

Appendix E

The U.S. Department of Agriculture's Database on Low-Resource Agriculture

As part of its determination of the current status of low-resource agriculture, OTA contracted with the Economic Research Service of the U.S. Department of Agriculture to compile data on low-resource production in Africa. An agricultural economist, Dr. John Staatz, and an agronomist, Dr. Charles Francis, then reviewed the data, drew conclusions on low-resource agriculture's current status, and analyzed its potential contributions to food security and economic development.

The U.S. Department of Agriculture (USDA) estimated agricultural production in Sub-Saharan Africa by using a sample of eight countries: Kenya, Malawi, Mali, Nigeria, Senegal, Sudan, Zaire, and Zimbabwe. An agroecological zone map, overlaid on internal regional/political maps of the eight countries, allowed USDA to break down production by agroecological zones.

USDA defined low-resource agriculture as:

... any agricultural production process in which no modern inputs (e.g. chemical fertilizer, pesticide, hybrid seed) or modern production technology (e.g., tractor, drip irrigation) is utilized (1)."

This definition is considerably narrower than OTA's more qualitative one. Therefore USDA's data are a *lower bound* on the volume or area of various crops produced under low-resource conditions (4). In addition, this definition forced USDA to look at production on a crop basis rather than on any other (how many farmers practice only low-resource agriculture, how many of these farmers are women, etc.), USDA had to use this definition to obtain quantitative estimates of low-resource production because aggregate production data are the only comparable data available across Africa (4).

USDA calculated total crop area and production (within a zone and a country), then subtracted estimates of area and production that were clearly not within this definition. The remaining area and production were considered low-resource agriculture.

Data were collected for 22 agricultural commodities in 4 agroecological zones in the 8 sample countries. These eight countries produce over 50 percent of the maize, sorghum, yams, cocoyams and cotton grown in Africa and 30 percent or more of the rice, wheat, sesame, cassava, and groundnut. Thus, the eight countries' data are a significant indicator for the major food commodities of the region

and certain export crops. These data are not a strong indicator for other important export crops, such as the perennial tree crops like coffee and cocoa.

African agricultural data are estimates and significant questions about the quality of this information exist. USDA drew from a number of data sources, including national sources, the U.S. Agency for International Development, the World Bank, and the U.N. Food and Agriculture Organization. OTA assumes that this is the best available data upon which preliminary conclusions can be based (3). Nevertheless, a number of clear data gaps exist. Several important crops (cowpeas, bananas, and plantains) are not included nor is animal production. Available data did not allow USDA to distinguish between local and improved varieties of perennial crops (e.g., coffee and palm oil). Therefore, the data undoubtedly reflect an overestimate of low-resource production for these crops. Some of the difficulties in gathering this data arise from OTA's desire to base the analysis on agroecological zones. Also, the weakness of the statistical base is a manifestation of the underinvestment in agriculture, and in low-resource agriculture in particular in Africa (4).

Low resource agriculture in Africa, and even within individual African countries, is extremely diverse; hence, any attempt to generalize for the continent as a whole is dangerous. Nonetheless, there are some common features of low-resource agriculture across countries. The USDA data indicate that a very large percentage of major crops in the eight sample countries are grown under low-resource conditions (table E-1). Several patterns emerge:

- Within the arid and semi-arid areas of Africa, most of the basic staples (millet, sorghum, and fonio) are grown under low-resource conditions. If data were available for cowpeas, they probably would show the same pattern,
- A much smaller percentage of maize than millet and sorghum is grown under low-resource conditions in all four ecological zones. This reflects the spread of hybrid maize in east and southern Africa (particularly Kenya and Zimbabwe) and the greater fertilizer responsiveness of maize compared with millet and sorghum, which has encouraged farmers to use chemi-

cal fertilizers on maize. In Kenya, 50 percent of smallholders grow hybrid maize and fertilizer use has reportedly doubled smallholder maize yields (1).

