

ABTCP 2015

48º CONGRESSO E EXPOSIÇÃO
INTERNACIONAL DE CELULOSE E PAPEL

48º CONGRESSO INTERNACIONAL DE CELULOSE E PAPEL
1ª CONFERÊNCIA IBEROAMERICANA SOBRE BIOECONOMIA



Tree Improvement, Biotechnology and Brazilian Forestry Sector

REALIZAÇÃO



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ArborGen





ArborGen: Global Leader in Tree Improvement





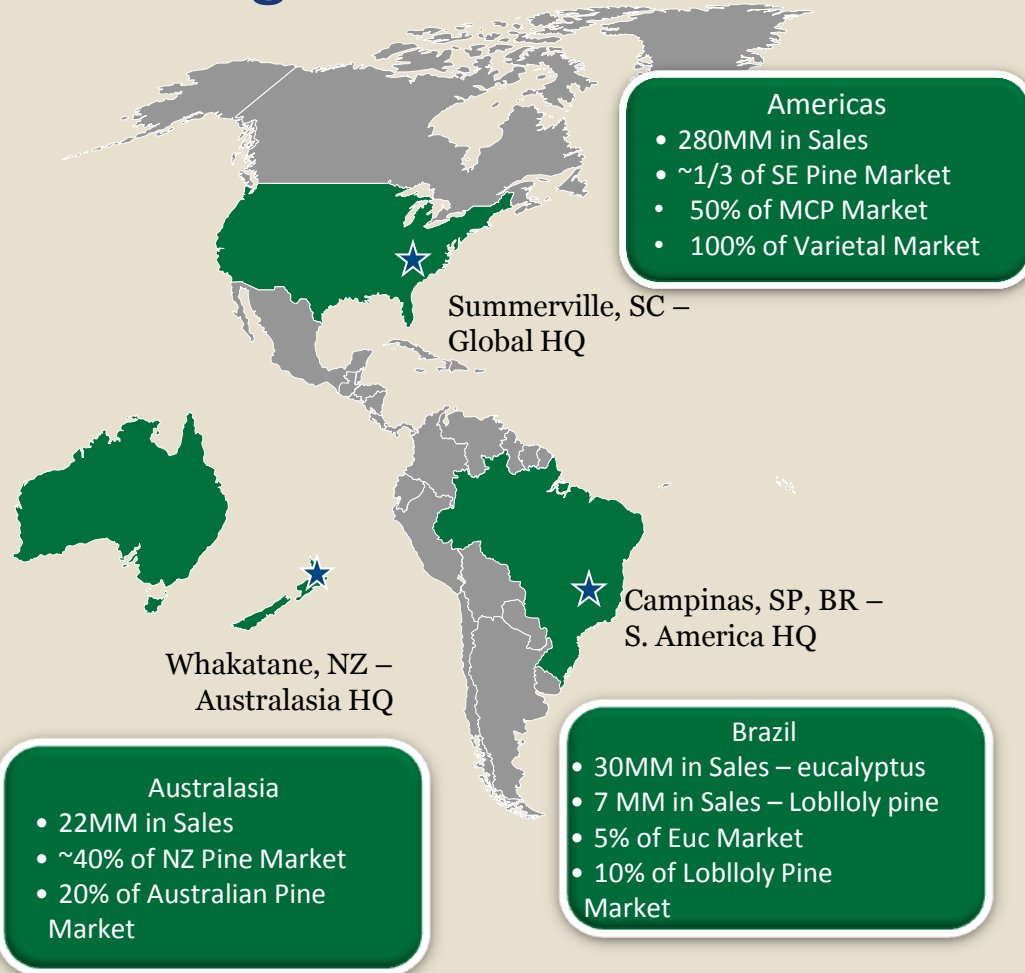
Major repository of advanced commercial pine germplasm and technology

- Built on over 100 years, in the aggregate, of tree improvement research from multiple industry leaders
- Further enhanced through ArborGen's broad and strong development program
- Germplasm includes over 50 distinct commercial tree species and hybrids
- Catalogued over 13,500 unique varieties for two largest commercial pine species: loblolly and radiata





ArborGen: Global Leader in Tree Improvement and Seedling Production



- Leading seedling producer of over 300 million trees per year
- Global operations
 - Southeastern U.S.
 - New Zealand & Australia
 - Brazil
- Providing step-changes in tree productivity
 - Faster growth
 - Disease resistance
 - Improved wood quality
 - Biomass production



Who We Are: Focused on the Future of Forestry

- Leading producer of purpose grown trees
 - Produce nearly 300 million seedlings per year
 - Drawing on 50+ years of forestry and technology experience
 - Multi-national team of dedicated foresters, researchers and scientists
- Technology leader
 - Innovative product platform: Pine and hardwood
 - Pipeline of world-class elite germplasm
 - More forestry field / regulatory trials than any other company
 - Somatic Embryogenesis





ArborGen inicia operação no mercado de mudas florestais

O acordo com a International Paper do Brasil disponibilizará clones de eucalipto de qualidade para os produtores brasileiros

RIDGEVILLE, S.C. & CAMPINAS, Brasil (BUSINESS WIRE) - A ArborGen, líder mundial na venda de mudas de tecnologia avançada, anuncia que firmou um acordo com a International Paper do Brasil. Este acordo concede à ArborGen o direito exclusivo de produzir e vender mudas de eucalipto de clones superiores da International Paper no Brasil. A ArborGen está produzindo as mudas em um viveiro localizado em Luz Antônio, estado de São Paulo.

"Enquanto as grandes empresas florestais têm acesso a materiais genéticos de qualidade, estes não são disponibilizados aos produtores independentes. Com este acordo, a ArborGen disponibilizará pela primeira vez a estes produtores independentes mudas de genética avançada", disse Gabriela Bassa, diretora da ArborGen Brasil. "O viveiro de Luz Antônio é o primeiro de uma série de operações que usaremos para abastecer o mercado brasileiro ao longo do tempo."

O setor florestal brasileiro apresenta mais rápido crescimento quando comparado a outros países, sendo o Brasil o maior produtor e exportador de celulose de eucalipto do mundo. O mercado de eucalipto consome aproximadamente 1 bilhão de mudas por ano. Produtores florestais independentes têm utilizado materiais genéticos desenvolvidos durante as décadas de 80 e 90, que não oferecem o mesmo crescimento ou qualidade quando comparados aos clones de genética avançada. Os resultados de testes de campo desenvolvidos a partir de extensa pesquisa da International Paper sugerem que os clones que a ArborGen está oferecendo ao mercado serão superiores aos atualmente em uso pelos produtores florestais.

A ArborGen Brasil iniciou suas operações em 2004 com um centro de desenvolvimento de produtos e negócio. A empresa tem trabalhado com diversas empresas do setor de celulose e papel de eucalipto para desenvolver produtos geneticamente modificados, e tem realizado extensos testes de campo com estes produtos potenciais. "A expansão para o ramo de mudas de eucalipto desenvolvidas através do melhoramento genético convencional nos permitirá oferecer um portfólio abrangente de tecnologias e produtos para o setor florestal brasileiro", disse Bassa.

<http://www.businesswire.com/news/home/20131022006085/pt>

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Eucalyptus Breeding

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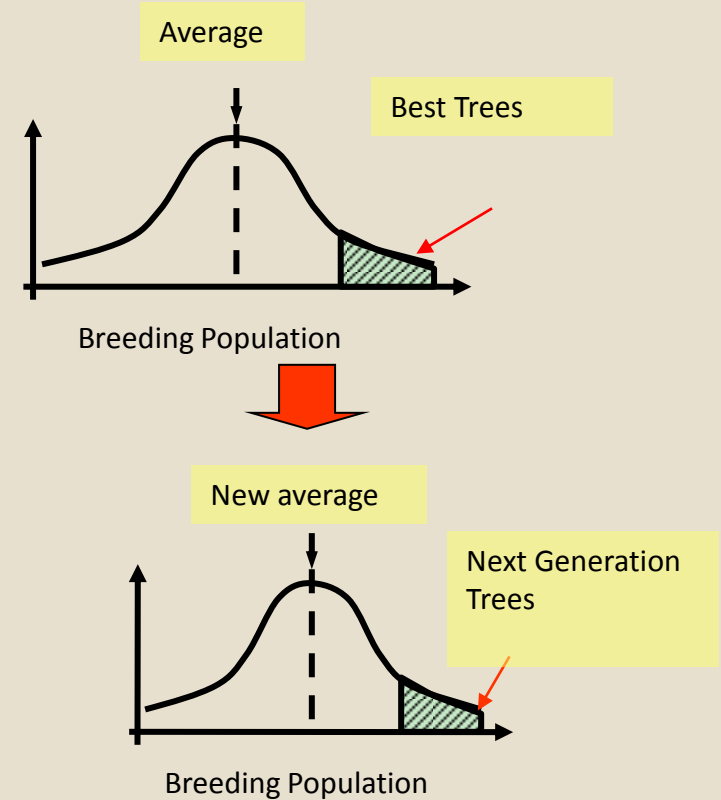
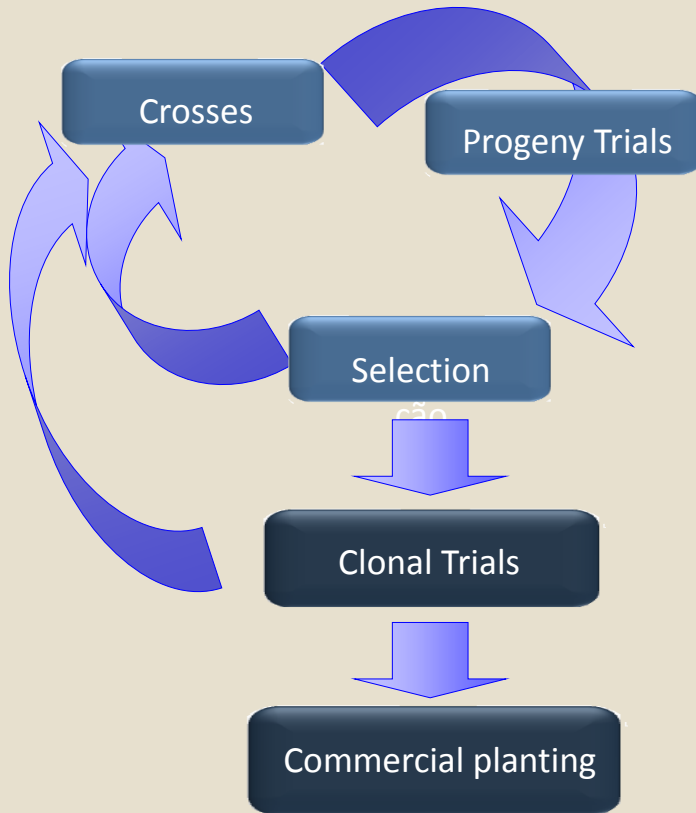


