

Staff Paper

Identity Crisis: Land Grant Research in the Biotechnology Era

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by

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”It is further the policy of the Congress to promote the efficient production, marketing, distribution, and utilization of products of the farm as essential to the health and welfare of our peoples and to promote a sound and prosperous agriculture and rural life... It shall be the object and duty of the State agricultural experiment stations...to conduct original and other researches, investigations, and experiments...including researches basic to the problems of agriculture in its broadest aspects, and such investigations as have for their purpose and development and improvement of the rural home and rural life and the maximum contribution by agriculture to the welfare of the consumer...” (The Hatch Act)

Land Grant Colleges and Universities (LGCUs) are experiencing an identity crisis. This identity crisis is most evident in agricultural research, where privatization is raising questions about the public-good nature of agricultural research, where the delivery of product to the consumer as originally stated in the Hatch Act of 1887 is hampered by increasing protection of intellectual property, and where there is no clear vision as to how 21st century agriculture is supposed to look. How can LGCUs maximize the contribution of agriculture to the improvement of rural life or consumer welfare if there is no clear vision?

Lack of leadership is just one reason why LGCUs are in an identity crisis. The response to this crisis from some of the elder statesmen of agricultural policy is to yearn for the days of long ago when one was responsible only to a few producer groups. We know that day is over. The definition of agriculture has broadened, many farmers do not belong to producer groups, and our customer base has expanded to include the global community. The art of leading an LGCU has been demoted to playing

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politics instead of seeking ways to maximize the public's welfare. Leading an LGCU is not a job for a politician; however, will we allow it to be? Who in the system is thinking through what an LGCU should look like in the 21st century?

The advent of biotechnology has further complicated this crisis and has changed not only what is deemed as public research, but also the role of LGCUs as providers of public agricultural research. It is hard to overestimate the importance of the ag-biotechnology effects on LGCUs. The public invests in LGCU research efforts; however, it is unclear what they get in return, particularly when innovations are patented, contracted with a private firm or otherwise legally protected. This begs the question, if the public were to start from scratch and design a land-grant system for the 21st century, would this system resemble its current structure? What is the LGCU's role in the ag-biotechnology era? Still struggling with the answers to these questions, the LGCUs are in an identity crisis.

This paper examines the identity crisis with respect to agricultural research and addresses the influence of ag-biotechnology in the LGCU's. The paper has two objectives: 1) to define the nature of the identity crisis with respect to ag-biotechnology, and 2) to make recommendations for how 21st century agricultural research can address the underlying issues of this crisis.

Background: Pressures on LGCU's

The Land Grant Mission

The Land Grant Mission, the essence of the land grant university system, is that LGCUs:

apply research, teaching and outreach to address the important practical problems of society and make those resources broadly available to members of society regardless of their social status. Land grant universities thus have the mandate to: (1) assure citizens access to higher education regardless of their socio-economic status; (2) provide instruction in areas of knowledge that students will need to serve the broad needs of society; and (3) reinforce democracy through programs of education, research and outreach that respond to societal needs, with special regard to the problems less likely to be addressed adequately by the private sector. (Tefft et al., 1999)

Knowledge generated from LGCUs through strategic research to enhance agriculture, natural resources, families, and communities is, in essence, the public's domain. As we look to the future, the LGCU mission is being jeopardized by the move toward protecting intellectual property rights (IPR) and by LGCUs partnering with private industry. This is particularly true when ag-biotechnology is considered. By partnering with large private firms, what are the implications for the smaller players in the agri-food system? This is an important question in light of the dramatic increases in concentration that we are witnessing.

The Funding Problem

Part of the LGCU confusion is the search for a healthy balance between mission and money. Nominal public expenditures for research have been fairly flat since the early 1980's and increasingly so in the early 1990's as shown in Figure 1 (Alston and Pardey, 1996). In real dollars, funding for public R&D has declined. Private sector expenditures on agricultural R&D have increased at a faster rate than public sector expenditures; however, they are growing at a slower rate in the 1990's than in the two previous decades. Figure 2 illustrates the sources of nominal public research funding. The primary funders of LGCUs, the states, have marginally increased their annual budgets. The federal government, the second largest source of public research funds, has continued the same slow-growth funding trend since 1975. The private sector, however, continues to increase funding for public research at a rate nearly 1.5 times that of the state and federal government

The stagnation in public support for R&D has pressured universities to contract with private industry. This pressure is both explicit, as in the Bayh-Dole Act, and implicit in the need to seek funding to maintain program quality. For example, the University of California, Berkeley recently signed a 10 year - \$25 million contract with Novartis that allows Novartis the first right of refusal for all ag-

biotechnology innovations (Rosset and Moore, 1998; Burrell, 1998). Most LGCUs have links with private industry, but none as dramatic as the Berkeley case. More generally, anecdotal evidence suggests that the public sector is spending most of their money on salaries and recurrent costs, while the private-sector leverages the research agenda by providing operating expenses for public-sector activity or projects of specific interest to the private sector. This raises the issue: is LGCU research actually public research if the private sector becomes the dominant player in determining the public research agenda?