- Most African rice is produced by low-resource agriculture, despite large, capital-intensive irrigation schemes in some semi-arid areas (for example, in Senegal and Mali) where over half the rice is produced under higher-resource conditions. Most of the low-resource rice production is produced under rainfed conditions or in small, low-lying areas using gravity irrigation or seasonal flooding.
- Almost all roots and tubers, which are extremely important staples in the humid areas, are produced under low-resource conditions. This reflects the almost total neglect, until very recently, of attempts to improve these crops by agricultural researchers. With increased population pressure, one would expect a gradual shift toward greater use of these crops because their caloric yield per hectare and per hour of labor is much higher than that of cereals.
- In general, a much higher percentage of export and cash crop production takes place under higher-resource conditions than does food crop production. For example, virtually no cotton, sisal, or pineapples are grown under low-resource conditions and only 32 percent of tea is. About half the production of groundnuts is reportedly produced under low-resource conditions in semi-arid areas, where groundnuts are an important cash crop; in more humid areas, where they are grown for home consumption, the share of low-resource production increases.
- The USDA figures indicate that almost all coffee and palm oil production in the sample countries takes place under low-resource conditions. However, this unexpected result reflects both the sample of countries chosen and difficulties in obtaining data. In most cases, the data did not allow USDA to distinguish between local and improved varieties of these perennial crops. USDA knows, for example, that much of the oil palm production in West Africa, particularly in the Ivory Coast (the leading exporter of palm oil in West Africa but not included in the USDA sample), takes place using improved high-yielding varieties, but precise figures were not available. Or farmers may be using low-resource techniques not because they prefer them or because more productive methods are not known but because the systems for deliv-

ering modern inputs have broken down. This apparently is the case for coffee and cotton production in parts of East Africa.

Generally, these findings reflect the greater attention paid to export crops both in terms of agricultural research aimed at producing varieties responsive to manufactured inputs and in terms of developing the supporting institutions (particularly, input and output markets) that makes such a reliance on external inputs possible. Although it is commonly asserted that the Green Revolution has bypassed Africa, during the last 60 years agricultural research in Africa has resulted in very significant yield increases for three crops: oil palm, cotton, and maize (in eastern and southern Africa) (2). These achievements are reflected in the low percentage of maize and cotton produced under low-resource conditions.

Production of Basic Food Crops. Total production of food crops and specialty crops is summarized in Table E-2 by crop group and by agroecological zone. Production figures are similar to those for area under cultivation. Cereal grains are the most important crops, and thus the primary sources of energy and protein, in the arid, semi-arid, seasonally humid, and highland regions of Sub-Saharan Africa. Grain legumes contribute substantially to total food crop production, especially in the arid and semi-arid zones, and starchy root crops are important sources of energy in the humid zones—especially the continuously humid zone of the sample countries.

Importance of Low-Resource Food Production. It is clear that low-resource agriculture focuses on production of food crops for local sale and consumption—essentially all of the yams, cocoyams, and cassava are produced this way. In the eight countries, low-resource agriculture also accounted for more than half of the millet, groundnut, and rice produced—recognizing that groundnut is both an export and a subsistence crop.

Specific Crop Results. The USDA data show that levels of productivity under low-resource conditions vary widely with crop and country although comparisons may be questionable due to the quality of the available data (table E-2). Cotton yields under low-resource conditions in the arid and semi-arid zones are about 205 kg/ha, while higher-resource yields in the same zone are calculated to be about 2,276 kg/ha. Thus, yields under low-resource conditions are only 9 percent of those under higher input conditions. Yields of groundnuts across the three lowland zones are about 680 kg/ha

under low-resource conditions and 1,180 kg/ha under higher-resource conditions (the former 58 percent of the latter). For sorghum, the respective yields are 635 kg/ha and 827 kg/ha; low-resource productivity is about 77 percent of the yield under improved conditions. Millet, primarily a crop of resource-poor farmers, has yields of 622 and 683 kg/ha under the two conditions and low-resource agriculture yields 91 percent of the higher-resource yields.