CORREALIZAÇÃO





Eucalyptus Breeding – Process



Falconer & Mackay, 1996

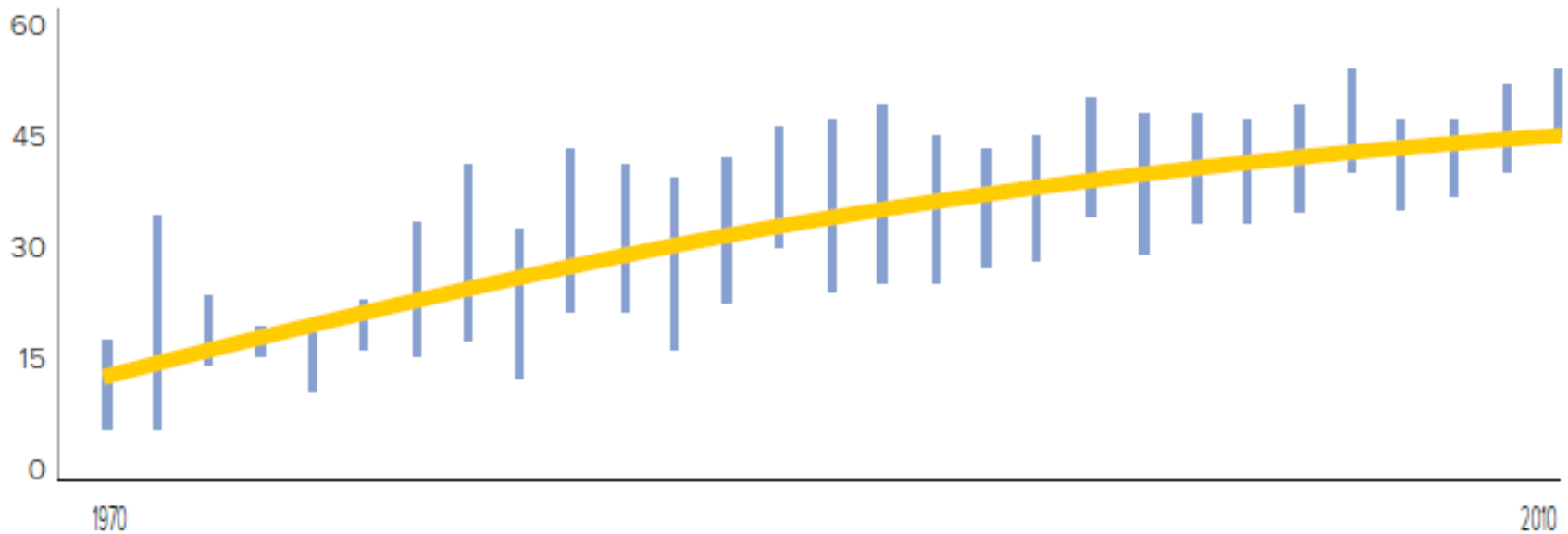
Guarantee of continuous improvement for traits of interest – selection and crosses



Results so far – breeding and silviculture

CHANGE IN EUCALYPTUS PRODUCTIVITY IN THE STATE OF SÃO PAULO, BRAZIL

m³/ha.year





Main Eucalyptus Species

ESPÉCIES POTENCIAIS

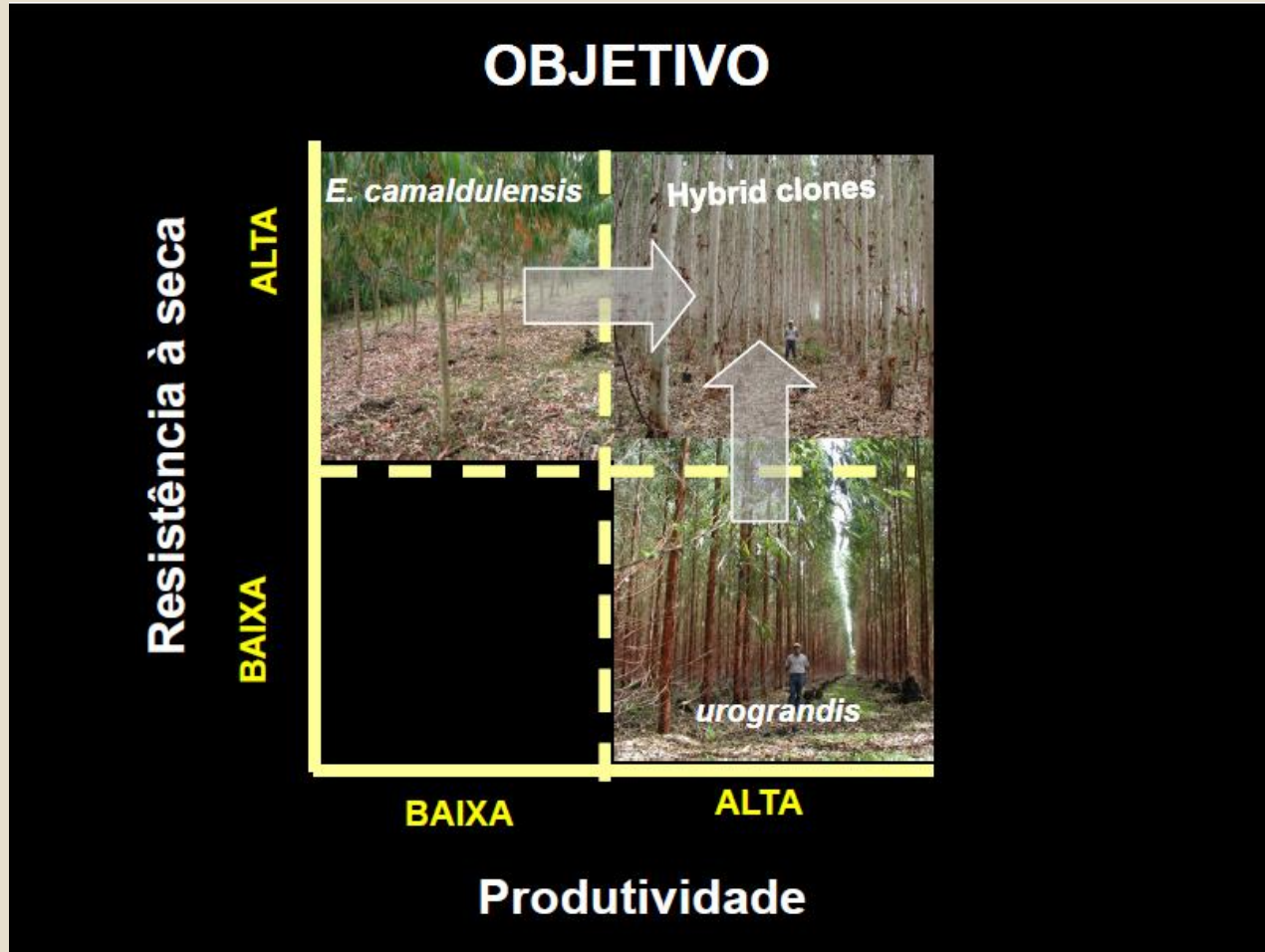
ESPÉCIES	CRESC.	RES. FERRUGEM	ENRAIZAM.	R. CANCRO	R. SECA	R. Ceratocs	DENS	RD	LIGNINA	HEMIC
<i>E. grandis</i>	MB	I	B	I	R	I	R	I	I	I
<i>E. urophylla</i>	B	I	MB	MB	B	I	I	I	R	I
<i>E. camaldulensis</i>	R	MB	MB	MB	MB	MB	MB	R	R	R
<i>E. pellita</i>	MB	MB	MB	MB	I	MB	MB	R	R	B
<i>E. dunnii</i>	R	I	R	R	R	?	B	B	B	B
<i>E. globulus</i>	R	I	R	?	B	?	MB	MB	MB	MB
RESULTADO	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB

CELULOSE

MB – Muito Bom B – Bom I - Intermediário R – Ruim



How to meet the target?





Seed orchard - Indoor

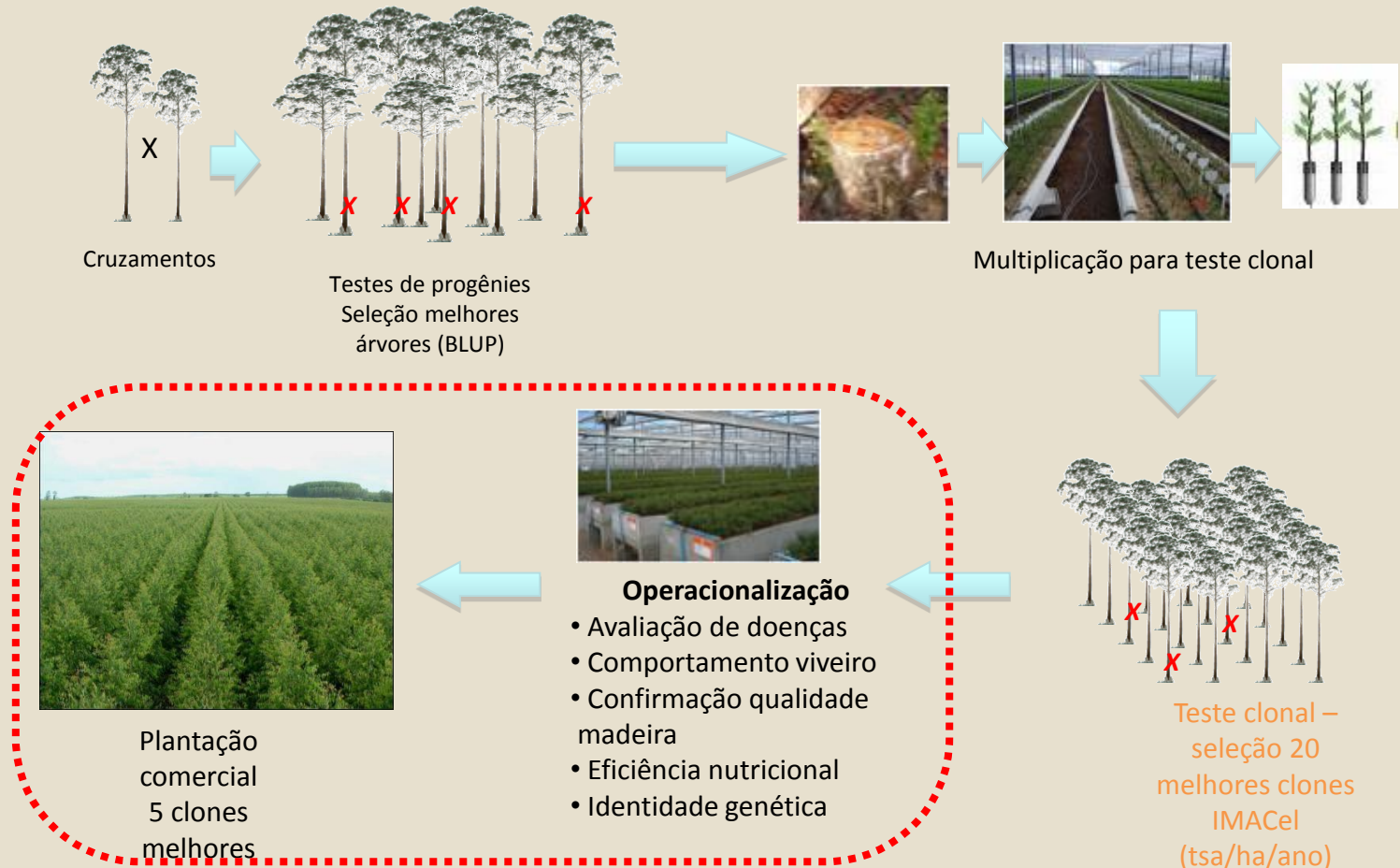
EVOLUÇÃO DOS MÉTODOS DE INDUÇÃO DO FLORESCIMENTO PRECOCE EM *Eucalyptus*



