

Banana

Genetic diversity

Over a period of thousands of years, population migrations and movement of plant material have placed the banana in very different ecological contexts on the various continents. Farmers have succeeded in harnessing the natural mutations resulting from vegetative multiplication. This combination of natural reproduction and selection by man since ancient times has resulted in the present genetic diversity.

Bananas originated in South-East Asia as wild seminiferous plants. Natural crosses built up a large base of genetic diversity that still exists today. These crosses were the origin of the seedless varieties. These bananas have food qualities that soon interested man, who incorporated them in agriculture using their vegetative multiplication potential.

From the botanical point of view, the genus *Musa* is divided into seminiferous species with inedible fruits and parthenocarpic varieties with fleshy seedless fruits. The *Eumusa* section includes *Musa acuminata* (genome symbol: A) and *Musa balbisiana* (genome symbol: B). These are wild species at the origin of the cultivated varieties.

The latter are classified according to their ploidy level and their genetic make-up. Some 1 200 varieties have been counted and classified around the world.

The inedible wild species with seed-containing fruits can be used for purposes other than human food-stuffs (fibre, livestock feed, etc.). They are all diploid (AA and BB). About 180 have been counted to date, all from South-East Asia, but the census is not definitive (especially for the BBs). These fertile varieties are nonetheless important since they possess different levels of resistance to pests and diseases. They therefore form base material for the various present and future conventional genetic improvement and varietal creation programmes. Numerous cultivars have been bred by man. They are classified in groups according to their genetic make-up and then in subgroups assembling the various cultivars derived from each other by natural mutation starting from a common genetic ancestor. Distinction is made between the following groups:

- diploid groups: AA (such as Figue sucrée or Frayssinette) and AB. These total about 290 cultivars grown mainly in South-East Asia where they originated;

- three triploid groups (at least 650 cultivars): AAA, AAB and ABB. The subgroups of each of these distinguish between the dessert varieties richer in sugar at maturity, cooking varieties with fruits that are firm and not sweet even when ripe, and sometimes bananas for beer-making by fermentation of the pulp (East Africa).

Even if the plants within the same subgroup display only weak genetic diversity, they do have a great range of phenotypes, resulting essentially from mutations and many centuries of selection by man. This is the case of the Cavendish (more than 20 cultivars), East African highland cooking and beer bananas (more than 150) and Central and West African plantain (more than 120) subgroups.

Although the intensive cultivation system used for approximately 25 percent of world production favours monovarietal production, it is important to remember that most production is based on less intensive family farming with the emphasis on varietal mixing. This contributes to continuing selection and hence ensures banana diversity ■

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Banana — Estimated world production in 2016

in tonnes	Cooking bananas		Dessert bananas		Total
	Plantain AAB group	Highland bananas + ABB group + others	Cavendish	Gros Michel + others	
North America	0	1 000	4 173	100	5 273
South America	5 908 141	577 600	13 264 239	3 229 180	22 979 160
Central America	1 017 039	63 455	8 259 711	86 500	9 426 705
Caribbean	873 547	733 957	1 236 769	273 764	3 118 037
West and Central Africa	9 386 629	1 130 094	3 024 532	443 203	13 984 458
East Africa	914 580	10 463 461	4 012 449	789 674	16 180 164
North Africa and Middle East	36	10 067	2 453 505	74 939	2 538 547
Asia	2 113 680	16 156 897	35 998 120	11 348 754	65 617 451
Oceania	1 069	629 155	739 339	276 299	1 645 862
Europe	2	17	486 155	27	486 201
World total	20 214 723	29 765 703	69 478 992	16 522 440	135 981 858

Source: Thierry Lescot - CIRAD according to references, surveys, professional sources, FAO, etc.

