Chapter 1
Genetic Improvement of Banana

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1.1 Introduction

World production of bananas, estimated at 106 million tons (Lescot 2006), ranks fourth in agricultural production. Bananas make up the largest production of fruits and the largest international trade, more than apple, orange, grape and melon. Bananas are cultivated in more than 120 countries in tropical and subtropical zones on 5 continents. Banana products represent an essential food resource and have an important socioeconomic and ecological role.

Current varieties are generally seedless triploid clones either of the single genome A from the species Musa acuminata (group AAA) or of both genomes A and B from species M. acuminata and Musa balbisiana (groups AAB and ABB). More rarely, diploid varieties (AA and AB) and tetraploid clones are encountered. There are two major channels of banana production: those cultivated for export and those reserved for local markets. The main banana varieties cultivated for export, known as ‘Grande Naine’, ‘Poyo’ and ‘Williams’, belong to the monospecific triploid bananas (AAA) of the Cavendish sub-group. They differ from each other only in somatic mutations such as plant height or bunch and fruit shape. Their production relies on an intensive monoculture of the agro-industrial type, without rotation, and a high quantity of inputs.

Banana cultivation for local consumption is based on a large number of varieties adapted to different conditions of production as well as the varied uses and tastes of consumers. Diploid bananas, close to the ancestral wild forms, are still cultivated in Southeast Asia. In other regions, triploid clones belonging to different sub-groups – Plantain, Silk, Lujugira, Gros Michel, Pisang Awak – are the most widely distributed.

Bananas have many uses. They are not only consumed as fresh fruits but also cooked, like plantains. They are processed in various ways, into chips, fries, fritters,
purees, jams, ketchup and alcohol (banana wine and beer have a very significant production in East Africa). The daily per capita consumption of bananas from 30 g to over 500 g in some East African countries. Apart from the fruit, other parts of the plant are also used: the pseudostem is used for its fibres and as floaters (Musa textilis or abacá) in the Philippines, and the leaves are used to make shelters or roofs or as wraps for cooking. In Thailand, the floral buds of particular varieties (Pisang Awak) are used in various culinary preparations. Some varieties are also considered to have medicinal properties.

Cultivated throughout the world, bananas are threatened by several diseases and pests (Stover and Simmonds 1987; Jones 1999) that need to be taken into account for banana improvement. Various major fungal diseases are constraints in industrial production and, to a lesser degree, in local production. For example, Sigatoka disease (SD) due to Mycosphaerella musicola and black leaf streak disease (BLSD) caused by M. fijiensis result in production losses in large industrial plantations and necessitate costly pest control measures to be adopted. In certain production zones, Fusarium wilt due to the soil fungus Fusarium oxysporum f. sp. cubense prevents the cultivation of susceptible varieties like the Gros Michel types. Great constraints are also exerted by the nematodes – Radopholus similis and several representatives of the genus pratylenchus – and by the black weevil of banana, Cosmopolites sor-didus. Also, viral diseases are spreading. Those of greatest concern are due to BBTV (banana bunchy top virus), CMV (cucumber mosaic virus), BSV (banana streak virus) and BBMV (banana bract mosaic virus).

Chemical control measures used in intensive cultivation are not available to small banana farmers in developing countries. Furthermore, for some diseases, there is no effective chemical control. Genetic improvement has thus been focused mainly on obtaining varieties resistant to principal pests and diseases. Breeding bananas through hybridisation, which began in the 1920s, is currently being pursued at seven research centres. FHIA in Honduras is breeding banana for export as well as the ‘cooking’ types (Rowe 1984). EMBRAPA-CNPMF in Brazil (Dantas et al. 1993), NRCB and TNAU in India (Sathiamoorthy et al. 2000; Krishnamoorthy and Kumar 2004) aim at breeding local types of dessert and cooking bananas. CARBAP (Jenny et al. 2003) in Cameroon and IITA (Tenkouano and Swennen 2004) in Nigeria are conducting research on plantain and banana breeding in Africa. These six research centres are mainly interested in developing new tetraploid varieties by crossing triploid varieties and wild or improved diploid clones with resistance to diseases. Some secondary triploids derived from crosses between these new tetraploid varieties and other diploid clones were also obtained.

In the French West Indies, CIRAD has conceived another crossing strategy aimed at the development of triploid varieties directly from diploid plant material (Bakry et al. 2001).

Since the 1980s, apart from these conventional breeding approaches, other groups have focused on mutagenesis as at IAEA (Roux 2004) in Austria or on the selection of somaclonal variants as at TBRI (Hwang and Ko 1990) in Taiwan. These technologies appeared as a result of the development of in vitro culture techniques designed for rapid industrial multiplication of micro-propagated banana plants.