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International Germplasm Transfer: Past and Present

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International Germplasm Transfer: Past and Present

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FOREWORD

Germplasm transfer has played an integral part in international development and improvement of crop plants. The need for international cooperation in germplasm exchange has never been any greater nor has it faced any greater challenges than it does today. Future supplies of safe and abundant food sources will depend on the continued infusion of germplasm into the plant genetic resources of all countries.

The Crop Science Society of America has a rich history in the support and sponsorship of activities relating to germplasm enhancement and exchange on both domestic and international levels. This publication is a result of two symposia sponsored by the Society at its annual meetings in 1992. The subject matter of these symposia covered the historic perspectives of plant germplasm transfer and the present global activities relating to plant germplasm resources. This publication substantiates the important contributions of international germplasm exchange and the need for its continuation.

Plant breeders and geneticists, crop scientists, and agronomist will find the information shared in this publication to be timely and useful, particularly as we strive to ensure sustained crop productivity. The editor, Ronny R. Duncan, is well-recognized for his contributions in international germplasm activities with sorghum, and the authors of the chapters are leading scientists and educators in their respective disciplines. Together, their backgrounds and expertise are well-suited to sharing the historic perspectives, as well as integrating the most current information available on this complex subject.

The Crop Science Society of America is pleased to jointly sponsor this publication with the American Society of Agronomy. The technical content of this publication should be a beneficial reference to its readers for years to come.

Robert (Bob) C. Shearman, *President*
Crop Science Society of America

PREFACE

The historical impact of worldwide plant genetic resource movement has dramatically affected mankind for more than 500 years. All countries have plant genetic resource deficiencies, and all have benefitted from an infusion of introduced crop germplasm. The travels of Christopher Columbus and other explorers may have escalated the intercontinental germplasm transfers, but genetic resources were moved prior to the Columbus era, continue to the present, and will continue in the future as long as populations and food requirements increase.

During 1992, two symposia were sponsored by the Crop Science Society of America in the C-8 Plant Genetic Resource division at the annual meetings in Minneapolis, MN. J. McD. Stewart organized one symposium entitled "1492–1992: 500 Years of Global Germplasm Transfer." Devon Doney organized the second symposium entitled "International Cooperation in Germplasm Activities." The combined topics of the two symposia provided an overview on the global movement of germplasm, the impact from intercontinental genetic resource transfers, an assessment of problems and current needs that are inherent in global germplasm exchange, philosophical and political ramifications involved in germplasm movement, and information on seven widely grown crops that have global mandates for continuous germplasm exchange. Their Crop Germplasm Committees are truly global in function, operation, and genetic resource exchange, and serve as examples of what can be accomplished as priorities are focused and implemented.

The earliest farmers were active participants in genetic enhancement. More sophisticated tools such as those evolving from the human and plant genome projects and other biotechnology-oriented research efforts should lead to a more efficient and escalated enhancement of genetic resources in the future. Future food sustainability will depend on these improvements. Hopefully, this publication will help to explain the past accomplishments of germplasm exchange and help to reinforce the global needs in the future that will require continued infusion of genetic resources to add value to crops, or to increase or sustain productivity. No country will be by-passed in this need. All will have to cooperate in germplasm exchange to benefit.

I am particularly grateful to the authors for meeting some very strenuously-enforced deadlines after I was appointed editor. I also appreciate their acquiescence to conformity requirements in my effort to provide some continuity among chapters within a section.

This publication should serve as a good foundation for past and present genetic resource exchange achievements. This next era of material transfer agreements and biodiversity *ownership* (intellectual property) rights should prove to be quite interesting.

