From the research on socially-sustainable agriculture (38)

INSTITUTE OF AGRICULTURAL AND FOOD ECONOMICS
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CHALLENGES, CHANCES, THREATS, PROPOSALS

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All authors are researchers from the Institute of Agricultural and Food Economics – National Research Institute

This monograph has been prepared under the Multi-Annual Programme 2015-2019 "The Polish and the EU agricultures 2020+. Challenges, chances, threats, proposals", within the subject **Dilemmas of the development of sustainable agriculture in Poland**, which involves three research tasks, as follows:
(1) Global and national conditions of the sustainable development of agriculture;
(2) Economic assessment of external effects and public goods in agriculture;
(3) Sustainable agriculture and food security.

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FOREWORD

The Multi-Annual Programme entitled *The Polish and the EU agricultures 2020+. Challenges, chances, threats, proposals*, established pursuant to the Resolution of the Council of Ministers of 10 February 2015, to be implemented by the Institute of Agricultural and Food Economics, National Research Institute (IAFE-NRI) in Poland in years 2015-2019, covers among 8 research topics, the issue of ***Dilemmas of the development of sustainable agriculture in Poland***. Within this topic, three research tasks have been distinguished, namely:
(1) Global and national conditions of the sustainable development of agriculture;
(2) Economic assessment of external effects and public goods in agriculture;
(3) Sustainable agriculture and food security.

The results of research on these issues, conducted in the years 2015--2016, were published in Monographs of Multi-Annual Programme under the name "From the research on socially-sustainable agriculture" No. 31-37. This monograph No. 38 contains three works relating to succession to the abovementioned tasks.

The first chapter The **Common Agricultural Policy in the view of economic sustainability of agricultural holdings** concerns the impact of subsidies under CAP mechanisms on a change in the potential and results of agricultural holdings in Poland. There were analysed farms' production and economic results. The empirical material covered 4.5 thousand FADN agricultural holdings, that continuously conducted agricultural accounting in the years 2004-2013. There were distinguished three farms' groups differ in the degree of "friendliness" for natural environment, namely: organic, mixed (non-specialised) and livestock (specialised) farms. The more important conclusions of the analysis are the following: (1) the importance of subsidies in farms' economics grows, in particular in the case of organic farms, whose dominant part of income comes from this source; (2) mixed farms are at the crossroads between the reorganization towards organic production (due to subsidies) and taking a course on specialization (due to market benefits); (3) specialised farms absorb subsidies in relatively smaller range, but they generate more profitable outcomes in respect of production scale; (4) in terms of the current system of agricultural support continuation, there is probable further decrease of mixed (non-specialised) farms' population and increase of specialised one, whereas in a lesser extent increasing number of organic farms. Dr Wioletta Wrzaszcz and prof. dr hab. Józef Stanisław Zegar are the authors of the first chapter.

The second chapter **Externalities of animal production in the context of production and economic results of farms on the example of dairy cattle welfare** concerns the production and economic effects of enhanced animal welfare norms. The problem is important because of a progressive process of transferring the weight of Common Agricultural Policy direct support from production to non-production aspects, such as the generation of external effects, including animal welfare. Valuation of externalities is therefore becoming one of the key tasks in agricultural economics. The author has attempted such a valuation based on 150 dairy farms. The basic conclusions of the study are: (1) upgrading dairy cattle welfare standards would be beneficial for small- and medium-sized farms, while unfavorable for farms with large-scale farming; (2) increased level of welfare is a benefit for consumers, but it may also be beneficial for farmers; (3) the complex valuation of animal welfare should be based on the net costs/benefits, that include valuation of all various individual elements. Dr Edyta Gajos is the author of the second chapter.

The third chapter **Scale of food losses and waste the in the world and in Poland** relates to huge problem, which constitute a food losses and waste. In all agri-food chain about one-third of the food produced is wasted. The effects of this in terms of reducing the number of people suffering from hunger, pressure on the environment, and efficiency use labour and capital are severe in terms of the development of civilization. The food wastage phenomena take place on all continents and in many countries in the world. Rich factual material made it possible to illustrate the phenomenon and draw the following conclusions: (1) with population growth and enrichment to be reckoned with the escalation of food waste; (2) counteraction the food wastage phenomena requires a multifaceted and comprehensive action at all levels of management; (3) desirable is a change in food consumption patterns that are not sustainable and (4) in the era of globalization – the vast diversity of supply of food products – the consumer education becomes important. Dr hab. Mariola Kwasek, associate prof. at IERiGŻ-PIB, is the author of the third chapter.

Chapter I

THE COMMON AGRICULTURAL POLICY IN THE VIEW OF ECONOMIC SUSTAINABILITY OF AGRICULTURAL HOLDINGS

Introduction

The European Union took the route towards the sustainable development of agriculture and rural areas to meet the challenges of today's world. It is made directly or indirectly possible thanks to instruments of the Common Agricultural Policy (CAP) and instruments of the European Union's policy in other areas. These instruments support, supplement or are crucial in stimulating actions of particular Member States to make sustainable development come true. The Common Agricultural Policy evolution analysis points to the intensification of instruments for the sustainability of agriculture and rural areas [Zegar 2012, Kociszewski 2014, Krzyżanowski 2015a, Krzyżanowski 2015b], although progress in sustainability differs from social expectations. Due to globalisation phenomena, an efficiency requirement and a competitiveness imperative, sustainability is often sacrificed for the sake of microeconomic interests and current benefits.

Agricultural holdings, mostly family holdings, hold a special place in the sustainable development of agriculture and rural areas which is understandable given the economic and socio-cultural role of such agricultural holdings and families that run them, primarily their role in the management of physical space – ecosystems. For many years, family agricultural holdings have been losing their economic power under pressure from agro-industrial corporations, a strengthening global food system and cultural megatrends. For several decades, however, such holdings have become of renewed social interest as a socially attractive way of agricultural production – in particular reconciling agricultural production growth and care for the natural and socio-cultural environment [Woś and Zegar 2002, Ploeg 2009].

As regards the issues of sustainable development, attention is generally paid to the environmental (ecological) aspect as a result of historical reasons – the roots of the idea and then the concept of such development. As a matter of fact, the conflict between economic development and the natural environment put the issue of sustainable development on the agenda of social discourse – in political terms in the 1970s. Initially, attention was paid to the depletion of natural resources and environmental pressure from economic growth, while economic growth or development, which protected ecosystems, was referred to as eco-development. Given hard economic realities, however, it proved necessary

to include also the economic aspect and then the social aspect in the original concept of sustainable development. The contemporary concept of sustainable development thus comprises three fundamental aspects of civilisation development: environmental, economic and social.

This paper, which is treated as a contribution to an analysis of sustainable development of agriculture and rural areas in Poland[1], addresses only the economic aspect. The main aim of the paper is to present how important subsidies under CAP mechanisms are in shaping the selected economic indicators of agricultural holdings, being relevant to the economic aspect of farms' sustainability. These subsidies are important for and – in many ways – relevant to the economics of agricultural holdings – the level and stability of income, financial stability and credit availability, and eventually investments of agricultural holdings as well as productivity and efficiency [Kulawik and Płonka 2014, Góral 2016]. The problem is made even more complex by a wide range of subsidies whose relations to particular economic categories and the environmental aspect of sustainability differ significantly[2].

The paper is based on a panel of Farm Accountancy Data Network (FADN) of agricultural holdings which kept continuous agricultural accounting records in 2004-2013. The population included over 4.5 thousand agricultural holdings. The "panel" approach was adopted to prevent analysis results from being "contaminated" by changes in the population of FADN holdings and, in particular, to use advantages of a panel study, including the traceability of the selected groups of holdings. However, the analysis period was selected based on the aim of the paper and data availability. In the first year of the period, effects of the implemented CAP mechanisms were insignificant, while it might be assumed that the last year gave a full insight into the effects. Current CAP solutions (2014-2020), which differ from the solutions in the analysis period, fall beyond such an analysis period. Furthermore, it particularly applies to types and sizes of subsidies for agriculture and rural areas. The panel of holdings includes three groups of holdings, i.e.: organic, mixed and livestock holdings. They may be treated as groups of holdings of different environmental "friendliness".

The group of organic holdings includes agricultural holdings with an organic production certificate or those under reorganisation. Their agricultural production is based on natural ecosystem processes and is conducted with the minimal use of industrial means of agricultural production.

[1] The state of sustainability of agriculture in Poland is presented in [Toczyński et al. 2013].
[2] All value categories were represented in current prices.

The group of non-specialist (mixed) holdings includes those with mixed crop and livestock production. According to the FADN classification, these are holdings of type 8[3]. In the light of sustainable development, mixed holdings are a very desirable group, as the combination of crop production and livestock production enables a closed cycle of nutrients in the holding-environment system, as was the case in traditional agriculture. Mixed holdings exert relatively less pressure on the natural environment.

The group of livestock holdings includes agricultural holdings specialised in livestock production (mainly in rearing and breeding cattle, and in rearing granivores), which are classified in the FADN system as type 4 and 5[4]. Due to the limitation of crop production and specialisation in livestock production, they may generate higher external environmental costs. A particularly negative impact is exerted by holdings with highly intensive livestock production, rearing livestock mainly or solely based on purchased feed resulting in local pollution of individual components of the environment – soil, water and air – due to the large amount of manure produced and gases generated (mainly methane and ammonia)[5].

The selected groups of holdings were analysed against the background of all the panel agricultural holdings in 2004 and 2013. Holdings from particular groups might be classified to various farming types or farming systems in particular years. Furthermore, the holdings, which were classified to the same farming type or farming system in 2004 and 2013, were thus separated to present what changes had occurred in the holdings of the selected groups. The groups of so-selected organic, mixed and livestock holdings were referred to as a subpanel and further analysed. This approach allowed for preventing the "new" holdings from influencing the average results of the entire group. The final part presents results of holdings which, when comparing 2013 to 2004, "joined" and which "left" the analysed groups of holdings.

[3] The following three farming types of holdings are specified in the FADN system (so-called general types, according to the GTF classification): specialised in field crops (type 1), specialised in horticulture (type 2), specialised in permanent crops (type 3), specialised in rearing grazing livestock (type 4), specialised in rearing granivores (type 5), with mixed crops (type 6), with mixed livestock (type 7), with mixed crops and livestock (type 8), see [Goraj, Mańko 2009]. The structure of agricultural production (plant and animal) is the basis of FADN farms' classification.

[4] See note above.

[5] In case of large concentration (of industrial farms), there is also a problem of odour, animal welfare as well as the quality of animal products due to the use of, *inter alia*, steroids and antibiotics.

1. Characteristics of agricultural holdings

1.1. Agricultural holdings in total and the selected groups

Table I.1 presents basic data on holdings in total which were included in the panel and in the selected groups. In 2004, the average panel holding covered an area of 30 ha which increased over 9 years to 36 ha, i.e. by 20%[6]. Labour inputs increased slightly (by 2%), so did livestock (by 9%).

Table I.1. Characteristics of agricultural holdings in 2004 and 2013 (panel agricultural holdings in total; on average per 1 farm)

Specification	In total		Organic		Mixed		Livestock	
	2004	2013	2004	2013	2004	2013	2004	2013
Number	**4 579**	**4 579**	**60**	**133**	**1 549**	**1 219**	**1 211**	**1 547**
UAA (ha)	30.4	36.0	19.6	29.9	28.8	33.2	27.8	32.6
Labour force (AWU)	2.0	2.1	2.1	1.8	1.9	1.9	2.0	2.1
Livestock (LU)	27.7	30.2	10.9	12.6	22.7	25.1	52.6	58.3
Total assets (PLN '000 000)	0.5	1.3	0.3	0.7	0.4	1.1	0.6	1.3
Standard Gross Margin (PLN '000)	105.0	119.2	51.2	57.7	92.6	98.7	130.4	149.6
Standard output (EUR '000)	44.4	49.4	23.8	29.5	37.2	39.6	58.0	64.2
Output (PLN '000)	159.8	282.7	69.7	115.8	130.2	212.2	210.4	374.0
Gross value added (PLN '000)	73.5	143.8	38.0	97.9	59.7	105.9	91.0	167.4
Net value added (PLN '000)	54.1	109.0	24.1	76.8	43.0	78.7	71.4	130.0
Farm income (PLN '000)	46.2	98.8	18.1	69.9	38.3	72.2	64.0	122.6
Gross value of investments (PLN '000)	21.0	54.8	15.2	21.3	14.0	39.2	23.8	54.3
Net value of investments (PLN '000)	1.6	20.1	1.2	0.2	-2.7	12.0	4.1	16.9

1 AWU (Annual Work Unit) is equivalent to full-time own and hired labour, i.e. 2120 working hours per year; 1 FWU (Family Work Unit) is equivalent to full-time labour of a farming family member; 1 LU (Livestock Unit) is a standard unit of livestock weighing 500 kg.

Source: own study based on 2004 and 2013 FADN data.

The value of assets (total assets) increased 2.6-fold; however, the increase relates mainly to fixed assets (machinery, buildings and structures, land) whose share in a balance sheet increased from 82% to 89%. Increasing the production potential of the average panel holding contributed to an increase in the value of agricultural production by 77% in the analysed period and by 49% per 1 ha

[6] According to the Central Statistical Office of Poland (CSO) data, the average individual agricultural holding (> 1 ha of UAA) in Poland increased its area during this period by 12.4% (from 7.6 ha to 9.5 ha).

of UAA[7]. Undoubtedly, a change in agricultural holdings' area and livestock had a significant impact in this case.

Using standard categories of production potential in agriculture, i.e. the Standard Gross Margin and standard output, it may be stated that the potential in the analysed period increased respectively by 14% and 11%.

The gross value added[8] increased by 96% and the net value added – by over 100%, while farm income increased over 2-fold – from 46 thousand in 2004 to 99 thousand in 2013. Operating subsidies (addressed in Section 3) were an important element that influenced the value of these categories.

The improving economic situation of agricultural holdings was reflected in investments made by agricultural producers. In 2004, the net value of investments in the average agricultural holding was very low in relation to the gross value of investments due to the high depreciation of their assets. In 2013, the gross value of investments increased over 2.5-fold, thus multiplying the net result as well.

Averaged data for holdings in total may be a reference point for the three groups of panel holdings which were classified to a specific group in 2004 and 2013. The number of organic holdings in 2004 accounted for only 1.3% of panel holdings, 34% of mixed holdings and 26% of livestock holdings. In the analysed period, the group of organic holdings and livestock holdings increased (respectively by 122% and 28%), while the number of mixed holdings decreased (by 22%). Although the significant increase in the group of organic holdings should be interpreted as a direction of positive changes in agricultural production, the decrease in the number of mixed holdings may raise concern. The diminishing population of mixed holdings and the growing number of livestock holdings are signs of the ongoing specialisation process in agriculture. On the one hand, it helps holdings improve their economic results, i.e. is justified from an economic point of view, but – on the other hand – these changes are unfavourable, since they make livestock production increasingly dependent on the feed industry, raise the risk of environmental pollution given, for example, difficulties in manure management and increase the use of natural resources by agricultural activity.

[7] In this period, the value of gross output per 1 ha of UAA in individual farming increased by 69%. In constant prices, output increased by only a few percent.

[8] The gross value added is calculated as the difference between the value of farm output and the value of intermediate consumption (i.e. the sum of direct costs and farming overheads), adjusted for the balance of operating subsidies and taxes (including operating subsidies and the VAT balance as well as other taxes, *inter alia*, agricultural tax, forestry tax, property tax). The gross value added indirectly allows for verifying what impact farming efficiency – reflected in both the level of agricultural activity costs and the activity of a farm manager with respect to securing external funding – has on the value of farm output [Bocian and Malanowska 2014].

The group of organic holdings in 2013 and 2004 differed not only in its number, but also in values of basic characteristics. For example, the area of the average organic holding in 2013 was thus higher than in 2004 by 50% (respectively 30 ha and 20 ha), while labour inputs were lower by 11% (respectively 2.06 AWU and 1.84 AWU). It was primarily due to the fact that, in the meantime, holdings with a relatively large area and crop production "joined" the group of organic holdings. In 2013, livestock increased by 16% (2004 – 10.9 LU, 2013 – 12.6 LU) and the value of assets – by 139% (current prices). When comparing organic holdings to panel holdings in total, it may be stated that the direction of changes in their area, livestock and value of assets was convergent; however, organic holdings, despite their increased production potential, achieved much worse production and economic results. In 2013, the average income of the organic holding amounted to PLN 70 thousand, while of the entire analysed population – to PLN 99 thousand. In the analysed period, however, organic holdings bridged the gap from 39% to 71% (holdings in total = 100). The relatively low income of organic holdings was reflected in lower investments.

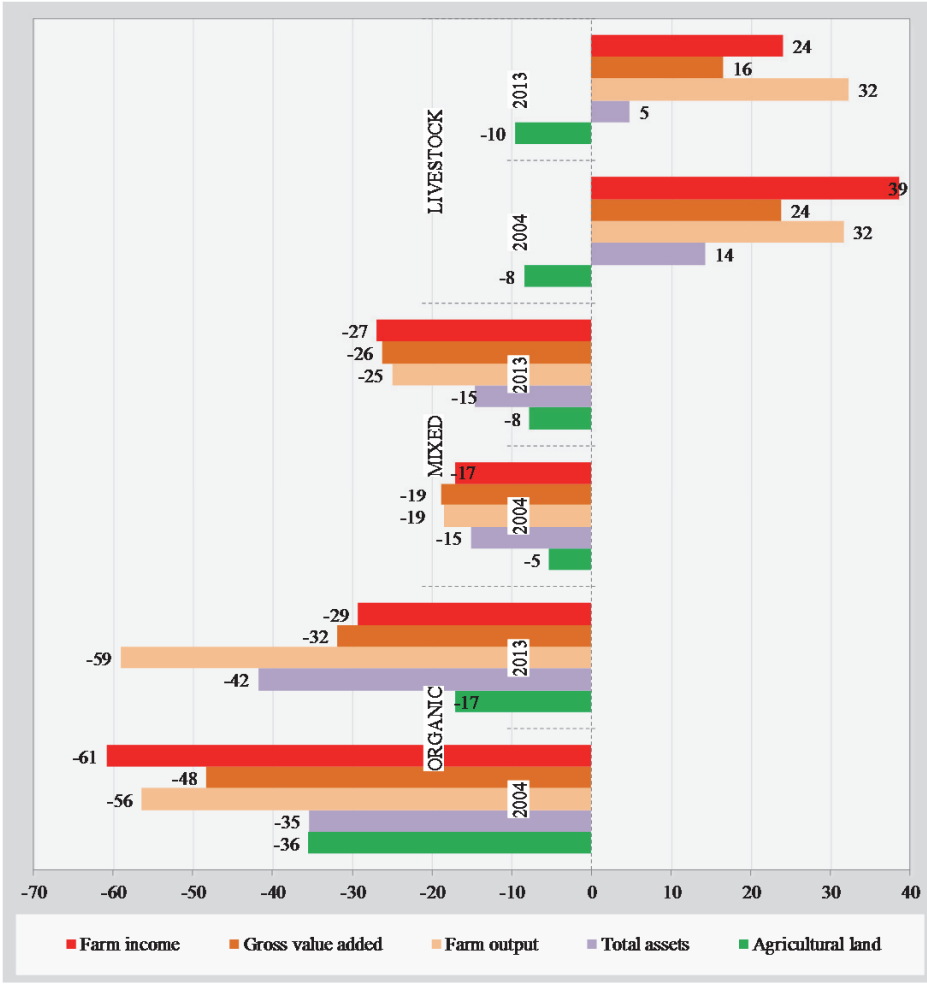
Values of and changes in basic characteristics of mixed holdings were close to the average. The value of standard results was comparable to the average for all the analysed holdings as well. However, the rate of changes in other production and economic categories was lower in mixed holdings compared to holdings in total. In 2013, the income of the average holding with crop and livestock production amounted to PLN 72 thousand and the gap widened by 10 percentage points (from 83% to 73%; holdings in total = 100). The value of their investments was below the average as well.

In terms of UAA, labour inputs and the value of assets, livestock holdings did not differ from the average panel holding. Of course, they were distinguished by relatively large livestock. The rate of changes in their production potential was similar to the average for holdings in total. Standard production results and other economic results in this group were significantly higher than in the average panel holding, while their growth in the analysed period was similar. It does not apply to farm income in terms of which the advantage of livestock holdings over holdings in total decreased from 39% to 24% (holdings in total = 100).

Figure I.1 presents relative differences in production potential and selected production and economic results between the analysed groups of holdings and the average for panel holdings in total, both in static terms (i.e. in a particular year) and dynamic terms (changes in the analysed period). The first conclusion after analysing the presented figure concerns livestock holdings which, in terms of the value of assets and production and economic results, leave the average panel holding far behind. Specialist livestock production is thus more fa-

vourable for an agricultural producer than mixed production. Although the production and economic advantage of livestock holdings over the average ones narrowed, it is still significant.

Figure I.1. Relative difference between the analysed groups of agricultural holdings and the average results (panel agricultural holdings in total) in 2004 and 2013 (%)



Source: own study based on 2004 and 2013 FADN data.

The second conclusion concerns organic holdings which lag far behind panel holdings in total, both in terms of production potential as well as output value and the size of farm income. The difference in income was the largest and amounted to over 60% in 2004. Changes taking place in organic holdings partially compensated for these differences, mainly in UAA and economic results. The gap in terms of output value did not change, however, in terms of income

narrowed by nearly half. Undoubtedly, it was due to organic production subsidies. However, the production and economic gap of this group of holdings is still significant – in terms of income value, it is about 30% (2013). Nevertheless, organic holdings increasingly lagged behind in terms of the value of assets. It may be assumed that the lower economic results impair the capacity of organic holdings to increase their assets at a proportional rate to panel holdings in total. The income of organic holdings was insufficient to make expensive and requiring – often long-term – economic investments.

The third conclusion concerns mixed holdings whose production potential and its changes did not differ from the situation of the average panel holdings. However, the gap between the average mixed holding and the average panel holding in terms of production and economic results widens.

The fourth conclusion follows from the growing advantage of livestock holdings over organic and mixed holdings, and concerns economic results. A question thus arises as to the effectiveness of the existing instruments of support for agricultural producers who run their holdings in a manner better suited to sustainable development requirements. These instruments seem to be too weak to alleviate effects of the market mechanism which encourages specialisation.

1.2. Subpanel agricultural holdings in the selected groups

The above data (Table I.1, Figure I.1) presented production and economic changes taking place in FADN agricultural holdings throughout the analysis period, i.e. in 2004-2013. The number of holdings in the selected groups varied – certain holdings "left" a particular group, as they no longer met the classification criteria, while others "joined" a particular group, as they started meeting the relevant criteria. The characteristics of holdings, which constantly conducted agricultural activity according to the same farming system (organic) or whose agricultural type did not change (mixed and livestock) in the analysed period, are interesting and very enlightening. For the purpose of the paper, groups of such holdings were referred to on a working basis as a subpanel of respectively organic, mixed and livestock holdings. Table I.2 presents their results. When comparing figures in Table I.1 and I.2, it may be stated that there are significant differences between the entire population of the selected groups of holdings in both years (Table I.1) and the subpanel population (Table I.2).

Most organic holdings (70%) covered by the agricultural accounting system in 2004 were further run in accordance with these principles in 2013[9].

[9] A question of what are reasons for: whether economic reasons (production and economic results, subsidies) or environmental reasons (natural values) or social reasons (possibility of in-

The production potential of the average subpanel organic holding increased to a lesser extent than of the entire population of organic holdings (respectively by 13% and 53%), livestock increased to a comparable extent, the value of assets in subpanel organic farms grew more slowly; labour inputs in subpanel holdings remained virtually unchanged, while decreasing in the entire population of organic holdings. The production potential of organic holdings, which have followed the same farming system for many years, is thus increasing, but lags behind that of new organic holdings which usually have a larger area, more fixed assets, are more mechanised, often with crop production or livestock production as a supplementary line.

Table I.2. Characteristics of agricultural holdings in 2004 and 2013 (subpanel agricultural holdings in the groups; on average per 1 farm)

Specification	Organic*		Mixed*		Livestock *	
	2004	2013	2004	2013	2004	2013
Number	**42**	**42**	**844**	**844**	**1 006**	**1 006**
UAA (ha)	19.9	22.5	27.9	32.4	27.0	33.0
Labour force (AWU)	2.0	2.0	1.9	1.9	2.0	2.2
Livestock (LU)	9.4	10.9	22.7	24.1	52.2	65.0
Total assets (PLN '000 000)	0.3	0.6	0.4	1.1	0.6	1.4
Standard Gross Margin (PLN '000)	46.3	43.1	92.0	97.6	125.9	159.8
Standard output (EUR '000)	21.7	21.7	36.6	39.0	57.8	70.4
Output (PLN '000)	56.4	81.2	128.6	211.2	210.4	420.3
Gross value added (PLN '000)	38.2	81.2	59.1	106.2	90.7	180.2
Net value added (PLN '000)	25.1	60.3	42.5	79.5	71.0	139.3
Farm income (PLN '000)	18.6	53.9	38.3	73.3	63.3	130.7
Gross value of investment (PLN '000)	12.1	18.5	13.2	38.7	25.5	57.8
Net value of investments (PLN '000)	-0.9	-2.4	-3.4	11.9	5.8	16.9

Subpanel agricultural holdings are marked with *

Source: own study based on 2004 and 2013 FADN data.

In 2013, the subpanel organic holding's output value amounted to PLN 81 thousand on average, while its income – to PLN 54 thousand. These values were lower than results of organic holdings in total respectively by 30% and 23%. The differences in values of these production and economic categories were also reflected in a smaller investment scale.

volving family labour resources and conducting additional non-agricultural activities based on an agricultural holding's assets), remains unanswered.

In general, it may be concluded that, despite the much worse economic condition of organic holdings, most of them still consistently follows this farming system. It seems reasonable to support them by using both subsidies and non-cash assistance. Relatively low production intensity and specialisation (determining their less favourable competitive position), and generated benefits for the environment and society justify the support for organic holdings.

