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ROLE OF U. S. PUBLIC RESEARCH SCIENTISTS IN SOLVING DISEASE AND NEMATODE PROBLEMS IN COTTON

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There are various opinions about the role of Public Research Scientists in providing solutions to disease and nematode problems in cotton. What I have to say today is my opinion. You may not share my views; however, I believe they have merit so I will present them to you.

Most of the cotton acreage in the US is planted to cultivars developed by commercial seed breeding firms. Growers today want, or are buying, cultivars with transgenic insect or herbicide resistance genes. With these they can have a much simpler production system. Thus, nearly all the acreage is planted, and I think will continue to be, planted to cultivars with one or more transgenes. All these transgenes are presently owned by industry. However, it would not change the needs or preferences of growers if public institutions owned some or all of the transgenes.

The global acreage of transgenic crops has increased from 4.3 million acres in 1996 to 109.2 million acres in 2000, (James, 2001). In the US the cotton acreage planted to transgenic cotton increased from 55% in 1999 to 72% in 2000 (James, 2001). In 1995 the estimated value of the global transgenic seed market for all crops was $1 million, and in 2000 the figure was $3.044 billion, (James, 2001, from source; Wood Mackenzie Agrochemicals Services 2001).

The fact that most cultivars planted today are transgenic has a profound effect on cultivar development and on the role of Public Research Scientists. A cultivar does not last long in the market today. For example, Monsanto has a new Bollgard II system. As I understand the situation today, companies using Monsanto technology will soon be offering for sale (perhaps in 2003) cultivars with Bollgard II. When these new cultivars come to the market growers will have little experience with them. Monsanto is also working on a new Enhanced Roundup Ready technology that seed breeders will soon add to the Bollgard II cultivars. Thus, about the time growers have one or two years experience with Bollgard II cultivars they may be offered new cultivars with Bollgard II technology plus Enhanced Roundup Ready technology. Thus, another new round of cultivars will be on the market and again growers will again have little experience with these when they are offered. The same scenario applies to other companies also.

What this has meant for the past six years, and is likely to mean for the future, is that a cultivar is sold for only a few years. Thus, cultivar development is driven by the need, desire, or the opportunity afforded by technology genes. I don't see this changing in the foreseeable future. It does not matter if cultivars are developed by industry or by public scientists, the same thing will happen. As technology develops new genes that are desired or useful to growers these genes will be bred into new cultivars, thus relegating the accepted cultivars to obsolesce. There are some who think that if Public Research Scientists were developing cultivars for growers, most of the present day problems with new cultivars would be solved. I do not believe that the result of development of cultivars by public research scientists would be any different from development by commercial plant breeding companies.

The present system is moving cultivars to market faster than ever before. We need to understand that this represents a "sea change" in cultivar development and find ways for Industry and Public Research Scientists to cooperate in a manner that insures that U.S. growers have the best cultivars available in the world. We need to devise ways to provide growers with as much information as possible about the ever changing scene of new cultivars. A task force of public and private scientists should be able to devise ways of cooperating together to provide growers with as much information as possible on each new cultivar. We must devise ways to insure that these cultivars have superior yield and fiber properties, plus the best technology traits available in the world. This is the only way the U.S. cotton grower is going to survive. Our best competitive tool is quick access to the best technology in the world. This includes breeding of transgenic cultivars and they of necessity are going to be short lived and thus, new cultivars will continue to quickly come to the market place. The net effect of this is that cotton breeding has fundamentally changed and I don't think it will ever go back to the old ways.

Before the biotechnology days there was no reason to offer a new cultivar to the grower unless it was higher in yield, or had better fiber, or better stability than the ones being presently grown. It took a long time to develop a cultivar that could offer more than presently grown cultivars. Contrast this with today when technology genes are available. For example, if a new herbicide resistance gene was developed that would offer season long, over the top application, of a broad spectrum herbicide, that controlled the major weeds in cotton, it would only take one year for this to be demonstrated and for growers

to grasp the significance of this new technology. Growers would immediately want, or demand, this new technology gene in the cultivars they plant. Breeding companies would immediately see the opportunities for cultivars with this new technology trait. Thus, new cultivars would be developed, but their development would be driven by opportunity afforded by the new technology gene. The seed breeding company and the grower each respond to this new opportunity for profits in the market place. The producer is just as interested in profits as is the seed company. With ELISA or other tests for the gene, the seed company can be sure that the gene of interest is in the cultivars they offer for sale. The grower wants the new technology gene, yet he also wants the desirable traits of the old familiar cultivar.

