8 The Protein Factor
CIAT's Bean Improvement Research in Central America

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Beans are the most popular legume for human consumption and historically have been valued by the poorest populations around the world as a source of vegetable protein. Accounting for more than 30 million hectares, the legume is one of the most cultivated crops in Africa, Asia, and Latin America. Despite its significance for human nutrition, studies on the history of bean improvement are less known among scholars, compared with studies of such grains as wheat, maize, and rice.[1] Regarding plant breeding in legumes, several studies focus on the research developed from within the Consultative Group on International Agricultural Research (CGIAR).[2] Yet few studies examine the research developed by the International Center for Tropical Agriculture (CIAT) based in Colombia, and fewer still focus on CIAT's specific impact in Central America.

This chapter analyzes the bean-breeding programs developed by CIAT in Central America between 1970 and 1990. The region is an ideal laboratory for studying plant breeding in beans during the Green Revolution. On the one hand, Central America became a Cold War hot spot from 1960 to 1990, as the United States waged counterinsurgent campaigns to stymie the spread of communism in this region. At the same time, Central America experienced rising rates of malnutrition, particularly in rural areas. Amidst this so-called "protein gap," world organizations and scientific institutions conducted numerous surveys and field research to identify the nutritional deficiencies in the region's rural

[1] Alan L. Olmstead and Paul W. Rhode, *Creating Abundance: Biological and American Agricultural Development* (New York: Cambridge University Press, 2008); Dana G. Dalrymple, *Development and Spread of High-Yielding Rice Varieties in Developing Countries* (Washington, DC: Agency for International Development, 1986); Jack R. Kloppenburg, *First the Seed: The Political Economy of Plant Biotechnology, 1492–2000*, 2nd edn. (Madison: University of Wisconsin Press, 2004).

[2] Thomas M. Arndt et al., *Resource Allocation and Productivity in National and International Agricultural Research* (Minneapolis: University of Minnesota Press, 1977); Vernon Ruttan, *Agricultural Research Policy and Development* (Rome: FAO, 1987).

population, as well as its causes and potential solutions. What role did the bean varietal improvement process play at this juncture of Cold War and nutritional crises? What were the results?

The first part of this chapter addresses CIAT's origins, its organizational framework, and the research and training programs it established. The second part examines the center's endeavors in approaching the "protein crisis" in the so-called Third World through the creation of a bean research program. The third part delves into the development of a bean-breeding program aimed at enhancing nutritional conditions among rural populations in Central America. The last part argues that the obstacles in advancing a bean monoculture and the consequences of civil war on peasant agriculture hindered the development of a Green Revolution in beans in the region.

CIAT's Research Programs

CIAT's precursor was the Colombian Agricultural Program (CAP), which was established by a 1949 agreement signed between the Rockefeller Foundation and Colombia's government. During World War II, the foundation funded research at the agriculture and veterinary programs of the Universidad Nacional (in Medellín and Bogotá, respectively), as well as by the Tropical Agriculture School in Cali (which would soon relocate to Palmira and join the Universidad Nacional system with Rockefeller Foundation support). At each campus, the foundation invested in building facilities and equipment. At the same time, the Rockefeller Foundation offered training scholarships for Colombian students and faculty at universities in the United States and through the Mexican Agricultural Program (MAP).[3]

The Colombian program was built from the blueprint of MAP. It came under the initial direction of Lewis M. Roberts and Joseph A. Ruppert, prominent US scientists who specialized respectively in maize and wheat in Mexico. In Colombia, Roberts led the program at the Tulio Ospina experiment station in Medellín, while Ruppert operated out of the new Tibaitatá experiment station outside Bogotá, which possessed favorable ecological conditions for wheat production.[4] The founding of Tibaitatá, which replaced the older Picota station in 1951, was due in part to Edwin J. Wellhausen, a veteran of the Mexican program, who modeled the new

[3] Rockefeller Foundation, *Annual Report 1947* (New York: Rockefeller Foundation, 1947), pp. 166–167. The history of CIAT is further detailed by Timothy W. Lorek, Chapter 3, this volume.

[4] E. C. Stakman, Richard Bradfield, and Paul C. Mangelsdorf, eds., *Campaigns against Hunger* (Cambridge: Harvard University Press, 1967), p. 219.

station on Mexican experimental stations.[5] Both stations, in Medellín and Bogotá, experimented with new varieties, using genetic material brought from Mexico. In 1955, once the research projects were fully consolidated, the Rockefeller Foundation advised in the creation of a new Colombian government agency, the Ministry of Agriculture's Department of Agricultural Research, or Departamento de Investigación Agrícola, which emulated the coordinated approach of the Office of Special Studies in Mexico.

Following the precedent for centralizing coordination of agricultural research in Colombia, represented by the Department of Agricultural Research, the Rockefeller Foundation then supported the establishment of the Colombian Agricultural Institute (ICA) in 1962. This was part of a broader land reform project funded in part by the Alliance for Progress, a program initiated by US President John F. Kennedy to foster economic ties between the United States and Latin America. After the establishment of ICA, the Rockefeller Foundation gradually withdrew from direct involvement in Colombian domestic agricultural research and partnered with the Ford and Kellogg Foundations to redirect their Colombian assets into a new international center. CIAT was created in 1967, the same year the International Institute of Tropical Agriculture (IITA) opened in Nigeria. Both institutions were funded by the United States Agency for International Development (USAID), the Rockefeller and Ford Foundations, and their respective state governments. Both centers' first goal was the development of agricultural research in tropical environments. Thus, research prioritized crops grown by peasants for local consumption, such as cassava and legumes, over global cereal crops, such as wheat and maize (Figure 8.1).

CIAT's particular framework stemmed from the organizational models of other CGIAR institutes. Following the experience of the International Rice Research Institute (IRRI) in the Philippines, CIAT built a brand-new campus in Palmira, Colombia, adjacent to the older ICA facilities that once formed part of the CAP.[6] It organized its research projects and scientific teams following the framework developed by the International Maize and Wheat Improvement Center (CIMMYT) in Mexico.[7] Furthermore, CIAT pursued livestock management research and prioritized support for smallholders over larger farmers. CIAT also worked in close contact with national research programs in Latin America in order to develop training programs and scientific networks.

[5] Ibid., p. 220.
[6] CIAT, *Annual Report 1969* (Cali, Colombia: CIAT, 1969), p. 8, https://hdl.handle.net/10568/61840.
[7] John Lynam and Derek Byerlee, *Siempre pioneros: CIAT: 50 años contribuyendo a la sostenibilidad alimentaria futura* (Cali, Colombia: CIAT, 2017), p. 19.

Figure 8.1 Beans featured among the objects of research and breeding at the Rockefeller Foundation's agricultural program in Colombia. Here a small group considers beans growing in the greenhouse, ca. 1954. CIMMYT repository. © CIMMYT.

Between its creation and the 1980s, CIAT developed six broad programs encompassing plant-breeding research and training. The rice program, launched in 1967, took advantage of an alliance with IRRI in the Philippines and ICA in Colombia.[8] On the one hand, cooperation with IRRI turned CIAT into a "genetic bridge," allowing the transcontinental exchange of rice varieties and the introduction of the high-yielding variety IR8 germplasm to Latin America. Following IRRI's experience, the program developed high-yield varieties suited for irrigated rice, and created an intensive agrochemical package for pest control and plant disease.[9] On the other hand, the association with ICA enabled experimentation and field testing of Asian rice varieties in Colombia and

[8] CIAT, *Annual Report 1969*, p. 27.
[9] CIAT, *Seminar on Rice Policies in Latin America* (Cali, Colombia: CIAT, 1971), https://hdl.handle.net/10568/56374.

facilitated the development of lines adapted to Latin America's tropical agricultures.