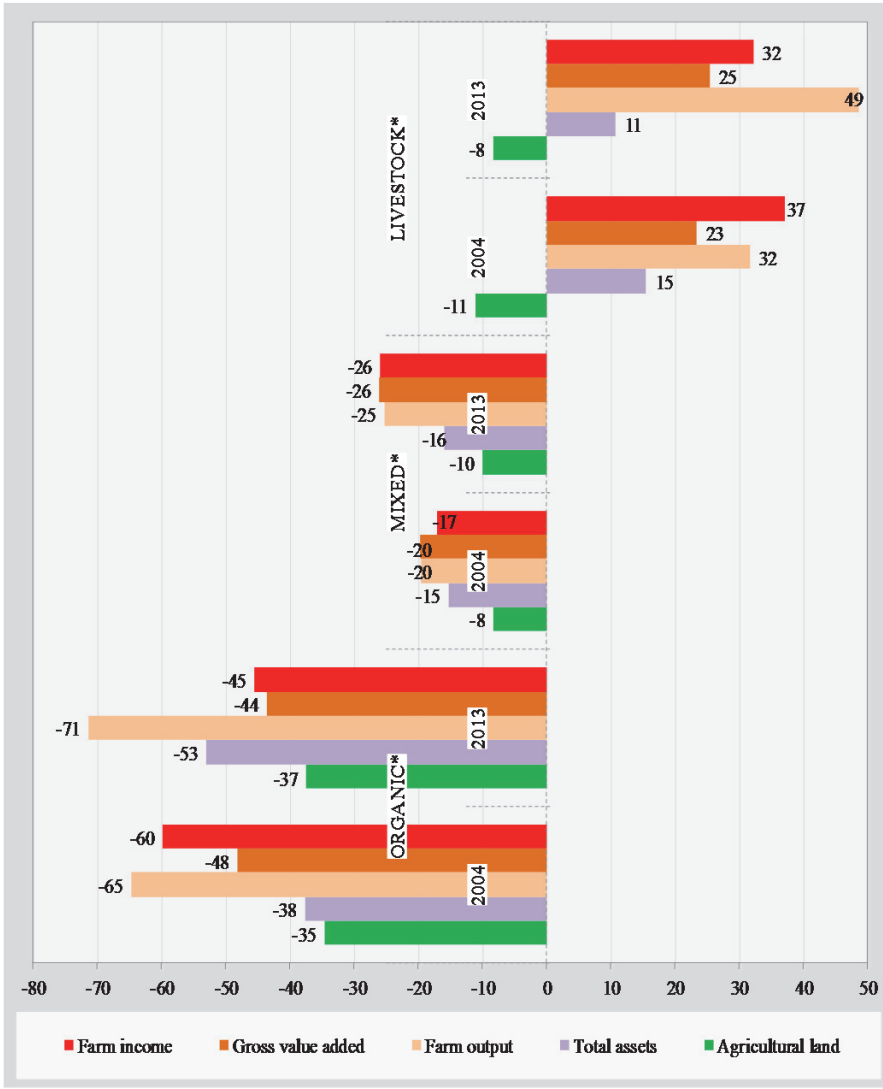
Among panel mixed holdings (2004), 54% of them did not change their farming type in the analysis period. They were treated as subpanel mixed holdings (Table I.2). Their characteristics were compared to mixed holdings in total (Table I.1). Subpanel mixed holdings increased their UAA (by 16%), thus slightly increasing (by 6%) their livestock. Subpanel mixed holdings' production potential, production and economic results as well as the direction and rate of ongoing changes in this area did not differ significantly from the analysed mixed holdings in total (Table I.1). This indicates that holdings, which join the population of mixed operators in subsequent years, have similar organisation and economics of agricultural production.

The number of subpanel livestock holdings accounted for 83% of the group of holdings of such specialisation in 2004. The direction and scale of changes in subpanel livestock holdings' UAA, labour inputs and assets were similar to those observed for panel livestock holdings in total. The livestock of subpanel holdings increased much more than that of livestock holdings in total (respectively by 25% and 11%) which represents a sign of increasing specialisation. Holdings, which had already been specialised in livestock production in 2004, took further investment decisions to increase the scale of livestock production.

The increasing specialisation of livestock holdings was reflected in their production and economic results in 2013. As regards subpanel holdings, each production and economic category (output value, gross and net value added, income) increased about 2-fold in the analysed period. A subpanel holding's output value amounted to PLN 420 thousand, while its income – to PLN 131 thousand, i.e. more than the results for livestock holdings in total respectively by 12% and 7%. The differences in the production and economic values were reflected in an economic investment scale.

Figure I.2 presents relative differences in production potential and selected production and economic results between the subpanel of the selected groups of holdings and the average for the analysed holdings in total. Similarly to Figure 1, it presents the gap (%) between the selected groups of holdings and the analysed holdings in total. The figure also indicates that the analysed holdings in total lag far behind subpanel livestock holdings.

Figure I.2. Relative difference (%) between the analysed groups of agricultural holdings and the average results in 2004 and 2013 (subpanel agricultural holdings in the groups)



Source: own study based on 2004 and 2013 FADN data.

The gap is even wider compared to the one presented in Figure 1. It indicates that the production and economic dominance of holdings, which increase their specialisation, is growing compared to the average holdings. However, subpanel organic and mixed holdings differed from the average holdings with their significantly lower production potential, and lower production and economic results.

2. Economic sustainability of agricultural holdings

The economic sustainability of agricultural holdings covers primarily issues of the productivity and profitability of factors of production. The level of productivity depends on the way natural resources and natural processes are used, while the social value of environmental resources is directly reflected in the cash flow – fees, taxes and subsidies – between the agricultural producer and the state, and further in the profitability of the agricultural holding.

The productivity of factors of production is a basic element of the economic efficiency of the agricultural holding. It is defined as the output-to-input ratio. It may be analysed in the context of individual factors (land, labour and capital) and of the factors in general. Its level may be due to increasing output or reducing inputs. In contrast, the profitability of factors of production is a basic output indicator of agricultural activity, indicating the size of income from a unit of a given input. Family farm income is a basic economic objective of a farmer's activity and is an important determinant of the standard of living of a farming family, hence it may be an important indicator of economic sustainability (Wrzaszcz and Zegar 2014). The size of income illustrates the level of remuneration for involving own factors of production in the agricultural holding's operations and for risk taken by a farm holder in an accounting year.

In order to analyse the productivity and profitability of factors of production in the selected groups of holdings, an indicator and comparative analysis was performed by using production and economic categories, i.e.: output value, gross value added and family farm income[10]. The analysis used the value of intermediate consumption as well which reflects the sum of direct costs (e.g. of seeds, fertilisers, plant protection products, feed) and farming overheads incurred in the agricultural holding (*inter alia*, of electricity, heating fuel, fuel, insurance, services). The selected indicators were used to assess the following:

- productivity of land inputs:
  - Standard Gross Margin/hectare of UAA,
  - output value/hectare of UAA,
  - gross value added/hectare of UAA,
  - net value added/hectare of UAA,
- productivity of labour inputs:
  - Standard Gross Margin/full-time worker in total,
  - output value/full-time worker in total,
  - gross value added/full-time worker in total,
  - net value added/full-time worker in total,

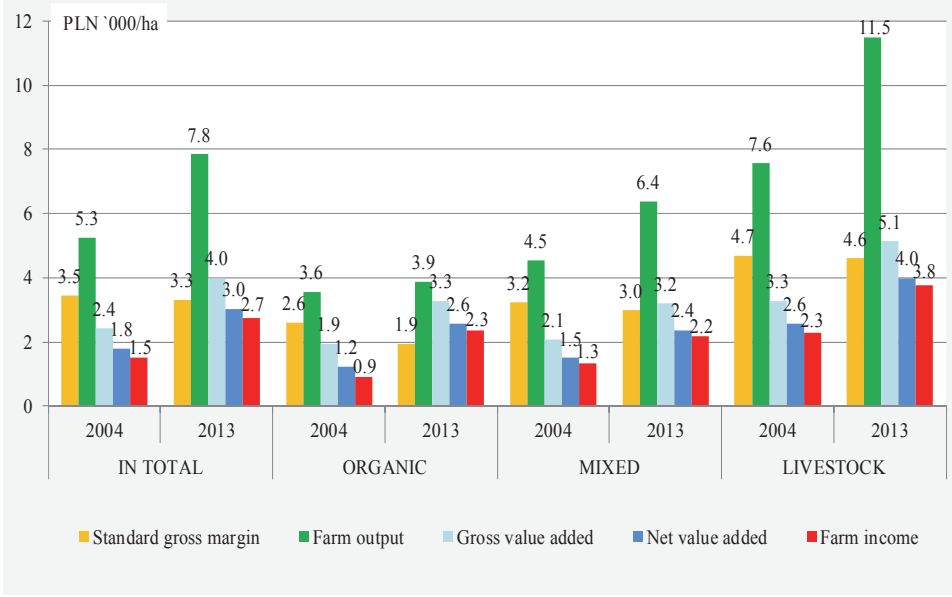
[10] The method of FADN standard results calculation was presented in [Bocian, Malanowska 2015].

- profitability of agricultural production (output/intermediate consumption),
- profitability of land inputs (income/hectare of UAA),
- profitability of labour inputs (income/full-time own labour).

2.1. Agricultural holdings in total and the selected groups

Figure I.3 presents the value of the selected economic sustainability indicators for the analysed holdings in total and the analysed groups of holdings. It covers values of both land productivity and land profitability indicators.

Figure I.3. Land productivity and profitability in 2004 and 2013 (panel agricultural holdings)



Source: own study based on 2004 and 2013 FADN data.

The average panel holding's land productivity, which is measured as the ratio of output value to UAA, amounted to PLN 5.3 thousand/ha in 2004 and PLN 7.8 thousand/ha in 2013 (up by 50%). Organic and mixed holdings achieved lower results – respectively by 32% and 14% in 2004, and 51% and 19% in 2013, compared to the value of the average. However, holdings specialised in livestock production increased their advantage over the average panel holding in terms of land productivity, both in static terms – when comparing value differences in particular years (in relation to the average, 44% in 2004 and 46% in 2013), and dynamic terms – taking into account the land input productivity growth indicator (results in 2013 were higher than in 2004 by as much as 52%).

Land productivity indicators based on the gross and net value added indicated also better economic sustainability of all the groups of holdings. The adopted production and economic categories include the value of operating subsidies. From such a perspective, the land productivity of organic holdings increased the fastest which is due to financial support for this production system and differences in prices of organic and conventional products (Figure I.3).

Taking the category of the Standard Gross Margin as a basis, it may be stated that the land productivity of holdings in total as well as of the group of mixed and livestock holdings in the analysed period fell slightly, while that of the group of organic holdings – by as much as 26%.

To sum up, it may be stated that regardless of what indicator we use to measure land productivity, organic and mixed holdings lag far behind the average units, while holdings specialised in livestock production have an advantage over other holdings.

The ratio of farm income value to UAA informs us about the profitability of land inputs. The average income per area unit was PLN 1.5 thousand/ha in 2004 and increased to PLN 2.7 thousand/ha in 2013, i.e. by 181%. Organic and mixed holdings achieved lower economic results compared to the average holdings, although the gap of organic holdings narrowed. The most favourable economic results were achieved by livestock holdings whose advantage over the average panel holdings, however, decreased despite land profitability growth. Operating subsidies (used to a greater extent by organic and mixed holdings) and costs related to payment for external factors – much higher in the case of livestock holdings (Table I.3), were important elements when calculating land profitability which affected relations between "pro-environmental" and livestock holdings and the average panel holdings.

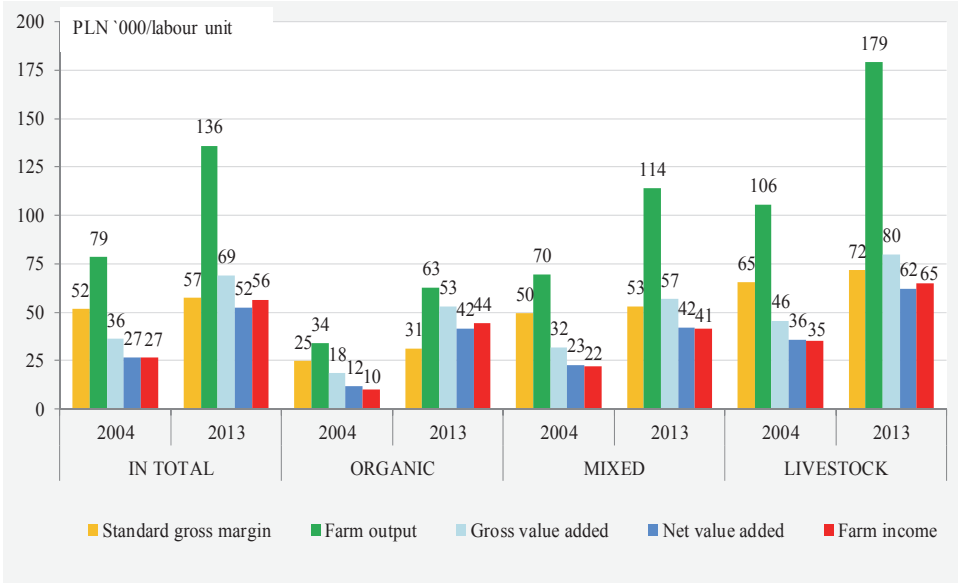
Table I.3. Selected economic indicators in 2004 and 2013 (panel agricultural holdings in total)

Specification	In total		Organic		Mixed		Livestock	
	2004	2013	2004	2013	2004	2013	2004	2013
Intermediate consumption (PLN '000/ha)	3.01	4.94	1.78	2.22	2.63	4.31	4.51	7.44
Balance of operating subsidies and taxes (PLN '000/ha)	0.17	1.08	0.16	1.62	0.18	1.11	0.21	1.09
Depreciation (PLN '000/ha)	0.64	0.96	0.71	0.71	0.58	0.82	0.71	1.15
Costs of external factors (PLN '000/ha)	0.21	0.39	0.21	0.29	0.13	0.27	0.21	0.37
Balance of investment subsidies and taxes (PLN '000/ha)	-0.05	-0.10	-0.10	-0.05	-0.03	-0.08	-0.06	-0.07

Source: own study based on 2004 and 2013 FADN data.

The productivity of labour inputs, which are based on the value of farm output, increased in 2004-2013 by 73% – from PLN 79 thousand/AWU to PLN 136 thousand/AWU (Figure I.4). As was the case with land productivity, organic and mixed holdings lagged behind the average holdings, while specialist livestock holdings were characterised by the highest labour productivity. These relations are also confirmed by values of indicators based on other production and economic categories. Furthermore, labour productivity, which is determined by using the Standard Gross Margin, pointed to labour productivity growth in all the selected groups. The group of organic holdings was the most noteworthy in this regard as it significantly improved its standing with respect to panel holdings in total.

Figure I.4. Labour productivity and profitability in 2004 and 2013 (panel agricultural holdings in total)



Source: own study based on 2004 and 2013 FADN data.

In 2004-2013, the labour profitability of the average holding more than doubled – from PLN 27 thousand/FWU to PLN 56 thousand/FWU. Similar changes occurred in livestock and mixed holdings. In 2013, however, the labour productivity of organic holdings was over 4-fold higher than in 2004 (cf. Figure I.3). Multiplied operating subsidies were a particularly important determinant of the value of the labour profitability indicator for the last group.

The profitability of agricultural production, which is measured as the ratio of output value to intermediate consumption, deteriorated in the analysed period

due to faster growth in the value of intermediate consumption rather than of output. The value of intermediate consumption in the average agricultural holding increased in 2004-2013 from PLN 3.0 thousand/ha to PLN 4.9 thousand/ha, i.e. by 64% (Table I.3), while output value – by 49%. Relative changes in intermediate consumption were similar in the group of mixed and livestock holdings, and significantly lower in the group of organic holdings (24%) which is due to lower dependence on industrial means of agricultural production. An increase in costs related to payment for external factors also differentiate analysed farms' groups – the costs in the average panel holding increased by 83%, in livestock holdings – by 75%, and in mixed holdings – as much as 2-fold, while in organic holdings – by 41%.

Figure I.5. Production profitability indicator in 2004 and 2013 (panel agricultural holdings in total)

Source: own study based on 2004 and 2013 FADN data.

Changes in output value, direct costs and farming overheads shaped the level of the profitability of agricultural production. As shown in Figure I.5, the output of the average agricultural holding per 1 thousand of intermediate consumption amounted to PLN 1.75 thousand in 2004 and to PLN 1.59 thousand in

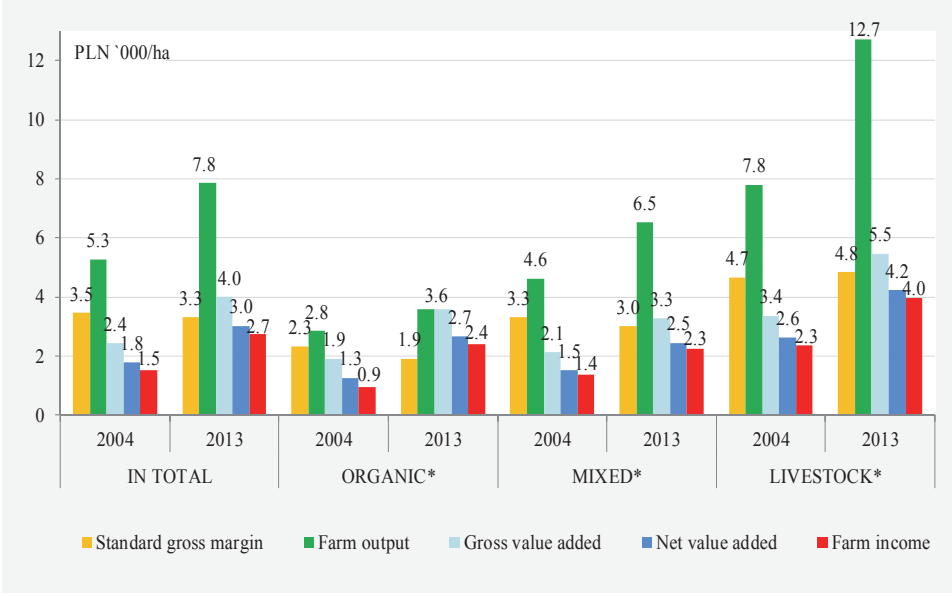
2013. The profitability of agricultural production thus declined – by 9%. The profitability of mixed and livestock holdings was comparable to the average, while more favourable relations were observed with respect to organic holdings whose profitability indicator was higher than the panel average – by 14% in 2004 and by 10% in 2013.

In the analysed period, the widest gap in terms of the level of production profitability was recorded for mixed holdings (14%) and organic holdings (12%), while that of livestock holdings amounted to 8%.

2.2. Subpanel agricultural holdings in the selected groups

The above analysis concerned the analysed holdings in total, and the group of organic, mixed and livestock holdings comprised all holdings which were classified to this fraction in 2004 and 2013. The subsection addresses the economic sustainability of holdings which formed a permanent panel for all the selected groups in 2004 and 2013, hereinafter referred to as the subpanel of respectively organic, mixed and livestock holdings (Figure I.6, Table I.4).

Figure I.6. Land productivity and profitability in 2004 and 2013 (agricultural holdings in total and subpanel holdings in the groups; number as at 2004 = 2013)



Subpanel holdings are marked with *

Source: own study based on 2004 and 2013 FADN data.

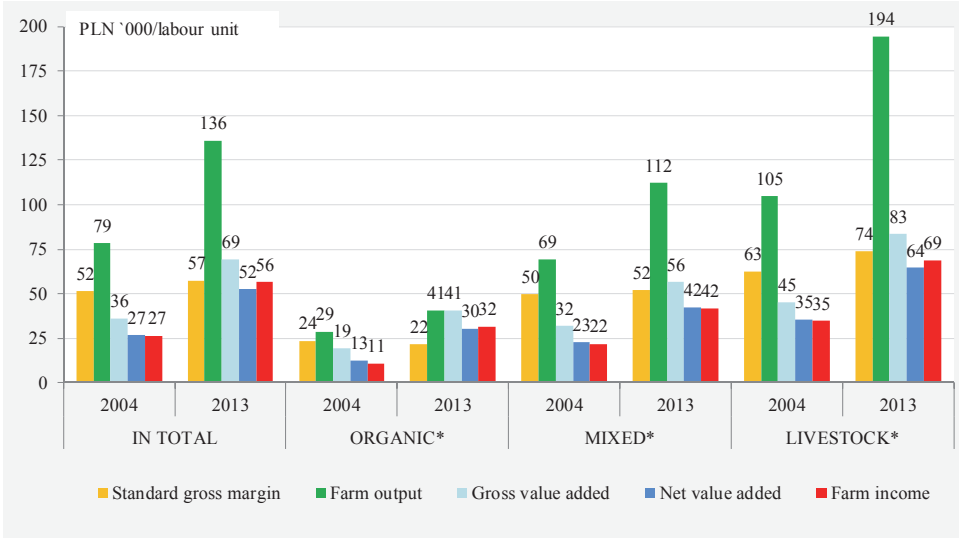
Table I.4. Selected economic indicators in 2004 and 2013 (subpanel agricultural holdings in the groups; number as at 2004 = 2013)

Specification	Organic*		Mixed*		Livestock*	
	2004	2013	2004	2013	2004	2013
Intermediate consumption (PLN '000/ha)	1.15	1.75	2.67	4.36	4.65	8.32
Balance of operating subsidies and taxes (PLN '000/ha)	0.23	1.75	0.18	1.12	0.21	1.05
Depreciation (PLN '000/ha)	0.66	0.93	0.60	0.83	0.73	1.24
Costs of external factors (PLN '000/ha)	0.21	0.38	0.12	0.28	0.22	0.41
Balance of investment subsidies and taxes (PLN '000/ha)	-0.12	-0.06	-0.03	-0.08	-0.06	-0.08

Source: own study based on 2004 and 2013 FADN data.

The land productivity of subpanel organic holdings (based on the production category) was lower than that of organic holdings in total, both in 2004 and 2013. The comparative analysis (Figure I.3 and Figure I.6) indicates that the land productivity of subpanel organic holdings increased by 27%, i.e. less than that of panel holdings in total (by 49%). However, the gap in terms of land productivity in relation to organic holdings in total narrowed in 2013, thus confirming the above conclusion that holdings, which joined the group of organic holdings, had larger area, but lower land productivity.

Figure I.7. Labour productivity and profitability in 2004 and 2013 (subpanel agricultural holdings in the groups; number as at 2004 = 2013)



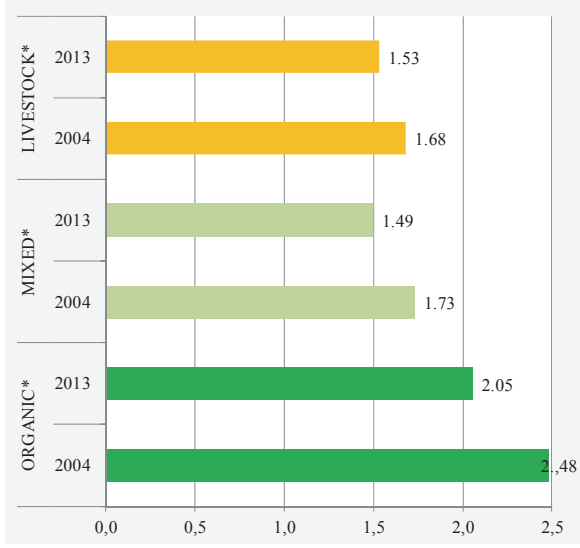
Source: own study based on 2004 and 2013 FADN data.

In the analysed period, the gap in terms of land productivity between organic holdings and holdings specialised in livestock production widened. The latter, i.e. those rearing and breeding livestock, increased their land productivity by as much as 63% in the analysed period. However, the land productivity growth rate of mixed holdings was comparable to that of the average units (41%), although their results were still below the average for the analysed population. Other indicators of the productivity and profitability of the land factor also reveal similar relations between the analysed groups of holdings. It is worth emphasising that subpanel organic holdings, despite the lowest income value per land unit in 2004, achieved the largest (over 2.5-fold) increase in unit results compared to the other analysed groups and the analysed holdings in total.

Changes in the labour productivity of subpanel agricultural holdings in the selected groups were similar to those recorded in organic, mixed and livestock holdings in total (Figure I.7).

However, the labour productivity of subpanel organic holdings was lower than that of organic holdings in total – as it was the case with land productivity. Nevertheless, livestock holdings were ranked the highest in terms of labour productivity (and land productivity) and its growth in the analysed period. These results once again confirmed that organic and mixed holdings generate significantly lower production results – their factors of production are of lower productivity – and their growth rate is lower than that of panel holdings on average.

Figure I.8. Production profitability indicator in 2004 and 2013 (subpanel agricultural holdings in the groups)



Source: own study based on 2004 and 2013 FADN data.

In turn, specialist livestock holdings enjoy production capacity to even more increase their production results. The above observations relate to both the level of and changes in the land and labour productivity of organic holdings and those specialised in livestock production (which is even more evident in the case of panel holdings). The situation of the profitability of factors of production is slightly different, as subsidies play a significant role in shaping the economic result and the growth rate of income as well as land and labour profitability, in particular as regards organic holdings. The fact still remains, however, that organic holdings are hardly profitable and uncompetitive – in the classic sense – compared to conventional ones and especially to operators specialised in livestock production.

3. Subsidies

Subsidies addressed to agricultural holdings are of vital importance for their sustainability. Directly, they are an additional financial stream and, indirectly, they determine the agricultural holding's organisation. Depending on the type and conditions of support, the agricultural holding's organisation is more or less sustainable. As a matter of fact, each subsidy support for the agricultural producer necessitates introducing certain pro-environmental practices (cross-compliance, greening principles, RDP measure-specific practices).

In 2004, area payments and few RDP measures were launched – constituting the agricultural holding's insignificant income at that time. It was evidenced by low values of indicators for that year, being ratios of subsidies to the agricultural holding's results. A part of agri-environmental programme packages for organic holdings and LFA support for holdings were introduced this year. Agri-environmental programmes are a basic RDP measure to promote sustainable agricultural production practices, while LFA support is to maintain agricultural activity in less favoured areas to ensure land productivity and biodiversity, and to shape the agricultural landscape and the viability of rural areas.

