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No-cook process at very high gravity of various cassava starches for ethanol production

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INTERNATIONAL SOCIETY FOR TROPICAL ROOT CROPS

CGIAR RESEARCH PROGRAM ON Roots, Tubers and Bananas

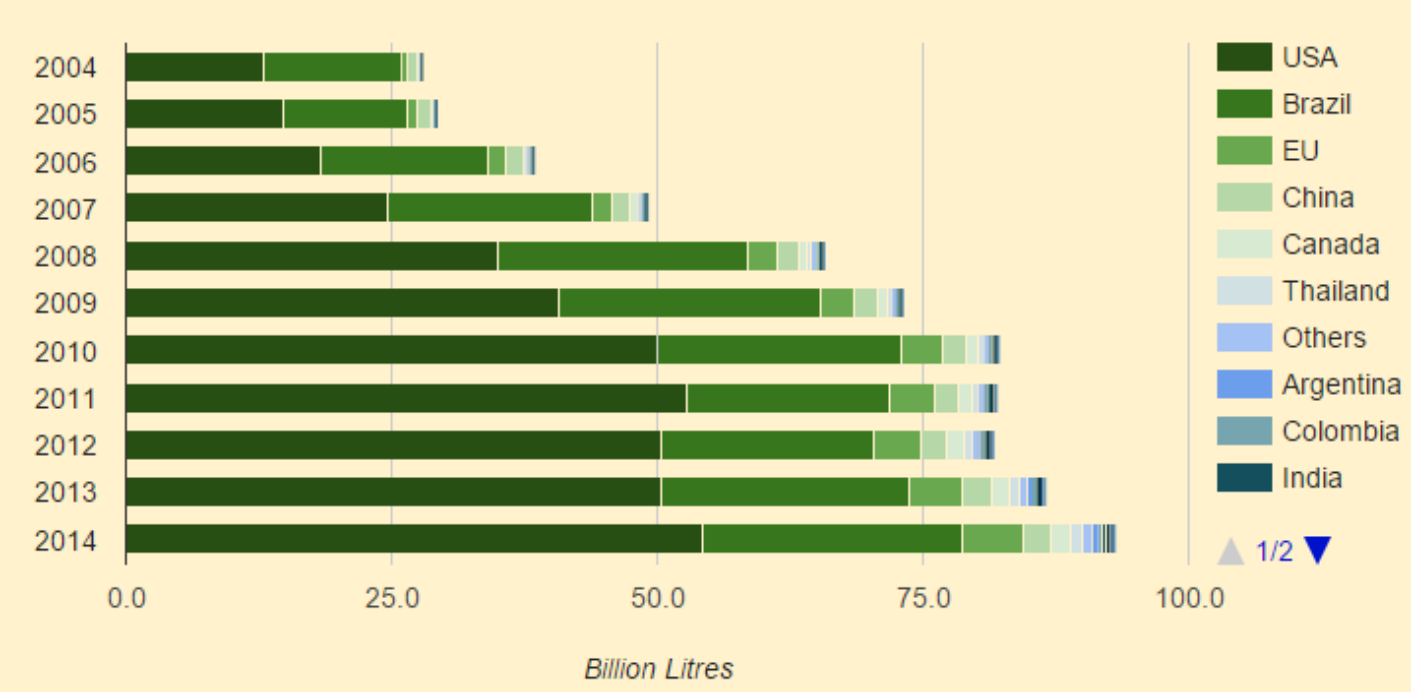
HarvestPlus Better Crops • Better Nutrition

CIAT International Center for Tropical Agriculture Since 1967 Science to cultivate change

