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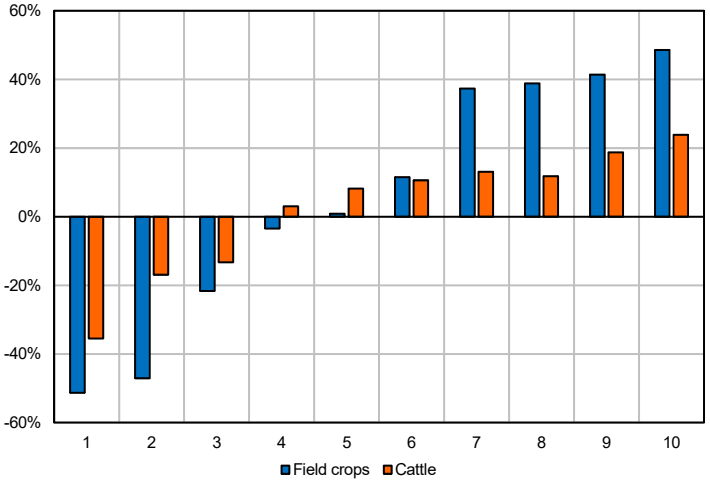
Productivity and environmental impact of farms according to their size

- Recent agricultural policies, particularly the EU's Common Agricultural Policy, distribute aid on the basis of holding size, measured in terms of agricultural area or number of animals. Thus, some aid is allocated only to a farm's initial hectares or, in the case of coupled support for livestock, aid is at a decreasing rate based on herd size, and then capped.
- The link between farm size and agricultural policy objectives is not fully documented in France. Large holdings are generally presented as being less virtuous for the environment and small holdings as being less productive. Analysing data from the Farm Accountancy Data Network (FADN) for the period 2011-2015 allows us to shed some light on these links.
- On average, labour productivity increases with the size of the farm, for both field crops and cattle (see chart on this page). This can be attributed to economies of scale in terms of labour (large farms are less labour-intensive), inputs, equipment (some of which can replace labour, such as tractors or automatic milking), veterinary costs and animal feed. However, farm size explains only a small portion of the variation in productivity.
- The environmental impact of large farms is more mixed. The negative impact increases with size in the case of cattle farming, but there is no significant correlation with size in the case of field crops. This impact is measured using an environmental indicator developed by the French National Research Institute for Agriculture, Food and Environment (INRAE), which relies on accounting or farm structure data in relation to the agricultural area farmed or livestock (e.g. the share of permanent and temporary grassland in the farm's utilised agricultural area).

Deviation from average labour productivity per decile of agricultural area (field crops) or livestock (cattle)



Source: DG Trésor, based on FADN data from 2011-2015.

How to read this chart: the labour productivity of field crop farms classified in the 9th decile by utilised agricultural area is, on average, 41% higher than that of field crop farms. For cattle, the classification by decile is based on herd size.

1. For both field crops and livestock, the larger the farm, the more productive it is

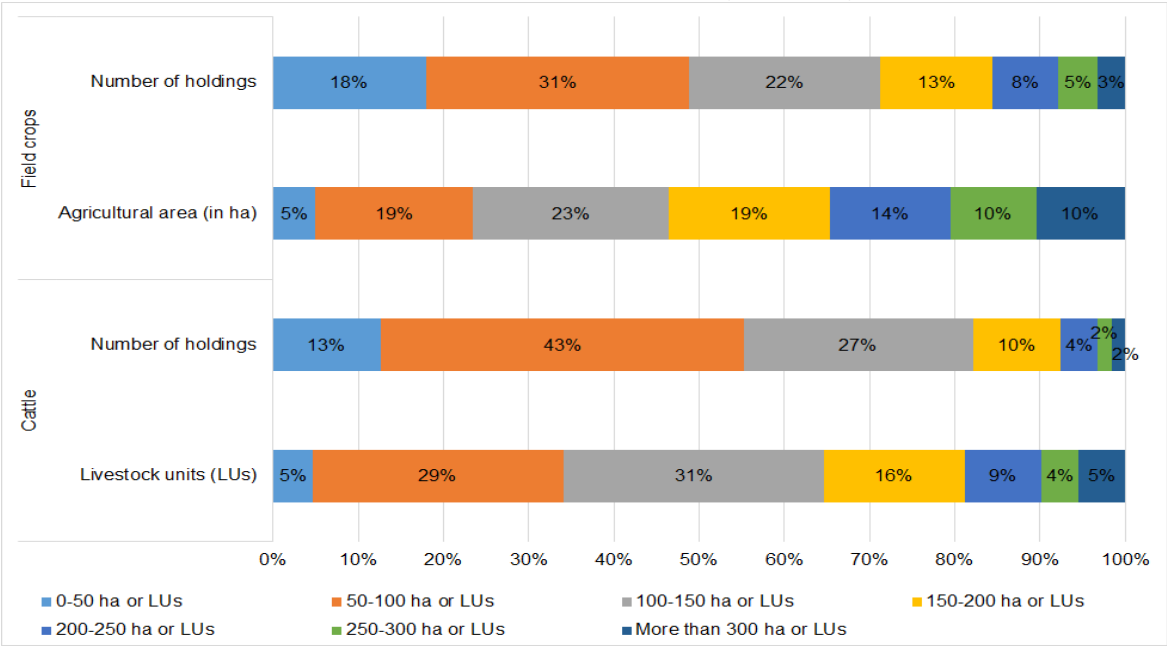
Numerous studies show a positive correlation between the size and labour productivity of industrial companies and providers of non-financial services. In many countries, the correlation is the same for farms, but this link has been little studied in France.[1] The methodology used in this paper is presented in Box 1.