An analysis is limited to subsidies under CAP mechanisms to shape the selected economic indicators of agricultural holdings which are relevant to their sustainability. As the subsidies vary, their selected categories and basic aggregated values were used. Their mean value per agricultural holdings and the selected ratios to production and economic results were presented.

3.1. Agricultural holdings in total and the selected groups

Table I.5 presents data on the size of transfers (subsidies) to the analysed groups of holdings in 2004 and 2013. In 2004, the average agricultural holding

received PLN 5.6 thousand of subsidies. They were only operating subsidies (measures to support investment activity were not yet launched at that time). The value was made up mainly by direct payments (nearly 3/4), while the remainder was attributable to transfers under the second pillar of the CAP.

Table I.5. Value of subsidies and ratios of subsidies to production and economic resultsof agricultural holdings in 2004 and 2013 (panel agricultural holdings in total)

Specification	In total		Organic		Mixed		Livestock	
	2004	2013	2004	2013	2004	2013	2004	2013
	Subsidies (PLN '000/holding)							
Total subsidies	5.63	47.41	4.27	52.95	5.99	43.59	4.74	43.37
operating	5.63	42.78	4.27	50.82	5.99	40.24	4.74	36.95
investment	0.00	4.63	0.00	2.13	0.00	3.35	0.00	6.42
Balance of operating subsidies and taxes	5.08	39.05	3.22	48.33	5.22	37.03	5.92	35.51
Balance of investment subsidies and taxes	-1.42	-3.48	-1.89	-1.62	-0.89	-2.73	-1.55	-2.15
Direct payments	4.09	30.95	1.69	26.21	4.78	28.56	2.56	27.82
basic	2.03	25.23	0.88	21.07	2.41	23.12	1.23	22.19
complementary	2.05	4.79	0.81	3.95	2.36	4.39	1.33	5.14
RDP payments	1.54	16.46	2.58	26.74	1.21	15.02	2.19	15.55
agri-environmental	0.02	4.02	1.46	18.06	0.02	3.98	0.01	2.76
organic[a]	0.02	0.47	1.15	15.93	0.00	0.30	0.01	0.37
LFA[b]	0.19	3.03	0.16	4.49	0.16	2.63	0.26	3.95
	Ratios (%)							
Total subsidies/output	3.52	16.77	6.13	45.73	4.60	20.55	2.25	11.60
Operating subsidies/GVA	7.66	29.76	11.24	51.89	10.04	37.98	5.21	22.07
Balance of operating subsidies and taxes/GVA	6.92	27.17	8.46	49.35	8.75	34.95	6.50	21.21
Total subsidies/income	12.20	47.97	23.60	75.77	15.64	60.34	7.41	35.38
Balance of subsidies and taxes in total/income	7.95	35.99	7.33	66.84	11.31	47.49	6.83	27.21

[a] As the method of aggregating data on agri-environmental payments in the FADN system was changed, the value was estimated for 2004; [b] LFAs – less favoured areas; output – farm output.

Source: own study based on 2004 and 2013 FADN data.

In order to determine the relative size of subsidies, the selected ratios of subsidies to production and economic results were used. The ratio of subsidies to output amounted to only 3.5% which indicates low farm income in respect of external transfers compared to output value[11] (in 2004). Ratios of the balance of

[11] Farm output value is the value of crop, livestock and other production – without subsidies which are taken into account at a later economic calculation stage.

operating subsidies and taxes to the gross value added as well as the ratio of the balance of subsidies and taxes in total to farm income were about 2-fold higher[12].

Support for agricultural holdings in the form of various subsidies significantly changed after covering Polish agriculture with CAP mechanisms – both by value and type. A wide range of government programmes encouraged farmers to undertake economic initiatives and, at the same time, comply with environmental commitments. The average holding received PLN 47 thousand of subsidies in 2013, i.e. nearly 8.5-fold more than in 2004. Most of these transfers were direct payments (65%), while RDP payments accounted for 35% of the total value of transfers (Table 5). Farmers may be deemed to be interested in taking environmentally friendly actions, as evidenced by the high share of agri--environmental payments received by farmers – 24% (nearly half was related to organic production), while 18% of the funds were LFA payments (assuming that total RDP transfers are 100%).

Ratios of subsidies to production and economic results reflect their increasing role in shaping the economic situation of agricultural holdings. The ratio of total subsidies to farm output was 17%, of the balance of operating subsidies and taxes to the gross value added – 27%, while of the balance of subsidies and taxes in total to farm income – 36% (in 2013). These results are difficult to interpret – on the one hand, a rural development programme was developed to support holdings and, at the same time, make them comply with environmental protection principles in agricultural production, and – on the other hand – such a high percentage of subsidies in agricultural holdings' results proves their growing dependence on external transfers. In particular, the farmer's income is mainly determined as the value of agricultural production in the holding – and it should remain so – and subsidies of various kinds. The issue of relations between the two main income sources of the farmer – in particular, the extent to which these subsidies encourage production, while minimising pressure on the natural environment, and the extent to which they affect farming efficiency – needs to be studied separately.

Taking the situation of the average holdings in terms of secured subsidies in 2004 as a reference point, it may be concluded that organic holdings initially received the lowest subsidies on that account (PLN 4.3 thousand per holding on average), while the highest subsidies – in 2013 (PLN 53 thousand). The structure of these subsidies by type significantly differed from that presented for the

[12] As regards the last output category, i.e. farm income, all subsidies, including operating and investment subsidies, are taken into account. Given that the investments made entail a VAT burden in respect of this activity, the balance of operating and investment subsidies and taxes in total is the most appropriate to measure the impact of subsidies on income value.

average holdings, as organic holdings received more funds in connection with their active participation in RDP measures in both 2004 and 2013 (respectively 60% and 51%). By reason of the nature of the production system, organic holdings were covered by an agri-environmental programme, including specific organic production support. Therefore, funds secured as part the implementation of the agri-environmental programme, including an organic package, amounted in the RDP support structure respectively to 56% and 79% in 2004, and 68% and 88% in 2013. The stream of subsidies on that account significantly exceeded values for the average holdings which is certainly understandable. Organic holdings secured a relatively low value of investment subsidies which indirectly may also indicate their limited investments compared to holdings in total. We have already stressed the problem.

Ratios of subsidies to organic holdings' results reveal that external transfers played a far greater role in shaping their economic situation than in the case of the average panel holdings, as evidenced mostly by values for 2013. In 2004, the differences between organic and average holdings were made evident by the ratio of subsidies to output (2-fold higher in organic holdings), while the remaining indicators were similar. The comparison revealed a significant gap between these groups of holdings in terms of their output – organic holdings lagging behind the average ones. In 2013, however, ratios of subsidies to production and economic results for organic holdings were many times higher, significantly exceeding the average values for panel holdings in total. The ratio of total subsidies to the organic holding's output was 46%, of the balance of operating subsidies and taxes to the gross value added – 49%, while of the balance of subsidies and taxes in total to farm income – 67%. It indicates a significant advantage of conventional holdings over organic ones in terms of their output and, at the same time, the superiority of the latter in terms of their absorption of subsidies, in particular rural development subsidies.

In the case of mixed holdings, the average size of subsidies, their change over time and structure by type did not differ significantly from the values for the average panel holdings. The average mixed holding secured PLN 5.6 thousand and PLN 47 thousand of support respectively in 2004 in 2013. These values were made up mostly by direct payments. Some funds were received in respect of the implementation of agri-environmental programmes and location in LFAs (respectively 1.3% and 14% of total RDP funds in 2004, and 27% and 18% of total RDP funds in 2013).

Ratios of subsidies to mixed holdings' results were much higher in 2013 and exceeded the values for holdings in total. It was due to lower output value in mixed holdings than in the average ones – as already mentioned. The ratio of

total subsidies to the mixed holding's output was 21%, of the balance of operating subsidies and taxes to the gross value added – 35%, while of the balance of subsidies and taxes in total to farm income – 48%.

On average, holdings specialised in livestock production secured lower subsidies than panel holdings in total, both in 2004 and 2013, although the gap narrowed in the analysed period. The average size of subsidies secured by a livestock holding in these years was respectively PLN 4.7 thousand and PLN 43.4 thousand, while most funds were direct payments. It is worth emphasising that the holdings secured the highest financial support in connection with undertaken investment actions compared to both holdings in total and the other selected groups.

Operators specialised in livestock production participated to a much lesser extent in pro-environmental actions (in 2013, 18% of RDP payments were secured thereunder) than the average holdings. The way the funds were used was certainly due to their organisation which often differed from environmental standards. Given the relatively high profitability of specialist livestock production, the reorganisation of the holdings by using agri-environmental payments is not a profitable economic alternative. Specialist livestock holdings secured more LFA funds than the average holdings (in 2013, 25% of total RDP payments). These results indirectly point to the regionalisation of specialist livestock production – its development in areas with limited crop production potential.

Based on ratios of subsidies to the selected output categories of agricultural holdings, it may be concluded that livestock holdings are less dependent on subsidies – external support, compared to holdings in total and the other analysed groups. It is primarily due to their very high output value. As indicated in Table I.5, the ratio of total subsidies to the output of the holding specialised in livestock production was 12%, of the balance of operating subsidies and taxes to the gross value added – 21%, while of the balance of subsidies and taxes in total to farm income – 27% (in 2013).

3.2. Subpanel agricultural holdings in the selected groups

When comparing the situation of organic holdings in total and subpanel organic holdings, it may be stated that they differed significantly in the amount of subsidy support (Table I.6).

Support secured by subpanel organic holdings in 2004 was higher (23%), while in 2013 – lower (18%), than that of organic holdings in total. In the initial period of support, holdings with many years of experience in conducting agricultural production in accordance with the system's principles were better prepared to effectively use the funds offered under government programmes. Given

that most subsidies are area-related, subpanel organic holdings lagged over time behind organic holdings in total which also included conventional units under reorganisation with often relatively large UAA. Area differences between the two groups of holdings were reflected in the amount of transfers. The subsidy structure by type did not contrast the analysed groups of holdings, while differences in production potential as well as in production and economic results were reflected in ratios of subsidies to output value and income which indicated an increasing importance of subsidies in shaping subpanel organic holdings' results compared to organic holdings in total. In other words, the situation of organic holdings subpanel more depends on external support.

Table I.6. Value of subsidies and ratios of subsidies to production and economic results in 2004 and 2013
(subpanel agricultural holdings in the groups; number as at 2004 = 2013)

Specification	Organic*		Mixed*		Livestock*	
	2004	2013	2004	2013	2004	2013
	Subsidies (PLN '000/holding)					
Total subsidies	5.26	43.36	5.69	42.94	4.58	43.05
operating	5.26	41.48	5.69	39.78	4.58	36.16
investment	0.00	1.89	0.00	3.15	0.00	6.90
Balance of operating subsidies and taxes	4.50	39.56	4.92	36.39	5.73	34.80
Balance of investment subsidies and taxes	-2.39	-1.40	-0.73	-2.58	-1.73	-2.54
Direct payments	1.95	21.64	4.70	27.90	2.27	27.51
basic	1.03	15.70	2.44	22.57	1.07	21.90
complementary	0.92	3.59	2.23	4.20	1.20	5.20
RDP payments	3.31	21.72	0.99	15.04	2.31	15.54
agri-environmental	2.01	14.16	0.01	3.98	0.01	2.35
organic[a]	1.58	11.48	0.00	0.27	0.01	0.34
LFA[b]	0.18	3.87	0.17	2.45	0.28	4.09
	Ratios (%)					
Total subsidies/output	9.32	53.44	4.42	20.33	2.18	10.24
Operating subsidies/GVA	13.79	51.11	9.62	37.45	5.05	20.06
Balance of operating subsidies and taxes/GVA	11.80	48.74	8.33	34.26	6.31	19.31
Total subsidies/income	28.33	80.44	14.85	58.62	7.24	32.95
Balance of subsidies and taxes in total/income	11.39	70.79	10.94	46.15	6.32	24.69

[a] As the method of aggregating data on agri-environmental payments in the FADN system was changed, the value was estimated for 2004; [b] LFAs – less favoured areas; output – farm output.

Source: own study based on 2004 and 2013 FADN data.

Subpanel mixed holdings did not differ significantly from mixed holdings in total in subsidy support, both in absolute terms (taking into account the average size per holding) and relative terms (based on the subsidy structure by type and ratios of subsidies to the holdings' results).

In the case of subpanel holdings specialised in livestock production, it may be stated that the stream and structure of support in the analysed period were similar to livestock holdings in total, while a significant difference in ratios of subsidies to the holdings' results was recorded. As already emphasised, holdings, which increase their specialisation, derive measurable production and economic benefits on that account. It is also confirmed by the indicators presented. Less dependence on subsidies and higher output value enable specialist livestock holdings to improve their economic situation without having to make various environmental commitments that are a condition for a wider range of subsidy support.

At the end of our analysis of the importance of subsidies in shaping agricultural holdings' results, let us stress that the economic situation of organic holdings is the most dependent on external support – subsidies (particularly of those which have been operated in accordance with these principles for many years). They are followed by mixed holdings, then the average holdings and finally specialist holdings with livestock production. The selected groups of holdings may be ranked in reverse order by secured investment subsidies. In the analysed period, differences in this regard between the selected groups deepened and the process is likely to proceed. Rural development instruments offer a chance to improve the condition of pro-environmental holdings.

4. Characteristics of agricultural holdings which reorganised their agricultural production

At this point, let us focus on holdings which changed their farming system or farming type, i.e. left or joined the group of organic, mixed or livestock holdings, in the analysed period. At first, we briefly characterise them and then we assess the level of their economic sustainability, taking into account output and farm income (although tables and figures present a much wider set of indicators), and finally we present the size of subsidies secured by these holdings. To clarify findings in tables and figures, those holdings, which left the selected (i.e. organic, mixed and livestock) group, were marked with the plus sign (+), while those, which joined it, were marked with the minus sign (-). Results of holdings, which left the group of organic, mixed and livestock holdings, were presented with respect to subpanel holdings from the relevant group, while re-

sults of holdings, which joined the indicated groups, were referred to results of panel holdings in total.

4.1. General characteristics

Agricultural holdings, which moved away from organic to conventional production after 2004, generally developed livestock production – increasing livestock by over 50%, slightly increasing UAA (by 10%) and increasing assets over 2.5-fold (current prices, Table I.7). The shift from organic to conventional production was economically advantageous to the agricultural producer. Output value increased nearly 2.4-fold and farm income – nearly 4-fold (current prices). For comparison, these values of subpanel organic holdings increased 1.4-fold and 2.9-fold, thus meaning that the shift from the organic farming system to the conventional farming system produced measurable production and economic results.

Table I.7. Characteristics of agricultural holdings which changed their farming system (2004-to-2013 comparison; on average per 1 farm)

Specification	Organic^{-}		Organic^{+}	
	2004	2013	2004	2013
Number	**18**	**18**	**91**	**91**
UAA (ha)	18.9	20.9	30.9	33.3
Labour force (AWU)	2.3	2.3	1.8	1.8
Livestock (LU)	14.3	21.6	21.1	13.4
Total assets (PLN '000 000)	0.3	0.8	0.3	0.8
Standard Gross Margin (PLN '000)	62.7	84.3	68.0	64.5
Standard output (EUR '000)	28.6	37.2	35.9	33.0
Output (PLN '000)	100.5	235.6	103.9	131.8
Gross value added (PLN '000)	37.7	116.7	40.8	105.7
Net value added (PLN '000)	21.6	87.4	25.9	84.4
Farm income (PLN '000)	17.0	66.1	21.9	77.6
Gross value of investments (PLN '000)	22.3	116.7	5.1	22.6
Net value of investments (PLN '000)	6.2	87.4	-9.8	1.3

Source: own study based on 2004 and 2013 FADN data.

The opposite group comprised holdings operated in accordance with conventional production principles in 2004 and organised according to organic production principles in 2013. In the analysed period, the holdings increased their area by 8% and, at the same time, reduced livestock by over 1/3 to shift to crop production. These changes resulted in an increase in output value by 27% and in income by 260%. As regards the average FADN holding, changes in output

were significantly higher (77%), while in income – smaller (114%). Conventional holdings record a higher dynamics of changes in output value, while those organised according to the organic system are characterised by higher income growth which is mainly due to external support.

Among mixed holdings which changed their farming type, nearly half of them specialised in field production (type 1), while 17% – in rearing grazing livestock (type 4) (Table I.8). It brought greater economic benefits compared to results of mixed production holdings. Holdings, which moved away from mixed agricultural production, increased output value by 69% and income by 132%. However, subpanel mixed holdings improved their results respectively by 64% and 91%. The shift of holdings from mixed to specialist production thus brought significant benefits to farmers.

Table I.8. Characteristics of mixed holdings which changed their farming type (2004-to-2013 comparison; on average per 1 farm)

Specification	Mixed $^{-}$		Mixed $^{+}$	
	2004	2013	2004	2013
Number	**705**	**705**	**375**	**375**
UAA (ha)	29.9	34.7	28.7	35.0
Labour force (AWU)	1.9	1.8	1.9	1.8
Livestock (LU)	22.8	22.9	34.0	27.5
Total assets (PLN '000 000)	0.4	1.1	0.4	1.1
Standard Gross Margin (PLN '000)	93.4	99.9	110.4	101.2
Standard output (EUR '000)	37.8	41.3	44.1	41.0
Output (PLN '000)	132.2	223.5	151.0	214.2
Gross value added (PLN '000)	60.3	123.8	69.0	105.3
Net value added (PLN '000)	43.6	95.1	51.7	77.1
Farm income (PLN '000)	38.3	88.7	46.9	69.9
Gross value of investments (PLN '000)	14.9	40.6	11.5	40.5
Net value of investments (PLN '000)	-1.7	11.9	-5.9	12.3

Source: own study based on 2004 and 2013 FADN data.

Agricultural holdings, which joined the group of mixed holdings (type 8 as at 2013), had previously been classified to the group of holdings with mixed livestock production (type 7, accounting for 52% of "new" mixed holdings in 2004), specialised in pig production (type 5, 26%), specialised in field crops (type 1, 14%) and specialised in rearing and breeding cattle (type 4, 8%). Few holdings were classified to the group of holdings with diverse crop production (type 6). Managers of these holdings decided to reorganise them which involved reducing the scale of livestock production and increasing crop production. In the

average holding of the group, livestock was reduced by 19% and area was increased by 22% in the analysed period. Output value increased by 42% and income – by 49%. For comparison, the average FADN holding under analysis had these values higher by 77% and 114%. These figures indicate a lower growth rate of results of "new" mixed holdings compared to the average ones.

17% of livestock holdings changed their farming type. Most of them diversified agricultural production, thus classifying to type 6, 7 or 8. In the general structure of holdings which moved away from specialist livestock production, holdings with mixed crop and livestock production (type 8) accounted for over 60%, holdings specialised in field crops – for 19%, while 18% of holdings combined various lines of livestock production, thus classifying to type 7. Moving away from specialist livestock production was not an economically advantageous decision. Output value increased by 22% and income – by 16%. However, the output and income of subpanel livestock holdings increased respectively by 100% and 106%.

Table I.9. Characteristics of agricultural holdings specialised in livestock production which changed their farming type (2004-to-2013 comparison; on average per 1 farm)

Specification	Livestock $^{-}$		Livestock $^{+}$	
	2004	2013	2004	2013
Number	**205**	**205**	**541**	**541**
UAA (ha)	31.9	40.0	27.7	31.7
Labour force (AWU)	1.9	1.9	1.9	2.0
Livestock (LU)	54.5	32.0	27.8	46.0
Total assets (PLN '000 000)	0.5	1.3	0.4	1.2
Standard Gross Margin (PLN '000)	152.8	125.2	95.3	130.7
Standard output (EUR '000)	58.9	47.3	39.2	52.7
Output (PLN '000)	210.7	257.7	127.3	287.9
Gross value added (PLN '000)	92.5	122.3	57.9	143.6
Net value added (PLN '000)	73.0	89.0	42.6	112.7
Farm income (PLN '000)	67.4	78.1	38.3	107.6
Gross value of investments (PLN '000)	15.3	41.2	17.1	47.8
Net value of investments (PLN '000)	-4.4	7.8	1.7	16.9

Source: own study based on 2004 and 2013 FADN data.

The number of holdings, which joined the group of livestock holdings in the analysed period, was over 2-fold higher than the number of holdings which moved away from specialising in livestock production (Table 9). These holdings increased their area by 14% and livestock by 65%. Their output value increased by 126% and

income – by 181%, i.e. much more than in the case of the average FADN panel holding (where the values increased respectively by 77% and 114%).

4.2. Land and labour productivity and profitability

Due to the shift of holdings from the organic to conventional system, land productivity and profitability results multiplied (the indicator of output increased by 112%, while that of income value – by 251%, Table I.10). These increases significantly exceeded changes that occurred in subpanel organic holdings (respectively by 27% and 156%).

Table I.10. Land and labour productivity and profitability (agricultural holdings which were not classified to the group of organic, mixed and livestock holdings in 2013; number as at 2004 = 2013)

Specification	Organic -		Mixed -		Livestock -	
	2004	2013	2004	2013	2004	2013
	Land productivity (PLN '000/ha)					
Standard Gross Margin	3.3	4.0	3.1	2.9	4.8	3.1
Farm output	5.3	11.3	4.4	6.4	6.6	6.4
Gross value added	2.0	5.6	2.0	3.6	2.9	3.1
Net value added	1.1	4.2	1.5	2.7	2.3	2.2
Farm income	0.9	3.2	1.3	2.6	2.1	2.0
	Labour productivity (PLN '000/labour unit)					
Standard Gross Margin	27.6	37.6	49.5	55.2	80.6	67.8
Farm output	44.3	104.8	70.0	123.6	111.1	139.6
Gross value added	16.6	51.9	31.9	68.4	48.8	66.3
Net value added	9.5	38.9	23.1	52.6	38.5	48.2
Farm income	8.8	40.0	22.1	53.1	39.3	47.3

Source: own study based on 2004 and 2013 FADN data.

There was also a significant increase in results of holdings which underwent the specialisation process, being classified in 2004 to type 8, i.e. holdings with mixed crop and livestock production. In this case, land productivity and profitability increased respectively by 45% and 99%. For comparison, the results of subpanel mixed holdings increased to a lesser extent, i.e. by 41% and 65%.

Nevertheless, the land productivity and profitability of holdings, which moved away from specialist livestock production, remained unchanged in the analysed period. Unlike this group, the land productivity and profitability of holdings, which continued specialist livestock production, increased respec-

tively by 63% and 69%. This comparison indicates missed opportunities of the former for generating higher unit production and economic results.

Table I.11 includes results of holdings which joined the group of organic, mixed or specialist livestock holdings. The shift from conventional farming to the organic farming system thus led to improving unit production and economic results. Although the land productivity of the group changed by 18%, its land profitability increased by 260%. In this period, the average results of the analysed FADN holdings changed respectively by 49% and 114%, thus indicating a lower growth rate of land productivity and a faster change in land profitability as regards organic holdings. Comparing results from Table I.10 and Table I.11, it may be concluded that organic holdings, whose land productivity is relatively high, shift to the conventional system, thus increasing their land profitability results. However, conventional holdings, whose unit production results are much below the average, tackle organic production challenges, thus increasing their economic sustainability.

Table I.11. Land and labour productivity and profitability (agricultural holdings which were not classified to the group of organic, mixed and livestock holdings in 2004; number as at 2004 = 2013)

Specification	Organic +		Mixed +		Livestock +	
	2004	2013	2004	2013	2004	2013
	Land productivity (PLN '000/ha)					
Standard Gross Margin	2.2	1.9	3.8	2.9	3.4	4.1
Farm output	3.4	4.0	5.3	6.1	4.6	9.1
Gross value added	1.3	3.2	2.4	3.0	2.1	4.5
Net value added	0.8	2.5	1.8	2.2	1.5	3.6
Farm income	0.7	2.3	1.6	2.0	1.4	3.4
	Labour productivity (PLN '000/labour unit)					
Standard Gross Margin	37.3	36.3	58.2	55.6	49.7	66.7
Farm output	57.0	74.2	79.6	117.7	66.4	146.9
Gross value added	22.4	59.5	36.4	57.8	30.2	73.3
Net value added	14.2	47.5	27.2	42.3	22.2	57.5
Farm income	13.3	51.0	26.7	41.0	21.0	58.4

Source: own study based on 2004 and 2013 FADN data.

The land productivity and profitability of holdings, which joined the group of holdings of type 8, i.e. with mixed crop and livestock production, improved (the indicators in question increased respectively by 16% and 22%). These changes are not, however, that large as in the case of the analysed holdings in total. Nevertheless, these results prove that the land productivity and

profitability of holdings with mixed crop and livestock production stabilised or increased moderately. Moving away from specialist production or single production does not necessarily entail economic sustainability losses.

Results of holdings, which joined the group of specialist livestock production holdings, were definitely most favourable. Their land productivity increased the most, i.e. by 98%, while land profitability rose by 146%. Furthermore, economic sustainability changes, which took place in the entire analysed FADN population, were not as high as those in holdings specialised in livestock production.

Similarly to land productivity and profitability, the value of output and economic results against labour inputs indicates their growth in each analysed group of holdings. Holdings, which shifted from the organic to conventional system, stand out with the size of changes, in particular in the labour profitability indicator which amounted to 357% (Table I.10). For comparison, the indicator in subpanel organic holdings increased by 187%. Organic holdings dominated other ones also with labour productivity growth.

