and Plants – Authorized Methods and Materials (Minerals)

- Agricultural limestone
- Natural rock phosphates
  - Fluorine not to exceed 5 kg/ha/yr
- Wood ash, Sulpomag, bonemeal, fishmeal
- Cottonseed meal, leathermeal
- Potassium sulfate (mined)

Soils and Plants – Authorized Methods and Materials (Minerals)

- Borax (solubor)
- Sodium molybdate
- Sulfate trace mineral salts
- Ammonia and urea, prohibited
- Nutrient sources containing highly-soluble nitrate, phosphate, chloride, prohibited

Rock Phosphate as a Phosphorus Source

$Ca_{10}(PO_4)_6(X)_2$ X = F, OH, Cl

- Minerals called apatites
- Most common is fluorapatite
- Finely-ground rock phosphate (RP) is an effective P source on acidic soils (pH < 6)
- Most effective on acid low-calcium soils

Rock Phosphate as a Phosphorus Source

- Application rates 2 to 3 X rates of manufactured P fertilizer needed to meet crop needs
- If lime is added to soils receiving RP as a P source, apply lime after RP has had time to react with soil for about 6 months.
- Fluorapatite is 3.77% F
- Limitation of 5 kg F/ha/yr means limit of 132 kg/ha of RP/yr

Potential Nutrient Sources for Organic Production - Nitrogen

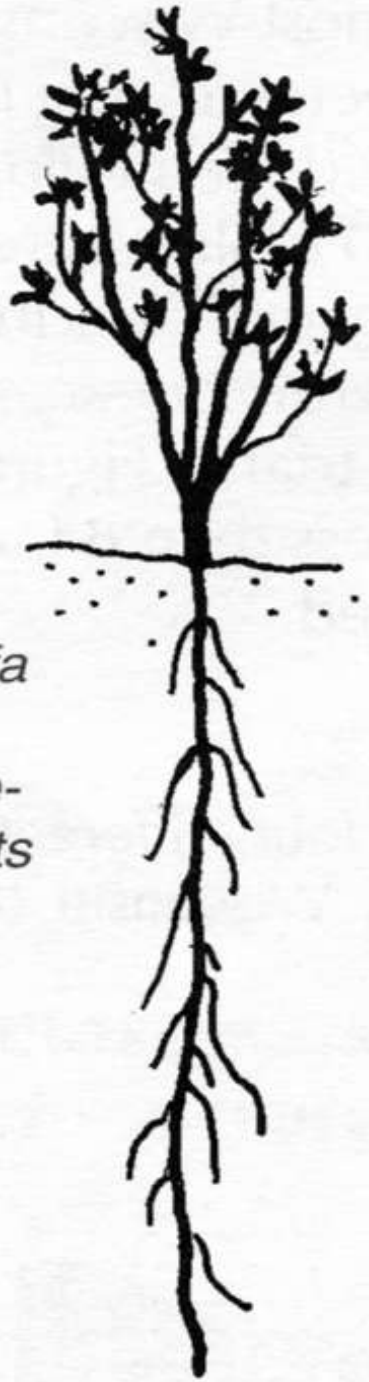
- Previous legumes in rotations
  - Provide adequate N for most crops
  - Provide an opportunity for application of fresh manures if crop is not for human consumption

Nitrogen credits for forage legumes

Based on:

- Crop
- Soil Texture
- Plant density
- Harvest management


UW
Soil Science
Extension



In a mature alfalfa plant, 40-60% of the N is in above-ground plant parts and 40-60% is in the roots.

Nitrogen Credits for Alfalfa

Stand density	Sandy soils		Other soils	
	Regrowth			
	≤8”	>8”	≤8”	>8”
	lb N/a			
Good *(70-100%, >4 plants/sq ft)*	100	140	150	190
Fair *(30-69%, 1.5-4 plants/sq ft)*	70	110	120	160
Poor *(0-29%, <1.5 plants/sq ft)*	40	80	90	130

Corn response to N following alfalfa, avg. of 24 sites, 1988-1991*

Treatment	Yield
No N	144
With N**	144

* Bundy & Andraski, 1993

** Avg. of 4-5 N rates

Nitrogen credits for green manure crops

Crop	N credit (lb N/acre)
Sweet clover *	80 - 120
Alfalfa *	60 - 100
Red clover *	50 - 80
Vetch **	40 - 90

* 40 lb N/a if less than 6 in. growth

** 110-160 lb N/a if more than 12 in topgrowth

Legume N Credits

- Red clover, Birdsfoot trefoil:
  - Use 80% of alfalfa credit for similar stands
- Forage legumes, 2nd year credit:
  - Credit 50 lb N/a for any good or fair stand
  - No credit on sand or loamy sand

Legume N Credits not affected by:

- Time of killing
  - Spring or fall
- Method of killing
  - Herbicide, tillage, or winterkill
- Tillage

Legume N Credits

- Key information:
  - Stand density
  - Regrowth in late October
- Confirm credits with presidedress soil nitrate test (PSNT)

Legume N Credits

- Soybean
  - Credit 40 lb N/a
- Vegetable crops:
  - Peas, beans, dry beans
  - Credit 20 lb N/a
  - No credit on sand or loamy sand

