The Role of Adaptive Research in Increasing Agricultural Productivity: The Experience From Haïti

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The views expressed in this paper are the author's and do not necessarily represent those of CIMMYT.

INTRODUCTION

The purpose of this paper is to analyze the contribution of adaptive research in generating productivity-increasing technologies in a low-income country such as Haïti. First, a brief recapitulation of food crop production is presented. The figures show important reductions in staple crop output leading to substantial food deficits during the past decade. Using the results of a research project carried out jointly by the International Maize and Wheat Improvement Center (CIMMYT) and the Haïtian Ministry of Agriculture, Natural Resources and Rural Development (MARNDR), it is argued that these trends could be reversed. The strategy to succeed requires, however, major policy changes involving a reorganization of agricultural research and extension and a new strategy for both International Agricultural Research Centers (IARC) and aid donor countries.

PROBLEM SETTING

Agriculture is one of the most important economic sectors in Haïti. It contributes 35% of the gross domestic product and provides a livelihood for 75% of the Haïtian people. However, since the mid 1970s, this prominent sector has been on the decline. The share of agriculture in exports slid from 70.1% in 1965 to 48.7% in 1983, representing a significant reduction in the production of export crops such as sugar cane and coffee. From the position of one of the major sugar exporters, Haïti has been a net importer since 1980 (Gestin and Cadet 1987). Imports of basic food products increased from US$14.4 million in 1972 to US$80.0 million in 1980, while exports of coffee and sugar declined (Table 1).

Yields of the principal food crops except rice remained fairly constant at low levels (Figure 1). Meanwhile, land areas planted to maize and sorghum decreased by 7.5% and 4.3%, respectively, per year since 1973, leading to a 7% per year reduction in the production of these two staple crops (Figures 2 and 3).

Approximately 10,000 hectares of arable land are lost every year in the hillsides where maize and sorghum are the predominant crops (Gestin and Cadet

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Table 1. Volume and value of principal agricultural exports

	Export value		Export volume	
	Coffee	Sugar	Coffee	Sugar
	(US$ million)		(000 tonnes)	
1960	20.2	3.9	28.2	33.1
1961	12.1	4.5	16.7	40.7
1962	20.7	1.7	32.6	16.8
1963	16.8	5.2	26.4	49.1
1964	17.5	2.0	22.4	14.7
1965	19.3	2.4	22.7	23.1
1966	20.7	2.8	24.4	23.1
1967	13.7	3.8	16.9	30.7
1968	14.6	3.1	19.5	24.4
1969	13.7	2.1	18.6	22.9
1970	15.2	2.5	16.1	18.0
1971	18.8	3.4	21.5	22.9
1972	15.7	3.6	18.6	20.7
1973	20.6	2.8	19.4	13.7
1974	23.8	0.9	18.7	5.6
1975	18.5	9.6	17.8	25.4
1976	46.5	3.0	27.5	20.0
1977	63.7	2.7	15.9	17.6
1978	62.3	2.3	19.1	15.3
1979	39.3	4.4	13.6	18.2
1980	90.9	6.4	25.0	21.1
1981	32.8	3.2	13.6	11.0
1982	65.4	—[a]	23.9	—[a]
1983	41.4	—	14.6	—
1984	44.9	—	18.8	—
1985	47.6	—	18.5	—
1986	49.5	—	14.7	—
1987	35.9	—	14.2	—

[a]Haiti became a net importer of sugar starting in 1981.
Source: Haïti, Institut Haitien de Statisiques; Zuvekas (1978).

1987). Given the magnitude of the erosion problem and the absence of any meaningful solution in the foreseeable future, sustained maize and sorghum production could be achieved only through yield improvements compensating for the reductions in land area.

The above setting shows a very bleak picture of the Haïtian agricultural sector, with declining output and increasing food imports. The cereals deficit for 1987 was estimated by Seguino (1987) at 35,000 tonnes of maize equivalent. However, the trends could be reversed if appropriate policies are implemented. The following

