Extended Abstract
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Paper Title	**Beef and Sheep Productivity in Northern Ireland: Total Factor Productivity and Drivers.**

Abstract prepared for presentation at the 98th Annual Conference of The Agricultural Economics Society will be held at The University of Edinburgh, UK, 18th - 20th March 2024.

Abstract	***200 words max***
This paper investigates productivity and factors influencing its growth. Analysis is conducted using a Fisher index measure of total factor productivity (TFP) of the beef and sheep sector in Northern Ireland (NI) over the period 2005-2019. Results show that that beef and sheep in LFA sector experienced marginal growth in TFP of 0.4% a year between 2005 and 2019. This implies that the expansion in output, relative to input used, was the main driving force of productivity growth. In contrast, beef and sheep farms in the Lowland areas experienced an average annual decline in productivity growth of 0.5% in the same period. Regression results using a fixed effect model suggests that beef and sheep farms operating intensive systems are more productive. Diminishing marginal returns to purchased feed may set in for some farmers, at which point higher feed input will not enhance productivity. Beef and sheep farms engaged in off-farm activities are optimising available time and able to run intensive unit. Reduction in labour inputs in NI beef and sheep farms may imply a gradual and partial replacement of labour inputs with capital, however, this has not necessarily translated to a growth in capital productivity.	

Keywords	O4 Economic Growth and Aggregate Productivity
JEL Code	O47 Empirical Studies of Economic Growth; Aggregate Productivity; Cross-Country Output Convergence

Introduction	***100 – 250 words***

Increasing productivity growth remains an essential element in sustaining international competitiveness of Northern Ireland's (NI) beef and sheep farm sector. Beef and sheep production represents a large share of farm businesses, with a significant proportion of these operating in Less Favoured Area (LFA), a poorer quality of land. These farmers face considerable challenges in running their businesses and uncertainties regarding future direct payments. Therefore, it is important to gain a better understanding of the sector's performance to maintain and improve competitiveness in a changing national and international context.

The productivity of NI agriculture as a whole is currently measured using aggregate data, however it is not disaggregated into individual sectors, so it is difficult to determine trends. The research reported in this paper investigates productivity and factors impacting the productivity of NI beef and sheep sector.

Methodology	***100 – 250 words***

There are two main measures of productivity: Partial Factor Productivity (PFP) and Total Factor Productivity (TFP). The former is simply the ratio of total outputs to a single factor input such as output per unit of labour, or labour productivity, and output per unit of land, or yields. The second measure, TFP, is more robust because it compares total outputs to all the productive inputs (land, labour, capital, materials, and services). In estimating TFP, the physical quantities of both the outputs and inputs are needed, however, these items have different units of measurement (they are heterogeneous), and therefore cannot be aggregated directly. An attempt to aggregate these different categories of outputs and inputs requires the application of an index formular which uses either price or value as weights for each item and enables comparison. Hence, this research applied a non-parametric formula called the Fisher Index (used by many national statistical offices and in the refereed academic literature) to construct indices of total outputs and inputs. Regression analysis of farm-level productivity, farm and farmer characteristics was carried out using panel fixed-effect approach. The data used for estimation are mainly obtained from the Farm Business Survey (FBS) data collected annually through the Department of Agricultural, Environment and Rural Affairs (DAERA). The dataset covers the period 2005 – 2019.

Results	***100 – 250 words***

Findings show that the NI beef and sheep sector in LFA experienced a positive average growth in TFP of 0.4% a year between 2005 and 2019. In contrast, the Lowland beef and sheep sector experienced an average decline in TFP of 0.5% a year in the same period. Further comparison with England shows a decline in annual productivity growth in the beef and sheep LFA sector by 0.7% during the period 2005-2019, and in increase of 0.5% in its Lowland sector. Out of the five factors of production (land, labour, capital, materials, and services), Labour input increased the least (0.1 % per year) compared to other inputs, making labour productivity growth the most important contributor to overall TFP growth in beef and sheep farms both in LFA and Lowland sectors in NI.

Results from the regression analysis reveal herd size, stocking density and off-farm participation to have a positive and significant relationship with farm productivity. Purchased feed, labour intensity, age, land quality (LFA/Lowland), Capital/labour ratio and part-time farming has a negative and significant relationship with productivity.

Discussion and Conclusion	***100 – 250 words***

The marginal improvement in productivity in the LFA beef and sector implies that the expansion in output from beef and sheep farms in LFA, relative to input used, was the main driving force of productivity growth. The decrease in productivity growth in the Lowland sector appears to be largely driven by input growth, with most inputs increasing at a faster rate than outputs. Beef and sheep in LFA in NI performed better than the sector in England during the same period. This may suggest that beef

and sheep farms in LFA, particularly part time farmers, are moving to a lower input system that requires less labour, improving output per labour unit, even if overall total output decreases.

Regression results further suggests that beef and sheep farms operating intensive systems are more productive. Diminishing marginal returns to purchased feed may set in for some farmers, at which point higher feed input will not enhance productivity. As expected, larger farms are more competitive and have been able to take advantage of economies of scale. Beef and sheep farms engaged in off-farm activities are optimising available time and able to run intensive unit to maximise overall economic welfare. Reduction in labour inputs in NI beef and sheep farms may imply a gradual and partial replacement of labour inputs with capital, however, this has not necessarily translated to a growth in capital productivity. Further suggesting inefficient use of capital resources, and the reluctance to adopt technological changes as farmers get older.