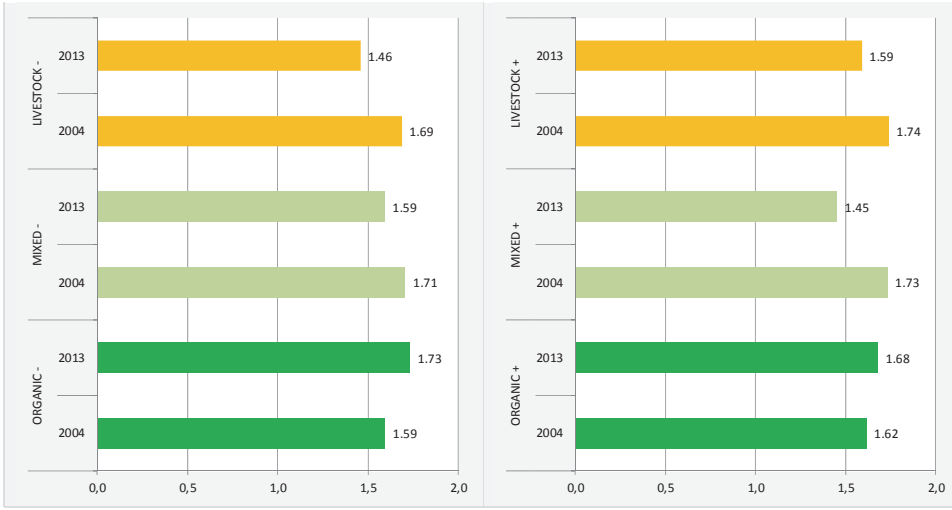
Furthermore, holdings with mixed crop and livestock production, which shifted to specialised livestock production, recorded more favourable economic sustainability indicators than holdings which continued diverse crop and livestock production (labour productivity and profitability in both groups changed respectively by: 77% and 141%, and 62% and 90%). The same observations may also be made after analysing holdings which underwent opposite organisational changes, i.e. shifted from specialisation to diversification. Dynamics of changes in their labour productivity and profitability was significantly lower than that observed in holdings which consistently maintain their specialisation in livestock production (these changes were 26% and 21% in the first group, and 86% and 98% in the second group).

The opposite group comprised holdings which "joined" the population of organic, mixed and specialist livestock production holdings. Table I.11 presents their labour productivity and profitability results. When taking changes in the entire analysed FADN population as a background (increase in labour productivity and profitability respectively by 73% and 113%), it is clear that changes in the labour productivity and profitability of specialist holdings were more intense (respectively 121% and 178%). Organic holdings recorded the highest, i.e. nearly 3-fold, increase in labour profitability in this period. The situation of holdings, which joined the group of mixed holdings and whose economic sustainability increased moderately, much less than the average results, was the least favourable.

Figure I.9. Production profitability indicator

A
holdings which were not classified to the group of organic, mixed and livestock holdings in 2013; number as at 2004 = 2013

B
holdings which were not classified to the group of organic, mixed and livestock holdings in 2004; number as at 2004 = 2013



Source: own study based on 2004 and 2013 FADN data.

As indicated in Figure I.9A, the decision to move away from organic production may be considered as profitable for the agricultural producer. The shift to the conventional system made agricultural production more profitable. Results of holdings, which moved away from specialist livestock production, were significantly lower. Their production profitability declined the most. Furthermore, results of holdings, which moved away from mixed crop and livestock production, were lower in this respect. Nevertheless, Figure I.9B proves that the conversion to organic production may also be profitable for the agricultural producer. Holdings, which moved away from specialist livestock production, recorded the largest decline in profitability.

4.3. Subsidies

In addition to the considerations above, we present the size of subsidies secured by holdings which were no longer classified to the selected groups of holdings in 2013 (Table I.12). Organic holdings, which were converted to the conventional system, received much lower transfers compared to organic subpanel holdings – both in 2004 and 2013. These holdings benefited from rural development support to a limited extent. Therefore, ratios of subsidies to production and economic results were low compared to subpanel holdings and the

analysed holdings in total. The ratio of the balance of subsidies and taxes in total to income was very low as a result of primarily expensive investments made in these holdings and then tax liabilities. In summary, holdings, which moved away from organic production, benefited from low subsidies and their reorganisation entailed tackling investment challenges (see Table 7).

Table I.12. Value of subsidies and ratios of subsidies to production and economic results in 2004 and 2013
(agricultural holdings which were not classified to the group of organic, mixed and livestock holdings in 2013; number as at 2004 = 2013)

Specification	Organic -		Mixed -		Livestock -	
	2004	2013	2004	2013	2004	2013
	Value of subsidies (PLN '000/holding)					
Total subsidies	1.96	25.18	6.35	47.19	5.54	48.32
operating	1.96	22.40	6.35	43.58	5.54	44.44
investment	0.00	2.78	0.00	3.61	0.00	3.88
Balance of operating subsidies and taxes	0.21	17.14	5.58	40.57	6.88	41.59
Balance of investment subsidies and taxes	-0.72	-15.90	-1.08	-1.90	-0.69	-3.34
Direct payments	1.07	16.74	4.89	31.20	3.95	32.71
basic	0.52	13.83	2.36	24.99	1.98	26.77
complementary	0.55	2.77	2.51	4.75	1.97	5.39
RDP payments	0.89	8.44	1.47	15.98	1.59	15.61
agri-environmental	0.17	1.45	0.02	5.24	0.00	4.75
organic	0.13	0.00	0.00	0.70	0.00	0.26
including: LFA	0.09	2.74	0.16	2.64	0.14	3.36
	Ratios (%)					
Total subsidies/output	1.95	10.69	4.81	21.12	2.63	18.75
Operating subsidies/GVA	5.21	19.20	10.53	35.22	5.98	36.33
Balance of operating subsidies and taxes/GVA	0.56	14.69	9.25	32.78	7.43	33.99
Total subsidies/income	11.55	38.12	16.59	53.20	8.23	61.87
Balance of subsidies and taxes in total/income	*	1.88	11.76	43.60	9.18	48.98

* As the balance of subsidies and taxes in total was negative, the indicator was not calculated.

Source: own study based on 2004 and 2013 FADN data.

Holdings with mixed crop and livestock production (mixed), which changed their farming type in the analysed period, did not differ significantly from holdings which continued their production to date (i.e. subpanel mixed holdings). Ratios of subsidies to production and economic results in both groups were similar as well.

However, the situation of holdings, which did not continue specialist livestock production, is different. The stream of transfers secured by them in 2013

exceeded the values for operators which continued such production, in particular transfers related to operating activity. Higher subsidy support is also reflected in the ratio of transfers to agricultural holdings' results. These values once again proved that government support plays an increasingly important role in shaping non-specialist agricultural holdings' economic results.

Table I.13 presents the size of subsidy support secured by holdings which joined the group of organic, mixed and specialist livestock production holdings.

Table I.13. Value of subsidies and ratios of subsidies to production and economic results in 2004 and 2013
(agricultural holdings which were not classified to the group of organic, mixed and livestock holdings in 2004; number as at 2004 = 2013)

Specification	Organic +		Mixed +		Livestock +	
	2004	2013	2004	2013	2004	2013
	Value of subsidies (PLN '000/holding)					
Total subsidies	2.38	57.37	5.15	45.05	4.26	43.97
operating	2.38	55.13	5.15	41.26	4.26	38.43
investment	0.00	2.25	0.00	3.80	0.00	5.55
Balance of operating subsidies and taxes	1.24	52.38	5.13	38.47	3.76	36.83
Balance of investment subsidies and taxes	-0.42	-1.72	-0.71	-3.05	-1.24	-1.43
Direct payments	1.43	28.32	3.89	30.05	2.76	28.39
basic	0.73	23.54	1.98	24.34	1.34	22.73
complementary	0.69	4.11	1.91	4.83	1.42	5.02
RDP payments	0.96	29.05	1.26	15.00	1.50	15.58
agri-environmental	0.07	19.86	0.02	3.99	0.03	3.53
organic	0.00	17.99	0.02	0.38	0.00	0.42
LFA	0.20	4.77	0.17	3.05	0.24	3.69
	Ratios (%)					
Total subsidies/output	2.29	43.54	3.41	21.03	3.35	15.28
Operating subsidies/GVA	5.83	52.17	7.46	39.17	7.36	26.75
Balance of operating subsidies and taxes/GVA	3.02	49.57	7.44	36.53	6.49	25.65
Total subsidies/income	11.09	74.26	10.99	64.42	11.14	40.86
Balance of subsidies and taxes in total/income	3.78	65.57	9.43	50.66	6.59	32.90

Source: own study based on 2004 and 2013 FADN data.

The presented figures on conventional holdings, which were converted to organic production, indicate that they were very well prepared for securing financial support, i.e. they met e.g. environmental requirements which are a condition for applying for subsidies. The stream of funds secured by "new" organic holdings was significantly larger than in the case of the analysed hold-

ings in total. These holdings secured also greater support for the implementation of rural development measures, including agri-environmental programmes. It was mainly the effect of their larger area of agricultural land. As regards organic holdings, the ratio of subsidies to output (in 2013) was higher than in the case of the analysed holdings in total which was due to both higher subsidies and lower organic farm output. Ratios based on income value were similar as well.

Another group comprised non-specialist holdings with mixed crop and livestock production in 2013. The size of subsidies and the subsidy structure by type in the case of these holdings and the analysed holdings in total were comparable. Ratios of subsidies to results of holdings exceeded the values for the average holdings. It was due to differences between them in the level of production and economic results. Nevertheless, holdings, which joined the group of operators specialised in livestock production, did not differ significantly from the average ones in the amount of subsidies and ratios of subsidies to production and economic results.

Table I.14. Change in production and economic results of agricultural holdings which left and joined subpanel groups in 2004-2013

Subpanel name	AGRICULTURAL HOLDINGS $^{-}$			AGRICULTURAL HOLDINGS $^{+}$		
	FAV.	UNFAV.	COMP.	FAV.	UNFAV.	COMP.
ORGANIC	O, I, LdProd, LrProd, LdProf, LrProf	T/O, T/I		I, LdProf, LrProf, T/O, T/I	O, LdProd, LrProd	
MIXED	O, I, LdProd, LrProd, LdProf, LrProf		T/O, T/I	T/O, T/I	O, I, LdProd, LrProd, LdProf, LrProf	
LIVESTOCK	T/O, T/I	O, I, LdProd, LrProd, LdProf, LrProf		O, I, LdProd, LrProd, LdProf, LrProf		T/O, T/I

Agricultural holdings $^{-}$/Agricultural holdings $^{+}$ which left/joined the subpanel group;
FAV./UNFAV./COMP. – change in the results was more favourable/less favourable/similar compared to that in subpanel holdings (holdings leaving the subpanel) or in the entire analysed population (holdings joining a specific subpanel); O – output, I – income, T – transfer of subsidies, LdProd – land productivity, LrProd – labour productivity, LdProf – land profitability, LrProf – labour profitability.

Source: own study based on 2004 and 2013 FADN data.

In the end, we present Table I.14 which summarises and shows how production and economic indicators changed (whether favourably, unfavourably, similarly to the comparative group) in the case of holdings which left and joined the group of organic, mixed and livestock holdings.

The presented values indicate that moving away from organic and mixed production brought more favourable changes in their results compared to subpanel holdings which continued their production to date, but a change in results of holdings, which moved away from livestock production, should be assessed as unfavourable. In the case of holdings which joined the organic group, the result of income and transfers of subsidies (thus indicators taking into account their value) significantly improved, while the production category – deteriorated, when assessing them in relation to changes in the analysed FADN panel holdings. A change in the income of mixed holdings was relatively unfavourable as well. The situation of holdings, which shifted to specialist livestock production and which improved their results more compared to changes in the analysed population of FADN holdings, was different.

Summary and conclusions

After covering Polish agriculture with Common Agricultural Policy mechanisms, economic conditions for the development of agricultural holdings changed significantly. Similarly to the EU, Poland took the route towards the sustainable development of agriculture and rural areas. It should be fostered by the CAP. In order to determine what the situation looks like, FADN panel holdings in Poland in 2004-2013 were analysed. The population of panel holdings was divided into the three groups of agricultural holdings of different environmental "friendliness", i.e.: organic, mixed and specialist livestock production holdings. As they changed their organisation and production system in the analysed period, the number of holdings in the selected groups varied in the first and last year. Therefore, holdings, which remained in the selected group in the analysed period, were analysed. Such holdings were brought together into the subpanel within the selected groups. Moreover, holdings, which – in the meantime – joined or left the selected groups, as they no longer met or started meeting the relevant classification criteria, were analysed.

The analysis covers particularly economic relations of agricultural holdings, especially those related to subsidies under CAP mechanisms. The subsidies significantly influenced land and labour productivity and profitability indicators, and other production and economic results of agricultural holdings which described their economic sustainability.

The analysis shows that Polish agriculture undergoes the industrialisation process – a decrease in the number of mixed holdings and an increase in the number of agricultural holdings specialised in livestock production which achieve the most favourable economic results. Besides the progressive specialisation in livestock production, specialisation in and scale-up of crop production are progressing as well, but they were not covered by the analysis. The relatively highest increase was recorded in the number of organic holdings which also received the highest support in the form of CAP subsidies.

Production and economic results, which describe the level of economic sustainability of organic and mixed holdings, lag behind the average results for panel agricultural holdings in total and even more behind the results of holdings specialised in livestock production. In the analysed period, the gap widened; however, the gap of organic holdings to the average ones in terms of the profitability of factors of production narrowed, while that of non-specialist holdings with mixed agricultural production widened.

Subsidies gain in importance when it comes to shaping economic results of agricultural holdings, in particular organic and mixed holdings which receive above-average subsidies. The increasing ratio of subsidies to income proves their growing dependence on external transfers, particularly as regards pro-environmental holdings. Despite receiving relatively smaller subsidies and thus being less dependent on them, holdings specialised in livestock production achieve better economic results.

In the analysed period, the group of organic holdings received the highest support. It seems justified due to poor production intensity and specialisation (determining their less favourable competitive position), and primarily due to generated non-marketable benefits for the environment and society. It turned out, however, that the support is insufficient to achieve economic benefits as those enjoyed by holdings specialised in livestock production. The same observation may be applied to mixed holdings. Given that situation, state intervention in two areas is recommended: firstly – to reward the creation of public goods and services (which is already rewarded, but perhaps needs to be developed), and secondly – to charge agricultural holdings for generated negative external effects (costs) (it is only at the initial stage).

In the analysed period, the number of agricultural holdings in the selected groups, i.e. organic, mixed and livestock groups, varied. Holdings, which moved away from organic and mixed production, generally improved their production and economic results: the size of output and income, land and labour productivity and profitability. In contrast, the results of holdings, which moved away from specialist livestock production, deteriorated. The situation of holdings, which

joined the selected groups, is more diverse. The income and profitability of holdings, which joined the group of organic holdings, increased, but their indicator of output value deteriorated. As regards "new" mixed holdings, the indicator deteriorated as well. Results of holdings, which joined the group of livestock holdings, improved. Therefore, the analysis reveals that changes in the farming system are motivated not only by the economic benefit – certainly being, the most important factor, but also by other circumstances. The second most important factor is the human factor – primarily age, professional skills and an upheld system of values. It, however, was not covered by the analysis.

Chapter II

EXTERNALITIES OF ANIMAL PRODUCTION IN THE CONTEXT OF PRODUCTION AND ECONOMIC RESULTS OF FARMS ON THE EXAMPLE OF DAIRY CATTLE WELFARE

Introduction

Externalities occur when decisions of production and consumption made by one market participant have a direct impact on decisions and actions of other market participants, and the impact is not fully reflected in market prices. It is particularly evident in the case of agriculture, because externalities, such as agricultural landscape, oxygen production, biodiversity or an environmental impact, are felt by a significant part of society.

Animal welfare is one of the externalities in agriculture. Researchers and practitioners have dealt with this issue for many years. Recently, it has also been subjected to broader social and political discussions. Besides aspects of ethics, humane animal maintenance or social awareness, recognizing welfare as an externality is an important element of these discussions. It is important because of a progressive process of the so-called greening of the common agricultural policy and the fact that the weight of support is gradually transferred from production to non-production aspects, such as the generation of environmental public goods.

There is no single definition of the term "farm animal welfare". Farm Animal Welfare Council stated that: *The welfare of an animal includes its physical and mental state and we consider that good animal welfare implies both fitness and a sense of well-being. Any animal kept by man, must at least, be protected from unnecessary suffering*. Changes in the level of welfare may have significant consequences for the farms' economics. On the one hand, its growth may lead to increase in production costs by 5-30% [Blandford 2006, Bennett 1997 as cited in Mitchell 2000]. On the other hand, healthy animals achieve better production results, thus providing a higher level of welfare may contribute to revenue growth [Kołacz 2006]. It was also found that about 20-30% of differences in productivity between different observed dairy herds are related to the level of animals' fear of humans [Słoniewski 2005a; Breuer et al., 2000]. Cows treated gently produced 500 litres of milk per year more than those treated more brutally (experimental studies) [Słoniewski 2005b], i.e. increase by as much as 13%.

The introduction of support mechanisms for generating external benefits, e.g. a higher level of welfare, will have a significant impact on production and economic results achieved by farms. Estimating that impact is an important element of the discussion on the phenomenon of externalities and their valuation. The paper presents dairy cattle welfare as an example of external benefits and indicates possible effects of its growth.

1. Externalities in agricultural production

The term "externalities" in economic theory originates from Alfred Marshall, but his understanding of the term differed from today's one. The theory was developed then by Arthur Pigou [Stankiewicz 2007].

Taking the definition proposed by Meade in 1952 (the first understanding of the term "externalities" which was close to today's understanding) as a basis and generalizing it to all market participants, it may be assumed that externalities occur when production efficiency or a single entity utility depends on another entities' actions, but that impact has a non-market character. Externalities are classified as one of the sources of market failures and, if occur, they lead to an inappropriate (i.e. inefficient or unfair) allocation of resources [Leszek 2010]. There are external benefits and costs. If the feasibility of an objective function for a specific entity improves as a result of another entity actions (assuming that the impact is non-market), external benefits arise, if this feasibility deteriorates, external costs occur [Graczyk and Kociszewski 2013].

Externalities are relevant for broadly understood social welfare. The social optimum and the private optimum differ when externalities occur. Microeconomic calculation does not take into account externalities and thus it does not cover all costs and benefits. If the economic calculation covered them, the optimal level of production would shift. If externalities are positive, the socially optimal level of production is higher than that taking into account only private calculation; if externalities are negative, it is lower. Zegar [2011] pointed out that the problem also applies to the competitiveness of agriculture – economic and social competitiveness are not the same and their level differs.

Scitovsky [1954] distinguished four types of interdependence with respect to externalities, depending on who generates and who receives them:

- consumer's utility may depend on other consumers' utility,
- consumer's utility may depend on producers' actions,
- producer's results may depend on consumers' actions,
- producer's results may depend on other producers' actions.

As far as agriculture is concerned, a farmer, as a producer, generates externalities, while consumers and other market participants that use agriculture-related environmental resources receive them. Interdependence of third and fourth type thus occurs. As a result, agriculture affects the utility and production level of entities that are only indirectly related to it, regardless of whether they are or are not located in rural areas. According to Kociszewski [2013], one can talk about external environmental costs and external environmental benefits as far as agriculture is concerned, while conventional agriculture, intensive live-

stock farming generate mostly external costs, and external benefits are generated mostly by organic farms and extensive farms located in environmentally valuable areas. Although undeniably positive externalities of organic agriculture are larger and its negative externalities – limited compared to conventional agriculture, claiming that conventional agriculture generates mostly environmental costs is somewhat an exaggeration. When analyzing dairy cattle farming, a range of external environmental benefits may be indicated, among others, agricultural landscape preservation, landscape diversity, oxygen production or animal welfare. Zegar [2010] stresses that precisely positive externalities are particularly relevant for agricultural activity, because agriculture produces not only market products, but also a range of non-marketable goods.

Animal welfare has a range of features which make it possible to classify it to the category of externalities:

- it is not recognized in a farm's economic calculation,
- its level is not reflected in the level of prices of agricultural products,
- it is not the main objective of farming,
- its level affects consumers differently than price.

Consumers are interested in conditions under which farm animals are kept, they want them to be treated humanely [Reklewski 2003, Szücs et al. 2007, Cozzi et al. 2008, Kehlbacher et al. 2012]. Therefore, a higher level of welfare contributes to an increased utility of interested consumers. The fact that recipients' expectations and suppliers' welfare level are not reflected in economic calculation, including prices, is the main argument which confirms that farm animal welfare is considered as an externality. It is more like an external benefit rather than an external cost. As a matter of fact, welfare, if occurs, contributes to utility growth and it would be socially viable to increase production with a higher level of animal welfare.

It should be stressed that the generation of externalities by agriculture is influenced by different legal regulations. As stated by Kociszewski [2013], external benefits are generated, while external costs – minimized after implementing an agri-environmental programme. It is so because of the programme's nature which involves meeting certain minimum requirements (cross-compliance). The authoress shares this view as well. In relation to animal welfare, the introduction of more stringent farm animal maintenance standards contributes to increased welfare, and therefore to an increased generation of external benefits.

An important issue in discussing externalities is their valuation. Given that agriculture generates mostly environmental externalities, their valuation may therefore be considered in terms of methods for valuing environmental public goods. The objective scope of environmental externalities and that of environ-

mental public goods actually overlap in part, e.g. welfare or agricultural landscape appear in both categories. Methods for valuing public goods include contingent valuation methods (CVM). The CVM is a method for valuing non-market goods which was formulated by Ciriacy-Wantrup [Małażewska 2015]. The CVM has two variants:

- estimation of benefits based on the consumer's answer to a direct question of how much s/he would be willing to pay for a specific good (willingness to pay);
- estimation of benefits based on the consumer's answer to a direct question of how much s/he would be willing to accept in compensation for changing or giving up a specific good (willingness to accept).

The method may also be adapted to the valuation of externalities, but such valuation will not be accurate and will only be based on consumers' declarations. Graczyk and Kociszewski [2013] propose to valuate externalities by using the "standard economic procedure". It is much more time-consuming and laborious, but also more accurate. It consists in identifying pathways of impacts and then valuing them. The authoress used a similar bottom-up method for the studies referred to in this paper.

2. Dairy cattle welfare in legislation

2.1. Global, European Union and national standards

The Universal Declaration of the Rights of Animals is one of the world's most important legal acts on animal welfare. It was passed in 1977 in London under the auspices of UNESCO. It was ratified by the United Nations three years later. Its preamble includes the following: *whereas all animals have rights; whereas disregard and contempt for the rights of animals have resulted and continue to result in crimes by man against nature and against animals; whereas recognition by the human species of the right to existence of other animal species is the foundation of the co-existence of species throughout the animal world; (...); whereas respect for animals is linked to the respect of man for men; whereas from childhood man should be taught to observe, understand, respect and love animals*. Its importance lies in the fact that it is a basis for national regulations, including the Polish Act on the protection of animals [Matuszewski and Walczak 2005].

In Europe, special attention should be paid to the European Convention for the protection of animals kept for farming purposes adopted in Strasbourg in 1976 by the Council of Europe (as amended in 1992). It contains provisions on animal maintenance and care. The provisions of the Convention provide for

ensuring animals conditions appropriate to their physiological and ethological needs in accordance with established knowledge. Poland is one of countries which have signed but not ratified the Convention.

The Animal Welfare Action Plan (until 2010), which was adopted in 2006 by the European Parliament (Portal of the European Commission), is another important piece of EU legislation. At present, the second edition of the Plan is in force, i.e. Animal Welfare – EU Action Plan, Evaluation and the Second Strategy on Animal Welfare. Furthermore, the European Union Strategy for the Protection and Welfare of Animals 2012-2015 was developed. It indicates animal welfare drivers in the European Union and addresses strategic measures to be taken to improve animal welfare in the Community.

In the European Union, farm animal welfare is governed by Directive No. 806/2003 of 14 April 2003. EU environmental law should be also included in European Union legislation on farm animal welfare. A high level of welfare is an important part of organic production systems [Lund and Röcklinsberg 2001 as cited in Lund and Algers 2003] and environmental provisions are far more restrictive than conventional ones.

The Act of 21 August 1997 on the protection of animals is the main normative act on the protection of animals in Poland, including animal welfare. Furthermore, animal welfare is governed by the Regulation of the Minister of Agriculture and Rural Development of 28 June 2010 on the minimum conditions of maintaining livestock other than that for which protection standards have been defined under European Union provisions, and the Regulation of the Minister of Agriculture and Rural Development of 15 February 2010 on the requirements and procedure for maintaining livestock species for which protection standards have been defined under European Union provisions.

In Poland, as in most European Union Member States, national legislation on farm animal welfare, including dairy cattle welfare, does not go beyond the EU legal framework.

2.2. Non-governmental national initiatives of EU Member States on dairy cattle welfare

Western European countries launched numerous non-governmental initiatives to promote a high level of animal welfare. These initiatives are often certified standards and are very popular. Joining them is voluntary and their certification ensures that products sold under a particular standard-brand comply with specific standards. There are "environmental" and "conventional" standards. The former include Bioland (Germany), SKAL (Netherlands), KRAV (Sweden) and the Soil Association (United Kingdom), whilst the latter include:

Neuland (Germany), Agriqualità (Italy), Freedom Food – the RSPCA (United Kingdom). Most of these standards were established in the 1980s and the 1990s and have been developing dynamically so far. All of these non-governmental environmental standards go beyond the European Union environmental legal framework at least in one aspect which is often not governed by EU law at all. Non-governmental conventional agriculture standards go beyond EU law more often than environmental standards. The reason may be that EU law on conventional agriculture is much less precise than that on organic agriculture. The United Kingdom's Freedom Food (RSPCA) provides for the most restrictive and complex standards.

No enhanced standards for animal welfare, including dairy cow welfare, were registered in Poland. There are only a few organic agriculture certification "brands" as well as QMP (Quality Meat Product) and PQS (Pork Quality System) standards for beef production (QMP) and pork production (PQS) in conventional agriculture. Nevertheless, they rather concern compliance with legal welfare standards than their enhancement.

3. Farm animal welfare – production and economic implications

Maintenance systems directly affect animals' well-being, productivity and health [MacArthur Clark et al. 2006, Winnicki et al. 2004, Grzegorzak et al. 1983]. Their physical and mental well-being in livestock housings is a prerequisite for their health, high productivity, long life and optimal use [Szulc 2005]. In order to ensure well-being, a farming system should meet basic needs of animals in terms of, among others, feeding, access to water and living space, companion animals, treatment and protection against injuries.

