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Genetic improvement: the only sustainable solution

A tribute to our colleagues

In the last two years, the banana world has been shocked and saddened by the loss of five of the most respected and pioneering banana breeders. In January 2000, Dirk Vuylsteke (IITA, Uganda), together with his colleagues and fellow banana researchers, Paul Speijer and John Hartman, tragically lost their lives in the Kenya Airways aeroplane crash. The year 2001 saw the deaths of Phil Rowe (FHIA, Honduras), Ken Shepherd (EMBRAPA, Brazil) and Ren Gonsalves (Banana Board, Jamaica) and in the early days of 2002, Norman Simmonds, one of the fathers of modern plant breeding, also passed away.

In this paper, INIBAP pays tribute to the work of these scientists. This is our opportunity to highlight the immense contribution each one

Phil Rowe (1939 – 2001)

Phil Rowe and Dirk Vuylsteke tasting new FHIA bananas. (R. Swennen, KuLeuven).

On Sunday, 25 March 2001, Dr Phillip R. Rowe died in La Lima, Honduras at the age of 62 years. For over thirty years he dedicated his career to breeding bananas and plantains. He developed a number of important improved varieties that are now being distributed around the world, from Cuba to Uganda, where they are bringing substantial relief from the effects of banana pests and diseases, most notably black Sigatoka and Fusarium wilt.

Phil Rowe and two Cubans farmers.

Phil was born and schooled in Arkansas. After he graduated from Michigan State University, he moved with his wife Jeannette, to Honduras to take up a post in what was then the United Fruit Company. He quickly became responsible for the banana breeding programme and continued to lead the research until his untimely death, seeing through the transition from a private enterprise to a government research institute, the Fundación Hondureña de Investigación Agrícola (FHIA). The exceptional FHIA hybrids, which Phil developed, are some of the best performing banana varieties in the world. They have proved resistant to multiple diseases and pests, they are high yielding and consistent in performance over wide ranging environmental conditions. Indeed on the strength of their results, these varieties have been selected for adoption and are gradually being taken up in many banana-producing areas. They particularly benefit the smallholder producers, farming in marginal areas without pesticides and fertilizers. Where the hybrids have been introduced, they have been taken up with alacrity by farmers. Cuba, having adopted the FHIA hybrids on the widest scale, provides the most enlightening example. Increased yields without the use of pesticides have had an immediate and impressive impact on farmers' incomes. Other ongoing projects, distributing the varieties to small-scale producers in Nicaragua, Nigeria and Tanzania for example, have resulted in preliminary increases in yields by a third.

Phil never tired of trying to convince people that "traditional breeding" was the best approach for improving the banana and plantain industry. He worked tirelessly to increase support for traditional breeding because he understood its true potential in improving this "intractable crop". Among the few who understood and appreciated Phil's work were the Cubans. As Jose Manuel Alvarez (Head of the banana research programme in Cuba) wrote" In Cuba we will always remember him with admiration, love and respect; and all those feelings will be manifest in the farms around the Island where today the fruits of his work are flowering". Phil's conscientious dedication to his work will continue to bring benefits to millions of people worldwide. His generosity, humour and compassion will, no doubt, be remembered by a more intimate circle of friends, colleagues and people who benefited from his kindness.

> "I know of no more urgent food security problem in the world than that confronting the plantain and cooking banana farmers and consumers in Africa. And I know of no plant disease that currently adversely affects more people than black Sigatoka. Breeding is the only practical solution, and substantial progress has already been made in this regard. More than anything else, the new hybrids produced by FHIA (FHIA-20, FHIA-21 and FHIA-23) are indicator plants. They show that disease resistant productive hybrids of banana and plantain which are preferred by farmers and consumers can be bred, and are indicative that even better hybrids can now be expected to be forthcoming."
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> **Phil Rowe,** in a letter to PROMUSA news, published in INFOMUSA Vol 7 (1), 1998.

of these researchers has made to banana improvement, and also to pay homage to our colleagues for their humanity and their commitment to research for the benefit of smallholder farmers. It is remarkable that such an important crop as* Musa *should have been neglected by researchers for so long. The five scientists that we remember today, recognised where others didn't, the value of the banana and plantain crop for subsistence farmers across the globe. They were convinced of the importance of their work and dedicated their lives to it. Breeding bananas is not an easy task. However, thanks to their work, a detailed understanding of the cytology and genetic background of both wild and cultivated bananas has been built up. Great progress has been made in understanding the breeding behaviour of bananas and plantains and an impressive stock of improved diploids have been developed. These are now providing the building blocks for present breeding efforts. These breeders, through long and painstaking years of research, finally developed a first generation of improved, pest and disease resistant, high yielding varieties. Banana farmers around the world began to believe that 'something could be done' to address their problems. Rapid progress is now being made in producing an ever wider range of improved varieties. However, it is very clear that today's achievements are only possible through the dedication, hard work and commitment of our sadly missed friends. ■

Dirk Vuylsteke (1958 – 2000)

Dirk, a Belgian national, graduated from the Katholieke Universiteit Leuven (KULeuven) in 1981 with an MSc in Tropical Soil and Crop Science. He worked for some time at KULeuven on the development of a shoot-tip culture protocol for the propagation, conservation, and distribution of plantain germplasm and in 1982, he joined the International Institute of Tropical Agriculture (IITA) as an associate expert. Dirk's work on tissue culture contributed to the successful establishment at KULeuven, of the Musa Germplasm Transit Centre by INIBAP. Dirk also established an efficient micropropagation laboratory at IITA's High Rainfall Station and produced training manuals for Musa micropropagation and field handling of in vitro plants.