ĐẠI HỌC BÁCH KHOA

cirad AGRICULTURAL RESEARCH FOR DEVELOPMENT

World Fuel Ethanol Production



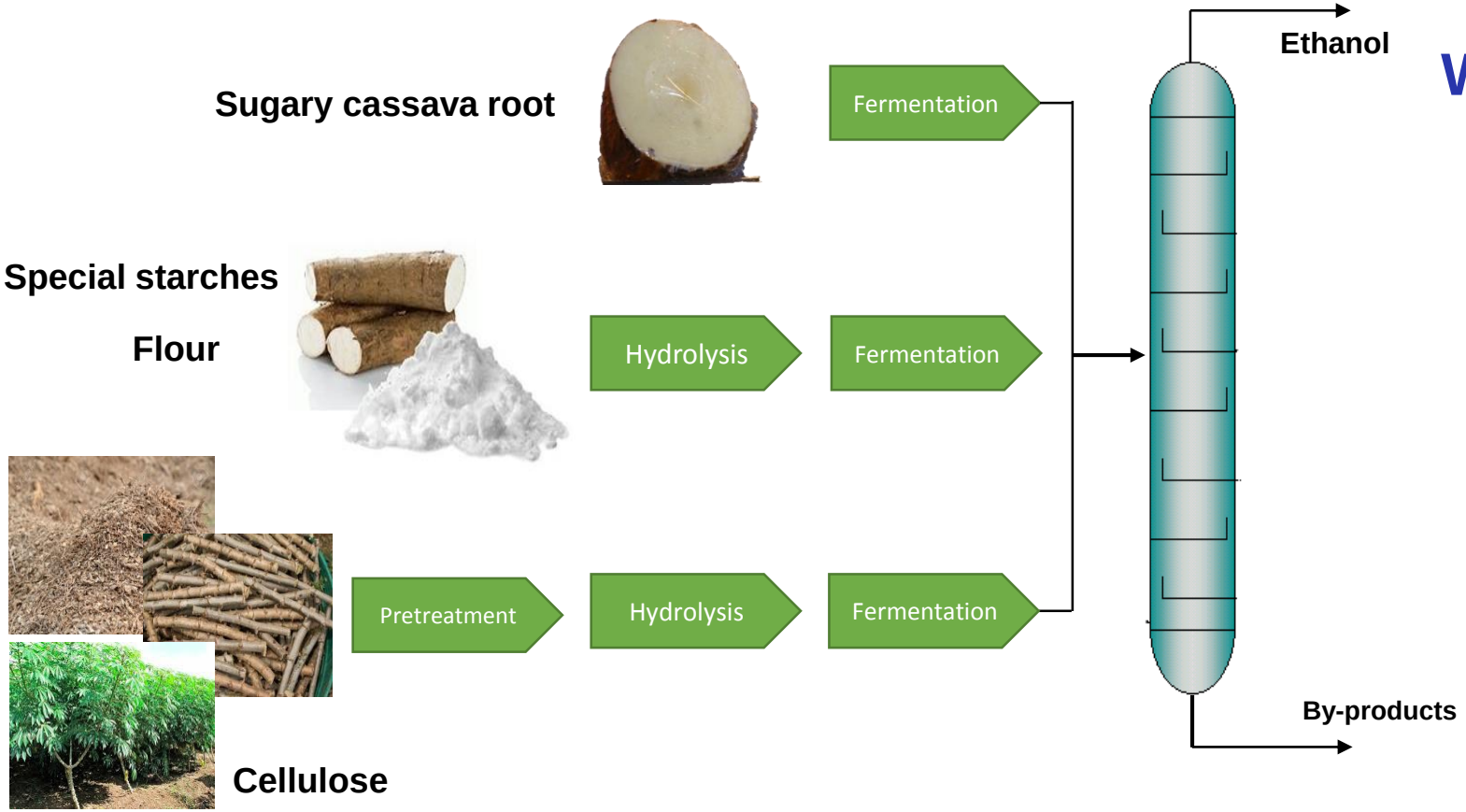
https://ethanolrfa.org/resources/industry/statistics/world/

Comparison of bioethanol production from different energy crops.

