Food Policy 38 (2013) 126–135

Contents lists available at SciVerse ScienceDirect

Food Policy

journal homepage: www.elsevier.com/locate/foodpol

Is the share of agricultural maintenance research rising in the United States?

John Adam Sparger [a], George W. Norton [a,*], Paul W. Heisey [b], Jeffrey Alwang [a]

[a] Department of Agricultural and Applied Economics, Virginia Tech, Blacksburg, VA 24061-0401, United States
[b] US Department of Agriculture, Economic Research Service, 355 E Street SW, Washington, DC 20024-3221, United States

ARTICLE INFO

Article history:
Received 11 October 2011
Received in revised form 6 November 2012
Accepted 11 November 2012
Available online 20 December 2012

Keywords:
Agricultural maintenance research
Expenditures
Productivity
Policy

ABSTRACT

Public research is a major contributor to agricultural productivity growth, but if research investments are not maintained, agricultural productivity can decline over time. Maintenance research replaces deteriorated research knowledge to forestall a productivity decline. Knowledge of the magnitude of maintenance research can facilitate a more complete assessment of the value of agricultural research programs. Trends in maintenance research and sources of change in those trends are investigated. Results indicate that overall, about 40% of US agricultural research is devoted to maintenance, up from about a third 25 years ago. A model is developed and estimated to explain maintenance research expenditures. Research funding, climatic conditions, insect and pathogen control, and agricultural production choices influence maintenance research expenditures. Increased reliance on out-of-state funding sources may skew agricultural research away from maintenance research, while climate change may increase the need for such research.

Introduction

Public agricultural research is a major contributor to US productivity growth (Ball, 2005; Alston et al., 2010; Huffman and Evenson, 2006a). Agricultural productivity can decline if research investments are not maintained (Ruttan, 2002). Research deteriorates as climate conditions, soils, pests, and other factors change and, in turn, render past innovations less effective. A major portion of agricultural research budgets is spent just to keep productivity from falling (Swallow et al., 1985; Adusei and Norton, 1990; Alston et al., 2010). Two broad types of agricultural research affect productivity: productivity-enhancing research and maintenance research. The former is concerned with increasing productivity above historic benchmarks while the latter is undertaken to replace deteriorated research in an attempt to keep productivity from declining below that benchmark. Maintenance research does not necessarily increase productivity above any historic benchmark (even though it may). Rather, the main objective of maintenance research is to maintain productivity at the benchmark when threatened with decline or return productivity to the previously reached benchmark when it has declined. Therefore, if research benefits are evaluated simply in terms of productivity increases that set a new benchmark beyond a previously reached benchmark, maintenance research may appear to offer few benefits. The failure to distinguish between productivity-enhancing versus productivity maintaining research might lead to underestimation of the benefits of agricultural research by ignoring the productivity losses avoided or recovered through maintenance research (Alston and Pardey, 2001; Plucknett and Smith, 1986; Adusei and Norton, 1990; Townsend and Thirtle, 2001).

Araji et al. (1978) estimate that elimination of agricultural maintenance research would result in a 25% reduction in US agricultural productivity in as few as five years with the amount differing by commodity. As overall agricultural productivity grows, a growing proportion of research must be devoted to maintenance so that already realized productivity gains will not be lost (Plucknett and Smith, 1986; Ruttan, 1982, 2002).

Despite its importance, little is known about patterns of public research resources devoted to maintenance research in the United States. A study by Evenson (1968) estimated that 30–50% of agricultural research expenditures on crops, poultry, and livestock were devoted to maintenance research. Araji et al. (1978) estimated that 10–35% of a research scientist's time, depending on the commodity, was spent on maintenance research in the western region of the United States. Araji (1990) found that 40% of Idaho agricultural research resources were used to maintain productivity. Adusei and Norton (1990) estimated the importance of maintenance research for a wide range of commodities in the United States. Their survey of US agricultural scientists found that 35% of agricultural research resources in 1986 were devoted to maintenance research – about 21% for livestock and 28–42% for crops.

The current study has two objectives. The first is to estimate the proportions of US public agricultural research devoted to

* Corresponding author. Address: Department of Agricultural and Applied Economics Virginia Tech, 205B Hutcheson Hall (0401), Blacksburg, VA 24061, United States. Tel.: +1 540 231 7731 (office); fax: +1 540 231 7417.
E-mail address: gnorton@vt.edu (G.W. Norton).

0306-9192/$ - see front matter
http://dx.doi.org/10.1016/j.foodpol.2012.11.004

maintenance research for various research programs and to compare those proportions to ones estimated more than 20 years ago by Adusei and Norton. If maintenance research shares are increasing, returns to agricultural research may be increasingly undervalued by methods which measure only the gains from productivity-enhancing research and ignore the losses avoided through maintenance research. This undervaluation essentially results from an omitted variable problem. Most models are unable to include variables that adequately capture the impacts of growing problems with plant diseases, abiotic stresses, and other factors that reduce the productivity of existing technologies and institutions. If these factors negatively affect output and are correlated with agricultural research expenditures, estimated research impacts are biased downward.

