

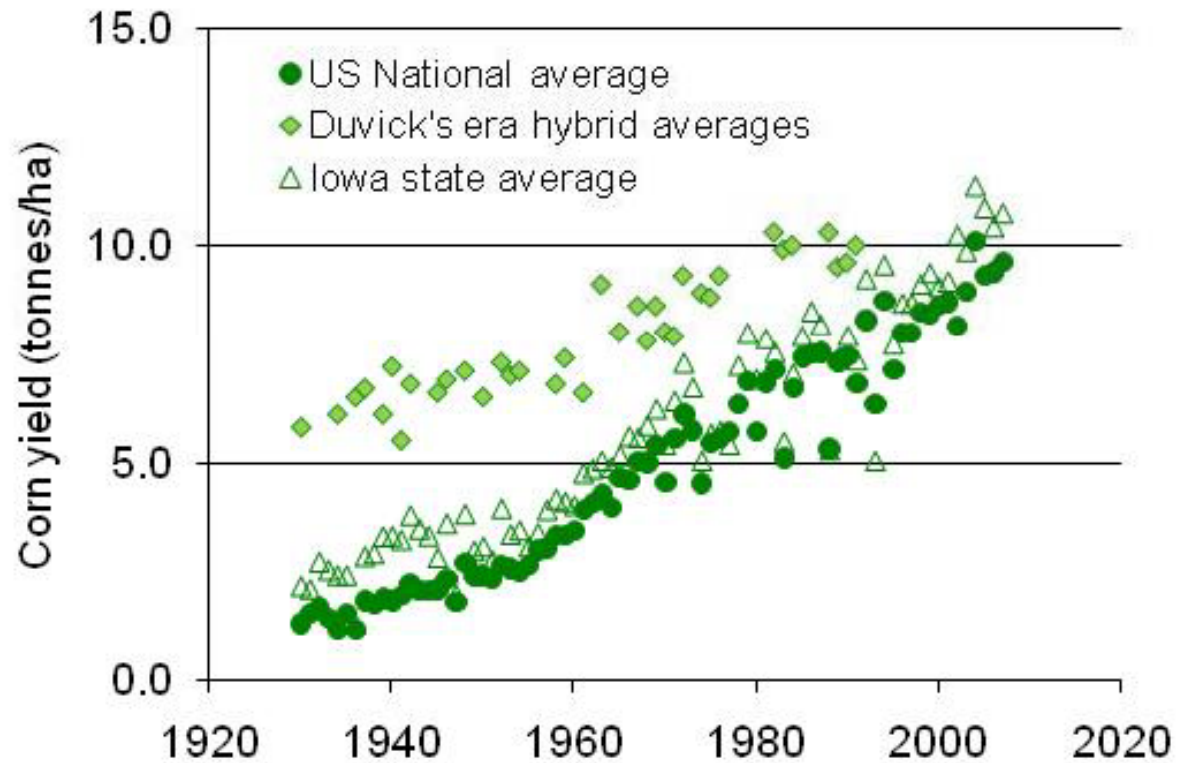


Breeding, Biotechnology and Business

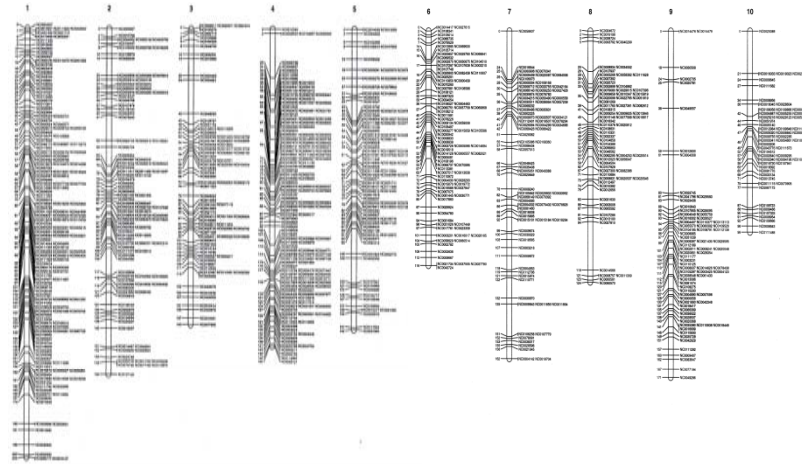
Increasing crop yields

Workshop on Land Use Change Simulations with the GTAP Model
Argonne National Laboratory and Purdue University
Mike Edgerton
25 January 2009