Crops	Yield (ton $ha^{-1}year^{-1}$)	Conversion rate to bioethanol (L ton^{-1})	Bioethanol yield (L $ha^{-1}year^{-1}$)
Sugarcane	70	70	4900
Cassava	**23**	**150**	**3450**
Sweet sorghum	35	80	2800
Maize	5	410	2050
Wheat	4	390	1560
Rice	5	450	2250

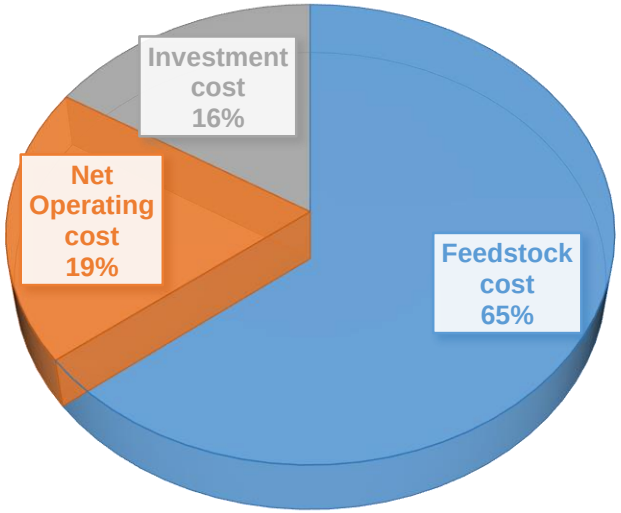
Wang W. Cassava production for industrial utilization in (the) PRC – present and future perspective. In: Cassava research and development in Asia: exploring new opportunities for an ancient crop. seventh regional cassava workshop, Bangkok, Thailand. October 28–November 1; 2002. p. 33–38.