Intellectual Property

Changes in the legal structure surrounding public intellectual property, combined with recent advances in ag-biotechnology, are changing the way in which LGCUs and other universities do business. Several key laws have granted public universities the ownership and the right to protect intellectual property generated with federal funds.

“The enactment of the Plant Patent Act in 1930 and the Plant Variety Protection (PVP) Act in 1970 expanded the IPR regime in the U.S. to include the protection of biological innovations. The 1980 Bayh-Dole Act allowed universities ownership rights to intellectual property generated by federally funded research. The passage of Public Law 98-620 further expanded universities’ ownership rights in 1984.” (Maredia et al. 1999)

In the judicial system, *Chakrabarty v. Diamond* validated IPRs for living tissue. Ensuing case law has expanded these IPRs to genetic material.

In response to this changing legal structure and the opportunities provided by recent advances in genetic manipulation, universities are increasingly seeking to protect academic and intellectual property and to generate revenues from this property. One approach is to assist faculty in creating small and medium university-related firms (SMURFs). SMURFs are firms that usually exist due to the inspiration and discovery of a single or a small team of scientists (Oehmke et al., 2000). Since the Bayh-Dole Act of 1980, universities have created 2,578 new SMURFs based on protected, academic, intellectual property

(AUTM, 1998). At least 364 of these, or 14%, were created in 1998, indicating the increased use of this opportunity. “Prior to the [Bayh-Dole] Act, fewer than 250 patents were issued to U.S. universities each year and discoveries often were not commercialized for the public’s benefit” (AUTM, 1995). From 1993-98, 13,274 patents were issued to universities with 3,224 issued in 1997 alone. In 1997, universities filed 4,267 patent applications, mainly in the life science area (AUTM, 1997). The data show similar increases in university use of invention disclosures, licenses and options, and equity interest (Table 1). These trends suggest that protection and commercialization of intellectual property are becoming increasingly important to universities. In other words, the public sector is behaving more and more as the private sector behaves, especially with respect to ag-biotechnology research. This raises the issue: Why should public funds be allocated to university ag-biotechnology research?

The LGCUs’ Role in Industrialized Agriculture

As the Hatch Act was deliberated, it is unlikely that our forefathers ever conceived of today’s food and agriculture system. As agriculture continues to industrialize with a movement toward large tightly coordinated or integrated systems made up primarily of large corporate agricultural enterprises, there is an ongoing debate regarding the social welfare impacts of such a system (Heffernan 1999, Drabenstott 1999). This evolving structure also brings up concerns for LGCUs. In the changing face of agriculture, can LGCUs partner with private industry and still fulfill the role of conducting and disseminating unbiased research for the benefit of the public and of the consumer? Do such alliances and interactions with private industry hasten the extinction of smaller enterprises that help maintain the system’s competitiveness?

If LGCUs produce basic knowledge, but then make it accessible only to specific private agents with the capability to commercialize the discovery rather than to a wide range of private sector agents,

the greater good is not well served nor is the land grant mission of conducting and disseminating unbiased research achieved. Rausser (1999) argues that alliances such as the U.C. Berkeley/Novartis alliance are “consistent with the fundamental complementary relationships that formed some of the principles structuring the original foundation for Land Grant universities.” Though LGCU’s clientele includes private agents with such capability in the agricultural system, those agents do not fully represent our clientele. Wolf and Zilberman argue instead that LGCUs’ role is to keep the system more competitive by producing basic knowledge and maintaining access to information and technology for a wide range of private sector agents. The debate over public-private alliances hinges on the definition of access. Is “access” defined as providing basic knowledge to the system or as providing basic knowledge to one actor in the system who can commercialize the knowledge and then provide “access” to that commercialized product for the whole system? The original language of the Hatch Act is clear in its intent to make basic knowledge accessible to the public. Unfortunately, as Wolf and Zilberman point out, “we are on a trajectory that is increasingly narrow in terms of access to and control of the technology.”

Ag-biotechnology: Changing the Playing field

Funding Pressures and University Competitiveness

Ag-biotechnology research has dramatically increased the cost of conducting research for both the public and private sector. Some of the reasons for this are:

- purchase prices for technology use rights have increased.
- ownership schemes of intellectual property have become extremely complex.
- secrecy within & outside of the public and private research sector has increased.
- resources needed to attain information have increased.
- regulatory costs have risen and continue to rise.

All of these factors increase the amount of time and dollars required to conduct research at both public and private institutions, suggesting that ag-biotechnology is not a scale-neutral technology.

