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# **Plant Scientists and the Productivity Effects of Extension Appointments**

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**Abstract:** This article analyzes the primary scholarship activities of agricultural college plant science faculty with and without Extension appointments using survey data from all 1862 land-grant institutions. The evidence suggests that differences between Extension professors and others without Extension appointments are small for minor Extension appointments, but show significant and increasing tradeoffs between Extension and research outputs above a 35-50% Extension appointment. The evidence is suggestive of the potential for gains from exploiting complementarities between Extension and research rather than from pursuing high levels of specialization. The work concludes with implications for the role of state specialists in Extension.

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## **Introduction**

Over the past several decades, scholars and administrators have debated the role and function of Extension in land-grant universities and have even called into question its very survival (Hoag, 2005; Alter, 2003; Adelaja, 2003; McDowell, 2001; Ileveto, 1997; Peters, 1996; Bromley, 1986; Schuh, 1986). Persistent budgetary pressures, an expanding scope of thematic activities, a decline in the relative importance of agriculture, growing private Extension services, and demands for better integration of research and Extension have all been factors driving discussions on the future of Extension (Wolf & Zimmerman, 2001). Significant changes in organizational form and direction have been discussed. So have the meaning and definition of scholarship based especially on the seminal work by Boyer (1990), with strong cases being made for the engaged and practical orientation of discovery, integration, application, and transmission (Davis, Burggraf-Torppa, Archer, & Thomas, 2007; Adams, Harrell, Maddy, & Weigel, 2005; Irwin, Schnitkey, Good, & Ellinger, 2004; McDowell, 2001).

At the same time, surprisingly little research attention has been given to the productivity of "state specialists" in particular, tenure-track faculty with Extension appointments in the land-grant system. In this work we focus only on tenure-track faculty (tenured and pre-tenure) to facilitate the comparison between Extension and non-Extension faculty. That dearth of empirical analysis means that we do not really understand what the potential synergies or tradeoffs might be for those faculty members with respect to their various types of scholarly efforts, especially across the range of appointments that state specialists can carry. Ironically, this lack of information means that reform discussions on scholarship are not well informed by research on the productivity of Extension personnel. State specialists, in particular, sit at the crossroads of Extension scholarship, generally serving as full-fledged faculty members and often working closely with county agents. If new approaches to scholarship are to be forged in Extension, state specialists will be the master blacksmiths of combining the various levels of engagement suggested by Boyer and promoted by so many since.

This article analyzes the productivity of tenure-track plant science faculty with Extension appointments using original data collected by the authors from a sample of university plant scientists. Plant scientists comprise about 11% of the total faculty in agricultural and life science colleges, and because of their direct engagement with the consistent changes in plants and their management, they are one of the disciplines that best affords ready integration of field research and active Extension efforts. Thus, the productivity of state specialists is relevant to plant science departments directly, and what happens in plant sciences is of great relevance to the outcome of the larger debate.

The key questions addressed here include: Are professors with Extension appointments actually different from other non-Extension professors in terms of demographic background and scholarly activity as measured by academic articles, Extension publications, grants, graduate students, presentations, and clientele visits? What are the tradeoffs associated with various research and Extension activities, and to what extent do they vary by the degree or extent of Extension appointment?

The main conceptual issue explored in the analysis is that of trade-offs versus synergies (e.g., economies of scope) between producing research outputs (disciplinary work) and Extension outputs. Conceiving of state specialists as "agents" engaged in a multi-product/service activity provides a similar framing to the question raised by Foltz, Barham, and Kim (2007) about synergies and tradeoffs between research products that are public goods (e.g., articles) and those that are commercial goods (e.g., patents). If research and Extension outputs are complementary, then faculty members who integrate research and Extension could be more productive than those who specialize in one activity or the other. If the outputs are substitutes with more specialized faculty doing the individual activities more productively, then there could be an argument for specialization in which Extension (or research) professors should be wholly focused on Extension (or research) outputs. This article provides evidence for the synergistic relationship between Extension and research outputs, but only does so at the level of individual faculty members, not at the department, college, or Extension system level, which are also clearly relevant to organization of departments, colleges, and universities.