Potential Nutrient Sources for Organic Production - Nitrogen

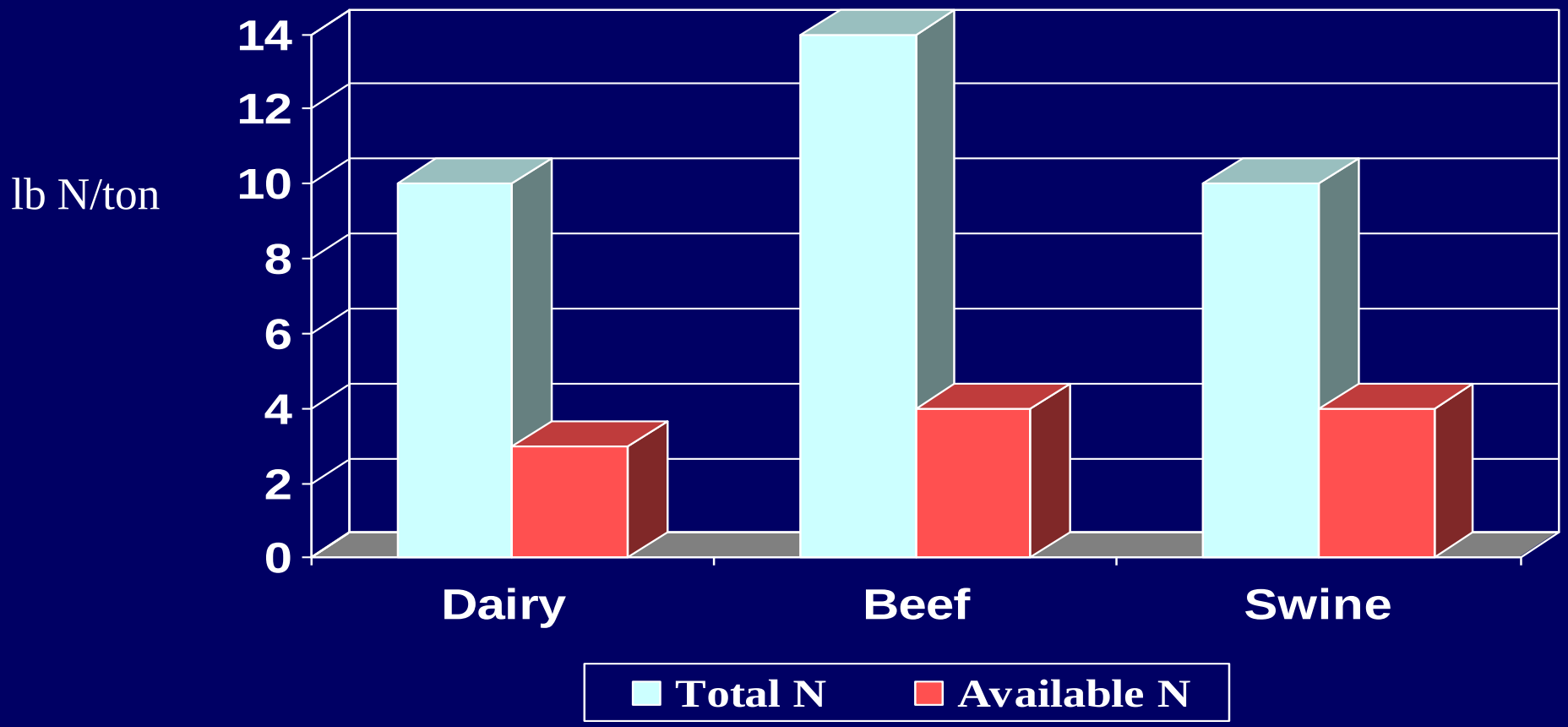
- Manure
  - Composted manure - Nitrogen availability may be reduced
  - Fresh or uncomposted – applied four months in advance to warm soils