Initially established in Colombia, the pasture program pursued livestock management systems that focused on herd improvement and animal health. After 1975, the program spread across other Latin American countries, focusing on grass improvement. Scientists at CIAT deemed depleted soils, droughts, and seasonal water availability changes as causes for low productivity of local grass varieties. Grass improvement required the creation of a germplasm collection (samples of varieties and populations thought to be useful in breeding) and the development of science-based knowledge on local pastures and grasslands. Thus, CIAT built the International Tropical Pastures Network, enabling germplasm exchange and research between the center and programs in other Latin American countries. Emphasis on increasing meat and dairy production on the acidic and infertile soils of the Latin American tropics reserved, in turn, more fertile lands for export-led agriculture, as Timothy W. Lorek chronicles in Chapter 3 of this volume.

The cassava program had no direct ties to other programs previously developed by the Rockefeller Foundation.[10] Therefore, CIAT designed the program's framework and built an international scientific network. The program started by assessing the disadvantages stemming from the crop's particular traits. For example, cassava improvement did not favor the development of varieties with general adaptability, as was the case with wheat or rice. Second, the crop was primarily grown by peasants in a slope farming system characterized by the low use of chemical inputs and the lack of irrigation. To overcome both limitations, the cassava program took over the creation of a germplasm collection, as well as the development of a technological package and agricultural practices that would "adapt the crop to the environment, instead of adapting the environment to the crop." Furthermore, the program established a global scientific network, allowing the exchange of knowledge with programs and institutes in Asia and Africa, particularly Thailand and Nigeria.[11]

Varietal improvement of beans to increase yields per hectare became one of CIAT's most complex tasks. For instance, Latin American

[10] CIAT, *A Proposal for the Improvement and Development of Cassava, A Tropical Root Crop* (Cali, Colombia: CIAT, 1971), https://hdl.handle.net/10568/72110.

[11] CIAT, *Informe anual del programa de yuca 1979* (Cali, Colombia: CIAT, 1980), pp. 99–101, https://hdl.handle.net/10568/77963; E. R. Terry and Reginald MacIntyre, eds., *The International Exchange and Testing of Cassava Germ Plasm in Africa* (Ottawa: IDRC, 1975), https://hdl.handle.net/10568/77936; CIAT, *CIAT 1984: Reseña de los logros principales durante el período 1977–1983* (Cali, Colombia: CIAT: 1984), p. 37, https://hdl.handle.net/10568/70299; CIAT, *CIAT Annual Report 1987* (Cali, Colombia: CIAT, 1987), p. 37, https://hdl.handle.net/10568/65942.

peasants grew a wide diversity of bean varieties in plots with other crops using local slope farming systems that enabled cultivation on sloping land while conserving water and soil. Thus, the bean program developed varietal selection processes through close coordination with national programs to take advantage of local experts' knowledge, producing varieties suited to each country's different agro-ecological and social environments. Accordingly, CIAT established a training program that offered internships and short courses in Colombia and other participant countries. In the 1980s, the successful results that CIAT achieved in Latin America spurred the launching of similar programs in Africa.

CIAT's genetic resources program managed the germplasm collections created by these breeding efforts. The bean program benefitted from the seed samples collected by the US Department of Agriculture in Mexico during the 1960s and from the collection gathered by the Rockefeller Foundation's CAP in Colombia.[12] Possessing more than 9,000 samples, or accessions, in 1980, the pasture program obtained its genetic material from the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia and the University of Florida in the United States.[13] It also acquired fodder legume accessions identified by CIAT's scientists in Brazil, Venezuela, and Southeast Asia. Furthermore, CIAT co-managed the cassava collection with IITA in Nigeria. By and large, the center became the most important global distributor of bean, cassava, and grass-breeding materials.

The training program supported the specialization of government officials in specific agricultural research fields, as well as the distribution and adoption of breeding materials and new varieties.[14] In the pursuit of both goals, CIAT published booklets and pamphlets, facilitating knowledge exchange with scientists from many Latin American countries. The program also organized field trips to Mexico, Colombia, and Central America, as well as visits to North American universities and Asian institutes, to become acquainted with various training programs. Throughout the 1970s, CIAT increasingly moved training activities from its facilities in Colombia to partner countries and provided education for scientists from the cassava, beans, rice, and grass programs. CIAT supported these programs directly and received funding from such entities as the Kellogg Foundation, USAID, the Inter-American Development Bank, and others.[15] The exchange of knowledge that resulted from this program set the foundation for CIAT's global network.

[12] Lynam and Byerlee, *Siempre pioneros*, p. 110. [13] Ibid., p. 111.
[14] CIAT, *Training and Conferences Report* (Cali, Colombia: CIAT, 1984), https://hdl.handle.net/10568/69052.
[15] Lynam and Byerlee, *Siempre pioneros*, p. 25.

CIAT and the Third World's "Protein Crisis"

During the 1950s and 1960s, the World Health Organization (WHO), the United Nations Children's Fund (UNICEF), and the United Nations Food and Agriculture Organization (FAO) acknowledged protein consumption deficiencies as one of the most significant problems affecting the Third World's population, marking what became known as the "protein crisis."[16] Multiple studies carried out during the 1930s in North America and Africa showed the impact of low protein intake on children's physical development and early child mortality. These findings led world organizations to establish food programs and scientific commissions, such as the United Nations Protein Advisory Group in 1955, and to hold symposiums and conferences in Mexico (1960), Italy (1963), and the United States (1960, 1964, and 1965) to address protein consumption in Third World countries. In 1964, FAO's survey "Protein: At the Heart of the World Food Problem" pushed the topic to the fore of its agenda. A few years later, the United Nations issued its 1968 "International Action to Avert the Impending Protein Crisis," declaring the "protein gap" a global-level emergency.[17] That same year, *Life* magazine published an image of malnourished children in the Biafra War in West Africa on its cover, bringing protein deficiency to wide public attention.[18]

These discussions regarding a protein crisis overlapped with the founding of CIAT and the development of the research programs described above. In 1966, prior to the creation of CIAT, the maize breeder Lewis M. Roberts and agricultural economist Lowell Hardin outlined a vision for an institute for agricultural research and training in the Latin American tropics.[19] According to their perspective, the institute should focus on improving a few tropical crops with high nutritional value and clear pathways to increased production. Thus, research should target such crops as soy and other beans, as well as livestock, to raise protein availability among impoverished rural populations.

