Benchmarking Best Practice

Profiling farms using machine learning approaches

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Introduction

Scottish agriculture is undergoing reform, and the Agriculture and Rural Communities (Scotland) Act (2024) sets out ambitious objectives for the future of the sector: promoting regenerative, sustainable and high-welfare practices; supporting the production of high-quality food; restoring nature and addressing climate change through mitigation and adaptation; and strengthening the resilience of rural communities.

To assess progress towards these goals, new monitoring approaches are needed that can capture change across multiple dimensions of farm performance.

Profiling Best Practice

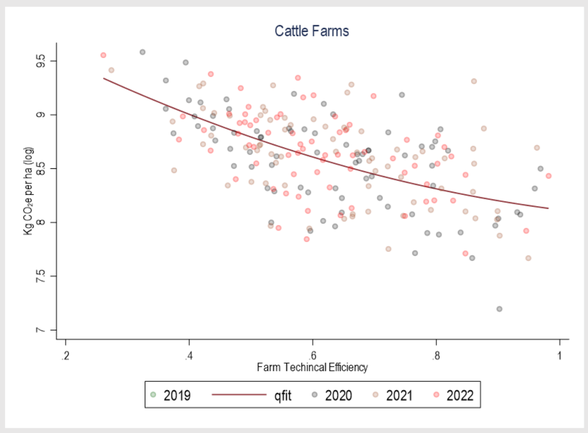
Best practice is a relative measure of performance across an industry sector. Whereas farming management has focused on single measures of progress, such as productivity, the Reform of Agricultural Policy requires best practice to be identified on multiple environmental, economic and social dimensions. This infers new techniques are needed to characterise farming performance.

Machine learning is a growing field of analytical approaches to that can both characterise and predict performance. Using the farm business survey in Scotland we show some of the approaches used to respond to the challenge of characterising farms under these new goals and how it helps us to define what Best Practice means from an industry applied approach.

Methods

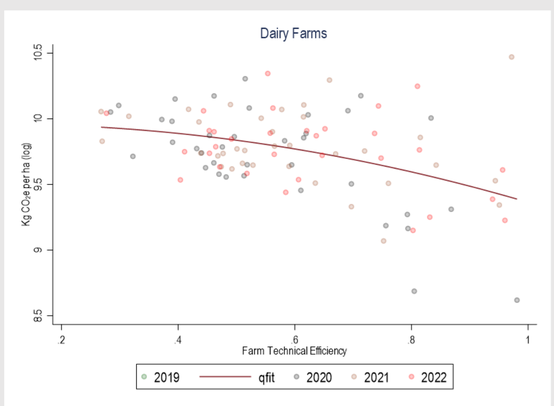
The FBS data is based on an annual survey of approximately 400 farms. The sampling strategy of the FBS is based on a stratified simple random sample and is effectively designed as a panel survey with little change in the membership of the sample between years.

From the period 2019/2020, FBS farmers have had a carbon audit. This involved a further detailed interview with each farmer to compile against a carbon calculator 'Agrecalc'.



Scatterplots showing the relationship between Emissions Intensity and Farm Technical Efficiency.

The figures show a weak relationship, indicating a great deal of heterogeneity around the estimates.



Results

Figure 1 – Clustering for Production and Environmental Emissions

Beyond Best Practice?: Using emissions intensity, technical efficiency, food production intensity and viability we identify different sizes of best practice for Scottish Arable Farms.