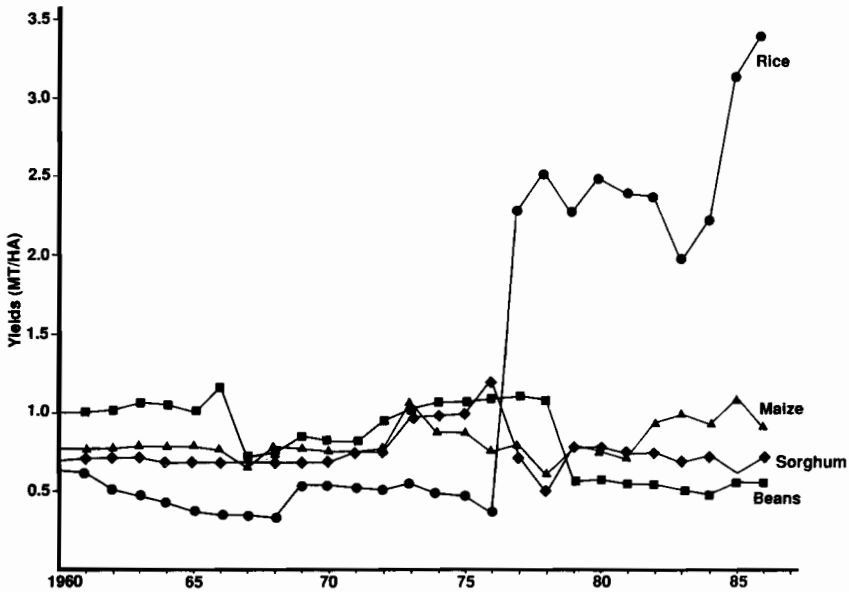

Figure 1. Yields of principal food crops

section reports on a research project jointly carried out by CIMMYT and MARNDR. The results underscore the role of research in raising agricultural productivity and incomes.

MARNDR-CIMMYT PROJECT

The research project on maize carried out by MARNDR and CIMMYT was initiated in 1981 and was initially funded by the Swiss Development Corporation (SDC) and the Rockefeller Foundation. The program has been financed by the Canadian International Development Agency (CIDA) since 1983.

The objectives of the program are twofold:

- To develop appropriate technologies to increase productivity and income for representative farmers. The development of these technologies is based on on-farm research (OFR). This approach involves four phases including diagnosis, planning, experimentation and evaluation.
- To institutionalize OFR as a cost-efficient method of generating productivity-enhancing technologies. The achievement of this objective involves training of Haitian agronomists and economists in OFR procedures.

To date, the project has led to the selection of two improved maize varieties (Maquina 7928 and 7827). Research carried out in Les Cayes Plain of southwestern Haïti shows that with or without fertilizer application, the yields of these two maize

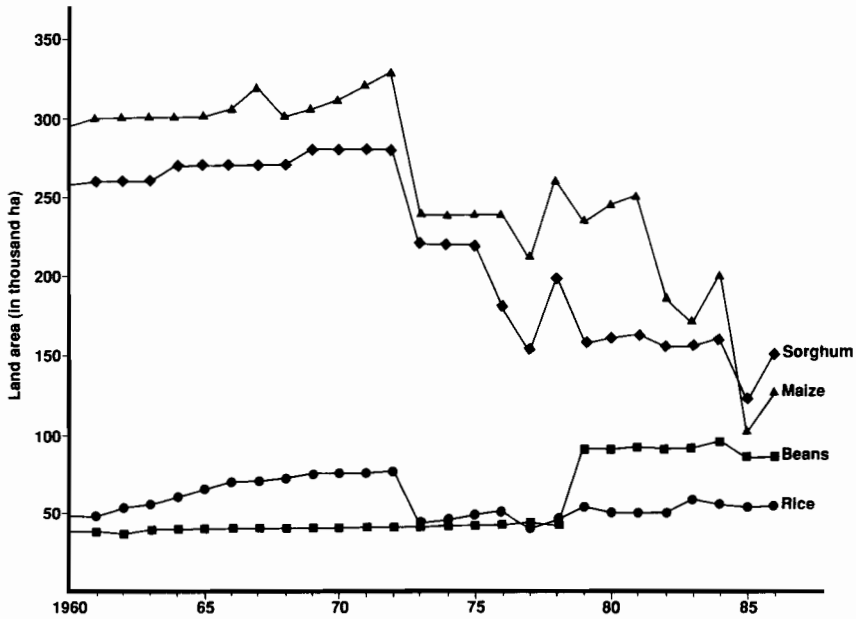

Figure 2. Land area planted to principal food crops

varieties exceeds that of the local variety (chicken corn). When 80 kilograms of nitrogen per hectare are applied to both Maquina and Chicken Corn, the yield difference is approximately 0.9 tonnes per hectare. The project has also identified urea as a profitable source of nitrogen. Research results indicated that an application of 40 kilograms of nitrogen per hectare increased the yield by 0.4 tonne per hectare. Other technological components developed by the project include zero-tillage and mulching for eroded hillsides. Further, 20 Haïtian agronomists were sent to CIMMYT headquarters in Mexico for instruction in maize breeding and crop management and an additional 17 agronomists were trained in Haïti in on-farm research methods.