Ethanol Production from cassava

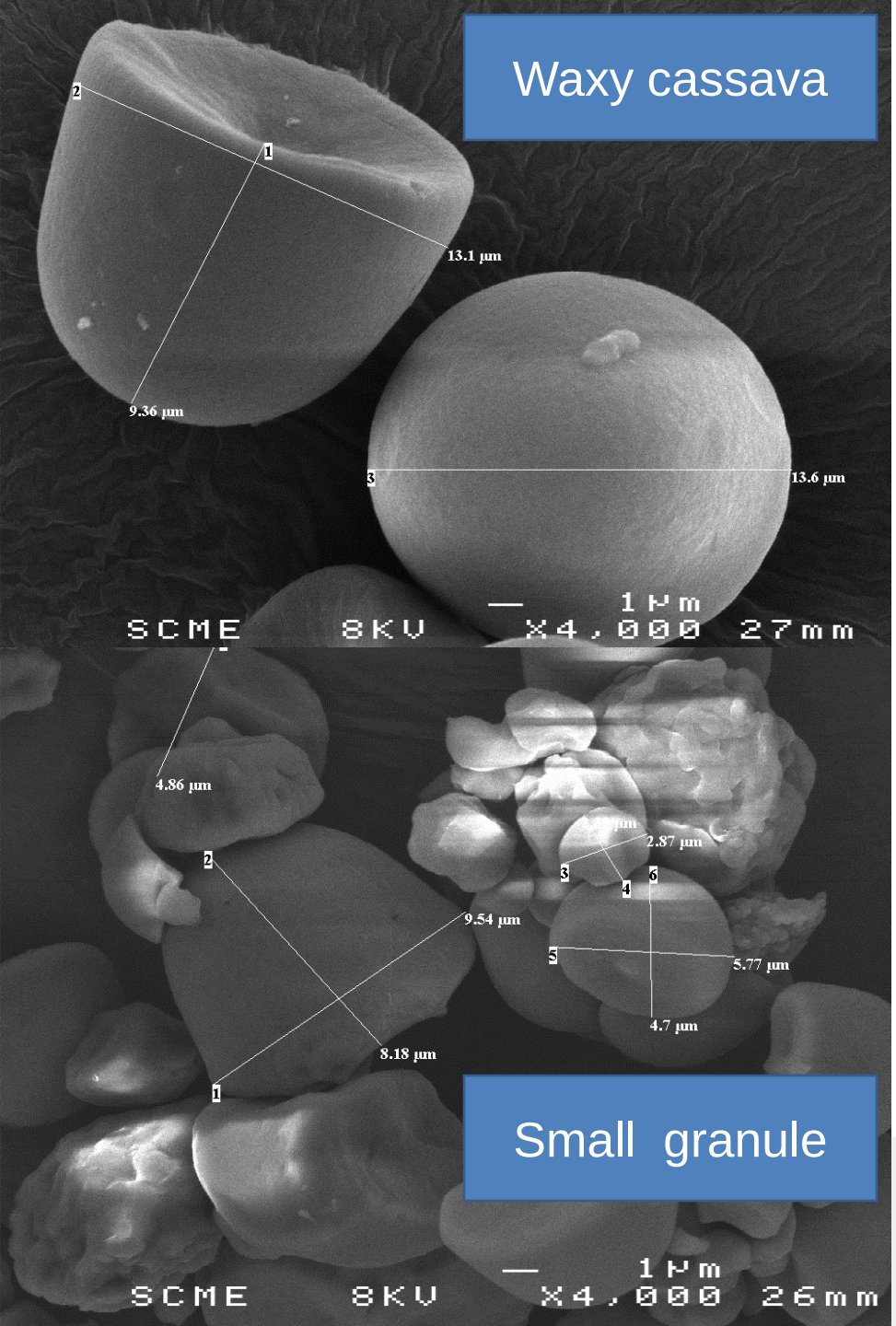


Why Cassava ?