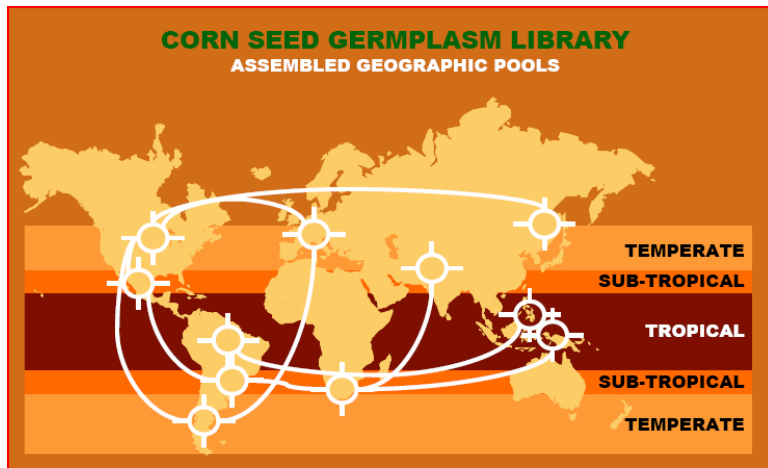
National yield average has increased as new technologies are developed and adopted



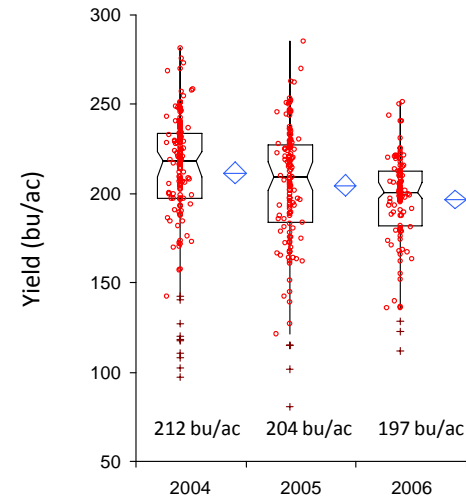
Breeding and Biotechnology are both needed for good yield



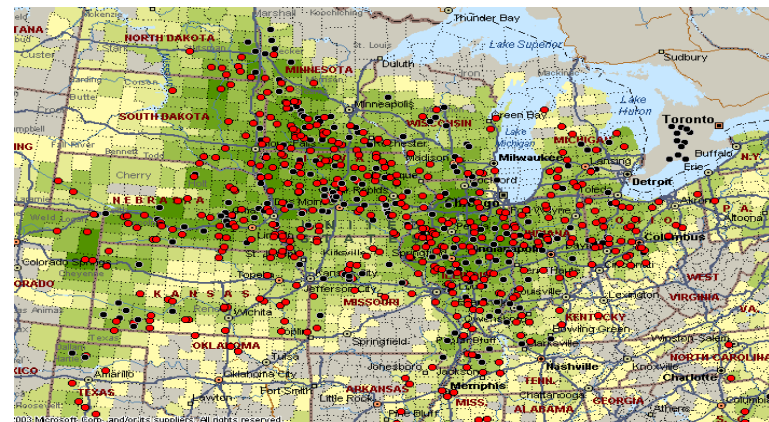
Genetic diversity and solid test data are the backbone of any breeding program



379 yield tests of same hybrid



- Monsanto's corn germplasm library is assembled from 36 breeding programs in 12 countries
- Annually, breeders exchange more than a million different "packages" of genetic material
- >50% of Monsanto's corn hybrids result from intra-company crosses
- > 3 million test plots grown in US in 2008



