

Each year, as part of the CGIAR annual performance measurement (PM) exercise, the Independent Science & Partnership Council (ISPC) receives and reviews a number of individual case studies of Center impact. From the 30 case studies submitted over the course of the 2009 and 2010 PM exercises, the ISPC's Standing Panel on Impact Assessment (SPIA) identified three case studies as being particularly meritorious in terms of quality of analysis and presentation. In recognition of these studies as good examples of emerging 'best practice', SPIA has, with the relevant Center's concurrence, prepared an ISPC/SPIA Brief on each. Publishing quality impact briefs responds to continued calls from donors to the CGIAR for more documented evidence of impacts to be made available in the form of such concise publications.



INDEPENDENT SCIENCE & PARTNERSHIP COUNCIL

STANDING PANEL ON IMPACT ASSESSMENT

BRIEF NUMBER 34



*Nourishing the Future
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Improved maize benefits millions of Africa's poor

The generation and diffusion of modern maize varieties has been cited as one of the most notable achievements of international agricultural research in sub-Saharan Africa. When poor farmers adopt new varieties, they generally see a significant rise in their yields and incomes. The estimated number of people moved out of poverty in this way has risen through the 1980s to reach a level of more than one million people per year since the mid-1990s. Over half of these impacts can be attributed to international maize research at the International Institute of Tropical Agriculture (IITA) and the International Maize and Wheat Improvement Center (CIMMYT).

Key facts and figures

- Modern maize varieties represented less than 5% of the maize area in the 1970s but accounted for about 60% in 2005.
- According to FAO data, yields increased from as low as 0.88 t/ha in 1971 to over 2 t/ha in 2005, with an average growth rate of 2% per year; the area of land sown to maize increased by over 3% annually over the same period.
- The estimated number of people moved out of poverty through adoption of new maize varieties rose gradually during the 1980s to reach more than one million per year during the past ten years.
- A total of US\$308 million was invested in maize research between 1971 and 2005; international maize research accounted for about 66% (US\$204 million) of this investment.

Background

International public sector maize research in West and Central Africa is conducted by IITA, CIMMYT and national agricultural research systems (NARS). IITA initiated maize research around 1970 and has had a regional mandate for maize improvement in West and Central Africa since 1980. In collaboration with NARS and CIMMYT, IITA has since made significant progress in developing modern varieties with high yield potential and increased tolerance to multiple biotic and abiotic stresses. These varieties, together with fertilizer subsidies and improved infrastructure, have brought about a dramatic change in the status of maize, from a minor product to one of the most important food and cash crops.

This Brief summarizes the work of Alene et al. (2009) who estimated the economic and poverty reduction impacts of international maize research in West and Central Africa over the period 1971–2005. The IITA study team assembled data from three regional maize research impact studies as well as regional and on-farm variety evaluation trials. Data on international maize research investments was acquired from IITA financial reports and data relating to maize area, yields, and production from the FAOSTAT database. See Alene et al. (2009) for further information on the methods of data collection and analysis.

Variety release, performance and adoption

The number of modern maize varieties released has increased markedly from less than one per year in the 1970s to more than 12 annually since the late 1990s. IITA and CIMMYT breeding programs have been the major sources of germplasm for the released varieties. Together, they supplied nearly 90% of the germplasm in the 1970s, 60% in the 1980s and 1990s, and 85% since the late 1990s. IITA has become an important source of germplasm since the 1980s and currently supplies nearly 70% of the germplasm in the region. Importantly, most of the IITA materials have needed little or no further improvement before release.

During the 1970s and 1980s, the majority of IITA germplasm was released directly by national programs with no further improvement, or selected by national programs after development. This was because many NARS lacked capacity to conduct their own improvement programs at this time. In contrast, CIMMYT has contributed mostly parent germplasm since the 1970s. Since the 1990s, IITA has focused more on parent

germplasm transfer, as the Institute begins to transfer full scientific capacity to the NARS. Indeed, the proportion of released varieties developed by national breeding programs using parent germplasm from IITA increased sharply from zero in the 1970s to 25% after the late 1990s. Open-pollinated varieties account for about 90% of all releases. This reflects an emphasis on variety development for small-scale farmers, most of whom do not buy fresh hybrid seed every year.