The impact of these pressures has LGCUs focused more on competitiveness than in earlier eras. Intra and inter-university competition for funding has increased. Since the state pool of research funds has decreased in real terms, LGCUs are more actively pursuing federal and private industry funds. Federal funds have increasingly been administered to LGCUs through competitive programs versus formula funding. For example, even in the past five years the proportion of Cooperative State Research, Education and Extension Services (CSREES) funds administered in the form of grants and agreements went from 35% of CSREES administered funds in 1993 to 40% in 1998 (figures include some non-competitive grants). Over the same period, National Research Initiative (competitively funded research grants) funding rose from 16 to 19% of CSREES administered funds (USDA-CSREES, 2000). With respect to industry funding, it is conceivable that all land grants will enter a race to be the next university to sign a multimillion dollar contract with an ag-biotechnology company. What is not pellucid about the path taken by the University of California, Berkeley:

- What impact will this contract have on state-funded research?
- Will the state continue to reduce their research expenditures but at a faster rate?
- Will this infusion of funds from private industry make the University of California, Berkeley more competitive than other land grant universities in attaining additional research dollars (i.e., grants, contracts, donations, etc.)?

The second issue of inter-university competition may emanate from the changing incentive structures in the universities. In several departments across the nation, it is evident that scientists are seeking private industry goals while remaining public servants (e.g., remaining a faculty member while starting a small business based on their innovations in the lab). This combination has not worked well historically and is not expected to work well in the future given current policies and laws (Collins, 1999). Faculty members who protect their innovations through secrecy, hoping to become rich and/or famous, are not adding value to the institution. The cross-pollination of ideas typically found in a research

program at an LGCU is stifled and is in danger of becoming extinct. If graduate students, faculty and staff are not being exposed to cutting edge research outside of their lab and cannot communicate their own results outside of the lab, where is the public good?

Small and Minority Land Grant Colleges and Universities (SMLGCUs)

As private funding becomes increasingly important to LGCUs, the historically Black colleges and universities, 1994 Institutions, Hispanic serving Land Grant Institutions, and other small Land Grant Colleges will suffer simply because they primarily work with small and/or minority farmers. Private-sector corporations seeking to maximize profits will look to universities that give them access to the largest clientele base. Although the SMLGCUs have been diligent and successful in serving their clientele, they will be less appealing as partners to the private sector. Hence, these institutions will be more dependent on government funds for research and educational purposes related to ag-biotechnology than the large LGCUs.

Considering that these institutions have been historically underfunded, particularly in the area of research (Seals, 1998), the concern is that the funding gap will widen at a faster rate due to ag-biotechnology's impact. This technology is not scale neutral as it is extremely expensive. This concern is made evident in a press release by the Agricultural Secretary Dan Glickman's office on 7/28/99.

...Dan Glickman today launched an innovative scientific exchange program to enhance crop biotechnology research in Sub-Saharan Africa. This start-up project will help reduce hunger, speed scientific progress, and help bring the benefits of biotechnology to small-scale farmers throughout Africa and the United States...USDA will provide \$100,000 in start-up funds for the project, begun in response to requests from 1890s universities for support of their research efforts in Sub-Saharan Africa (King, 1999).

To date, \$50,000 has been allocated to Tuskegee University and \$50,000 to the International Maize and Wheat Improvement Center (CIMMYT) in Mexico (King, 2000). No other monies have been allocated or earmarked for this project. The \$100,000 gesture by the USDA to engage in ag-biotechnology

education and research for all of Sub-Saharan Africa, the 16 1890 Universities, Tuskegee, and CIMMYT would be laughable if we were not talking about such a serious issue. If the SMLGCUs are to conduct research and produce educational programs for their clientele, governmental funds are the most likely source; however, given the initial level of funding and the history of under-funding by the government, the opportunity for SMLGCUs to conduct ag-biotechnology research and educational programs is absent.

Consumer Access to Ag-biotechnology

Agricultural biotechnology has the potential to generate vast improvements in public health—at a price. Grains and milk having medicinal or enhanced nutritional values are in the development stages. It is now possible to produce hogs which can grow human body parts compatible for transplantation to specific human hosts. Will these products be paid for by medical insurance? Will socioeconomic status determine access to these products? How will LGCUs discharge the Hatch Act mandate to “promote the efficient...utilization of products of the farm as essential to the health and welfare of our peoples?”

Cultural Voices

Will this technology endanger cultures domestically and internationally? Domestically, numerous groups such as the Native American have not been involved in this research or discussions. Could scientists currently be conducting research that will adversely affect the sacred plants of the Native Americans (some of which may be considered pests by corporate agriculture)? What impact would that have on those cultures? Who will bear the cost of negative ag-biotechnology externalities? Developing countries are investing in ag-biotechnology because of a need to find affordable food sources for undernourished populations. Will they ‘pay’ for this ag-biotechnology by being the ‘guinea pigs’ for

under-tested technologies? What role do the LGCUs have in evaluating or influencing this risk/reward tradeoff?