An increase in milk yield of cows, which has been continuing for many years, necessitates changes in maintenance and feeding conditions, as high-yielding cows have different needs than average-yielding cows. Changes, which are introduced by farmers, relate primarily to reducing pasture grazing [Reklewski 2003, Solan and Józwik 2009], thus limiting movement and raising the incidence of lameness. About 50% of animals in Western Europe suffer from lameness [Robertson 2006 as cited in D'Silva 2006]). Apart from fertility disorders and udder diseases, it is one of the main reasons for increased culling in high-yielding cow herds [Lewandowski 2008, Grzegorzak et al. 1983]. Furthermore, lameness has an adverse impact on achieved production and economic results. Sick animals are less productive which translates into lower revenues, while additional veterinary expenses increase costs. Barej [1991] states that hoof diseases may reduce milk yield by 10%. Other studies reveal that the productivity of lame cows was lower than that of healthy cows by about 988 kg per year

[Dorynek et al. 1980 as cited in Winnicki et al. 2004]. A proper maintenance system, feeding and very good herd management may significantly reduce the incidence of lameness. According to Reklewski [2003], only 3-6% of animals in well-maintained high-yielding cow herds suffer from lameness.

Maintenance systems of different types, i.e. tied and loose, have both advantages and disadvantages that affect cows' well-being and welfare as well as their production results. In his studies, Fiedorowicz [2012] evaluated housings in terms of welfare. 17 of 50 evaluated housings received the highest ratings of the author's own functionality indicator (from standard to very good) – they were all loose housings. The obtained results were then compared to milk production quantitative and qualitative results. A quite evident positive correlation between annual milk yield of cows and the functionality indicator was found, so was a very evident relation between milk quality and the functionality indicator. Other studies [Lasek et al. 2004] revealed that cows kept in a mixed maintenance system had higher milk yield than those kept only in the loose system: the tied system for the first 100 days of lactation and then the loose system. For the first 100 days, the average daily milk yield was higher by 1.3 kg and after the entire lactation period – by 0.7 kg. Importantly, milk fat and protein content was not statistically different. One reason for such results was feeding. Cows kept in the tied system better used dry matter in the peak lactation period thanks to individual feeding. As a result, their productivity increased. Similar results were achieved by Simensen's team [2010]. Studies cited by Barej [1991] also revealed that cows kept in tied housings had higher milk yield than cows kept in loose housings – by 74 kg for 305-day lactation. However, milk yield of cows deteriorates when they are transferred to a housing of different type. It was demonstrated that yield of cows decreases by less than 1 kg/day for the first few months following the change in their maintenance system [Hovinen et al. 2009, Norell and Appleman 1981].

A proper herd structure and stable herd composition are no less important aspects of maintaining a high level of welfare. Improperly selected animals in a group may cause unrest there, thus reducing productivity, just like their frequent regrouping [Barej 1991, Herbut 2009]. Experimental studies revealed that a herd of 8 cows, if regrouped five times every 28 days, would produce 0.7 kg milk less [Brakel and Leis 1974 as cited in Barej 1991]. Other studies demonstrate that daily milk yield of cows, which are transferred between groups, deteriorates by about 3 kg and their adaptation period is 3-5 days [Herbut 2009].

Limited pasture grazing is one of the key problems of dairy cattle welfare – it adversely affects the welfare, health and productivity of animals. Keeping dairy cow herds behind closed doors all over the year is becoming increasingly popular,

but has numerous adverse consequences for animal health. The zero-grazing farming system reduces reproduction and increases culling of animals [Grzegorzak et al. 1983, Markiewicz 1981], thus adversely affecting achieved economic results. It also has many consequences for animal welfare, among others: increased risk of various diseases, lameness, behavioural changes, limited movement, higher stress [Lewandowski 2008, Sossidou 2007]. Summer pasture grazing reduces the incidence of lameness, injuries, makes young animals grow faster [Corazzin et al. 2010]. At the same time, however, pasture-grazed cows experience large seasonal changes in the quantity and quality of available feed which adversely affect their welfare and productivity if they are improperly switched to another type of feed [Schütz et al. 2006].

Feeding is another problem faced in high-yielding cow herds. Besides the already mentioned problems due to switching to a different type of feed, it is also difficult to provide adequate nutrient content per ration. It is achieved by providing animals with concentrated feed. However, if its share is too high, gastrointestinal diseases may occur. Their increased incidence contributes to productivity losses and higher veterinary costs.

Milking is another factor which affects both animal welfare and productivity. Its frequency is of great importance. Increasing milking frequency from 2 to 3 times per day improves recreational conditions of cows (empty udder makes them feel better) and increases their productivity by over 10% [Reklewski 2003, Dodd and Griffin 1979 as cited in Barej 1991]. The more frequent the milking, the higher the animal welfare and the higher the milk yield. At the same time, however, milking costs and labour inputs increase, thus a milking frequency of only 2 and 3 times is taken into account in the breeding practice [Barej 1991].

The way animals are handled by humans is no less important than conditions in livestock housings and the farming system. It was demonstrated that, due to the presence of persons whom animals associated with poor treatment, in a milking parlour, milk yield was lower by 10% and, at the same time, the amount of milk remaining in an udder after milking was higher by 70% [Słoniewski 2005b]. The way persons who handle animals behave is closely correlated with the way the animals behave during milking and moderately correlated with milk yield. Cows were less likely to avoid those persons who frequently used friendly gestures during milking. In contrast, the increased use of neutral gestures correlated with kicking/unrest and reduced milk yield [Waiblinger et al. 2002].

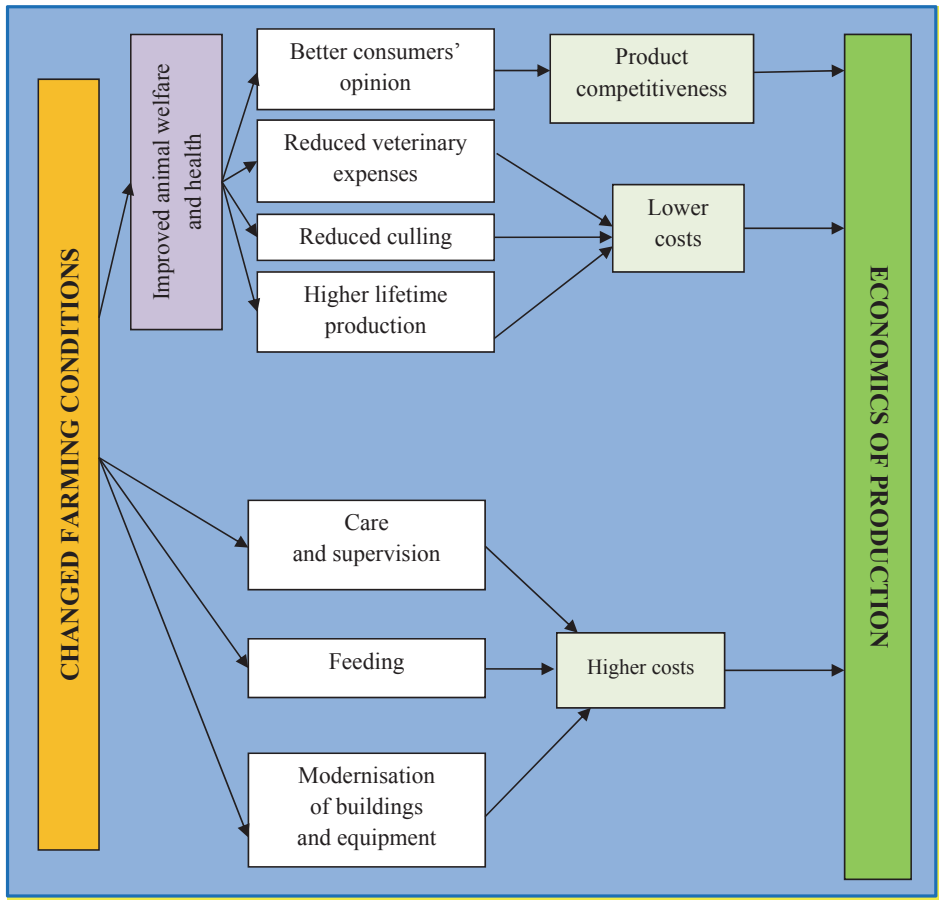
Many studies point that the quality of work of persons, who care for animals, is the primary factor affecting farm animal welfare. Stress reactions caused by improper handling may lead to lower productivity or reproductive

disorders [Lewandowski 2008, Grzegorzak et al. 1983]. Better production results are achieved in herds where animals were handled more frequently and warmly [Herbut 2009]. In contrast, if animals were handled negatively during milking, milk yield of cows in these herds would be lower [Waiblinger et al. 2002]. As much as 20-30% of milk yield of cows depends on the way persons, who handle them, behave [Słoniewski 2005a]. According to other studies, 19% of productivity differences are attributable to the factor of fear of humans [Breuer et al. 2000]. One study revealed that milk yield of cows of a similar genetic level, which were kept under identical feeding and environmental conditions, was higher by over 500 litres of milk per year (13%), depending on by whom they were handled [Słoniewski 2005b]. Better production results were recorded in a herd where animals were handled more friendly.

Figure 1 presents a schematic impact of animal welfare on the economics of agricultural production. A change in farming conditions, which leads to improved animal health and welfare, may influence elements such as: consumers' opinion, veterinary expenses or animal productivity. In turn, it has a bearing on revenues and costs, the competitiveness of products and thus the economics of production.

Animal welfare is considered rather as a factor limiting the profitability of agricultural production. Results of numerous studies indicate that more stringent welfare standards, if introduced, may increase animal production costs by 5-30% [Blandford and Fulponi 2000, Bennett 1997 as cited in Mitchell 2000, Blandford and Fulponi 1999]. At the same time, there is a growing realization that higher welfare may significantly improve economic results of animal farming [Lewandowski 2008]. Benefits of eliminating stereotypes and diseases of environmental origin may compensate for losses due to reduced stocking or costs of installing new equipment [Kołacz and Bodak 1999]. Losses due to cow limb diseases may amount to USD 75/cow per year of which 32% is due to subclinical diseases without clear external symptoms [Bruijnis et al. 2010]. Furthermore, high-welfare maintenance systems often do not require high expenditures, as they comprise extensive maintenance elements, such as shelter rearing, grazing rearing and mixed grazing-alcove rearing [Kołacz and Dobrzański 2006]. Reduced welfare directly affects the condition of animals, reduces their immunity and production effects [Mroczkowski 2006], while its improvement may positively influence animal health and productivity [Herbut 2009]. Lower incidence and frequency of injuries reduce veterinary costs and herd replacement costs, while increasing animal productivity [Słoniewski 2005a]. A high level of welfare gives rise to profit due to quantitative production growth achieved by exploiting the full biotic potential of animals [Kołacz and Dobrzański 2006].

Figure II.1. Impact of animal welfare on the economics of production



Source: study based on [Słoniewski 2005a].

It is very difficult to estimate the net value of economic effects caused by changes in animal welfare standards. Some of these changes seem to be cheap to implement, while others may significantly increase production costs. On the other hand, savings may be expected as a result of, among others, lower mortality, increased reproduction efficiency, lower veterinary care costs, etc.

A team of the EconWelfare project estimated in its studies that enhanced dairy cattle welfare standards would result in significant changes in earned revenues and incurred costs of agricultural production. However, the net effect of these changes will be minor. Having analyzed costs and benefits, it was possible to determine what percentage change in the price of finished products is necessary to compensate for costs of implementing enhanced animal welfare standards. Table II.1 presents achieved results.

Table II.1. Price changes (%) necessary to compensate for costs of implementing enhanced animal welfare standards

Species	Poland	Nether-lands	Sweden	United Kingdom	Germany	Italy
Pigs	18.4	36.2	21.9	15.0	36.3	19.6
Laying hens	44.8	43.5	2.8	18.4	38.3	38.1
Broilers	8.0	13.3	14.6	12.4	11.2	12.0
Cows	-0.2	-0.4	-0.3	-0.1	-4.3	-0.9
Beef cattle	0.5	7.6	4.0	0.1	8.1	2.2

Source: Spoolder et al. 2011.

According to the figures in Table II.1, the introduction of more stringent farm animal welfare standards would increase production costs of pigs, eggs and broilers. At the same time, production costs would not change significantly in the case of cow and dairy cattle farming.

Additional production costs in the case of the first group of species are clearly higher than benefits of enhanced welfare standards, thus significantly increasing net costs. As regards beef and veal production, there were no major net changes in operating costs. In the case of dairy cows, minor net benefits can be observed as a result of enhancing welfare standards. Dairy cattle is an exception among the species in question. Net benefits occur mainly due to lack of significant restrictions on stocking density under enhanced standards and the fact that some requirements of high welfare may raise milk yield and/or reduce veterinary costs.

It is also important that there are differences between particular countries. The introduction of the same more stringent standards in one country may increase production costs by less than 40% net, while in another one – by only a few percent. It should be noted that countries, which currently apply welfare standards higher than the minimum ones required under EU law, would face significantly smaller changes than other countries. The level of labour costs and the cost of meeting certain requirements for, among others, access to green fodder or the use of appropriate litter are important as well. Differences between countries are also due to unequal potential for productivity growth – smaller changes will be recorded in countries with initially high productivity. The introduction of more stringent farm animal welfare standards would thus not only increase prices paid by consumers for products of animal origin, but would also influence the competitiveness of particular countries in the European market.

The loose housing system, which is widely regarded as superior to the tied one in terms of animal welfare, is also characterized by economic benefits. It was demonstrated that labour productivity during milking in the system is significant-

ly higher, thus enabling the same number of on-farm workers to handle more cows [Romaniuk 1980 as cited in Lasek et al. 2004]. Barej [1991] also recommends the loose system, but only with a solid floor and soft beddings which are preferred by cows [Solan and Józwik 2009].

4. Social, political and economic perspective

Wider political interest in welfare has emerged relatively recently. It gains importance at international trade level as well. Protecting the welfare of animals kept under mass, intensive farming conditions is an important element of public health protection [Kołacz and Dobrzański 2006].

A public attitude to farm animal welfare is very accurately described by the following quote from the "On the future of animal husbandry" report developed by the German Ministry of Agriculture: *The way consumers perceive animal welfare has changed considerably over time. A consumer wants animals to be kept under "natural" conditions/systems and to be treated humanely. Consumers believe that meat from animals kept under conditions, which ensure a high level of welfare, is of better quality. Transport and slaughter also often cause public concern. Nonetheless, consumers usually do not focus on specific aspects of animal farming, maintenance, transport and slaughter* [Malak-Rawlikowska et al. 2010a]. In highly developed countries, the society considers it inappropriate to treat animals so as to make them feel pain or substantial discomfort and prevent them from satisfying their basic species-, sex- and age-related needs [Słoniewski 2005a]. Moreover, the society is interested in establishing sustainable development standards taking into account animal welfare [Cozzi et al. 2008, Szücs et al. 2007].

Since the second half of the 20th century, there has been a slow but steady increase in environmental awareness of particular societies [Szücs et al. 2007, Blandford 2006, Matuszewski and Walczak 2005]. Consumers seek products from healthy, happy animals [Reklewski 2003]. Concern for the way animals are treated has never been of such interest as now. As much as 77% of the EU population, asked about their opinion, state that welfare standards need to be made even more stringent, as animal welfare protection is considered to be very important [Cozzi et al. 2008]. According to other studies [Smith 2001 as cited in Walczak 2005], consumers of meat find animal welfare in between expectations regarding taste (of greatest importance) and packaging (of little importance), and it is slightly more important than price. Some consumers in the European Union are ready to pay more for products produced in compliance with high welfare standards [Kehlbacher et al. 2012, Szücs et al. 2007]. Nevertheless, declarations of consumers do not always reflect their actual behaviour. When shopping, most

of them are not interested in products which were produced in compliance with a high level of welfare [Webster 2001]. Declarations and shopping habits differ.

In recent years, the development of animal production systems has been increasingly dependent not only on the legal framework and farmers' requirements, but also on consumers' expectations. Consumers want animals to be treated in a humane and near-natural way, public sensitivity to pain and suffering in animals increases [Kołacz and Bodak 1999], therefore their welfare is taken into account when designing animal maintenance systems [Hessing et al. 1994 as cited in Herbut and Walczak 2003]. It is important here to change the frame of reference – animals are treated less and less as a product and more and more as an organism capable of feeling suffering [Kołacz and Bodak 1999]. Striving for farm animal welfare is motivated mainly by moral reasons [Słoniewski 2005a].

Environmental organizations and organizations fighting for animal rights are among those most interested in the quality of farm animal welfare and its improvement. They were established to follow the belief that animals have the right to exist [Walczak 2005]. Their awareness-raising and educational campaigns, in addition to legal actions, contribute to changing the attitude of the society which increasingly focuses on the way farm animals are handled [Blandford 2006, Kołacz 2006, Pisula 1999]. The activity of such organizations is particularly useful in making the society aware of the problem of animal suffering. Animal welfare is usually of little interest to retail trade, except for stores offering the so-called "healthy food" and delicatessens – an offer of products produced in compliance with high welfare is poor or does not exist at all. For organic products, welfare is actually a marketing tool, as they are perceived by consumers as being produced in an animal-friendly way [Holmberg 1999 as cited in Lund and Algers 2003]. As regards traditional products, there is no interest in welfare promotion.

Interest in welfare was particularly low in the case of supermarkets which offered only few products (primarily eggs) complying with enhanced welfare standards. The most significant examples of interest and promotion of such products were observed in the United Kingdom (Tesco), Italy (Coop Italia) and the Netherlands (Albert Heijn), but they concerned mostly eggs and poultry, excluding dairy products or beef [Malak-Rawlikowska et al. 2010b]. Since 1996, one of supermarket chains in the United Kingdom has offered products labeled as "Freedom Food" which is affiliated by the Royal Society for the Prevention of Cruelty to Animals [Walczak 2005]. Similarly to the previous examples, however, the label concerns only barn eggs.

5. Level of dairy cattle welfare in the context of production and economic results of dairy farms

In 2011, the authoress studied a sample of 150 farms. Given that the geographical distribution of milk production in Poland is uneven and that two voivodeships, i.e. Mazowieckie and Podlaskie, are milk production leaders in terms of the number of cows, stocking and milk production per 1 ha of UAA (utilized agricultural area), it was decided to study farms in these two voivodeships.

150 farms were selected by using a quota sampling method. It consists in sampling facilities so that the sample structure corresponds to the structure of the population studied. In the studies, the sample was differentiated by farming scale – small (10-19 cows), medium (20-49 cows) and large (50+ cows).

Results of the study were used to develop a linear regression model. The gross margin per 1 cow (PLN/cow) was a dependent variable in the model. An initial set of explanatory variables included 45 variables related to cattle welfare, farm resources, including factors of production and milk production.

Table II.2. Explanatory variables and their selected characteristics

Variable	Variable description	Parameter	p-value
Absolute term		**-4 553.35**	**<.0001**
x_1	UAA (ha)	15.40	0.0805
x_2	Period during which calves were fed with natural milk (weeks)	71.90	0.0343
x_3	Milk price (PLN/litre)	2 977.38	<.0001
x_4	Milk production (litre)	0.46	<.0001
x_5	Cattle sales revenues (PLN)	0.95	<.0001
x_6	Animal purchase (PLN)	-0.67	<.0001
x_7	Loose housing (yes/no)	603.84	0.0177
x_8	Use of mattresses (yes/no)	-705.62	0.0004
x_9	Access to pasture (yes/no)	146.80	0.0511
x_{10}	Calf dehorning (yes/no)	644.55	0.0023

Source: own study.

In order to select the best set of explanatory variables for the model, a backward elimination method[13] was used after eliminating variables uncorrelated with the dependent variable and outliers. Table II.2 presents explanatory variables used in the model, parameters and p-values of a test for statistical significance of variables.

[13] Level of significance was set at $\alpha = 0.05$.

The resulting model is as follows:

$$y = 15.40x_1 + 71.90x_2 + 2977.38x_3 + 0.46x_4 + 0.95x_5 - 0.67x_6 + 603.84x_7 - 705.62x_8 + 151.01x_9 + 644.55x_{10} - 4553.35$$

The linear regression model may only be developed by using normally distributed variables. The paper applies the law of large numbers according to which all distributions tend to the normal distribution if samples are sufficiently large.

The model explains 77% of gross margin volatility (R^2=0.77) and is statistically significant. Model residuals are normally distributed (test results are presented in Table II.3), the problem of heteroscedasticity (result of the White test is presented in Table II.3) and collinearity do not occur.

Table II.3. Results of selected tests for the linear regression model

Test	Test statistics	p-value
Cramer von Mises	0.02812767	>0.250
Anderson-Darling	0.18988280	>0.250
White	65.69	0.4182

Source: own study.

Most variables, which were used in the model, have a positive impact on the dependent variable, i.e. the farm gross margin per one cow. They are as follows: UAA, milk price, milk production, the period during which calves were fed with natural milk, calf dehorning, the use of a loose housing and access to pasture. Variables, which adversely affect the gross margin per one cow, include animal purchase costs and the use of mattresses. Variables related to farm animal welfare are addressed in detail below.

If the period, during which calves were fed with natural milk, is extended by one week, the achieved farm gross margin per one cow increases by PLN 71.90. The positive impact of extending the period, during which calves were fed with natural milk, on the gross margin can be explained by a better health of calves which stay with their mothers longer [Weary and Chua 2000, Flower and Weary 2001], thus resulting in lower veterinary costs. The explanatory variable – the loose housing – has a positive impact on the dependent variable as well – farms with loose housings had the achievable gross margin per cow higher than those with only tied housings by PLN 603.84. The direction of the variable's impact is related to animal treatment costs as well. It was proved that regular movement has a positive impact on the health of cows [Lewandowski 2008, Keil et al. 2006, Loberg et al. 2004]. Animals kept in loose housings can freely move there, they are not tied. Even if no access to pasture is ensured, they are thus

provided with movement which has a positive impact on their fitness and health. Another addressed element of the model is the use of mattresses as bedding material. Farms with beddings covered with mattresses can have the gross margin lower by PLN 705.64 than those using natural litter which is the best bedding material for cattle [Kaczor 2005]. Access to pasture is the last variable addressed. Providing animals with access to pasture increases the gross margin by PLN 146.80. Pasture has a major impact on the health and productivity of animals, and thus on both costs and revenues of agricultural production. Keeping dairy cow herds in housings, in particular tied housings, all over the year has numerous consequences for animal welfare, among others: increased risk of various diseases, behavioural changes, limited movement, higher stress [Lewandowski 2008, Sossidou et al. 2007]. It was also found that keeping cattle in housings all year round has an adverse impact on their reproduction. At this point, it is worth mentioning aspects such as lack of pasture, stressors and adverse environmental conditions [Grzegorzak et al. 1983].

The studies further involved performing a statistical analysis of the data collected. One of aspects, in which the studied farms differed significantly, was their housing type.

Table II.4. presents selected parameters of the studied farms divided according to their housing type into two groups: the group of farms with tied housings and the group with loose housings or both tied and loose housings.

Statistically significant differences for multiple factors were identified. Farms with loose housings were characterized by higher milk yield which may be related to their housing type and their specialization degree. Loose housings occurred mostly in the group of large farms which were more specialized and achieved better production and economic results. It is confirmed by a higher level of milk sales revenues and the gross margin per one cow. Furthermore, their animal treatment costs and total veterinary expenses were lower, while no difference in insemination and prevention expenses was found. In accordance with the literature, a higher incidence of limb diseases was recorded in this housing type [Winnicki et al. 2004], but lower treatment expenses indicate that keeping cows in the loose system is good for their health.

Table II.4. Selected parameters of farms by their housing type

Specification	Tied housing	Loose housing	p-value
Milk yield (kg)	5 408.74	6 424.48	0.00
Insemination expenses (PLN/cow)	106.27	78.93	0.29
Treatment expenses (PLN/cow)	202.98	89.33	0.01
Prevention expenses (PLN/cow)	49.31	51.92	0.86
Total veterinary expenses (PLN/cow)	252.29	141.25	0.01
Milk revenues (PLN/cow)	6 959.58	8 581.19	0.00
Gross margin (PLN/cow)	5 320.77	6 354.07	0.02
Cow culling rate (%)	0.17	0.18	0.87
Calving intervals (days)	372.94	385.50	0.11
Use of pasture (% of farms)	68.64	34.38	0.00
Use of a open-run (% of farms)	45.76	56.25	0.30
Slatted floor housings (% of farms)	5.08	56.25	0.00
Farrowing pen housings (% of farms)	35.59	75.00	0.00
Calf dehorning (% of farms)	25.42	75.00	0.00

Source: own study.

In order to determine organizational and economic effects of enhanced animal welfare standards in dairy farms, the studies further involved developing an optimization model by using the Positive Mathematical Programming (PMP) method. It is an optimization model with a non-linear limiting function.

When developing the model, the method involves starting from a linear programming function – the optimization model with a linear limiting function. As regards the studies referred to in this paper, the optimal structure of agricultural production is the linear model's solution. This structure is not identical with empirical data, because it is an "ideal" solution and the method itself has several disadvantages: linear cost functions do not cover farmer's non-financial preferences, the model strongly favours the most profitable activities and tends to a monoculture. The Positive Mathematical Programming method's non-linear limiting function purpose is to cover all limitations not included in linear functions, is a solution to these problems.

The non-linear limiting function is developed in two stages. The first stage involves adding calibration limitations which make the model's solution an accurate reflection of the observed reality. The second PMP stage uses shadow prices to determine a non-linear objective function and thus the non-linear limiting function. Every non-linear function may be used in this regard, but a quadratic function is most commonly used.

The model as such allows for obtaining real values of variables in modelled farms, and the non-linear objective function reflects preferences and limitations which are not included in limiting conditions.

The model-based studies considered a scenario of introducing more stringent dairy cattle welfare standards which was developed based on results of the EconWelfare research project. The following welfare standard changes were assumed in relation to current legal regulations:

- at least 60% of roughage to be used in a daily feed ration;
- calves to be fed with natural milk for at least 5 days after birth;
- calf dehorning without anesthesia prohibited;
- litter to be used in cow stands;
- slatted floors prohibited;
- permanent tethering of cattle prohibited: the loose housing or the tied housing with everyday access to the open-run;
- at least 5 m^2 per adult cow in the housing;
- access to green fodder in the summer: pasture grazing or feeding with green fodder on the open-run; both methods can be used.

