Plant breeding

Plant breeding has existed in its most primitive form since the first farmers saved the seeds of their best plants from one season to the next more than 10,000 years ago. Over the centuries, this selection process has gradually become more scientific, bringing major improvements in the yield, quality and diversity of crops grown in Britain.

Plant Breeding Past, Present and Future

In the 19th century Gregor Mendel established the basic principles of plant genetics. He discovered that inherited traits are determined by units of material which are transferred from one generation to the next. The plant breeder's aim is to reassemble these units of inheritance, known as genes, to produce crops with improved characteristics. In practice, this is a complex and time-consuming process. Each plant contains many thousands of genes, and the plant breeder is seeking to combine a range of desirable traits in one plant to produce a successful variety.

How Does Conventional Plant Breeding Work?

Conventional breeding involves crossing selected parent plants, chosen because they have desirable characteristics such as high yield or disease resistance. The breeder's skill lies in selecting the best plants from the many and varied offspring. These are grown on and tested in subsequent years. Typically this involves examining thousands of individual plants for different characteristics ranging from agronomic performance to end-use quality. Developing a new variety can take up to 15 years for wheat, 18 years for potatoes, even longer for some crops. The scope of conventional plant breeding has increased with improvements in technology. In the laboratory, chemical and mechanical techniques are used to speed up the selection process and remove natural barriers to cross-fertilisation, for example between different crop species.

Progress in UK plant breeding

Cereal yields have increased up to 250% in the past 40 years as new crops, such as oilseed rape and maize, bred for UK conditions have brought quality improvements, e.g. wheat for bread making, barley for brewing and potatoes for crisping. But even with the help of more advanced technology, conventional plant breeding still involves the shuffling of thousands of genes from one plant to another. It may transfer the desired gene (or trait), but it may also result in the uptake of other unwanted characteristics which the breeder must then select out.

What is Plant Biotechnology?

The term plant biotechnology is increasingly used to describe modern breeding techniques which involve the latest advances in molecular biology. Crick and Watson's discovery of DNA's double helix structure in the 1950s held the key to cracking the genetic code which determines how all living things work. The tools of the biotechnologist, developed as a result, have increased the speed and precision of plant breeding techniques and widened the choice of characters for selection. Technology available today enables crop improvement to take place at the level of

individual genes. Genetic modification allows breeders to identify the single gene responsible for a particular trait, and insert, or delete or modify it in a plant variety. This enhances the precision of conventional breeding, and makes entirely new combinations of genes possible. Other applications of modern biotechnology have improved the efficiency of plant breeding. For example, 'genetic fingerprinting' allow breeders to identify plant characteristics without having to wait until the plant is fully-grown.

Farmers	disease and pest resistance, better weed control, drought and frost tolerance, novel crop
Food industry	better processing quality, longer shelf life, extended growing season, less chemical inputs
Consumers	higher protein foods, modified fat foods, higher vitamin produce, longer lasting produce
Environment	reduced agrochemical use, industrial crops, renewable fuel sources, drought resistant crops

Who Will Benefit from Plant Biotechnology?

Modern biotechnology has put the plant breeding industry on the verge of exciting new breakthroughs. It offers improvements in virtually every area of crop production and utilisation, with potential benefits to agriculture, the food industry, consumers and the environment. The world's population continues to grow. By the year 2040 there could be twice as many mouths to feed. The advances made possible through biotechnology will be essential to meet global food needs by increasing the yield, hardiness and diversity of crops available to farmers. Plant biotechnology offers further benefits in the form of non-food crops. Through genetic modification, it will be possible to develop industrial crops as renewable sources of medicines, industrial chemicals, fuels and even biodegradable plastics.

How is Plant Biotechnology Currently Being Used?

The use of biotechnology in plant breeding programmes has become more widespread in recent years, but in commercial terms the technology is still in its infancy. The table below summarises current developments in the genetic modification of major UK food crops.

Crop Modification

Maize	insect resistance, herbicide tolerance
Oilseed rape	modified oil, herbicide tolerance
Sugar beet	modified sugar content, herbicide tolerance
Wheat	modified starch, disease resistance
Potato	modified starch, insect resistance, disease resistance
Tomato	slower ripening
Apple	disease resistance, slower ripening
Field vegetables	pest resistance
Soft fruit	slower ripening

Are Genetically Modified Crops Safe to Eat?

In scientific terms the effects of genetic modification are much more precise and predictable than the wholesale transfer of genetic material through conventional plant breeding.

What are the Environmental Effects of Growing Genetically Modified Crops?

Some environmentalists are concerned that genes from genetically modified crops could escape and transfer to other species with unwanted consequences. For example, it is argued that herbicide-resistant crops could cross with weedy relatives to create a new strain of 'super weed'. In practice, since the reproductive systems of genetically modified and conventionally bred crops are identical, the behaviour of domesticated crop plants is unlikely to be affected by single gene changes. In ten years of worldwide field trials there have been no adverse reports of genetically modified crops spreading in the environment. Furthermore, resistance to weed killers has been available for decades in a number of conventionally bred varieties without causing any such problem. The development of genetically modified crops is viewed as more precise than conventionally bred crops - nevertheless the technology is subject to much tighter controls. In the long history of plant breeding, the strict regulations applied to the development and use of genetically modified crops is unprecedented. In both the laboratory and the field, each genetically modified crop must go through a rigorous process of monitoring and evaluation before it can reach the customer. Extensive and ongoing evaluation of genetically modified crops has shown that the technology presents no new food safety risks. Indeed, biotechnology will enable breeders to develop food crops with improved nutritional value and better keeping qualities. Enhanced disease and pest resistance will also reduce pesticide residues.

Further reading:

Advances in Plant Biotechnology - a study resource for A level and GNVQ students. 1996. FREE. Published by BBSRC/CEST, Polaris House, North Star Avenue, Swindon SN2 1UH. Telephone 01793 413 200.

The New Biotechnologies - opportunities and challenges. 1996. FREE. Published by BBSRC (as before). *Additional information on the use of modern biotechnology in farming and food production is available from the Institute of Grocery Distribution, Grange Lane, Letchmore Heath, Watford, Herts WD2 8DQ. Tel: 01923 857141.*

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