Intellectual Property and Technology Transfer by the University of California Agricultural Experiment Station

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ABSTRACT

One of the primary missions of the University of California Agricultural Experiment Station (AES) is to create knowledge and develop technologies that improve the productivity and environmental sustainability of agriculture in California. In addition to the public release of information and the educational activities of cooperative extension services, the University of California places the inventions of AES faculty directly into commerce through the process of patenting and technology transfer. This channel is particularly useful—and often essential—when further financial investments are necessary to develop the technology for practical applications or to manufacture, market, and distribute new products that incorporate the new technology. This report documents the patenting and formal technology transfer activities of the University of California Agricultural Experiment Station over the last 40 years.

More than 800 inventions have been reported by AES researchers between 1960 and 2001. These inventions are categorized into the five broad technology areas: biotechnology (49%), plant varieties (19%), chemicals (14%), equipment/machinery (13%), and environmental (1%). Biotechnology inventions were entirely absent until the mid-1980s, but the category has grown rapidly over the last 15 years. The growth in the number of biotechnology-related inventions has occurred not at the expense of inventions reported in the areas of plant varieties, agricultural equipment, or novel chemicals, all of which have shown a relatively stable level of activity.

Financial returns from the licensing of AES inventions was US$1.4 million in fiscal year 1982 (2.5 million in 2001 dollars) but had grown to US$12 million by fiscal year 2001. After accounting for expenses associated with patenting new inventions and distribution of a share of income to inventors, AES inventions returned over US$6 million to the university in fiscal year 2001. Since 1982, the cumulative financial return has totaled US$105.2 million in fees and royalties. About 87% of that income has been derived from the licensing of plant varieties in spite of the fact that they compose only 19% of the AES inventions, indicating the commercial importance of UC plant varieties. To date, relatively few biotechnology- or environmental-related inventions have been commercialized, but the extensive and growing UC portfolio in these areas should provide a strong base for future licensing activity.

1. INTRODUCTION

1.1 *The Agricultural Experiment Station at the University of California*

The Agricultural Experiment Station (AES) at the University of California (UC) is composed of nearly 700 researchers in 60 disciplines, carrying out over 1,000 research projects. These AES researchers are in the College of Natural Resources on the Berkeley campus, the College of Natural and Agricultural Sciences on the Riverside campus, and the College of Agricultural and Environmental Sciences and the School of Veterinary Medicine on the Davis campus. The common research goal of the AES is to create knowledge and develop technologies that

Graff GD and AB Bennett. 2007. Intellectual Property and Technology Transfer by the University of California Agricultural Experiment Station. In *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices* (eds. A Krattiger, RT Mahoney, L Nelsen, et al.). MIHR: Oxford, U.K., and PIPRA: Davis, U.S.A. Available online at www.ipHandbook.org.

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improve the productivity and environmental sustainability of agriculture in California for the public benefit.

1.2 *AES research as an engine of commercialized inventions*

Much of the AES faculty research makes its impact on California and the world through the public release of new technologies or plant varieties, through cooperative extension services, and through the teaching of university students who apply their new skills and knowledge in the field.

In addition, the University of California places the inventions of AES faculty directly into commerce through the process of patenting and technology transfer. This channel is particularly useful—and often essential—when further financial investments are necessary to develop the technology for practical applications or to manufacture, market, and distribute applications that take advantage of the new technology. In this situation, the researcher is able to make an invention disclosure to the University of California's Office of Technology Transfer (OTT) at the UC Office of the President or to their individual campus's Office of Technology Licensing (OTL). Either office—the UCOP Office of Technology Transfer or the campus Office of Technology Licensing—provides a number of services to the faculty inventor. The staff evaluates the invention, and, if the invention seems to hold commercial promise, engages in efforts to protect and to market the invention. Companies that think they may be able to use one of the university inventions can take the technology for a test drive by buying an option on the technology; if a company decides that they indeed can use the technology profitably, they will sign a license agreement with the university. If the company feels that the technology is risky, is undeveloped, will require a lot of investment, or may have very uncertain returns, it may request that the option or license be sold only to itself (exclusive). Otherwise, options and licenses can be signed with more than one company (nonexclusive).