Thus, new cultivar development is driven more by technology genes than the other traits the grower wants and needs. This is not the fault of anyone, it is just the "facts of life". If the company spends too much time getting everything in the new cultivar exactly right, plus including the new technology gene(s), the grower will no longer buy their new cultivar because better ones, especially from a technology standpoint will already be on the market from another company. As of now, the agriculture community is on notice that the old slow years and ways of developing cultivars are gone forever. Seed breeding companies recognize this, but many Public Research Scientists do not. This is the new reality of the market place and no amount of wishing or whining will change this. Public Research Scientists must devise creative ways to cooperate with the seed breeding industry to provide growers with the best information and the best cultivars. It is important to recognize that it does not matter if public or private breeders are developing the cultivar, technology will still drive new cultivar development.

I now will discuss recommendations for the role of Public Research Scientists.

First, Public Research Scientists should recognize that they as well as private industry have something to offer, but each has different roles to play in providing solutions. Resistant cultivars are the best approach to all nematode and disease problems, except perhaps seedling diseases.

Second, Public Research Scientists should recognize that cooperation is better than competition with private industry in cultivar development. It is not our job to develop competing cultivars for the market place. Public Research Scientists can develop unique roles thru cooperation if we use imagination and creative thinking and germplasm development.

Third, Public Research Scientists should recognize their unique role, opportunity, and responsibility to be of service and value to growers and other taxpayers. As a public research scientist we each should realize that we work for the taxpayers and that includes all the taxpayers. Unfortunately some Public Research Scientists do not want to accept this fact. *We are public servants. We need to find ways to serve the public and cotton growers in this rapid pace cultivar development environment.*

Fourth, Public Research Scientists should recognize that there has of necessity been a fundamental change in how cultivars are being developed. We should devise and create ways for us to make major contributions to future cultivar development via germplasm development and cooperation with the seed breeding industry to quickly bring the best cultivars to market for our growers.

At this point I will consider the specific disease and nematode problems that are the focus of this symposia. I note the following: Of all the diseases discussed today only the nematodes, in my opinion, are actually reducing yields on major acreages.

1) The Wilts. We first need to make a collective judgment on whether these wilts are presently causing adequate losses to be of concern. Private seed companies know how to breed for resistance to verticillium and fusarium wilt in cotton. We have, or did have at one time, cultivars with adequate tolerance to each of these diseases for most of the cotton belt. If public researchers have any present responsibilities with these diseases it may be to develop marker assisted selection technology so that breeding companies and growers can quickly know when the new cultivars have the needed level of resistance to these two diseases. Public Research Scientists may also need to devise ways to provide ratings for wilt susceptibility on new cultivars before they are sold to growers. This would mean forming a cooperative relationship with the seed breeding industry for early access to experimental lines. This would probably mean developing some type of Regional Evaluation Nursery for Verticillium and Fusarium Wilt for experimental lines and cultivars developed by Industry. Also a means of quickly making the results available to growers will need to be used. Innovative and creative thinking will be required to accomplish this.
2) Considering seedling diseases, I believe the use of fungicides is the most economical means of controlling these diseases. The role for public research scientists should be to develop, or work with industry to evaluate, new products for seedling disease control. It is not very likely that genes for resistance to all the various fungi causing seedling disease can be found and utilized in an effective breeding program given today's scenario for cultivar development.

3) Bronze Wilt. *The control for bronze wilt is known!!! Avoid the germplasm that carries the susceptibility gene or genes!!!* There is probably some role for a modest investment by public research scientists in determining the causal agent and etiology of the disease. However, this will not offer a better means of control. We already know how to make this problem go away. Money presently being spent on this problem could be more wisely spent on developing controls for more important diseases and nematodes.
4) Bacterial Blight: We have good genes for bacterial blight resistance and know how to breed for them. The role for public research scientists is for one scientist or institution to curate the known races of blight and supply inoculum, if there are breeding companies who wish to screen their lines. Alternately one scientist could evaluate all new cultivars for blight resistance. Acid delinted seed has already solved most of the problems in the U.S. so there may not be any need for Public Research Scientists to do anything with this disease.
5) Root-knot nematode is a major problem in parts of the U.S. cotton belt and we do not have any highly resistant cultivars. Public research scientists have found genes that essentially provide immunity. These genes have been given to the private seed breeding industry; however, they have not fully used these genes. We know why they are not being effectively used. We don't have a good selection technique for root-knot nematode resistance genes. My laboratory has been in the forefront of the development of these genes, yet we have not provided industry with a marker assisted selection technology to use these genes. The major role for public research scientists should be to develop marker assisted selection technology for root-knot nematode resistance genes that is useful in a commercial breeding program. This has proven to be a very challenging problem.
6) Reniform nematode is a major pest in several areas of the cotton belt. Losses are estimated at 300 to 400 pounds of lint per acre in highly infested fields. Clearly Public Research Scientists have two fold role to play here. These are to 1) find genes for resistance and 2) develop marker assisted selection technology that is useful in a commercial breeding company. A commercial breeding program can use a highly infested field to select for tolerance but this needs to be coupled with marker assisted selection for genes for high resistance to make the maximum progress. Because of the high reproductive potential of this nematode we need a high level of genetic resistance to be successful.
7) Columbian and lance nematode are developing into a greater pest in the southeast than a few years ago. This needs to be addressed by Public Research Scientists in a fashion similar to reniform nematode.