Vertical Integration and the Quality of Rural Life

The issue of free access to technologies for US producers without signing contracts or other legally binding documents which determine how they can produce their products is paramount. Is this the technology that will make all farmers nothing more than independent contractors to larger companies such that we essentially have only corporate farming? This question will become increasingly important as the system becomes more concentrated both horizontally and vertically, in part attributable to technological advances. In pork packing, for example, the four-firm concentration ratio increased from 40 percent in 1990 to 56 percent in 1998 and continues to rise. During that same period, vertical control by packers tightened as the percentage of hogs produced via production contracts increased rapidly from less than 3 percent to over 25 percent. Will the pork industry move toward an industry structure similar to that of the broiler industry where virtually all broilers are produced by poultry producers contracting with one of a few large poultry integrators to provide land, capital, and management skills while the poultry integrators provide the poultry, production practices, and technical advice? The Land Grant system must work toward a vision where the food system provides social justice for all; that is, it must provide market participants an opportunity to compete on the merits of a level playing field.

Policy Recommendations

Policy 1: Get out of the Ivory Tower

People are extremely passionate about GMOs—whether they are pro or con. Can LGCU biotechnology research successfully serve the needs of these desperate groups? One sure recipe for failure would be to exclude or ignore selected groups—particularly critics of the land grant system. Nonetheless, the LGCUs have not engaged in public debate about the advantages and disadvantages of public ag-biotechnology research.

A recent article by Lemaux (1999) exposes complacency and fear of ridicule as major contributors to the silence about ag-biotechnology research at LGCUs.

...I had read that European field tests of genetically engineered plants by large multinational companies were being destroyed by protesters and that farmers' fields in India containing genetically engineered crops were being burned to the ground. ...Can we as scientists continue to stand by and watch this happen? Can we let misunderstandings about modern plant biology and biotechnology go unchallenged, resulting in painful interruptions in the training of tomorrow's scientists or stopping our own pursuits of fundamental scientific discovery?...Over the years scientists have kept a low public profile, conducting their research within the confines of their laboratories in universities, publishing their research results and rarely communicating with the general public about the implications of their work or its potential risks or rewards to society. Utilizing funding from federal grants was sufficient for most scientists...without having to justify or explain what they were doing to the public....Few controversies in biology have caused this level of public debate...Those who chose to venture out into the public arena were often misquoted or misrepresented, only serving to drive them further into their "ivory towers".

Ruttan points out that as agricultural scientists, we have focused on the science itself and have failed to spend much time considering the impact of the science on society. What action plans can be developed to wake the system from its slumber? Is this a job for the various academic societal organizations or is it the responsibility of the research and outreach administration and faculty?

Hysteria has prevailed in society's response to GMOs. The public needs assistance in understanding the science of genetically modifying food and agricultural products and the potential

impacts of the science, both positive and negative. The most objective source for that debate and flow of information is the university system, specifically the land grant system with its many years of food production research. The LGCUs need to be the brokers and create an honest and inclusive dialogue among groups concerned with ag-biotechnology while interjecting rationalism and providing factual information for all groups.

Policy 2: Policy Implications for Public Sector Interaction with the Private Sector

Balancing money and mission will continue to be the most important issue that the LGCUs will have to address. This leaves us with the paradox of balancing our mandates of assisting agribusinesses, keeping the playing field level and improving the welfare of consumers. A cultural change has taken place in the land grant system partially due to the change in our clientele. The average size and concentration level of farms and agribusiness firms has increased dramatically. Along with increased concentration, these groups have increased their political power. The agribusiness political machines are making policy for LGCUs, which may be a detriment to the public's and consumers' welfare. The LGCUs must reexamine their mission and assure that they are serving not only large agribusinesses, but also our "traditional" clientele by improving rural life and assisting in leveling the playing field. Simultaneously, the LGCUs must recognize that 'consumers' is a misnomer for diverse groups with different preferences, the majority of whom dwell mostly in urban and suburban areas.

The LGCUs have a responsibility to help provide access to ag-biotechnology products for those who want them, and to provide opportunities to avoid ag-biotechnology products for those who do not want ag-biotechnologies forced on them. Providing access means, to the extent possible, insuring that ag-biotechnology products are widely distributed at affordable cost (without jeopardizing future research budgets). Providing opportunities to avoid objectionable products means not just continuing research

into alternatives to transgenic modifications (or whatever the objectionable product is), but expanding the traditional benefit-cost calculus and political decisions making to include such things as impact on Native-American sacred plants.

Policy 3: Targeted Research

The advent of ag-biotechnology, along with increasing industry concentration and vertical coordination, has affected the public-good nature of agricultural research. As stated by Ruttan (p. 182), “The primary rationale for the public sector’s investment in agricultural research has been that in many areas incentives for private-sector research have not been adequate to induce an optimum level of research investment—that the social rate of return exceeds the private rate of return because a large share of the gains from research are captured by other firms and by consumers rather than by the innovating firm.” If the private sector is highly invested in ag-biotechnology, then the logical targets for public research are areas related to ag-biotechnology in which the private sector has no profit motive to invest. This reassessment of targeted public research would result in:

- Decreased traditional commodity sector research by LGCUs in sectors where private industry has a strong presence.
- An increased role of the LGCUs as the honest broker concerning externalities between industry R&D and the public.
- Increased niche market research by LGCUs to assist small and medium size farms in remaining independent and keeping agriculture more competitive.
- Increased niche market research to assist farmers in meeting the needs of niche consumer groups, such as organic produce consumers.