Source: Teotonio Assis



Breeding and clonal deployment



Timeline – 13 a 14 years



Industrial segments *

Segment	Growth	Wood density	Lignin content	Holocelulose content	Extrative content	Calorific Power	Carbon content
Pulp and Paper						na	na
Charcoal							
Biomass/ Bioenergy							
Treated Wood				na		na	na
Panels							

* Under construction



ArborGen's plan for Brazil – short, medium and long term

Ano	Short term	Medium term	Long term
2014	Trials – clonal and demo	Access to genetics/seed orchard establishment	Access to genetics/seed orchard establishment
2015		Crosses	Crosses
2016		Crosses	Crosses
2017	Selection	Propagation	Propagation
2018		Trials – clonal and demo	
2019	Market		
2020	5 years		Selection
2021		Selection	
2022			Trials – clonal
2023		Market	
2024		9 years	
2025			Selection
2026			
2027			Trials – demo
2028			
2029			
2030			Market
2031			14 years
2032			



6 years

Quantitative genetics role

Demo trials

- 5 planted trials – Mato Grosso do Sul State in 2014 e 2015
- Clients's land - partnership
- New trials 2015 – research and pre-launch phases



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Lobloly Pine Breeding

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Major Categories of Genetics Today

Open Pollinated

OP Advanced, Select & Elite

- Produced from best mother & fertilized with pollen of an unknown father tree

Elite Genetics Products

Mass Controlled Pollinated

MCP[®]

MCP-Select

MCP-Elite

- Seedlings produced from best mother and father
- ArborGen's has the most advanced and most broadly adapted MCP pipeline in the industry

Varietals

Varieties 1, 2, 3, 4....

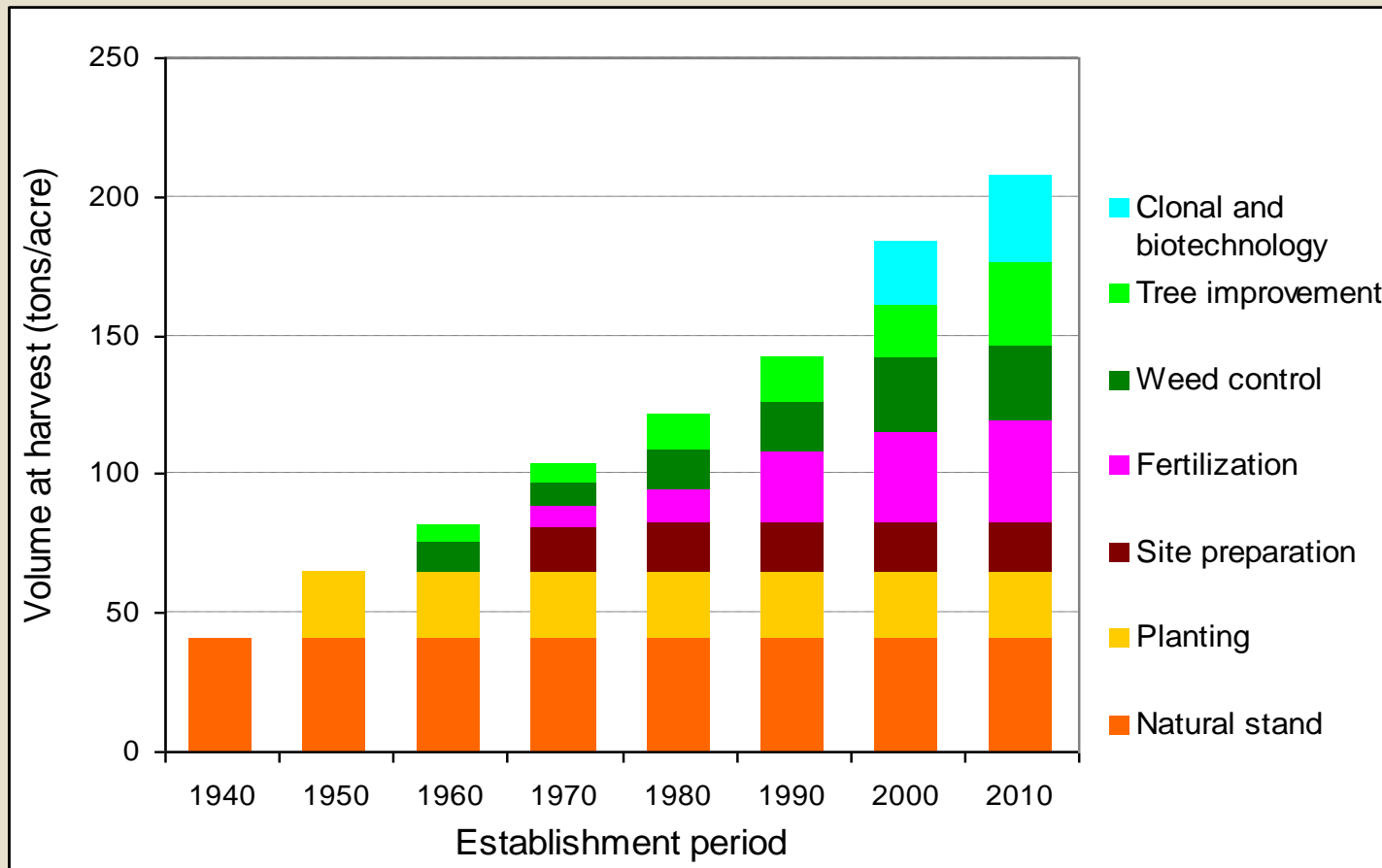
- Multiple copies of best MCP seedlings, selected from extensive trials
- With the acquisition of CellFor, ArborGen is the only company in the world with the ability to produce varieties at scale

ADVANCING GENETICS THROUGH BREEDING



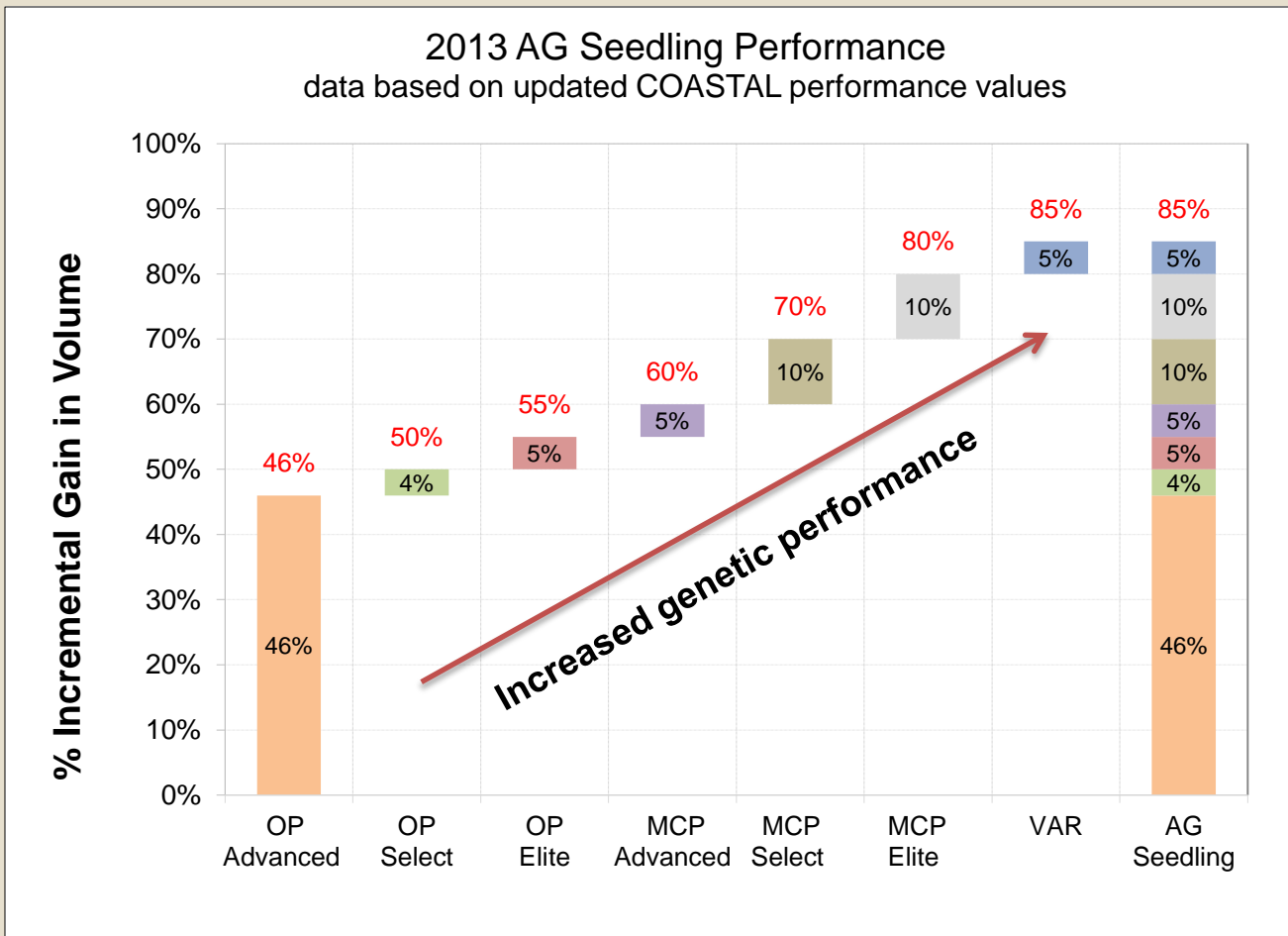
Genetics...The Last Frontier

Pine Yield History & Drivers





Volume Gains for ArborGen Seedlings



Product Profiles

- **OP:**
 - STP 20-50%.
 - Wide phenotypic variation
- **MCP® :**
 - STP 50-80%
 - Less phenotypic variation
- **Varietals:**
 - STP >80% potential.
 - Least phenotypic variation with planting identical genetics