Cost structures of the ethanol production from fresh cassava roots



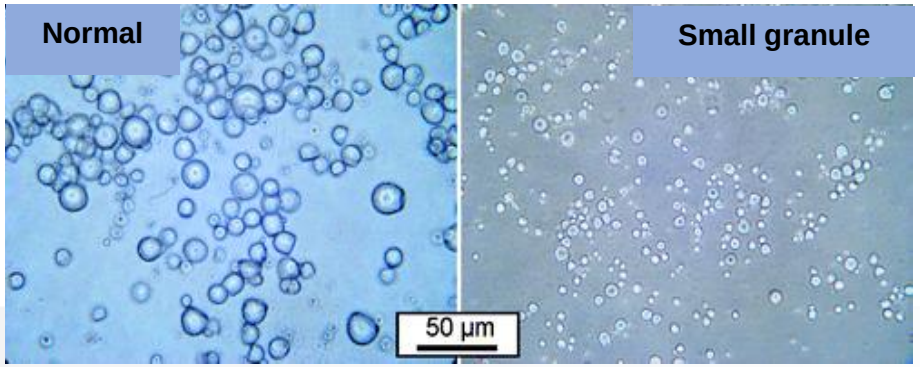
Sorapipatana & Yoosin, 2011



Cassava special starches

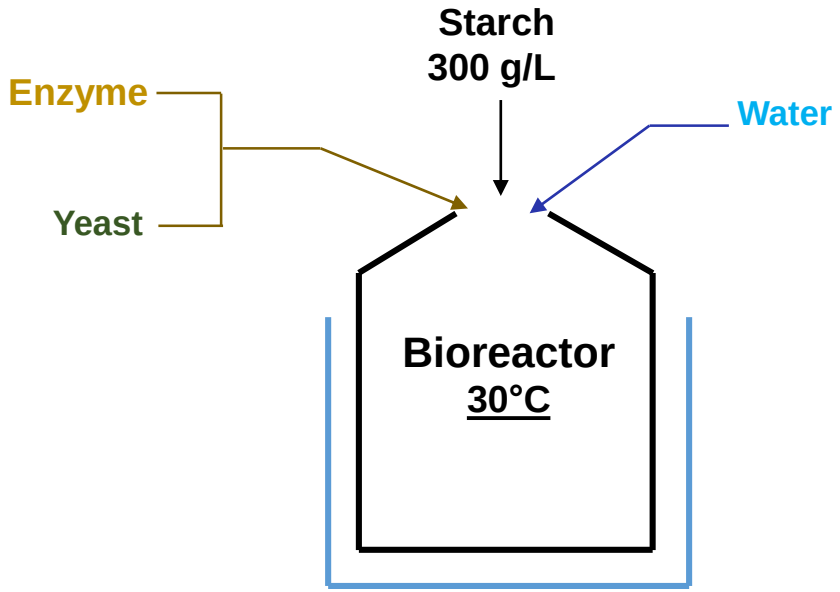
CIAT developed unique genotypes in the world

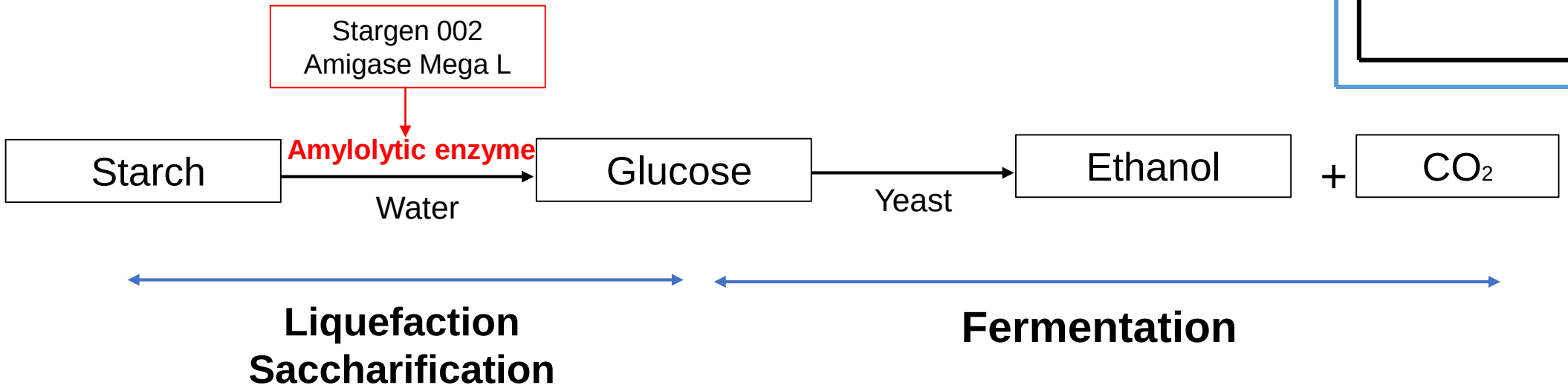
	Amylose content (%)	Granule size (µm)	Crystallinity (%)
Waxy cassava	0.0	16.0	40.0
Small Granule	26	5.8	-
Double mutant	0.0	6.5	-
Normal Cassava	16.8	15.1	35.0



