



Abstract

To find opportunities to improve, in efficiency or performance, farms are often compared on the basis of standard typologies (i.e. categorisations). For example the EU "specialist-cereals-oilseeds-pulses" farm type, known in Britain as "cereals" farms. These categories, being aggregates, contain significant numbers of atypical enterprises. For example, in 2017 there were 30 cattle and 69 sheep on the average "general-cropping" farm in England. This means that comparators are averages across farms with widely divergent scales of different enterprises (and hence farm characteristics), that are not relevant for the comparison. Furthermore, farmers may not necessarily even know their own farm "type". We therefore present a novel method that matches a specific farm against all farms in a comparator group (the survey sample), and then selects the nearest neighbours (in Z-score). This is undertaken in 34 dimensions for English farms. These include, in the matching procedure, almost all the enterprises characteristic of English farms, as well as tenure and geographic proximity. Means and other statistics are calculated specifically for that "peer set" (of 25 farms, or more if less than 1 Z-score away across all 34D). This generates a uniquely defined comparator for each individual farm and gives a much better idea of key-performance-indicators. This methodology has potential to be applied across the full range of farms and in wider contexts.

Keywords Benchmarking, Survey & administrative datasets, Farm typologies, Peers, Performance

JEL code Micro Analysis of Farm Firms, Farm Households, and Farm Input Markets Q120

INTRODUCTION:

Individual farmers face considerable problems when attempting to compare their individual performance with the performance of other farms: every farm is different, with a number of different enterprises, generating a variety of different income streams. However, it is clearly helpful for individual farmers to be able to have some standard against which to judge their performance, to identify areas in which they may be underperforming and aspects of the business that could be improved. Benchmarking (also "Decision Support", Rose and Bruce 2017) is an increasingly popular approach in efforts to enable farmers to increase their incomes and levels of productivity (e.g. Camp 1989, Jack 2009, Vitale et al. 2019, Wilson et al. 2005) or to reduce their ecological footprint (e.g. de Olde et al. 2016, de Snoo 2006, Halberg et al. 2005, Mu et al., 2017). Therefore, farms are often categorised and compared on the basis of typologies. For example, in the European FADN/RICA classification (European Commission 2013), "Specialist COP" (cereals-oilseed-pulses; also called "cereals" in Britain) or "Specialist other field crops" (also called "mixed-cropping", or in Britain "general-cropping"). These categories, being aggregates, contain significant quantities of atypical enterprises. Meaning that comparisons are aggregates of farms with widely divergent characteristics (in scales of different enterprises), that are not relevant for the comparison being sought. For example, there are 30 cattle and 69 sheep on the mean "general-cropping" farm in England. In addition, many farmers may not even know their "type" - or are close to the cut-off point between types (which leads to unstable typing). Furthermore, there is a tendency to assume that a farm is "mixed", where there are small numbers within a particular enterprise (to take an extreme example, a farm with cereal crops and a single sheep is not a

mixed farm). To address these issues, this paper introduces the innovation of matching to "farms like mine", where matching is primarily on land use areas and livestock numbers contained in farm survey datasets. We thus demonstrate a novel method for the identification of benchmark standards, that can provide more relevant and useful standards for farm management decision-making.

METHODOLOGY:

