ANNALS OF THE POLISH ASSOCIATION
OF AGRICULTURAL AND AGRIBUSINESS ECONOMISTS

received: 10.12.2019
acceptance: 03.02.2020
published: 20.03.2020

Annals PAAAE • 2020 • Vol. XXII • No. (1)

JEL codes: Q10

DOI: 10.5604/01.3001.0013.7907

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LIVESTOCK PRODUCTION IN METROPOLITAN AREAS – CHANGES IN SCALE AND STRUCTURE[1]

Key words: metropolitan area, production location, livestock production, farm

ABSTRACT. The main aim of the studies was to identify and assess the changes in the organisation and scale of livestock production of farms operating within varying distance from the cores of metropolitan areas (MA). The studies covered production units specializing in animal production and mixed farms that participated in the FADN system over an uninterrupted period between 2004 and 2016. The results show that, in the study group of commercial farms operating in areas bordering MA cores, there is a clear reduction of both the numbers of herds and the scale of livestock production. The group of farms located outside metropolitan areas was characterised by a relatively high share of permanent crops and high density of pigs. The intensity of agricultural production organisation increased as the distance from the cores of metropolitan areas grew. It confirms the concept of reversed Thünen rings formulated by Sinclair and known in the theory of economics, according to which production results and productivity per unit area increases with the distance from city centres. The conducted analyses confirm the general trend of withdrawal of farmers operating near cities from animal production and a clear extensification of farm organization.

INTRODUCTION

The relationships between the organisation of agricultural production and its special location became a subject of widespread interest in the science of economics. As early as the mid-19th century, the importance of the location of agricultural production was recognised, and models for the optimal location of its different types around a single, centrally organised market emerged. In his model, published in 1826, John Heinrich von Thünen pointed out that the intensive production of vegetables and milk should be located in the first ring, which directly borders a city, followed by forestry production (firewood), cereal and potato production in the next rings, and fodder plant production and livestock farming in the ring that lies furthest away from the city. Meanwhile, over a century later Robert Sinclair [1967] noted that production performance and production per area unit grew as the

[1] Research funded by the National Science Centre, Poland No.2016/21/D/HS4/00264.

distance from city centres increased. The differences in the observations and conclusions formulated by these researchers indicate that, over time, between their respective studies, a significant change occurred in the intensity of agricultural production carried out within areas of city influence. This may suggest that agricultural activity located in city impact zones is highly likely to be subjected to extensification, and later also liquidation. The paper attempts to answer the question of whether the changes occurring in metropolitan areas analysed really lead to farms abandoning intensive production.

RESEARCH MATERIAL

The paper addresses the problem of the evolution of farms in metropolitan areas in Poland. The main aim of the studies was to identify and assess the changes in the organisation and scale of livestock production. It was accepted that a metropolitan area is the area of a large city, i.e. one with over 300 thousand inhabitants, along with its functionally connected direct environment as established in the National Spatial Management Concept [MRR 2011].

In accordance with the assumptions of the research project financed by the Polish National Science Centre, as part of which this study was conducted, the paper used purposive sampling of research area and research objects. The study covered commercial farms that were active on the market and located in six different geographical and economic regions of Poland, i.e. in the Lower Silesia Province, Lubelskie Province, Lesser Poland Province, Masovia Province, Pomerania Province and Greater Poland Province. The selected regions were characterised by significant environmental, agrarian and economic diversity.

Based on planning documents, which indicate the directions and objectives of land-use management as well as the principles governing the activity of a human being in space, three research zones were distinguished in each of the provinces selected for the study. These zones were referred to as [Sroka et al. 2018]:

– The "MA inner zone", i.e. municipalities directly bordering the MA core,
– The "MA outer zone", encompassing remaining municipalities located within MA but not directly bordering the MA core.
– „outside of MA", i.e. the part of a province lying outside the metropolitan area.

Of the commercial farms participating in the FADN system over an uninterrupted period between 2004 and 2016, production units (1854) operating within the provinces selected for the study were identified. In such a study group, 46 farms operated within MA inner zones and 143 in MA outer zones, with the remaining farms carrying on their activity outside of metropolitan areas. For these groups of farms, a comparative analysis was conducted in terms of changes in production scale and structure as well as the dominant direction of production (production type). Special attention was paid to production units specialising in livestock production and mixed production farms. The dynamic analysis of production value took changes in the time value of money based on yearly price indices of consumer goods and services published by Statistics Poland [GUS 2019] into account.