Policy 4: Leveling the Playing Field for All LGCUs

There are numerous actions that are essential in involving SMLGCUs in this area of research and education. Increased funding and building infrastructure are the most obvious ways to assist SMLGCUs in the short run, given how expensive biotechnology research is. Access to current and future technology

is a major restriction that these institutions face. Partnering with international agencies, industry, government agencies and other LGCUs is imperative. Firms and individual government agencies need to be encouraged and rewarded for partnering with SMLGCUs.

In an earlier section, the question was asked, if the US were starting fresh in designing a LGCU system in 2000, would it look like our present system? The USDA and land grant system need to restructure funding, tear down walls, and address the land grant culture to make it more inclusive and serve all people. The key policy points to address include:

- Cooperation among the different classes of land grants (teaching institutions, research institutions and etc.)
- Rewards for and encouragement of inter-university research agendas, particularly between SMLGCU and regular LGCUs.
- Acknowledgment and promotion of diversity in thought, culture, and research approaches. George Washington Carver used a spiritual research methodology approach which was extremely successful when measured in Hatch Act terms of serving the public. This type of program would most likely not be supported at any LGCU today. Why are we intolerant of different methodologies that may provide the key to new discoveries that are beneficial to the people?
- Promotion of transparency within the whole land grant system (i.e. eliminate the good ol' boy image of agriculture).
- Reevaluation of the reward system. Publications and patents are good for ranking research programs at universities, but is there a healthy balance between these activities and pursuing the fulfillment of the public's needs?

Summary and Conclusions

The combination of the funding pressures such as (1) slow to zero growth research budgets, (2) accountability to the public for expenditures, and (3) increasing privatization of research with private ownership of intellectual property rights, along with the increased cost of conducting research in the ag-biotechnology area, has jeopardized the fulfillment of the land grant mission of teaching, outreach and conducting research to increase the social welfare of US citizens. The new land grant culture of pseudo private research enterprises does not add value to the education and research systems. This argument is

supported by: (1) the theoretical results in Oehmke, et al regarding the public good status of agriculture research, (2) the number of new patents being filed by universities, (3) the growing number of new SMURFs each year, (4) the new template of privatizing a certain section of a public university by signing a multimillion dollar contract, and (5) increasing inter and intra-university competition.

Ag-biotechnology has had and will continue to have a tremendous effect on land grant universities. The fundamental structure and objectives of the LGCUs have changed and the incentive system has started to reflect that protecting knowledge has become the way to get promoted within the LGCU system. The winners in this structure are not clear; however, society's welfare is the clear loser.

Society loses in this situation for a number of reasons. The fact that every land grant university innovation will most likely be kept secret or patented will slow down innovations as well as the release of knowledge to the public. This phenomenon is further exacerbated by the increasing consolidation of the food supply chain. Fewer and fewer firms are entering ag-biotechnology races because they have been either bought out or are strapped for funds. With fewer firms and the new trend for land grant universities to privatize research results, the overall effect is that there may be fewer innovations and a decline in the diversity of products in the market. Hence, consumer and social welfare would decline. The land grant institutions were created for the purpose of increasing the public's welfare. How we continue to privatize knowledge and increase society's welfare simultaneously is the question for this millennium..

References

- Alston, J. and P. Pardey, *Making Science Pay: The Economics of Agricultural R&D Policy*, Washington, D.C., AEI Press, 1996.
- Association of University Technology Managers (AUTM), 1999. "The Bayh-Dole Act."
Available online at <<http://autm.rice.edu/autm/publications/survey/facts.htm>>.
- Association of University Technology Managers (AUTM). "Licensing Survey FY 1997: Executive Summary" Available online at
<<http://autm.crpc.rice.edu/autm/publications/survey/1997/execsumm.html>>
- Burrell, C., "UC Finalizes Pioneering Research Deal With Biotech Firm Pie Tossers Leave Taste of Protest," *San Francisco Chronicle*, Tuesday, November 24, 1998.
- Collins, H.B., Presentation at the American Agricultural Economics Association Meetings, Vice President of Technology Transfer, Delta and Pine Land Company, Nashville, TN, 8/99.
- Drabenstott, Mark. "Consolidation in U.S. Agriculture: The New Rural Landscape and Public Policy." Federal Reserve Bank of Kansas City, *Economic Review*, First Quarter 1999, p.63-71.
- Fuglie, K., D. Schimmelpfennig, *Public-Private Collaboration In Agricultural Research: New Institutional Arrangements and Economic Implications*, Ames, Iowa, Iowa State University Press, 2000.
- Gray, R., S. Malla and P. W.B. Phillips, "The public and not-for-profit sectors in a biotechnology-based, privatizing world: the canola case," Paper presented to the NE-165 Conference: "*Transitions in Agbiotech: Economics of Strategy and Policy*" in Washington, D.C., June 24-5, 1999.