In a 1970 study, Roberts declared the protein consumption deficit as one of the most crucial global nutritional problems of the time.[20] He

[16] Richard D. Semba, "The Rise and Fall of Protein Malnutrition in Global Health," *Annals of Nutrition and Metabolism* 69, no. 2 (2016): 79–88.
[17] United Nations, *International Action to Avert the Impending Protein Crisis: Feeding the Expanding World Population* (New York: United Nations, 1968); FAO and OMS, *Informes sobre nutrición*, Informe No. 42 (Rome: FAO-OMS, 1966).
[18] "Starving Children of Biafra," *Life* (July 12, 1968).
[19] Lewis M. Roberts and Lowell S. Hardin, "A Proposal for Creating an International Institute for Agricultural Research and Training to Serve the Lowland Tropical Regions of the Americas," October 1966, https://hdl.handle.net/10568/72329.
[20] Lewis M. Roberts, "The Food Legumes," November 1970, https://hdl.handle.net/10947/1528.

warned that although world food production had generally stabilized in recent years, per capita consumption of protein in the poorest countries continued to decline. According to Roberts, unlike meat with its high production costs, legumes – particularly beans – offered the possibility of tackling this imbalance. Legumes contributed to high protein intake in the diet, were available at low prices, displayed high adaptability to different agro-ecological environments, and were consumed more among peasants. However, governments had prioritized research on agricultural cash crops over research on local consumption staples such as beans. Roberts concluded that this led to declining yields per hectare and limited information on varietal improvement, plant diseases, and pest control.[21]

Early in the 1970s, CIAT surveyed the production and consumption of beans in Latin America and the contribution of the legume to protein intake, aiming to create a bean research program.[22] The results, released in the program's previous drafts and written reports, identified Latin America as the place of genetic origin for *Phaseolus vulgaris* and as the world's largest producer. Furthermore, the studies identified bean consumption as the primary protein source in Latin American rural diets, surpassing animal protein consumption. Notwithstanding these advantages, the region as a whole showed oscillating production with decreasing yields per hectare.

The Bean Program, officially launched in 1974, aimed at the genetic improvement of beans to increase production. It set four goals. To begin with, it created a bean germplasm collection. CIAT's designation as the global gene bank for bean germplasm led to a rapid increase in accessions: from 21,000 in 1978 to 35,000 in 1984.[23] Second, the program established a cooperative network with national research institutes. CIAT's bean program stemmed from a set of projects developed by seventy-four researchers specializing in varietal improvement across Latin America by

[21] Ibid., 132.

[22] Ricardo Bressani et al., "Proposal for the Establishment of a Cooperative Programme for Field Bean Research in Latin America and the Caribbean Zone," November 1973, https://hdl.handle.net/10947/968; Grant M. Scobie, Mario A. Infante, and Uriel Gutiérrez Palacios, "Production and Consumption of Dry Beans and Their Role in Protein Nutrition: A Review," April 1974, https://hdl.handle.net/10568/69739; Uriel Gutiérrez Palacios, Mario Infante, and Antonio Pinchinat, *Situación del cultivo de frijol en América Latina* (Cali, Colombia: CIAT, 1975), https://hdl.handle.net/10568/71869.

[23] CIAT, *Programa de frijol: Informe de 1978* (Cali, Colombia: CIAT, 1979), C-3, https://cgspace.cgiar.org/handle/10568/69042; CIAT, *Informe anual 1984: Programa de frijol* (Cali, Colombia: CIAT, [1984]), p. 9, https://cgspace.cgiar.org/handle/10568/69042. The establishment of global germplasm collections within CGIAR is discussed in Marianna Fenzi, Chapter 11, this volume.

1979.[24] Although these national projects lacked scientific impact and proper funding, CIAT assembled national researchers through training activities such as courses and internships. Varietal improvement became a predominant topic in CIAT's training program: nearly 44 percent of the bean program trainees had become specialized in the subject by 1983.[25]

Third, the program created regional projects for varietal improvement in Latin America and Africa. One of these projects was the Cooperative Regional Project on Beans for Central America, Mexico, and the Caribbean (PROFRIJOL), discussed later in this chapter, which was launched in 1978 and aimed at improving beans to increase production in Mexico, Central America, and the Caribbean. Likewise, CIAT signed a cooperation agreement with the Brazilian government and developed another bean project in the Andean countries. During the 1980s, CIAT established three additional regional improvement projects in Africa.[26]

Finally, CIAT's bean program developed new varieties through international testing and experimental nurseries.[27] CIAT assembled a varietal research team in Colombia comprised of three breeders, each assigned to a geographical region: the first managed Central America and regions of Brazil with significant cultivation of black and red beans; the second oversaw the rest of Brazil, Mexico, Chile, Argentina, and the Middle East; the last supervised the Andean countries and Africa. In addition to their having a geographical specialization, the three breeders developed their varieties paying attention to specific ecological traits, such as diseases, pests, or types of soil. Every year, the breeders supplied CIAT with a selection of promising lines, which were then assessed in three trial cycles. The first cycle, "Bean Team Nursery," consisted of the evaluation of these promising lines in CIAT's experimental stations in Colombia. The second cycle, "Preliminary Performance Testing," assessed the lines' productive performance, as well as additional traits concerning consumers' preferences. The last, known as "Bean Performance and Adaptation

[24] N. L. Johnson et al., "The Impact of CIAT's Genetic Improvement Research on Beans," in R. E. Evenson and D. Gollin, eds., *Crop Variety Improvement and Its Effect on Productivity: The Impact of International Agricultural Research* (Cambridge: CABI Publishing, 2003), pp. 257–274, at 260.

[25] This percentage was well above the next-highest percentages of trainees, including "Production" (18%), "Agronomy" (15%), "Entomology" (11%), and "Phytopathology" (11%). CIAT, *Informe anual 1983: Programa de frijol* (Cali, Colombia: CIAT), p. 225, https://cgspace.cgiar.org/handle/10568/69042.

[26] Oswaldo Voysest, *Intercambio de germoplasma dentro de la red de frijol* (Cali, Colombia: CIAT, 1983), https://hdl.handle.net/10568/71967.

[27] Ibid.

International Nursery," evaluated lines selected for their performance in the previous trials. CIAT carried out this cycle in its stations, or abroad at other governments' request. The distribution of testing sites abroad aimed at the international exchange of potentially productive varieties and the evaluation of this material under local ecological conditions. This methodology allowed the implementation of roughly 1,400 experiments for bean improvement across 82 countries.[28]

The bean program widened its scope between 1970 and 1990, expanding its funding from $350,000 at the outset to $14 million by the final year. Moreover, the program's staff increased from two top scientists at the beginning to twenty-six by the end of the period, including seven varietal improvement experts.[29] Furthermore, the impact of varietal improvement, measured by the share of land cultivated with improved varieties, grew over three decades: by 1988 nearly half of the bean fields in Latin America used improved varieties from CIAT's genetic material. But distribution of CIAT material was uneven between regions. In Latin America, such countries as Costa Rica, Argentina, and Bolivia accounted for up to 70 percent of the land hosting CIAT's improved bean varieties, while in Colombia, Peru, and Ecuador their share ranged from 10 to 20 percent. In contrast, Africa accounted for only 15 percent of the land cultivated with varieties released and made available to farmers under the program.[30] During the 1990s, the total number of released varieties in both continents was almost 350.

CIAT's bean programs add additional dimensions to interpretations of the Green Revolution. The foundational accounts of a Green Revolution in Asia presented an economic narrative of agricultural development that regarded technology as a tool for increasing agricultural productivity.[31] According to this narrative, modern technology aimed at the improvement of yields per hectare for peasants, reducing productivity differences between developed and underdeveloped countries. Thus, high-yielding varieties became the suitable solution to end global hunger while enhancing economic growth in the Third World.