RESEARCH FINDINGS

The value of livestock production exceeds plant production in the structure of market production, although the gap between the two has systematically been narrowing over the last several decades [Głębocki 2005]. This is directly reflected in a decrease in farmed animal stock. Despite a noticeable shift away from livestock production, it still plays a significant role in the structure of national agricultural production, representing an important source of farm income [Parzonko, Runowski 2015]. In the agriculture of highly developed countries, the basic source of income is livestock production, to which plant production is significantly subservient [Sulewski 2014]. This is due to the economic balance, as products of animal origin are, as a rule, more processed and achieve relatively higher prices compared to products of plant origin [Flaga, Sroka 2012].

Polish agriculture specialises in pig livestock and milk production. However, over the last dozen or so years, a marked decrease in the animal population has been observed in both cases (Table 1). Negative changes in the population of pigs,[2] determined by the so-called pork cycle[3], were compounded by negative price ratio indices [Płonka, Musiał 2014, Płonka, Paluch 2016, Ziętara 2019]. Meanwhile, the reduction of the population of milk cows was impacted – apart from economic factors (i.e. low prices of livestock and milk not guaranteeing production profitability) – by a limitation of milk production and raising of sanitary and veterinary requirements for farms [Parzonko 2013]. As a result, the population of pigs kept on individual farms in Poland, in 2016, decreased by almost 7 million animals compared to 2004, while the population of cows decreased by 449 thousand animals. In contrast, the population of cattle increased by 11.5% and that of

Table 1. Population of farmed animals on individual farms in Poland between 2004 and 2016

Specification	Farmed animals				Change in the population of animals (2004 = 100)
	thousands of animals		per 100 ha of AA		
	2004	2016	2004	2016	
Pigs including sows	15,405.3 1,477.5	8,474.5 673.0	108.0 10.0	64.0 5.1	55.0 45.5
Cattle, including cows	5,049.3 2,655.7	5,630.8 2,206.9	35.0 19.0	42.0 17.0	111.5 83.1
Horses	312.8	179.2	2.2	1.4	57.3
Poultry	108,987.0	116,781.0	761.0	878.0	107.2
Sheep	291.2	224.4	2.0	1.7	77.1

Source: own work based on data from Statistics Poland [www.stat.gov.pl, access on 22.07.2019].

[2] As stated by Wojciech Ziętara [2019], a dramatic fall in the population of pigs after 2007 was mainly observed in farms keeping up to 200 pigs.

[3] Pork cycle is a typical economic cycle resulting from natural delays between the moment of taking a decision (e.g. about investments to increase production capacity) and its outcome (e.g. actual increase in production). In this cycle, both the price and production volume is subject to fluctuations.

poultry grew by 7.2% compared to 2004. Analysis of the average size of the population of farmed animals on individual farms in Poland per 100 ha of agricultural area shows that pigs saw the most severe downturn trends. Changes in density led to a decrease in the number of animals per 100 ha of agricultural area from 108 to 64, i.e. by 40%, between 2004 and 2016.

It has been found that similar trends in the changes in the farmed animal population also occurred in the commercial farms analysed. Production units located in the MA outer zone and those situated outside metropolitan areas saw an increase in the population of cattle and poultry (Table 2). In contrast, the number of farmed animals kept on farms located in municipalities directly bordering MA cores declined. There are two main causes of these trends. The first of them is the size of the farms. Larger farms usually specialise in plant production, which generally requires less labour input and does not bound the farmer to daily work, allowing him/her to have an off-farm job. A certain role is also played by pressure of the environment, which, in the case of urban areas (but increasingly also rural areas), presses for the elimination of livestock production.