Traits of interest – breeding for value - Growth



Age 5 Varietal: Columbia, SC



Age 4 Varietal: Fargo, GA



Traits of interest – breeding for value

Straightness: SawTimber Yield



Varietal



OP Family



Traits of interest – breeding for value - Forking

Pulpwood



SawTimber





Mass Controlled Pollination





Mass Controlled Pollination: MCP®

46 million ArborGen MCP® seedling sold in 2014





Varietals : Somatic embryogenesis process

Production Overview



**Produce Plantable
Germinants**

ArborGen Lab
Ridgeville, SC



**Grow Plantable
Germinants into
Miniplugs**

Miniplug
Greenhouses
Ridgeville, SC



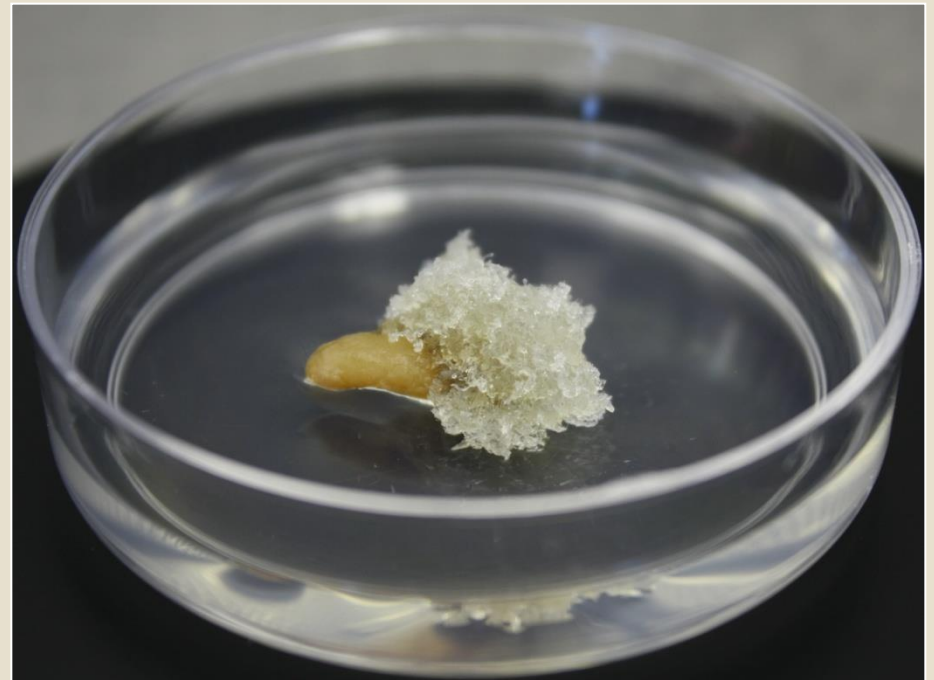
**Grow Miniplugs into Finished
Seedlings**

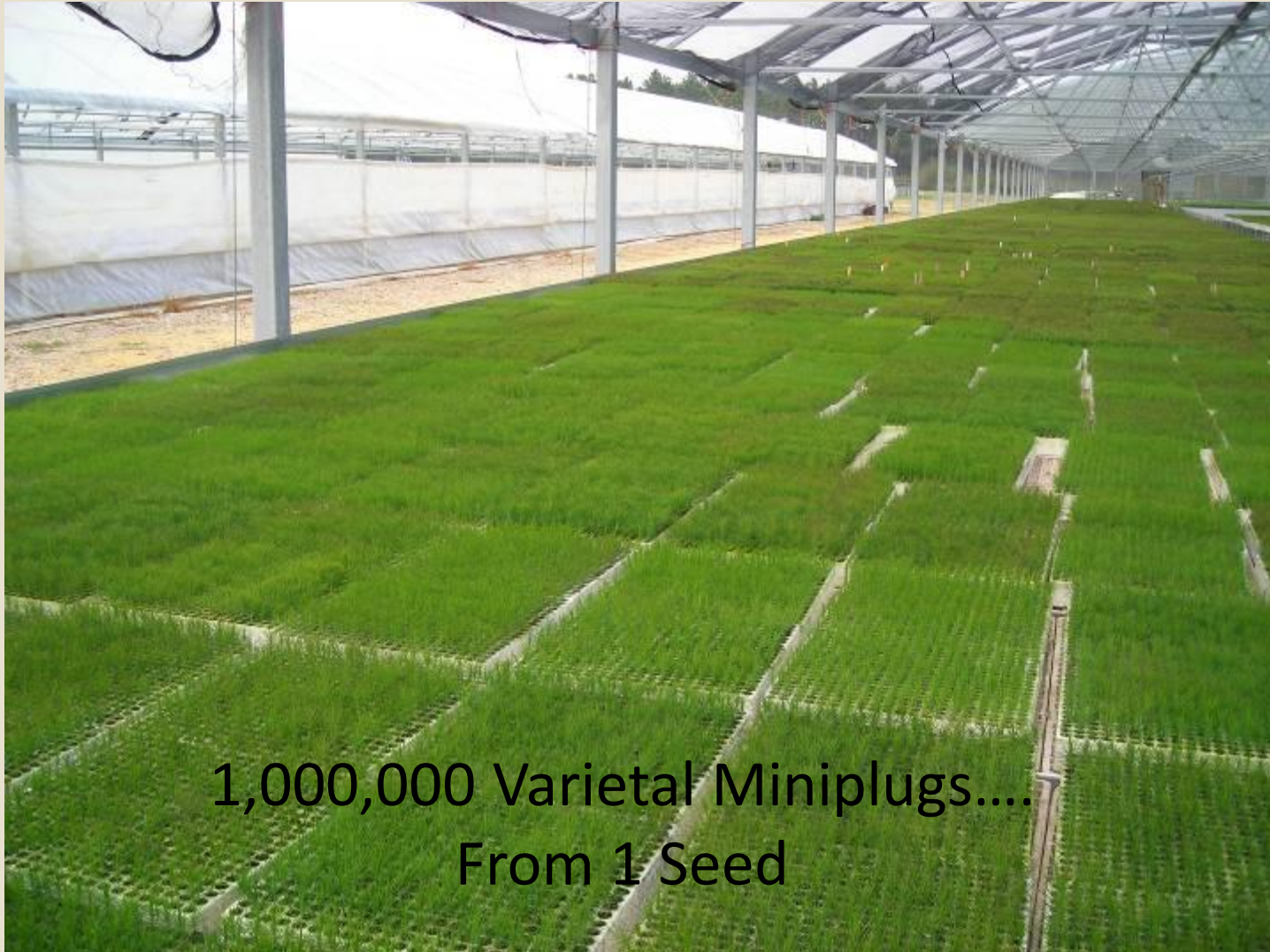
Bare Root and
Containerized
Nurseries

Process completed in 12 to 18 Months



Embryogenic tissue from dissected seed





1,000,000 Varietal Miniplugs....
From 1 Seed



4 Year Old Varietal Stand – North Carolina

Improved growth, increased stand uniformity and high percentage of sawtimber crop trees

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Biotechnology

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Wood Demand Increase - 40% for industrial use and energy generation

The Food and Agriculture Organization of the United Nations (FAO) forecasts a **world population of approximately 9.5 billion inhabitants by 2050**. The largest part of this growth will take place in developing countries, where, for various reasons, the birth rates are higher. **This scenario leads to the need to increase food production by 70% over the next 40 years; there will also be increasing demand for land, fiber and energy.** Considering current levels of productivity, this increase means approximately 2.5 billion additional hectares will be needed for agricultural crops (17% of the area globally used for agriculture).

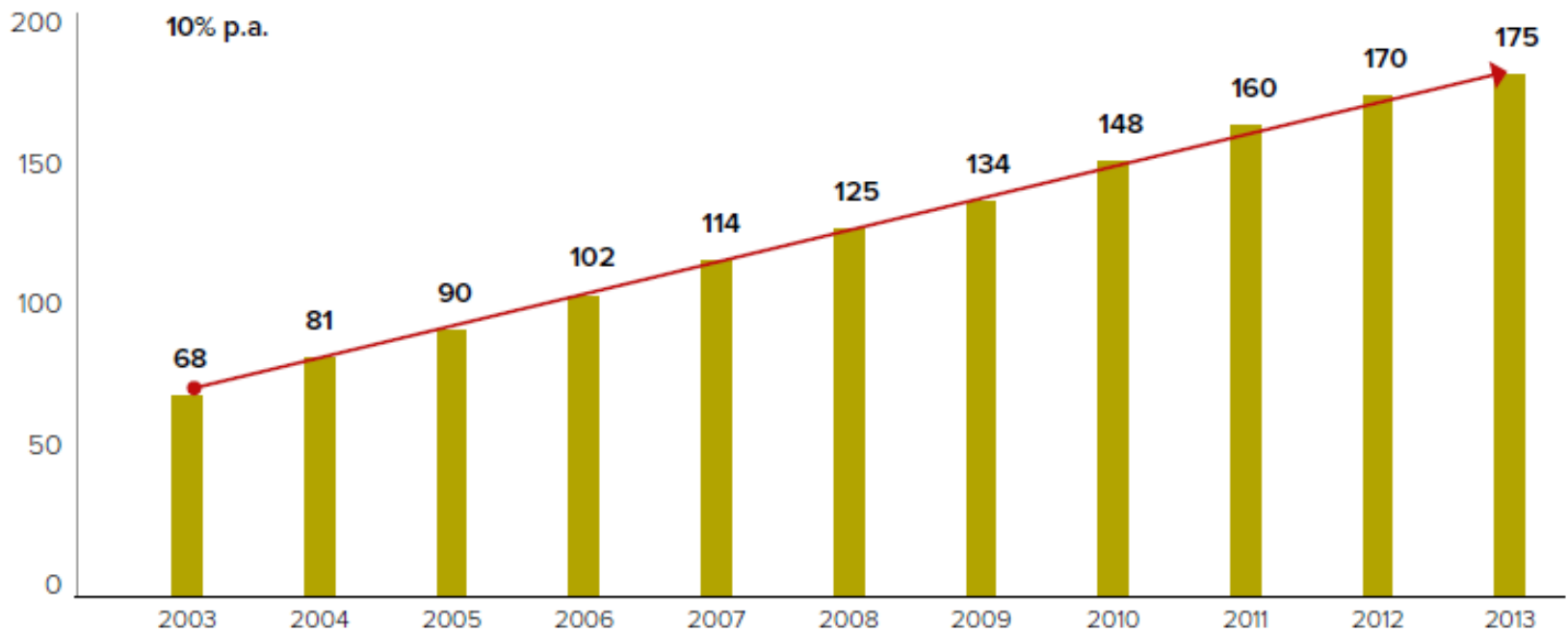
Still within this scope, FAO estimates that, based on population increase and per capita consumption, demand for timber for industrial use and energy generation will reach 5.2 billion m³ per year by 2050, an increase of 40%.