Production and trade (2016 data and 2015 data in italics) Estimates in tonnes	Production				Total	Exports		Imports	
	Cooking bananas		Dessert bananas			Cavendish	Plantain	Dessert bananas	Plantain
	Plantains AAB	Highland bananas + ABB + other AAB + AAA + AA	Cavendish AAA	Gros Michel & other AA, AAA, AAB, ABB					
North America									
Canada					0	35	4	569 818	18 133
United States		1 000	4 173	100	5 273	698 351	20 834	4 593 337	608 836
Greenland					0			600	63
Saint Pierre & Miquelon						3		60	
Total	0	1 000	4 173	100	5 273	698 386	20 838	5 163 815	627 032
	0.0%	19.0%	79.1%	1.9%	100.0%	0.0%	2.0%		
Central America									
Belize	5 757	200	76 000	1 000	82 957	71 741	2		
Costa Rica	110 000	3 000	2 409 543	25 000	2 547 543	2 365 000	5 238	8 192	1 487
Guatemala	347 157	21 000	2 500 000	10 000	2 878 157	2 239 271	251 669	10 030	4 394
Honduras	95 125	10 000	707 120	10 000	822 245	616 452	554	63 085	22 867
Mexico	230 000	10 000	2 114 778	30 000	2 384 778	448 311	14 056	85	2
Nicaragua	120 000	12 000	150 000	4 000	286 000	78 408	27 887	2 364	23
Panama	72 000	6 800	300 000	6 000	384 800	249 625	6 784	192	52
El Salvador	37 000	455	2 270	500	40 225		2 888	64 761	84 978
Total	1 017 039	63 455	8 259 711	86 500	9 426 705	6 068 808	309 078	148 709	113 803
	10.8%	0.7%	87.6%	0.9%	100.0%	73.5%	30.4%		
South America									
Argentina			90 000	50	90 050			433 442	1 257
Bolivia	100 000	10 000	200 000	50 000	360 000	114 743	2 051		
Brazil	560 000	130 000	3 621 702	2 452 622	6 764 324	64 361	794	37	
Chile					0	1	36	205 512	5 050
Colombia	2 700 000	250 000	2 043 668	320 000	5 313 668	1 841 918	118 621		30 005
Ecuador	570 413	40 000	6 379 676	150 000	7 140 089	5 974 366	201 903		1
Guiana	8 000	800	6 000	1 000	15 800				
French Guiana	2 387	500	2 000	4 208	9 095			2 200	
Falkland Isl.								30	
Paraguay		300	71 870	4 300	76 470	40 345		258	255
Peru	1 391 339	125 000	437 656	120 000	2 073 995	202 408	31	1	
Surinam	18 856	1 000	61 073	7 000	87 929	58 000	100		
Uruguay					0	1	21	45 902	1 194
Venezuela	557 146	20 000	350 594	120 000	1 047 740	1	1 314	58	10 000
Total	5 908 141	577 600	13 264 239	3 229 180	22 979 160	8 296 144	324 871	687 440	47 762
	25.7%	2.5%	57.7%	14.1%	100.0%	62.5%	5.5%		
Caribbean									
Anguilla			1					70	12
Antigua & Barbuda	550	25	267	25	867			1 805	53
Netherlands Antilles	1	1	10	1	13	10		2 928	1 000
Aruba					0			2 314	2 209
Bahamas	3 200	150	5 800	250	9 400			1 840	421
Barbados	68	40	858	15	981			4 478	1 198
Bermuda	400	30	326	5	761			760	28
Cuba	200 000	518 069	40 000	248 081	1 006 150		42		
Dominica	2 000	400	1 100	100	3 600	10	60	2	
Grenada	840	120	1 100	36	2 096		7	3	
Guadeloupe	3 300	400	73 000	300	77 000	68 608			200
Haiti	244 410	60 000	130 000	18 000	452 410	170	100	77	500
Cayman Isl.	21	1	185	8	215			794	17
Turks and Caicos Isl.	5	1	15	3	24			350	501
Virgin Isl. (USA)	250	50	1 300	100	1 700			300	20
Virgin Isl. (UK)	80	10	332	20	442			102	49
Jamaica	42 437	1 000	50 000	2 215	95 652	300	11		
Martinique	3 000	150	194 067	200	197 417	179 888			10
Montserrat	75	10	101	5	191			5	10
Puerto Rico	83 520	2 000	75 818	500	161 838	3 800		800	500
Dominican Republic	279 055	150 000	647 726	3 000	1 079 781	485 000	19 094	573	573
St. Kitts & Nevis					0			600	500
St. Vincent & Grenadines	2 410	400	1 500	300	4 610	400	500		
St. Lucia	3 000	600	10 000	500	14 100	8 000	554		
Trinidad & Tobago	4 925	500	3 263	100	8 788			8 000	3 200
Total	873 547	733 957	1 236 769	273 764	3 118 037	746 186	20 368	25 731	11 001
	28.0%	23.5%	39.7%	8.8%	100.0%	60.3%	2.3%		