It should also be stressed that complete abandonment was very frequent in the study group of farms analysed. In MA inner zones, of the 46 farms analysed, only 16 practised livestock production in 2016. The pace of current changes suggests that, relatively soon, livestock farming will almost be completely abandoned in highly urbanised areas, including

Table 2. Selected parameters of livestock production

Specification	Year	MA inner zone	MA outer zone	Outside MA
		Average density of animals [LU/100 ha of AA]		
Milk cows	2004	3.1	21.1	18.1
	2016	1.7	18.9	18.2
Other cattle	2004	3.9	14.1	12.2
	2016	3.6	19.1	20.1
Sheep and goats	2004	0.0	0.7	0.4
	2016	0.0	0.0	0.3
Pigs	2004	31.8	40.3	60.4
	2016	9.4	25.8	48.6
Poultry	2004	1.3	13.8	4.8
	2016	0.0	11.5	4.9
Animals in total	2004	40.1	90.0	95.9
	2016	14.7	75.3	92.1
Share of farms [%]				
Without large farmed animals*	2004	43.5	14.0	13.2
	2016	65.2	26.6	27.6

* Large farmed animals include cattle, pigs, sheep and goats
Source: own study based on FADN data

around big cities. Livestock production was also eliminated by units located in outer zones of the MA and in the parts of provinces outside MA, but to a lesser extent. The number of farms engaged in livestock production decreased there between 2004 and 2016 by a dozen or so percent. In 2016, livestock production was still carried out by 71.9% of units located in outer zones of MA and 72.4% of entities situated outside MA.

Moreover, detailed studies demonstrated that farms operating on the outskirts of MA (outer zone) and outside MA recorded a decrease in the average density of animals despite an increase in herd size. The growth of land area in commercial farms is faster than the growth of the population of animals. Additionally, point concentration is observed, i.e. an increase in the size of single herds, while a share of production units in a given area resign from maintaining a given species of animals. The number of farms in an inner zone of MA keeping milk cows decreased by 60.0%, cattle for fattening – by 44.4%, pigs – by 53.8%, while poultry – by 83.3%. Thus, there was a clearly visible elimination of livestock production arduous to the environment. Much smaller was the scale of abandoning livestock production among farms operating in an outer zone of MA and outside MA, with units further away from the strict centre of the metropolitan area more often resigning from livestock production. Resigning from keeping livestock by some farms can be a sign of the initial stage of de-agrarianisation of such areas [Wojewodzic at al. 2015].

Table 3. Value of production in the farms analysed (in fixed prices from 2016)

Specification	Years*	MA inner zone	MA outer zone	Outside MA
		On average [PLN 1,000/1 ha of AA]		
Livestock production (SE 131)	2004-2006	1.2	3.5	3.6
	2014-2016	0.5	3.8	3.8
Total production (SE 206)	2004-2006	5.8	6.6	7.0
	2014-2016	6.4	6.9	7.7

* On average in a given period
Source: own study based on FADN data

Changes in farm size, as well as organisation, impact the value of farm output. Analysis of the structure of total output shows a clear regress in livestock production. In contrast, the importance of livestock production grew in the structure of the output of farms located in an outer zone of the MA. In production units operating outside metropolitan areas, the value of livestock production in 2016 was similar to that of plant production. The observed changes in the value of production show that livestock production is pushed from inner metropolitan areas to areas further away from central city, where it can be carried out with less resistance from the local (often agricultural) society.

Summing up this section of the discussion, it is worth pointing out that there is a clear extensification of livestock production in the analysed group of commercial farms operating in the inner zone of the MA, with a significant number of farms resigning completely from keeping animals. The density of cattle for fattening and milk cows in

2016, in farms located in an outer zone of the MA, was similar to that of farms operating outside the MA. At the same time, it was at a much higher level than in production units operating in municipalities directly bordering the core of the MA. Moreover, in an outer zone of the MA, there was a significantly higher density of poultry, and the further away from the strict centre of the MA, the higher the density of pigs. A higher intensity of the organisation of agricultural production was also seen in farms located outside the MA.

Analysis of the study group of farms, in terms of structure, shows that so-called mixed production farms accounted for the biggest share in an inner zone of the MA. Changes observed in farms located in an outer zone of the MA and those operating outside of the MA were very similar. They involved a decrease in the number of farms specialising in keeping granivores and farms with mixed production. In contrast, the number of farms specialising in milk production grew (Table 4). All of the analysed groups of farms recorded a decrease in the share of farms specialising in keeping graminivorous animals.