In the UK, the Farm Business Survey (FBS) has ten 'robust' farm types, where type is determined by an enterprise or combination of enterprises that exceed a threshold of two thirds of total farm output. Outputs are standardised to reflect a "normal farm in average conditions" (Defra 2018). For example, Dairy Farms are "holdings on which dairy cows account for more than two thirds of their total Standardised Output (SO)"; Cereal Farms are "holdings on which cereals and combinable crops [...] account for more than two thirds of the total SO". A Mixed Farm is effectively a farm that does not fit into any of the other FBS categories, as no single or defined combination of enterprises meets the two thirds threshold (Defra, *ibid*). As noted in the introduction, the problem for an individual farm manager is that these farm types may have different characteristics to the farm being managed. For example, Mixed Farms in the FBS can be 'mixed' in different ways; the 'mean' farm may include a wider range of livestock enterprises; whereas the benchmark farm may only contain a subset of these enterprises. In contrast, we present results here from an alternative methodology that matches farms to all farms in the comparator group (survey sample) and selects the nearest neighbours (on Z-score) in 34 dimensions; the matching procedure includes almost all characteristic enterprises for farms in England, including additionally tenure and geographic proximity. Means and other statistics are then calculated specifically for that small "peer set" (of 25 farms, or more if the total summed distance is less than one Z-score across the 34D). Euclidean, Mahalanobis, and other distance metrics (incl. Manhattan Block) were also tested (Piegorsch 2015).

Where Euclidean distances are:

$$d_{1..n} = \text{sqrt}(\text{sum}(\mathbf{X}_{1..n} - \mathbf{x}_i)^2)$$

$$x_i = (\text{MyFarm}_j - \text{SampleMean}_j) / \text{SampleSD}_j$$

$$\mathbf{X}_{1..n} = (\mathbf{Y}_j - \text{SampleMean}_j) / \text{SampleSD}_j$$

Where $d_{1..n}$ is a vector of 1-to-n sums of normalised distances, away from each farm in the sample n farms. $\mathbf{X}_{1..n}$ is a matrix of j standardised variables (the 34D) by 1-to- n farms (the sample n). x_i is a vector of the j standardised variables (the 34D) for "my farm" (i). And $\mathbf{Y}$ is the matrix of un-standardised 1-to- n sample values (for the j variables). SD is standard deviation.

RESULTS:

34 Dimensions are chosen for Britain. Namely: *winter wheat area; winter barley area; spring barley area; other cereals area; oilseeds area; peas beans area; potatoes area; sugar beet area; other arable crops area; fodder crops area; fallow area; uncropped area; temporary*

grass area; permanent grass area; sole rough grazing principle area; top fruit area; outdoor vegetable area; other male cattle 1 to 2years; other female cattle 1 to 2years; other male cattle over 2years; heifers; dairy cows; beef cows; ewes; other sheep; breeding sows; store pigs*; broilers*; laying flock*; growing pullets*; organic area fully*; EASTING†; NORTHING†; TENANTED_Percentage*

* double (2x) weighted

† weighted at 0.6

Farms that are geographically far away will be matched very closely on all other dimensions; farms which are in close proximity may diverge more in other dimensions. However, note that the closest matches will be chosen in all cases. The simplest distance metric (namely Euclidean), on Z-scores (of farms with the enterprise only), was found to be superior to others. The method has the capacity to provide farmers with better guidance as to how the management and organisation of their business might be improved.

DISCUSSION AND CONCLUSIONS:

This paper has demonstrated a new approach to benchmarking. While this has been applied to farms, there is no reason in principle why it should not be applied in benchmarking in other sectors (like that discussed by: Camp 1989, and ten Raa 2009), from survey or administrative datasets. However, the need for benchmarking in agriculture is clear for a range of reasons. The rate of productivity increase in the UK is low (Baráth and Fertő 2017). Allowing for uncontrollable farm diversity due to environmental factors such as altitude, soil type and weather, it is clear from the Farm Business Survey that performance varies considerably between similar farms. Brexit (Ward 2019) and a potentially more stringent financial environment gives an added urgency to the need to increase farm productivity and incomes through techniques such as Benchmarking. "Farms like mine" (i.e. matched to closest-peers) - gives a better idea to a farm manager - e.g. of key-performance-indicators such as cost per unit weight produced - because the comparison is made to a more relevant peer set: more relevant than is the case for comparisons with standard farm types. In the case of General Cropping farms in particular, average figures, from farms with a large range of enterprises, will compromise the usefulness of benchmark comparisons with farmers' own farm. With "farms like mine", these peer sets of more similar farms, as matched here, provide more relevant comparisons. Options for future development may be: i) selection of different variables for matching, ii) doing more to understand farmers' objectives and developing matching around those objectives (be they climate, farm-income, or economic - e.g. Total Factor Productivity), iii) systematic analysis of the weighting criteria for different variables; and iv) finding new technologies or enterprises that might be added in particular circumstances - and then extending matching to encompass these.

