

EMBRAPA COMMON BEAN BREEDING PROGRAM: A CURRENT OVERVIEW

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Common bean (*Phaseolus vulgaris* L.) is the most important legume for direct human consumption. It is grown and consumed worldwide in distinct areas and different seasons, mainly by subsistence level farmers with low-technology input. *P. vulgaris* is particularly important in the Americas, especially Latin America, as well as in Africa and Asia, once it is largely a subsistence crop used as a major source of dietary protein in these countries, as a complement to carbohydrate-rich sources such as rice, maize, and cassava. The common bean is also an important source of minerals, i.e., iron and zinc, and of certain vitamins. For this reason, it is considered as an economically, nutritionally, and socially important crop (Broughton *et al.* 2003). In Brazil, the current second main producer country (FAO 2012), *P. vulgaris* dry bean is a very popular and relevant crop, representing the major source of dietary protein. It is grown across all edafoclimatic areas of the country, with sowing dates happening almost every month. Its per capita consumption can be as high as 17 kg per year. The total growing area in 2010 was 2.1 million ha with a mean productivity of 1.285 kg/ha (FEIJÃO 2012). For this reason, provide Brazilian farmers with improved cultivars should be considered as mandatory and strategic to the country, both to increase farmers' income as to ensure food security.

Through the understanding, assessing, and exploration of allelic variability available at *P. vulgaris*, the Embrapa common bean breeding program drives its efforts on the development of high-yielding cultivars improved for tolerance to abiotic and biotic stresses, focusing the demand of the producing regions and consumer markets in the country and abroad. In this sense, 70% of its efforts are aimed at commercial grain type "carioca" (medium-sized cream-colored grains with brown stripes), the most consumed in the Brazilian market, 20% at black seeded type, and the remaining 10% at grain types "mulatinho", "roxo", "rosinha", "jalo", "rajado" (medium-sized cranberry-sugar bean) and "vermelhinho" (medium-sized red seeded beans), in addition to white seeded bean, cranberry-sugar bean, dark red kidney, light red kidney and calima, targeting the international market.

Currently, the core project of the Embrapa common bean breeding is being developed in partnership with other 42 research and academic organizations with extensive tradition and experience on agricultural research and development: 15 Embrapa research centers, 10 public state organizations for agricultural research and development, 13 academic organizations (universities and colleges), and four international organization on bean research. This partnership has been consolidated over many years, since the Embrapa bean breeding program began in 1978, with the strong collaboration in previous research projects. Hence, it has been possible to exchange staff and facilities to support all research goals, allowing the development of complementary actions for research, innovation and development, and maximizing the work efficiency.

The germplasm flow in the program pipeline is structured in actions of pre-breeding and breeding, which are organized into 10 subprograms or action plans (AP) that comprise 93

interrelated and interdependent activities of research, innovation and development. The management of the bean breeding project is in charge of Embrapa Rice and Beans (Santo Antônio de Goiás, GO) that deals with technical, administrative, and financial issues, being aided by a committee composed by the leaders of each project AP. The AP “Evaluation and Valuation of the Embrapa Bean Core Collection” conduces the phenotypic and molecular characterization of common bean accessions considered as representative of the genetic variability available at the Embrapa Bean Active Germplasm Bank. It also organizes a database with all information obtained from this characterization. There are five APs focusing on pre-breeding, i.e., identification and incorporation of desirable alleles in adapted genotypes to be used as donor parents of important traits such as disease resistance, biological nitrogen fixation, upright growth habit, tolerance to lodging, early maturity, drought tolerance, efficiency on nutrient absorption, tolerance to high temperature, and nutritional, culinary and commercial grain quality. These APs are entitled “Common Bean Breeding for Fungi Resistance”, “Breeding for Resistance to Bacterial Diseases and Efficiency in Biological Nitrogen Fixation”, “Breeding for Resistance to Viruses”, “Breeding for Tolerance to Morphological, Physiological and Abiotic Stresses”, and “Breeding for Grain Quality”. The advanced lines generated from these efforts are combined to develop segregating populations aiming at the association and simultaneous selection of two or more important traits. This stage of the program is named as AP “Integrated Breeding”, being realized separately for each commercial grain type and using conventional and participative breeding methods to develop elite lines. Some of these APs cited above are also assisted by molecular markers. The lines obtained are further evaluated during the APs “Initial Evaluation of Advanced Lines” and “Final Evaluation of Advanced Lines”, on an evaluation network conducted by distinct institutions in the main growing areas of the country. The last trials are conducted in all Brazilian bean growing regions and seasons by a national bean assay network, named as Tests of Value for Growing and Use. If the superior agronomic performance of a bean line is confirmed in these tests, it could then be released as a new cultivar. When necessary, the final AP to be held is the extension of cultivar recommendations for those states and growing seasons that were not covered in the initial process of cultivar registration.

The data obtained during the execution of all cited APs are used to support basic and applied genetic studies aiming to optimize the processes of development and evaluation of elite lines. This has assured the indication of new cultivars with high agronomic performance. In addition, these studies are also being used as subsidy to develop human resources, i.e., training of graduate and undergraduate students. Additional information about the Embrapa common bean breeding program and its portfolio of cultivars are available upon request. As could be verified, there are many opportunities for national and international collaborative researches. The consolidation and ampliation of scientific partnerships have always been one of the priorities of the Embrapa common bean breeding program.

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