Hatch Act, The, Act of March 2, 1887;(1) ch. 314,24 stat.440,7 U.S.C.361a et seq., Chap. 314,
Sec.2.(6)

Heffernan, William. “Consolidation in the Food and Agriculture System”, Report to the National
Farmers Union, February 5, 1999. Available online at <<http://www.nfu.org/whstudy.pdf>>

Holt, Donald A. and J. Bruck Bullock. “Are Research Alliances Between Private Firms and Land Grant
Universities Compatible With the Original Purpose?” *AgBioForum*, Vol. 2, No. 1(Winter
1999):11-16. Available online at <<http://www.AgBioForum.org>>

King, Frankie D. “Telephone Conversation” Special Trade and Development Staff, Foreign Ag. Serv.,
3/14/2000.

King, Frankie D. “Press Release,” Special Trade and Development Staff, Foreign Ag. Serv., 7/28/99.

Lemaux, Peggy G. “Safe in the Ivory Tower?” 1999. American Society of Plant Physiologists
Newsletter, November/December 1999 issue, Volume 26, No. 6.

Maredia, M., F. Erbisch, A. Naseem, A. Hightower, J. Oehmke, D. Weatherspoon, and C. Wolf.

“Public Agricultural Research and the Protection of Intellectual Property: Issues and Options,”
AgBioForum, Vol. 2, No. 3 & 4 (Summer/Fall 1999):247-252. Available online at
<<http://www.AgBioForum.org>>

Oehmke, J., D. Weatherspoon, C. Wolf, A. Naseem, M. Maredia, and A. Hightower, “Is Agriculture Still
A Public Good” forthcoming, *Agribusiness: An International Journal*, 1999.

Pennsylvania State University. 1998. *Penn State Agriculture*. Fall/Winter (1998-99). Pennsylvania State
University.

Rausser, Gordon. “Public/Private Alliances.” *AgBioForum*, Vol. 2, No. 1(Winter 1999):5-10. Available
online at <<http://www.AgBioForum.org>>

Rosset, P and M. Moore, "Research Alliance Debated Deal Benefits Business, Ignores UC's Mission," *San Francisco Chronicle*, Friday, October 23, 1998.

Seals, Rupert G. *Disparity: An Analysis of the Historical, Political, and Funding Factors at the State Level Affecting Black Academic Agriculture*. Vantage Press, New York, 1998.

James Tefft, Niama Nango Dembele, Josue Dione, and John Staatz. "Le Mali, l'Universite de l'Etat de Michigan (MSU) et l'USAID: 14 ans de partenariat pour la securite alimentaire." Note de Synthese no. 45F, Food Security II Cooperative Agreement, Michigan State University, Dept. of Agricultural Economics, September, 1999.

USDA-CSREES, Current Research Information System, National Summary CSREES Administered Funding, various years. Available on-line at <http://cristel.nal.usda.gov:8080/>

Wolf, Steven and David Zilberman. "Public Science, Biotechnology, and the Industrial Organization of Agrofood Systems." *AgBioForum*, Vol. 2, No. 1(Winter 1999):37-42. Available online at <<http://www.AgBioForum.org>>

Figure 1. Public vs. Private R&D Expenditures.