Available Nitrogen Content of Manure

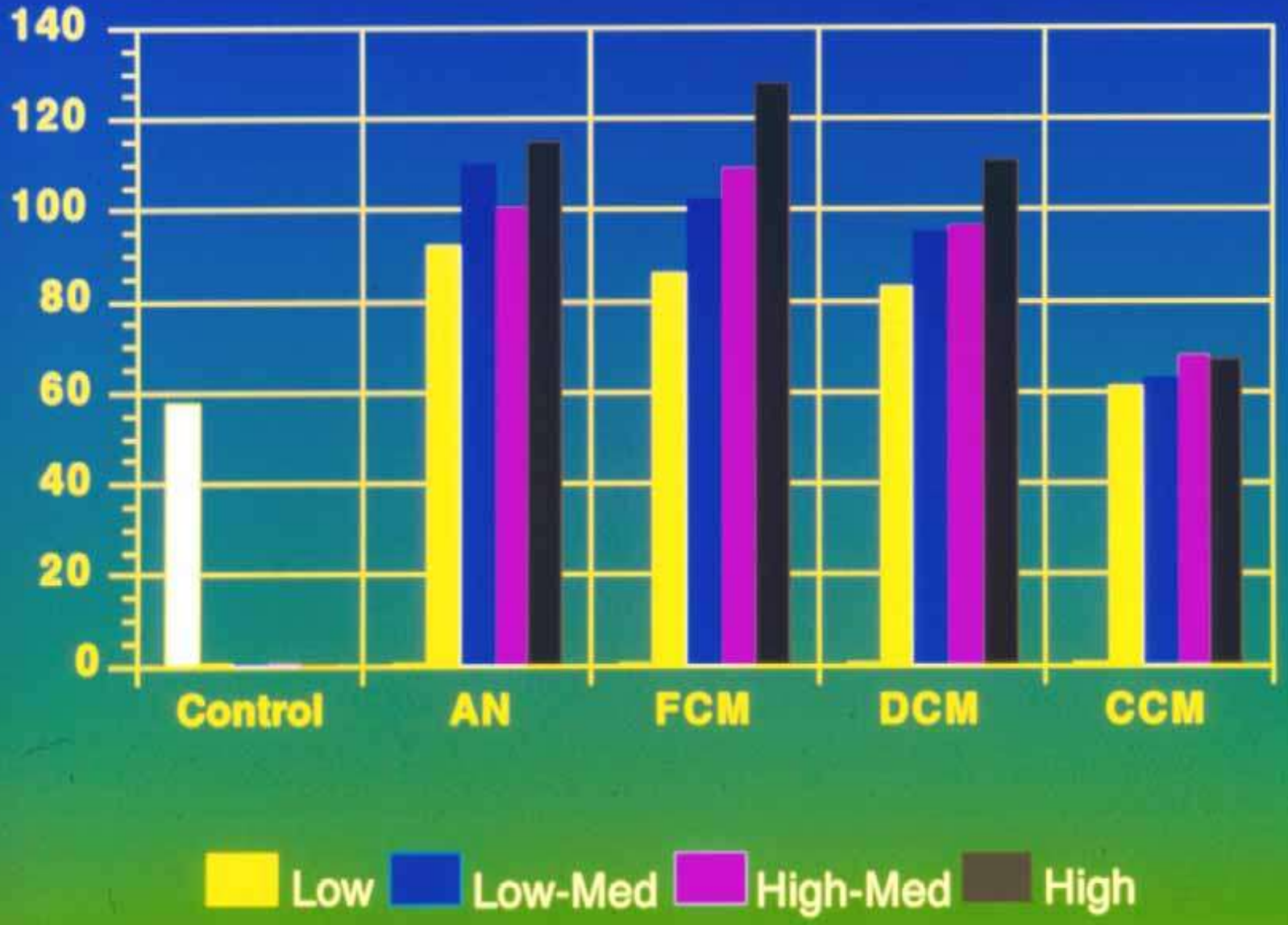
Solid Manure

	Surface Applied	Incorporated
	(lb N / ton)	
Dairy	3	4
Beef	4	4
Swine	4	5

Manure Nitrogen Content – Solid Manure



First-Year Corn Grain Yield (bu/a)
1992



Estimated N availability from several manure types.

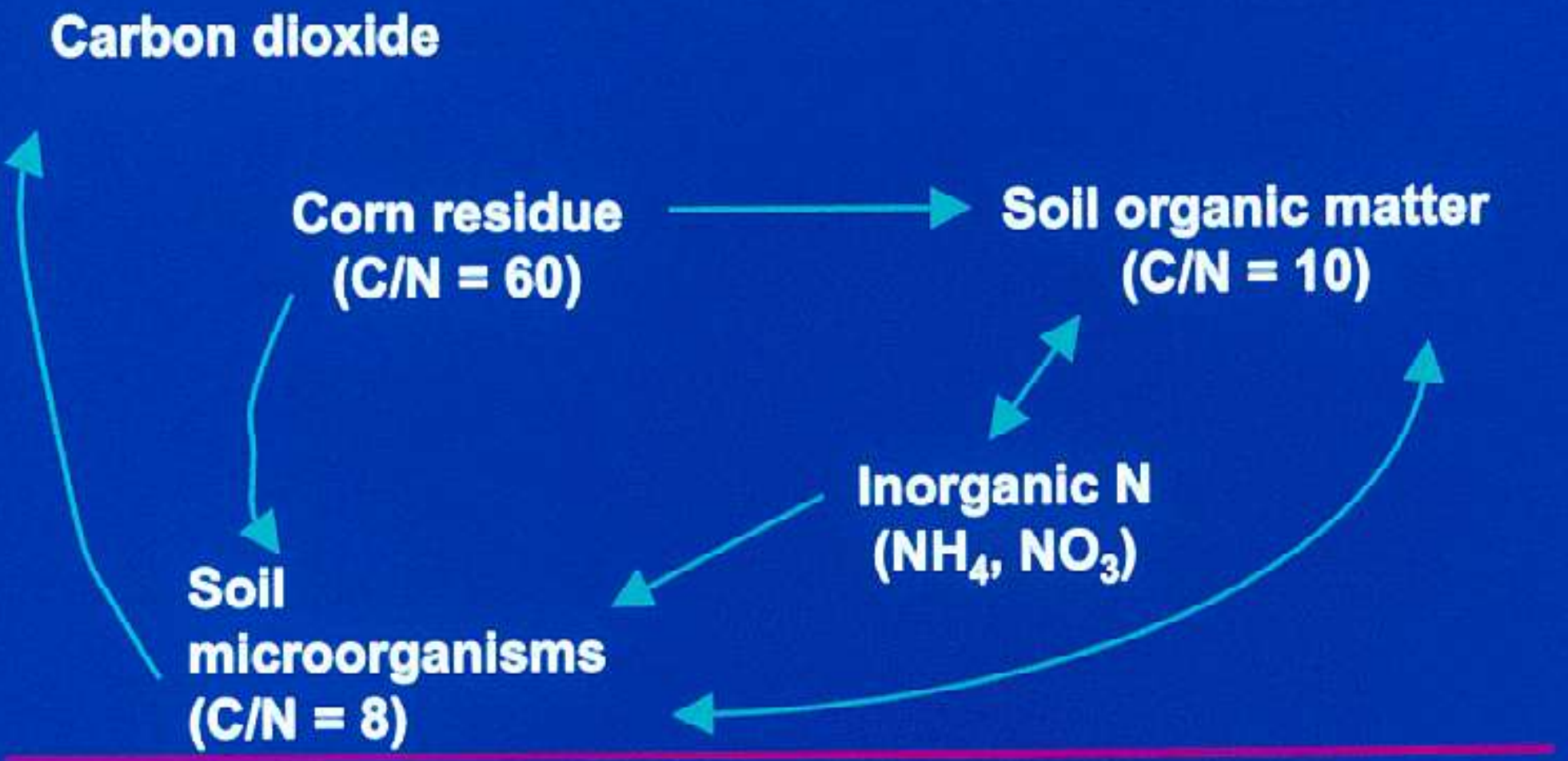
Manure type	Fert. equiv.		N recovery	
	Range	Avg.	Range	Avg.
	----------%		----------%	
Fresh chicken	26 – 65	45	11 – 42	29
Dries chicken	26 – 90	50	12 – 88	35
Composted chicken	3 – 31	16	(-4) – 17	6
Composted cow	5 – 27	14	(-21) – 33	1

3 year average, Arlington, WI.