Following changes in U.S. laws in the early 1980s, the results of publicly funded research can more easily be patented and managed by universities. Other changes made biological inventions much easier to patent. A number of UC researchers have been at the forefront of making research discoveries and, under these new laws, obtaining patents with applications in agriculture. This chapter was produced in order to document the patenting and formal technology transfer activities of the California Agricultural Experiment Station over these last 20 years.

2. FINDING THE DATA ON UC'S AES INVENTIONS

The UC Office of Technology Transfer maintains the Patent Tracking System (PTS) database containing information on all inventions made by UC researchers and disclosed to the university since the early 1960s. PTS also includes complete annual financial records on every UC invention since 1982.

In order to identify those inventions made by AES faculty, rosters were obtained from the three host campuses—Berkeley, Riverside, and Davis—listing the names of all faculty members that had held AES appointments between 1980 and 2000. These names were then matched against the names of all UC inventors in the PTS database. The matches compiled showed that 283 of the AES faculty had registered at least one invention with the university (198 from Davis, 61 from Riverside, and 24 from Berkeley.) Then, using this list of active AES inventors, it was possible to exhaustively search the PTS database for all of the inventions on which the inventors were listed as contributing inventors. This yielded 808 invention disclosures, on which a total of 574 patent applications were filed in the United States, resulting in 243 U.S. utility patents and 76 U.S. plant patents issued to UC between the years of 1960 and 2001. For some of these AES inventions, foreign filings were submitted, resulting in the issue of 190 foreign utility patents and 354 various foreign plant-variety rights in a total of 83 countries.

3. IN WHICH AREAS ARE AES INVENTORS WORKING?

The 808 AES inventions are distributed among five broad technology areas (Figure 1a): 49%

are biotechnologies, including plant, animal, and human medical biology; 19% are plant varieties, primarily strawberries, avocados, peaches, grapes, and various rootstock; 14% are chemicals (primarily for pest control); 13% are equipment and machinery (for agriculture, food processing, and medicine); and 1% are environmental technologies for toxic cleanup and remediation.

Changes in emphasis over the years by the AES in these broad technology areas are illustrated in Figure 2. The number of invention disclosures in each of these five categories is shown for each year since 1960. Before the 1980s, AES inventions consisted entirely of equipment and machinery, chemicals, and plant varieties. Beginning in the 1980s, there was a large, sustained boom in biotechnologies. The rise of biotechnology, however, does not seem to have affected inventiveness in the other areas. Chemical inventions, while always sporadic, have continued, and there was a surge of new plant varieties in the late 1990s. The new, small area of environmental technologies emerged only in the 1990s. Equipment and mechanical inventions have remained remarkably steady throughout the 40-year timeframe. However, within the category of equipment and machinery, there has been a definite shift toward advanced technologies (computer and scientific equipment) for agriculture and medicine and away from farm machinery.

4. WHAT ARE THE FINANCIAL RESULTS OF AES INVENTIONS?

Four types of accounts are reported in the PTS data for each invention.

- **expenses**. All expenditures made in investigating the legal and market potential of a new invention, applying for patents, paying patent maintenance fees, and, in rare cases when necessary, enforcing UC's legal rights in patent litigation
- **reimbursements**. From firms licensing a UC invention that agree to pay for some or all of the expenses incurred in patenting the invention
- **fees/royalties**. Payments made to UC by firms for a license to use (or the option to license) a UC invention
- **disbursements**. A designated proportion of the fees/royalty revenues that is paid directly to the UC inventors as personal income

Out of the 808 AES inventions on record, only 174 have generated any fee or royalty income after 1982, when financial data began being recorded. The first 50 of these are listed in Table 1, ranked in order of revenue generated, from most to least. The most consistent "big hits" on the list are the strawberry varieties. The UC strawberry licensing program has been one of the brightest spots in the university's entire technology transfer enterprise.[1] Figure 3 plots the total licensing revenues collected for each of the 174 inventions and plots revenues from greatest to least. It is important to notice how skewed the distribution of revenues has been. The top 12 AES inventions alone account for 88% of all AES licensing revenues over 20 years of the program. It is also important to note that the inventions with lower revenues, toward the bottom of Table 1 and toward the right of Figure 3, tend to be more-recent inventions, which naturally show much less income, as they have had less time to generate royalties.

