



SRUC

# Scottish Farm resilience: robustness, adaptation and transformation of Scottish farms 1989 to 2020.

*Andrew Barnes, Department of Rural Economy, Environment and Society, SRUC, West Mains Road, Edinburgh, UK*

## Summary

Given changes in the external environment, there has been much concern over the resilience of farming within Scotland. Resilience is a dynamic concept and covers a number of areas, namely: i) how robust a farm is to the changes in the external environment. This includes how they both are affected by a drop in incomes but also the rate at which they may recover from a drop in incomes, ii) adaptation to the external environment, this covers how much a farm may change its key approaches such as intensifying or extensifying, or specialising or diversifying its on-farm activities, and iii) transformation in response to the external environment, which covers the way in which a farm changes from its original purpose, such as converting to organic or increasing its off-farm diversification.

We find that most farms score highly on their robustness scale, which reflects a high resistance to change. However, around 20 to 25% of farms suffer shocks, in terms of a 30% drop in incomes from one year to the next. Moreover, the farms scored lower on adaptation, which shows that less farms were adapting to the external environment, in terms of changing their practices. Finally very few farms had changed their off-farm income, which is used as an indicator of transformation here. Generally those farms with more diversity of on-farm activities tend to score better than those with more specialised enterprises. Mixed farms tend to have the highest levels of robustness, whereas General Cropping farms had higher levels of adaptation. However, there is a considerable range of performance within farming types.

Under the potential for new reform of Scottish agricultural policy, accommodating resilience should be key to promoting sustainable resource use. Understanding how our farms have changed to external environments in past will give some direction towards supporting farms to enable change but also buffering them for shocks and disturbances within the external economic environment.



Scottish Government  
Riaghaltas na h-Alba  
gov.scot



## 1.0 Introduction

Farming resilience is a significant concern in policy circles given recent price fluctuations, increases in weather variances and policy uncertainty around the UK's withdrawal from the European Union. Resilience has a number of dimensions and the literature tends to argue it is composed of the following components:

**Robustness:** This relates to how the farm would react to short term changes in the external environment. This encompasses the resistance of the farm to these external changes, but also the rate by which the farm recovers from any external change.

**Adaptation:** How farms change over time in response to the external environment. This will be specific to the farm but could generally see a trend towards more specialisation, or increasing levels of intensification or extensification of activity over time.

**Transformation:** How farms redistribute their factors of production towards a different aim. This can be inferred through, for example a switch from conventional to organic farming, or through an increase in off-farm revenue.

Generally, resilience is a dynamic concept and based on how an individual farms responds over time. The purpose of this briefing note is to present results of trends in the resilience traits of the main Scottish farm types, namely Specialist Dairying, Cereals, General Cropping, LFA Cattle, LFA Sheep and LFA Cattle and Sheep as well as mixed enterprises. This allows us to understand how these farms have changed over time but also how certain activities, e.g. more specialised compared to diversified, will support or limit resilience characteristics.

## 2.0 Method

The Scottish Farm Business Survey (SFBS) collects data for around 400-500 individual farm businesses across Scotland. The FBS has collected data since the 1930s but has only been digitised from 1989 onwards. Data are collected over each succeeding crop year using detailed farm accounts data for each farm business and collated through an individual assessor. The data go through numerous quality checks before release and are used as the basis for understanding some of the main changes in economic circumstances of Scottish farms.

To estimate the components of resilience we derive a number of indicators over time, based on Slijper *et al.* (2021) analysis of EU FADN data. We estimate the rate of return on total assets (RoA), measured as the change in cash income - a short-term indicator of liquidity - to total assets. This is used as a benchmark against a farm's peers within each farm type, e.g. dairy farms in one year. We then measure the change in RoA on a per year basis and assess how that farm has changed in terms of whether the RoA has changed. By effectively setting the range of performance from 0-lowest performing farm within that type within that particular year - to 1 - the highest performing farm - we can understand how farms have changed relative to similar farms over time. If the farm has lower RoA in one year then we can assess how the percentage loss measures against peers in the same sector and the same year, but also how long that farm suffers a fall in RoA. This also allows us to understand the recovery rate, which is the rate at which the farm may increase RoA over time. Hence our indicators of resilience are measured in terms of the rate by which RoA changes over each year, e.g. whether the RoA increased or decreased from year 1 to year 2.