Researchers who sought to apply the vision of agricultural development in Central America in the 1970s and 1980s added two new tenets to this narrative. To begin with, observers established an association between

[28] Oswaldo Voysest, *Viveros internacionales de rendimiento de frijol: Manual descriptivo: Frijol arbustivo, frijol voluble* (Cali, Colombia: CIAT, 1983), p. 12, https://hdl.handle.net/10568/69567.
[29] Johnson et al., "The Impact of CIAT's Genetic Improvement Research," p. 259.
[30] Ibid., p. 268.
[31] Yujiro Hayami and Vernon Ruttan, *Agricultural Development: An International Perspective* (Baltimore: Johns Hopkins University Press, 1971).

plant breeding and malnutrition. CIAT and its bean research program unfolded amid the "protein crisis" in the Third World, described in greater detail below. Thus, Central America became a laboratory for boosting protein consumption among the region's impoverished rural populations through bean genetic improvement. In this vein, CIAT's research was innovative: the Green Revolution in beans sought the increase in yields per hectare, as had been the case with crops like wheat and rice, but also the enhancement of the crop's nutritional value. Accordingly, the research interests of agronomists at CIAT and nutrition experts converged under an interdisciplinary association that was unusual at the time.

Finally, the narrative connected malnutrition to physical performance among rural workers. According to some experts, the nutritional deficit among Central America's rural population was not only a matter of public health but also a hindrance to the agricultural workforce. During the 1970s and 1980s, nutrition and agricultural development became the focus of international conferences in which experts analyzed the impact of poor diets on workers' physical performance. A 1974 symposium held in Guatemala produced a study compiling contributions from American universities' scholars and members of world organizations such as FAO, the Nutrition Institute of Central America and Panama (INCAP), CIMMYT, and CIAT.[32] The event was attended by Green Revolution experts and bean-breeding researchers such as Lester R. Brown, Robert F. Chandler, Antonio M. Pinchinat, and Lewis M. Roberts. Moreover, nutrition specialists such as Marina Flores, Leonardo Mata and Fernando E. Viteri participated alongside economists and agronomists. Further, a group of scientists at INCAP and American researchers carried out a field study to gauge the effects of the nutritional condition and caloric intake on rural workers' daily productivity.[33] As this body of research suggests, a narrative based on the tenets of agricultural modernization and public health influenced bean breeding in Central America, a process that sought the improvement of plants and the enhancement of human bodies as well.

[32] N. Scrimshaw and M. Behar, eds., *Nutrition and Agricultural Development: Significance and Potential for the Tropics* (New York: Plenum Press, 1976).

[33] Fernando E. Viteri, "Definition of the Nutrition Problem in the Labor Force," in Scrimshaw and Behar, eds., *Nutrition and Agricultural Development*, pp. 87–98; Maarten D. C. Immink et al., "Energy Supplementation and Productivity of Guatemalan Sugar-Cane Cutters: A Longitudinal Approach," *Archivos Latinoamercanos de Nutricion* 36, no. 2 (1986): 247–259.

CIAT's Bean Research and Nutritional Crisis in Central America

After CIAT's inception, Central America quickly emerged as a strategic site for its research programs. Between 1969 and 1982, 16 percent of trainees in any CIAT program came from Central America, a number surpassed only by Colombia, which supplied 21.3 percent.[34] Central America's presence was dominant even compared with countries that had much more extensive agricultural lands, such as Brazil, Mexico, Peru, and Ecuador. Likewise, scientists from the region participated prominently in almost all research programs: they represented 23 percent of participants in the bean program, above Colombia and Brazil. They also accounted for 15 percent of recruits to the pasture program, a number exceeded only by Colombia. Meanwhile, 19 percent of participants in the rice program came from Central America, which was a lower share than came from Brazil, but higher than Colombia. Finally, the region supplied 6 percent of participants in the cassava program.[35]

Central American participants trained to become specialized in the different research programs offered by CIAT. Almost half of the bean trainees came from Honduras and Guatemala, while Costa Rica and Panama led the cassava training program, providing 60 percent of recruits. In rice training, Costa Rica, Panama, Honduras, and Guatemala each supplied between 20 and 25 percent of trainees. Among these, the bean training program was arguably the most influential in circulating knowledge and agricultural research training across Central America. It accounted for more than 30 percent of the total number of Central American professionals trained through CIAT, far above any other program. Beyond Central America, the bean training program encompassed roughly one-fifth of the total professionals trained by CIAT between 1969 and 1983, exceeding the cassava and pasture programs' share of trainees and assembling researchers from thirty-five countries across three continents.[36]

Central America's prominence in CIAT training programs was due to specific conditions on the ground. During the 1960s and 1970s, the nutritional condition of the rural population in Central America was critical. A set of surveys conducted in the region showed a deficit in the population's intake of protein and calories measured according to recommendations by world health organizations. One study reported a decline in the overall consumption of protein and calories between 1965 and

[34] CIAT, *Training and Conferences Report*, pp. 8–14. [35] Ibid. [36] Ibid., pp. 6, 8–14.

1982.[37] These declines were most severe in El Salvador and Guatemala, which, not coincidentally, experienced significant political turmoil and conflict during this period.

These studies revealed the demographics of unequal nutritional access. In Central America, malnutrition affected mostly the impoverished rural populations, particularly children. A study performed by INCAP found an increase in the prevalence of children with some level of malnutrition between 1965 and 1975, excluding Costa Rica.[38] During the 1970s, rates of malnutrition in children surpassed 40 percent in Guatemala, El Salvador, and Honduras, while this figure came close to 20 percent in Nicaragua and Panama. Further, between 37 and 50 percent of total deaths occurred among children under the age of six in Guatemala, Honduras, El Salvador, and Nicaragua during the same period.

Much of the Central American population's daily diet included high consumption of maize and rice, with limited meat consumption.[39] In Guatemala and El Salvador, maize supplied 60 percent of calories to the diet, while in Costa Rica and Panama, rice provided between 39 and 47 percent of calories. Urban and rural areas within the region differed, as wheat and rice predominated most among urban populations but was considerably less dominant among rural populations.

Beans were crucial to Central American diets. Excluding Panama, nutritional data showed a common trend across the region: beans added more calories to the rural population's diet than beef. In Guatemala, El Salvador, Nicaragua, and Costa Rica, beans provided three times more caloric sustenance than beef. In Honduras, beans doubled beef's consumption rate. Panama was the only country where beef supplied more calories than beans. Beans also surpassed beef as a protein source in the region, excluding Panama. The comparative predominance of beans for both calories and protein was most dramatic among impoverished rural populations.[40]

Despite the dietary importance of beans for the Central American population, regional bean production fluctuated, leading scholars to describe an acute supply crisis.[41] What production growth did occur came as a result of

[37] Victor Valverde, Hernán Delgado, and Arnulfo Noguera, "Nutrition in Central America and Panama: Comparative Data and Interpretations," *Food and Nutrition Bulletin* 9, no. 3 (1987): 1–12, at 5.

[38] Charles Teller et al., *Desnutrición, población, desarrollo social y económico: Hacia un marco de referencia* (Guatemala: INCAP, 1980), p. 37.

[39] INCAP, *Nutritional Evaluation of the Population of Central America and Panama: Regional Summary* (Guatemala: INCAP, 1971), pp. 9–22.