Potential Nutrient Sources for Organic Production - Nitrogen

- Waste materials and by-products
  - Uncertainty about N availability
  - May depend on C/N ratio of material
  - Risk of contamination with prohibited materials
  - Many are too expensive to supply entire crop N need

Carbon and nitrogen transformations in corn residue decomposition



Carbon: Nitrogen Ratios of Organic Materials

Material	C : N Ratio
Soil microorganisms	8
Soil organic matter	10
Alfalfa	12
Rotted manure	20
Corn residue	60
Grain straw	80
Sawdust	300

Carbon : Nitrogen ratio effects on N release

Expected N Effect	C : N range
Release N	< 20
Depends on Composition	20 - 50
Immobilize (Tie up) N	> 50

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Potential Nutrient Sources for Organic Production

- Phosphorus
  - Rock phosphate
  - Manures
- Potassium
  - Potassium sulfate – mined sources only
  - Manures

Manure Credits

Nutrients available for crop use in the first year after spreading manure

Animal	Solid				Liquid			
	N		P_2O_5	K_2O	N		P_2O_5	K_2O
	Incorp*	Not Incorp			Incorp*	Not Incorp		
	---------lbs/ton---------				---------lbs/1000 gal---------			
Dairy	4	3	3	8	10	8	8	21
Beef	4	4	5	8	12	10	14	23
Swine (finish)	5	4	3	7	28	22	15	26
Swine (farrow)	5	4	3	7	15	12	6	8
Poultry	15	13	14	9	41	35	38	25

***injected or incorporated into the soil within 72 hours after spreading.**

Source: Dept. of Soil science, College of Agricultural and Life Sciences, University of Wisconsin-Madison, University of Wisconsin-Extension.

Potential Nutrient Sources for Organic Production

- Sulfur
  - Manures
  - Gypsum, potassium sulfate – mined sources only
  - Potassium magnesium sulfate (sulpomag) – mineral forms
- Micronutrients
  - Sulfate salts of some cationic nutrients may be allowed

Sources of potassium & sulfur

Name of fertilizer	Chemical formula	Fertilizer analysis (%) $N\text{-}P_2O_5\text{-}K_2O$	Sulfur Content (%)
Calcium sulfate (gypsum)	$CaSO_4 \cdot 2H_2O$	0-0-0	17
Potassium sulfate	K_2SO_4	0-0-50	18
Potassium-magnesium sulfate (langbeinite)	$K_2SO_4 \cdot 2MgSO_4$	0-0-22	23
Greensand (glauconite)		0-0-7	0

Available sulfur from several types of manure

Animal type	Sulfur content			
	Solid (lb S/ton)		Liquid (lb S/1000 gal)	
	Total	Avail.	Total	Avail.
Beef	1.7	0.9	4.8	2.6
Dairy	1.5	0.8	4.2	2.3
Poultry	3.2	1.8	9.0	5.0
Swine	2.7	1.5	7.6	4.2

Yield and Vitamin Content of Organically and Conventionally Grown Sweet Corn, Nova Scotia

	Year 1		Year 2		Year 3	
Parameter	C	O	C	O	C	O
Sweet corn yield, tons/ha	4.73	4.80	12.95	11.16	8.92	5.97
Vitamin C, ppm	78	73	109	105	13	16
Vitamin E, ppm	4.3	3.7	2.6	2.5	0.9	1.4

Warman & Harvard (1998). O = organic; C=conventional. Vitamin C = fresh wt.; vitamin E = dry wt.