Agriculture exemple

CHANGE IN AREA PLANTED WITH GENETICALLY MODIFIED CROPS WORLDWIDE, 2003 - 2013

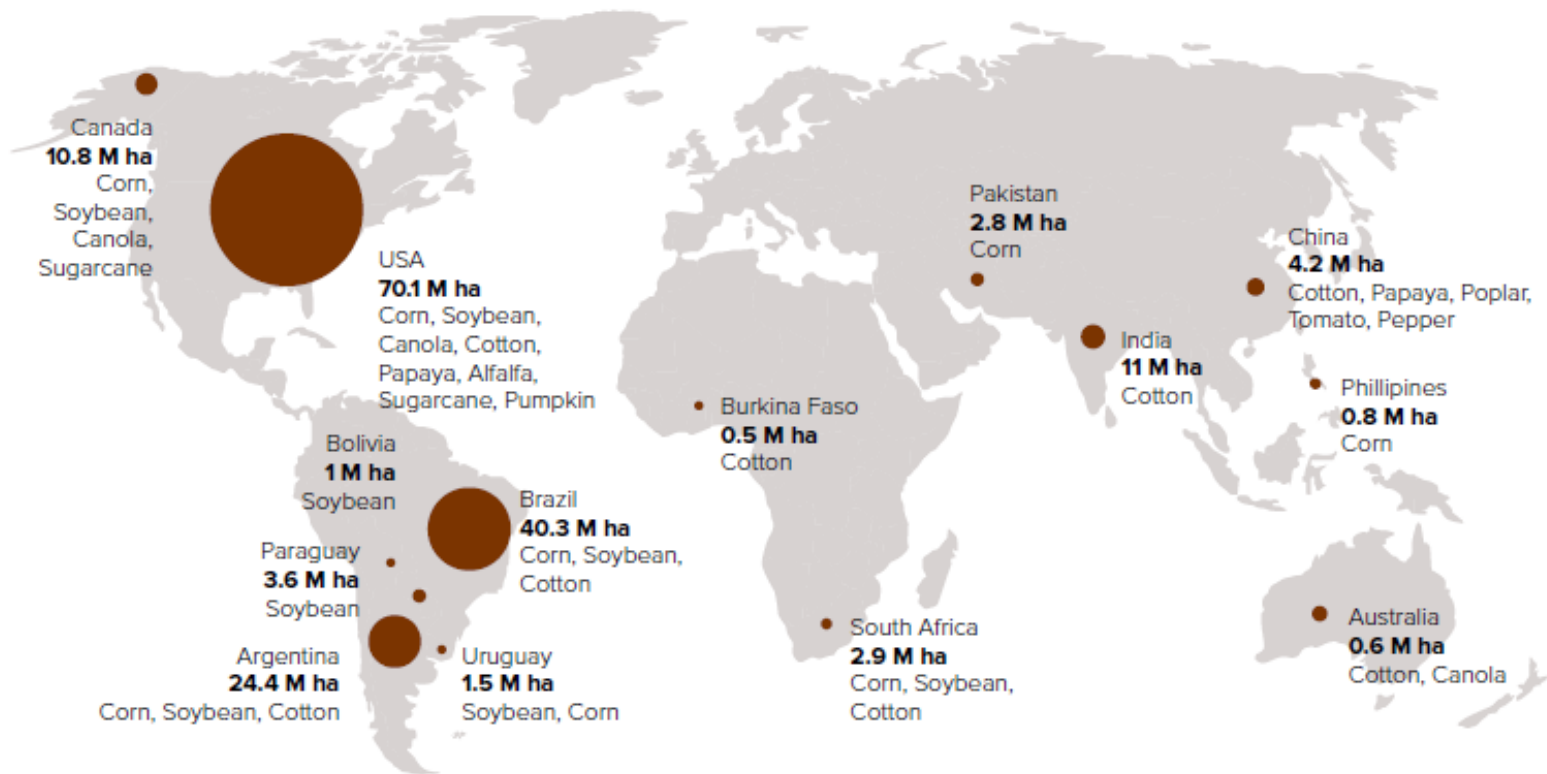
Millions ha





Agriculture exemple

DISTRIBUTION OF AREA PLANTED WITH GENETICALLY MODIFIED AGRICULTURAL CROPS WORLDWIDE, 2013





Technologies Needed To Increase Growth

Improved Germplasm

*Conventional Breeding
Varietal Technology*



Management Systems

*Increased Densities
Shortened Rotations
Other Silvicultural
Improvements*



Biotech Improvements

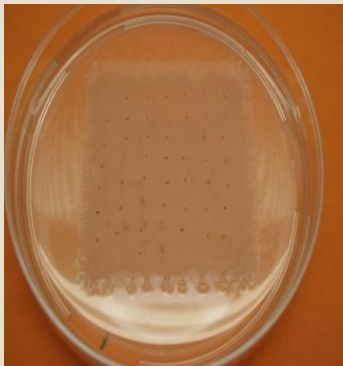
*Improved Growth
Shorter Rotation
Stress Tolerance
Improved Processing
Improved Wood Quality*





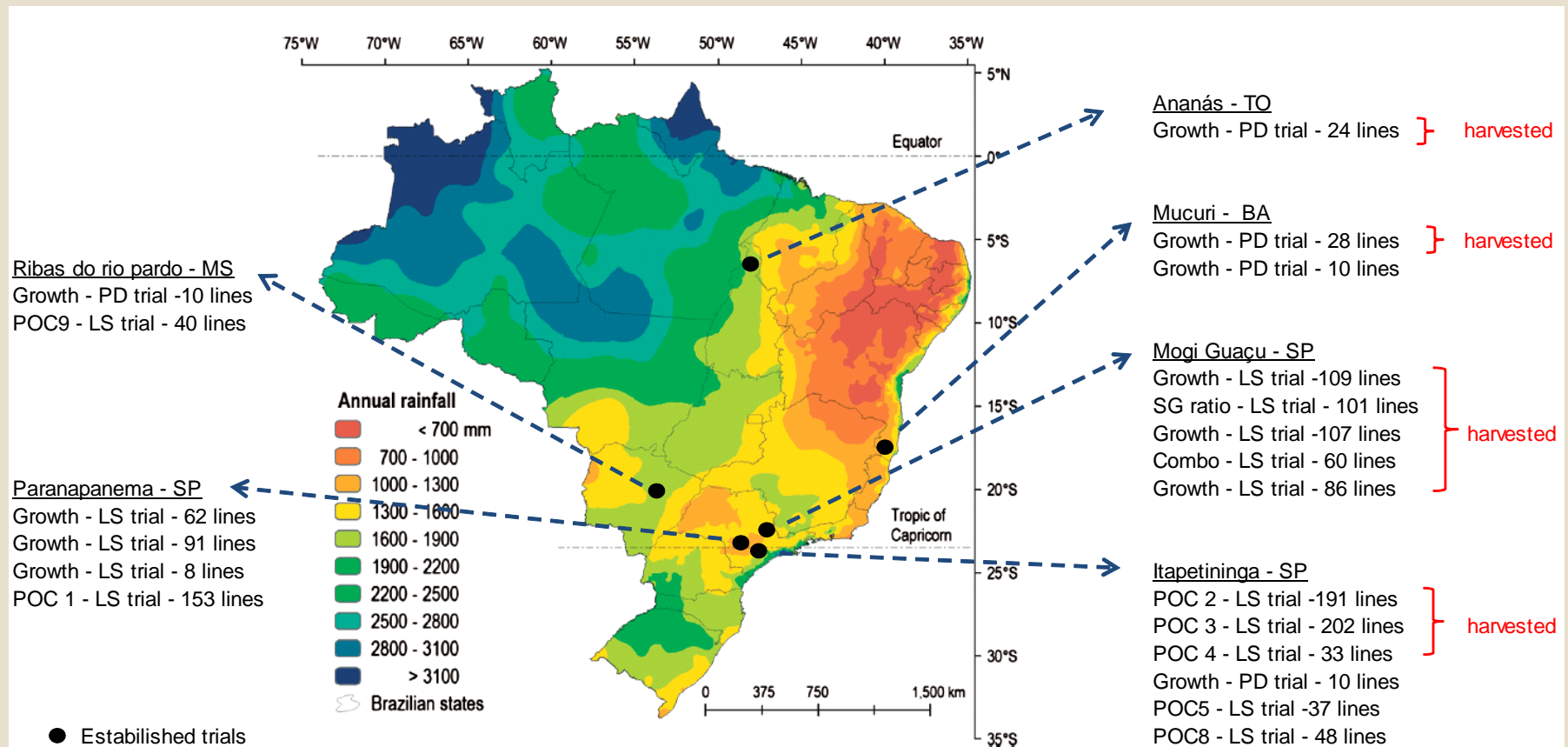
Eucalyptus Transformation

- Elite clones transformation
 - Development of regeneration protocols for over 30 elite clones
 - Transformation of 15 clones from Brasil
 - Over 20 genes in field trials
- High capacity to test genes in model clones – potential to test over 50 constructions per year/1000 events HQ






Where are the field trials?



We are in the most significant area of tropical eucalyptus plantations.