[40] Ibid., pp. 12–13.

[41] Antonio M. Pinchinat, "El PCCMF y el fomento del cultivo de frijol en Centroamérica," in PCCMCA, *Frijol: XIV Reunión Anual* (Tegucigalpa, Honduras: IICA, 1968), pp. 63–70, at 68.

the expansion of cultivated land rather than an increase in productivity. Low bean production yields prevailed, even though Central America boasted incredibly rich genetic diversity in bean varieties. In fact, the region's diversity had contributed substantially to the bean gene banks in North America and Europe. Early in the 1980s, CIAT built a collection with roughly 30,000 bean accessions donated by 47 countries. Although North American and European countries were the main donors – providing 33 and 22 percent of accessions, respectively – nearly 30 percent of all accessions of *Phaseolus vulgaris* traced their lineage to Central America[42] (Figure 8.2).

This imbalance – a region with high crop diversity but poor production amidst an escalating protein crisis – prompted CIAT to carry out bean research in Central America. Such programs were not new. In 1954, the Rockefeller Foundation developed the Central American Cooperative Project: Maize Improvement, which was renamed the Central American Cooperative Program for the Cultivation and Improvement of Food Cultivars (PCCMCA) in 1964.[43] The program stemmed from an agreement between Central American governments and the foundation, aiming to improve agricultural practices in maize farming through the exchange of knowledge and technology on farming systems, pests, and diseases, as well as on fertilization and crop varieties. Although the program focused on maize, it added beans (1962) and rice (1965) as strategic crops to the research agenda, as well as other products during the following years.

Institutions such as El Zamorano Pan-American Agricultural School in Honduras and the Inter-American Institute for Cooperation on Agriculture (IICA) in Costa Rica developed bean research programs during this time. IICA – coordinator of PCCMCA since 1965 – administered an alimentary crops unit from its facilities in Turrialba, Costa Rica. The unit coordinated the dissemination of crop varieties among farmers and conducted technical surveys on bean farming. Furthermore, the Bean/Cowpea Collaborative Research Support Program under the auspices of USAID facilitated the creation of a network of bean research projects that included Costa Rica, Honduras, and Guatemala, in collaboration with Michigan State University, the University of Puerto Rico, and Cornell University.[44]

[42] CIAT, *Programa de frijol: Informe anual 1982* (Cali, Colombia: CIAT, 1983), p. 21, https://hdl.handle.net/10568/69042.

[43] PCCMCA, *Frijol: XIII Reunión Anual* (San José, Costa Rica: IICA, 1967); PCCMCA, *Frijol: XIV Reunión Anual* (Tegucigalpa, Honduras: IICA, 1968); PCCMCA, *Frijol: XVI Reunión Anual* (Antigua, Guatemala: IICA, 1970); PCCMCA, *Frijol: XVII Reunión Anual* (Panamá: IICA, 1971).

[44] Bean/Cowpea Collaborative Research Support Program (CRSP), "The Linkage Experience of the Bean/Cowpea CRSP," June 23, 1986, Michigan State University, East Lansing, MI, https://pdf.usaid.gov/pdf_docs/PNABK895.pdf.

Figure 8.2 The bean collections established earlier in CIAT's history continue. Today, maintaining CIAT's collections of bean germplasm involves the multiplications of seeds in screenhouses in Colombia's Central Cordillera, 2017. Photo by Neil Palmer/CIAT. By permission of Alliance Bioversity–CIAT.

In 1978, CIAT appointed a permanent resident scientist to Central America to improve coordination with national bean programs.[45] This step set the foundation of PROFRIJOL. During its first two years, the project received funding from the United Nations Development Programme (UNDP); afterwards, in the 1980s, the Swiss Agency for Development and Cooperation (SDC) provided funds.[46]

PROFRIJOL became an international plant-breeding network integrating programs in Mexico, Central America, and the Caribbean (Figure 8.3). The project established a regional nursery and testing system for reviewing new genetic material across different countries, replicating CIAT's decentralized varietal improvement strategy. One of

[45] CIAT, *Programa de frijol: Informe de 1978*, C-73.

[46] CIAT, *Informe anual del programa de frijol 1980*, p. 83; Rafael Rodríguez, "Evolución e integración de la investigación del frijol en América Central, México y El Caribe: PROFRIJOL," in S. P. Singh and O. Voysest, eds., *Taller de mejoramiento de frijol para el siglo XXI: Bases para una estrategia para América Latina* (Cali, Colombia: CIAT, 1997), pp. 531–546.

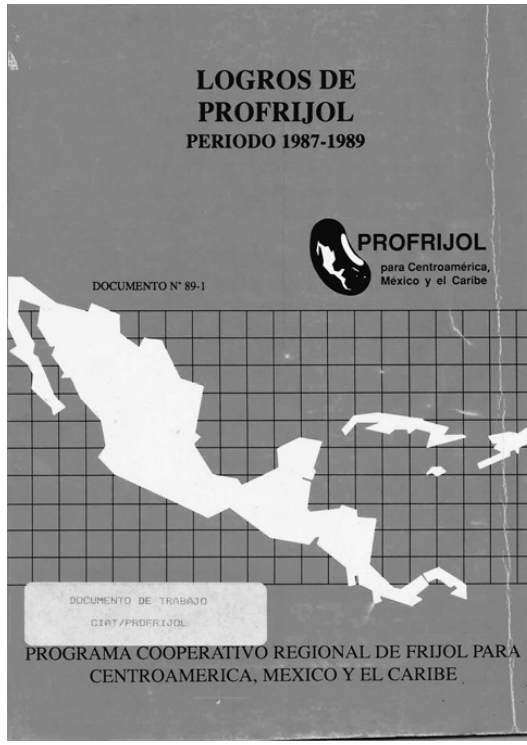

Figure 8.3 The PROFRIJOL program, launched in 1978, sought to coordinate bean research, breeding, and testing across Mexico, Central America, and the Caribbean. *Logros de PROFRIJOL, Periodo 1987–1989* (San Jose, Costa Rica). By permission of Alliance Bioversity–CIAT.

its tasks was avoiding the duplication of projects between countries to save financial and scientific resources for varietal research in the region. In this way, CIAT promoted research and disseminated scientific publications among officials in each country. PROFRIJOL balanced broad participation in the decision-making process through a general coordinator, a directing board, and an assembly consisting of representatives from the associated countries.[47]

PROFRIJOL produced mixed results across the region. Despite the political crises and economic hardships of the 1980s, the project

[47] Rodríguez, "Evolución e integración," pp. 532–533.

succeeded in linking national bean programs in a network, mobilizing twenty-three plant-breeding experts. However, during the 1990s, economic liberalization affected national institutions, weakening local programs through staff reductions. By 1999, the network employed only four expert researchers.[48] Regarding varietal improvement, the program developed eighty-one distinct genetic varieties between 1978 and 1997, fifty-six of which were certified and made available to farmers. More than 80 percent of these new varieties originated in genetic material from CIAT or research programs coordinated by the center.[49] However, new varieties' acceptance among farmers was limited: in 1996 roughly 44 percent of bean-cultivated land in Central America grew varieties improved by the program. While countries like Costa Rica accounted for 85 percent of land cultivated with new varieties, noncertified varieties, or *criollas*, remained predominant among peasants in countries such as El Salvador and Nicaragua.[50] Despite the limitations in determining the actual scope of the project in the region, the mild and fluctuating increase in yields per hectare between 1970 and 1990 suggests a limited success of varietal innovation.[51] These limits were owing considerably to political violence. PROFRIJOL created a significant network of people, seeds, and agronomic knowledge. Its campus specialized in the improvement of *Phaseolus vulgaris*, sustained by dozens of scientists from different countries, hundreds of varieties of beans, and thousands of dollars of accumulated investment since the late 1970s. All of these resources were applied to improving the lives of thousands of poor farmers in Central America. This was surely no easy task for CIAT scientists, or for the partner national governments. More complicated still, during its development PROFRIJOL collided with the social realities of Central America, in which the territorial and political scale transcended the bean fields. Specifically, PROFRIJOL contended with the dynamics of the international protein market, new agricultural technology, and, above all, civil war.