Not all agricultural research is devoted to commodities. By expanding the program areas under investigation to include commodity and non-commodity areas not included in Adusei and Norton's study, this study develops a comprehensive understanding of maintenance research across a wider range of public agricultural research programs.

The second objective of this study is to assess the importance of factors that explain differences in maintenance research expenditures by state. States spending a higher proportion of their research budgets on maintenance find it harder to enhance productivity, but may be avoiding significant productivity declines. It is important to know the relative effects of factors such as agricultural research intensities and funding sources on maintenance research shares compared to the effects of factors such as climate and commodity mixes. We find that increased reliance on sources of funding from outside a given state for agricultural research is associated with less spending on maintenance research within that state. We also find that climate change increases the need for maintenance research. These findings suggest a possible policy concern. The optimal balance between productivity-enhancing and maintenance research, which may be affected by climate change, could be more difficult to attain because of changing sources of funding.

Conceptual framework

The output of research is new knowledge and for many types of agricultural research this knowledge is embedded in new technologies and products (Swallow et al., 1985; Adusei and Norton, 1990). Technologies can depreciate over time resulting in the need for new research. The timing and magnitude of research depreciation, and hence the need for maintenance research, depends on the type of knowledge produced. More basic research depreciates less rapidly than more applied research because basic research is less affected by changes in physical, biological, and socio-economic environments (Adusei and Norton, 1990).

In applied biological research, the need for maintenance research can help explain the difference between theoretical and actual yield gains. For example, in plant breeding, theoretical yield gains can be assessed using quantitative genetics principles and the parameters of the breeding trials, while actual yield progress can be measured with the data from those trials (Swallow et al., 1985). The gap between theoretical and actual genetic progress is due to several factors, including the need for maintenance research. Research which addresses increasing productivity beyond the theoretical limit is productivity-enhancing while research that is focused on closing the gap between actual and theoretical is maintenance research.

Research can depreciate due to obsolescence and deterioration. The analysis in this paper focuses exclusively on deterioration and not on obsolescence. Obsolescence is the depreciation of past research due to newer research that addresses the same base conditions but is more productive, economically efficient, or otherwise better than the previous research. Essentially, the theoretical limit has been increased. This is not because the old research has deteriorated but, rather, because the old research has depreciated relative to the newer research. In this case, the new research is productivity-enhancing research. Examples of productivity-enhancing research include selective breeding resulting in increased or more frequent litters, more efficient irrigation practices that limit loss while providing equal or better dispersion, developing farm management practices that are regionally suited to maximize potential, and developing new cultivars of crops with higher yields.

In contrast, maintenance research replaces previous but deteriorated research knowledge. Deterioration is the depreciation of past research due to changes in the underlying base conditions that render previous research less productive. This happens when the gap widens between theoretical and actual yield limits. Maintenance research might be necessitated by a pesticide or pest management practice that has lost its efficacy or has been eliminated due to a pesticide restriction. It can also address entirely new problems such as a newly introduced invasive species, the effects of climatic change, or an environmental stress such as a prolonged drought. In all of these cases, productivity has declined from a previous benchmark because of changes in the underlying base conditions; the research undertaken to address the decline is maintenance research. See Table 1 for selected maintenance research examples from a survey of scientists described in more detail below.

Many factors may be associated with variations in the proportion of maintenance research expenditures in total agricultural research expenditures (known as research intensity) across states and over time. These factors include the level of agricultural research funding, climatic conditions, land degradation, pests and pathogens, the agricultural product mix, and economic conditions. These factors are included in an econometric model of correlates of maintenance research described in more detail below.

Methods and data

To assess changes over time in proportions of state research budgets devoted to maintenance research, a two part approach was taken. In the first part, a survey questionnaire was emailed to approximately 4000 US agricultural research scientists from a list obtained from US Department of Agriculture in order to determine the percentage of their research devoted to maintenance research and the nature of their maintenance research projects. Results were used to compare maintenance research proportions with those from the 1986 survey of Adusei and Norton. In the second part, the examples given in individual survey responses were further used to identify corresponding research problem areas and knowledge areas from the Current Research Information System (CRIS) which could be classified as maintenance research and distinguish them from those which could be classified as productivity-enhancing research. These classifications of CRIS data allowed for construction of a variable to be used in a time-series analysis of the proportion of total research devoted to maintenance research in each state over the 1976–2006 time period. A regression model was then run to explain this proportion.

Survey of agricultural scientists

The survey questionnaire (see Appendix) was emailed with a letter which defined and provided examples of research depreciation and maintenance. In order to compare results with those of Adusei and Norton, many survey questions were identical and