Parameters used in the model-based studies, such as milk yield, yields, labour and production inputs, the cattle herd structure and parameters related to the impact of the assumed changes on the organization of farms and achieved production and economic results, were estimated based on interviews conducted in the studied farms, findings of EconWelfare project experts, a literature review and consultation with experts. The parameters are individually tailored to each modelled farm.

Models for two scenarios were developed:

- base – calibrated PMP model results in accordance with a survey;
- welfare – PMP model results after introducing welfare standard changes;
- "welfare" and "base" model solutions are provided for the same point in time.

Model solutions were prepared for 12 purposively selected farms – 4 farms with 10-19 dairy cows (small-scale farming), 4 – with 20-49 dairy cows (medium-scale farming), and 4 – with 50+ dairy cows (large-scale farming). Having introduced welfare standard changes, the following "welfare" model parameters changed: labour inputs, the feeding ration, the amount of milk intended for calf rearing, milk yield, cow culling, veterinary costs, insemination costs, UAA and its structure, the number of cow stands in the housing.

Table II.5 summarizes organizational changes and information on what investment is required to adapt the farm to the new requirements – results of the model-based studies.

Table II.5. Organizational changes in model solutions

Farm		Number of cows	Utilized agricultural area				Housing type	Number of cow stands in the housing	Open--run	Pasture	Family labour inputs	Hired labour inputs	Investment type
			in total	arable land	ley grass	permanent grassland							
Small 1	Base	19	21	16	3.5	1.5	Tied	23	No	No	2 401	0	
	Welfare	19	23	14.5	3.5	5	Tied	23	Yes	Yes	2 812	0	Open-run construction and housing modernisation
Small 2	Base	19	22.1	15	3.9	3.2	Tied	18	No	Yes	2 896	0	
	Welfare	19	22.4	13.5	3.9	5	Tied	18	Yes	Yes	3 099	0	Open-run construction
Small 4	Base	12	14.5	10	0	4.5	Tied	12	Yes	Yes	2 205	0	
	Welfare	12	14.5	10	0	4.5	Tied	12	Yes	Yes	2 205	0	Housing modernisation
Medium 1	Base	25	19.5	10.5	0	9	Tied	25	No	No	3 512	0	
	Welfare	23	21.5	9.5	0	12	Tied	25	Yes	Yes	3 512	489	Open-run construction
Medium 2	Base	40	38.9	27.5	9	2.4	Tied	40	No	Yes	3 024	1 580	
	Welfare	55	58	37	15	6	Loose	60	No	Yes + delivery of green fodder	3 206	2 607	Housing reconstruction
Medium 3	Base	23	26.8	3.8	0	23	Tied	27	Yes	Yes	2 455	0	
	Welfare	20	23.2	3.2	0	20	Tied	24	Yes	Yes	2 283	0	Housing modernisation
Medium 4	Base	40	45	20	15	10	Loose	45	Yes	No	3 192	0	
	Welfare	40	47	18	17	12	Loose	45	Yes	No – delivery of green fodder	3 401	0	N/A
Large 1	Base	50	46	35	0	11	Loose	75	No	No	2 465	2 180	
	Welfare	50	55	30	0	25	Loose	75	No	Yes	2 465	3 025	Land purchase
Large 2	Base	58	67	17	0	50	Tied	66	No	Yes	4 720	0	
	Welfare	55	71.5	16.5	0	55	Tied	66	Yes	Yes + delivery of green fodder	5 213	0	Open-run construction
Large 3	Base	85	65	35	10	20	Loose	100	No	No	1 978	2 942	
	Welfare	85	65	35	10	20	Loose	100	Yes	No – delivery of green fodder	2 156	3 474	Open-run construction
Large 4	Base	75	50	22	11	17	Tied	80	Yes	No	3 568	0	
	Welfare	70	48	20	11	17	Tied	80	Yes	Yes	4 098	0	N/A

Source: own study.

In the course of the studies, it was found that not all small-scale farms continue their production after introducing more stringent dairy cattle welfare standards. The Small 3 farm would need a high investment in the reconstruction of the housing. With the same dimensions of the building, the number of available cow stands, if adapted to the new requirements, would be reduced from 14 to 11. The housing's location prevents its expansion. Following model calculations, it was found that achieved agricultural income would fall that much after introducing more stringent welfare standards that production profitability could not be ensured. The Small 3 farm is therefore excluded from analyses and omitted in further considerations.

The number of cows in all the analyzed small-scale farms remains unchanged. The housing type does not change as well, some of them introduce the use of pasture and/or the open-run. Small 1 and Small 4 farms also require an investment in the modernization of the housing which consists in reconstructing stands – adapting them to the new standards. In two of the three analyzed farms (Small 1 and Small 2), labour inputs in the model solution increase (by 16.7% and 6.9%) as a result of requiring that animals be pastured during the summer and put on the open-run in the winter. In terms of changes in farms' UAA structure where the use of pasture is introduced, the area of permanent grassland increases – by 2.7 ha on average, so does its share in the structure – by 11.2% on average. It is due to the need to provide pasture area for animals.

Among medium-scale farms, the number of cows in only one farm remains unchanged – Medium 4. The same farm does not need an investment, as only a cattle feeding system changes, i.e. the delivery of green fodder to the open-run during the pasture period is introduced. In the model solution, the number of cows in two farms (Medium 1 and Medium 3) falls respectively by 2 and 3 heads (down respectively by 8% and 13%). As regards the Medium 1 farm, it is related to increased labour inputs as a result of introducing the use of the open-run and pasture. The lower number of cows in the Medium 3 farm is due to a decrease in the number of stands following the modernization of the housing. After introducing more stringent welfare standards, an owner of the Medium 2 farm may decide to invest in increasing the farming scale. In most of the studied medium-scale farms, the farmer's family members were the only ones to work. The Medium 1 farm introduces hired labour in the assumed scenario. In one of the four analyzed farms (Medium 3), labour inputs decreased by 6.9% which was due to the lower number of cows. In the other farms, labour inputs increase. In the Medium 2 farm, they rise by 47.8% which is due to a higher production scale, in the other two farms – by 10.3% on average. In terms of changes in medium farms' UAA structure, the share of agricultural

land decreases by 2.2% on average, while the share of permanent grassland increases by 2.9%. It is so, as cows need to be fed with green fodder in the pasture period.

After introducing more stringent dairy cattle welfare standards, the number of cows in two of the four analyzed large-scale farms does not change. In the other two farms, it decreases by 5-7%. In contrast to medium-scale farms, this fall in the number of cows is not due to a fall in the number of stands in modernized housings, but due to an increase in the laboriousness of production as a result of introducing the use of the open-run, pasture or the delivery of green fodder to the open-run. The two studied large-scale farms employed hired labour and these proportions do not change as far as the assumed scenario is concerned. Given the introduction of laborious cattle farming elements, i.e. the use of the open-run, pasture or the delivery of green fodder, labour inputs in all the studied farms increase in model solutions – by 14.5% on average. In terms of changes in large farms' UAA structure, the share of agricultural land decreases by 5.4% on average, while the share of permanent grassland increases by 5.9%. Therefore, the changes match those in medium-scale farms and also result from introducing the requirement of green fodder feeding in the summer.

Table II.6 presents primary production parameters of the studied farms in model solutions by their farming scale.

Table II.6. Production parameters in model solutions by farming scale*

Farms		Number of cows (heads)	Area (ha)	Milk production (l)	Milk sale (l)	Milk yield (l/cow)	Cow culling rate (%)
Small**	Base	17	19.2	72 211	68 348	4 247.7	9.8
	Welfare**	17	20.0	72 337	68 475	4 255.1	9.8
	Change (%)	0.0	4.0	0.2	0.2	0.2	0.0
Medium	Base	32	32.6	244 996	241 402	7 656.1	16.0
	Welfare	35	37.4	271 839	268 117	7 879.4	15.6
	Change (%)	9.4	15.0	11.0	11.1	1.4	-2.3
Large	Base	67	57.0	545 018	541 702	8 134.6	14.3
	Welfare	65	59.9	524 246	520 974	8 065.3	13.4
	Change (%)	-3.0	5.0	-4.4	-4.4	-1.5	-6.7

* Mean values, ** Farm of the farmer, who ceases milk production in the assumed scenario, is omitted.

Source: own study.

In the "welfare" scenario, the number of cows in medium-scale farms increases by 9.4% on average, while in large-scale farms decreases by 3.0% on average. In the group of small-scale farms, it remains unchanged. UAA increases in all the analyzed groups of farms respectively by 4.0%, 15.0% and 5.0%. The average increase in the number of cows in medium-scale farms is related to a significant increase in their farming scale in one model solution. The increase in UAA results directly from the need to provide green fodder to feed cows in the summer. In the analyzed scenario, milk production and sale in small- and medium-scale farms increases (respectively by 0.2% and 11.0% on average), while in large-scale farms decreases (by 4.4% on average). Reasons, therefore, are the same as those found when analyzing the number of cows. In model solutions, milk yield in small- and medium-scale farms increases, while in the group of large-scale farms decreases. The reason is the assumption that increased welfare will reduce the incidence of diseases and will help increase milk yield. As regards small- and medium-scale farms, profit arising from improved animal health is greater than losses due to providing animals with more movement (access to pasture and/or the open-run).

As regards large-scale farms, initial milk yield is high. It decreases in the model solution as a result of introducing animal movement solutions – pasture and/or the open-run, and the requirement of feeding with green fodder in the summer. During the transition from winter to summer feeding, production results deteriorate. Moreover, it is more difficult to ensure high productivity in pasture feeding than in indoor feeding and greater fluctuations in this parameter should be assumed. In model solutions, the cow culling rate significantly decreases which is related to improved animal health after introducing more stringent welfare standards. In particular, the requirements of providing animals with movement and feeding calves with natural milk have a significant impact on this rate. It does not change only in small-scale farms.

Table II.7 presents revenues, costs and laboriousness of milk production in model solutions.

It may be noted that particular economic parameters improve as the farming scale grows. It is a typical example of economies of scale – production efficiency increases as the production scale grows. At the same time, an adverse impact of enhanced animal welfare standards is most evident in large-scale farms. Their laboriousness and profitability of production are most affected by the requirement of green fodder feeding in the summer or providing animals with regular movement. It is due to, among others, a simplified organization of farms in this group.

Table II.7. Revenues, costs and laboriousness of production in model solutions by farming scale*

Farms		Total revenues (PLN/ cow)	Milk sales revenues (PLN/ cow)	Direct costs (PLN/ cow)	Direct cost of production of 1 litre of milk (PLN)	Laboriousness of production of 100 litres of milk (h)
Small**	Base	7 832.15	5 138.60	1 966.96	0.520	4.29
	Welfare**	7 924.16	5 170.12	1 886.03	0.497	4.43
	Change (%)	1.2	0.6	-4.1	-4.5	3.2
Medium	Base	12 563.97	9 464.15	3 612.74	0.468	1.77
	Welfare	12 978.17	9 552.60	3 671.81	0.473	1.89
	Change (%)	3.3	0.9	1.6	1.1	6.7
Large	Base	12 928.47	10 607.81	3 049.77	0.425	1.00
	Welfare	12 799.06	10 348.42	3 140.54	0.450	1.20
	Change (%)	-1.0	-2.4	3.0	5.9	19.2

* Mean values; ** Farm of the farmer, who ceases milk production in the assumed scenario, is omitted.

Source: own study.

In model solutions, total revenues per one cow and milk sales revenues per one cow increase in the analyzed scenario in the case of small-scale farms (respectively by 1.2% and 0.6% on average) and medium-scale farms (respectively by 3.3% and 0.9% on average), while decrease in the case of large-scale farms (respectively by 1.0% and 2.4% on average). It is so due to factors such as improved milk yield of cows and a lower number of calf falls as a result of improved animal welfare and organizational changes in these farms. In model solutions, direct costs per one cow and the direct cost of production of 1 litre of milk decrease in small-scale farms and increase in the other groups of farms. The largest increase is recorded on large-scale farms. The laboriousness of production of 100 litres of milk increases on all the groups of farms. The largest increase is recorded on large-scale farms (by 19.2% on average), while the lowest – on small-scale farms (by 3.2% on average). The increase in the laboriousness of production is primarily due to increased labour inputs for handling animals to provide them with regular access to pasture and the open-run. The use of pasture in the summer feeding of cows is popular on small farms and therefore the requirement of providing access to green fodder in the pasture period does not have much impact on the labour intensity of production. However, the use of pasture on large farms is much less popular and, regardless of whether the intro-

duction of pasture grazing or the delivery of green fodder is an optimal solution on a specific farm, it significantly increases labour inputs.

Table II.8 presents economic results of agricultural production of the studied farms in model solutions.

Table II.8. Economic results in model solutions by farming scale*

Farms		Gross margin per farm (PLN)	Gross margin per cow (PLN)	Net farm income per farm (PLN)	Net farm income per cow (PLN)
Small**	Base	102 307	5 865	66 683	3 679
	Welfare**	105 041	6 038	64 563	3 550
	Change (%)	2.7	2.9	-3.2	-3.5
Medium	Base	295 851	8 951	148 334	4 506
	Welfare	332 443	9 306	163 526	4 657
	Change (%)	12.4	4.0	10.2	3.4
Large	Base	643 370	9 879	348 938	5 403
	Welfare	614 055	9 659	318 354	5 013
	Change (%)	-4.6	-2.2	-8.8	-7.2

* Mean values, ** Farm of the farmer, who ceases milk production in the assumed scenario, is omitted.

Source: own study.

As in the case of revenues and costs, returns to scale are evident – large farms outperform small and medium farms. At the same time, however, these are large-scale farms which, in model solutions, record the most evident deterioration in their results. In the analyzed scenario, the gross margin of small- and medium-scale farms increases by a few percent both per farm in total and per one cow. Small-scale farms are the only group in which revenues increased and direct costs decreased, thus determining gross margin growth.

In the group of medium-scale farms, both revenues and direct costs increase in the analyzed model solution, but a higher growth rate of the former makes the gross margin follow an upward trend – per one cow by 4.0%. The average change is negative only in the case of large-scale farms which is due to a decrease in revenues and an increase in direct costs. In model solutions, net farm income per farm increases only in the group of medium-scale farms, while in the other groups – decreases. It is due to, among others, increased hired labour costs and increased depreciation costs. It is important that the decline in the net farm income of small- and medium-scale farms is also significantly determined by costs of a credit to finance necessary investments.

Summary and conclusions

The paper identified possible organizational, production and economic effects of more stringent dairy cattle welfare standards introduced in dairy farms. It also characterized the term "welfare" itself and related issues.

It is, therefore, concluded that enhanced dairy cattle welfare standards would have a significant impact on production and economic results achieved by farms. It may lead some farmers to cease milk production and encourage other farmers to decide to develop their activity. In both cases, possible changes would contribute to increasing the average profitability of milk production in the group of small- and medium-scale farms. The situation would be reversed in the group of large-scale farms.

With respect to the results obtained, it may be stated that animal welfare, as an externality of agricultural production, is a benefit from the point of view of both consumers and most producers. Possible mechanisms for encouraging farmers to improve animal welfare should take into account that its increase does not involve only expenditures and costs on the side of farmers, but also brings certain benefits. The valuation of animal welfare, as an externality, should also take into account both elements and should be based on net costs/benefits.

Chapter III

SCALE OF FOOD LOSSES AND FOOD WASTE IN THE WORLD AND IN POLAND

Introduction

Food losses and waste are so high that they should be treated as a global problem prevalent throughout the agri-food chain, i.e. "from farm to table", in both developed and developing countries. Food is wasted by producers, processors, suppliers, sellers, restaurateurs and consumers.

Negative effects of food losses and waste are primarily a missed opportunity to reduce the number of people who suffer from hunger in developing countries and the number of people who are unable to meet their food needs in developed countries, and huge waste of resources, such as soil, water and energy, which are needed for food production, as well as economic losses for food producers.

According to the Food and Agriculture Organization of the United Nations (FAO), about 796 million people suffer from hunger globally, 1.6 billion people are overweight, including 500 million obese people, and 1.3 billion tonnes of edible food per year, i.e. 1/3 of produced food, is wasted. Given such huge global food waste, the European Parliament adopted a resolution: *How to avoid food wastage: strategies for a more efficient food chain in the EU (2011/2175(INI))*, to call on all citizens to undertake decisive steps to reduce the amount of wasted food by 2025 and to improve access of the most deprived residents of European Union Member States to food. It is an important initiative to make the European public aware of the weight and importance of food management.

Reducing global food losses and waste can make a significant contribution to food security which is related to meeting the most common human need, i.e. food, and to ecological security. Lower food losses and waste mean lower use of limited natural resources.

Sustainable consumption and production, and a sustainable diet recommended by human nutrition specialists are a way to reduce food losses and waste.

The aim of the paper is to present the scale of food losses and waste globally, including in Poland, and the ways to reduce them.

1. Food losses and food waste – a global problem

Food losses are defined as *a decrease in the amount of edible food due to the poor management, errors and irregularities in the processes, e.g. in agricultural production, harvest, processing, transport or storage*, while food waste – as *a decrease in the amount of edible food due to improper food distribution, transport, storage and preparation for consumption in households and catering establishments*[14] [FPBŻ 2012]. The definition as such does not take into account inedible parts of food (skins, peelings, eggshells and parts customarily regarded as inedible) and food raw materials produced for other purposes than for consumption e.g. for feed or bioenergy.

As there is no uniform definition of food waste in Europe, the European Parliament [2011] proposed to consider it as *foodstuffs discarded from the food supply chain for economic or aesthetic reasons or owing to the nearness of the 'use by' date, but which are still perfectly edible and fit for human consumption and, in the absence of any alternative use, are ultimately eliminated and disposed of, generating negative externalities from an environmental point of view, economic costs and a loss of revenue for businesses*.

Food is lost or wasted throughout the agri-food chain, starting from primary production – harvest through postharvest, processing and packing, distribution up to consumption of food (Figure III.1).

In developing countries, food is lost most often at early stages of the agri-food chain (primary production, harvest and storage), mostly due to lack of advanced agricultural techniques, refrigeration units, inadequate infrastructure and transport as well as storage capacity of food products to ensure their durability. The largest losses at the stage of harvest were recorded in Latin America (13.4%) and Sub-Saharan Africa (12.5%), while at the stage of postharvest – in sub-Saharan Africa (12.7%), and South Asia and Southeast Asia (9.6%).

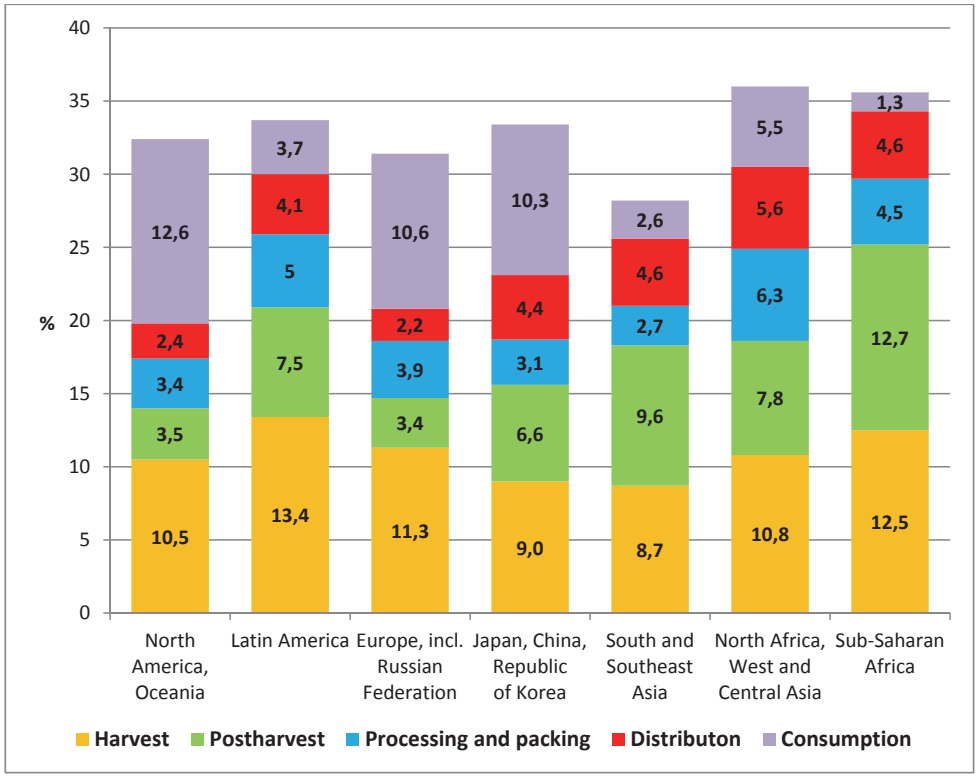
In highly developed countries, most food is wasted at the stage of distribution and consumption. The largest food waste at the stage of consumption (12.6%) was recorded in North America and Oceania which is due to, *inter alia*, food overproduction, market/pricing mechanisms, institutional and legal frameworks as well as disrespect for food and bad habits of consumers.

The largest food losses and waste throughout the agri-food chain were recorded in North Africa, West Asia and Central Asia (36.0%) and Sub-Saharan Africa (35.6%), followed by Latin America (33.7%), Japan, Republic of Korea

[14] The definition developed by the working group for research of the Council for Rational (now: Sustainable) Use of Food at the Federation of Polish Food Banks (FPBŻ) in 2012.

and China (33.4%), North America and Oceania (32.4%), Europe, incl. Russia (31.4%), and the lowest – in South Asia and Southeast Asia (28.2%).

Figure III.1. Distribution of food losses and waste along the agri-food chain in the different world regions



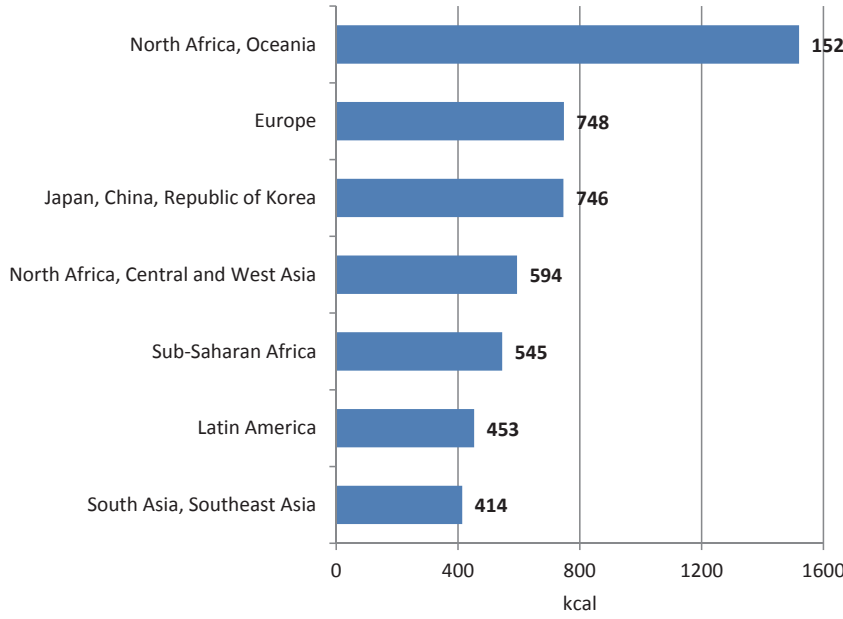
Source: study based on [HLPE 2014].

Food waste is also waste of the energetic value of food that could be consumed by humans. Research carried out by Lipinski et al. [2013] reveals that the level of food losses and waste, i.e. 1.3 billion tonnes of food per year, equals $1.5x10^{24}$ kcal (1.5 quadrillion kcal). Cereals represent most of global food losses and waste in relation to the lost calorific value (53%), followed by root and tuber (14%), fruits and vegetables (13%), oilseeds and pulses (8%), meat (7%), milk (4%), and fish and seafood (1%).

In regional terms, the largest losses and waste expressed in energetic value were recorded in the industrialized part of Asia – Japan, China, Republic of Korea – (28%) and Southeast Asia (23%), followed by North America and Oceania (14%), Europe (14%), Sub-Saharan Africa (9%), North Africa, Central Asia and West Asia (7%), and the lowest – in Latin America (6%).

The largest food losses and waste expressed in energetic value per capita a day is recorded in North America and Oceania – 1520 kcal, and the lowest – in South Asia and Southeast Asia – 414 kcal (Figure III.2).

Figure III.2. Food lost and wasted by region (kcal/per capita/day), 2009



Source: study based on [Lipinski et al. 2013].

According to FAO estimates, about 89 million tonnes of food per year is wasted in European Union Member States (Table III.1) and about 179 kg per capita. For comparison, 6-11 kg of food per capita a year is discarded in Sub--Saharan Africa [BCFN 2012].

Most food is wasted in the United Kingdom – over 14 million tonnes, including in households – over 8.3 million tonnes. Nearly 9 million tonnes of food is wasted in Poland. Production accounts for about 6.6 million tonnes of food waste, households – for about 2 million tonnes, other sectors – for about 0.4 million tonnes.

Scale of food waste per capita in individual European Union Member States varies widely (Figure III.3). Least food is discarded by the Greeks – 44 kg per capita a year, and most food – by the Dutch – 579 kg. Food waste of over 100 kg per capita was recorded in eleven European Union Member States, i.e. in Romania, Slovakia, Denmark, Germany, Portugal, France, Italy, Lithuania, Spain, Hungary and Finland (from 105 kg in Romania to 193 kg in Finland).