ArborGen — Field tests - biotechnology

CQB Piraflora 

© 2014 Google

Image © 2014 CNES / Astrium

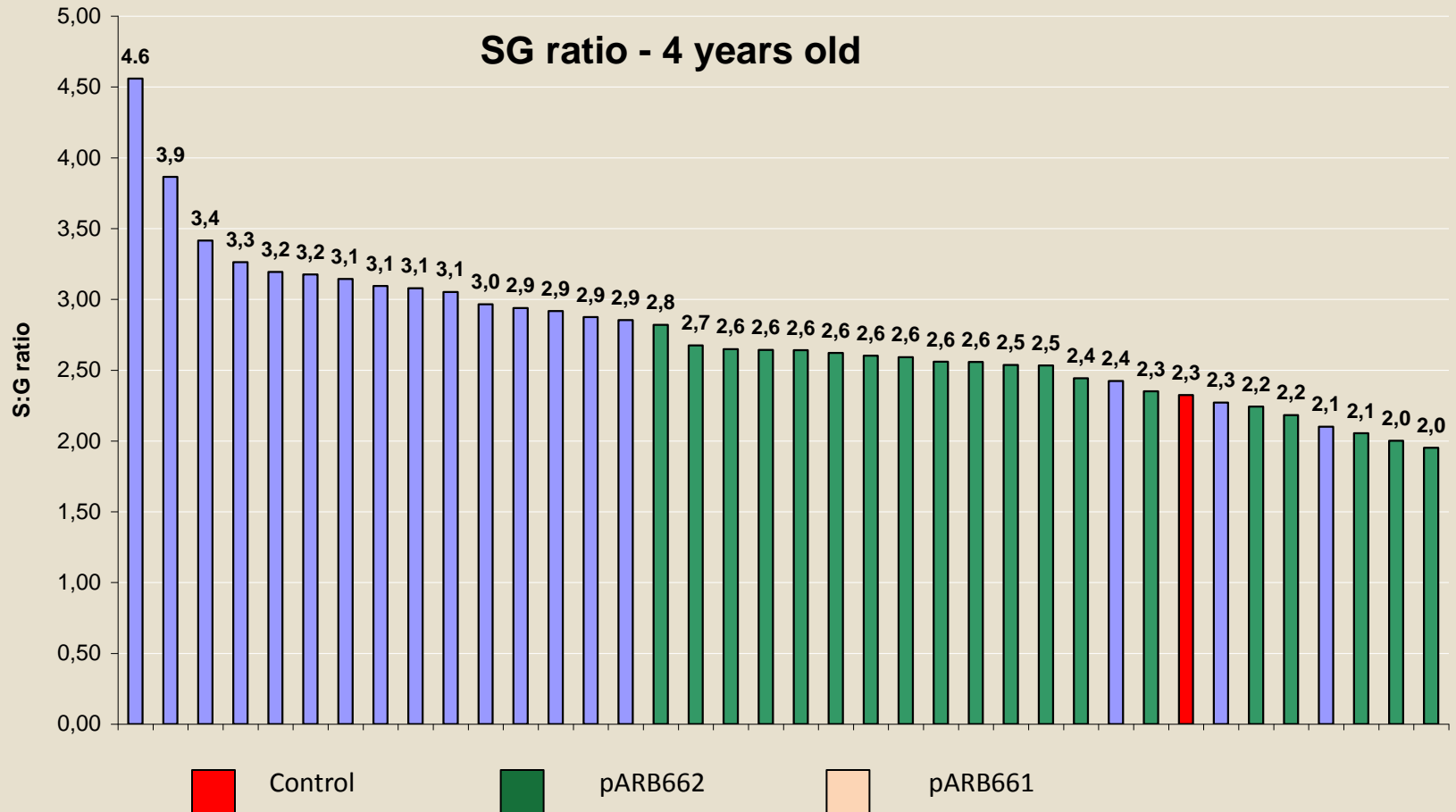
Google earth



ArborGen – GM trees



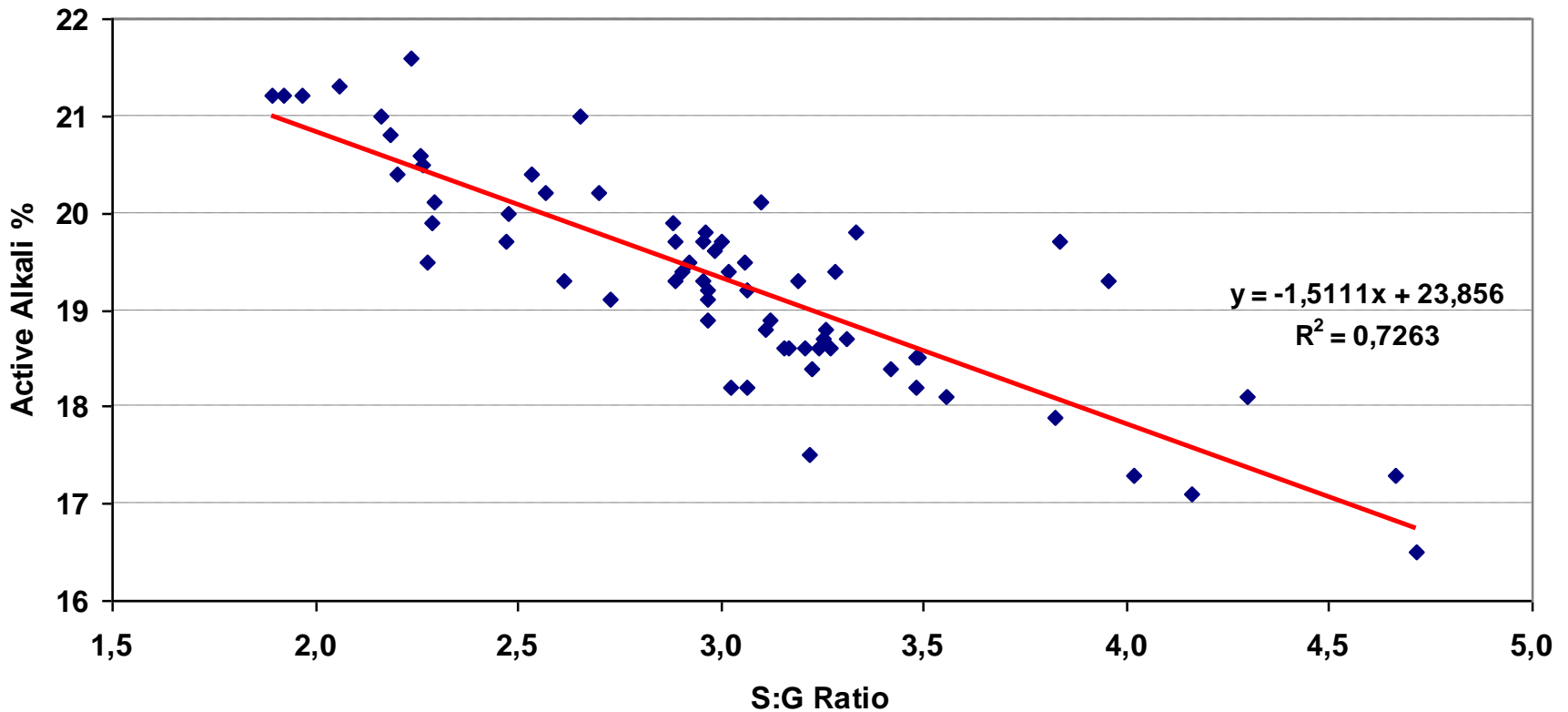
SG ratio Increase





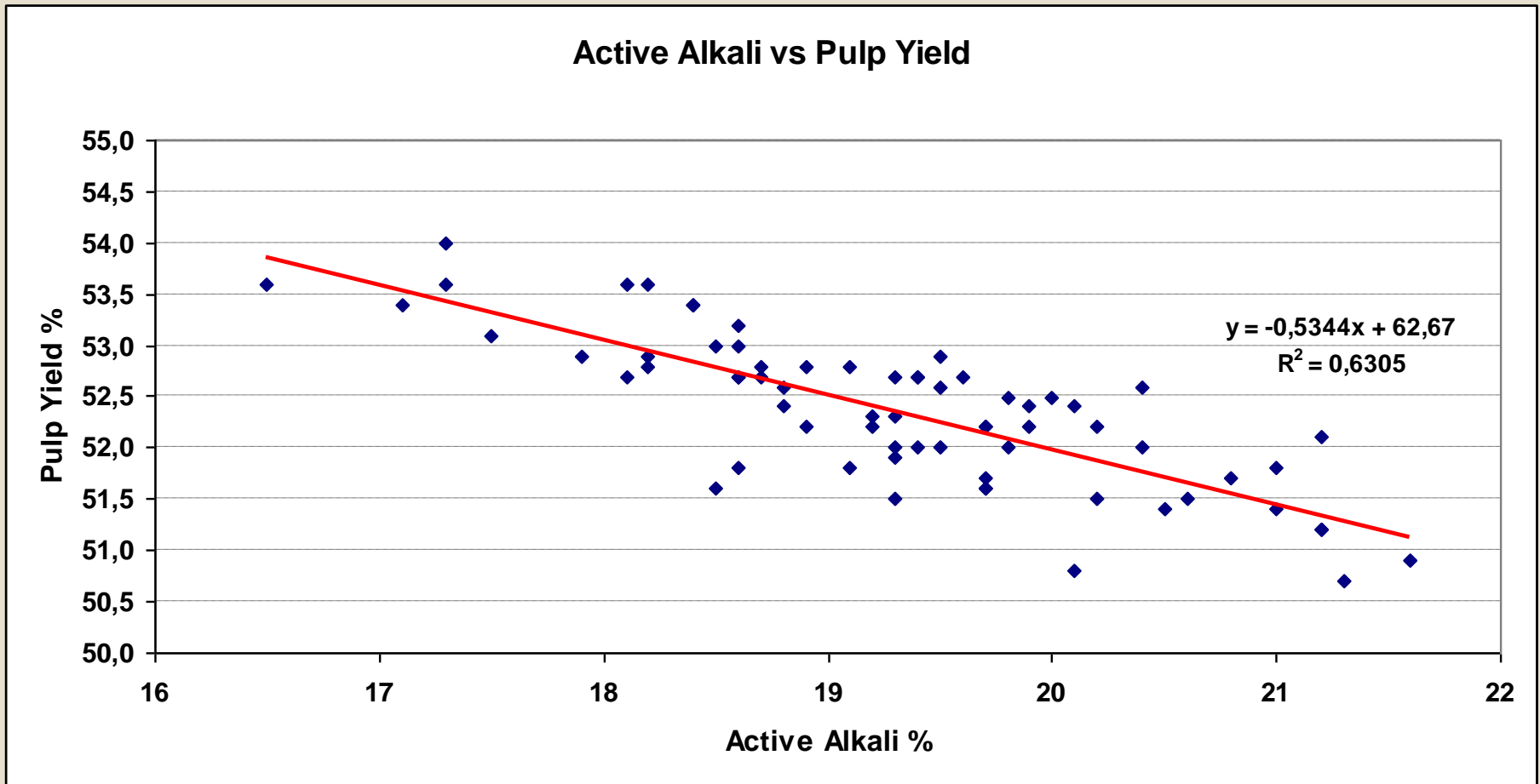
Less chemicals needed to produce pulp – up to 15% cost reduction

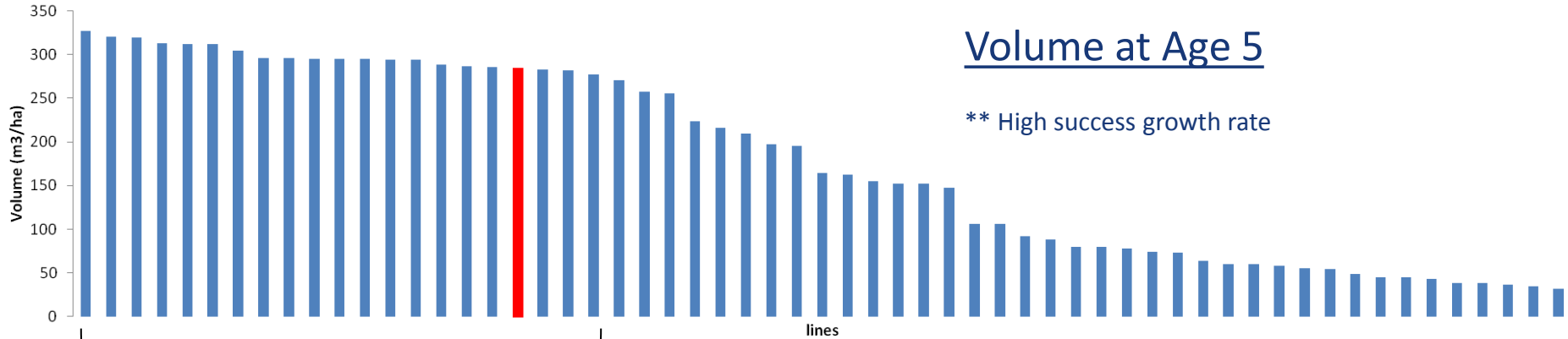
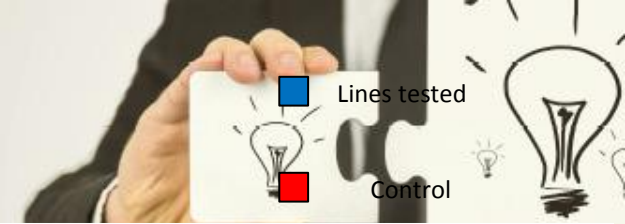
S:G Ratio vs Active Alkali