Adoption figures were estimated only from the early 1980s onwards, to account for the recognized time lag between variety release and adoption (due mainly to constraints relating to seed production and distribution). The figures suggest that adoption has grown steadily in all countries (Figure 1). The aggregate adoption curve closely follows adoption patterns in Nigeria (which accounts for nearly half the maize-growing area in the region) and shows that in 2005, 60% of the maize-growing area was planted to modern varieties. Furthermore, the overall maize-growing area tripled from 2.6 million hectares in 1981 to over 7 million hectares in 2005, with the area under modern varieties increasing from 111,000 hectares to 4.2 million hectares.

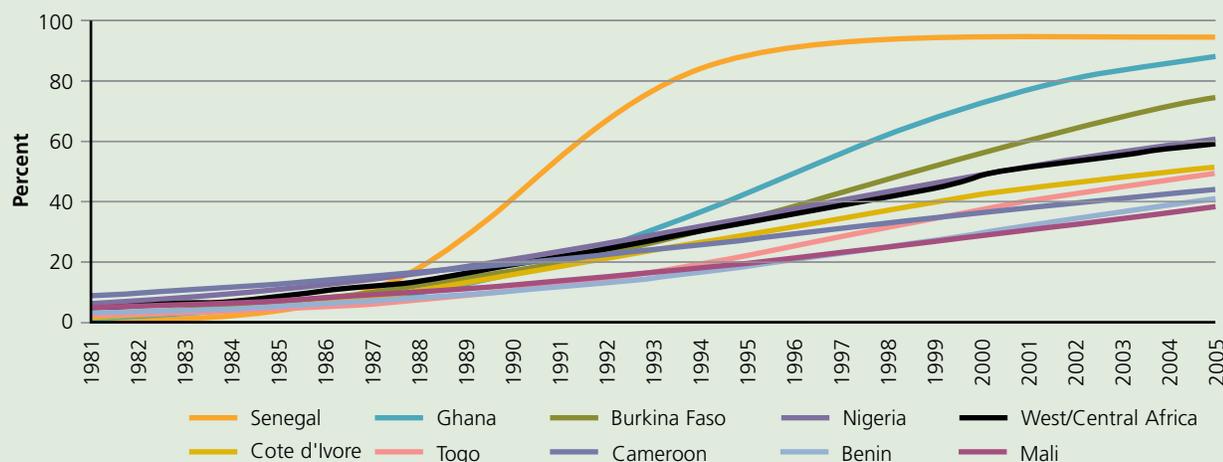
Moving people out of poverty

While the number of poor people in sub-Saharan Africa rose sharply in the 1980s, the rate of increase has since slowed and the proportion of people living in poverty has declined. In West and Central Africa, poverty increased throughout the 1980s and early 1990s, but generally declined thereafter, most notably in Benin, Burkina Faso, Cameroon, Ghana, Mali, and Senegal (Chen and Ravallion, 2007).

Maize and maize technologies have a number of features that make them particularly useful in the fight against poverty. Firstly, maize grows in a wide range of production environments and is thus an important source of home-produced food. Secondly, maize is a desirable cash crop, providing a useful income to farmers and helping keep market prices affordable for the urban poor. Thirdly, resource-poor farmers are able to adopt the predominantly open-pollinated modern maize varieties, since they do not have to buy fresh seed each season.