A comprehensive list of project achievements would be too long to present here. In the following section, the project impacts will be assessed in terms of two technological components, i.e., production of improved maize varieties and urea sales.

IMPACTS

Maquina Seed Production

Both the CIMMYT project and MARNDR each year produce foundation and certified seed of Maquina varieties. MARNDR'S production is done either by the

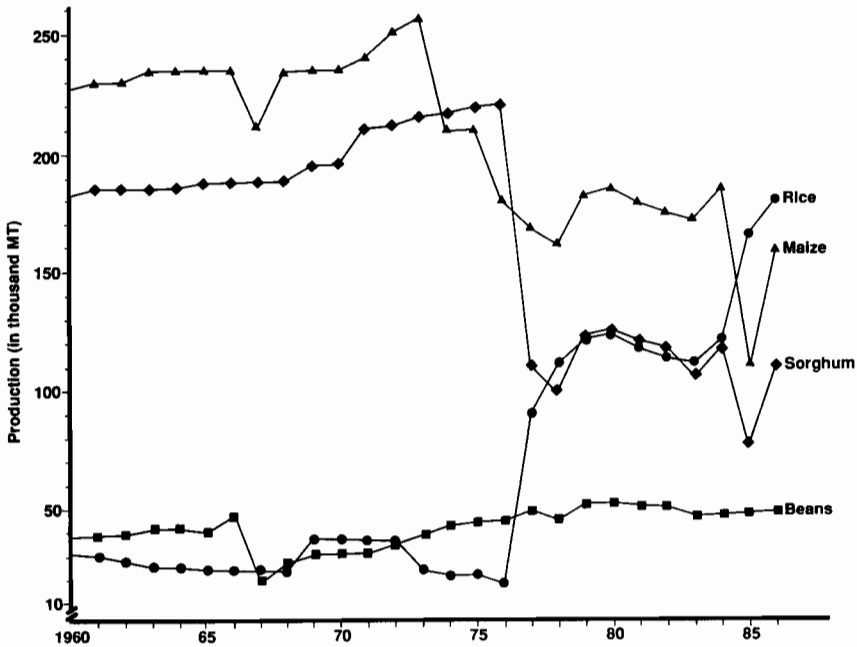

Figure 3. Production of principal food crops

research branch of the ministry or through contracting with private sector firms (Table 2). The maize seed is sold by MARNDR along with subsidized fertilizers mostly to farmers in the Port-au-Prince area. It is estimated that the use of Maquina varieties resulted in annual additional maize production varying between 1,116 and 2,835 tonnes and induced additional gross revenues ranging from US$133,920 to US$340,000 (Table 3).

These benefits assume that yield differences between improved and local maize varieties in the area where the seed is sold are the same as those identified in on-farm trials in Les Cayes Plain. Further, the gains derived from research have been realized almost entirely outside the targeted area because of inefficient government seed distribution programs and conflicting policies.

Urea Sales

Prior to 1984 when the project recommended urea as a profitable source of nitrogen, only small amounts of urea were sold in southwestern Haïti. However, projects sponsored by the Institut de Développement Agricole et Industriel, the Banque Nationale de Développement Agricole et Industriel and the Bureau du Crédit Agricole were supplying farmers with subsidized fertilizers including urea on a credit basis. These fertilizers were primarily purchased in Port-au-Prince. After the rec-

Table 2. Maquina seed production[a]

Year	Maquina foundation and certified seed produced by MARNDR	Maquina foundation and certified seed produced by the project
	(tonnes)	
1986	35	3.5
1987	60	3.5
1988	21	3.8

[a]Data on Maquina seed production in 1984 and 1985 are not available.

ommendation was made, private sector urea sales surged from 105 tonnes in 1984 to 414 tonnes in 1988, which represents a 394% increase in five years (Table 4). Note that this rise in urea sales represents a net increase in fertilizer sales, given that sales of compound have not decreased in absolute terms. However, the share of urea in overall fertilizer sales has sharply increased to approximately 60%.