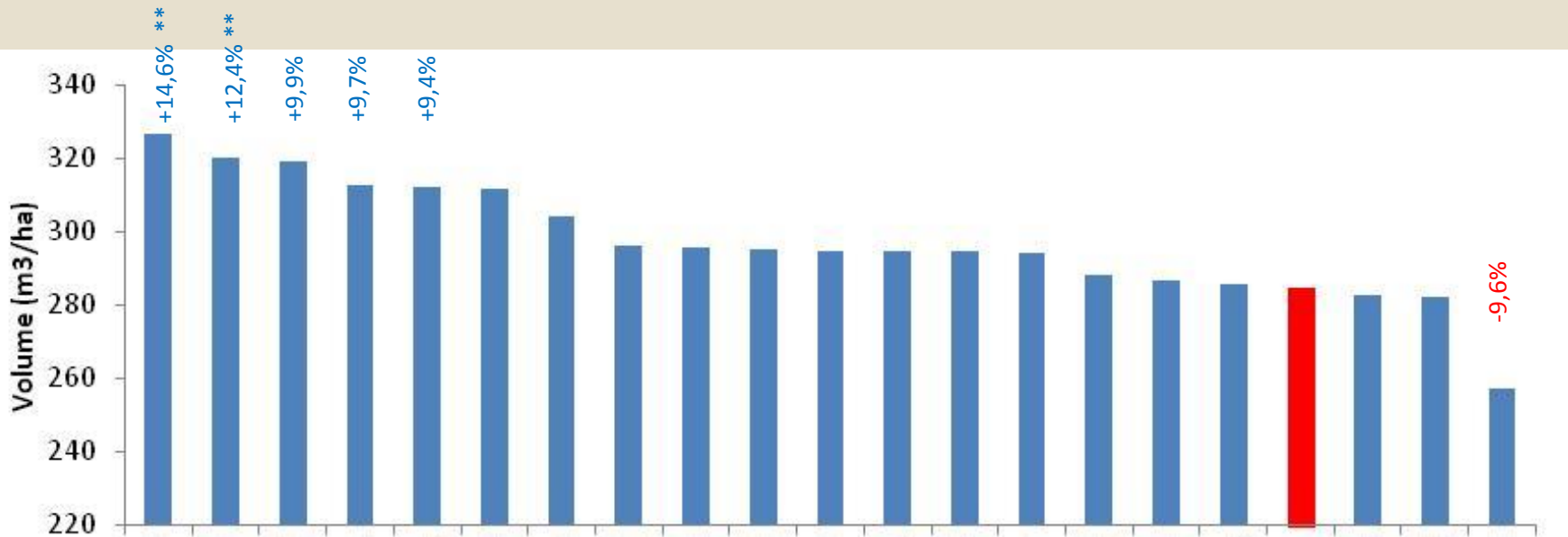


Lower alkali content relates to pulp yield





Growth increase – m³/ha





trials	Volume 5 yrs					
	BLUP	Std Error	mu	Predicted	Gain S530	
1	86,39225	21,0508	243,4720	329,8643	23,3%	
1	75,64141	21,0508	243,4720	319,1134	19,3%	
2	74,47712	23,4758	243,4720	317,9491	18,8%	
1	68,53808	21,0508	243,4720	312,0101	16,6%	
1	63,87287	21,7651	243,4720	307,3449	14,9%	
1	63,73290	21,0508	243,4720	307,2049	14,8%	
1	63,43271	21,0508	243,4720	306,9047	14,7%	
1	57,50928	21,0508	243,4720	300,9813	12,5%	
1	57,39694	21,0508	243,4720	300,8689	12,5%	
2	56,24752	29,0097	243,4720	299,7195	12,0%	
1	56,21572	17,3054	243,4720	299,6877	12,0%	
1	55,21909	17,3054	243,4720	298,6911	11,6%	
1	54,80860	17,3054	243,4720	298,2806	11,5%	
2	54,59582	29,0097	243,4720	298,0678	11,4%	
2	52,29028	29,0097	243,4720	295,7623	10,6%	
1	48,98056	17,6411	243,4720	292,4526	9,3%	
1	45,39653	21,7576	243,4720	288,8685	8,0%	
2	35,30241	29,0097	243,4720	278,7744	4,2%	
2	24,21418	29,0097	243,4720	267,6862	0,1%	
Control	3	24,05746	8,6190	243,4720	267,5295	0,0%
	2	22,21482	29,0097	243,4720	265,6868	-0,7%
	1	20,55130	17,3054	243,4720	264,0233	-1,3%
	1	20,06532	19,3080	243,4720	263,5373	-1,5%
	1	19,22160	17,3054	243,4720	262,6936	-1,8%
Control	3	3,69914	10,7490	243,4720	247,1711	-7,6%
	2	3,16469	22,5595	243,4720	246,6367	-7,8%
	2	2,35916	22,5595	243,4720	245,8312	-8,1%
	1	2,15540	17,3054	243,4720	245,6274	-8,2%
	1	1,56965	23,4711	243,4720	245,0416	-8,4%
	2	1,08895	22,5595	243,4720	244,5610	-8,6%

Growth increase – m³/ha

10 lines selected

Volume gains between 12 and 20% at 5 years old





Freeze tolerant Eucalyptus

Resultados do 2º inverno no Alabama



Controle

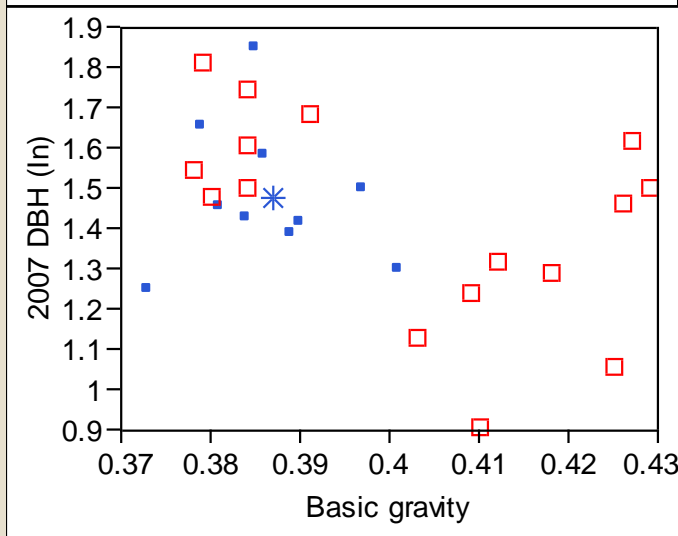
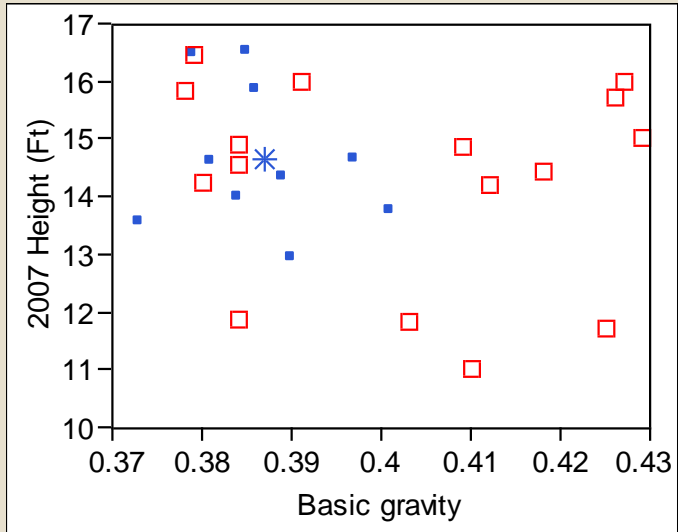


Linhagem



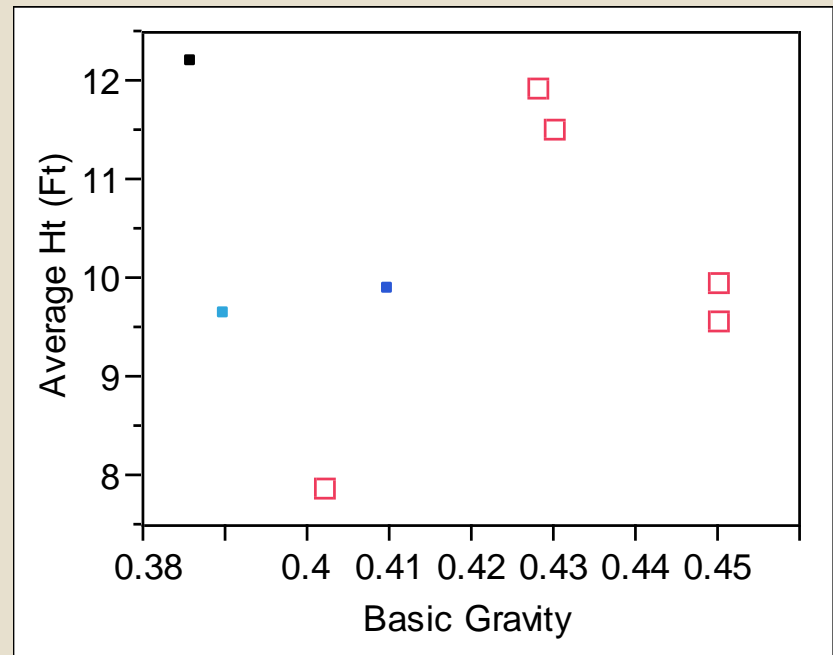
Teste em blocos

Resultados de testes indicam tolerância ao frio para ~16°F (- 8° to - 9°C)