DNA-based markers and high quality software allow in country breeders to be “molecular breeders”

Project Details
 Project: 170201 Crop: Maize Cycle: C0 Parents: 23CDC5, 90LDC2 Origin: 90LDC2*2/23CDC5

Score QC Trait Analysis **Model Build** Recombination Markers List

P-Value: 0.1
 Auto Compute
 Compute Model
 Save Model
 Reset

	MTI	H:MB_MST	H:MB_TWT	H:MB_YLD	H:SB_EHT	H:SB_PHT	H:SB_SHW
%Weight applied	100.00	33.33	33.33	33.34			
Direction	Increase	Decrease	Increase	Increase	Increase	Decrease	Increase
Model response	2.60	0.31	-0.37	20.42	-0.02		2.65
Maximum response	2.60	-0.41	1.17	21.92	0.04		2.65
Mean	100.00	17.62	56.42	123.41	35.13	85.25	17.27
Genetic Var Explained	0.28	0.33	0.26	0.28	0.00		0.45
H			0.32	0.43			0.45
Genetic Var Exp			0.81	0.87			
23CDC5	2.26	0.03	-0.05	17.77	-0.00		2.26
90LDC2	0.33	0.28	-0.32	2.65	-0.01		0.39

Parental Contribution

Parent	# Markers	# Regions
23CDC5	22	9
90LDC2	9	4
Total	31	13

Marker Effects

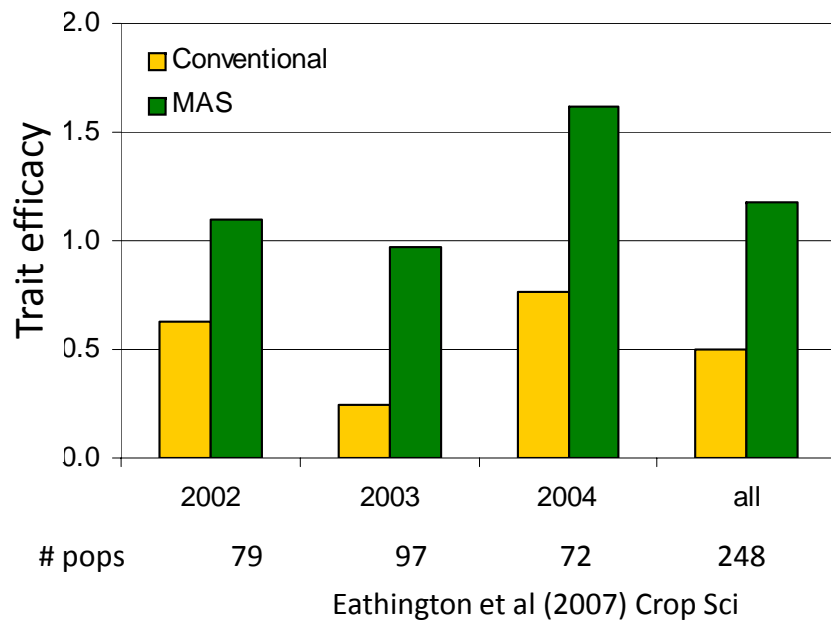
Marker	Chr	Pos	Select	Weight	MTI	P- MTI	H:MB_MST	P-H:MB_MST	H:MB_TWT	P-H:MB_TWT	H:MB_YLD	P-H:MB_YLD	H:SB_EHT	P-H:SB_EHT
Q-NC0024027	1	2.8	<input type="checkbox"/>		0.0947	0.2090	0.0168	0.2267	0.0399	0.4003	0.7679	0.1970	0.0000	
Q-NC0019086	1	10.4	<input type="checkbox"/>		0.1006	0.1783	0.0293	0.0345	0.0245	0.6037	0.8164	0.1668	0.0000	
Q-NC0081537	1	122.1	<input type="checkbox"/>		0.1058	0.1599	0.0286	0.0399	0.0270	0.5692	0.8566	0.1499	0.0000	