Of particular note, the tomato harvester, invented in 1960, is the first invention recorded in the dataset. Even in its third and fourth decades on the market (1982–2001), that invention brought in over US$160,000 in royalties to the university.

From 1982, when detailed annual records began to be kept, through 2001, the licensed inventions by AES researchers have earned a total of US$125 million in fees and royalties,[2] with 87% of that coming from the licensing of plant varieties, 10% from biotechnologies, 3% from chemicals, and 1% from equipment and machinery (Figure 1b). It is very interesting to note that while plant varieties make up just 19% of the inventions, they generate 87% of the revenues, while chemicals and machinery, and particularly biotechnology, fall far behind in terms of revenue generation relative to numbers of inventions (compare Figures 1a and 1b). Of the total amount, US$42 million was disbursed as inventor shares.

Figure 1a: Proportions of AES Inventions in Five Broad Technology Areas

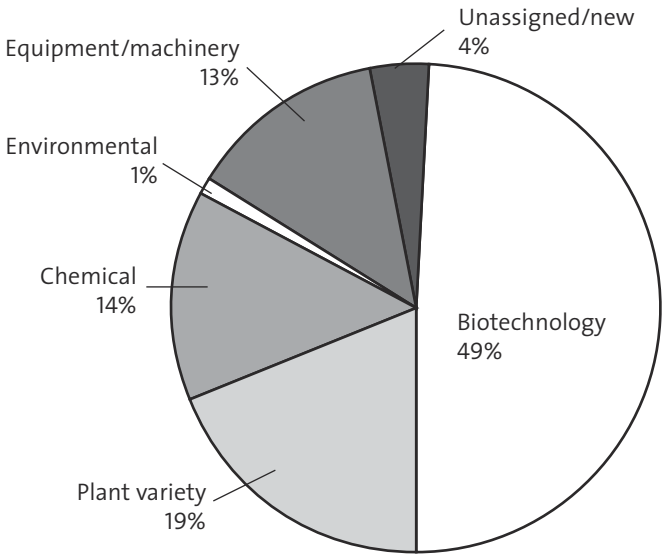
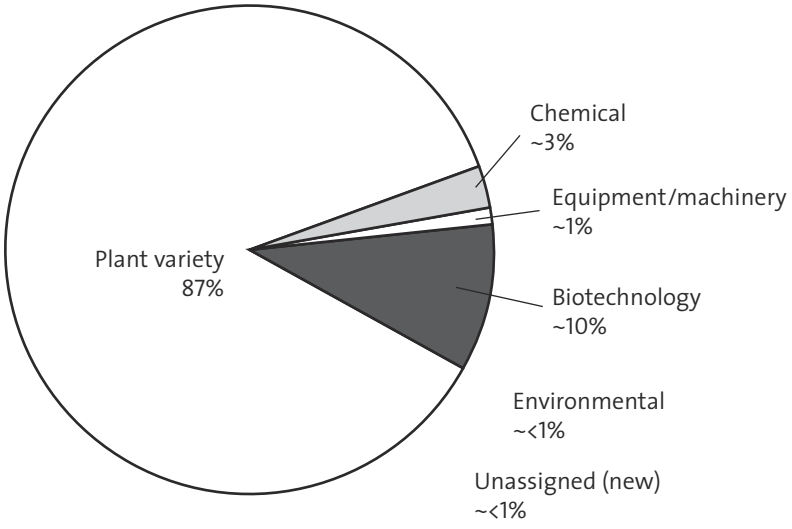


Figure 1b: Proportions of Income from AES Inventions in the Five Broad Technology Areas



Expenses incurred in the patenting and marketing of these inventions totaled US$23 million, of which US$5.4 million was reimbursed by the licensing companies.