There is actually no exact measure of the adoption of urea in southwestern Haïti. However, some estimation can be made on the basis of interviews with fertilizer dealers in Les Cayes. According to these sources, approximately 50% of urea sold in the area was used in maize fields. Assuming that 30% of urea sold by both private and public sector was used in maize fields according to the recommended usage rate of 40 kilograms of nitrogen per hectare, the induced increase in maize production has been significant.

Annual additional maize production had risen from 145 tonnes in 1984 to 571 tonnes in 1988 and extra net revenue secured by farmers had correspondingly expanded from US$7,005 to US$37,176. Unlike the results from the selection of the improved maize varieties, the benefits derived from the urea recommendation were realized mainly in the targeted area.

Although there are not enough data to perform a cost-benefit analysis, the results clearly show that investments in maize research have been rewarding for

Table 3. Additional maize production and revenue induced by adoption of Maquina varieties

Year	Area planted to Maquina[a]	Additional maize production[b]	Maize price	Additional gross revenue
	(hectares)	(tonnes)	($/tonne)	($)
1986	1,750	1,575.00	120.00	189,000.00
1987	3,150	2,835.00	120.00	340,000.00
1988	1,240	1,116.00	120.00	133,920.00

[a]Assuming a seeding rate of 20 kilograms per hectare.
[b]Assuming an increase in maize production of 0.9 tonnes per hectare.

Table 4. Increase in maize production induced by adoption of nitrogen recommendation

Year	Annual sales of urea (1)	Amount of urea used in maize fields (2 = 1 × 0.3)	Amount of nitrogen used in maize fields (3 = 2 × 0.46 × 1,000)	Number of ha with nitrogen application (4 = 3/40)	Additional maize production (5 = 4 × 0.4)
	(tonnes)	(tonnes)	(kilograms)	(hectares)	(tonnes)
1984	105	31.5	14,490	362.25	144.9
1985	289	86.7	39,882	997.05	398.8
1986	318	95.4	43,884	1,097.1	438.8
1987	360	108.0	49,680	1,242.0	496.8
1988	414	124.2	57,132	1,428.3	571.3

the country as a whole. In only four years after the Maquina varieties and urea were recommended, the value of increased agricultural production following the adoption of these two technologies exceeded the cost of the project (US$180,000). Other technologies such as zero and conservation tillage and density are at the recommendation stage. Hence, agricultural research and extension services must be strengthened in order to realize the full production potential of new technologies. The impact of the project could have been far greater if there had been a vigorous extension service delivering research results to farmers.

POLICY IMPLICATIONS

Research

The budget allocated to the ministry's research branch in 1988–89 is approximately US$10,000, excluding employees' salaries. Prior to this date the amount was even smaller or nonexistent. There are fewer than 20 people within the ministry working in research and few of them are located outside Port-au-Prince.

As a result, there is no established research program for plant breeding in food crops. Crop management research is rather weak. Further, there is no functional mechanism for diagnosing priority problems or setting a research agenda because of the lack of social science research capacity. Another distressing issue is the absence of operating funds and logistics at the local level, which limits access to farmers and their fields. Additionally staff working outside offices are underpaid relative to their office-based colleagues. The turnover rate is high and field staff is mostly made up of inexperienced agronomists.

There is some research done by church and nongovernmental organizations and community development projects. However, this research is neither defined nor coordinated by the Ministry of Agriculture. There is no guarantee that these research projects are consistent with the ministry's goals. Further, the vast majority

Table 5. Increase in farmer's gross and net revenues induced by adoption of nitrogen recommendation

Year	Additional maize production (1)	Farm price (2)	Increase in gross revenue (3 = 2 × 1)	Amount of urea used in maize fields (4)	Price of urea (5)	Cost of urea used in maize fields (6 = 4 × 5)	Increase in net revenue (7 = 3 − 6)
	(tonnes)	($/tonne)	($)	(tonnes)	($/tonne)	($)	($)
1984	145	120	17,400	330	31.5	10,395	7,005
1985	399	120	47,880	280	86.7	24,276	23,604
1986	439	120	52,680	272	95.4	25,949	26,731
1987	497	120	59,640	208	108.0	22,464	37,176
1988	571	120	68,520	310	124.2	38,502	30,018

of people involved in these research projects have limited experience or training in research.