## Robustness

Resistance	Percentage decrease in profitability
Shock	Whether the farm experienced at least a 30% drop in RoA in the pervious year.
Recovery rate after year 1	Degree of recovery after 1 year. Expressed as a percentage of the decrease in profitability

Robustness is composed of three indicators which run from 0 (low robustness) to 1(highest robustness). Resistance is the change in the RoA from this to last years RoA. If the RoA increases then the farm scores 1, but if the RoA is lower than last years' then the difference reflects the percentage decrease in profitability. Secondly, we measure whether the farm suffers a shock. This is taken as whether the farm suffered a drop in at least 30% of their RoA from last year to this year and calculated as either a 1(no shock) or a 0(experienced a shock). Finally, the recovery rate is measured as the change in this to next year's RoA if the RoA has improved.

## Adaptation

Production Intensification	Percentage change in stocking density or fertiliser use from one year to the next
Structural Intensification	Percentage change in labour units per ha from one year to the next
Specialisation	Percentage change in either livestock or crop revenue to total revenue from one year to the next

Adaptation reflects year on year change in the farm. It is reflected in changing intensification or specialisation in response to the external environment. Again, all variables were adjusted to run from 0 where there was no adaptation to 1 the highest amount of adaptation within those farm types for that year.

## Transformation

A farm transformation is difficult to measure given the scope of the SFBS on agricultural business indicators. However, whilst only a few farms may have changed to organic, we can identify the change in off-farm compared to on-farm income. Hence, this ratio was measured from 0 - where there was no transformation to 1- the highest amount of transformation within those farm types for that year.

To estimate these components we dropped all farms that were only in the SFBS for less than 3 years in a row. We then estimated an index based on different weights of the three components. These were estimated using a principal components analysis approach.

We estimate these overall but present them against key periods reflecting policy changes, namely:

- 1989-2003: This period reflects the MacSharry reforms and the establishment of set-aside, as well as reductions in payments on previous periods.
- 2003-2014: This period brings in the Fischler reforms for a single farm payment which decoupled payment from most production (aside from, for example the Scottish Beef Farm Scheme).
- 2015-2020: There period is the most modern era, and the 2014 reforms which had cross-compliance criteria for more support of environmental goals.

The growth rates show how our farming systems have developed over the last 30 years. This should also show progress in terms of adoption of new practices and technologies, but also disturbances from external events, such as high input costs, disease outbreaks and extreme weather disturbances.

## 3.0 Results

### 3.1 Robustness

Robustness is made up of the resistance score, the number of shocks experienced by the farms and the recovery rate. These three variables were weighted to reflect the differing importance of these factors to each of the farms<sup>1</sup>. The average score for each farm type over the three periods is shown below.

Table 1. Average robustness index for Scottish farm types<sup>^</sup>

	LFA Cattle and Sheep	LFA Sheep	LFA Cattle	Dairy	Mixed	Cereals	General Cropping
1989-2003	0.68	0.77	0.73	0.75	0.91	0.70	0.73
2004-2014	0.66	0.71	0.74	0.70	0.82	0.70	0.68
2015-2020	0.76	0.62	0.78	0.81	0.73	0.49	0.63
Overall	0.70	0.70	0.75	0.75	0.82	0.63	0.68

<sup>^</sup> A score closer to 1 suggest greater robustness over the period.

For each farm type the average robustness score ranges from 0.63 to 0.87 over the whole period, with an average of around 0.72 for the whole industry. Compared to a similar exercise across Europe, livestock farms in Western Europe (UK, France, Germany, Belgium, the Netherlands) robustness was higher compared to Scotland alone (at 0.84), and far higher for cropping farms at (0.85), but lower for mixed farms (0.84) (Slijper *et al.*, 2021). Though this reflects more intensive systems and, in livestock, with countries with far less Favoured Area than Scotland.