Over time, the annual fees and royalties generated by AES inventions has increased from approximately US$3 million (adjusted) per year in the early 1980s to almost US$12 million a year today, with particularly strong growth in the 1990s. Expenses have also grown, but at a slower rate, and reimbursements continue to offset approximately one third of expenses. The increase in expenses in the 1990s (Figure 4) was largely a result of increased foreign patent filings, particularly for plant varieties. The resulting foreign patents, however, have contributed directly to the large increase in revenues. Net income, that is, each year's total amounts received (includes fees and royalties plus reimbursements) minus each year's expenses, has continued to grow. Inventors' shares are paid out of the net income, and what is left over is returned to the university and reinvested into new research projects or used to cover university operating expenses.

5. CONCLUSIONS

The formal process of technology patenting and licensing is just one of the many ways that the University of California AES contributes to the state's agricultural economy and to the public welfare. In increasing numbers, inventions are being patented by the University of California on behalf of AES researchers and the income generated by this intellectual property is helping to support research and education at the university. A significant trend in invention disclosures is the tremendous increase in biotechnology-related inventions and the emergence of inventions in environmental technologies. At the same time, inventions reported in the areas of plant varieties, agricultural equipment, or novel chemicals have grown or remained at a stable level of activity.

Figure 2: Annual Number of AES Inventions Disclosed by Broad Technology Area

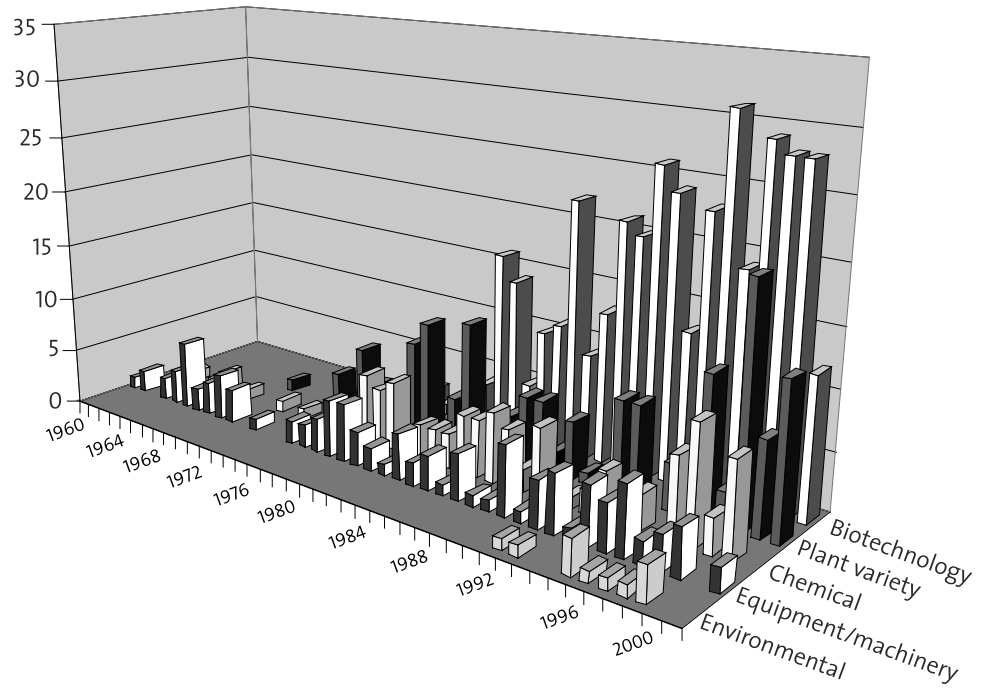


Table 1: The top 50 Inventions at the University of California AES by Positive Financial Earnings (1982–2001)

