

## **Abstract for “Measuring Output, Input and Total Factor Productivity in Australian Agriculture”**

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Increasing productivity has long been recognised as the most important source of long-term output growth and income improvement in the Australian farm sector. Although there are differences in methodology and data, previous literature has generally reached the consensus that more than two thirds of agricultural output growth and almost all growth in farm profits in Australia have come from productivity growth over the period from 1949–50 to 2010–11 (Mullen 2010; Productivity Commission 2011). Agricultural productivity growth in Australia also plays an important role in maintaining international competitiveness given declining terms of trade, increasing climate variability and tightening constraints on natural resource use.

The total factor productivity (TFP) index is a widely used measure of agricultural productivity performance, as it provides a broad indicator of how efficiently farmers combine inputs to produce total output. To measure TFP, researchers aggregate crop and livestock products in an index of total output and compare it with an index of total input that aggregates land, labour, capital, and materials and services inputs. Agricultural productivity changes are identified when the ratio of total output to total input changes over time.

Statistical agencies in Australia have applied growth accounting based index formulas (namely, the Fisher or Törnqvist indexes) to obtain agricultural TFP estimates. ABARES uses a gross output model and farm survey data to derive ‘bottom-up’ TFP measures for Australian broadacre and dairy industries. These industries cover around 70 percent of agricultural activities and the TFP estimate begins from 1977-78. As the survey data do not cover all agricultural industries, the usefulness of such estimates lies in providing a measure of TFP growth for individual industries.

In contrast, the Australian Bureau of Statistics (ABS) measures TFP for the agriculture, forestry and fisheries sector as a whole. Using national accounts data and two models—the value-added model and the gross output model—the ABS derives ‘top-down’ TFP measures, which start from 1985–86 for the value-added estimates and from 1994–95 for the gross output estimates. These estimates are primarily suited to comparisons of productivity growth across market sectors, but cannot reflect the long term trend change in agricultural productivity given the limited time series. In addition, the absence of quality adjustments for some inputs such as land and labour and the inappropriate treatment of intermediate inputs potentially bias the estimates.

This paper develops a growth accounting based measure of Australian agricultural TFP that includes all agricultural industries and covers the period between 1949-50 and 2010-11. The approach builds on existing ABS methodologies and international best practice for gross output based input and output measurement. Three contributions are made to existing agricultural productivity measures in Australia. First, the paper is the first attempt to measure productivity in the agriculture sector separately from the forestry and fisheries sectors. Second, the paper develops a production account specific to Australian agriculture with data from both national accounts and farm surveys, which allows for the 'top-down' TFP measure to account for characteristics specific to the 'bottom-up' system (the farm production). Third, quality adjustments are made for land and intermediate inputs. In particular, returns to self-employed labour are derived endogenously from the accounting equality between output and input value (or the model closure).

The results show that total factor productivity in Australian agriculture has grown at an annual rate of 2.03 per cent a year between 1949-50 and 2010-11, accounting for more than 80 per cent of output growth in the industry. Changes in output composition and input mix have played a significant role in driving productivity growth. In particular, the adoption of new technology and management skills has been apparent in a substitution of capital and intermediate inputs for labour over the past six decades.

As a robustness check, the estimated agricultural TFP is compared with existing estimates. The agricultural TFP growth between 1977-78 and 2010-11 estimated in this paper (1.8 per cent a year) is higher than the ABARES estimate for the broadacre industry (1.0 per cent a year), while it is lower than that the ABS value added measure for the Agriculture, Forestry and Fisheries sector (the ABS estimate is 2.6 per cent a year between 1985-86 and 2010-11, compared with 1.5 per cent a year in this paper).