Figure 1: Certified organic farms by state, 2001

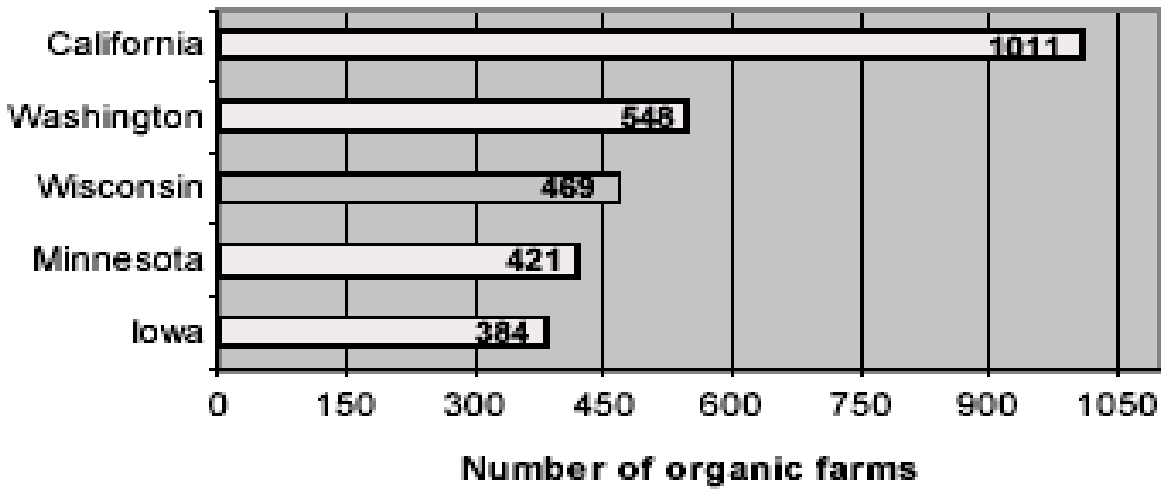
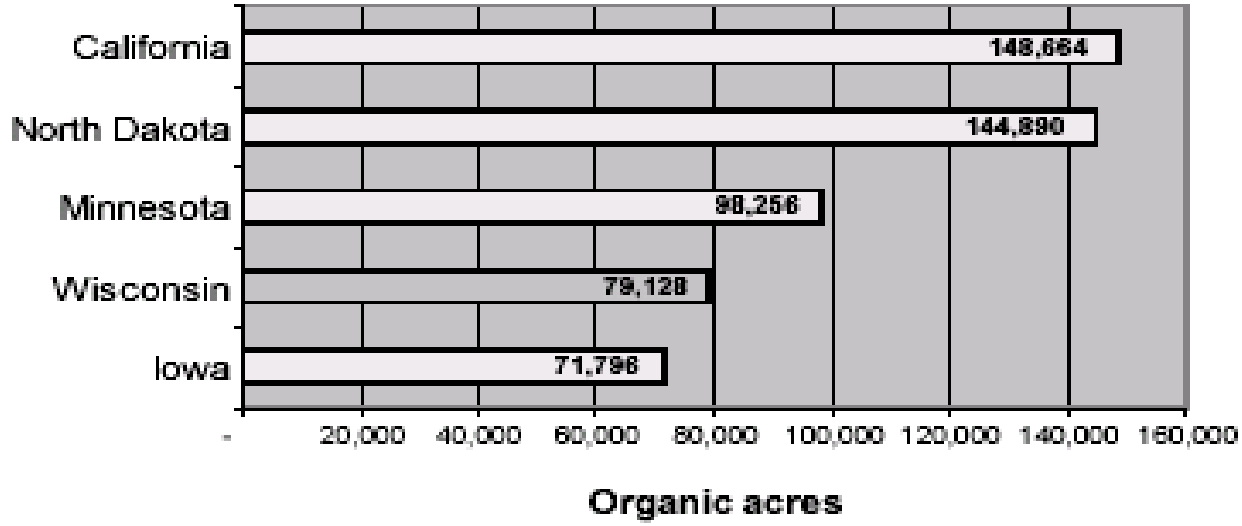