[48] Johnson et al., "The Impact of CIAT's Genetic Improvement Research," p. 260.
[49] Abelardo Viana Ruano, *Flujo de germoplasma e impacto del PROFRIJOL en Centroamérica: Período 1987–1996* (Guatemala: PROFRIJOL, 1998), pp. 16–19.
[50] Ibid., pp. 21–28.
[51] PROFRIJOL, *Plan quinquenal 1993–1997* (Guatemala: PROFRIJOL, 1992), p. 7; CORECA-IICA, *El mercado mundial del frijol y sus vinculaciones con el mercado centroamericano* (San José, Costa Rica: IICA, 1999), p. 45, https://repositorio.iica.int/handle/11324/9158.

Interpreting Bean Research, the "Protein Crisis," and Civil War in Central America

In a 1974 article in the *Lancet*, Donald McLaren of the Nutrition Research Laboratory at the American University of Beirut disputed the claim made by international organizations (such as FAO, WHO, and UNICEF) a decade prior about the existence of a "protein crisis," instead dubbing the episode the "protein fiasco."[52] According to McLaren, the root causes of childhood malnutrition among Third World impoverished populations were more complex than the protein insufficiency explanation. On the one hand, McLaren argued that a lack of available data hindered the establishment of linkages between protein insufficiency and other health problems associated with "proteic-caloric malnutrition." On the other hand, he labeled concerns about protein as reductionist: poverty and lack of access to food caused malnutrition, rather than food quality itself. McLaren's article showed the cracks in the "protein crisis" narrative. Nor were data limitations and reductionism the only concerns. The food crisis of 1972 and the oil shock of 1973 had demoted the protein crisis within many organizations' agendas, including the dismissal of the once-influential United Nations Protein Advisory Group in 1977.

From the perspective of Central America, concerns regarding protein deficiencies encountered two paradoxes. The first related to decreasing meat consumption amid increasing production. Cattle raising in the region had been growing since the 1950s. Central America became a net beef exporter to US markets, increasing exports from 362,000 kilograms in 1957 to nearly 80 million in 1980.[53] Likewise, the industry expanded from roughly $8 million in exports to the United States in 1960 to $200 million in 1980.[54] These increases were due to the convergence of political, ecological, and market factors. The North American fast-food boom of the 1950s and 1960s substantially increased the demand for beef, while the foot-and-mouth disease quarantine imposed on South America's cattle industry allowed a broadening in export quotas from Central America to the United States.[55] Moreover, national governments, under the auspices of the Alliance for Progress in the 1960s, pursued public infrastructure projects, such as roads and bridges, thereby

[52] Donald S. McLaren, "The Great Protein Fiasco," *Lancet* 304, no. 7872 (1974): 93–96.
[53] Robert G. Williams, *Export Agriculture and the Crisis in Central America* (Chapel Hill: University of North Carolina Press, 1985), p. 204.
[54] Ibid., p. 206.
[55] Alfredo Guerra-Borges, "El desarrollo económico," in Héctor Pérez Brignoli, ed., *Historia General de América Central: De la posguerra a la crisis (1945–1979)* (Madrid: FLACSO, 1993), pp. 13–84, at 32–34.

improving transport to port facilities. These developments led to the growth of nearly thirty meat-packing facilities in the region with refrigerating systems that met the quality standards required by US markets. Thus, in two decades, the region's beef agro-industry experienced significant industrial expansion.

This thriving industry grew despite decreasing meat consumption in Central America. According to one study, beef consumption per capita declined in Central America from 11.9 to 10.2 kilograms during the 1970s and 1980s.[56] In Guatemala, consumption dropped from 5.3 to 3.8 kilograms, while in Nicaragua it drastically decreased from 15.6 to 8.6 kilograms. Demonstrating the effect of civil war and political instability in these countries, comparatively peaceful and stable Costa Rica actually increased beef consumption slightly from 20.4 to 22.9 kilograms per capita. Other factors contributed to decreasing beef consumption in parts of Central America, including regional demographic growth, the impact of the 1980s economic debt crisis on consumer purchasing power, and the rise in the consumption of poultry and other types of meat. Still, for some observers, a contradiction came to define the region: the allocation of ecological and capital resources towards export-led cattle raising contrasted with the nutritional crisis among the region's impoverished rural populations who lacked animal-based protein and depended on beans to fulfill this dietary need.

The second paradox posed by protein deficiency in the region was related to land tenancy. Protein programs focused on the most impoverished rural families, whose agricultural production often took place on sloping lands with highly depleted soils. Since the 1960s, the territorial expansion of monoculture crops, such as sugarcane, cotton, and coffee, and cattle raising contributed to the growing marginalization of sectors of the rural population. Many social scientists understood these populations' economic and social hardships as a root cause for civil war and insurgency in Central America in the 1970s and 1980s. Scholars interpreted the political crisis as resulting from a high concentration of lands in large estates owned by a few landowners.[57] Meanwhile, peasant

[56] David Kaimowitz, *Livestock and Deforestation in Central America in the 1980s and 1990s: A Policy Perspective* (Indonesia: Center for International Forestry Research, 1996), pp. 30–31.

[57] Antonio García, "El nuevo problema agrario de América Central," *Anuario de Estudios Centroamericanos* 5, no. 1 (1979): 111–118. Several critical texts in wide circulation during this time more broadly interpreted these inequalities in land tenure as the basis for social conflict historically across Latin America. For example, Alain de Janvry, *The Agrarian Question and Reformism in Latin America* (Baltimore: Johns Hopkins University Press, 1981); Eduardo Galeano, *Open Veins of Latin America: Five Centuries of the Pillage of a Continent* (New York: Monthly Review Press, 1973).

families survived by cultivating less fertile lands for self-consumption, and squatting on state-owned lands or abandoned estates. In 1985, the anthropologist Billie DeWalt argued that the beef-exporting boom fostered the expansion of grasslands, pushing peasants towards marginal lands.[58] The economist Robert Williams asserted that initially lands with the most fertile soils were monopolized by cattle ranchers and cotton farmers, displacing maize farmers towards sloping and frontier lands; cattle raising later colonized sloping lands as well, forcing peasants to move beyond the margins.[59]

Other scholars of the 1980s and early 1990s concurred that the agricultural export boom expelled peasant communities from the best-suited lands, advancing marginalization and poverty in Central America.[60] Agricultural modernization deepened social inequalities in the region.[61] Meanwhile, nutrition researchers studied the relationship between land tenure structures, poverty, and malnutrition. Some studies found the prevalence of moderate child malnutrition was higher among small landowners (between 1 and 2 hectares) than among middle-to-high landowners.[62] As a result, many organizations strove to increase protein intake among Central America's impoverished rural populations. Ironically, those groups had been displaced from their lands by an industry involved in exporting animal-based protein to North American markets.