To increase the output of hybrids from the Musa breeding programme, Dirk developed embryo culture techniques for improved in vitro germination of hybrid seed. This technique soon proved to be a key instrument in the breeding programme for plantain and banana, which was initiated at IITA in 1987. The results of the research at IITA showed that segregation takes place in the triploid plantain genome during the modified megasporogenesis leading to a new concept for improving bananas and plantains, whereby a vast array of new genetic combinations is generated through relatively few crossing operations.

From 1991 to 1994, Dirk Vuylsteke led a team that succeeded in developing a range of black Sigatoka-resistant plantain and banana hybrids. For this, IITA was presented with the King Baudouin Award, the highest award bestowed on researchers in the Consultative Group on International Agricultural Research (CGIAR) system.

In 1994, Dirk was appointed as Team Leader of the newly established IITA 'East and Southern Africa Regional Center' (IITA-ESARC) in Uganda. As breeder, he took on the challenge of improving the East African highland bananas, a basic staple food crop in the Great Lakes region. The first hybrids are now being tested in Uganda to assess their value and further use in Musa breeding for this country and others in the Great Lakes region of Africa. Dirk managed a comprehensive programme for the genetic improvement of bananas and plantains and a new and very promising generation of hybrids, the secondary triploids, was created.

In order to make available to Musa scientists world-wide the most relevant parts of his two decades of research at IITA, Dirk's PhD thesis was published posthumously. This thesis provides a testimony of his innovative ideas and dedication for improving the Musa crop, particularly for African smallholder farmers. This PhD thesis, as well as Dirk's many other journal articles and book chapters, will be always a source of inspiration to his colleagues and the new generation of scientists involved in germplasm enhancement of research-neglected tropical crops.

In the words of Dirk Vuylsteke

"A broad-based, improved Musa germplasm with pest/disease resistance will be a major component to achieve sustainable production of this vegetatively propagated, perennial crop. Such germplasm can be produced through conventional cross-breeding, enhanced by the utilization of innovative methods for the introduction of additional genetic variation. Also, the increased use of molecular markers will accelerate the process of recurrent selection of improved Musa germplasm and, hence, facilitate the development of new hybrids. The prospects of banana and plantain breeding are unlimited and increased efforts will at once initiate a new phase of Musa evolution."

The last paragraph of the PhD thesis of **Dirk Vuylsteke**

Kenneth Shepherd (1927 – 2001)

During the more than 40 years that he dedicated to banana research, Ken Shepherd made an immense contribution not only in cytogenetics and improvement but also in taxonomy. In recognition of his immense contribution, Embrapa Mandioca e Fruticultura has recently named it's latest banana variety 'Pacovan Ken'

Kenneth Shepherd was born in England in 1927. His career in banana research started in 1950 when, as a 22 year old newcomer he arrived in Trinidad, appropriately enough, from a banana boat. He joined the banana breeding programme at the Imperial College of Tropical Agriculture in Trinidad, where for nine years, he worked closely with Norman Simmonds. Amongst other areas of research, Shepherd and Simmonds studied banana taxonomy, coming up with a new system of nomenclature for banana cultivars based on a scoring method to indicate the relative contribution from the parental wild species, Musa acuminata and M. balbisiana to the cultivar. The purchase of a new and advanced microscope encouraged a serious interest in cytology, which culminated in the publication in 1999 of his book 'Cytogenetics of the Genus Musa', published by INIBAP as a tribute to his work in this area.

In 1960 he transferred to the Jamaican Banana Board's breeding programme, where he created several genotypes including the hybrid M53. The latter was then added to the Embrapa genebank and was the origin of the variety 'Pacovan Ken'. During his period in Jamaica, a number of other hybrids such as 'Calypso', 'Bucanier' and 'Ambrosia', were also developed.

From December 1981 onwards, Ken continued his career in Brazil as a consultant with Embrapa, where he set up a banana breeding programme. Throughout his time spent at Embrapa, Ken played a vital role in the breeding programme, in particular by introducing genetic material from other countries, a complex, difficult task that was only possible because of his contacts and his credibility with the international bodies working on Musa. The first concrete result of his work in Brazil was the launching of the 'Pioneira' cultivar in 1992.

On his departure from Brazil in 1994, he left behind him a well-trained team capable of continuing the work on promising genotypes. One of these was 'Pacovan Ken', launched in November 2001 as a national crop plant. The new variety is not only more productive that the 'Pacovan' variety traditionally grown in the Nordeste in Brazil, but it is also resistant to yellow and black Sigatoka and to Fusarium wilt, the three curses of banana around the world. We shall always remember Kenneth Shepherd as a model of competence, modesty, abnegation, impartiality and altruism.