Box 1: Methodology for studying the link between farm size and productivity

The productivity measure used is partial labour productivity, defined as the ratio between the value added of the holding and the amount of labour employed, measured in annual work units (AWUs).[a] Data from the Farm Accountancy Data Network (FADN), which records accounting and structural data from more than 7,000 farms each year,[b] was analysed for the years 2011-2015. In addition, the "size of the holding" is measured by agricultural area for predominantly crop production holdings (field crops, etc.) and by the number of livestock units (LUs) for predominantly animal holdings (cattle, etc.). The farms studied below are field crop farms and cattle farms, which are broken down by size in Chart 1.

To study the relationship between labour productivity and farm size, the standard assumption is that the relationship between productivity *Y* and farm size *S* is expressed as $Y + c \cdot S^{\alpha}$ where c and α are constants.[c] If α is positive, then productivity increases on average with farm size.

Chart 1: Breakdown of farms into field crops and cattle according to size (agricultural area or livestock)



Source: DG Trésor, based on FADN data from 2011-2015.
How to read this chart: 22% of field crop farms have an agricultural area of between 100 and 150 ha, accounting for 23% of the agricultural area of field crop farms.

a. Note: productivity makes it possible to assess the quantity of value added generated per production factor and is not directly linked to the concept of profitability, as certain charges or income come between the value added and the net result (e.g. financial charges or income).
b. Only holdings with more than 25,000 euros of standard gross production are taken into account in this analysis. They correspond to the "medium" and "large" holdings in agricultural statistics and represent 97% of the national standard gross production.
c. Schreyer P. and Pilat D. (2001), "Measuring Productivity", *OECD Economic Studies*, No. 33, pp. 137-184.

Labour productivity increases with the size of the holding, for both field crops and cattle (see chart on first page).

By representing labour productivity as a function of agricultural area, it can be seen that on average a 10% increase in agricultural area correlates with a 5.4% increase in labour productivity, with area variations accounting for 13% of labour productivity variations. Moreover, large holdings are less labour-intensive, with a strong reduction in the number of AWUs per hectare above 100 ha.

(1) The detailed results presented here are the subject of a working paper by the Directorate General of the Treasury: X. Ory (2020), "Lien entre la taille des exploitations agricoles, leur productivité et leur impact sur l'environnement", *DG Trésor Working Paper* No. 2020/2.

As with field crops, the larger the herd, the higher the labour productivity of a cattle farm, although the correlation is not as strong. A 10% increase in the number of LUs is correlated with a 3.9% increase in labour productivity. As with field crops, the number of AWUs relative to the number of LUs is lower for large farms, reflecting economies of scale. Moreover, in addition for cattle holdings, labour productivity also increases slightly with agricultural area, with a 10% increase in area leading to a 2.1% rise in productivity.

2. Negative environmental impact increases with size only for cattle farms

The environmental impact of farms is complex to assess, because it depends heavily on the practices implemented by each farm. However, in order to be able to carry out large-scale comparative analyses, INRAE has developed a method based on accounting data, which is presented here (see Box 2).