Q-NC0111052	1	122.8	<input type="checkbox"/>		0.1010	0.1830	0.0297	0.0345	0.0497	0.2964	0.8454	0.1585	0.0000	
Q-NC0070305	1	125.2	<input checked="" type="checkbox"/>	2.908	0.1436	0.0590	0.0216	0.1269	0.0537	0.2612	1.1521	0.0550	0.0000	
Q-NC0016674	1	163	<input type="checkbox"/>		0.1112	0.1451	0.0111	0.4322	0.0176	0.7164	0.8595	0.1544	0.0000	
Q-NC0009082	1	169.3	<input type="checkbox"/>		0.1141	0.1298			0.353	0.4605	0.8987	0.1318	0.0000	
Q-NC0145267	2	4.1	<input checked="" type="checkbox"/>	3.323	0.1641	0.0355			1.38	0.0193	1.4047	0.0227	0.0000	
Q-NC0144276	2	9.2	<input checked="" type="checkbox"/>	3.248	0.1604	0.0369	0.0474	0.0008	0.1074	0.0268	1.3706	0.0239	0.0000	
Q-NC0002812	2	59	<input checked="" type="checkbox"/>	2.662	0.1314	0.0865	0.0337	0.0196	0.0379	0.4453	1.0654	0.0794	0.0000	
Q-NC0080704	2	61.2	<input checked="" type="checkbox"/>	2.519	0.1244	0.1050	0.0341	0.0153	0.0376	0.4325	1.0135	0.0942	0.0000	
Q-NC0111617	2	77.1	<input checked="" type="checkbox"/>	2.651	0.1309	0.0852	0.0122	0.3862	0.0153	0.7508	1.0050	0.0944	0.0000	
Q-NC0060879	2	90.2	<input checked="" type="checkbox"/>	3.185	0.1573	0.0350	0.0070	0.6171	0.0162	0.7314	1.1709	0.0471	0.0000	
Q-NC0057210	2	98.7	<input type="checkbox"/>		0.1217	0.1131	0.0036	0.7997	0.0534	0.2667	0.9497	0.1178	0.0000	
Q-NC0044080	2	109.5	<input type="checkbox"/>		0.0866	0.2480	0.0135	0.3325	0.0226	0.6320	0.6857	0.2470	0.0000	
Q-NC0029138	2	123.4	<input type="checkbox"/>		0.0438	0.5646	0.0104	0.4602	0.0096	0.8411	0.3319	0.5808	0.0000	