How well are we as Public Research Scientists accepting these responsibilities? I looked over the list of presentations for the entire disease conference. I noticed that nearly all papers are being given by Public Research Scientists. The titles of papers in this program tells me what pathologists and breeders think are their roles as Public Research Scientists. However, I saw very few papers (5 of 33) that I would consider to offer solutions to real problems. I think Public Research Scientists need to consider what I have outlined as our responsibilities and work more in these areas. *The Public Research Scientist has a responsibility to solve problems in cotton production. Otherwise he or she is not needed by the taxpayers or growers. This is an easily understood mission, but not often heeded.*

If I am a Public Research Scientist and the research that I am doing is not contributing directly to solutions for the major disease and nematode problems, then I should ask, w*hy are the cotton growers and taxpayers keeping me on the payroll?* We need to return to a concentrated and cooperative approach to solve problems for cotton growers. We surely have enough problems to keep all public research scientists busy for several years. With an active and creative approach to solve real disease problems we will do enough highly creative and publishable research to keep us interested and perhaps to also make some of us famous.

I ask you to look over the list of papers at this disease conference and rate each paper. Is the research being reported highly likely to provide solutions to important cotton diseases, or does it simply reflect the personal interest of the particular scientist, or reflect the current hot topic, that incidentally, may or may not be, important in the grand scheme of things. Or does it reflect a grant that the scientist has from a company for research on a product that is not going to offer a better solution than we already have?

As a Public Research Scientist have you continued to do the same thing year after year and still haven't solved the problem? I only counted 5 of 33 papers in the disease conference as possibly contributing to solutions for important disease and nematode problems for cotton growers. What I am suggesting is that Public Research Scientists must stop doing most of the routine things we are now doing and start doing some of the very difficult things that will lead to solutions to real and important disease and nematode problems. *We are public servants. We need to find ways to serve the public and cotton growers in this changing and challenging cultivar development environment.*

When you as a Public Research Scientist have worked for 10 years, the taxpayers have, as a minimum, one million dollars invested in you and your research. A more likely figure is $2.5 million. Ask yourself the question, have the taxpayers made a good investment in me? Have I provided any solutions that have solved a cotton production problem? If your answer is no,

then why do the taxpayers continue to pay you? Are all the disease and nematode problems already solved? I think not. We owe an honest and creative approach to our growers and other taxpayers who pay our salary.

A good definition of insanity is "continuing the same behavior yet expecting the results to turn our differently". For example, are 10 more years of Telone and Temik research highly likely to provide a better solution to the reniform nematode problem? I think not. If not, then why will Public Research Scientists continue to do 10 more years of these experiments? Unless someone with authority accepts the responsibility to stop them, these experiements will continue. I ask, why do one more year of these same type of experiments? A rational person would conclude that to obtain different results we must change our behavior, i.e. conduct different experiments. To expect a change in results while continuing the same behavior is like watching reruns of the game where the home team lost, but after 25 reruns we decide to watch it one more time, and place a bet that this time the home team will win the game. That's insanity. Are we doing a similar thing in our research program?

So, I have now given you my ideas of the role of Public Research Scientists in solving disease and nematode problems. I believe these ideas should challenge us to stop doing the same experiments year after year and adopt a problem solving approach in our research, i.e., do something different that will provide solutions.

I don't believe I am alone in these views, nor am I naïve enough to believe that all, or most, of you agree with me. The road to solutions is usually long, difficult, and lonely, but the rewards are many to those who accept the challenge. *We Public Research Scientists need to accept the challenge to provide solutions to real problems or quit accepting our paycheck from the taxpayers under the pretense of providing solutions.*

References

James, Clive. 2001. Global review of commercialized transgenic crops: 2000. International Service for the Acquisition of Agri-Biotec Applicatons. Nov. 23, 2001. 110 pp.