Box 2: Methodology for studying the link between holding size and environmental impact

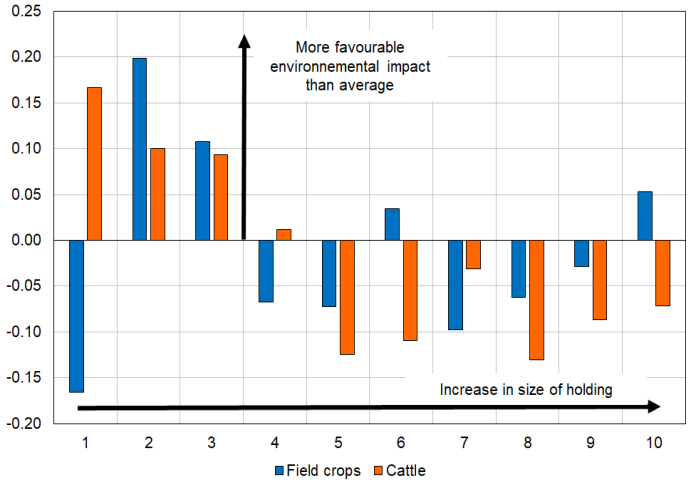
The environmental impact of agricultural holdings is measured by a synthetic indicator developed by INRAE,[a] The environmental impact of agricultural holdings is measured by a synthetic indicator developed by INRAE,a which enables holdings with similar types of production to be compared with each other based on eleven environmental performance indicators, such as the portion of grassland in the utilised agricultural area or plant protection product loads per hectare of productive area. Within each techno-economic category, holdings are classified by decile and each holding is given a number of points equal to its decile for each indicator (between 1 and 10 points per indicator, the tenth decile corresponding to the most environmentally-friendly). The total environmental indicator for a farm is calculated by adding the number of points obtained for each indicator, each indicator being considered of equal importance by default. Thus, the more a holding has a high environmental indicator, the more favourable its environmental impact compared with other farms of the same type (field crops or cattle breeding). which enables holdings with similar types of production to be compared with each other based on eleven environmental performance indicators, such as the portion of grassland in the utilised agricultural area or plant protection product loads per hectare of productive area. Within each techno-economic category, holdings are classified by decile and each holding is given a number of points equal to its decile for each indicator (between 1 and 10 points per indicator, the tenth decile corresponding to the most environmentally-friendly). The total environmental indicator for a farm is calculated by adding the number of points obtained for each indicator, each indicator being considered of equal importance by default. Thus, the more a holding has a high environmental indicator, the more favourable its environmental impact compared with other farms of the same type (field crops or cattle breeding).

a. Kirch A., Kroll J.-Ch. and A. Trouvé (2017), "Aides directes et environnement: la politique agricole commune en question", *Économie rurale*, no. 359.

If we assess the relative environmental impact of field crop holdings as a function of the size of the holding we can see that, on average, the environmental impact per hectare of field crop holdings is not dependent on the holding's size.

On the other hand, for cattle farms, the larger the herd size, the more unfavourable the environmental impact of the holding (see Chart 2). Moreover, if we look at the 25% of cattle farms with the largest herds, we can see that these farms are also less virtuous than the others in terms of the "energy load", "crop rotation diversity" and "protein plants" criteria.

Chart 2: Deviation from the average environmental indicator by decile of holding (field crops) or livestock (cattle)



Source: DG Trésor, based on FADN data from 2011-2015.

How to read this chart: the average environmental indicator is reported at 5 points. On average, cattle farms in the 5th decile have an environmental indicator of 4.88 points, which is lower than the average environmental indicator for this category (−0.12 points).

3. Holding size is taken into account when calculating agricultural sector subsidies

The bulk of Common Agricultural Policy (CAP) support is directly proportional to the size of the holding, such as the basic payment and the green payment schemes. However, some support is more beneficial to small farms. This is particularly the case for the redistributive payment, additional aid paid only for the first 52 hectares of each holding,[2] and for livestock aid. Suckler cattle farms receive stepwise decreasing aid for each suckler cow, with a cap set at 139 cows, and dairy cattle farms receive aid for each dairy cow, with a cap at 30 cows (in mountainous areas) or 40 cows (outside mountainous areas). Here too, therefore, smaller farms receive proportionately more.

Thus, in view of the results presented above, some aid is granted preferentially to holdings that are, on average, less productive compared with holdings with the same type of production.

This may in particular enable the public authorities to provide support to holdings with a more favourable environmental impact, particularly when it comes to cattle farms. In addition, this distribution of agricultural aid to small farms may make it possible to pursue other public objectives such as maintaining the economic and social fabric in rural areas that favour spatial planning and reduce social isolation in agriculture, preserving landscapes, improving the quality of production or efficiently managing health and climate risks (increasing resilience through diversity of production and practices from one farm to another).

A small number of large holdings may be less able to meet these objectives than a greater number of average-sized ones. Further studies would be needed to better assess the role of holding size in these public policy objectives.

Xavier Ory,

(2) However, the effects of the redistributive payment need to be qualified because, the envelope of direct payments being fixed, holdings of up to about 100 ha are net beneficiaries of the redistributive payment compared to a situation without redistributive payment and, for holdings in agricultural groups of joint holdings (GAEC), the 52 ha ceiling is multiplied by the number of partner holdings (see call for research project "Agr'Income", 2019, Ministry of Agriculture).

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