Figure 2: Certified organic cropland by state, 2001



Source: USDA ERS

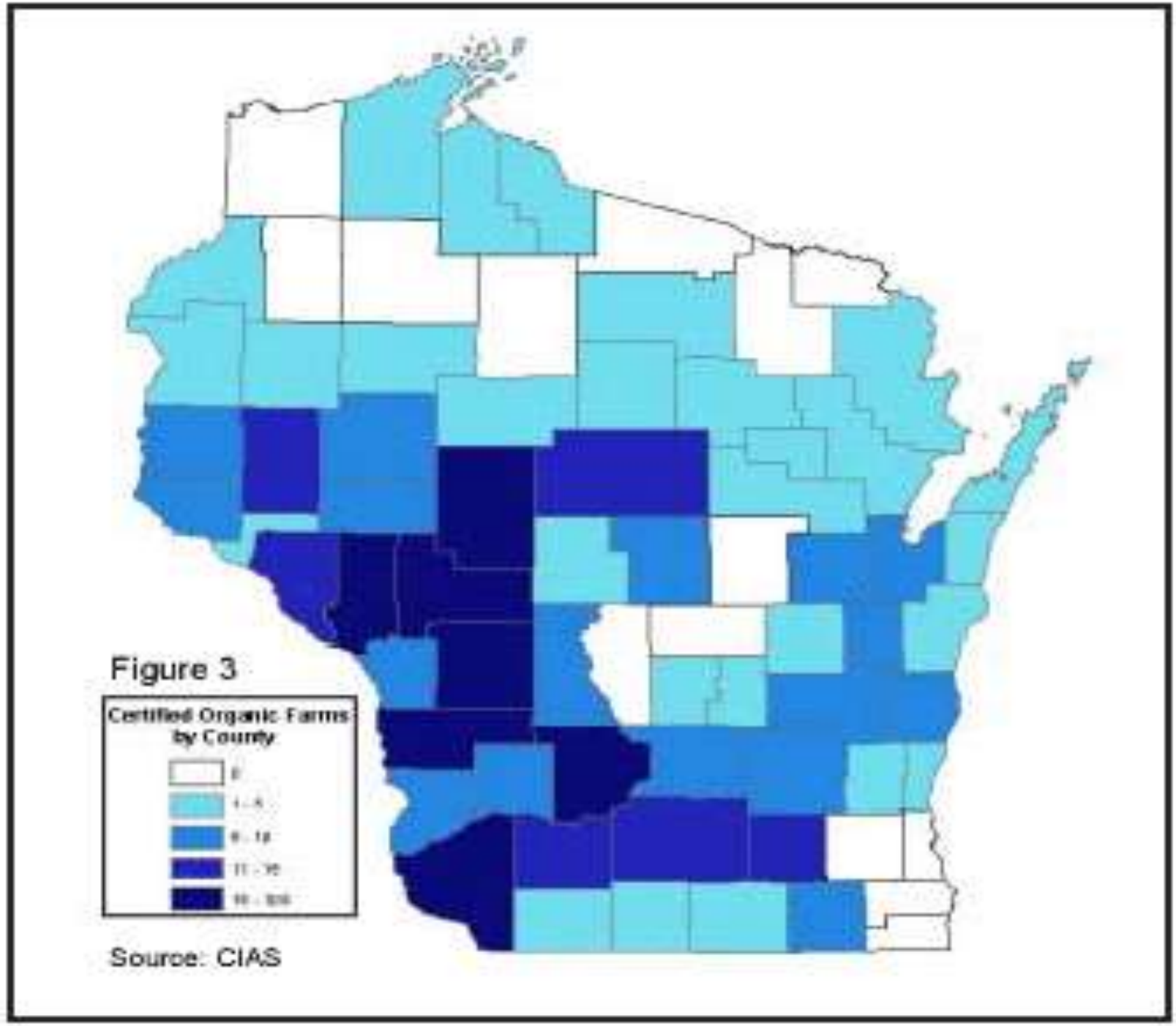
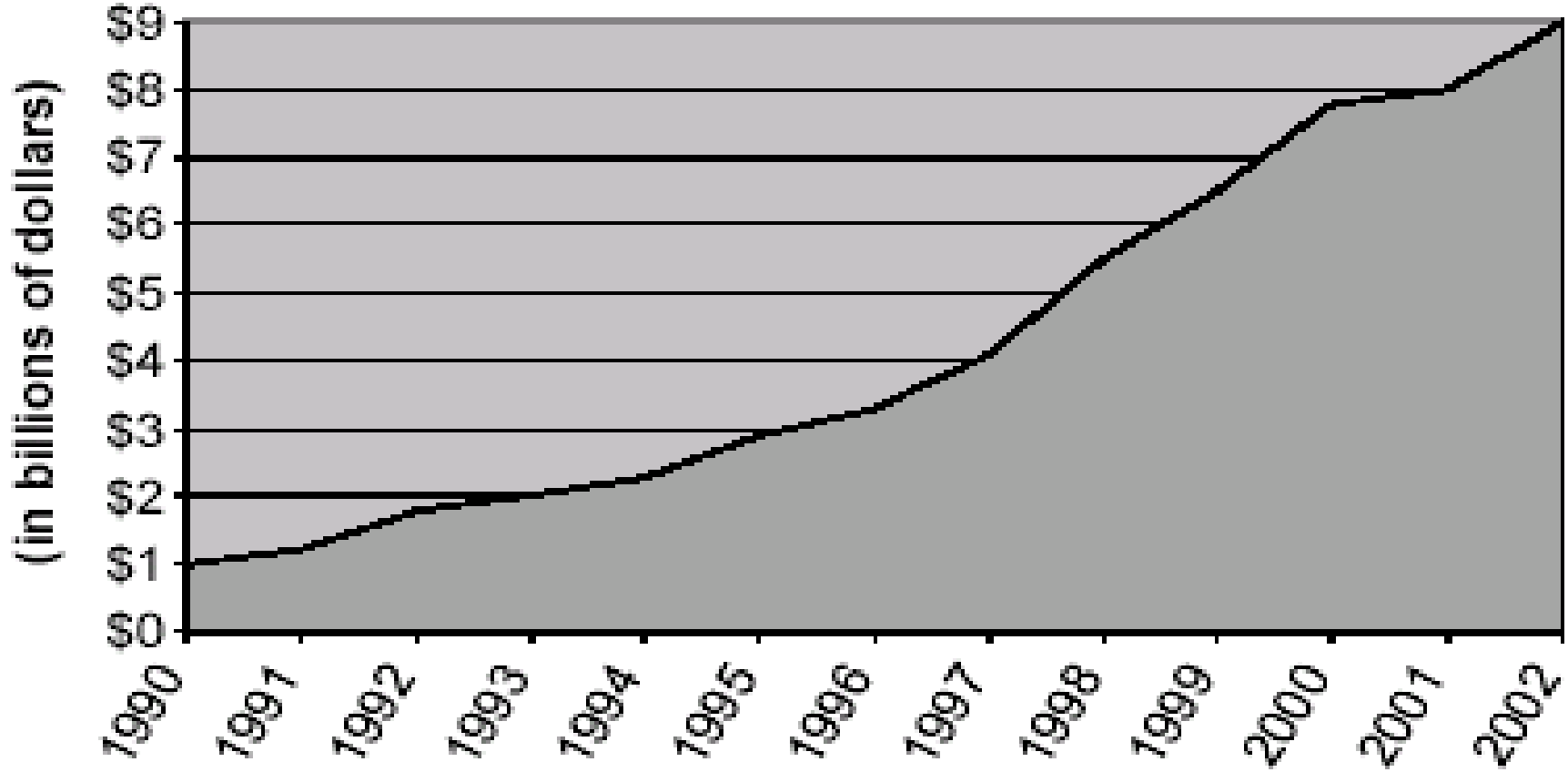