What is perhaps more interesting is the fluctuations over the period with some farms experiencing a drop in their overall robustness in the more recent period (*Cereals, General Cropping, LFA Sheep*) whereas others experienced an increase (*LFA Cattle and Sheep, LFA Cattle, Dairy*). This shows fragility to weather but also the changes experienced from the direction of policy and fluctuation global prices and increasing pressures on inputs on less intensive operations.

#### 3.1.1. Farms experiencing a Shock

Table 2 shows the average proportion of farms in each farm type which were classified as experiencing a shock. This is defined as a reduction of at least 30% in RoA from one year to the next. This fluctuates from year to year, e.g. during 2001 foot and mouth around 80% of livestock farms experienced a shock. The table shows that mixed farms experienced the lowest proportions of farms in shock, whereas most other farms experienced an average of 20 to 25% of their farms experience a shock.

<sup>1</sup> We used Principal Components Analysis which reduces the three variables into one index using the

Table 2. Average proportion of farms experiencing a price shock by period<sup>^</sup>

	LFA Cattle and Sheep	LFA Sheep	LFA Cattle	Dairy	Mixed	Cereals	General Cropping
1989-2003	0.26	0.21	0.25	0.24	0.09	0.21	0.21
2004-2014	0.23	0.25	0.21	0.32	0.16	0.19	0.22
2015-2020	0.23	0.25	0.21	0.18	0.28	0.36	0.22
Overall	0.24	0.23	0.22	0.25	0.18	0.25	0.22

<sup>^</sup> a price shock is a loss of at least 30% in cash income to total assets from one year to the next.

### 3.2. Adaptation

Adaptation is made up of changes in stocking density or fertiliser per ha, changes in labour per ha and changes in livestock revenue growth on an annual basis. These reflect changing practices over the different periods.

Table 3 Average adaptation index for Scottish farm types <sup>^</sup>

	LFA Cattle and Sheep	LFA Sheep	LFA Cattle	Dairy	Mixed	Cereals	General Cropping
1989-2003	0.43	0.48	0.40	0.53	0.46	0.42	0.55
2004-2014	0.46	0.54	0.37	0.50	0.52	0.40	0.57
2015-2020	0.45	0.46	0.44	0.46	0.50	0.43	0.52
Overall	0.45	0.50	0.41	0.49	0.49	0.41	0.55

<sup>^</sup> a farm closer to 1 shows high adaptation, whereas a score closer to 0 shows low adaptation

These tables show that most farms show a moderate amount of adaptation, with General Cropping Farms revealing a consistently high amounts compared to LFA Cattle and Cereals farming.

Compared to the EU averages though, these indicate higher levels of adaptation than those in comparable western European states. Nevertheless they also reveal very little change over the time periods within only slight fluctuations occurring in the early two periods and, for most farm types a drop in adaptation - meaning that the farms have not overly changed stocking densities, labour use and specialisations since 2015.

### 3.3 Transformation

Our transformation variable is simply the ratio of off-farm to total revenue. Again this is adjusted so that it runs from 0 where there has been no transformation and 1 where there has been the most transformation within that farm type for that year. As expected the rate of transformation is low and, for most farm types this has remained constant throughout the period. Notably there was a rise in the mid-period for LFA Sheep in response to changes in CAP reform but this fell back in the later period. Similarly for the cereals and general cropping sectors, this has steadily declined, presumably as they focused on more farm to off-farm activities.