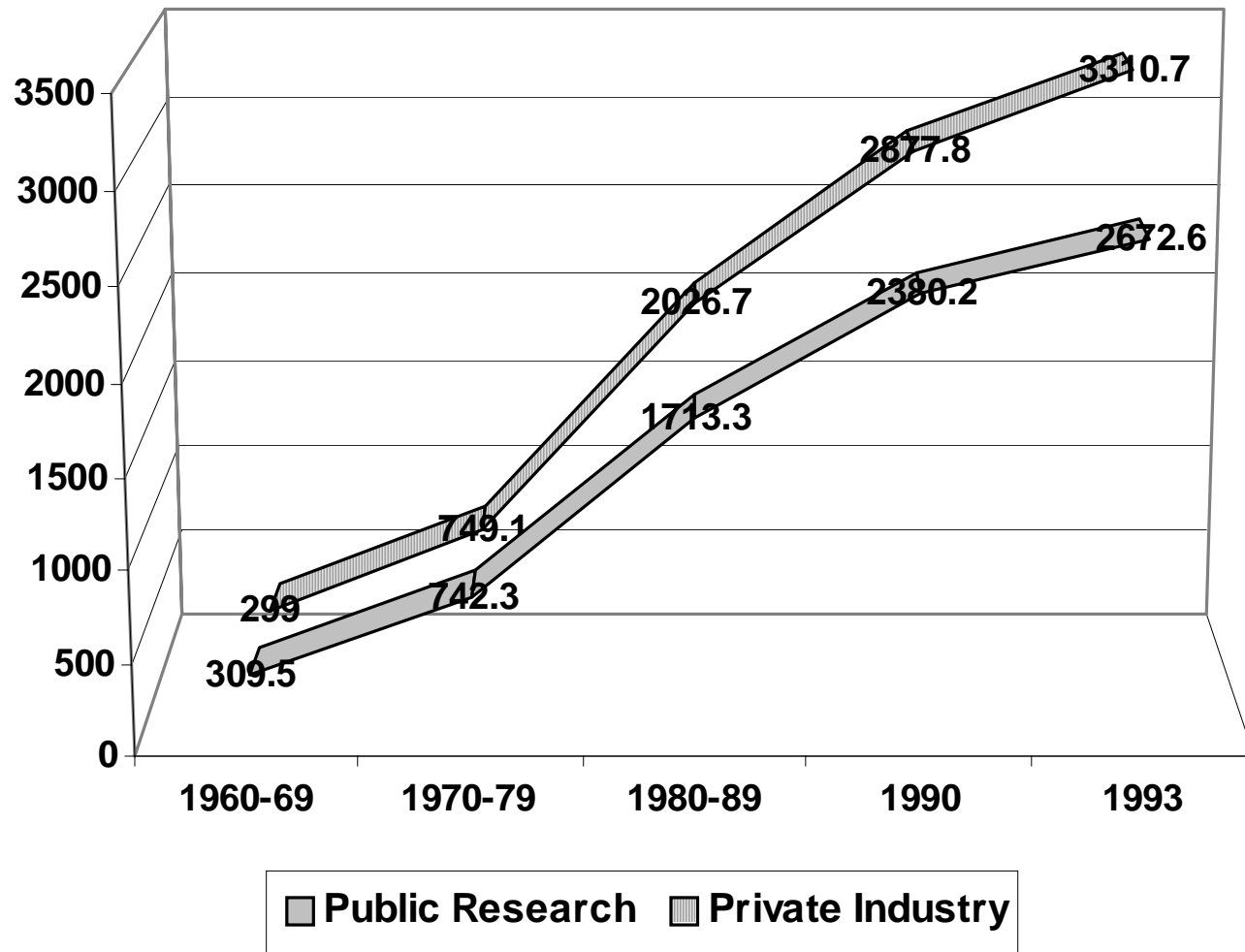
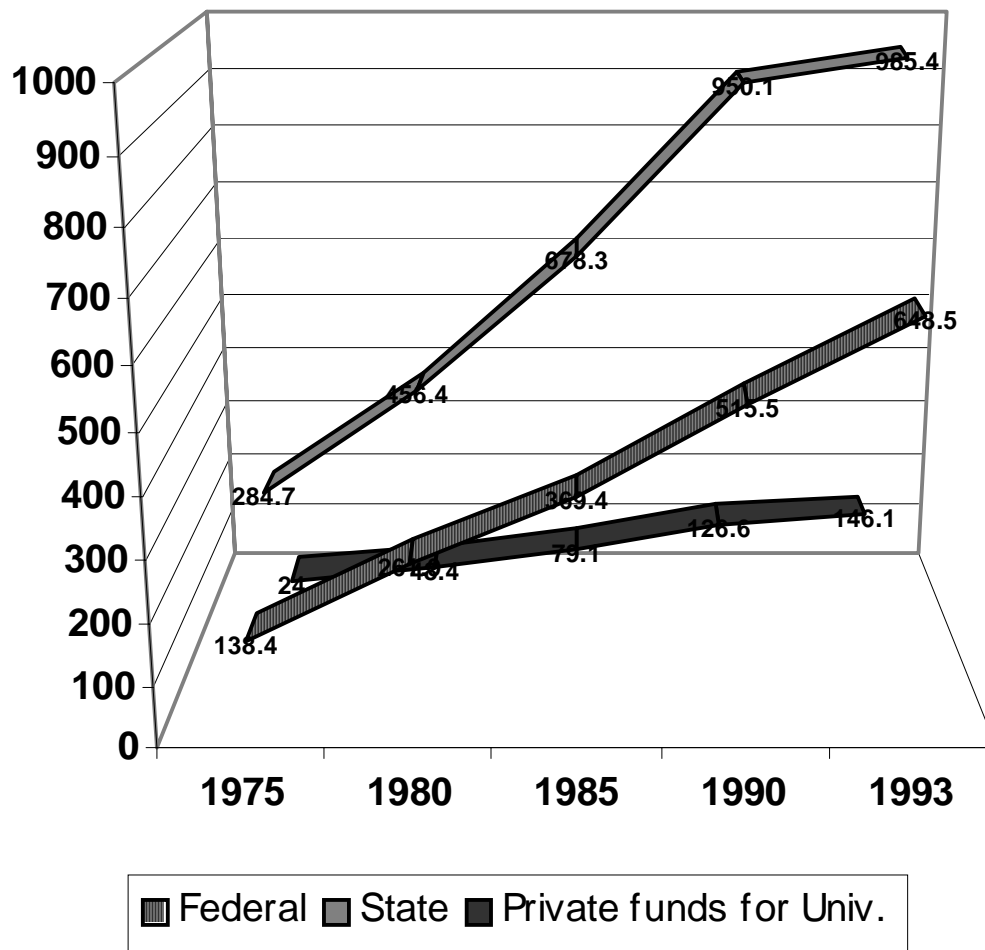


Figure 2. Public Research Dollars by Source.