Figure 3

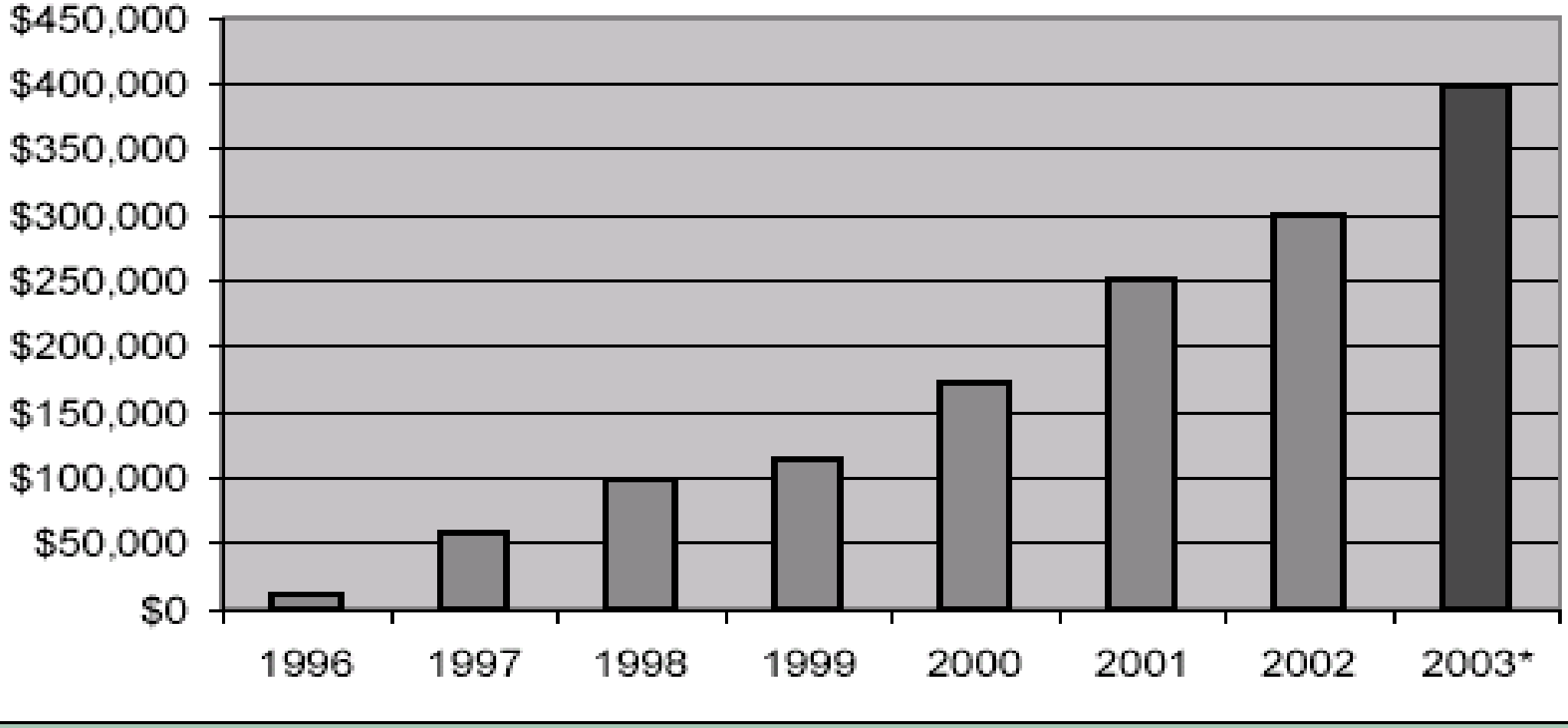
Source: CIAS

Figure 8: National Sales of Organic Products, 1990-2002



Source: Dimitri and Greene

Figure 6: Home Grown Wisconsin Annual Gross Sales



*projected

Source: Home Grown Wisconsin

Figure 4: Dairy Farmer Pay Price, 1990-2001