The empirical analysis uses original survey data collected in 2005 from a random sample of 1,000 agricultural college faculty members at all 1862 U.S. land-grant universities. This work focuses on the nearly 300 plant scientists in the sample (see Foltz & Barham, 2009, for an explanation of the full data set). The survey was conducted on the web and elicited a 57.6% response rate. With a high-quality sampling frame and a high response rate, we are confident that our sample of agricultural scientists is representative of the total population of professorial-rank individuals engaged in active research in colleges of agriculture at the nation's land-grant universities. The sample includes a mix of faculty with a wide range of Extension appointments and a majority without any formal Extension appointment, which permits a full range of comparisons in terms of demographic characteristics and research productivity.

## Measuring Professor Output

The measures of output we use are journal articles, Extension bulletins and publications, presentations to Extension audiences, presentations to academic audiences, clientele visits, and masters and Ph.D. students produced. We do not explicitly measure teaching output except in the form of graduate students produced, because at the undergraduate level teaching is in most cases prescribed by contract. We emphasize that the measures we present here are only some portion of all the scholarly output of a faculty member. This is especially true of Extension outputs, which could be expanded to include a variety of forms of software/data services, consultation, collaboration, and leadership activities beyond those captured by bulletins, presentations, and visits. What we measure as Extension bulletins and publications is in response to a question that asked "Over the past five years, how many of the following types of publication have you authored or co-authored" where "Bulletins/reports" was a category. All of these outputs should also be thought of as intermediate rather than final products when it comes to real-world impacts. We investigate the levels and changes in these output measures across the different levels of Extension appointments, which for most of the analysis are divided into the following categories: 0, 0-34%, 35-64%, 65-100%, of which the mean appointment percentages are 0%, 16.1%, 50.9% and 81.8%, respectively.

Overall in 2005, 32% of the plant science sample had a formal Extension appointment. Table 1 shows the distribution of Extension appointments across the sample of all plant scientists. For those with some Extension appointment, one can see that 41% fall in the 0-34% appointment range, 20% in the 35-64% range, and 39% in the 65-100%. This means that the bulk of appointments are at the outer edges of the distribution, with only one-fifth in the interval surrounding a 50-50 split.

**Table 1.**  
Extension Appointment Percentages in the Sample of Plant Scientists

Extension % of formal appointment	Frequency	% of Sample	% Among Extension Staff (Extension % > 0)
zero	204	68.2	0
$0 < x \hat{=} \leq 35$	39	13.0	41
$35 < x \hat{=} \leq 65$	19	6.4	20
$65 < x \hat{=} \leq 100$	37	12.4	39
Total	299	100	100

Table 2 shows the appointment division by Extension categories. As Extension appointments increase across the range, the next largest appointment category is always research for plant scientists. Starting with professors with Extension appointments in the 0-35% Extension category, 51% of time is spent researching, 26% teaching, and 5% administration. As the Extension appointments rise above 35%, teaching allocations drop below 15%, and administrative duties fall to less than 1%, but research appointments fall to 34% in the 35-65% Extension appointment category and 16% in the over 65% Extension category. Thus, clearly in terms of appointment and activity, the main area of interest for tradeoffs versus synergy is research and Extension.

**Table 2.**  
Plant Scientist Appointments: Research, Teaching, Administration and Extension

<b>Extension % of formal appointment</b>	<b>Research</b>	<b>Teaching</b>	<b>Administration</b>	<b>Mean % Appointment of Extension Staff</b>
zero	66.1	27.7	5.4	0.0
0 < x ≤ 35	51.0	26.6	6.1	16.1
35 < x ≤ 65	34.4	13.1	0.5	51.0
65 < x ≤ 100	16.1	2.2	0.0	81.8
All Plant Scientists	55.9	23.5	4.5	15.5

