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Sustaining a steady flow of high yielding, improved bean varieties through the bean research network in Central America

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Over the past 20 years, the National Agricultural Research Systems (NARS) in Honduras, El Salvador, Nicaragua, and Costa Rica, in collaboration with such private and public institutions as the Bean/Cowpea Collaborative Research Support Program (B/C CRSP) and the International Center for Tropical Agriculture (CIAT), have actively generated and promoted improved varieties (IVs) of common bean. This impact brief summarizes the results of a recent study conducted by Michigan State University that focused on estimating bean farmers' yield gains from the new genetic varieties available in the region.

The Bean Research Network of Central America: Justification and History

Although beans are an important staple in Central America, bean production is relatively small in each country. During 1990–2009, bean production in the region averaged 296,000 MT, with nearly 47 percent of this total coming from Nicaragua, the largest bean producer in the region. The small size of the bean-producing area as well as the existence of common bean production environments and market classes that cut across country boundaries provide opportunities for spillover benefits and the economic justification for a regional bean improvement research program.

Recognizing the potential for spillover benefits, CIAT, with support from the Swiss Agency for Development and Cooperation (COSUDE), established *Profrijol*, a regional bean research network, in 1981. During the 1980s and 1990s, *Profrijol* was the only research network conducting bean research in the region. Initially, Guatemala was one of the main regional suppliers of germplasm for the network; however, in 1996 the PanAmerican Agricultural School (Zamorano, a private university located in Honduras), using funds from the B/C CRSP and *Profrijol*, was given a mandate to lead efforts to breed small red beans for the region. In 1999,



The bean crop against a Nicaraguan landscape

Pulse CRSP: Contributing to Economic Growth and Food and Nutrition Security in Latin America and Africa

Key Findings

- The establishment of a regional bean research network in Central America has facilitated the exchange of germplasm, strengthened national bean programs, and helped reduce crop losses caused by the bean golden yellow mosaic virus.
- Over the last two decades, 52 unique bean IVs have been released in the four countries of interest (Honduras, Nicaragua, El Salvador, Costa Rica). At least 28 of the 52 varieties were developed using (direct or indirect) CRSP funding; seven were spillover varieties released in more than one Central American country.
- Over the last decade, the yield gains of new IVs averaged 0.49 percent per year in Central America as a region and 0.56 percent per year in Honduras, which suggests that farmers who replace their old IVs with new IVs attain increasingly higher yields.

Zamorano was also given the mandate for breeding small black beans for Central America.

In 2002, COSUDE’s support to Profrijol ended and CIAT’s participation in the region was drastically reduced. However, given that the Profrijol network provided a valuable vehicle for testing and disseminating breeding materials, its members continued their collaboration and the B/C CRSP became the major supporter of this (now informal) network. Since 2002, Zamorano’s bean program has provided leadership to the region’s bean research network, which currently includes NARS from Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Puerto Rico, and Haiti. Although in collaboration with this network, CIAT provided funding to implement *Agrosalud*, a biofortification research project, beginning in 2004, the Dry Grain Pulses CRSP (DGP CRSP, formerly the B/C CRSP) has been the major financial supporter of the network through Zamorano since 2007.

One of the major contributions of Profrijol has been the establishment of regional bean nurseries in which lines from different breeding programs (e.g., Zamorano, CIAT, University of Puerto Rico) are assembled and distributed to collaborators for testing. These nurseries have facilitated the exchange of germplasm within the region. Figure 1 generally illustrates this flow.