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Conversion Factors for SI and non-SI Units

Conversion Factors for SI and non-SI Units

To convert Column 1 into Column 2, multiply by	Column 1 SI Unit	Column 2 non-SI Unit	To convert Column 2 into Column 1, multiply by
		Length	
0.621	kilometer, km (10^3 m)	mile, mi	1.609
1.094	meter, m	yard, yd	0.914
3.28	meter, m	foot, ft	0.304
1.0	micrometer, μm (10^{-6} m)	micron, μ	1.0
3.94×10^{-2}	millimeter, mm (10^{-3} m)	inch, in	25.4
10	nanometer, nm (10^{-9} m)	Angstrom, Å	0.1
		Area	
2.47	hectare, ha	acre	0.405
247	square kilometer, km^2 (10^3 m)^2	acre	4.05×10^{-3}
0.386	square kilometer, km^2 (10^3 m)^2	square mile, mi^2	2.590
2.47×10^{-4}	square meter, m^2	acre	4.05×10^3
10.76	square meter, m^2	square foot, ft^2	9.29×10^{-2}
1.55×10^{-3}	square millimeter, mm^2 (10^{-3} m)^2	square inch, in^2	645
		Volume	
9.73×10^{-3}	cubic meter, m^3	acre-inch	102.8
35.3	cubic meter, m^3	cubic foot, ft^3	2.83×10^{-2}
6.10×10^4	cubic meter, m^3	cubic inch, in^3	1.64×10^{-5}
2.84×10^{-2}	liter, L (10^{-3} m^3)	bushel, bu	35.24
1.057	liter, L (10^{-3} m^3)	quart (liquid), qt	0.946
3.53×10^{-2}	liter, L (10^{-3} m^3)	cubic foot, ft^3	28.3
0.265	liter, L (10^{-3} m^3)	gallon	3.78
33.78	liter, L (10^{-3} m^3)	ounce (fluid), oz	2.96×10^{-2}
2.11	liter, L (10^{-3} m^3)	pint (fluid), pt	0.473

		Mass	
2.20×10^{-3}	gram, g (10^{-3} kg)	pound, lb	454
3.52×10^{-2}	gram, g (10^{-3} kg)	ounce (avdp), oz	28.4
2.205	kilogram, kg	pound, lb	0.454
0.01	kilogram, kg	quintal (metric), q	100
1.10×10^{-3}	kilogram, kg	ton (2000 lb), ton	907
1.102	megagram, Mg (tonne)	ton (U.S.), ton	0.907
1.102	tonne, t	ton (U.S.), ton	0.907
		Yield and Rate	
0.893	kilogram per hectare, kg ha^{-1}	pound per acre, lb $acre^{-1}$	1.12
7.77×10^{-2}	kilogram per cubic meter, kg m^{-3}	pound per bushel, lb bu^{-1}	12.87
1.49×10^{-2}	kilogram per hectare, kg ha^{-1}	bushel per acre, 60 lb	67.19
1.59×10^{-2}	kilogram per hectare, kg ha^{-1}	bushel per acre, 56 lb	62.71
1.86×10^{-2}	kilogram per hectare, kg ha^{-1}	bushel per acre, 48 lb	53.75
0.107	liter per hectare, L ha^{-1}	gallon per acre	9.35
893	tonnes per hectare, t ha^{-1}	pound per acre, lb $acre^{-1}$	1.12×10^{-3}
893	megagram per hectare, Mg ha^{-1}	pound per acre, lb $acre^{-1}$	1.12×10^{-3}
0.446	megagram per hectare, Mg ha^{-1}	ton (2000 lb) per acre, ton $acre^{-1}$	2.24
2.24	meter per second, m s^{-1}	mile per hour	0.447
		Specific Surface	
10	square meter per kilogram, m^2 kg^{-1}	square centimeter per gram, cm^2 g^{-1}	0.1
1000	square meter per kilogram, m^2 kg^{-1}	square millimeter per gram, mm^2 g^{-1}	0.001
		Pressure	
9.90	megapascal, MPa (10^6 Pa)	atmosphere	0.101
10	megapascal, MPa (10^6 Pa)	bar	0.1
1.00	megagram per cubic meter, Mg m^{-3}	gram per cubic centimeter, g cm^{-3}	1.00
2.09×10^{-2}	pascal, Pa	pound per square foot, lb ft^{-2}	47.9
1.45×10^{-4}	pascal, Pa	pound per square inch, lb in^{-2}	6.90×10^3