Very High Gravity (VHG): 30% dry matter

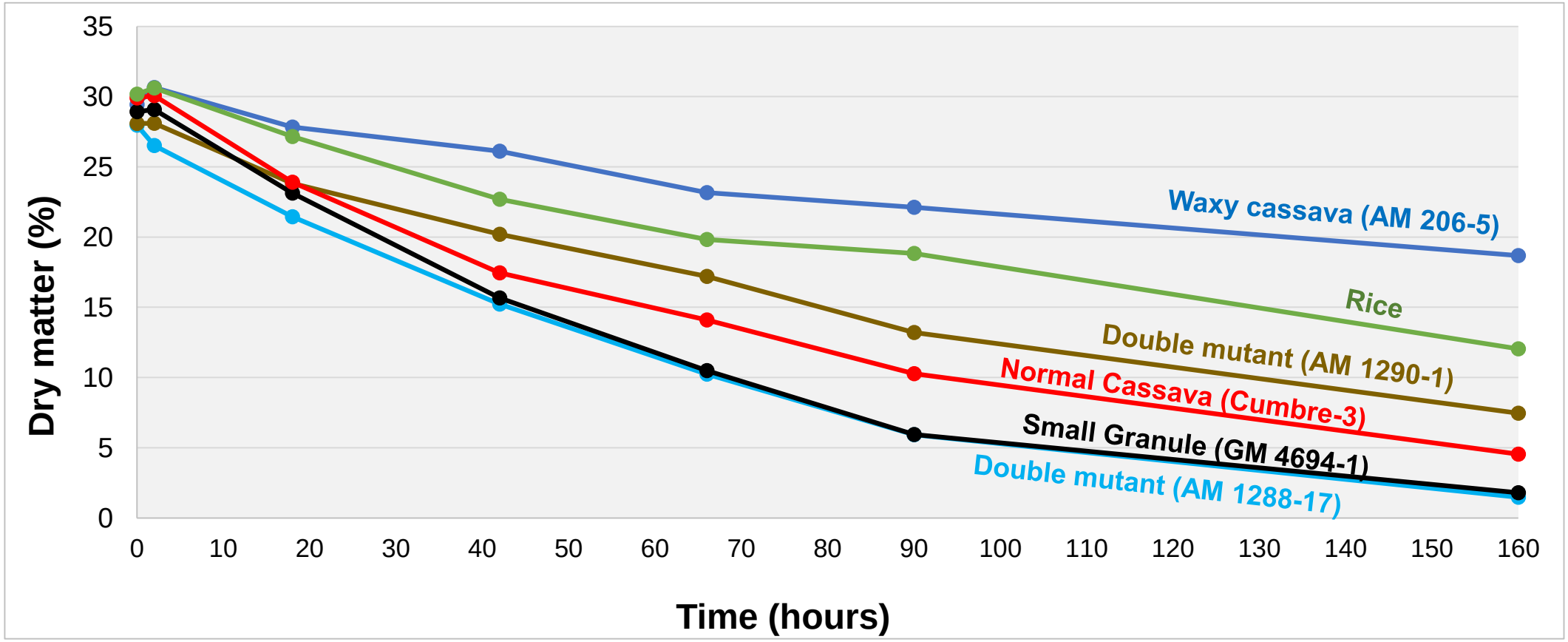
Increasing plant capacity and reduction in capital costs
Increasing plant efficiency
Reducing risk of contaminating bacteria