Several factors could be responsible for the gaps in yield between low and higher-resource production among these four crops. First, they could reflect the crops' individual importance to governments, to research specialists, and to those who finance research and development. Cotton is primarily a low-value export crop and groundnuts are both an export and a subsistence crop. On the other hand, sorghum is primarily a basic food crop, although areas exist where the crop is grown commercially with added inputs as in the Gezira irrigation project of Sudan. Millet is almost exclusively a subsistence crop, with 70 to 80 percent of the area and production coming from low-resource agriculture. Thus, research on subsistence grain groups may have been less than for export crops and the larger gaps between low- and higher-resource yields may reflect this. Or the yield gaps may exist because of how and where the grain crops are grown—extensively cultivated on more marginal lands. In these areas, production constraints are severe, and responses to technology may be limited by unrelated constraints, for example, plants will not respond to added fertilizer if water is limiting growth.

conclusion

The primary purpose for gathering and analyzing the USDA data was to determine the relative importance of low-resource agriculture in Africa's current agricultural production. The data show clearly that low-resource agriculture is an impor-

tant starting point for building food security and economic development of Africa (1,3,4), although different people would come to different conclusions about how this should be done,

In practice, even with its conservative definition of low-resource agriculture, the USDA analysis indicates that low-resource agriculture is extremely widespread in Africa. From the point of view of U.S. foreign assistance policy it probably matters little whether low-resource agriculture accounts for 74 percent or 83 percent of millet production in Africa; what is important is that most producers are low-resource agriculturalists and they account for the bulk of production (4).

Appendix E References

1. D'Silva, Brian and Dommen, Arthur J., "The Role of Low-Resource Agriculture in Africa. Overview and Summary, and Supplementary Information," contractor report to the Office of Technology Assessment (Springfield, VA: National Technical Information Service, December 1987).
2. Eicher, Carl, "International Technology Transfer and the African Farmer: Theory and Practice," Department of Land Management, University of Zimbabwe, Working Paper 3/84, May 1984.
3. Francis, Charles A., "OTA Technical Paper Series: Potentials for Development in Low-Resource Technologies for African Agriculture," contractor report to the Office of Technology Assessment (Springfield, VA: National Technical Information Service, December 1987).
4. Staatz, John M., "The Potential of Low-Resource Agriculture in African Development, contractor report to the Office of Technology Assessment (Springfield, VA: National Technical Information Service, December 1987),

Table E-1.— Production of Various Crops Under Low-Resource Conditions by Agroecological Zone in Eight African Countries^a

	Agroecological zone				Total, all zones ^b
	Arid, semi-arid	Seasonally humid	Continuously humid	Highlands	
Food crop					
Millet					
Total production	4,289	385	N . A . ^d	240	4,914
% low-resource agriculture	74	67		38	72
Sorghum					
Total production	3,326	2,238	N.A.	N.A.	5,564
% low-resource agriculture	62	59			61
Fonio					
Total production	54	N.A.	N.A.	N.A.	54
% low-resource agriculture	100				100
Maize					
Total production	1,241	3,468	891	1,998	7,598
% low-resource agriculture	35	37	70	23	37
Rice					
Total production	194	956	1,093	39	2,282 ^e
% low-resource agriculture	45	67	90	0	75 ^e
Beans					
Total production	N.A.	103	68	N.A.	171
% low-resource agriculture		22	90		49
Yams					
Total production	N.A.	4,995	11,655	N.A.	16,650
% low-resource agriculture		100	100		100
Cocoyams					
Total production	N.A.	333	1,332	N.A.	1,665
% low-resource agriculture		100	100		100
Cassava					
Total production	N.A.	6,806	18,435	N.A.	25,241
% low-resource agriculture		92	93		
Export/Cash Crops					
Groundnuts					
Total production	1,882	658	237	N.A.	2,777
% low-resource agriculture	49	60	90		55
Cotton					
Total production	1,835	208	N.A.	12	2,055
% low-resource agriculture	3	3		100	4
Coffee					
Total production	11	7	82	84	184
% low-resource agriculture	0	100	100	100	94
Tea					
Total production	N.A.	N.A.	N.A.	126	126
% low-resource agriculture				32	32
Sisal					
Total production	34	N.A.	N.A.	16	50
% low-resource agriculture	0			0	0
Pineapples					
Total production	N.A.	N.A.	N.A.	155	155
% low-resource agriculture				0	0
Tobacco					
Total production	N.A.	147	N.A.	N.A.	147
% low-resource agriculture		0			0
Wheat					
Total production	235 ^f	N.A.	N.A.	222	457 ^g
% low-resource agriculture	0 ^h			0	0

Table E-1.—Production of Various Crops Under Low-Resource Conditions by Agroecological Zone in Eight African Countries^a —Continued

	Agroecological zone				Total, all zones ^b
	Arid, semi-arid	Seasonally humid	Continuously humid	Highlands	
Rubber					
Total production	N.A.	N.A.	86	N.A.	86
% low-resource agriculture			58		58
Palm Oil					
Total production	N.A.	22	663	N.A.	685
% low-resource agriculture		99	78		79

^aKenya, Malawi, Mali, Nigeria, Senegal, Sudan, Zaire, and Zimbabwe

^bThe percentages shown in this column are weighted averages of the figures for each of the 4 zones.