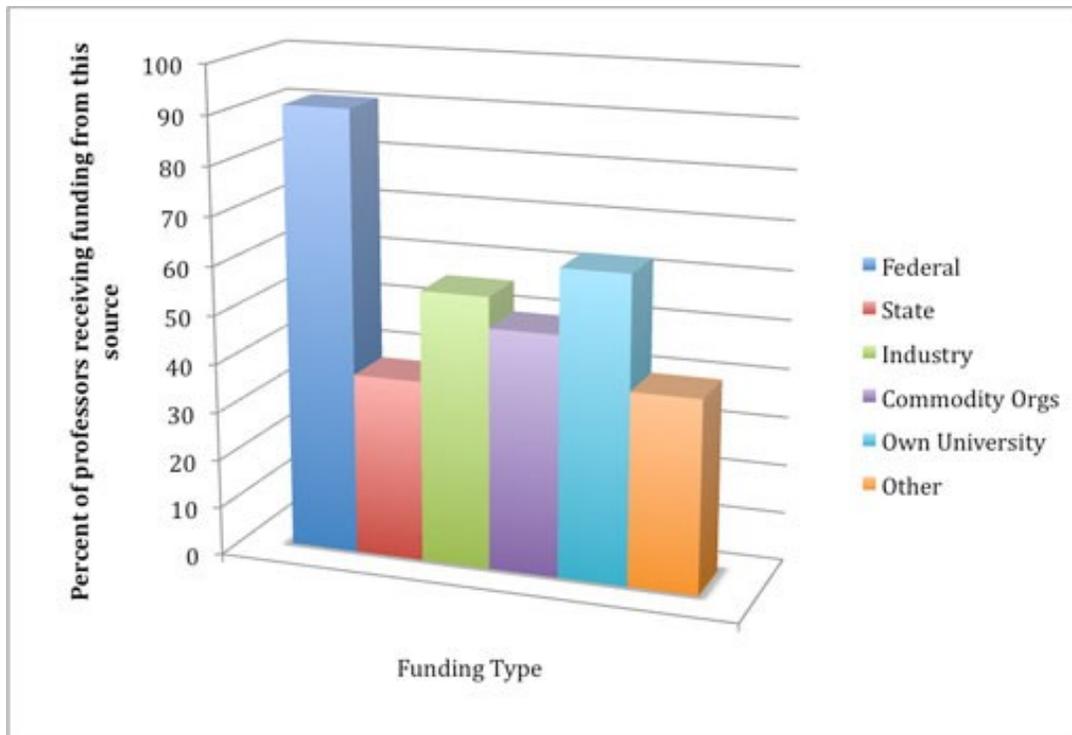
There is a small gender difference between Extension and non-Extension professors, with women representing 15% of non-Extension professors and 11% of Extension professors, but the difference is not statistically significantly different than zero. We also investigated differences in rank among plant sciences Extension professors, which are not statistically significantly different than non-Extension professors, except for the 35-65% range. This range shows much higher proportions of assistant professors, about 37%, compared to about 20% for other ranges, suggesting that new Extension professors are more likely to begin their careers with 35-65% Extension appointments.

## Research, Extension, and Student Production

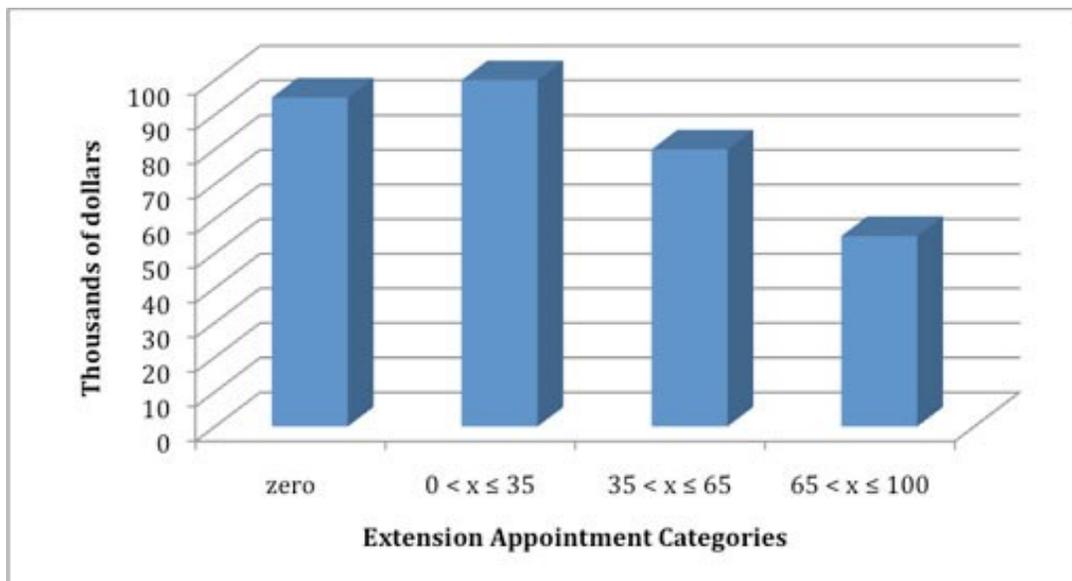
The demographic information suggests only minor gender, rank, and origin differences between Extension professors and those without Extension appointments. Presumably, the biggest difference that would be likely to have an effect on their academic productivity is the type of appointment itself, with higher levels of research type outputs (articles and graduate students) among those with zero or low Extension appointments and higher levels of Extension outputs among those with high Extension appointments.