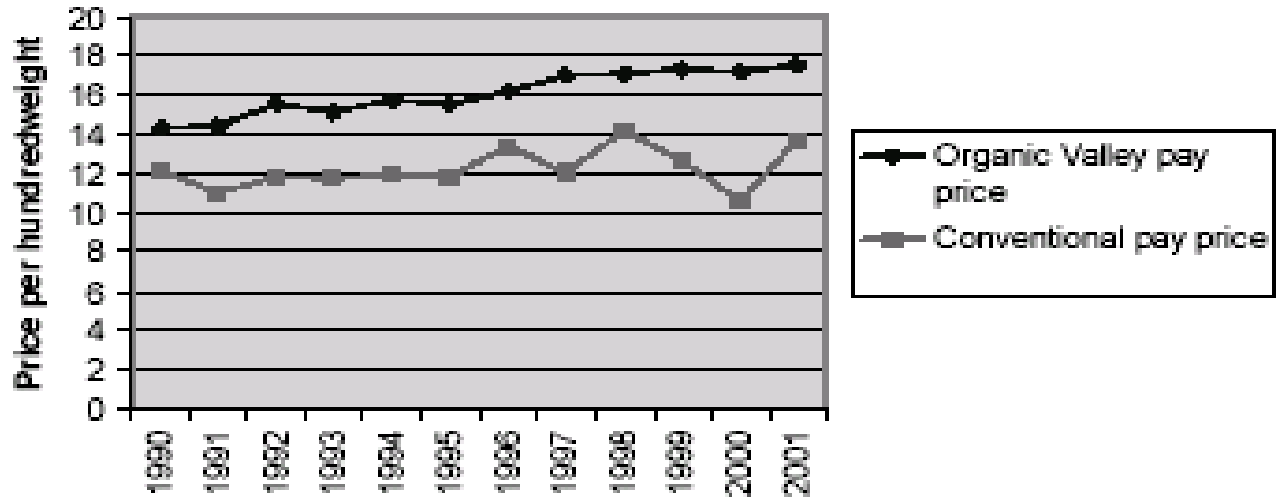
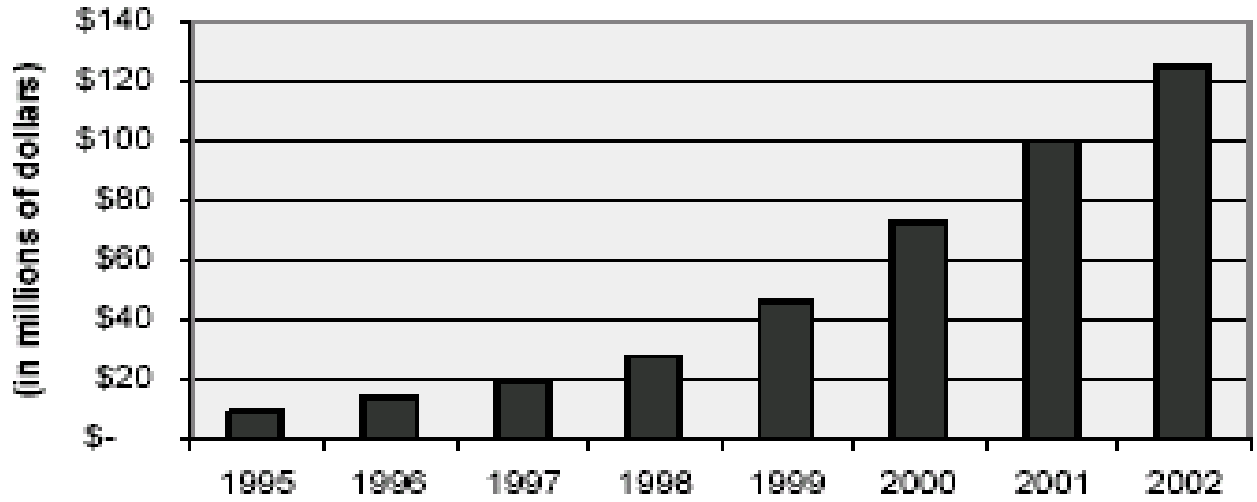
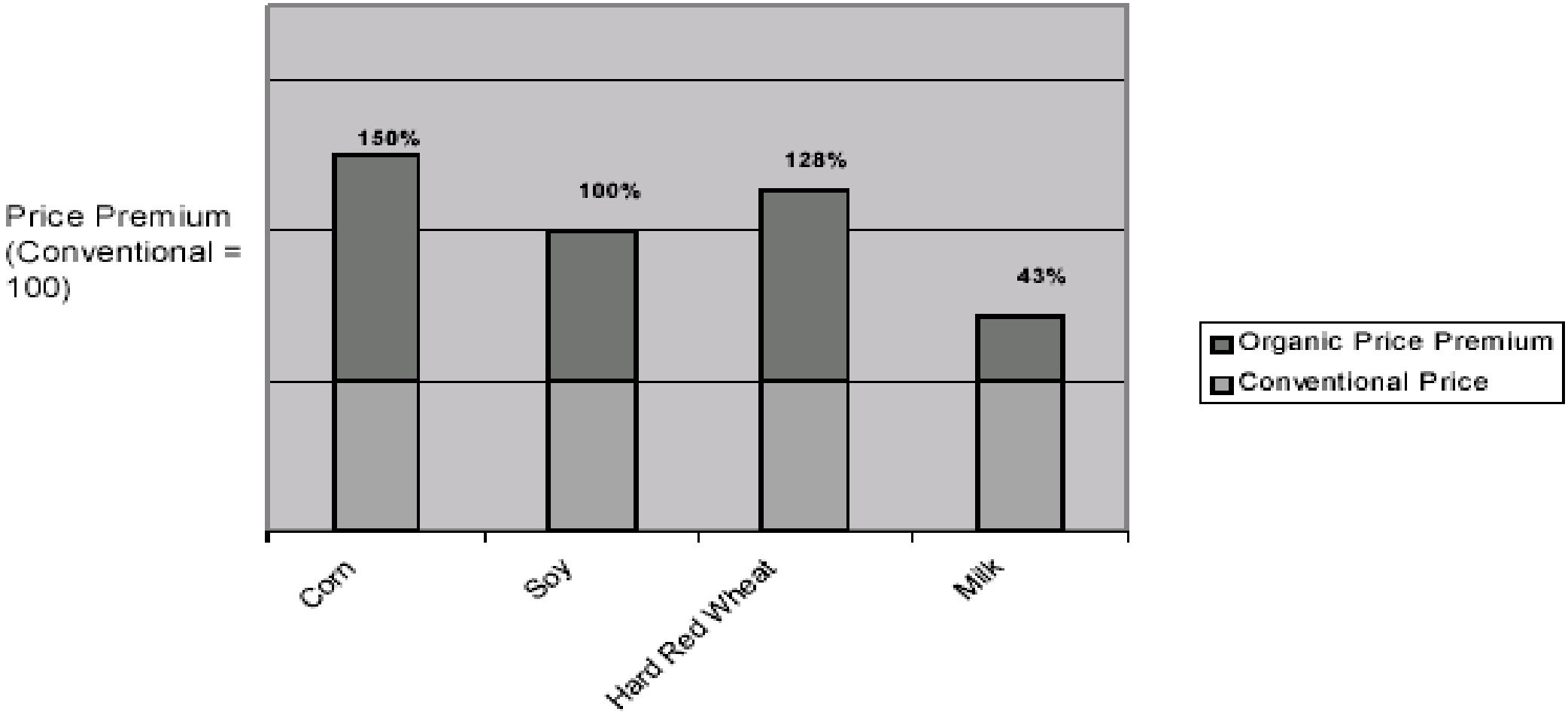


Figure 5: CROPP Yearly Sales, 1995-2002



Source: UW Center for Cooperatives

Figure 7: National Organic Price Premiums for Producers



Source: Rodale Inst. (corn, soy, wheat); CROPP 5-year avg. (milk)