^cData are given in thousands of metric tons

N.A. indicates that no data were available on the production of the crop in the zone. In most cases, this signifies that the crop is not grown in the zone

^dDiscrepancies between sources corrected by OTA.

SOURCE: Brian D'Silva and Arthur Dommen, "The Role of Low-Resource Agriculture in Africa: Overview and Summary," contractor report to the Office of Technology Assessment (Springfield, VA: National Technical Information Service, December 1987), Table 3; compiled by John M. Staatz, "The Potential of Low-Resource Agriculture in African Development," contractor report prepared for the Office of Technology Assessment (Springfield, VA: National Technical Information Service, December 1987), Table 1

Table E-2.—Production of Basic Food Crops and Specialty Crops Grown Under “Low Resource” (LRA) Conditions and Total Production of Same Crops

Region	Cereal grains			Grain legumes			Starchy roots			Specialty crops		
	Crop	LRA	Total	Crop	LRA	Total	Crop	LRA	Total	Crop	LRA	Total
Arid, Semi-Arid	Millet	3,189	4,289	Groundnut . . .	920	1,882				Cotton	60	1,835
	Sorghum . . .	2,047	3,326	Soya	0	11				Sisal	0	34
	Wheat	0	235							Coffee.	0	11
	Rice	86	194									
	Maize	439	1,241									
	Sesame	72	117									
	Fonio	39	39									
	Total	5,872	9,441		920	1,893		0	0		60	1,880
Seasonally Humid	Maize	1,299	3,468	Groundnut . . .	393	658	Cassava	6,243	6,806	Coffee.	6	7
	Rice	636	956	Beans	22	103	Yams	4,995	4,995	Cotton	5	208
	Millet	259	385				Cocoyams . . .	333	333	Tobacco	0	147
	Sorghum . . .	1,314	2,238							Palm oil	22	22
	Sesame	20	20									
	Total	3,528	7,067		415	761		11,571	12,134		33	384
Continuously Humid	Maize	622	891	Groundnut . . .	213	237	Cassava	17,059	18,435	Coffee.	82	82
	Rice	984	1,093	Beans	61	68	Yarns	11,655	11,655	Rubber	50	86
							Cocoyams . . .	1,332	1,332	Palm oil	516	663
	Total	1,606	1,984		274	305		30,046	31,422		648	831
Highlands	Wheat	0	222							Sisal	0	16
	Rice	0	39							Tea	40	126
	Maize	450	1,998							Coffee.	8	4
	Millet	90	240							Cotton	12	12
										Pineapple. . . .	0	155
	Total	540	2,499		0	0		0	0	Sugarcane . . .	1,550	3,107
											1,686	3,500
Total (8 country)		11,546	20,991		1,609	2,959		41,617	43,556		2,427	6,595

SOURCE: Charles A. Francis, “OTA Technical Paper Series: Potentials for Development of Low-Resource Technologies for African Agriculture,” contractor report prepared for the Office of Technology Assessment (Springfield, VA National Technical Information Service, December 1987),

List of Related OTA Reports

- *Grassroots Development: The African Development Foundation, OTA-F-378* (Washington, DC: U.S. Government Printing office, June 1988). GPO Stock No. 052-003-01109-3; price \$8.50.
- *Continuing the Commitment: Agricultural Development in the Sahel, OTA-F-308* (Washington, DC: U.S. Government Printing Office, August 1986). Out of print from GPO; NTIS Order No. PB 87-117 644/AS (available photocopied or in microfiche).
- *Africa Tomorrow: Issues in Technology, Agriculture, and Foreign Aid, OTA-BP-F-31* (Washington, DC: U.S. Government Printing office, December 1984). GPO Stock No. 052-003-00985-4; price \$5.50.

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