Production and trade (2016 data and 2015 data in italics) Estimates in tonnes	Production				Total	Exports		Imports	
	Cooking bananas		Dessert bananas			Cavendish	Plantain	Dessert bananas	Plantain
	Plantains AAB	Highland bananas + ABB + other AAB + AAA + AA	Cavendish AAA	Gros Michel & other AA, AAA, AAB, ABB					
East Africa									
South Africa	20	1 500	306 397	2 200	310 117	8 123		97 643	20 931
Botswana					0			10 000	6 512
Burundi	64 000	641 697	119 000	86 496	911 193	843		1	10
Comoros	3 000	6 600	31 533	3 500	44 633		776	6	
Djibouti			1		1			5 456	
Eritrea			10	1	11			15 000	
Ethiopia	100	1 000	534 702	2 500	538 302	9 837			
Reunion Isl.	10	500	6 645	3 361	10 516				
Kenya	32 162	872 412	312 000	72 014	1 288 588	109	2	1 374	771
Lesotho					0			2 387	1 901
Madagascar	42 000	12 000	311 896	8 000	373 896	67	53		
Malawi	75 000	20 000	50 000	10 000	155 000	50		512	35
Mauritius	10	600	7 731	700	9 041	1		100	
Mayotte	640	6 400	6 000	1 000	14 040				
Mozambique	30 000	4 000	400 000	1 000	435 000	20 000		59	
Uganda	180 000	3 710 010	50 000	352 839	4 292 849	763	2 044	30	1 000
Rwanda	320 000	2 347 962	300 000	70 000	3 037 962		1	215	149
Seychelles	80	300	1 475	100	1 955			6	
Somalia	3 000	800	17 285	700	21 785	41	1	8 308	194
Sudan		1 000	908 110	1 000	910 110	120 000		256	253
Western Sudan	2	300	153 698	500	154 500			1 222	
Swaziland	5	4	6 207	1	6 217	1 000		4 055	2 127
Tanzania	150 700	2 835 826	400 000	173 113	3 559 639	1 868	16	1	
Zambia	1	50	677	49	777	7		1 415	2
Zimbabwe	13 850	500	89 082	600	104 032	821	492	14	
Total	914 580	10 463 461	4 012 449	789 674	16 180 164	163 530	3 385	148 060	33 885
	5.7%	64.7%	24.8%	4.9%	100.0%	4.1%	0.4%		
West and Central Africa									
Angola	120 000	10 000	550 000	15 700	695 700	200		85	64
Benin	12 000	500	16 467	3 000	31 967		200	8 000	2 100
Burkina Faso	100	10	15 000	10	15 120	1		8 000	4 496
Cameroon	1 700 000	200 000	470 000	200 000	2 570 000	300 000	100 000	2	
Cape Verde	10	30	10 373	30	10 443			3	
Congo	85 926	3 000	29 000	3 000	120 926			11	2 000
Congo (Dem. Rep.)	507 729	600 000	223 000	88 087	1 418 816	3	4 000	151	1
Côte d'Ivoire	1 589 643	90 000	650 000	6 000	2 335 643	400 000	35 000	4	4
Gabon	80 000	10 000	15 682	2 000	107 682	19		165	10 000
Gambia	8	1	180	1	190			2 800	
Ghana	1 980 000	50 000	244 000	15 000	2 289 000	58 000	800	39	100
Guinea	450 000	19 252	200 000	12 874	682 126	2 000	20		
Guinea Bissau	42 234	4 000	7 058	400	53 692	1			
Equatorial Guinea	19 749	3 000	4 972	2 000	29 721	1	1	2 000	20 000
Liberia	50 259	7 000	30 000	5 000	92 259			2	100
Mali	6 500	500	156 371	500	163 871			18 000	6 000
Mauritania		1	70	1	72			3 543	
Namibia					0			5 121	1 839
Niger			350		350	18		3 763	887
Nigeria	2 580 000	127 000	296 938	85 000	3 088 938	75		336	10 000
Central African Rep.	85 251	1 500	24 258	1 800	112 809				2 000
St Helena								12	1
Sao Tomé & Príncipe	3 000	1 000	1 500	1 000	6 500				
Senegal	200	100	37 863	100	38 263	18		17 726	50
Sierra Leone	46 020	2 000	15 000	1 000	64 020			10	
Chad			10		10			15 000	1 500
Togo	28 000	1 200	26 440	700	56 340	99	25	2	100
Total	9 386 629	1 130 094	3 024 532	443 203	13 984 458	760 437	140 046	84 775	61 242
	67.1%	8.1%	21.6%	3.2%	100.0%	25.1%	1.5%		
North Africa — Middle East									
Algeria			1	482	493			250 000	4 494
Saudi Arabia				5	5	7 924		320 000	
Bahrain			956	50	1 006			15 000	
West Bank		5	2 939	5	2 949			15 000	
Egypt	3	3 000	1 273 475	65 000	1 341 478	11 788		13 885	267
United Arab Emirates			199	1	200	2 953		164 174	
Iraq			10		10			97 644	
Iran		3 000	123 687	3 000	129 687			196 596	
Israel		1 000	134 000	1 000	136 000			11	
Jordan		300	40 000	557	40 857			50 000	
Kuwait					0	41 437		97 644	
Lebanon	3	400	92 000	740	93 143	32 372		121	57
Libya		1	2	1	4			1 755	
sub-total (to follow page 101)	6	7 707	1 667 755	70 364	1 745 832	96 474	0	1 221 830	4 818