Table 4. Share of selected types of farms in different zones*

Type of farm (TF8)	Years	MA inner zone	MA outer zone	Outside the MA
		%		
Milk (5)	2004	0.0	8.4	5.8
	2016	2.2	21.0	18.4
Other grazing livestock (6)	2004	0.0	11.9	8.0
	2016	2.2	2.8	3.8
Granivores (7)	2004	13.0	14.7	16.5
	2016	2.2	11.2	8.6
Mixed (8)	2004	32.6	42.7	43.6
	2016	17.4	33.6	32.1

* General types according to WTGR: Fieldcrops, Horticulture, Wine – neglected in Polish conditions due to the very small number of such farms; Other permanent crops, Milk, Other grazing livestock, Granivores, Mixed
Source: own study based on FADN data

The causes of that, as already mentioned, include an increased risk of production, changes to the regulations on the conditions under which animals are kept, increasing competition in international trade (in particular from Germany and Benelux countries), charges in profitability, and global tendencies to concentrate production.

An interesting subject of observation is also the directions of farm evolution in different groups. Most often, an increased importance of field crops, increased production of milk and diversification of activities towards mixed production were observed (Table 5). Detailed analyses of data, taking the location of livestock production into account, showed that the changes in the agricultural type of farms ran along very similar lines, which means that their location, relative to the core of the MA, was of marginal significance.

Table 5. Changes of the agricultural type of farms between 2004 and 2016

Type of farm	Metropolitan areas			Outside metropolitan areas		
	2004	type changing	preferred directions of type changes*	2004	type changing	preferred directions of type changes (TF8)*
	number of farms			number of farms		
Milk	12	2	mixed fieldcrops	96	18	mixed other permanent crops other grazing livestock
Other grazing livestock	17	15	milk fieldcrops mixed	133	120	milk fieldcrops mixed
Granivores	27	17	mixed fieldcrops milk	274	168	mixed fieldcrops milk
Mixed	76	36	fieldcrops milk granivores	726	364	fieldcrops milk other grazing livestock

* Three most selected directions of changes arranged by prevalence
Source: own study based on FADN data

SUMMARY

Around the regional centres of socio-economic development, we can see differences in the scale and structure of production depending on location. The analyses conducted in this paper confirm the phenomena known from the theory of economics. In the study group of commercial farms operating in an inner zone of the MA, both the herd number and the scale of livestock production are reduced. In 2016, the outer zone of the MA saw a high density of milk cows and poultry. An increase in the population of milk cows was accompanied by an increase in the number of other groups of cattle. The group of farms located outside metropolitan areas was characterised by a relatively high density of pigs. The intensity of organisation of agricultural production increased as the distance from the core of the MA increased, which confirms the concept of reversed Thùnen rings formulated by Robert Sinclair, and known in the theory of economics. The analyses confirm the general trend of the abandonment of livestock production by farmers located near cities and a clear extensification of the organisation of farms.

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PRODUKCJA ZWIERZĘCA NA OBSZARACH METROPOLITALNYCH – ZMIANY W SKALI I STRUKTURZE

Słowa kluczowe: obszar metropolitalny, lokalizacja produkcji, produkcja zwierzęca, gospodarstwo rolne

ABSTRAKT

Głównym celem badań była identyfikacja i ocena zmian w zakresie organizacji i skali produkcji zwierzęcej gospodarstw rolnych prowadzących swoją działalność w różnej odległości od rdzeni obszarów metropolitalnych (OM). Badaniami objęto podmioty specjalizujące się w produkcji zwierzęcej oraz gospodarstwa z produkcją mieszaną, prowadzące rachunkowość rolną w systemie FADN nieprzerwanie w latach 2004-2016. Z badań wynika, że w populacji gospodarstw towarowych prowadzących swoją działalność na obszarach graniczących z rdzeniami OM następuje wyraźne ograniczanie zarówno liczb stad, jak i skali produkcji zwierzęcej. Natomiast grupa gospodarstw zlokalizowanych poza obszarami metropolitalnymi charakteryzowała się relatywnie wysokim udziałem upraw trwałych i wysoką obsadą trzody chlewnej. Intensywność organizacji produkcji rolniczej wzrastała wraz z oddalaniem się od rdzeni obszarów metropolitalnych. Potwierdza to opisaną w teorii ekonomii koncepcję odwróconych kręgów Thünena, sformułowaną przez Sinclaira, zgodnie z którą wyniki produkcyjne i wydajność z jednostki powierzchni zwiększają się wraz z oddalaniem się od centrów miast. Przeprowadzone analizy potwierdzają generalny trend wycofywania się rolników funkcjonujących w pobliżu miast z produkcji zwierzęcej i wyraźną ekstensyfikację organizacji gospodarstw.

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