Cottonwood

POCs – Wood density increase – 5 genes in field trials



Pine

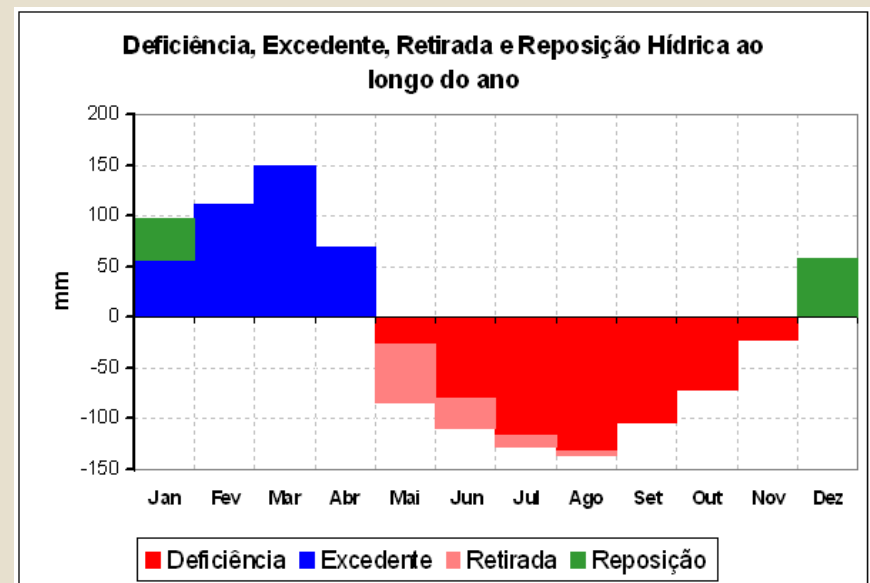
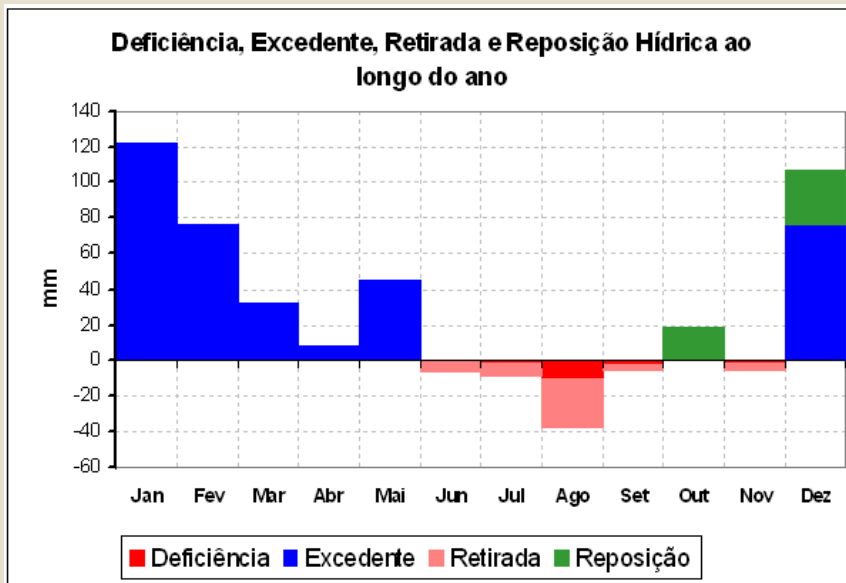
Gene #1 – 13-15% increase in density

Each red square is an average of transgenic density lines
Blue dots are average of transgenic control lines
Blue asterik is non-transgenic control



POC9 – drought tolerant gene

2 trials established – Mato Grosso do Sul e Tocantins





Herbicide tolerant genes

- New project
- Field trials to be established in Brazil in 2015

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What About The Future of Biotechnology?

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Future of Biotechnology in Brasil

- Approval of the first Biotech Eucalyptus in the world by CTNBIO
 - Very important regulatory step
- What's next?
 - Commercial plantation
 - New products to be approved
 - Technology adoption by growers
- Promise that becomes a reality

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Forest Market

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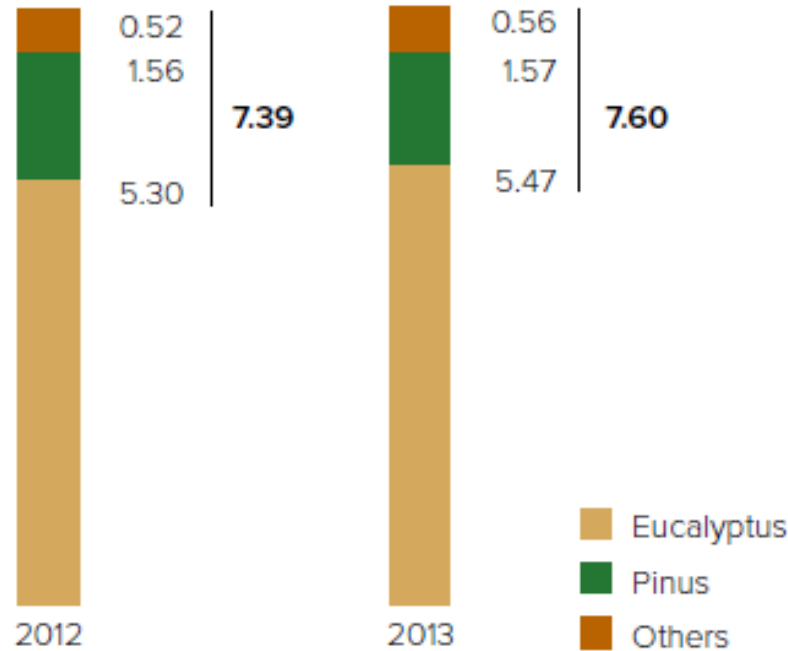




Forest Market

AREA OCCUPIED BY PLANTED TREES IN BRAZIL

Millions ha





Forest Market

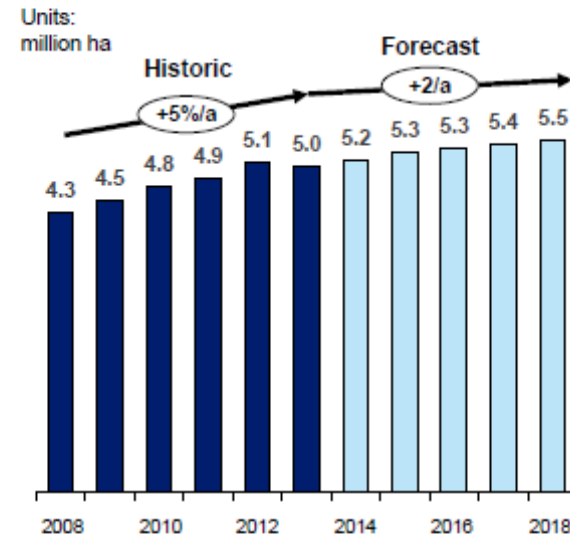
Eucalyptus plantation area in Brazil has been increasing over the last 5 years at an annual rate of 5%/a and totaled 5.5 million ha at the end of 2013. The states of São Paulo and Minas Gerais contain 50% of the planted areas.

Eucalyptus Plantation Area Distribution in 2013



Source: Pöyry Analysis

Eucalyptus Area Development





Forest Market

State	Annual Seedling Consumption (Million)									
	Historical Peak	Historical Average	2013	2014	2015	2016	2017	2018	Average (2019-2025)	Long Term Average
Mato Grosso do Sul	124	53	163	156	138	137	108	115	169	169
Bahia	134	96	103	107	122	136	136	144	138	138
São Paulo	234	145	95	93	98	98	97	97	131	145
Minas Gerais	251	193	75	85	79	102	116	116	233	193
Espirito Santo	33	29	30	48	48	48	42	42	55	55
Paraná	56	35	30	32	38	49	49	49	49	49
Rio Grande do Sul	103	30	14	34	55	55	55	55	55	55
Maranhão	12	7	9	48	58	58	58	58	37	37
Other	63	64	42	48	56	51	53	48	65	69
Total	1,010	642	561	650	691	733	712	722	931	910

Source: Pöyry Analysis



Forest Market

PLANTATION RESOURCE

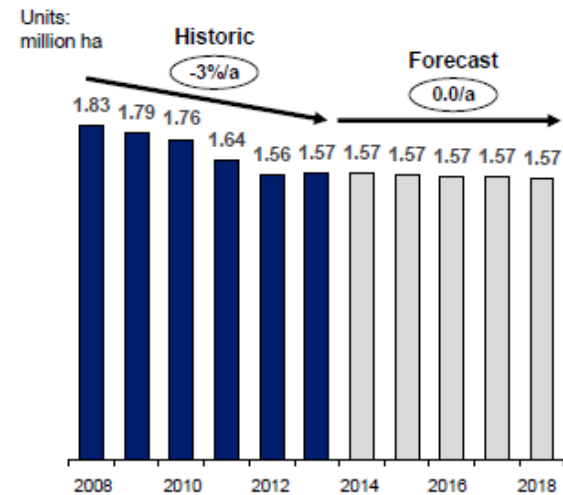
Pine plantation area in Brazil has been decreasing over the last 5 years and totaled 1.57 million ha at the end of 2013. It is Pöyry's opinion that pine plantation area is expected to remain stable in the coming years.

Pine Plantation Area Distribution - 2013



Source: Pöyry Analysis

Pine Area Development





Forest Market

State	Annual Seedling Consumption (Million)						Long Term Average
	2013	2014	2015	2016	2017	2018	
Paraná	35	35	36	40	41	41	55
Santa Catarina	29	30	32	36	39	39	50
São Paulo	5	4	4	4	5	6	12
Rio Grande do Sul	2	2	2	3	4	5	10
Other	1	1	1	1	1	1	1
Total	72	72	75	84	90	92	128

Source: Pöyry Analysis



Wood consumption

BRAZILIAN CONSUMPTION OF ROUNDWOOD FOR INDUSTRIAL USE
PER SEGMENT AND GENUS, 2013

SEGMENT	CONSUMPTION OF ROUNDWOOD (m ³)			
	EUCALYPTUS	PINUS	OTHERS	TOTAL
PULP AND PAPER	56,628,357	8,067,258	498,085	65,193,700
WOOD PANELS	6,428,162	13,457,258	378,612	20,264,031
LUMBER AND OTHER SOLID PRODUCTS	6,870,498	15,295,499	357,052	22,523,049
CHARCOAL	23,533,724	-	-	23,533,724
INDUSTRIAL FIREWOOD	41,832,528	3,929,361	4,262,239	50,024,128
TREATED WOOD	1,824,012	-	-	1,824,012
WOOD CHIPS AND OTHERS	1,129,621	-	781,200	1,910,821
TOTAL	138,246,903	40,749,376	6,277,187	185,273,466



Conclusions

- ArborGen has been working to license / develop genetics for the forest sector
 - Partnerships
 - Breeding
 - Biotechnology
- Market presence with Eucalyptus and Loblolly Pine

ABTCP 2015

48º CONGRESSO E EXPOSIÇÃO
INTERNACIONAL DE CELULOSE E PAPEL

48º CONGRESSO INTERNACIONAL DE CELULOSE E PAPEL
1ª CONFERÊNCIA IBEROAMERICANA SOBRE BIOECONOMIA



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REALIZAÇÃO



CORREALIZAÇÃO