How did an emphasis on bean breeding affect these conditions? The fundamental aim of CIAT's bean research program was increasing yields per hectare in Central America. However, the particularities of bean crops hindered the possibility of developing a high-yielding variety. Consider rice as a comparison. Rice breeding brought two remarkable achievements. First, it created an "ideal type" of plant embodied in IR8, the Green Revolution's "miracle rice."[63] This semi-dwarf variety

[58] Billie R. DeWalt, "The Agrarian Bases of Conflict in Central America," in Kenneth Coleman and George C. Herring, eds., *The Central American Crisis: Sources of Conflict and the Failure of US Policy* (Wilmington, DE: Scholarly Resources, 1985), pp. 43–54.

[59] Williams, *Export Agriculture*, pp. 155–165. In Chapter 3, this volume, Timothy W. Lorek describes this process of deterritorialization as it related to CIAT in Colombia.

[60] Victor Bulmer-Thomas, *The Political Economy of Central America since 1920* (Cambridge: Cambridge University Press, 1987), p. 207; Alain Rouquié, *Guerras y paz en América Central* (México: Fondo de Cultura Económica, 1994), pp. 98–106; Guerra-Borges, "El desarrollo económico," pp. 19–36.

[61] Edelberto Torres-Rivas, *Revoluciones sin cambios revolucionarios: Ensayos sobre la crisis en Centroamérica* (Guatemala: F&G Editores, 2013), pp. 110–132.

[62] Victor Valverde et al., "Relationship between Family Land Availability and Nutritional Status," *Ecology of Food and Nutrition* 6, no. 1 (1977): 1–7.

[63] Peter Jennings, "Plant Type as a Rice Breeding Objective," *Crop Science* 4, no. 1 (1964): 13–15.

combined the best traits of *japonica* and *indica* varieties, including high yields per hectare, pest and disease resistance, increased response to chemical fertilization, and high consumer acceptance. Arguably, the capacity to adapt to different ecological and social environments was the most outstanding characteristic of varieties genetically associated with IR8.[64] Second, the adoption of high-yielding rice varieties succeeded owing to the development of a farming system based on six conditions, typically affordable only to wealthy farmers: the exploitation of flat fertile lands, the use of farming and harvesting machinery, the application of chemical fertilizers, soil exploitation based on a single crop (a monoculture system), a dependency on pest and disease control, and the availability of irrigation systems.

In contrast to rice, bean improvement posed difficulties. Most obviously, given the variety of shapes, colors, sizes, and flavors of beans, scientists struggled to develop the "ideal type" of plant. CIAT bean researchers Aart van Schoonhoven and Oswaldo Voysest found that populations in Latin America routinely ingested almost fifty different types of bean, which they identified by their colors, sizes, and local names.[65] Variable approaches to cultivation further complicated this encounter with diversity. Depending on local economies and ecologies, peasants often cultivated beans alongside maize, coffee, or other crops. According to van Schoonhoven and Voysest, Latin American peasants produced between 60 and 80 percent of beans in companion plantings with maize. In addition, farmers in different locations practiced culturally specific planting methods. For example, Nicaraguan and Costa Rican peasants relied on nonconventional farming techniques, such as the "frijol tapado," which consisted in spreading the beans over organic waste, such as leaves and branches, left after clearing the forest.[66]

The common conditions of bean cultivation in Central America also hampered the development of a bean monoculture in the region. Peasants generally cultivated legumes in sloping lands, hindering farming mechanization and irrigation. They usually grew beans in acidic and depleted soils with nitrogen deficiencies.[67] Finally, the mixed planting of beans and other crops in small plots inhibited the development of a monoculture system. Meanwhile, chemical fertilization and pest control were limited among peasants. Beans frequently fell prey to numerous diseases and

[64] Robert F. Chandler, *Rice in the Tropics: A Guide to the Development of National Programs* (Colorado: Westview Press, 1979).

[65] Aart van Schoonhoven and Oswaldo Voysest, "El frijol común en América Latina, y sus limitaciones," in Marcial Pastor-Corrales and Howard F. Schwartz, eds., *Problemas de producción del frijol en los trópicos* (Cali, Colombia: CIAT, 1994), pp. 39–66, at 42–44.

[66] Ibid., pp. 48–49. [67] Ibid., pp. 56–57.

pests. According to experts in the 1990s, between 200 and 450 insect plagues and more than 200 types of malady damaged harvests in the region.[68] Finally, bean production in Central America was most often located in the Dry Pacific Slopes, a subregion frequently affected by droughts. Given the above factors, the development of a Green Revolution in bean production equivalent to that seen in rice seemed an unlikely enterprise.

Political conditions added to these complications. The bean improvement program in Central America overlapped with a period of civil war between 1978 and 1990 that affected most of the region. Although the insurgent movement in Nicaragua started during the 1960s, opposition to Anastacio Somoza's dictatorial regime crystalized in 1974, finally leading to the victory of the Sandinista Revolution in 1979. In El Salvador, guerilla groups and others resisting government repression became one united front, the Farabundo Martí National Liberation Front, in 1980, initiating a decade of civil conflict. In Guatemala, leftist rebel groups seeking land redistribution and an end to repressive government regimes emerged during the 1960s and successfully entrenched in rural areas in the late 1970s. Confrontations between insurgents and the Guatemalan army developed during the 1980s, peaking between 1982 and 1985. Finally, although Honduras and Costa Rica remained free from internal clashes, both countries became the focus of migration for thousands of displaced people. Also, the two countries defended the United States' geopolitical interests in the region indirectly by supporting counter-insurgent strategies[69] (Figures 8.4 and 8.5).

The civil wars affected agriculture in Central America via different avenues. By and large, export farmers avoided the war crisis better than local market producers. The land tenure structure for cash crops (e.g., coffee, sugarcane, bananas) and cattle raising in the region remained unchanged, despite land reform attempts during the 1970s and 1980s.[70] Where it occurred, land redistribution took place in marginal and less fertile lands already occupied by most of the peasant population. Land reform efforts did not necessarily upset the activities of wealthier export farmers. By comparison, peasant agriculture endured far more significant damage on the fields because of conflict than export agriculturists. Peasants grew staple crops, such as maize and beans, in sloping lands and agricultural frontiers, where guerrilla members found shelter

[68] Ibid., p. 48.
[69] Stephen G. Rabe, *The Killing Zone: The United States Wages Cold War in Latin America* (Oxford University Press, 2012). One of the best analyses from Central America is Torres-Rivas, *Revoluciones*.
[70] Guerra-Borges, "El desarrollo económico," pp. 57–67.

