Zimbabwe: Exploitation of Biotechnology in Agricultural Research

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Zimbabwe is a small country (390,000 square kilometers) with a population of 12 million. Agriculture and mining are the pillars of the Zimbabwe economy, with limited industrialization to add value to products. The main sources of revenue for Zimbabwe are agricultural products and mineral export. The leading contributors to GDP are tourism, tobacco, gold, ferroalloys, sugar, and nickel.

Zimbabwe's main agricultural products are tobacco, maize, cotton, and soybean. Maize is the staple food crop, and tobacco, cotton, and soybean are cash crops. Tobacco farmers have established a sustainable support system that ensures their success. The farmers have instituted a levy system whereby they raise money to support tobacco research, which is under the oversight of the Tobacco Research Board. Earlier funding from Government has essentially been replaced by levy funds from stakeholders.

The tobacco industry Kutsaga Research Station has laboratories where scientists work on improving tobacco breeding, pathology, and other areas using biotechnology. The farmers get good yields of tobacco leaf, and market it at the Harare Tobacco Auction Floors from April to October. Harare boasts the largest tobacco auction floors in the world.

Agriculture is reasonably developed in Zimbabwe. The two major farming groups are the commercial farmers, and the smallholder farmers largely in villages. The main divisions of farming are crop and animal breeding. The main constraints to Zimbabwe agriculture are the unpredictable rainfall patterns and the high cost of fertilizer.

About 90 percent of crops are grown under rainfed conditions. There are limited provisions for irrigation, largely on commercial farms. There is increasing donor interest in supporting dam construction in village areas to improve the agricultural performance of resource-poor farmers.

Maize Cultivation

There is a strong desire to improve the agricultural performance of Zimbabwe. Considerable research has been done by the Department of Agricultural Research and Specialist Services over many years in developing hybrid maize using traditional crop breeding techniques. Zimbabwe hybrid maize seed is grown in most of the Southern African Development Coordination Conference (SADCC) countries. The different hybrid varieties are now bulked and marketed by Seed Co., a local seed company. In recent years the sales of Zimbabwe hybrid maize seed encountered increasing competition from imported maize seed marketed by Cargill and Pioneer Hi-Bred.

The patchy rainfall patterns in recent years have heightened awareness of the need to develop drought-tolerant crop varieties. Conventional plant breeding through pollen transfer is time consuming. It generally takes about 10 years to fully develop an improved hybrid maize variety. The slowness associated with conventional maize breeding is due to the number of genera-

tions required to cross, select, and evaluate new progenies.

Efficiencies in conventional breeding are only acquired from long experience working with a particular crop. The experience enhances a breeder's efficiency in developing a maize variety that gives higher yields in a targeted farming area.

Using conventional maize breeding, the records show that U.S. maize yields were increasing at an annual rate of 1 percent. Half of this gain was from improved plant breeding, and the other half from improved management practices.

In the 1997-98 growing seasons U.S. farmers planted 32.6 million hectares of maize, and got an average yield of 8.1 metric tons/hectare. The total production was 263 million metric tons. During the same period, the whole of sub-Saharan Africa planted about 22 million hectares of maize with an average yield of 1.2 metric tons/hectare. Total annual maize production in sub-Saharan Africa is 26 million metric tons. These low yields frequently result in food deficits.

African farmers need to improve these low maize yields, by improving management practices and having access to the best available maize breeding technology. Biotechnology offers the best opportunity to increase maize yields. It also offers opportunities to develop new crop varieties with desired characteristics more rapidly than conventional crop breeding.

Biosafety Considerations

The United States has led in field trials of genetically improved (GI) crops (14,153 trials from 1986 to 1997). Canada had 3,747 trials during the same period. South Africa has done significant field testing of some genetically improved crops.

Dominant traits introduced to transgenic crops include: maize and soybean tolerant to glycophosphate herbicide; insect-tolerant Bt maize and Bt cotton; virus-resistant tobacco; late-ripening tomato; and herbicide-tolerant canola. These transgenic plants have been transformed by the introduction of new genes. The general safety concern about transgenic crops is: Will the gene and its protein product transform the crop into a new variant with harmful properties to the environment? This concern relates to other crops and live forms in the ecosystem.

There is no evidence to date of demonstrated risk in the presently available genetically improved crops that should cause concern. The approvals for commercial use have only been granted after field evaluation to satisfy biosafety requirements.

There might, in a few cases, be reason for concern that the field evaluations have not always been exhaustive. There is some evidence, for example, that the monarch butterfly may be damaged by Bt maize, in laboratory experiments.

There needs to be careful assessments of benefits and risks, and monitoring of the behavior of genetically improved crops in the environment, so as to identify any unintended impact on the ecology.

Biotechnology in Zimbabwe

In the early 1980s biotechnology education was expanded through a masters degree at the University of Zimbabwe. A number of graduate biotechnology specialists are now working in agricultural and pharmaceutical biotechnology laboratories, food processing companies, and medical research institutions in Zimbabwe. The Zimbabwe Biotechnology Program, especially its capacity-building component, has benefited considerably from funding by the Dutch Government, SAREC (Sweden), and the Rockefeller Foundation.

Maize Biotechnology

The government has established a Biotechnology Research Institute (BRI), which is one of seven under the Scientific and Industrial Research and Development Centre (SIRDC). The major project in BRI is maize research carried out in collaboration with CIMMYT. The main priority is to develop a drought-tolerant maize strain. This project is at an advanced stage.

Large biotechnology research laboratories have been built for a long-term maize research program. We are seeking international research funding and hope to attract international maize research specialists to spend periods of time in the laboratories. So far we have a team of four molecular biologists and two breeders. We are also pursuing research on sweet potato, mushroom, and cassava, to exploit their potential as both food and cash crops.

Zimbabwe's Biosafety Regulations are to be gazetted as Statutory Instrument 1999 by the Zimbabwe Government. A Biosafety Board has been established to oversee the conduct of biotechnology in Zimbabwe. Intellectual property rights in biotechnology provide an environment that meets the prevailing international statutes.

Biotechnology in its broad sense does not always have to involve genetic engineering. In Zimbabwe micropropagation technology has been used to generate seedlings of root tuber crops (sweet potato and now cassava and banana) and make them available to resource-poor farmers.

Biotechnology in Agriculture and Medicine

Biotechnology has so far had its greatest impact in medicine. Its application in making recombinant vaccines and recombinant insulin for treating diabetes has been a great success. The applications of biotechnology to agriculture could be equally as powerful.

It is appreciated that genetic engineering can be used to make a number of unique products. Those of us in the field have a responsibility to apply it in ways that benefit human existence and the environment.