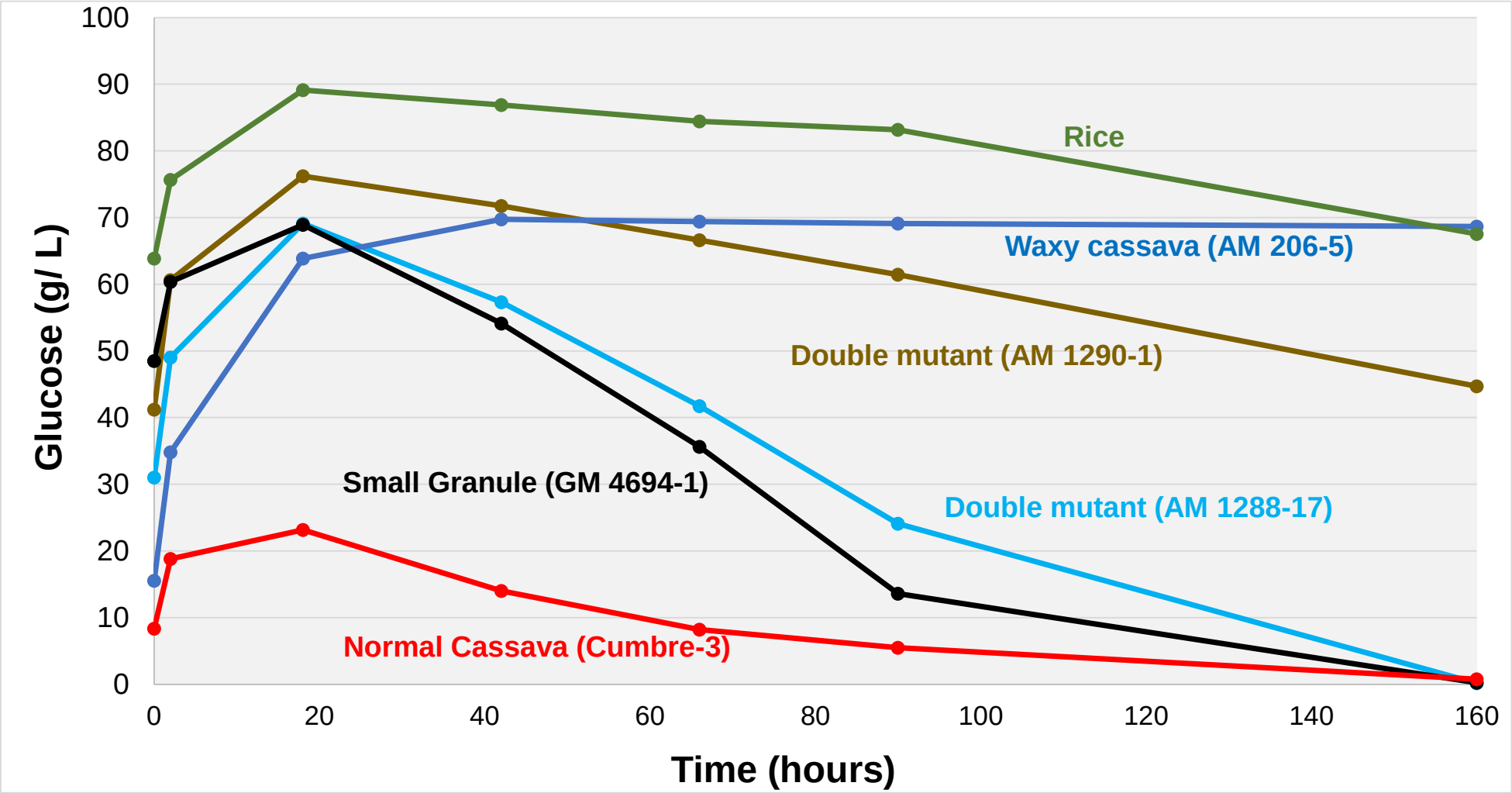


Simultaneous Saccharification and Fermentation (SSF)