We start with research funding, which is a critical input to the academic production of plant scientists and an increasingly key source of funding for agricultural colleges, the sources of which are shown in Figure 1. Overall, median dollars of annual research funding of non-Extension professors is not statistically different from that of Extension professors. (A non parametric K-sample test of equality of the medians cannot reject the null of equal medians:  $\chi^2(1)=1.44$  p-value 0.231). Figure 2 shows only a slight difference in median funding levels between the zero Extension and 0-35% Extension categories. The most substantial differences in median funding occur at the 35% and 65% Extension breaks, suggesting that median funding is negatively correlated with Extension appointments over 35%.

**Figure 1.**  
Sources of Funding for All Plant Scientists



**Figure 2.**  
Median Annual Research Funding Over Previous 5 Years

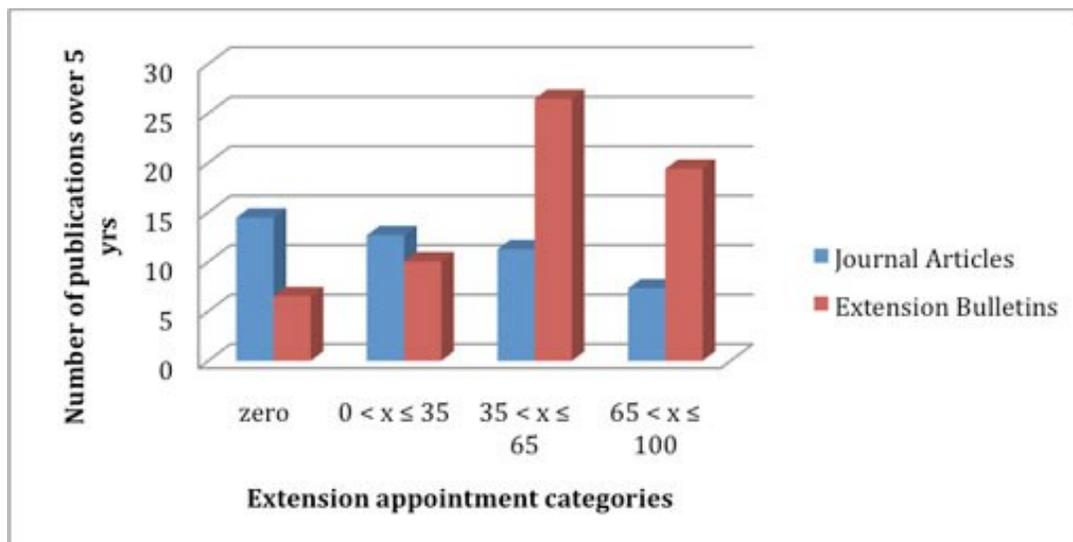


In terms of funding sources, Extension and non-Extension professors in plant sciences were equally likely to receive federal funding, with 92% and 94% of each group, respectively, receiving some form of federal funding (t-test of difference=0.6980). Professors with Extension appointments are significantly more likely to receive research funding from commodity organizations (62% versus 48%, t-test of difference =2.3844) and

from private industry (70% versus 53%, t-test of difference = 2.8655). Across Extension appointment categories, funding from commodity organizations increases from 44% for those with a 1%-35% appointment, to 63% for those with a 35%-65% appointment, and to 78% for those with a 65%-100% appointment. Funding from industry also rises over Extension categories, from 49% for those with a 1%-35% appointment, to 68% for those with a 35%-65% appointment, and to 92% for those with a 65%-100% appointment. Overall, engagement with commercial organizations rises as Extension appointments increase.