Identify and Select QTLs

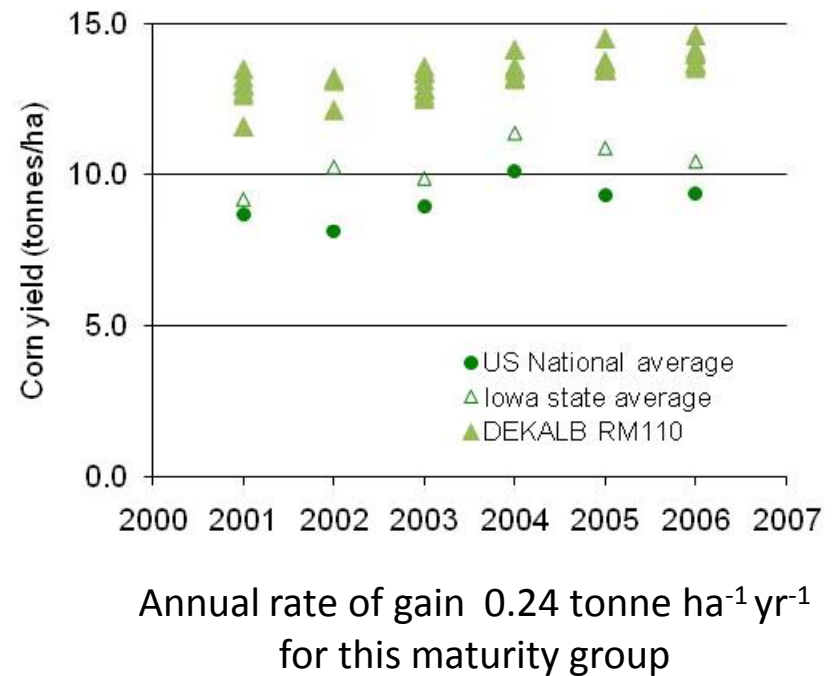
MONSANTO imagine®

Marker assisted breeding increases breeding rate of gain

Increased rate of gain with marker assisted breeding



Yield of DEKALB hybrids released 2001-2006 in 110 maturity group



SmartStax is the next generation of insect protection



European
Corn Borer



Corn
Rootworm



Cry1A



Cry3B

SmartStax™



Cry1A.105/Cry2A



Cry1F



Cry3B



Cry34A/Cry35A

Improved crop protection increases yield

Increase in yield due “triple stack” biotech products



Next generation biotech traits will directly increase yield

Yield & stress collaboration biotech trait pipeline: January 2009 update

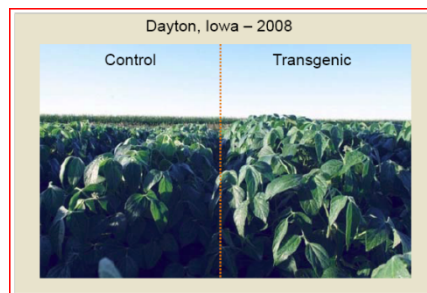
Yield and stress pipeline	Discovery Phase	Phase 1	Phase 2	Phase 3	Phase 4
Drought-tolerant corn family					
Drought-tolerant corn	[Progress bar: 75% green, 25% yellow]				
2 nd -gen drought-tolerant corn	[Progress bar: 50% green]				
Nitrogen-utilization corn family					
Nitrogen-utilization corn	[Progress bar: 25% green]				
Broad-acre higher-yielding corn family					
Higher-yielding corn	[Progress bar: 50% green]				
Broad-acre higher-yielding soybean family					
Higher-yielding soybeans	[Progress bar: 75% green, 25% yellow]				
2 nd -gen higher-yielding soybeans	[Progress bar: 50% green]				
Drought-tolerant cotton family					
Drought-tolerant cotton	[Progress bar: 25% green]				
Broad-acre higher-yielding canola family					
Higher-yielding + Roundup Ready 2 yield [®] canola*	[Progress bar: 50% green]				