Production and trade (2016 data and 2015 data in italics) Estimates in tonnes	Production				Total	Exports		Imports	
	Cooking bananas		Dessert bananas			Cavendish	Plantain	Dessert bananas	Plantain
	Plantains AAB	Highland bananas + ABB + other AAB + AAA + AA	Cavendish AAA	Gros Michel & other AA, AAA, AAB, ABB					
North Africa — Middle East (cont'd)									
Morocco		100	332 820	100	333 020	41		11 159	2 749
Oman	10	2 000	10 568	4 000	16 578	252		20 935	
Qatar					0			33 000	
Western Sahara					0			2 500	
Syria			110	10	120			150 000	
Tunisia		10	55	50	115	22		65 249	
Turkey		50	305 926	115	306 091	10	1	209 369	23
Yemen	20	200	136 271	300	136 791	25 041		48	
Total	36	10 067	2 453 505	74 939	2 538 547	121 840	1	1 714 090	7 590
	0.0%	0.4%	96.6%	3.0%	100.0%	5.0%	0.0%		
Asia									
Afghanistan					0			142 518	
Azerbaijan					0			22 580	18
Bangladesh	13 000	120 000	449 012	216 000	798 012		200		
Bhutan	70	500	2 845	400	3 815				
Brunei		40	841	70	951	281		2 822	
Cambodia	2 000	40 000	140 610	12 000	194 610	1			
China	1 000	568 000	11 891 540	606 238	13 066 778	8 279		1 308 022	
South Korea					0	1		364 580	19
North Korea					0	3		1 713	
Hong Kong					0	2 562		66 360	16
India	1 900 000	8 600 000	11 549 000	7 075 000	29 124 000	111 803	2 133		
Indonesia	70 000	2 000 000	3 748 010	1 189 115	7 007 125	9 235	10		
Japan			32		32			956 410	646
Kazakhstan					0	1		35 534	
Kyrgyzstan					0	19		7 045	
Laos	1 000	153 000	577 200	65 000	796 200	350 000			
Macau					0			4 483	
Malaysia	20 000	60 000	159 508	70 000	309 508	25 102		16 818	7
Maldives	90	448	1 000	290	1 828			1 926	12
Mongolia					0			2 447	160
Myanmar	20 000	298 069	560 000	230 000	1 108 069	109 340	165		
Nepal	10	20 000	201 185	15 000	236 195			21 017	
Uzbekistan					0			1 620	
Pakistan	500	3 000	128 171	5 000	136 671	50 280	21	20	17
Philippines	1 000	3 073 542	4 419 751	1 409 391	8 903 684	3 049 000		21	
Singapore					0	191		56 107	182
Sri Lanka	63 000	294 558	242 000	55 000	654 558	78	200		
Tajikistan					0			7 663	
Taiwan		100	257 259	200	257 559	10 284		16	
Thailand	20 000	330 000	575 251	150 000	1 075 251	24 764	3	20 982	
East Timor	10	40	570	50	670				
Turkmenistan					0			87	
Vietnam	2 000	595 600	1 094 335	250 000	1 941 935	100 000	736	1 205	
Total	2 113 680	16 156 897	35 998 120	11 348 754	65 617 451	3 851 224	3 468	3 041 996	1 077
	3.2%	24.6%	54.9%	17.3%	100.0%	10.7%	0.2%		
Oceania									
Australia	20	70	314 151	40 000	354 241	138		446	95
Fiji	100	500	3 728	300	4 628	21			
Guam		100	354		454			1 000	
Cook Isl.		20	27	3	50				
Marshall Isl.					0			100	
Solomon Isl.		90	247		337				
Kiribati		3 300	3 954	400	7 654				
Micronesia	200	308	1 513	13	2 034			89	
Nauru	1	20	80	10	111			3	
Niue		10	71	2	83	1			
New Caledonia	45	1 500	1 169	100	2 814			1 000	
New Zealand					0	9		95 479	136
Palau					0			50	
Papua New Guinea	500	600 000	391 553	232 500	1 224 553	20		1	
French Polynesia		900	2 100	600	3 600			6	
Samoa		13 237	10 417	80	23 734	1			
Samoa (USA)	2	250	524	70	846				
Tokelau		5	10	1	16				
Tonga	100	2 328	705	100	3 233	2			
Tuvalu	1	117	155	20	293				
Vanuatu	100	6 000	8 281	2 000	16 381	4			
Wallis & Futuna		400	300	100	800				
Total	1 069	629 155	739 339	276 299	1 645 862	196	0	98 174	231
	0.1%	38.2%	44.9%	16.8%	100.0%	0.0%	0.0%		