Figure 8.4 The scorched-earth ferocity of Central America's civil wars affected rural peoples and food production. In this image from 1983, a young woman with the insurgency poses with child and assault rifle in front of maize in Guazapa, El Salvador, a region targeted by the Salvadoran army. Gio Palazzo Collection, Museo de la palabra y la imagen (San Salvador, El Salvador). By permission of Museo de la palabra y la imagen.

from the repressive army forces. Farm fields became battlegrounds, displacing hundreds of thousands of peasants. According to the United Nations Refugee Agency, conflict expelled roughly 20 percent of El Salvador's population, while other estimates indicate that 14 percent of the population in Guatemala and Nicaragua fled from their countries.[71] Some studies estimate that a total of around 2 million

[71] Cástor Miguel Díaz, *Los conflictos armados de Centroamérica* (Madrid: Instituto de Estudios Internacionales y Europeos-Universidad Carlos III, 2010), p. 62; Juan Rafael Vargas et al., "El impacto económico y social de las migraciones en Centroamérica (1980–1989)," *Anuario de Estudios Centroamericanos* 21, no. 1/2 (1995): 39–81, at 41.

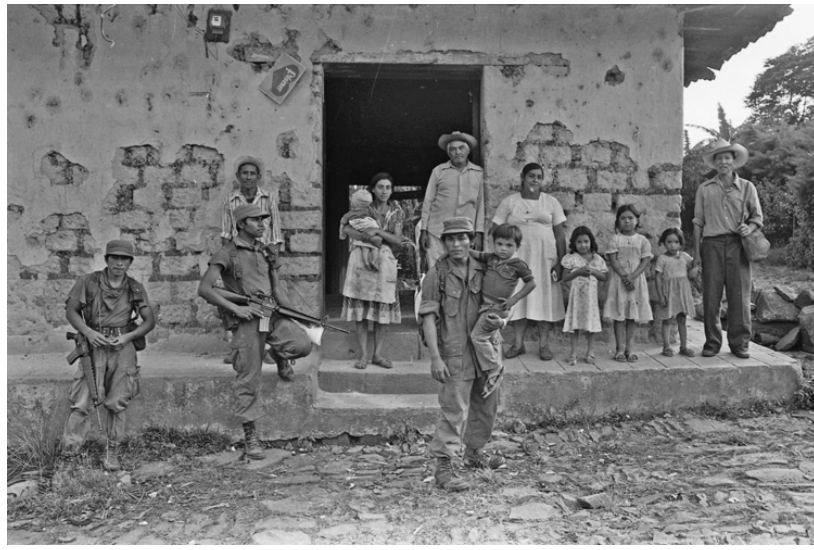

Figure 8.5 Civilians and army soldiers in front of a building in Perquín, El Salvador, 1983. Photograph by Richard Cross. Courtesy of the Tom & Ethel Bradley Center at California State University, Northridge.

people in Central America left their countries during the 1980s, fleeing violence and persecution.[72]

Across the region, state and military efforts to fight insurgents led to the reallocation of public budgets to military spending. Guatemala's military expenditure grew from $67 million in 1975 to $180 million in 1983, while El Salvador's increased at a similar rate, from $37 to $99 million, during the same period. Military expenses in both countries reached nearly 15 percent of the public budget in 1983.[73] The economic crisis triggered by the 1979 oil shock further aggravated the effects of such resource allocation. Mirroring the broader Latin American economic environment, Central American states underwent financial setbacks due to rising external debt, fiscal deficit, inflation, and capital outflows.[74] Cuts in public spending such as farmer subsidies and loans affected peasant agriculture. For instance, in 1983, coffee and cotton farmers held

[72] This calculation is complicated by the lack of reliable data. Abelardo Morales, *La diáspora de la posguerra: Regionalismo de los migrantes y dinámicas territoriales en América Central* (San José, Costa Rica: FLACSO, 2007), pp. 117–119.

[73] Alfredo Guerra-Borges, "Reflexiones sobre la economía y la guerra en Centroamérica," *Anuario de Estudios Centroamericanos* 12, no. 2 (1986): 75–88, at 80.

[74] Bulmer-Thomas, *The Political Economy of Central America*, pp. 230–266.

60 percent of farming loans, while rice producers obtained 10 percent. On the other hand, bean producers had access to only 1 percent, despite the dietary importance of the legume.[75]

The socioeconomic impact of the civil war on the most vulnerable populations fostered an increase in the United States' food assistance. Between 1979 and 1987, the United States spent more than $700 million on food relief through such programs as PL-480.[76] Most of the aid, almost 70 percent, consisted of wheat, vegetable oils, maize, rice, milk, and beans. This food relief had significant effects beyond the simple provision of calories. For example, the scope of these programs disrupted regional food systems, changing Central Americans' consumption patterns and diets. As the region imported cheap food, such as maize, via donations or low-cost purchases, relief programs discouraged local production and further marginalized peasant farming.

Conclusion

Some US politicians and scholars thought it plausible that Central America would become a "Vietnam of the Americas" during the 1980s. This analogy suggests that the military conflict in Central America, particularly in El Salvador, almost resembled Vietnam before 1975.[77] Indeed, after the 1960s, Central America became one of the many Third World hot spots where the United States led an anti-communist campaign. Most of its population faced poverty and marginalization within agrarian-based economies while enduring political instability from both dictatorial regimes and insurgent guerrilla movements. The success of the Cuban Revolution in 1959 and the island's close relations with the Soviet Union anticipated the radicalization of rebel movements in the region, prompting the United States' military and political intervention in defending its geopolitical interests.

Varietal improvements for increasing food production in Central America during the 1970s and 1980s differed from the Green Revolution in Asia. In contrast to the development of high-yielding varieties of wheat and rice, CIAT's bean research program in Central America went against all the odds. The bean-breeding program unfolded

[75] CEPAL, "Centroamérica: Crisis agrícola y perspectivas de un nuevo dinamismo," February 12, 1985, 24, http://hdl.handle.net/11362/26594.

[76] Rachel Garst and Tom Barry, *Feeding the Crisis. US Food Aid and Farm Policy in Central America* (Lincoln: University of Nebraska Press, 1990), p. 61.

[77] George C. Herring, "Vietnam, El Salvador, and the Uses of History," in Coleman and Herring, eds., *Central American Crisis*, pp. 97–110; Susanne Jonas and David Tobis, *Guatemala* (New York: North American Congress on Latin America, 1974), p. 187.

amid civil wars and poverty crises, which were linked to nutritional crises among peasant populations. Yet unlike wheat and rice, the bean was less suited to monoculture and industrial cultivation, maintaining its association with small peasants who farmed mixed plots on sloping lands. These conditions hindered the development of high-yielding varieties and the design of modern technical-package-based farming systems.

Central America was a laboratory for Cold War geopolitics between the 1960s and the 1980s. During this period, this region was the scene of wars between dictators, armies, and guerrillas, all of which were affected by the interests of the United States and the Soviet Union. As a result, Central America became a zone of exchange in military technology, espionage, arms deals, and food assistance from both the capitalist and communist worlds. At the same time, the region was also a laboratory for CIAT efforts to increase the consumption of protein by the poorest classes via the genetic improvement of beans. Although this was a just war against the malnutrition that caused the suffering of thousands of children, it was also paradoxical, in that the program for the improvement of beans occurred in Central America even as thousands of tons of animal protein were exported to the United States or consumed by the wealthiest populations of the region. As the United States and Central American governments combined to invest billions of dollars in the region's civil wars, this episode of the Green Revolution in Central America was characterized not only by the politics of the Cold War but also by the persistent and underlying social inequalities of the region.