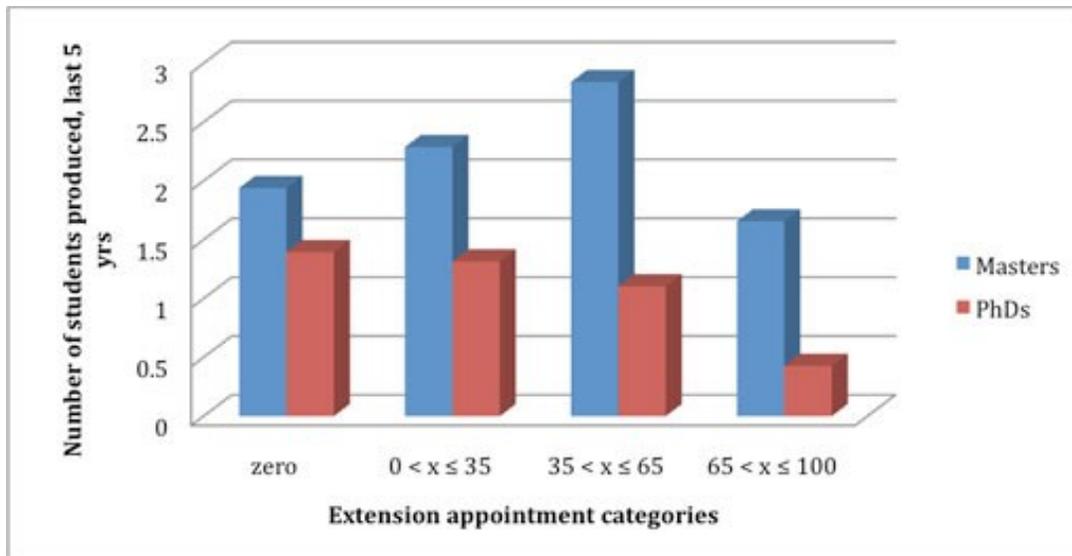
In contrast to funding sources, the data for written research output in Figure 3 show significant differences between Extension and non-Extension professors. Measuring research output over the previous 5-year period, the Extension professors produced an average of 10 journal articles, while the average non-Extension professor produced 14 journal articles (t-test of difference= 3.197). In Extension bulletins and publication output, Extension professors produced an average of 17 publications over the previous 5 years, which is significantly higher than the average non-Extension output of seven publications (t-test of difference=4.99). Note, however, that perhaps more striking than the differences are the high levels of engagement in both types of written research output by professors with both types of appointments.

**Figure 3.**  
Average Journal Articles and Bulletins



Another meaningful measure of faculty output is graduate student production shown in Figure 4. We measure it in two forms: terminal Masters and Ph.D. students produced in the previous 5-year period. Overall, Extension professors produced 2.2 Masters students, while non-Extension professors produced 1.94, but this difference is not significant (t-test of difference= 0.79). Over the previous 5 years, non-Extension professors produced 1.4 PhD students, while Extension professors produced 0.9 students, which is significant (t-test of difference=2.88). The figure shows that while low-level Extension appointments are actively engaged in training graduate students, professors with Extension appointments above 65% are much less engaged in graduate education. This finding is consistent across other fields (Foltz & Barham, 2009).