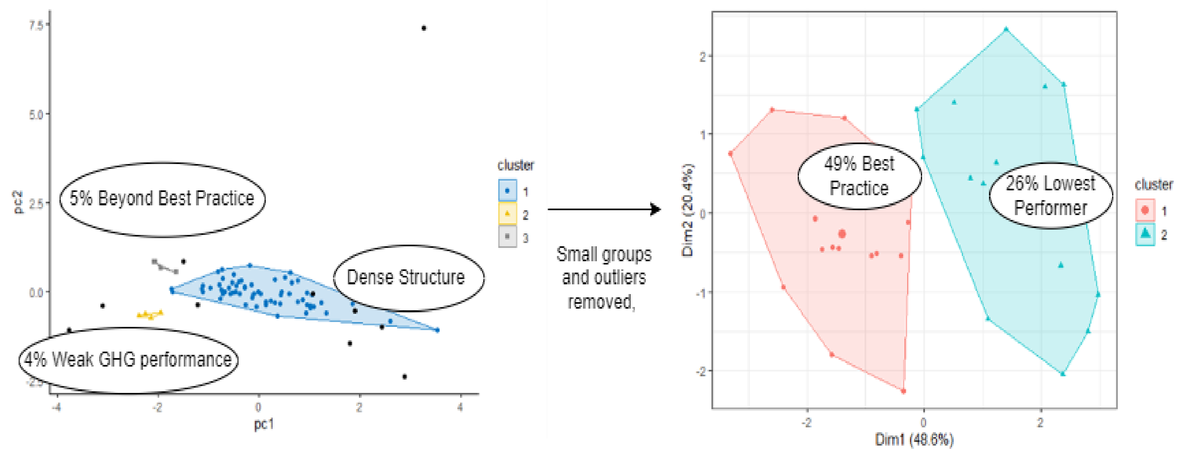
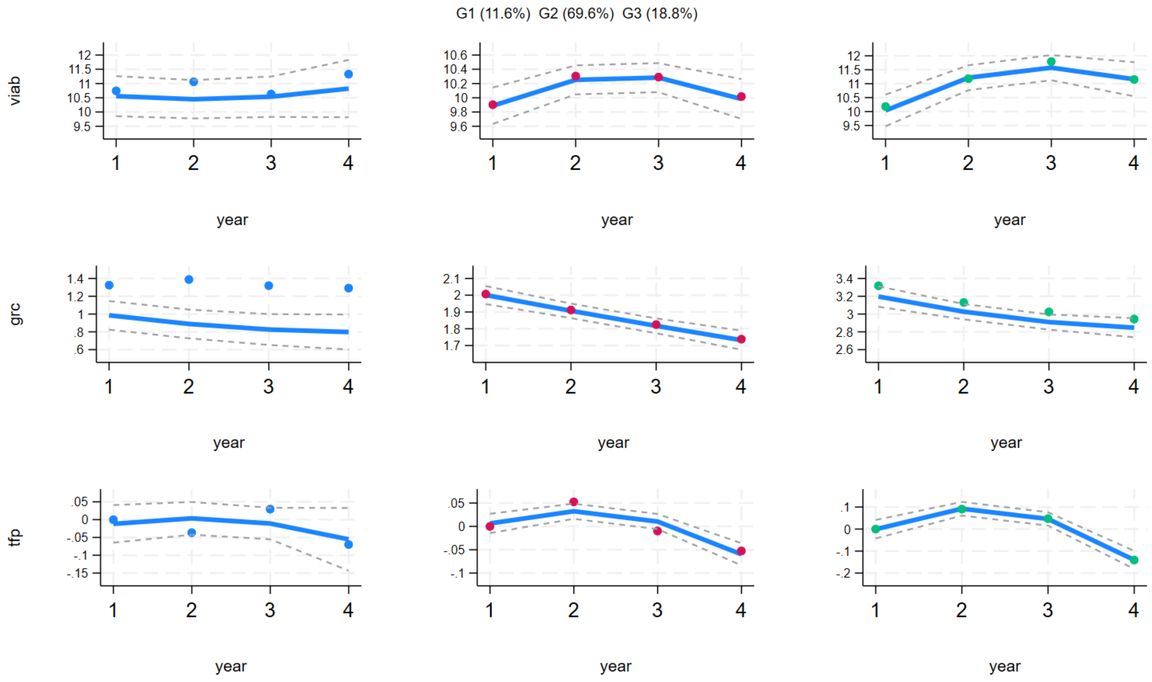


Figure 2 - Characterising Trajectories to examine performance:

Looking over viability (viab), carbon productivity (grc) and technical change (tc). We find three main trajectories for Scottish livestock farms,



Conclusions

Identifying best practices in farming is challenging given its heterogeneity. Newer methods of characterisation are available to accommodate more complex goals for agricultural policy

Testing ML algorithms identify both large and smaller groups, reflecting a spectrum of practices

Testing trajectory-based clustering overcomes the use of single or aggregated data reflecting one time point.

Whilst we focus on characterising farms, the next stage is on the prediction of facets to inform agricultural policy

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Environment, Natural Resources and Agriculture (ENRA) Strategic Research Programme 2022-2027, project: Ensuring positive behavioural change for farmers towards best practice for clean growth, (Project B3-1): Scottish government, Grant/Award Number: SRUC-B3-1.

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Further Reading

Barnes, A. P., Bevan, K., Moxey, A., Grierson, S., & Toma, L. (2023). Identifying best practice in Less Favoured Area mixed livestock systems. *Agricultural Systems*, *208*, 103664.

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