(continued on next page)

Conversion Factors for SI and non-SI Units

To convert Column 1 into Column 2, multiply by	Column 1 SI Unit	Column 2 non-SI Unit	To convert Column 2 into Column 1, multiply by
		Temperature	
1.00 (K − 273)	Kelvin, K	Celsius, °C	1.00 (°C + 273)
(9/5 °C) + 32	Celsius, °C	Fahrenheit, °F	5/9 (°F − 32)
		Energy, Work, Quantity of Heat	
9.52×10^{-4}	joule, J	British thermal unit, Btu	1.05×10^{3}
0.239	joule, J	calorie, cal	4.19
10^{7}	joule, J	erg	10^{-7}
0.735	joule, J	foot-pound	1.36
2.387×10^{-5}	joule per square meter, $J\ m^{-2}$	calorie per square centimeter (langley)	4.19×10^{4}
10^{5}	newton, N	dyne	10^{-5}
1.43×10^{-3}	watt per square meter, $W\ m^{-2}$	calorie per square centimeter minute (irradiance), $cal\ cm^{-2}\ min^{-1}$	698
		Transpiration and Photosynthesis	
3.60×10^{-2}	milligram per square meter second, $mg\ m^{-2}\ s^{-1}$	gram per square decimeter hour, $g\ dm^{-2}\ h^{-1}$	27.8
5.56×10^{-3}	milligram (H_2O) per square meter second, $mg\ m^{-2}\ s^{-1}$	micromole (H_2O) per square centimeter second, $\mu mol\ cm^{-2}\ s^{-1}$	180
10^{-4}	milligram per square meter second, $mg\ m^{-2}\ s^{-1}$	milligram per square centimeter second, $mg\ cm^{-2}\ s^{-1}$	10^{4}
35.97	milligram per square meter second, $mg\ m^{-2}\ s^{-1}$	milligram per square decimeter hour, $mg\ dm^{-2}\ h^{-1}$	2.78×10^{-2}
		Plane Angle	
57.3	radian, rad	degrees (angle), °	1.75×10^{-2}

Electrical Conductivity, Electricity, and Magnetism			
10	siemen per meter, $S\ m^{-1}$	millimho per centimeter, $mmho\ cm^{-1}$	0.1
10^4	tesla, T	gauss, G	10^{-4}
Water Measurement			
9.73×10^{-3}	cubic meter, m^3	acre-inches, acre-in	102.8
9.81×10^{-3}	cubic meter per hour, $m^3\ h^{-1}$	cubic feet per second, $ft^3\ s^{-1}$	101.9
4.40	cubic meter per hour, $m^3\ h^{-1}$	U.S. gallons per minute, $gal\ min^{-1}$	0.227
8.11	hectare-meters, ha-m	acre-feet, acre-ft	0.123
97.28	hectare-meters, ha-m	acre-inches, acre-in	1.03×10^{-2}
8.1×10^{-2}	hectare-centimeters, ha-cm	acre-feet, acre-ft	12.33
Concentrations			
1	centimole per kilogram, $cmol\ kg^{-1}$	milliequivalents per 100 grams, $meq\ 100\ g^{-1}$	1
0.1	gram per kilogram, $g\ kg^{-1}$	percent, %	10
1	milligram per kilogram, $mg\ kg^{-1}$	parts per million, ppm	1
Radioactivity			
2.7×10^{-11}	becquerel, Bq	curie, Ci	3.7×10^{10}
2.7×10^{-2}	becquerel per kilogram, $Bq\ kg^{-1}$	picocurie per gram, $pCi\ g^{-1}$	37
100	gray, Gy (absorbed dose)	rad, rd	0.01
100	sievert, Sv (equivalent dose)	rem (roentgen equivalent man)	0.01
Plant Nutrient Conversion			
	Elemental	*Oxide*	
2.29	P	P_2O_5	0.437
1.20	K	K_2O	0.830
1.39	Ca	CaO	0.715
1.66	Mg	MgO	0.602