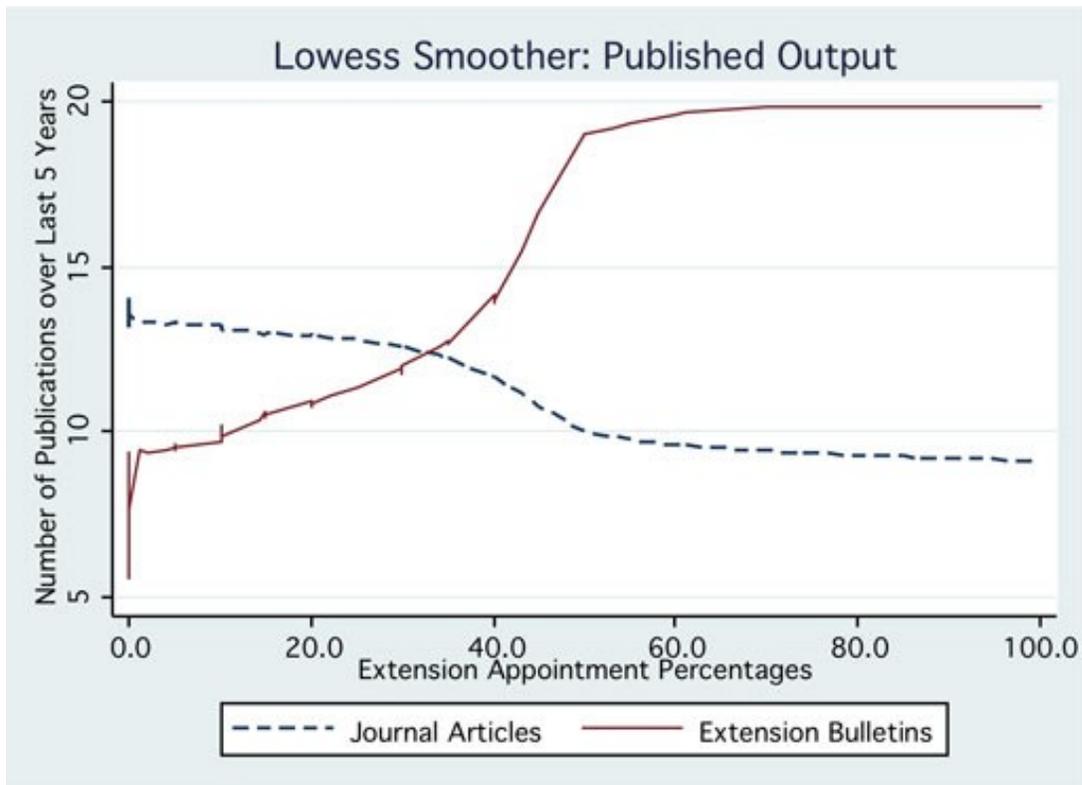
**Figure 4.**  
Number of Graduate Students Produced, Previous 5 Years



## Determinants of Research and Extension Production

In order to explore further the potential tradeoffs or synergies between journal publications and bulletins we also estimate a non-parametric Lowess smoothed surface for them with respect to Extension appointment. The Lowess smoothed surfaces, which are local non-parametric regressions, allow a more flexible analysis of potential non-linearities in the relationship between appointment and output. A Lowess smoother provides a locally weighted polynomial fit, which provides a non-parametric representation of the data (see e.g., Hardle, 1990). The Lowess smoothing was performed with articles and bulletins as separate equations and a single independent variable, Extension appointment percentage, in STATA 10 using the mean smoothing and the default level bandwidth of 0.8.

**Figure 5.**  
Lowess Smoothed Graphs of Research Output by Appointment Type



In Figure 5, the relationship demonstrates increasing tradeoffs between the two publication types as Extension appointments increase. While tradeoffs between academic and Extension presentations are evident throughout the distribution, bulletin production begins to plateau at about a 50% Extension appointment level. Until this point, the figure shows the percent time in Extension produces bulletins at a decreasing rate. Journal article production, however, decreases steadily as Extension appointment increases. These results reinforce the earlier descriptive figures, which suggest a spike in bulletin production in the middle of the range of Extension appointments and a steady decline in journal production as Extension appointment increases. It is also worth reiterating that at both extremes faculty are producing outputs beyond their formally allocated effort percentages. Faculty with no Extension appointments account for an average of one Extension bulletin per year at the same time those with no research appointments account for 1.3 journal articles per year.

