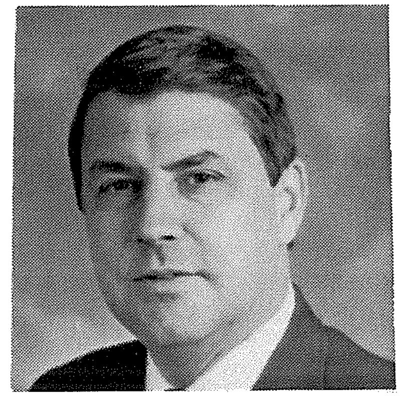
John D. Kemp is the director of the Plant Genetic Engineering Laboratory and a professor of plant pathology at New Mexico State University. As director of PGEL, he oversees about 50 faculty members, technicians and students. In 1983, the first successful recombinant DNA transfer was performed under Kemp's direction at the University of Wisconsin and Agrigenetics Corporation. This experiment proved for the first time that a plant gene could be transferred into and expressed in a distantly related species. Kemp received a B.S. in chemistry and a doctorate from UCLA. He is a member of the Water Resources Research Institute's Program Development and Review Board.



NEW PLANTS FOR THE 21ST CENTURY

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The Plant Genetic Engineering Laboratory (PGEL) is one of five original Centers of Technical Excellence established in 1983 in New Mexico. The state legislature was quite farsighted in identifying plant genetics, plant genetic engineering, and biotechnology as the future of agricultural technology. Since that, time virtually every state in the union has created some type of biotechnology program, many of which are based on what was initiated here in New Mexico. The mission of PGEL is fairly simple: develop basic and applied research programs in plant biotechnology emphasizing agriculture for semiarid lands and New Mexico.

Plant genetic engineering can be defined as using the new tools of biotechnology to improve plants; the tools may be new, but man has been improving plants for probably 10,000 years. We have been improving plants ever since we stopped our nomadic wanderings across the face of the earth and settled into communities. We could stop being nomads because we made a fundamental scientific discovery 10,000 years ago. Although the discovery seems quite simple today, it was very profound then. Man was wandering across the face of the earth gathering seeds and using those seeds as a source of food. What man discovered so long ago was that he could place some of those gathered seeds in the ground and a plant would emerge. That plant would provide more seed of the same kind. Suddenly, man did not have to wander on the face of the earth gathering seed for food. Instead man could grow crop plants in one location and settle into communities. We then carried the concept one step further and began selecting those plants best suited for our needs. Hence, we became true genetic engineers. A photograph of a tomb in Thebes, Egypt, around 4000 B.C. shows a man standing next to wheat of a uniform height about shoulder high so it could be sickled by hand. Other paintings from that era reveal that flax and hybrid fig trees were also being cultivated and selected for desirable characteristics.

An example a little closer to home can be found near the Organ Mountains outside of Las Cruces. Some of the oldest hybrid corn in the world has been discovered in 4000-year-old archeological sites at the base of the Organ mountains. Over the last 3000 to 4000 years, man has made tremendous improvements in corn beginning with teosinte and ending today with the famous high yield midwestern Dent corn.

Though man has been a genetic engineer for perhaps 10,000 years, the early technology that man used was rather simple. It involved making a genetic cross by taking the pollen from one plant and placing it in female parts of another plant. Then the ripe seeds of the cross were gathered and the plants that emerged from those seeds were selected for desirable characteristics.

George Mendal was a scholar who revolutionized our understanding of these processes by teaching us that genes are little packets of information that can be transferred in a predictable manner every time a cross is made. This knowledge break through allowed us to continue on to the sophisticated breeding programs that we have today.

The next breakthrough in the technology of genetic engineering came perhaps 40 years ago when we discovered genes are made up of a chemical - DNA (deoxyribonucleic acid). With that discovery, we suddenly had available to us a way of isolating genes as pieces of DNA. The difference between genetic engineering using traditional breeding versus using DNA techniques is that in a traditional breeding experiment you are limited to making a cross within a species. In other words, only males and females of the same species can breed. Therefore, if a particular trait is not within the species of interest, we do not have access to that trait using traditional breeding programs. However, if you can isolate that trait as a piece of DNA, you have the potential of moving that DNA into any species. That is the power of this technology, for it expands our gene pool from the species to virtually the living world. Two examples of this type of work is being conducted at PGEL. The first project deals with improving cotton by genetically engineering pest tolerance into this crop. A serious pest problem in cotton is the boll worm. This worm feeds on the cotton boll and destroys it. Our normal procedure for controlling the worm is to apply chemical pesticides. This is a very costly procedure and environmentally unsound. Soon we may have an alternate strategy. Recently, we were successful in isolating a gene from a bacterium that produces a biologically controlled agent that kills the boll worms. We also have been successful in transferring that gene as a piece of DNA from the bacterium into tomato plants. The gene in the new plant species is stable and perfectly functional. The plant is now protecting itself against those pesky insects. In the near future, cotton farmers will also realize an economic savings by having this protection gene in cotton. Furthermore, the environment will benefit as well with less reliance on chemical pesticides. Recently, we have identified a second gene we think will protect cotton against the boll weevil, an organism that has plagued cotton farmers for a 100 years. Currently, the boll weevil has not arrived in New Mexico but it will not be long before it does. We just hope it does not occur before the 21st century because it will take us that long to fully develop the new technology.

Another problem I see on the horizon is nematodes. These microscopic worms are potentially an enormous economic catastrophe on plants. Billions of dollars in crop loss occur each year because of nematodes. They may soon become a significant problem in this state especially in chiles and potatoes. We can apply pesticides to control them, but nematocidal chemicals today are among the most environmentally persistent and the most toxic of all the pesticidal chemicals. As a result, the federal government has removed from use all but a very few, and if it is necessary to remove the remaining one or two left on the market, many of our crop plants are going to be vulnerable to devastation by this worm. The alternative is to use a naturally occurring enemy of nematodes. At PGEL, we are investigating the potential of using a biological compound that kills nematodes by dissolving its skin. We are in the process of isolating the gene and transferring it to plants to see if indeed that gene will allow plants to protect themselves by killing any invading nematodes. This is another example of biological control making our plants resistant to many of the pests that we can only control today using chemical pesticides.

The economic impact that this technology will have on New Mexico agriculture can best be illustrated with the two projects I have just discussed (insect resistance and nematode resistance) plus our liquid wax project which I did not have time to cover. Together, these three projects will have a $237 million per year impact on the state's $1 billion agriculture business, an increase of over 23 percent. Gross cash receipts will increase nearly $76 million per year from the current $300 million. However, the biggest impact will occur in net farm income which will increase by $63 million per year from its current level of about $50 million. This is an incredible 129 per cent increase! We believe that the future for engineering our crop plants is very bright and exciting. The new tools of biotechnology will expand our abilities beyond our wildest dreams. It will not come in the next year or so and it will not be cheap, but maybe with your support and the continued success of programs like PGEL, we will see practical results by the turn of the century.