BIBLIOGRAPHY:

Baráth, L. and Fertő, I. (2017), Productivity and Convergence in European Agriculture. *Journal of Agricultural Economics*. 68:228-248. doi:[10.1111/1477-9552.12157](https://doi.org/10.1111/1477-9552.12157)

- Camp, Robert C. (1989). *Benchmarking: the search for industry best practices that lead to superior performance*. American Society of Quality Control: Milwaukee.
- de Olde, Evelien M., Oudshoorn, Frank W., Sørensen, Claus, A.G., Bokkers, Eddie A.M., de Boer, Imke J.M. (2016). Assessing Sustainability at Farm-Level: Lessons learned from a comparison of tools in practice. *Ecological Indicators*. 66:391-404. [dx.doi.org/10.1016/j.ecolind.2016.01.047](https://doi.org/10.1016/j.ecolind.2016.01.047)
- de Snoo, Geert R. (2006). Benchmarking the Environmental Performances of Farms. *International Journal of Life Cycle Analysis*. 11(1):22-25. [dx.doi.org/10.1065/lca2006.01.235](https://doi.org/10.1065/lca2006.01.235)
- Defra. (2018). *Farm Business Survey, Technical Notes*. Available at: <https://www.gov.uk/guidance/farm-business-survey-technical-notes-and-guidance#fbs-documents> Accessed 13/03/2019.
- European Commission. (2013). *Farm Accountancy Data Network*. Available at: http://ec.europa.eu/agriculture/rca/concept_en.cfm Accessed 14/03/2019.
- Halberg, Niels., Verschuur, Gerwin., Goodlass, Gillian. (2005). Farm Level Environmental Indicators; Are They Useful? An overview of green accounting systems for European farms. *Agriculture, Ecosystems and Environment*. 105:195-212. doi.org/10.1016/j.agee.2004.04.003
- Jack, Lisa. (2009). *Benchmarking in Food and Farming*. Gower: Farnham.
- Mu, W., van Middelaar, C.E., Bloemhof, J.M., Engel, B., de Boer, I.J.M. (2017). Benchmarking the Environmental Performance of Specialized Milk Production Systems: Selection of a set of indicators. *Ecological Indicators*. 72:91-98. [dx.doi.org/10.1016/j.ecolind.2016.08.009](https://doi.org/10.1016/j.ecolind.2016.08.009)
- Piegorsch, Walter C. (2015). *Statistical Data Analytics*. John Wiley: Chichester.
- Rose, David C., Bruce, Toby J.A. (2017). Finding the Right Connection: What makes a successful decision support system. (Editorial). *Food and Energy Security*. doi.org/10.1002/fes3.123
- ten Raa, Thijs. (2009). *The Economics of Benchmarking*. Palgrave: Basingstoke.
- Vitale, Pilja., Vitale, Jeffrey., Epplin, Francis. (2019). Factors Affecting Efficiency Measures of Western Great Plains Wheat Dominant Farms. *Journal of Agricultural and Applied Economics*. 51(1):69-103. doi.org/10.1017/aae.2018.24
- Ward, Simon. (2019). The UK Governments Role in Post BREXIT Farm Income Support and Trade Policy. Paper presented at *The 22nd International Farm Management Association Congress*: Launceston. <http://ifma22.org>
- Wilson, Ross H., Charry A.A., Kemp, D.R. (2005). Performance Indicators and Benchmarking in Australian Agriculture: Synthesis and perspectives. *Extension Farming Systems Journal*. 1(1):45-57.