Fee and royalties rank	Invention: short title	Year invented	Campus
1	STRAWBERRY:CAMAROSA	1992	Davis
2	STRAWBERRY: CHANDLER	1982	Davis
3	STRAWBERRY: PAJARO	1978	Davis
4	STRAWBERRY: OSO GRANDE	1987	Davis
5	STRAWBERRY: SELVA	1982	Davis
6	STRAWBERRY: DOUGLAS	1978	Davis
7	LIPOSOME STORAGE METHOD	1984	Davis
8	STRAWBERRY: SEASCAPE	1989	Davis
9	N-AMINO-S INSECTICIDE	1972	Riverside
10	GRAPE: TABLE: REDGLOBE	1979	Davis
11	REPLACE PHOSPHATE BY PHOSPHITE	1990	Riverside
12	STRAWBERRY: TUFTS	1972	Davis
13	STRAWBERRY: PARKER	1982	Davis
14	ASPARAGUS: F 109	1979	Riverside
15	CHERRY: BROOKS	1987	Davis
16	ASPARAGUS: M 120	1979	Riverside
17	ROOTSTOCK: GRAPE: 039-16	1985	Davis
18	STRAWBERRY: FERN	1982	Davis
19	FOOD SURFACE DISCOLORA REDUCER	1993	Davis
20	STRAWBERRY: DIAMANTE	1997	Davis
21	STRAWBERRY: IRVINE	1988	Davis
22	ROTARY SHAKER TOMATO HARVESTER	1978	Davis
23	STRAWBERRY: AIKO	1975	Davis
24	AVOCADO: LAMB/HASS	1993	Riverside
25	MODULATION OF ETHYLENE LEVELS	1990	Davis, non-UC
26	AVOCADO: GWEN	1982	Riverside
27	STRAWBERRY: AROMAS	1997	Davis
28	STRAWBERRY: MUIR	1987	Davis
29	ROOTSTOCK: AVOCADO: THOMAS	1986	Riverside
30	STRAWBERRY: GAVIOTA	1997	Davis
31	ANTIMICROORGANISM FINISH	1996	Davis
32	VOLATILE ELECTROLYTES	1976	Davis
33	RICE RESISTANCE TO XANTHOMONAS	1995	Davis
34	TOMATO HARVESTER	1960	Davis
35	INHIBIT FROST DAMAGE TO PLANTS	1981	Berkeley
36	GRAPE: TABLE: CHRISTMAS ROSE	1979	Davis
37	STRAWBERRY: CARLSBAD	1992	Davis
38	STRAWBERRY: HECKER	1978	Davis
39	DNA/ICE NUCLEATION BACTERIA	1982	Berkeley, non-UC
40	STRAWBERRY: BRIGHTON	1978	Davis
41	PLANT CELL FERMENTATION	1993	Davis
42	STRAWBERRY: SANTANA	1982	Davis
43	CONTROL RELEASE BIOMATERIAL	1992	Davis
44	SOLUBLE EPOXIDE HYDROLASE	1992	Davis
45	HIPPELATES EYE GNAT-CHEMICAL	1974	Riverside
46	STRAWBERRY: CUESTA	1992	Davis
47	STRAWBERRY: TORO	1975	Davis
48	LYME DISEASE: ASSAY & VACCINE	1990	Davis
49	BOVINE PARASITE DIAGNOSTIC	1993	Davis
50	GRAPE: TABLE: DAWN	1979	Davis

Figure 3: Distribution of Total Fees and Royalties Earned by the 174 Income-Generating AES Inventions (1982–2000)