The number of poor people lifted out of poverty due to maize research was estimated as the product of: (a) the percentage share of the value of additional

Figure 1. Cumulative adoption rates of modern maize varieties in West and Central Africa (1981–2005)



maize production due to maize research in total value of agricultural production; (b) reported elasticities of poverty reduction with respect to agricultural production growth in Africa; and (c) the total number of poor people. Table 1 shows the estimated poverty reduction impacts of maize research in West and Central Africa between 1982 and 2004. The figures show an average of 740,000 people moved out of poverty per year. Poverty reduction expressed as a percentage of the poor by country ranges from less than 0.2% per year in Cameroon to 0.6% in Benin, 0.75%

in Ghana, and 0.9% in Nigeria. The relatively greater poverty impacts in Benin, Ghana, and Nigeria reflect the fact that maize accounted for about 10% of the value of agricultural production over the period 1981–2004 in these countries. In 2005, maize accounted for 15% of the value of agricultural production in Nigeria and 13% in Ghana. In Ghana, the dramatic growth in maize production over the period 1979–1998 is cited as a major success achieved through sustained research and extension investments (Morris et al., 1999; World Bank, 2007).

Table 1. Aggregate poverty reduction impacts of maize improvement research in West and Central Africa (1982–2004)

Year	% reduction	'000 people
1982	0.08	52
1984	0.20	148
1986	0.35	256
1988	0.71	564
1990	0.83	693
1992	0.81	681
1994	1.11	999
1996	1.50	1,713
1998	0.90	1,030
2000	0.70	821
2002	0.91	1,017
2004	1.26	1,433
Annual average	0.75	740

On the basis of the germplasm content of improved varieties, poverty reduction that can be attributed specifically to international maize research is estimated at between 300,000 and 500,000 people moved out of poverty per year. Given total IITA spending, for example, it is estimated that every US\$1 million invested in international maize research at IITA on average lifted between 35,000 and 50,000 people out of poverty. With an estimated NARS investment of over US\$100 million since 1970, national maize research programs have also contributed significantly to poverty reduction efforts in the region. There is no sign of any decline in the poverty impacts of modern varieties, suggesting that maize research will continue to be a factor in promoting poverty reduction in the future.

Net benefits, conclusions, and implications

The total net benefit from international and national maize research in West and Central Africa over the period 1981–2005 is estimated at US\$6.8 billion,

equivalent to 12% of the present value of total maize production over the same period. Annual net benefits increased from US\$43 million in 1981 to over US\$400 million in 2005, with an average of US\$274 million per year (in 2000 constant prices).

International and national maize improvement research in West and Central Africa had an impressive benefit–cost ratio of 21, indicating that each dollar invested in maize improvement research generated US\$21 worth of additional food. Estimates of the country-level benefit–cost ratio ranged from 11 in Mali to 84 in Nigeria. The overall rate of return to maize improvement research in West and Central Africa was estimated at 43%. This is much higher than the prevailing market interest rates and confirms that maize research has generated a stream of benefits in excess of expenditures and has thus been a worthwhile investment in the region.

International research has played an important role, with over half of the economic and poverty impacts attributable to maize research conducted by IITA and CIMMYT. Future research into the non-yield benefits of modern varieties (e.g. early-maturing varieties that escape drought and ‘quality protein’ maize for better nutrition and health) may realize even greater benefits. The study results suggest that poverty in the region would have been substantially worse had there been no research and no improvement in maize yields in the face of increasing pest and disease pressure, soil fertility decline, and area expansion into marginal lands.

There is no sign of any decline in the benefits from modern varieties of maize in the region, suggesting that maize research will continue to be a powerful factor in reducing poverty. Any decline in variety adoption and benefits is likely to be due to constraints outside the research system; for example maize research benefits stagnated during the late 1990s when the maize-growing area declined, and the area under modern varieties stagnated following the

removal of fertilizer subsidies and the collapse of support services in Nigeria. High fertilizer prices and poor access to credit together reduce the profitability of modern varieties and limit further adoption.

The evidence points to the fact that the impacts of research investments are conditioned by farmers’ physical and economic access to a number of complementary inputs. High rates of return to agricultural research are difficult to sustain in an environment where farmers cannot access or afford inputs. An efficient seed system to supply improved seed is another critical input for achieving greater levels of adoption. Modern varieties can diffuse only with the help of an effective national seed industry, but this is still lacking in many countries in West and Central Africa. More efficient extension and input-supply systems and improved market infrastructure would thus be needed to achieve greater impacts from maize research in the region.

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