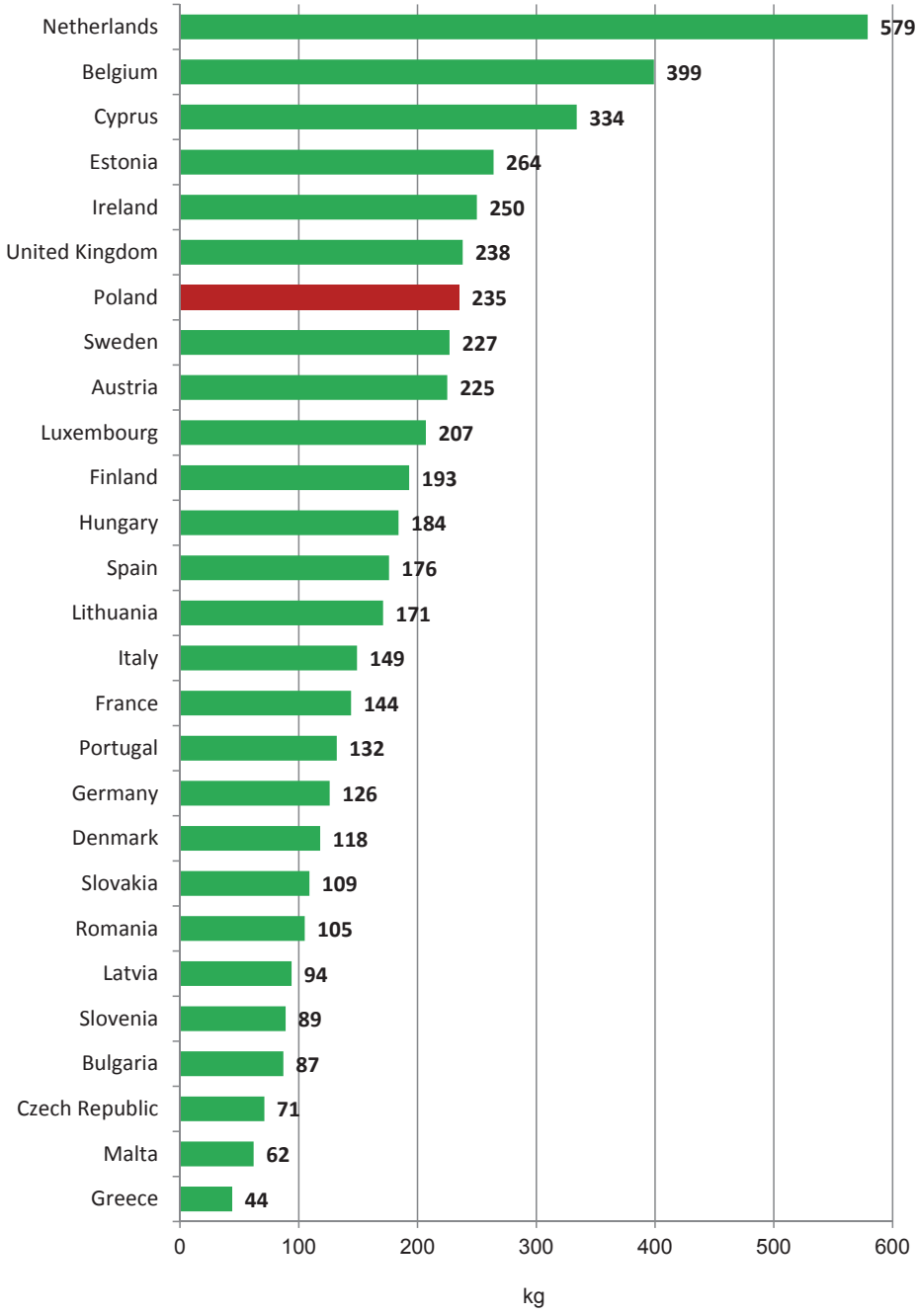
Food waste in Poland was estimated at 235 kg per capita a year. Poland is ranked seventh in terms of food waste per capita after the United Kingdom, Ireland, Estonia, Cyprus, Belgium and the Netherlands.

Table III.1. Total food waste generation in EU Member States by sectors, tonnes

Country	Manufacturing	Households	Other sectors	Total
Austria	570 544	784 570	502 000	1 857 114
Belgium	2 311 847	934 760	945 000	4 191 607
Bulgaria	358 687	288 315	27 000	674 002
Cyprus	186 917	47 819	21 000	255 736
Czech Republic	361 813	254 124	113 000	728 937
Denmark	101 646	494 914	45 000	641 560
Estonia	237 257	82 236	36 000	355 793
Finland	590 442	214 796	208 000	1 013 238
France	626 000	6 322 944	2 129 000	9 077 944
Germany	1 848 881	7 676 471	862 000	10 387 352
Greece	73 081	412 758	2 000	487 839
Hungary	1 157 419	394 952	306 000	1 858 371
Ireland	465 945	292 326	293 000	1 051 271
Italy	5 662 838	2 706 793	408 000	8 777 631
Latvia	125 635	78 983	11 000	215 618
Lithuania	222 205	111 160	248 000	581 365
Luxembourg	2 665	62 538	31 000	96 203
Malta	271	22 115	3 000	25 386
Netherlands	6 412 330	1 837 599	1 206 000	9 455 929
Poland	6 566 060	2 049 844	356 000	8 971 904
Portugal	632 395	385 063	374 000	1 391 458
Romania	487 751	696 794	1 089 000	2 273 545
Slovakia	347 773	135 854	105 000	588 627
Slovenia	42 072	72 481	65 000	179 553
Spain	2 170 910	2 136 551	3 388 000	7 695 461
Sweden	601 327	905 000	547 000	2 053 327
United Kingdom	2 591 000	8 300 000	3 500 000	14 391 000
EU-27	**34 755 711**	**37 701 761**	**16 820 000**	**89 277 472**

Source: study based on [European Commission 2011a].

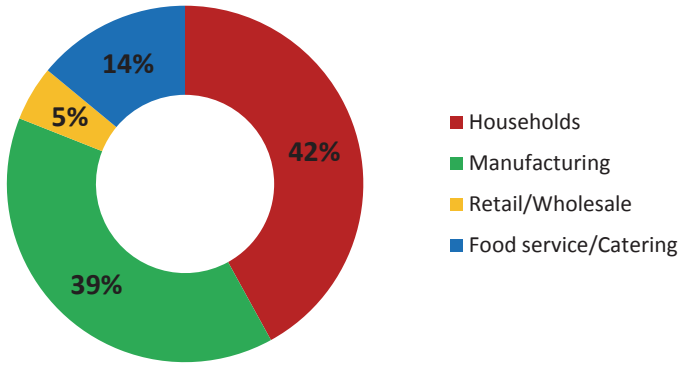
Figure III.3. Food waste in EU-27, kilogrammes/per capita/year



Source: study based on [BCFN 2012].

Households produce the largest fraction of European Union food waste among the four sectors considered, at about 42% of the total or about 38 Mt (2/3 of which, i.e. about 76 kg per capita a year, could have been avoided). The complexity of factors affecting the level of household food waste is presented in Figure III.5. Manufacturing account for 39% of the total amount of wasted food, food service, including restaurants and catering networks – for 14%, and retail/wholesale – for 5% [European Commission 2011a].

Figure III.4. Percentage breakdown of EU-27 food waste arisings by manufacturing, households, wholesale/retail, and food service/catering sectors

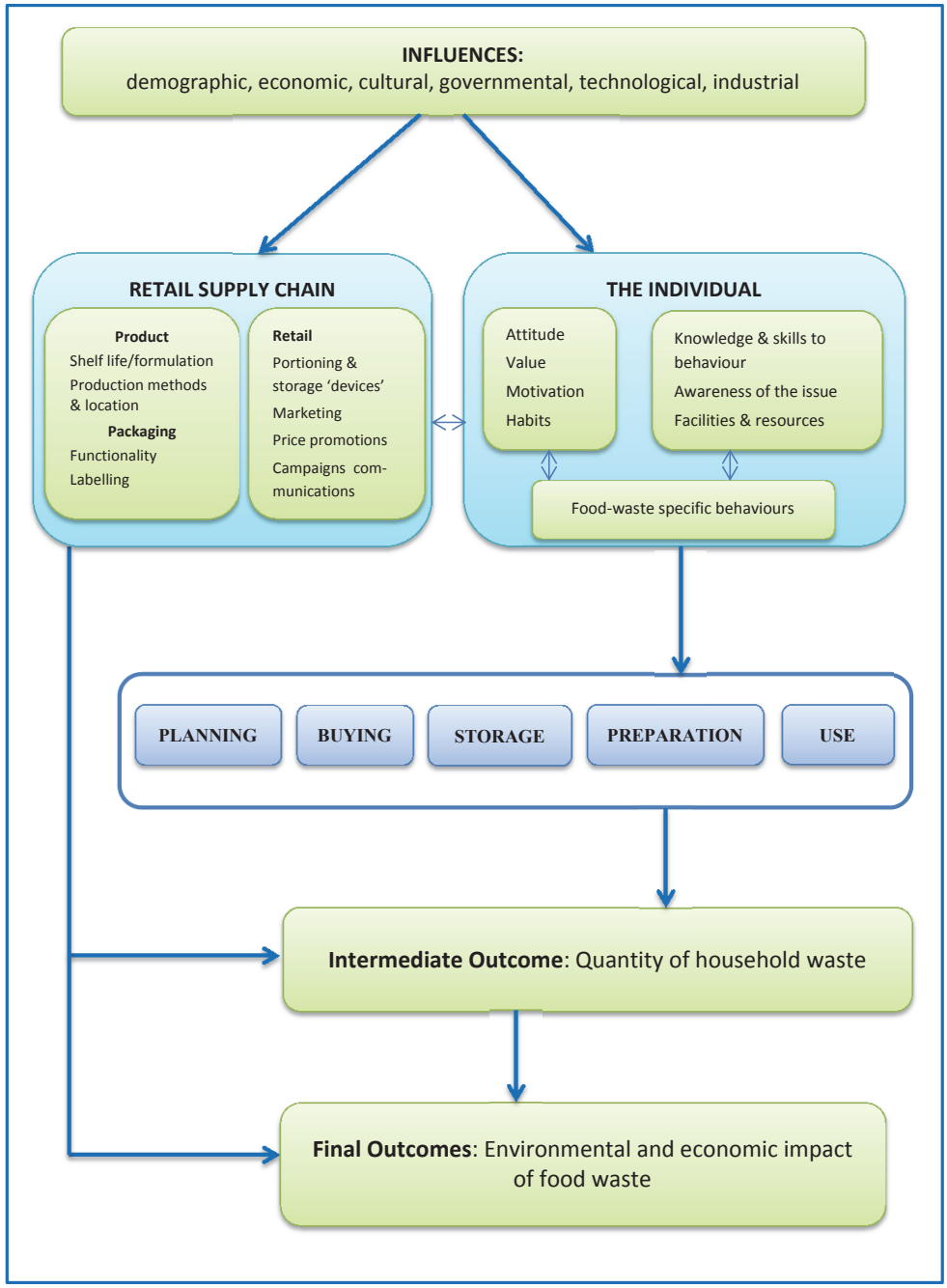


Source: study based on [European Commission 2011a].

Discarding still edible food is huge waste. Throwing food into garbage means wasting natural resources. Food production is water-intensive. For example, 1300 litres of water is needed to produce 1 kilogramme of wheat [Bailey 2011]. The cost of animal protein production is also related to significant water expenditure. 250 litres of water is needed to produce one glass of milk and 15,500 litres of water to produce 1 kilogramme of beef. Making analyses of this type, which are referred to as "virtual water" use, more common, gives a global insight into the management of water resources.

Reducing food waste has clear benefits for climate change mitigation. An astonishing 7% of all global greenhouse gas emissions (GHGs), or 3.3 billion tonnes per year, are due to food waste. Waste & Resources Action Programme estimates that by 2030 GHGs could be lowered by at least 0.2 and possibly as much as 1 billion tonnes per year through food waste reductions [WRAP 2015].

Figure III.5. Complexity of factors that influence household food waste



Source: WRAP 2015.

Furthermore, food losses and waste negatively affect sustainable food systems and food security. Table III.2 presents examples of potential effects of food losses and waste on a sustainable food system at the level of the household and individual enterprises (micro), at the level of the agri-food chain (meso) and at the level of the food system and beyond (macro) as well as in three dimensions: economic, social and environmental.

Table III.2. Examples of potential impacts of food losses and waste on the sustainability of food systems

LEVEL	DIMENSION		
	Economic	Social	Environmental
MICRO (household or individual enterprise)	Businesses and consumers spend a larger portion of their budget on foods that will not be sold or consumed	Lower wages Consumers with fewer resources for purchase Lack of products	Among of garbage and waste Contamination of individuals in rural and urban areas
MESO (agri-food chain)	Imbalance in production flows and need for more investment such as the construction of silos and warehouses for intermediate stocks Profit reduction Inefficiencies in supply chain Cost of disposal and treatment of waste	Lower labour productivity Difficulties for companies to make their planning	Multiplication of landfills
MACRO (food system and beyond)	Unrealized economic effort Public investment in agriculture and infrastructure being less productive and turning into an opportunity cost Reduction in financial resources for investment in other areas	Higher level of food prices and difficulties in access to food Larger number of people below the poverty line	Pressure on natural resources: water and soil Emission of greenhouse gases Occupation of forests and conservation areas Depletion of fishery resources Pressure on wildlife Greater spending on non-renewable energy

Source: HLPE 2014.

2. Food losses and food waste versus food security

Mitigating effects of food losses and waste may greatly contribute to food security. According to the definition adopted by the Food and Agriculture Organization of the United Nations (FAO), food security should be construed as *a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life* [FAO 2009].

Unfortunately, not all inhabitants of the world have constant physical and economic access to food. In 2013-2015, the vast majority of people suffering from hunger, i.e. 780.9 million, live in developing countries; they accounted for 13.1% of the total population of these countries (Table III.3). Although food is a fundamental human right, numerous countries fail to respect it in the 21st century.

Table III.3. Undernourishment around the world, 1990-1992 to 2013-2015

Specification	Number of people (millions)		Share of people (%)	
	1990-1992	2013-2015	1990-1992	2013-2015
World	**1 010.7**	**795.5**	**18.7**	**11.0**
Developed countries	20.0	14.6	< 5.0	< 5.0
Developing countries	990.7	780.9	23.3	13.1
Africa	181.7	225.4	27.6	19.8
North	6.0	4.4	< 5.0	< 5.0
Sub-Saharan	175.7	213.0	33.2	23.0
Asia	741.9	519.0	23.6	12.3
South	291.2	280.9	23.9	18.7
East	295.4	151.2	23.2	10.1
Latin America and the Caribbean	66.1	35.1	14.7	5.6
Oceania	1.0	1.4	15.7	13.2

Source: study based on FAOSTAT data.

Most people suffer from hunger in three regions of the world:

- South Asia – 280.9 million, including India – 194.1 million,
- Sub-Saharan Africa – 213.0 million,
- East Asia – 151.2 million, including China –139.8 million.

The problem of hunger cannot be explained by lack of food in the world, because current food production provides everyone with 2849 kcal per day (by 21% higher than the recommended level). Due to unequal access to food, however, 795.5 million people worldwide suffer from chronic hunger. The problem is particularly acute in areas at risk of drought where the majority of the population depends directly on agriculture and pasturing. It means that, the production

of adequate levels of food is thus not enough to reduce hunger and malnutrition. Hunger is not due to lack of food, but lack of funds for its purchase. In addition to people debilitated by undernourishment and famine victims, there is another category – people suffering from qualitative malnutrition. Deaths caused by qualitative undernourishment are not included in FAO statistics.

Physical and economic access to sufficient, safe and nutritious food is one of the main challenges of the 21st century. The United Nations provided for 17 Sustainable Development Goals for 2015-2030 which are to change the world. Goal 12 is as follows: *Ensure sustainable consumption and production patterns*. One of its several tasks is to reduce the global food waste at the retail and consumer levels, and reduce food losses along production and supply chains, including post-harvest losses by 2030.

The problem of overweight and obesity is the opposite of the problem of hunger and food insecurity. At present, the world obese population is more than two times larger than the chronically undernourished population.

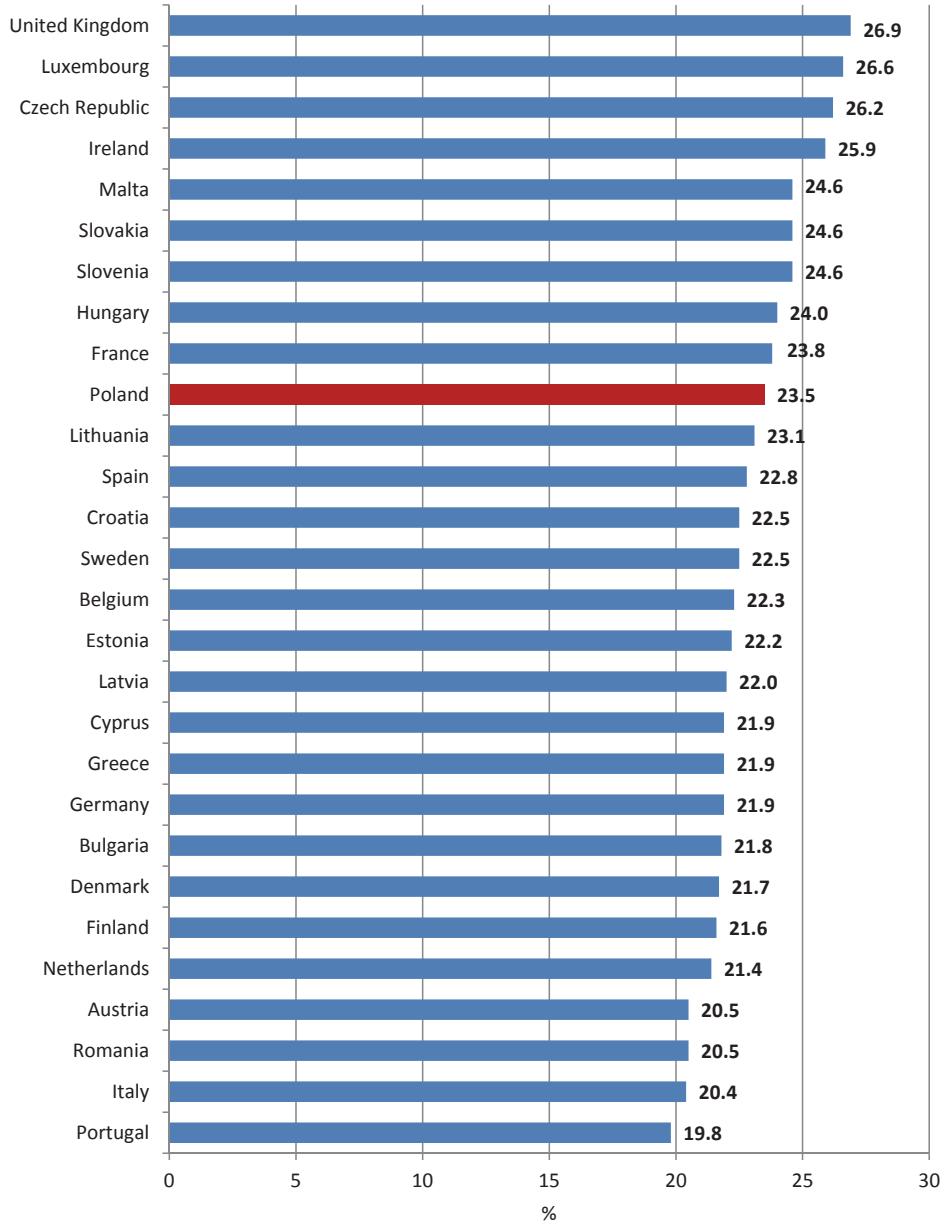
Experts of the World Health Organisation (WHO) identify and monitor overweight and obesity by using BMI (*Body Mass Index*)[15]. The percentage of overweight and obese people worldwide is growing rapidly. Among OECD countries, the highest percentage of obese people (BMI ≥ 30) aged 15 and over is recorded in the United States[16] (35.3%), Mexico (32.4%) and New Zealand (31.3%), while the lowest – in India (2.1%), China (2.9%) and Japan (3.6%).

In the European Union Member States, the highest percentage of obese men aged 18 and over in 2014 was recorded in Lithuania, Poland, France, Hungary, Slovakia, Malta, Ireland, the Czech Republic, Luxembourg and the United Kingdom (from 23.1% in Lithuania up to 26.9% in the United Kingdom), while the lowest – in Portugal (19.8%), Italy (20.4%), Romania and Austria (20.5%). In other European Union Member States, the percentage of obese men ranged from 21.4% in the Netherlands to 22.8% in Spain (Figure III.6).

[15] BMI is the ratio of body weight to height (kg/m^2). The achieved results are presented as BMI distribution by groups identified by the WHO: BMI < 18.5 – underweight, BMI 18.5-24.9 – normal weight, BMI ≥ 25 – overweight, BMI 25.0-29.9 – pre-obesity, and BMI ≥ 30 – obesity (BMI 30.0-34.9 – 1st degree obesity, BMI 35.0-39.9 – 2nd degree obesity, BMI ≥ 40 – 3rd degree obesity). The higher the ratio, the higher the incidence of various diseases, including hypertension, ischemic heart disease, non-insulin-dependent diabetes mellitus, certain cancers, including breast, prostate, endometrial, colon cancer. The World Health Organisation recognised obesity as a chronic condition that requires treatment, that is conducive to the development of other diseases and related to increased mortality.

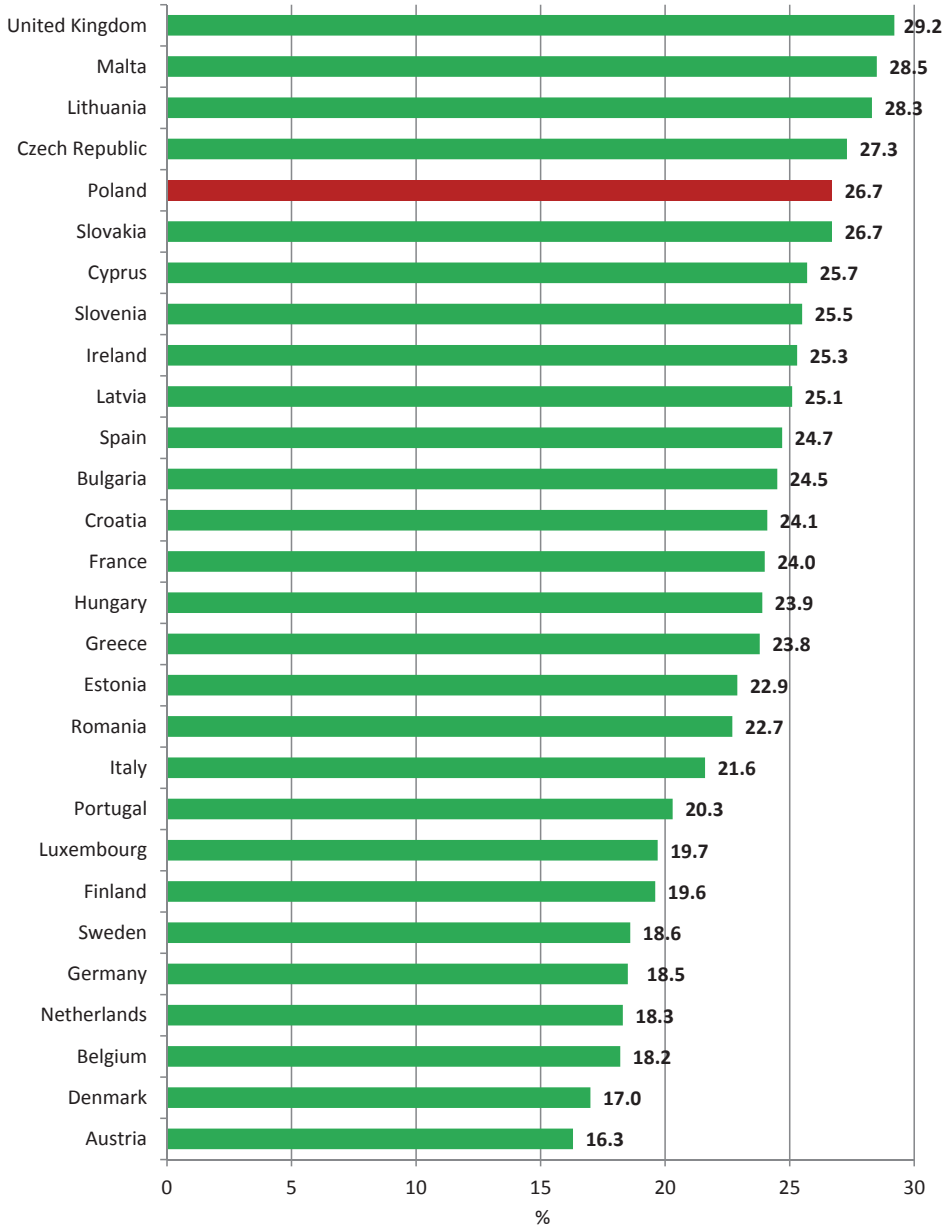
[16] In the United State of America the Centre for Disease Control and Prevention (CDCP) updates the problems of overweight and obesity on an ongoing basis and undertakes educational activities to reduce the number of obese people.

Figure III.6. Obesity among men aged 18 and over in EU Member States in 2014 (%)



Source: study based on [WHO 2015].

Figure III.7. Obesity among women aged 18 and over in EU Member States in 2014 (%)



Source: study based on [WHO 2015].

Most European Union Member States had the percentage of obese women aged 18 and over in 2014 higher than that of men, while Austria, Belgium, Denmark, Finland, the Netherlands, Ireland, Luxembourg, Germany, Sweden and Hungary had it lower. The highest percentage of obese women was recorded in ten European Union Member States, i.e. in Latvia, Ireland, Slovenia, Cyprus, Slovakia, Poland, the Czech Republic, Lithuania, Malta and the United Kingdom (from 25.1% in Latvia up to 29.2% in the United Kingdom), while the lowest – in Austria, Denmark, Belgium, the Netherlands, Germany, Sweden, Finland, Luxembourg and Portugal (from 16.3% in Austria up to 20.3% in Portugal). In other European Union Member States, the percentage of obese women ranged from 21.6% in Italy to 24.7% in Spain (Figure III.7).

Global data on young children are worrying. It is estimated that nearly 43 million children under 5 years of age are overweight and obese [UNICEF, WHO, WB 2012]. According to WHO forecasts, if the current trend continues, 70.0 million children in 2050 will be overweight and obese.

