THE CROP THAT CAME IN FROM THE COLD

Transforming the cowpea, a staple African orphan crop

13

One of the lost crops of Africa

Cowpea – also known as black-eyed pea or field pea among other names – is one of the most important food crops in the semi-arid areas of Africa. It thrives in the Sahel and the dry Guinea savannahs, stretching in a great continental arc from Senegal in the west to Sudan and Somalia in the east, then reaching south into western Kenya, Tanzania, Zimbabwe and northern South Africa.

In all, millions of hectares are under cultivation, and tens of millions of rural poor depend on it for their subsistence and as a major source of protein. In many parts of Africa the crop is predominantly cultivated by women, both to feed their families and for the income it generates in local markets or from travelling traders. Roadsides in Senegal, for example, are dotted with women offering fresh pods for sale.

The plant is a drought-tolerant legume that can be grown even at high temperatures and where annual rainfall is as low as 300 millimetres per year. Commonly grown for its grain, which like all legumes is rich in protein, the cowpea also has protein-rich leaves that can be eaten raw or cooked. All round it offers an excellent source of nutrition for humans as well as for animals, as cowpea hay is valuable fodder. Like the great majority of legumes, it is also capable of fixing nitrogen from the air in its root nodules, which not only promotes growth, but releases the nitrogen to the soil as the plant dies back, making it available for the next crop.

With an annual production volume of more than 5 million tonnes – 94 per cent of global production – the cowpea is the most important legume crop in Africa. Most is consumed there as well, although it would have potential markets in Europe, Brazil and India were it not for the fact that production is inadequate, quality is not assured and internal demand is so high. Africa, then, could clearly benefit from increased yields through improvements such as better insect resistance.

Hungry insects

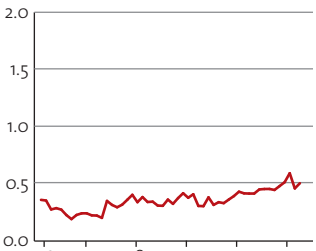
Over the past 30 years African breeders have worked hard to develop a higher yielding cowpea, and have in fact bred varieties with the potential to produce as much as 1.5–2 tonnes per hectare. But – even though yields have approximately doubled

KEY THEMES

- Importance of an overlooked crop.
- Transformative technology.
- Factors determining uptake.

Figure 13.1 Global cowpea yields, 1961–2012

Tonnes per hectare



Source: FAOSTAT

over recent decades – full potential yields are rarely achieved in the field because of immense losses to insect infestation (Figure 13.1).

The effective use of insecticides can increase grain yields as much as 20-fold. Indeed, unless farmers apply insecticides, in some years there is no pea yield at all; only the leaves are harvestable. But insecticides are not a good solution either. They are often not available, are too expensive for farmers to buy, are of low quality or just unsuitable for the crop, and farmers may not have the equipment or the knowledge to apply them safely.

The chief pests plaguing the growing crop are the *Maruca* pod borer, thrips, a few species of pod-sucking bugs and aphids. Then, after the cowpea is harvested and stored, it is under more attack from seed-feeding beetles belonging to the bruchid family. The cowpea bruchid can destroy a whole crop after just a few months of storage. Then there are non-insect pests such as bacteria and viruses that cause diseases in the plant, along with parasitic weeds that also decrease yields.

Constraints on the crop

In the face of these obvious pressures on the cowpea, why has its advance as a crop been held back? A variety of social, economic and policy constraints have been hindering development of the cowpea.

- Investment in agricultural research has generally been rather low in Africa compared to investment in urban and industrial infrastructure. Agriculture is regarded as relatively unexciting and the cowpea, being a crop of the poor – and of women – has seemed particularly unworthy of development.
- There is little international trade in the cowpea outside Africa, so it does not attract investment like those crops that promise to bring in significant amounts of foreign exchange.
- Although some of the tools of modern biotechnology have been deployed to improve the plant, the testing of genetically modified (GM) crops has been held back by the slow pace of biosafety legislation and an absence of regulatory processes, which are necessary for new varieties of crops to be tested, evaluated and grown in the field.
- International institutions have simply paid too little attention to this relatively minor crop.

Like the great majority of legumes, the cowpea is capable of fixing nitrogen from the air in its roots, where it produces nitrogen compounds that promote plant growth. When the plant dies, the fixed nitrogen is released, fertilising the soil for the next crop.