http://www.monsanto.com/pdf/investors/2009/monsanto_basf_yield_stress_update.pdf

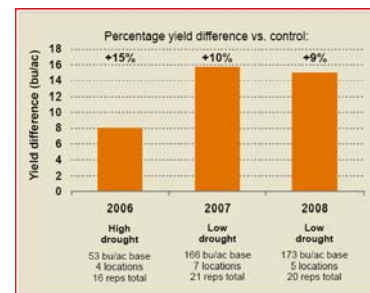
1st Gen drought tolerant corn



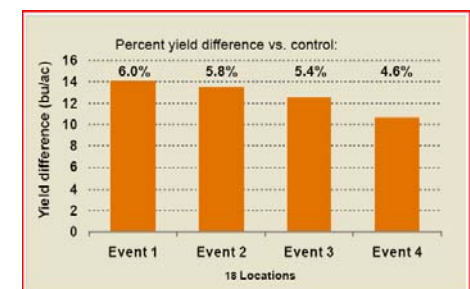
Higher-yielding soybeans



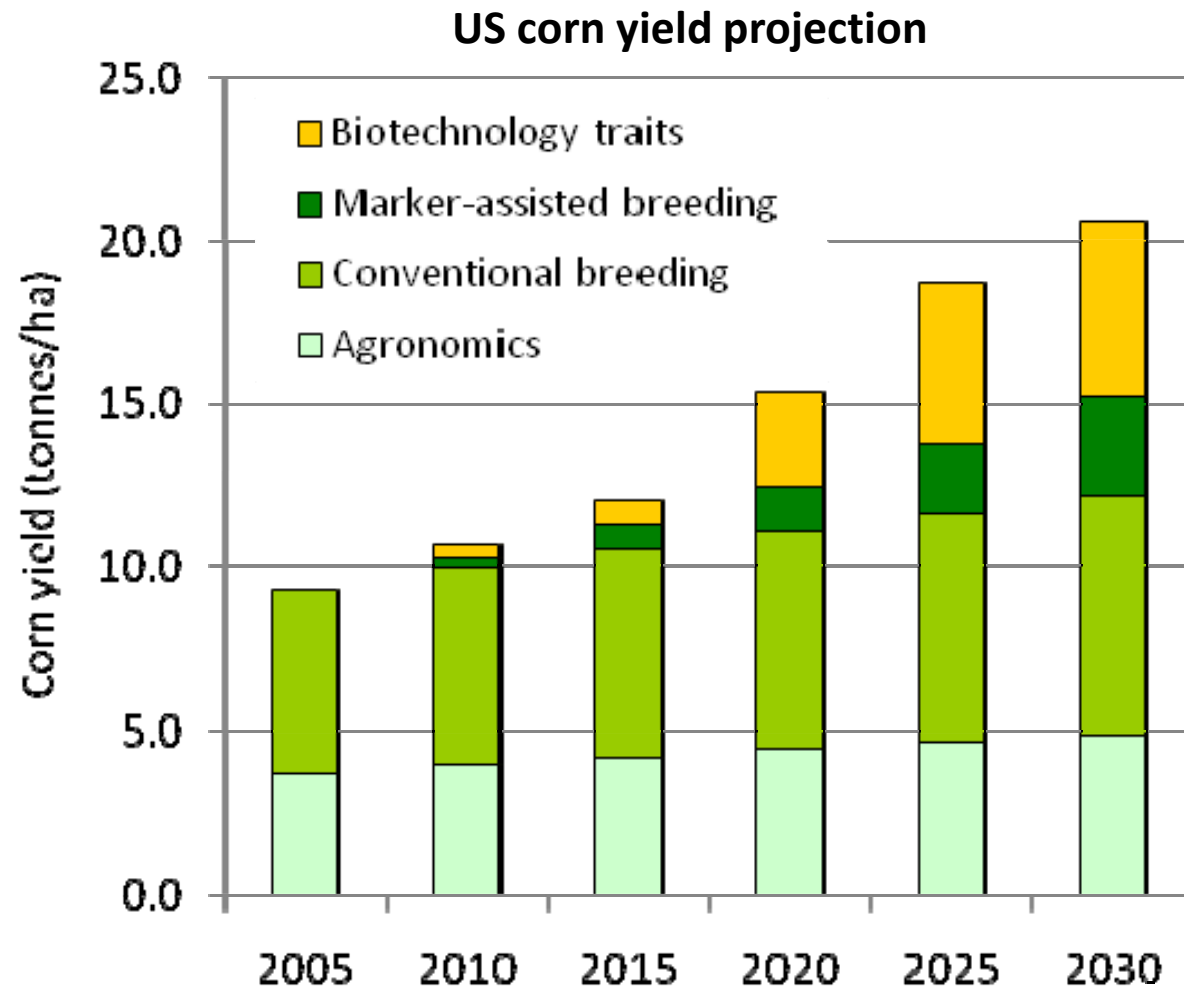
2nd Gen drought tolerant corn



Higher-yielding corn

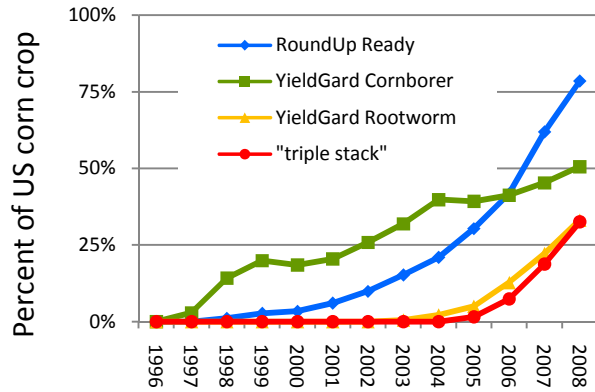


New technologies will accelerate corn yields

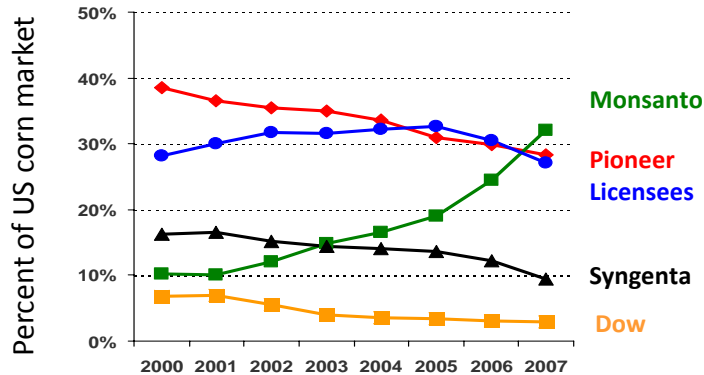


Improved genetics and traits in the world markets

Trait market share



Genetic market share



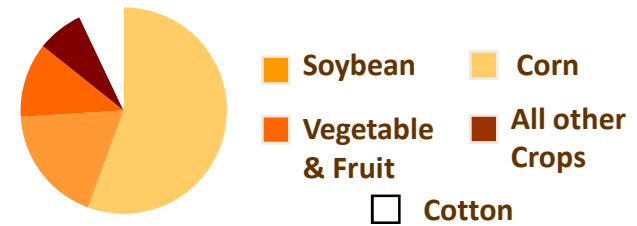
SOURCE: Doane Marketing Research, Inc.

Monsanto Net includes Asgrow, DeKalb and ASI (16 companies)

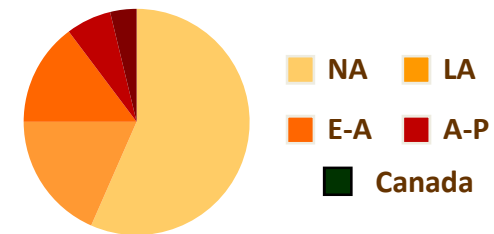
Syngenta Net includes Garst, Golden Harvest, Laser and NK brands

Beyond the US corn market

Sales by Seeds and Traits



Sales by Geography



References

Corn yield projection

Edgerton MD (2009) Increasing crop productivity to meet global needs for feed, food, and fuel. *Plant Physiol.* 149:7-13

Breeding

Duvick DN (2005) The contribution of breeding to yield advances in maize (*Zea mays* L.). *Adv Agron* 86: 83–145