The problem of obesity used to occur only in developed countries, while it is now dramatically on the rise in developing countries, despite their unresolved problems of undernourishment and hunger. In Southeast Asia, the number of overweight and obese people has been steadily increasing over the years, as the Western lifestyle has been adopted, which is particularly evident in urban areas. The process we are dealing with is homogenisation, i.e. alignment of food consumption patterns. Homogenisation is facilitated by: development of international retail chains, unification of shopping centres' offer, the media, development of the satellite network, development and spread of computer technologies, the Internet and cordless telephones, development of fast food restaurant chains, distribution of convenience food, and massive development of tourism conducive to exchanging food consumption patterns between tourists and locals.

For example, 5.9% of men and 8.0% of women in China suffer from obesity, in India – 3.2% and 6.7%, and in Japan – 3.4% and 3.2%. The figures are not high; however, given that the population of China is very large, they indicate that about 41.8 million men and over 53.4 million women are obese. In India, obesity affects over 21.7 million men and over 42.3 million women, while in Japan – about 2.1 million men and about 2.1 million women[17].

According to the McKinsey Global Institute's research [2014] published in a report, *Overcoming obesity: An initial economic analysis*, the problem of overweight and clinical obesity will affect half of the world population by 2030 if the current trends continue.

[17] Calculations based on [WHO 2015 and United Nations, Department of Economic and Social Affairs, Population Division 2015].

Already in 1998, the World Health Organisation (WHO) recognised obesity as a worldwide epidemic, which affects both adults and children, and one of the greatest threats to the health of the world population.

3. Household food waste in Poland

In Poland, data on food waste are published by Polish Food Banks. They thus raise the problem of unmet food needs in numerous Polish households. The Central Statistical Office's surveys reveal that about 2.8 million people in 2014 lived in households with expenditure below the extreme poverty line (i.e. below the subsistence minimum) and about 6.2 million people – in households below the relative poverty line, i.e. in which expenditure amounted to less than 50% of the average expenditure of all households in Poland. It was estimated that about 4.6 million people lived below the statutory poverty line [GUS 2015].

In its survey, *Food waste declarations of Poles*[18], the Public Opinion Research Centre asked Poles how often it happens in their households to discard food and undertake actions to prevent it. In accordance with the survey:

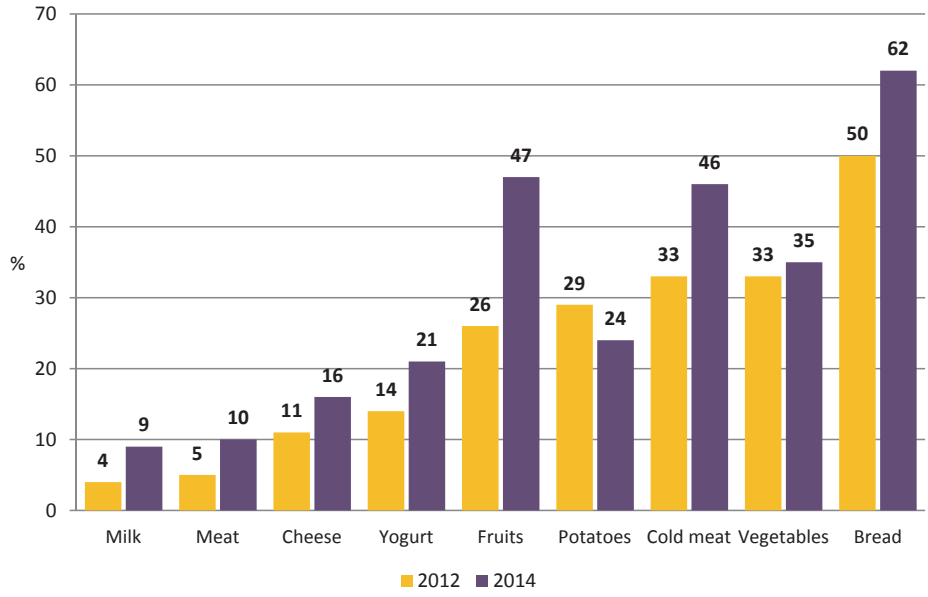
- every fourth person admits that in the last seven days, it happened in their households that food was discarded;
- young people (pupils and students) admit to discarding food; adults find it more difficult to admit to mismanaging food;
- 94% of people aged 65 and over, 88% of people assessing their material conditions as poor and 93% of people with primary education or lower secondary education declared that no food in their households was discarded;
- people who are more affluent, who attained higher education and hold managerial positions discard food more often;
- vegetables, fruits, bread and leftovers from meals are food products that are discarded most often;
- Poles discard less food than in 2005, but – as regards most categories of products (cold meat, meat and meat products, milk and milk products, vegetables, fruit and fruit products) – more than in 2000.

In accordance with Millward Brown SMG/KRC's surveys commissioned by the Federation of Polish Food Banks, 35% of the respondents, mostly from urban areas, admit to discarding food. Most often discarded products are as follows: bread, vegetables, cold meat, potatoes, fruits, yogurt, cheese, meat, milk and prepared dishes (e.g. a pizza, delicatessen dishes).

[18] The "Current problems and events" survey (314) was conducted by using face-to-face computer-assisted personal interviewing (CAPI) between 30 June and 7 July 2016 on a representative random sample of 983 adult people in Poland [CBOS 2016].

Although the Federation of Polish Food Banks has run an information campaign, *Don't waste food. Think ecologically*, since 2009, which is addressed to food producers and consumers, more and more food products are discarded. In 2014, Polish consumers threw out more fruits than in 2012 by 21 pp, cold meat – by 13 pp, bread – by 12 pp, yogurt – by 7 pp, milk, meat and cheese – by 5 pp and vegetables – by 2 pp, while discarding fewer potatoes by 5 pp. These changes are presented in Figure III.8.

Figure III.8. Food products that were most often discarded by Polish consumers, 2012 and 2014 (%)



Source: study based on Millward Brown SMG/KRC commissioned by the Federation of Polish Food Banks [http://bankizywnosci.pl].

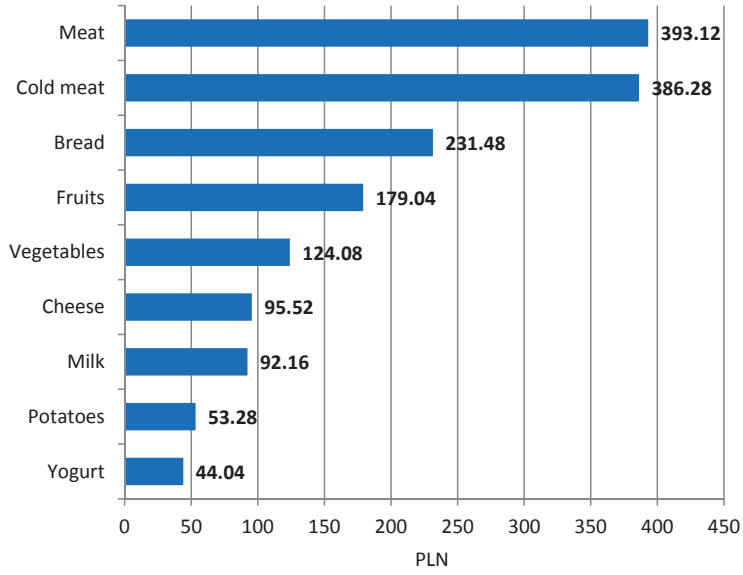
Groups of people admitting to wasting food include people with higher education (26%), respondents who positively assess the financial situation of their households (30%), managers and specialists (35%), people with primary education (12%), retirees and pensioners (12%) and respondents aged 60 and over (12%).

TNS Poland's surveys [2012] also reveal that affluent people who can afford to buy more food that is not always necessary, and people whose job makes them spend more time outdoors and, to a lesser extent, control what they have in their refrigerators, more often feel that they waste food. Food waste is less common in households whose members cannot afford such waste.

In accordance with TNS Hoffmann's *Tesco Food Waste Survey CE* [2016] conducted among consumers from the Czech Republic, Hungary, Poland Slovakia and in 2016, the consumers have numerous explanations of why they discard food. For example, 20% of respondents do not know what to do with leftovers, another 20% – do not believe that discarding food costs them much, and 10% – have no idea on how to reduce the amount of discarded food.

Food waste generates higher food expenditures. In 2014, food expenditures in the Polish households in total accounted for 24.4% of total consumer expenditures. The average annual expenditures on meat, processed meat, vegetables, bread, fruits, cheese, milk, potatoes and yogurt, i.e. food products that are usually discarded by consumers, are presented in Figure III.9. Expenditures on these products amounted to PLN 1,599 in total which accounted for 50,6% of total expenditures on food and non-alcoholic beverages.

Figure III.9. Average annual expenditures on food products that were usually discarded in households in Poland in total in 2014, PLN/per person



Source: study based on unpublished CSO data.

Together with discarded food, consumers discard their money. When comparing the percentage of food products that are usually discarded and expenditures that is incurred to buy them, it turns out that an estimated cost of discarded food in 2014 was PLN 534 per person. A family of 4 may thus save up to PLN 2,136 per year by not wasting food.

4. Actions against global food waste

The paradox of the contemporary world is that nearly 796 million people suffer from hunger, 1.6 billion people are overweight, 500 million of whom are obese, and 1.3 billion tonnes of edible food per year, i.e. 1/3 of produced food, is wasted. If no preventive actions or measures are undertaken, it is forecast that the amount of wasted food will increase by 2020 to 126 million tonnes per year, i.e. by 40%.

In its *Roadmap to a Resource Efficient Europe*, the European Commission considers that a combined effort by farmers, the food industry, retailers and consumers can, through resource-efficient production techniques, sustainable food choices (in line with the WHO recommendations on the amount of animal proteins, including meat and milk products, consumed per person) and reduced food waste, contribute to improving resource efficiency and food security at a global level [European Commission 2011b].

In accordance with a report, *Strategies to achieve economic and environmental gains by reducing food waste*, developed by the Waste & Resources Action Programme and the Global Commission on the Economy and Climate, reducing food waste by consumers would save USD 120-300 billion per year by 2030 and would help in the fight against climate change. Primarily in developed countries, consumers must, however, undertake actions to reduce the amount of discarded food by 20-50% [WRAP 2015].

In its adopted resolution: *How to avoid food wastage: strategies for a more efficient food chain in the EU (2011/2175(INI))*, the European Parliament [2011] proposed introducing the following solutions:

- recovering, locally, unsold and discarded products throughout the food supply chain in order to redistribute them to groups of citizens below the minimum income threshold who lack purchasing power;
- offering varying packaging sizes by producers to help consumers choose the right amount of a product (so-called intelligent packaging systems), optimising and efficiently using packaging;
- providing advice on how to store and use products;
- developing financial incentives for enterprises that introduce a policy to reduce food waste;
- prioritising food that is produced closest to where it is consumed and supporting initiatives aimed at stimulating sustainable small- and medium-scale production;

- issuing recommendations by the Commission regarding refrigeration temperatures, because non-optimal storage temperature leads to food becoming prematurely inedible;
- clarifying the meaning of the date labels ('best before', 'expiry date' and 'use by') in order to reduce consumers' uncertainty regarding food edibility and to disseminate accurate information to the public, notably the understanding that the minimum durability 'best before' date is related to quality, while the 'use by' date is related to safety, in order to help consumers make informed choices;
- facilitating local producers to take part in public procurement procedures for the implementation of specific programmes promoting the consumption of fruit and milk products in schools;
- holding information campaigns on the causes and effects of food waste, and promoting the principles of sustainable development, solidarity and responsibility.

The proposals indicate that the problem of food losses and waste is multidimensional, and show directions in which national and EU actions should be undertaken [Dziliński 2012].

4.1. Federation of Polish Food Banks

Established to prevent food waste and to reduce malnutrition areas by providing food to the most deprived people, the Federation of Polish Food Banks brings together 32 Food Banks that operate throughout the country.

The Federation of Polish Food Banks operates based on three principles:

1. Non-profit principle – non-profit activity – achieved through obtaining and distributing food free of charge.
2. The principle of directing food to those in need through charity organizations working directly in the fight against hunger.
3. The principle of political neutrality and ideological diversity.

The Federation of Polish Food Banks pursues its mission through:

- searching for sources of food produced in excess;
- obtaining food, including products with a short shelf life, the so-called non-commercial products, packaged incorrectly and whose nutritional value is satisfactory;
- storing and rationally distributing the obtained food products to organisations, not individuals;
- promoting attitudes against food utilisation or waste.

In 2015, the Food Banks supported 2 million people, who expected help, by providing over 146,000 tonnes of food in total for social purposes. The use of fruit and vegetables covered by the Russian embargo by the Food Banks was a huge success. 81 thousand tonnes of fresh products were obtained and distributed among those in need. Producers donated 8.2 thousand tonnes of food, retail chains – 1.4 thousand tonnes [FPBŻ 2016].

Since 2013, Tesco – a United Kingdom retail chain which was the first in Poland to launch a programme of transferring surplus food (fresh products: unsold and edible fruit, vegetables and bread) from stores to the Food Banks – has cooperated with the Food Banks. The process involves 131 stores in Poland. Tesco's aim is that all stores in Central Europe, including Poland, transfer food to NGOs that support those in need by 2020, and that any edible food is not wasted in Tesco stores[19]. Furthermore, Tesco engaged in the education of the youngest consumers, i.e. primary school pupils. As part of its educational programme, "From growing to food", it uses classroom scenarios and trips to teach children how not to waste food.

4.2. Sustainable food consumption

Given huge food waste, sustainable consumption is increasingly recognised. The idea of Sustainable Consumption and Production (SCP), which holds an important place in the green economy, i.e. socio-economic development in which sustainable development objectives are more effectively pursued, became the key to stop global food waste [Jaros 2014].

The term *Sustainable Consumption and Production* has been defined as: *a holistic approach to minimising negative environmental impacts from the production-consumption systems in society. Sustainable Consumption and Production aims to maximise the efficiency and effectiveness of products, services, and investments so that the needs of society are met without jeopardising the ability of future generations to meet their needs* [Norwegian Ministry of Environment 1994].

The definition encompasses the three pillars of sustainability: economy, society and environment. The social component involves the provision of generational and inter-generational justice as well as consumer protection. The economic and environmental dimensions were described in the Kiev Declaration as the necessity to "decouple economic growth and environmental degradation to promote both economic growth and environmental protection" [EEA 2007].

[19] At the European Conference of 11 October 2016 in Budapest, "No food to waste. No time to waste", Tesco signed a declaration of cooperation against food waste with the European Federation of Food Banks (*Fédération Européenne des Banques Alimentaires*, FEBA) and Food Banks in the Czech Republic, Hungary, Poland and Slovakia.

Sustainable food consumption refers to the idea of sustainable development and provides an alternative to consumerism. Sustainable consumption is the use of goods and services that correspond to needs and bring a better quality of life, but given that two conditions are met at the same time:

- implementation of these objectives will be accompanied by a simultaneous drastic reduction in the use of natural resources and energy, a reduction in waste emissions and environmental pollution, and discontinuation of toxic materials;
- achieving a better quality of life by present generations will not become an obstacle to satisfying the needs of future generations [Jastrzębska-Smolaga 2000].

Sustainable consumption aspects include:

- economic aspect – related to finding the right balance between consumption by the current generation and consumption by future generations;
- ecological aspect – related to selecting possibly the least environmentally burdensome forms of consumption, and to maximising the usefulness of consumption and, at the same time, maintaining the usefulness and quality of natural resources and the environment;
- social aspect – indicating that all people have equal access to all kinds of goods, including primarily socially desirable goods; preferred forms of consumption are those that minimise the incidence of social problems and contribute to their elimination;
- psychological aspect – consumption contributes to finding the balance between welfare and well-being;
- demographic aspect – related to the social aspect, meaning that affiliation to a certain demographic or socio-professional group does not restrict access to socially desirable goods;
- spatial aspect – society meets its consumption needs so as not to violate the principles of spatial order;
- inter-temporal aspect – all these sustainable consumption aspects will be feasible in the future as well; in an unlimited timeframe [Kiełczewski 2008].

4.3. Sustainable diets

Given the changes in food consumption patterns, the increased demand for animal food products, the systematic increase in the overweight and obese population, food losses and waste, and environmental degradation, the FAO delivered a definition of the sustainable diets in 2010 at an international scientific symposium on biodiversity and sustainable diets in Rome.

Sustainable diets are those *diets with low environmental impact which contribute to food security and nutrition security and to healthy life for present and future generations. The sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources* [FAO 2012].

The definition of the sustainable diets are multidimensional, as it covers aspects, such as: agriculture, food, nutrition, environment, society, culture and economy, which are interdependent. The adopted definition highlights the interdependence between food production and consumption and nutritional recommendations by WHO and FAO, and – at the same time – acknowledges that human health cannot be isolated from the health of ecosystems.

Sweden, as the first country in Europe, proposed to change the contemporary food consumption pattern to make it safe for humans (in terms of a rational diet) and the environment (in terms of pollution, greenhouse gas emissions in food production and marketing, and the use of chemicals in agricultural production). The Swedish National Food Administration (NFA) developed recommendations for six food groups: meat and meat products, fish and shellfish, fruit and vegetables, potatoes, cereals and rice, fat and water [Kwasek, Obiedzińska 2013].

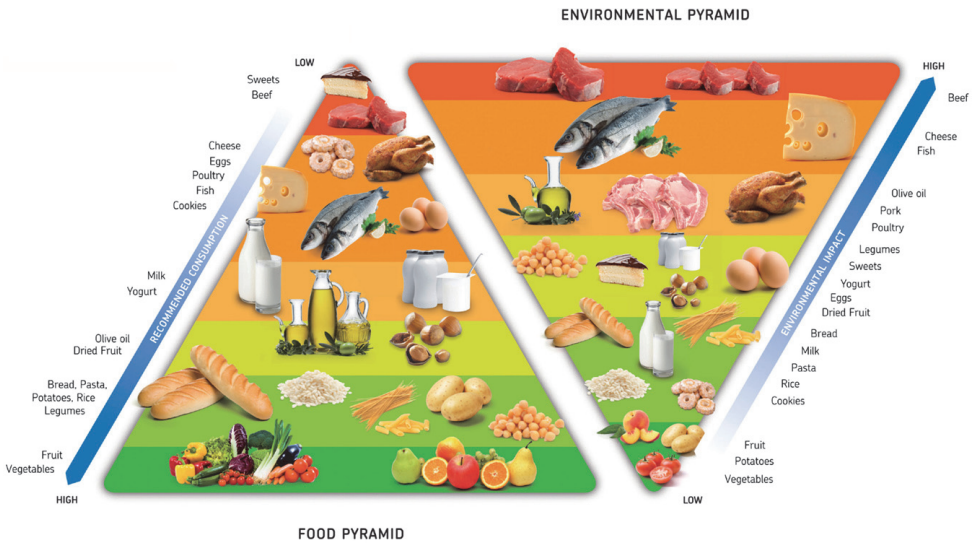
Given that meat and meat production have a decisive impact on the quality of the environment, the Swedish National Food Administration recommended to: reduce meat consumption, choose locally produced meat and favour the consumption of pork and poultry instead of beef and mutton (lower greenhouse gas emissions).

In Sweden, there were also studies as part of which different sustainable meals, which were made from local and imported food products, were compared in terms of their nutritional value. The studies reveal that the Global Warming Potential (GWP) of a vegetarian meal made from local products is nine times lower than that of a meal with pork and imported products [Carlsson-Kanyama 1998].

Scientists from the Barilla Centre for Food & Nutrition (BCFN) also analyse how food affects human health and the environment. They developed a model of the Double Pyramid: the food pyramid and the environmental pyramid. The former was built based on nutritional properties of food products. In the latter, food products were organised based on their environmental impact. The result is an inverted pyramid with respect to the food pyramid: products with the greatest environmental impact are at its top, while those with the lowest environmental impact – at its bottom.

Placing the two pyramids next to each other shows that food products with higher recommended consumption (e.g. vegetables and fruit recommended for consumption five times per day) have the lowest environmental impact and those whose consumption should be limited, including red meat, have the greatest environmental impact (Figure III.10).

Figure III.10. Double Food-Environmental Pyramid



Source: BCFN 2014.

As the most consistent nutritional model with nutritional recommendations, the Mediterranean diet has a positive environmental impact. The model was taken into account when developing the Double Pyramid. The Mediterranean diet was entered in the UNESCO World Cultural Heritage List in 2010. Many nutrition specialists consider it as the best diet, since it prevents chronic diseases, primarily cardiovascular diseases.

The Double Pyramid fulfils two important objectives: it maintains human health and protects the environment. In other words, food with a positive impact on human health has also a positive environmental impact.

By developing the model of the Double Pyramid, it was also estimated how much following four different weekly diets would cost in Italy: (1) a meat- and fish-free vegetarian diet, (2) the sustainable diet (Mediterranean) developed based on the food pyramid with sustainable meat and fish consumption, (3) a diet with meat consumed every day, and (4) a meat and fish diet. The study shows that the vegetarian diet is the cheapest one, i.e. EUR 41 per week, fol-

lowed by the sustainable diet (Mediterranean) – EUR 43, the meat diet – EUR 44, and the meat and fish diet – EUR 45. It was also demonstrated that environmental impact differences between the sustainable diet and the vegetarian diet are minimal, while between the meat diet and the meat and fish diet – significant [BCFN 2014].

Given that following the sustainable diet (Mediterranean) is cheaper than following the meat diet and the meat and fish diet, and that it also brings health benefits and has a positive environmental impact, the public should be made aware of choosing it from the other diets. Education in this field is of vital importance for present and future generations.

The most important in economic terms for low-income consumers, however, is to maximise the energetic value of food and minimise costs at the same time. These requirements are met by junk food which has the advantage of being cheap, easy to store and prepare (e.g. a frozen pizza heated in a microwave). Furthermore, it is widely available. Junk food is poor in terms of its nutritional value, because it is rich in salt, saturated fat, sugar, artificial additives and colourings, and poor in protein, fibre, vitamins and minerals. If consumed for a long time, it leads to obesity and overweight and then to the development of diet-related diseases.

Investing in proper nutrition brings many economic benefits, *inter alia*, lower health care costs, a smaller burden of chronic non-communicable diseases (their prevention, diagnosis and treatment are very costly), higher productivity and economic growth. Good health represents potential for personal development and economic security in the future.

Summary and conclusions

Food losses and waste are not only a missed opportunity to reduce the population suffering from hunger in developing countries, but also huge waste of resources, such as soil, water and energy, which are needed for food production. Global food production is higher than food consumption which has a negative environmental impact. As regards the rational management of natural resources, food losses and waste pose a significant problem which should be considered in economic, social, nutritional, health and environmental terms.

Reduced food losses and waste throughout the agri-food chain, sustainable food choices by consumers in line with the recommendations of the World Health Organisation and rationalised nutrition can contribute to improving resource efficiency, land use efficiency, water management, to providing benefits to the entire agricultural sector worldwide and to reducing hunger/malnutrition

in developing countries and excessive food consumption in highly developed countries and thus to achieving food security in the world.

Food waste is related to the constantly evolving consumer demand. We should change the way we eat, as the current food consumption patterns are unsustainable. Raising consumer awareness is an essential step to improve nutrition planning, food purchase, food storage, food preparation and food consumption skills. The education of all consumers in this regard, starting from the youngest consumers and their parents, as well as government and non-government initiatives are an important starting point to reduce food waste.

It is predicted that food losses and waste will steadily increase along with an increase in the world population – 9 billion by 2050, the demand for food, primarily for animal food products, and the wealth of the world population. All agri-food chain actors: producers, processors, suppliers, traders, sellers, restaurateurs and consumers, are responsible for food losses and waste. Therefore, everyone must also undertake actions to prevent and reduce food losses and waste on both the supply side and the demand side.

All actions to reduce food losses and waste should be undertaken, including:

1. Introduction of a coordinated strategy which brings together national and European actions to improve efficiency along the entire agri-food chain.
2. Support for initiatives of cooperation between different stakeholders: food producers, retail chains, government representatives, NGOs, international organisations and scientific research institutes. The combination of knowledge and skills can contribute to a significant reduction in food losses and waste.
3. Constant monitoring of food losses and waste throughout the agri-food chain.
4. Development of financial incentives for entrepreneurs that pursue policy to reduce food waste.
5. Modification of requirements for food quality standards in terms of the size, shape and colour of fruit and vegetables to enable the sale of less aesthetic products. Food products, which are rejected by retail chains due to non-compliance with quality standards, should be sold at lower prices or forwarded through the Food Banks to those in need.
6. Information campaigns in EU Member States to raise public awareness of food waste consequences. In Poland, the Federation of Polish Food Banks runs numerous information campaigns for both food producers and consumers. Established to prevent food waste and to reduce malnutrition areas, the Federation of Polish Food Banks brings together 32 Food Banks that operate throughout the country.

7. The European Union should support actions to redistribute food to people in a difficult financial situation, and to support the provision of milk and milk products to pupils, and actions as part a programme promoting the consumption of fruit in schools. Two educational programmes are run in Poland: the School Fruit Scheme and the School Milk Scheme.
8. Implementation of food redistribution programmes that allow for reducing prices of food products with a close 'use by' date. It would prevent massive discarding of food and, at the same time, would enable low-income people to buy food.
9. Allowing for taking an uneaten meal home from a restaurant. The practice is commonly used in the United States of America.
10. Use of edible by-products as e.g. pet food, according to the framework directive on waste.
11. Introduction of educational programmes on nutrition at all levels of the education system to explain how to store and prepare food, and how to dispose of leftovers.
12. Disciplinary actions should be undertaken with respect to food production, food quality and security, nutrition rationalisation, health promotion and raising consumers' awareness of nutrition and health.
13. It is necessary to educate consumers about food packaging information on the expiration date of food: (1) 'use by' for perishable food products and (2) best before relating to the minimum durability of food products which are safe for the health of consumers. Consumers often do not distinguish between these terms and discard food with best before information on its packaging. The 'use by' date refers to food security and the 'best before' date – to food quality.

These actions will bring numerous economic, social, health and environmental benefits to not only the present world population, but also to future generations.

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