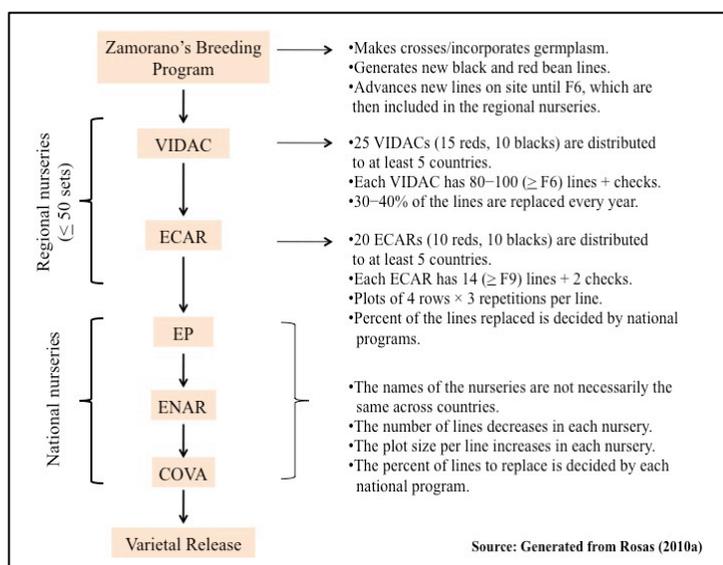


Figure 1. From crosses to varietal release: Flow of germplasm facilitated by the Central American bean research network

In addition, activities carried out under Profrijol have resulted in increased collaboration between breeding programs in the region, strengthened the national bean programs (through financing fieldwork and capacity building), and reduced crop losses caused by the bean golden yellow mosaic virus (through the development of resistant varieties).

Currently, Zamorano’s bean program supplies regional collaborators with two nurseries for evaluating breeding lines: VIDAC (Central American Adaptation Nursery) and ECAR (Central American Adaptation and Yield Trial). In return, the collaborators send Zamorano data from the trials (e.g., yield) that are used to select promising bean lines and, eventually, new IVs for release by national programs. The major differences between these nurseries are the number of lines included, which is greater in VIDAC, and the number of repetitions per line, which is greater in ECAR. Additionally, the lines included in ECAR are generally more homogeneous than those in VIDAC. NARS use these nurseries to select materials to include in their own national nurseries and, eventually, to release an IV. Without this collaboration, multilocational testing lines would be limited and more expensive than they currently are. Realizing the benefits provided by the network, bean breeders have devoted significant efforts to maintaining their current collaboration.

Bean varieties released, 1990–2010

Between 1990 and 2010, Costa Rica, El Salvador, Honduras, and Nicaragua released a total of 64 bean varieties (Table 1), including several spillover varieties released across Central America under different names. The varieties released in more than one country are *Dorado* and *Amadeus 77* (four countries each), *Tío Canela 75* (three countries), and *DEORHO*, *Carrizalito*, *DOR 390*, and *Don Silvio* (two countries each). The four countries released 52 unique varieties; most of which were small reds or reds (45 of 52), followed by blacks (6 of 52). At least 28 of the 52 varieties were developed using CRSP funding.

Estimating yield gains from new varieties

The use of improved varieties generates two types of yield gains: Type I gains, as a result of farmers replacing traditional varieties (TVs) with IVs (i.e., new adopters), and Type II gains, as a result of farmers replacing old IVs with new IVs (i.e., current adopters). The study on which this brief is based estimated the Type II yield gains associated with the release of new

Table 1. Varieties released between 1990-2010.

Number of varieties:	Costa Rica	El Salvador	Honduras	Nicaragua	Total
Released (total)	18	9	21	16	64
Small reds/reds	12	9	21	14	56
Developed using CRSP funding	9	5	17	4	35
Developed using participatory methods	9	0	12	16	37
Released since 2000	10	5	16	7	38
Released per year per '000 ha of bean (average)	0.0257	0.0055	0.0101	0.0042	--

bean IVs using experimental yield data. Due to sample size limitations, Type II gains were only estimated for Central America as a region and Honduras.

Data

The Zamorano bean program provided the experimental yield data, which came from the ECAR nurseries. The ECAR dataset contained information on small red varieties for the period 1999–2009—a total of 16 lines per nursery, each with three repetitions. The ECAR dataset contained information for 13 of the 45 small red varieties released between 1990 and 2010 in Central America. As expected, data for varieties released in Honduras were included most frequently. Although there is an ECAR dataset for black bean varieties for the period 2003–2009, it did not contain enough observations for analysis. Therefore, Type II gains were only estimated for small red bean varieties.