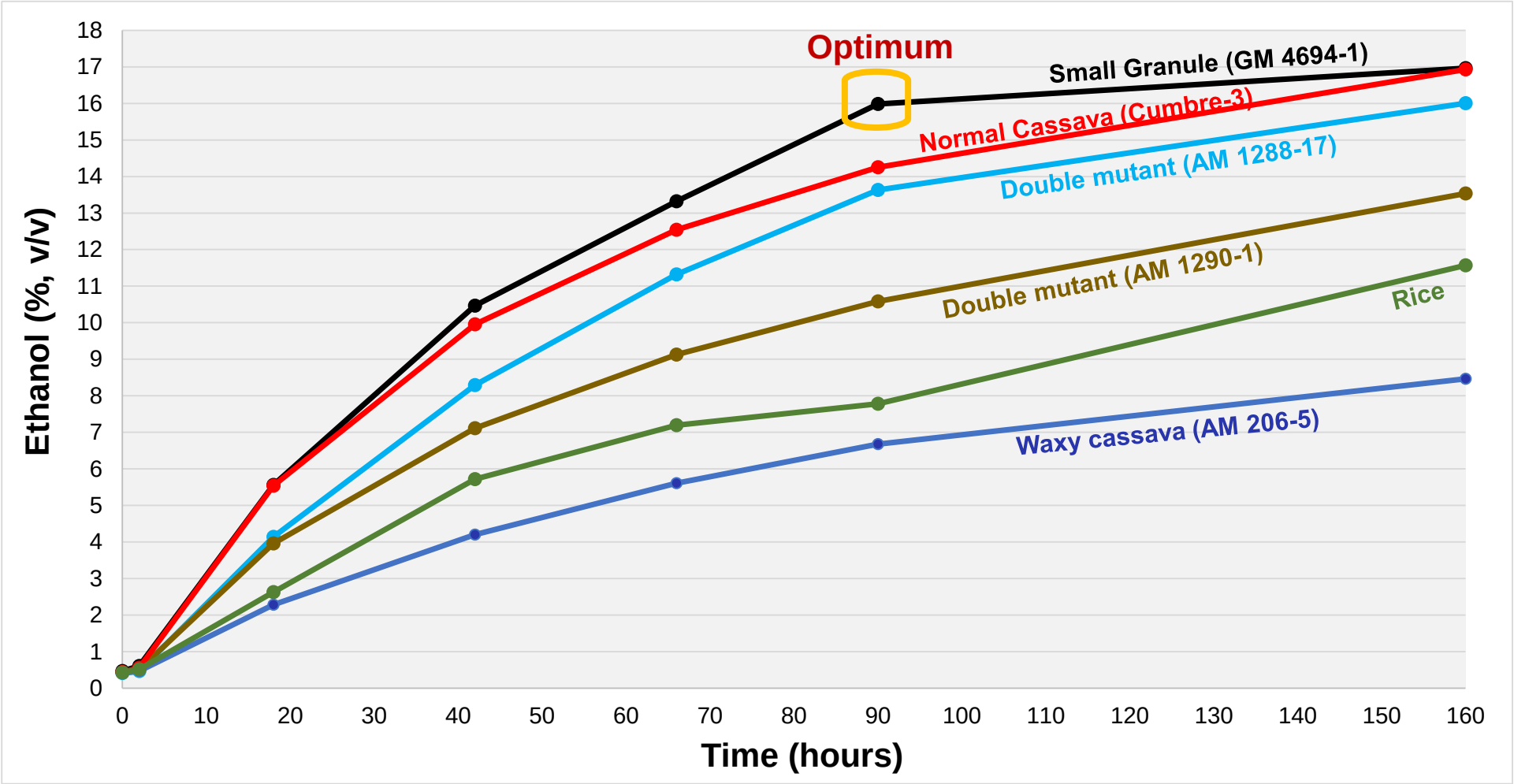
Dry matter content during SSF process



Evolution of the concentration of Glucose during SSF process



Ethanol production during SSF process



Ethanol yield during SSF process

			Ethanol yield (%)*	
Starch	**Genotype**	**Characteristic**	**90 hours**	**160 hours**
Cassava	GM 4694-1	Small granule	**80.1**	**84.9**
Cassava	Cumbre-3	Normal	70.1	84.7
Cassava	AM 1288-17	Double mutant	68.2	80.1
Cassava	AM 1290-1	Double mutant	53.0	67.8
Cassava	AM 206-5	Waxy	33.4	42.4
Rice	Rice	Normal	39.0	57.9

* The conversion efficiency was calculated from the theoretical yields

Highest rate of hydrolysis with Small Granule Cassava (GM 4694-1) and Double Mutant (AM 1290-1)

Combination of:

1) **Small granule variety**
2) **Very high gravity fermentation process**

Enables high ethanol yield at lower costs and shorter time – nearly 3 days faster for same ethanol production as the control

Thank you!

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