Table 4. Average transformation index for Scottish farm types<sup>^</sup>

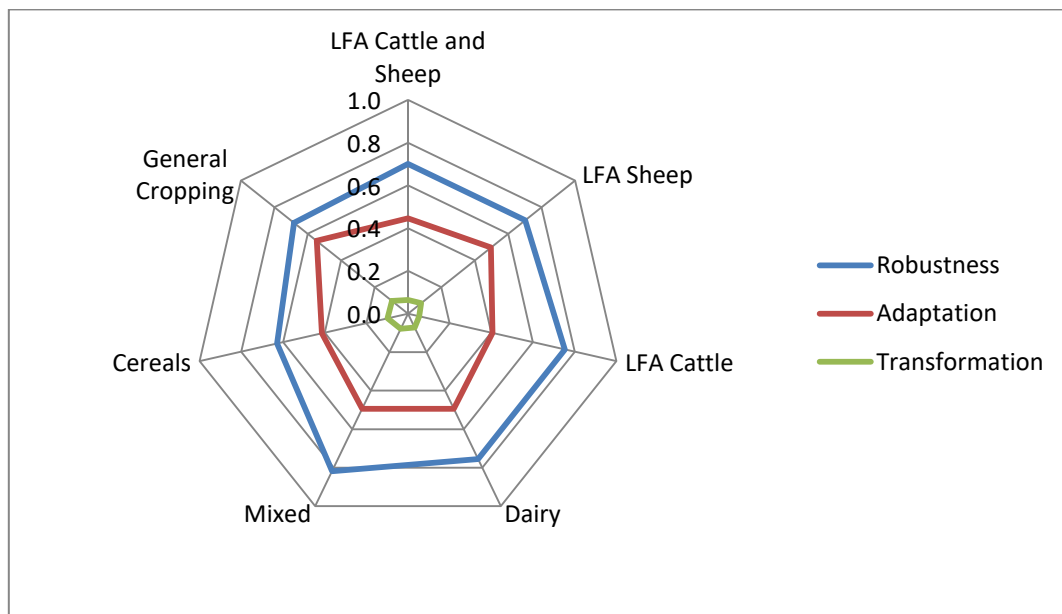
	LFA Cattle and Sheep	LFA Sheep	LFA Cattle	Dairy	Mixed	Cereals	General Cropping
1989-2003	0.06	0.05	0.07	0.07	0.09	0.18	0.12
2004-2014	0.07	0.12	0.04	0.08	0.06	0.08	0.08
2015-2020	0.07	0.06	0.05	0.07	0.08	0.04	0.09
Overall	0.06	0.08	0.05	0.07	0.08	0.10	0.10

<sup>^</sup> a farm closer to 1 shows high levels of transformation, whereas a score closer to 0 shows low levels of transformation

## 4.0 Summary

- Resilience is a key measure of how our farms can survive and respond under external pressures. Traditionally we view resilience as composed of how robust our farms are to change, how our farms can adapt to change and, at the more extreme, how they can transform to change.
- Here we produce a common metric for all three aspects of resilience and find that there are differences both across farms but also within farms, driven by various external factors, e.g. foot and mouth, financial price shocks etc.

Figure 1. Average resilience scores for Scottish Farm Business Survey farms, for the period 1989-2020<sup>^</sup>



<sup>^</sup>a score closer to 1 shows high levels of resilience, and a score closer to 0 shows low levels of resilience.

- The figure shows that scores for robustness are the highest, followed by adaptation with very little transformation (in this case changes in off to on farm revenue), throughout the whole period.
- Generally, those farms with more diversity of on-farm activities tend to score better than those with more specialised enterprises. Mixed farms tend to have the highest levels of robustness, whereas General Cropping farms had higher levels of adaptation.

## References

Slijper, T., de Mey, Y., Poortvliet, P. M., & Meuwissen, M. P. (2022). Quantifying the resilience of European farms using FADN. *European Review of Agricultural Economics*, 49(1), 121-150.

## Acknowledgements

This work was funded under the Scottish Government's Strategic Research Programme under the Rural Industries work package, specifically the '[Resilience of rural economies to key external drivers](#)' (RD 2.4.1) work stream.

For further details please contact: Andrew Barnes 

☎: +44(0)131 535 4042 ✉: [andrew.barnes@sruc.ac.uk](mailto:andrew.barnes@sruc.ac.uk)