Results

In Central America (N=108), the average experimental yield was 2,125 kg/ha. Further, experimental yields were highly variable and ranged from an average of 1,400 kg/ha to 3,140 kg/ha (Table 2).

For Central America, the results suggest that Type II gains from 1989 to 2009 averaged 0.49 percent. This result, along with the data in Table 2, suggests that in Central America, Type II yield gains averaged roughly 10 kg/ha/year.

For Honduras (N=88), the results suggest that Type II yield gains from varieties released from 1989 to 2009 averaged 0.56 percent, slightly higher than for all other Central American countries. This result, along with the data in Table 2, suggests that in Honduras, Type II yield gains averaged roughly 12 kg/ha/year.

Conclusions and implications

This study found that in Central America the national bean programs function as a network because of their small size and limited human and financial resources, and because this collaboration facilitates the exchange of germplasm within the region. This collaboration has generated several spillover benefits, including access to a higher number of locations to test lines, several spillover varieties released in more than one country, and greater access to technical and financial assistance.

Key to the success of Central America's bean research program was the establishment of Profrijol—especially its network of regional bean nurseries, which are currently being implemented with partial support from the DGP CRSP. In addition, the regional network has helped increase collaboration between breeding programs in the region, strengthen the national bean programs, and reduce crop losses caused by the bean



Bean trials in Nueva Esperanza, Santa Barbara, Honduras

Table 2. Mean yields (kg/ha) of small red and red bean varieties based on experimental trial data. Central America, 1999-2009.

Year of release	Variety Name	N	kg/ha	Std. Dev.	Std. Err.	Minimum	Maximum
1989	Dorado (DOR 364)	35	2,011	786	133	523	3,954
2002	Amadeus 77	5	1,963	237	106	1,704	2,292
2003	Carrizalito	10	2,216	839	265	912	4,118
2003	Cayetana 85	3	1,922	90	52	1,863	2,026
2003	Cedron	11	1,972	720	217	1,057	3,534
2005	CENTA Pipil	12	2,248	823	237	1,179	3,658
2007	Tongibe	5	1,983	590	264	1,303	2,895
2007	Cardenal	2	2,005	324	229	1,776	2,235
2007	Don Cristobal	4	2,490	1,122	561	1,634	4,010
2007	Deorho	9	2,272	764	255	1,446	3,460
2008	CENTA C.P.C.	3	1,890	352	203	1,683	2,297
2009	La Majada	3	2,357	678	391	1,744	3,086
2009	Briyo AM	6	2,294	726	297	1,383	3,257
<i>Average</i>			2,125	619	247	1,400	3,140

golden yellow mosaic virus. Currently, Zamorano's bean program is responsible for supplying germplasm to regional collaborators through the regional nurseries. Especially over the past decade, the DGP CRSP's financial support (through Zamorano's bean program) has been critical to sustaining the collaboration among former Profrijol members.

Over the past two decades, a total of 64 bean IVs have been released by the four Central American countries of interest, seven of them in more than one country. This clearly demonstrates the spillover benefits that small countries can capture through collaboration with countries in a similar agro-ecological region.

Over the past decade, Central American bean research programs have been able to sustain a steady flow of higher yielding, improved small red bean varieties. The Type II yield gains averaged 0.49 percent per year in Central America as a region and 0.56 percent per year in Honduras. Thus, farmers who replace their old improved varieties with new improved varieties will obtain higher bean yields than farmers who plant old improved bean varieties under similar conditions.

About this brief

This brief is based on the Ph.D. dissertation by Byron Reyes entitled *The Economic Impact of Improved Bean Varieties and Determinants of Market Participation: Evidence from Latin America and Angola*. Specifically, it draws from the essay "The Economic Impact of Improved Bean Varieties in Latin America: A Surplus Analysis." The USAID-funded Dry Grain Pulses CRSP provided financial support for this research under the terms of Cooperative Agreement No. EDH-A-00-07-00005-00.

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