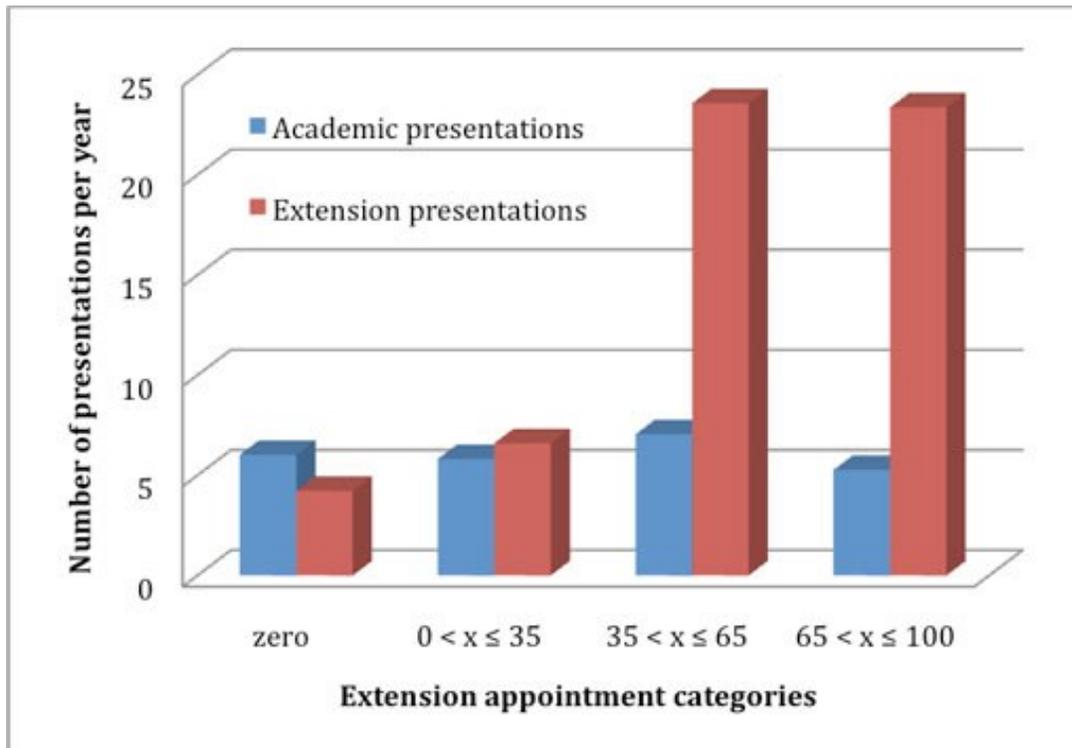
## Clientele Work

In addition to standard research outputs such as journal articles, Extension publications, and students, Extension personnel in the plant sciences are most often expected to interact on a regular basis with farmers, Extension agents, non-governmental groups, and government agencies. This interaction ideally is a two-way information flow; clientele receive information from the land-grant university personnel at the same time they provide information that can be a key input into the research process.

Figure 6 shows the output direction of the information flows demonstrating how many times professors, by Extension appointment category, presented to various groups during the year 2005. In this case Extension clientele includes farmers, Extension agents, non-governmental and community groups, and government agencies, while academic presentations include seminars at their own university, other universities, and academic conferences. Plant science professors with Extension appointments above 35% present far more

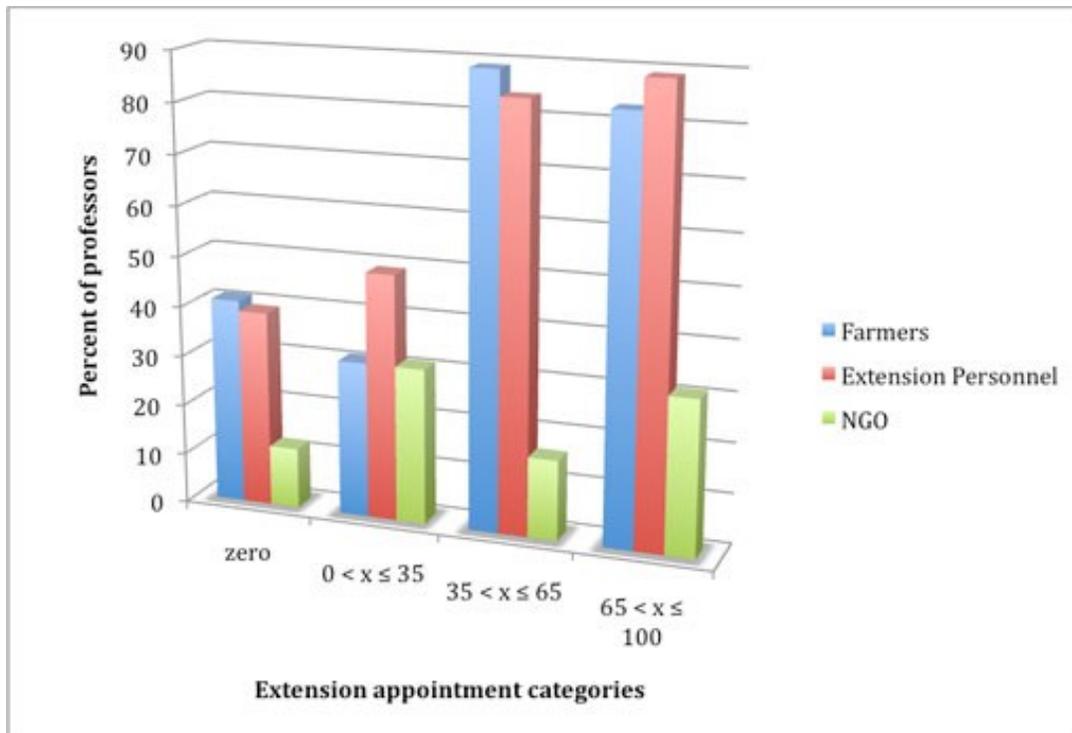
Extension presentations, nearly 18 more, than both professors with zero Extension appointment and professors with appointments in the 0-35% range. Academic presentations, surprisingly, vary only slightly for all Extension appointment categories, including zero Extension appointment, suggesting that Extension professors maintain active academic interactions in their careers.