There is no private sector research and, under the present institutional setting of no invention patent, it is unlikely that there would be any in the foreseeable future. Even in the doubtful situation where the private sector undertakes some agricultural research, it is probable that the focus would be on satisfying the needs of large farmers in favorable environments. Hence, the public sector research would have to cater to small farmers in order to guarantee that social welfare objectives such as equity and environmental issues are adequately met (Byerlee 1989).

Addressing the challenges of the coming decade will require a research agenda involving both adaptive and strategic research issues. Carrying out this agenda will in turn necessitate a strengthening of research services and substantial investments in human resource development, especially social scientists. Such a reorganization should aim at enabling the research branch to translate development goals of the ministry into research priorities and programs.

Extension

The extension service carried out by the Ministry of Agriculture comes under the direction of the Rural Development Branch. Therefore, even the meagre research results generated by the research branch or other development projects within the ministry are not adequately extended to farmers. Moreover, there is a negative perception among ministry staff regarding the use of fertilizers, pesticides or any new technology in general.

As in the case of research, the private sector does not play any meaningful role in technology transfer to farmers. The agri-business sector consists basically of four private firms that sell fertilizer and pesticides. Two of these firms have subsidiaries outside Port-au-Prince. There are also some local retailers.

One way to extend research results to farmers in the short run may be a more effective use of church and nongovernmental organizations. The Catholic and Protestant Churches carry lot of clout in the country and work with closely knit farm groups through their parish networks. There are numerous foreign and local nongovernmental organizations working in Haïti and most of them deal with agricultural issues. Skills of agronomists working with these organizations could be upgraded through seminars and visits to demonstration plots run by senior scientists. In the medium term, the existing vacuum in the delivery system could be filled through a reorganization of the MARNDR's services that would transfer the extension service to the research branch. Then field-based extension staff could demonstrate in farmers' fields the increased production potential of new technologies such as high-yielding maize, rice, sorghum and bean varieties as well as providing farmers with services such as market information.

Given the high illiteracy rate in Haïti (over 90% in rural areas), extension should emphasize in the short term a "recipe" approach to crop production. The low level of farmers' schooling and training is a hindrance to the enhancement of agricultural productivity. However, as farmers' skills improve, extension should focus in the long run on developing the broad understanding that farmers need to adapt and use the new technology efficiently (Byerlee 1989). Additionally, as research moves from plant variety testing and evaluation to more sophisticated crop management activities, a greater support will be needed from extension to effectively transfer and ensure use of generated technologies.

International Agricultural Research Centers

In the short run, a "quantum leap" in productivity such as the one realized in Asia is improbable for many crops in Haïti because of the lack of an extension system allied to a limited irrigation and drainage infrastructure and marketing facilities. Incremental yield increases in the short and medium run would likely come from appropriate intermediate technologies.

Mountains occupy 80% of Haïti and the forest cover is less than 9% (Gestin and Cadet 1989). Most of the agricultural land is unsuitable for modern agricultural techniques, although the bulk of the rural people live in these areas.

Although International Agricultural Research Centers (IARCS) and many donor countries favor work for resource-poor farmers, in Haïti this category of farmers is synonymous with farmers having marginal or no resources. The high-yield technology that led to the "green revolution" in Asia did not succeed in unfavorable agro-ecological conditions. Further, there is evidence that technological progress in favorable areas will often benefit less favorable areas through "technological spillovers," labor migration and lower food prices to the poor, including small farmers in less favorable areas who are usually net food purchasers (Byerlee 1989).

Hence, any relevant research program must be articulated around areas where production can be sustained. Moreover, generated technologies ought to give rise to a large number of spinoffs in order to lead to major policy changes. Under the actual circumstances, adaptive research appears to be the most promising research strategy for generating new technologies in the short run that would provide some answers to the problems of agricultural production. For this strategy to succeed, there must be a massive training, technology testing and evaluation program along with the development of a vigorous extension system. Strategic research aimed at generating technologies addressing widespread problems such as erosion and declining yields should hold a high priority in any articulated research agenda. However, in spite of its importance, the Ministry of Agriculture is not endowed either in staff or in other resources to engage in such kind of research. Collaborative work with IARCs remains the best prospect for the success of this type of research.

CONCLUSION

Except for rice, food crop yields in Haïti are the lowest in the Central America and Caribbean region. This situation will prevail until agricultural research is recognized as a key issue and receives adequate resources to address priority problems. Reorganization of research services must focus on developing a relevant research agenda and foster linkages with extension.

To make effective use of scarce resources, research activities must demonstrate the potential of new technologies in favorable environments in order to bring about major policy changes.

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