Eathington S, et al. (2007) Molecular markers in a commercial breeding program. *Crop Sci (Suppl 3)* 47: S154–S163

Biotechnology

Nelson DE, et al (2007) Plant nuclear factor Y (NF-Y) B subunits confer drought tolerance and lead to improved corn yields on water-limited acres. *Proc Natl Acad Sci USA* 104: 16450–16455

Castiglioni P, et al (2008) Bacterial RNA chaperones confer abiotic stress tolerance in plants and improved grain yield in maize under water-limited conditions. *Plant Physiol* 147: 446–455

Monsanto presentations (<http://www.monsanto.com/investors/presentations.asp>)

Yield and Stress traits

http://www.monsanto.com/pdf/investors/2009/monsanto_basf_yield_stress_update.pdf (latest presentation)

<http://www.monsanto.com/pdf/investors/2008/09-16-08.pdf> (includes timelines, market size estimates)

Business

<http://www.monsanto.com/pdf/investors/2008/12-09-08.pdf> (Current market share and projections across major agricultural countries)

http://www.monsanto.com/pdf/investors/2008/2008_biotech_acres.pdf (Area planted with biotechnology traits – 1996-2008)

http://www.monsanto.com/pdf/investors/2008/ea_investor_tour.pdf (International and pricing detail)