**Figure 6.**  
Presentations by Audience Type



We then investigate with which groups outside the university plant scientists have collaborations. Showing a similarly strong pattern, collaborations with farmers and Extension personnel show in Figure 7 a significant increase once Extension appointments increase above 35%. Between 80-82% of plant science professors with Extension appointments collaborate with both farmers and Extension personnel in identifying an important research problem. These data suggest an important threshold around the 35% appointment range. In the 0-35% range, less than 30% of professors consult with farmers in identifying a research problem, while a little over 40% consult with Extension personnel. In the zero percent appointment category, roughly 38% of professors consult with both farmers and Extension personnel in identifying research problems. As for consulting with nongovernmental organizations, less than 30% of professors in all categories consult with them in identifying a research problem; around 10% of professors with zero Extension appointment consult with NGOs.

**Figure 7.**  
Inputs into Research: Collaborations of Plant Scientists



## Conclusion

These results show that Extension professors in the plant sciences are quite active in research and teaching at their universities. They receive federal funding at nearly the same level as non-Extension professors and are as academically productive, and in some cases more productive, than non-Extension professors. In addition, plant science professors with zero Extension appointment also engage in work (Extension bulletins and clientele contacts) that is typical of Extension professors in the plant sciences. This Extension work by non-Extension professors suggests that the land-grant idea of a university engaged in its community is still alive in the plant sciences. Overall, the results for plant scientists have many of the same findings as recent work for all agricultural scientists by Foltz and Barham (2009). This suggests impressive levels of common ground across diverse appointment mixes as well as across different departmental affiliations within agricultural colleges.

Across the Extension appointment categories, we find that plant scientists with zero Extension appointment are comparable to plant scientists with 0%-35% appointments in graduate students produced, funding received, and journal articles published. In fact, average funding, journal article publications, and graduate students produced show little variation among the zero, 0%-35%, and even to some extent the 36%-65% categories.

At the same time, there is a dramatic difference in terms of Extension bulletin production and clientele visits between low levels of Extension appointments and the upper range above 65%. The tradeoffs between research and Extension activities do not seem to be particularly strong until Extension appointment levels hit around the 40-50% range, and they appear to become quite strong in the over 65% category in terms of many of the research measures mentioned above. Specifically, from the LOWESS curve estimation, we saw that for plant scientists above a 50% Extension appointment level, journal publications drop significantly without any particular gain in Extension bulletin output, or for that matter clientele visits. This suggests that faculty

above a 50% appointment may be engaged with both more standard educational activity within Extension and perhaps activities oriented toward organization and leadership rather than research. It may also be the case that these more specialized Extension personnel are engaged in providing basic information on crop varieties and practices, business management, and the like, that may have fewer synergies with research outputs.

Nonetheless, the fact that these tradeoffs do not become strong until faculty appointments become highly specialized is also suggestive that there may be an ideal level of moderate Extension appointments that do not exceed 50%. It may be especially important to keep this possibility in play for younger faculty, both for promotion reasons and for professional development options. Another important avenue for administrators to consider may be developing better metrics for measuring the type of organizational and leadership type activities that are often done by high Extension appointment faculty, but rarely get adequately measured. We hope that our work motivates future investigations that explore and measure these outcomes.

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