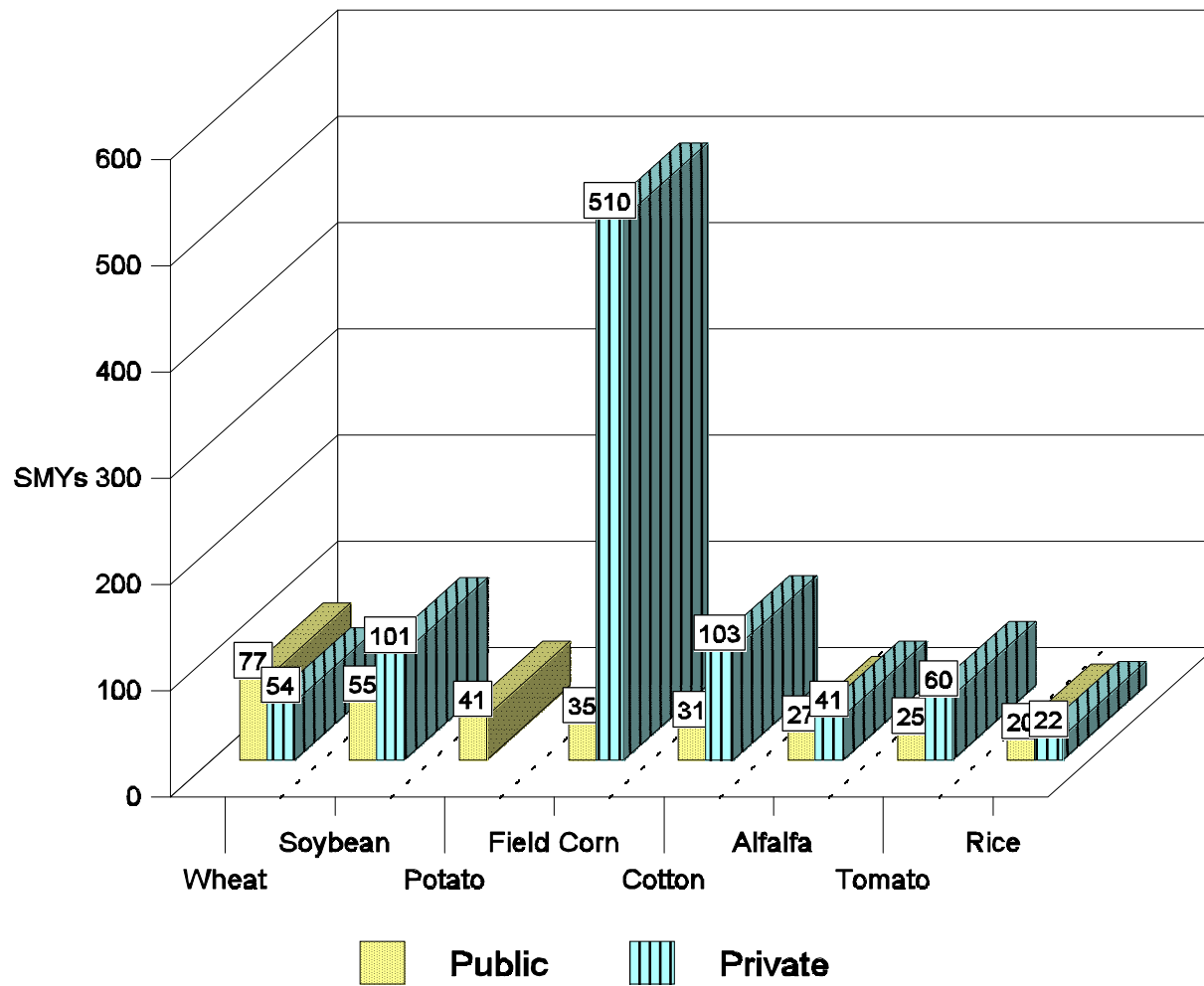


Figure 5. Public and Private Scientist Man Years for Plant Breeding, By Crop, Top 8 Public-Sector Crops.

Source: Freys. Private potato data not available.

Table 1. Protection and Commercialization of Academic Intellectual Property

Type of Protection/ Commercialization	Aggregate	1995	1996	1997	1998
Invention Discoveries	Not Available	9,784	10,178	11,303	11,784
New Patent Applications	Not Available	2,872	3,261	4,267	4,808
Patents Issued	13,274 since FY 1993	1,833	2,095	2,645	3,224
Licenses and Options	17,088 active in FY 1998	2,616	2,741	3,328	3,668
SMURFs	2,578 formed since 1980	223	248	333	364
Equity Interest		99	167	251	272

Source: AUTM, 1999.