> "Perhaps the greatest problem of growing bananas in Brazil is the lack of productive commercial varieties, with convenient plant stature and resistance to the major diseases and pests, that satisfy the taste preferences of the vast majority of Brazilian consumers. The varietal improvement project led by EMBRAPA/CNPMF aims to address these constraints."
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> **Ken Shepherd** at the First meeting of the Musa breeder's network, held in Honduras, 1994.

Ken Shepherd (3rd from the right) looking at an improved hybrid banana bunch (C. Picq, INIBAP).

Norman Simmonds (1922 – 2002)

Norman Simmonds is probably most well-known as the author of every banana researchers reference book "Bananas" in the Longman Tropical Agriculture Series (1959, 1966 and with R.H. Stover in 1987).

Simmond's career spanned more than five decades, focussing on plant breeding, taxonomy, economic botany and tropical farming systems. His expertise on bananas, sugar cane and potatoes was particularly well recognised. Major collecting trips in East Africa and Asia and the Pacific during the 1940s and 50s allowed him to develop a deep understanding of the origin and spread of bananas. In 1955, together with Ken Shepherd, he created the genome-based system of nomenclature for cultivated bananas as an alternative to the Linaean system to reflect more effectively levels of ploidy and hybridization. In his lifetime, he published 48 scientific papers on banana alone, covering many subjects from genetics to the development of fruit and germination of seeds.

Norman Simmonds' inspirational impact on banana research will dominate for many years. He laid the foundations for a banana breeding strategy which still serves as a model. Norman was the promoter of the concept of 'broadening the genetic base' for improvement, and the method was applied with great success for sugarcane. He regretted that the concept, although widely accepted in principle, was in his opinion, not sufficiently applied in the field. With the advent of INIBAP, he perceived the great opportunity to see the concept applied for the improvement of bananas and plantains, the staple food of many people in the tropics.

Right until his last weeks Norman actively participated in agricultural research, regularly interacting with researchers and responding to new developments through his frequent letters published in journals. He made his disapproval of the investment in research on biotechnology well known. This outspoken voice will be missed by his many friends all over the world.

> "Twenty-five years ago few people even noticed that perennial plants (including bananas) were of profound socioeconomic importance to tropical subsistence farmers; nowadays awareness of perennials is creeping up on agricultural research systems. One symptom of this awareness has been the recent formation of the International Network for the Improvement of Banana and Plantain (INIBAP)… There is no more important science in the world than tropical agricultural research and we hope that the new 'Bananas' really will be of service, first to the researchers, and subsequently, their customers, the banana growers."
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> ***N.W. Simmonds*** writing in the Preface to "Bananas". Stover and Simmonds, 1987.

> "No other scientist has developed the broad in depth knowledge of the genus Musa. He also had a profound knowledge of crop physiology and genetics in general. It was a privilege and honour to have known him. His "Evolution of the Banana" will be the starting point for all studying bananas and banana breeding."
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> ***R.H. Stover,*** La Lima, Honduras, April 2002.

Reynold Gonsalves (1928 – 2001)

Ren Gonsalves, a Jamaican national, was born in Cuba in 1928. He graduated from Howard University, Washington, with a BSc degree majoring in biology. In 1952, he became Senior Station Master at the banana breeding station, Jamaica and was made Senior Plant Breeder in 1969. During his time as banana breeder, diploid breeding began at the Jamaica breeding scheme and, over the years a great number of crosses were made on an empirical basis. This exercise allowed some generalizations to be made on the available genetic resources and how they may best be used in the future. Following the worldwide spread of black Sigatoka and the decline in Jamaican banana exports, which was accentuated from 1980, genetic studies continued in Jamaica with the aim of finding lines to replace over-sensitive cultivars.

The breeding scheme developed in Jamaica was used to produce improved tetraploids that were: resistant to Sigatoka and to race 1 of Fusarium wilt; comparable to Cavendish clones in yield; better cooking quality than Cavendish clones; and in some cases, better performers under non irrigated conditions than Cavendish clones. Later, the emphasis was placed on the breeding of secondary triploids, with at least one variety showing good promise.

Ren's work made a considerable contribution to international Musa breeding and he participated in numerous international conferences and meetings. He was a prominent figure in the Regional Musa Network for Latin America and the Caribbean and his participation and input were much appreciated. At home, his contribution to agricultural development was also recognised and he was awarded the order of distinction at the rank of Commander for his contribution to Agriculture.

Phil Rowe and Ren Gonsalves (right) discussing banana breeding strategies (R. Jaramillo, INIBAP).

> "Mycosphaerella pathogens have perhaps become the agents most responsible for the near demise of the banana and plantain cultivars of the producing areas of the world. It is therefore necessary that varieties resistant to these pathogens must be bred to revive the food shortages of the world, especially those areas so dependant on banana and plantain as their staple diet."
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> ***Ren Gonsalves*** in Memoria de la Reunión Regional de INIBAP para América Latina y el Caribe, 1987.