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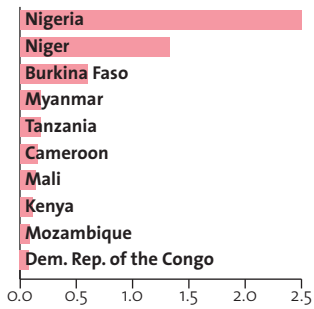
However, decades after the need was first recognised, insect-resistant cowpeas – developed by an international public-private partnership managed and coordinated

by the African Agricultural Technology Foundation (AATF) – are now expected to be available to farmers within a few years.

Figure 13.2 Top ten cowpea producers, 2012

Million tonnes



Source: FAOSTAT

How the cowpea has been transformed

Stage one: Some 20 years ago a group of researchers saw a need for a genetically transformed cowpea. Other scientists along with African cowpea breeders agreed. A meeting was held in Dakar in 2001 and the Network for the Genetic Improvement of the Cowpea for Africa was set up, supported by a number of other institutions.

Stage two: The search began for a method to transform the cowpea. The new technology focused on introducing resistance to the *Maruca* pod borer, which can reduce yield by more than 50 per cent, and to the bruchid beetle *Callosobruchus maculatus*, which does severe damage during storage.

Stage three: It was known that sprays of *Bacillus thuringiensis* – *Bt* – could control *Maruca*, so the researchers used a synthesised version of a gene from this naturally occurring soil bacterium that could be expressed – switched on – in the crop host. The protein encoded by the gene was designed to kill MPB caterpillars and larvae and confer protection to all parts of the growing plant.

Stage four: The gene was incorporated into a carrier – a DNA vector – derived from a bacterium that would be capable of taking sections of DNA into the plant's cells where it was incorporated into the plant genome in the nucleus. Once integrated, these genes were passed on to succeeding generations. Thus transfer and regeneration were achieved, which is termed transformation.

Stage five: Research is now continuing on this transformation in several laboratories. Scientists are currently putting the transformed plants through stringent selection procedures in order to find the most suitable parents for a breeding programme. Field trials are being carried out in Sub-Saharan environments: so far four have yielded promising results.

Making the innovation acceptable

Several issues have to be addressed before the new crop – if and when it becomes commercially possible – is widely accepted.

The cowpea appears to have originated in the Horn of Africa before spreading to the west of the continent. Any potential danger of gene flow from the GM varieties

to wild cowpea species needs to be built into risk assessment procedures. In addition, the question of movement of *Bt* cowpea across national borders needs attention during any safety assessment prior to its commercialisation. The new crop needs a roadmap to ensure proper insect-resistance management and safe use.

In sum, there has to be a sound regulatory system in place under which *Bt* cowpea can be grown in the field. If harmonised at a regional level this would go a long way to meeting any transboundary problems, and steps are currently being taken to ensure that such a system will be put in place.

Public awareness

There is still ambivalence towards GM crops among the general public in Africa, despite the efforts of some African heads of state to promote the new varieties. Some resistance may be an overhang from Africa's European colonial past, which could still be causing antagonism towards these technologies.

Those GM crops being evaluated in confined field trials are the subject of much dialogue and public debate. Some progress in addressing concerns is being made by the Open Forum for Agricultural Biotechnology in Nigeria, Kenya, Uganda, Egypt and, to a lesser extent, Tanzania. If *Bt* cowpea is shown to be effective in controlling yield losses due to insect infestation and to be successfully grown by smallholder farmers in the next five years or so, like all GM innovations it will need appropriate, responsible and cost-effective regulatory systems, strong political will and continuing provision of varieties of crops that meet the needs of the relevant countries in Africa.

Importance of seed systems

Widespread adoption of *Bt* cowpea will depend critically on having effective seed-growing and distribution systems in place, and on developing agricultural extension services to provide advice on cultivation.

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Cowpeas tolerate poor sandy soils and can grow in the shade, making them an important component of traditional intercropping systems.

West Africa has to build a workable system to ensure access to seed, comprehensive quality control and competent stewardship. The improved cowpea has to be affordable for smallholder farmers and reduce poverty while increasing food and income security. Some help may well come from governments and other donor agencies but, ultimately, for true sustainability, the solutions will have to be those that enable the many millions of smallholder farmers to become financially self-reliant by selling at least some of their harvest so that they can reinvest in future crops.