Production and trade (2016 data and 2015 data in italics) Estimates in tonnes	Production				Total	Exports		Imports	
	Cooking bananas		Dessert bananas			Cavendish	Plantain	Dessert bananas	Plantain
	Plantains AAB	Highland bananas + ABB + other AAB + AAA + AA	Cavendish AAA	Gros Michel & other AA, AAA, AAB, ABB					
Europe									
Azores			1 000		1 000				
Albania					0			22 809	553
Germany					0	296 676	49 950	1 379 962	51 000
Andorra					0			484	2
Armenia					0			11 773	
Austria					0	10 431	14	127 171	75
Belarus					0	33		64 410	109
Belgium					0	1 030 000	110 111	1 187 000	115 000
Bosnia Herzegovina					0			44 953	2 696
Bulgaria					0	800	387	35 307	7 092
Canaries	1	5	450 000	5	450 011	417 176			
Cyprus			4 690	5	4 695	420		5 485	190
Croatia					0	1 376	3	58 780	137
Denmark					0	11 334	81	78 407	1 730
Spain			250	5	255	136 246	30 000	702 377	39 502
Estonia					0	116	1	16 813	1
Finland					0	7 118		110 404	133
France					0	254 150	37 908	794 778	56 000
Georgia					0	182	25	17 125	100
Gibraltar					0			110	11
Greece		2	3 453	2	3 457	9 640	2 000	151 726	2 876
Hungary					0	1 446	5 811	37 679	12 630
Faroe Isl.					0			195	
Ireland					0	13 000	1 507	79 992	7 556
Iceland			1		1	6		7 142	300
Italy			354		354	78 063	6 803	658 000	17 596
Latvia					0	12 165	81	28 140	1 273
Lithuania					0	17 682	247	48 272	3 735
Luxembourg					0			5 967	650
Macedonia					0		138	22 629	300
Madeira	1	10	26 203	10	26 224	21 167			29
Malta					0			8 778	10
Moldova					0	60		10 784	990
Montenegro					0			10 700	500
Norway					0	62		83 634	212
Netherlands					0	568 683	62 688	769 946	73 309
Poland					0	33 471	2 804	304 777	65 082
Portugal			204		204	14 682	16	162 729	894
Czech Republic					0	61 601	25	192 463	3 386
Romania					0	339	184	102 708	74 838
United Kingdom					0	63 774	15 442	1 147 787	86 343
Russia					0	38 041		1 355 990	2
San Marino					0			280	
Serbia					0	118		66 376	81
Slovakia					0	13 164	301	68 107	8 328
Slovenia					0	33 218	10	72 423	852
Sweden					0	8 872	3	201 191	2 198
Switzerland					0	12		89 847	1 452
Ukraine					0	2		152 834	6
Total	2	17	486 155	27	486 201	3 155 326	326 540	10 499 244	639 759
	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%		313 219
World total	20 214 723	29 765 703	69 478 992	16 522 440	135 981 858	23 862 077	1 148 595	21 612 034	1 543 382
	14.9%	21.9%	51.1%	12.2%	100.0%	34.3%	5.7%		

Note 1: for EU members, imports of Cavendish from third countries only, not counting intra-Community trade or European produce supplies.

Note 2: differences between import and export totals result from re-exports between non-producer countries (intra-EU trade for example), taking into account two years (2015 and 2016) and the experimental nature of this work.

Source: Thierry Lescot of CIRAD, who used bibliographical research, surveys, professional sources, FAO, etc.