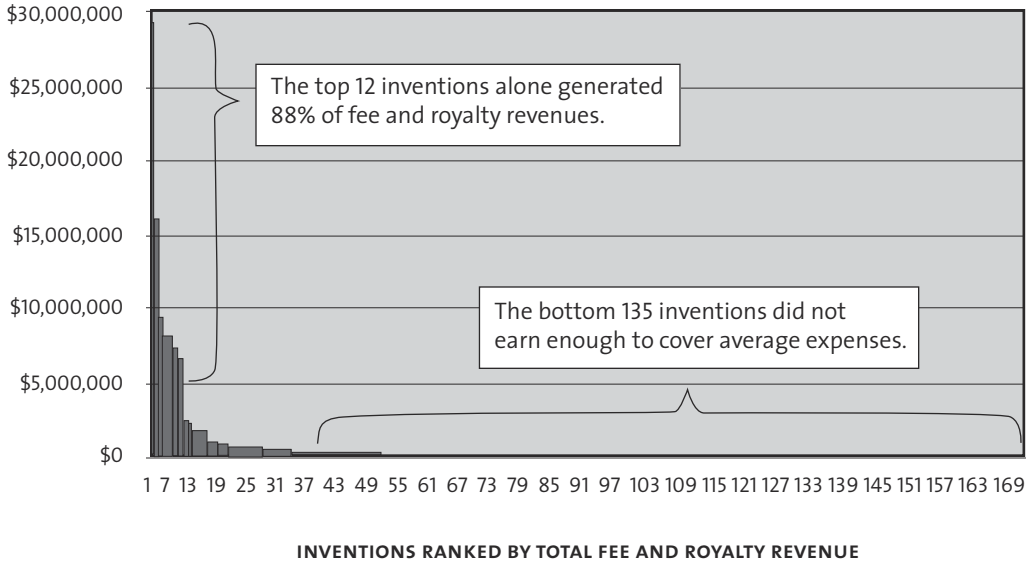
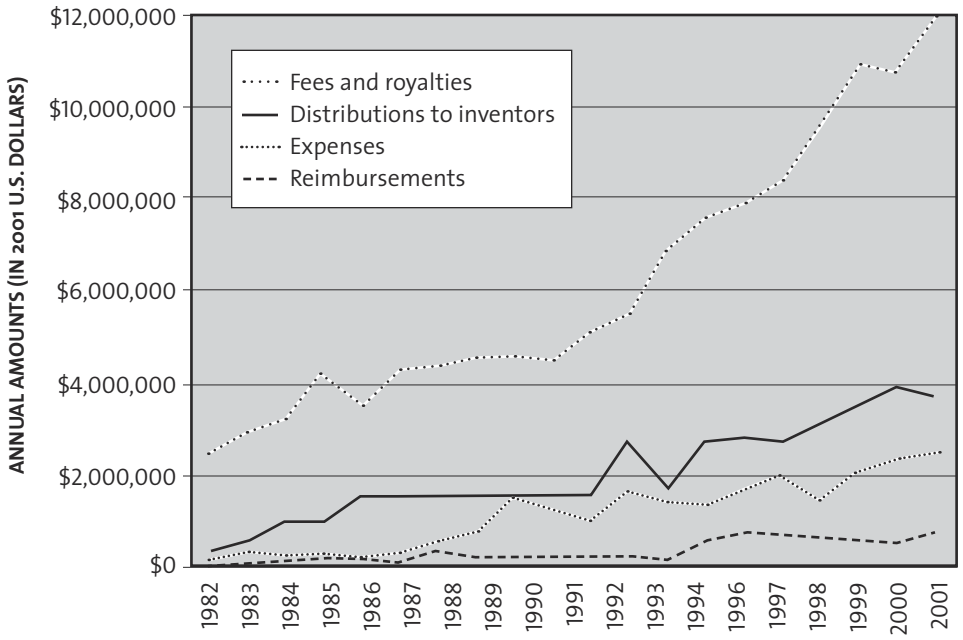


Figure 4: Annual Financial Performance of All AES Inventions, 1982–2001



Relatively few biotechnologies or environmental technologies have been commercialized to date, but the extensive and growing portfolio in these areas should provide a strong base for expanded licensing activity in the future.

Several elements of the process of technology transfer through patenting and licensing are helping to advance the mission of the AES in new and more targeted ways than did the older mode of public release:

- The protection of technologies as intellectual property means that a clear accounting is kept of the commercially viable results of AES research.
- Protection under foreign filings means that, when foreign competitors want to use a technology developed by California, they need to compensate California to use it.
- Protection also provides the opportunity to entice companies to invest in developing earlier-stage technologies that would otherwise not likely be developed and thus not benefit the state's economy.
- The collection of licensing fees and royalties works like a highly targeted tax. The companies and growers that benefit most from AES research are thereby directly supporting the kinds of research and education at UC that commercially benefits them.
- The payment of an inventor's share of royalties works like a research prize, even if it is not quite as prestigious as the Nobel Prize. It rewards researchers for innovations that are effectively taken up in the state's agriculture in proportion to how significant their contributions have been to the economy. ■

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1 See, also in the *Handbook*, section 4.1 of chapter 17.13 by AB Bennett and M Carriere.

2 Amounts are normalized to 2001 dollars to adjust for inflation.