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Food Insecurity among Small-Scale Farmersin Poland

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Abstract: The problem of food insecurity is generally associated with developing countries, but at the household level it also occurs in developed countries, especially in socially vulnerable groups, such as small-scale farms. However, the issue of food insecurity in developed countries, especially at the household level, is rather neglected in the scientific literature. This study was conducted to fill this gap and examine the level of food insecurity among small-scale farms in Poland. Data were collected using a structured questionnaire from 710 small-scale farms in Poland. The incidence and degree of food insecurity was measured with the Household Food Insecurity Access Scale (HFIAS). The study found that about 43% of the respondents were exposed to food insecurity, including almost 9% to severe food insecurity, which is well above the average for the entire Polish population. By applying cross-tabulation and the zero-inflated Poisson regression model, the study found that the higher age and secondary or higher education of the farm manager, having children in the household and higher land productivity have a statistically significant negative influence on households' food insecurity (i.e., decreased HFIAS score). On the contrary, family size of five or more and production type "permanent crops" and "dairy cows" have a statistically significant positive influence on households' food insecurity (i.e., increased HFIAS score).

Keywords: food insecurity; HFIAS; small-scale farmers; zero-inflated Poisson regression

1. Introduction

Food insecurity means a situation in which "people do not have adequate physical, social or economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" [1] (p. 8) and is generally associated with developing countries. But the problem of deficiency of food security is global and is most noticeable and harmful at the household level, also in the developed countries. As Radimer et al. [2,3] distinguished, there are some stages that food insecure households go through. The initial phase is worry about having enough food, the next one appears as dietary changes and the final one means the decrease in food consumption by adults followed by children. Such a track is visible both in developing and developed countries [4]. Assessment of the household food insecurity, its level, locations, circumstances and determinants is crucial to solve the problem of hunger and achieve food security for all people and meet the second United Nations Sustainable Development Goal (Goal 2.1).

While the problem of food insecurity in developing countries is widely discussed by economists and politicians, the issue of food insecurity in developed countries is not in the field of interest of many researchers. Access to food at the household level in developed economies is especially neglected in the scientific literature [5,6], although it has been changing slowly as the debate on food security in developed countries is emerging [7–10]. Available studies concern households at risk of food insecurity in such countries as the U.S. [11,12], Canada [13], Australia [14,15], New Zealand [16], France [17],

Spain [18], UK [19,20], Portugal [21] or Germany [22]. Research focuses on socially vulnerable groups such as children [18,23,24], older [15,21], women [16,25–27], minority ethnic groups [15,25,28,29] or homeless [30]. But to the best of our knowledge, there is no such research for households of small farms in developed countries, which are also considered as a socially vulnerable group.

As Davidova et al. [31] said, small farms are perceived as an unwanted phenomenon and as an impediment to rural growth. Generally, they are characterized by low efficiency and productivity and weak integration into the market. The consequences of this are reflected in insufficient household income [32]. There is an ongoing debate in the literature on whether small farms should play the role of "landscape guardians" at the expense of public support and economic vegetation, or should they strive to improve productivity [33–35]. Although farmers play an important role in ensuring food security (e.g., at the national level), they are also exposed to food insecurity at the household level. That is typical for owners of small farms and their families [36]. There is a rich body of literature devoted to the problem of food insecurity among small-scale farmers in developing countries [37–39]. In our opinion, the scarcity of such studies for developed economies is a substantial research gap. This is particularly striking when taking into consideration the number of small-scale farms in developed countries where the agrarian structure is strongly fragmented [40,41]. One of the examples is Poland, where small farms represent almost 54% of the 1.4 million Polish farms and use about 13% of agricultural land [42]. Considering the economic size, 2/3 of Polish farms are units of size up to 8000 EUR of standard output (SO) (Standard Output of an agricultural product is the average monetary value of agricultural output at a farm-gate price in euro per hectare or per head of livestock. There is a regional SO coefficient for each product, as an average value over a reference period. The sum of all SO per hectare of crop and per head of livestock in a farm is a measure of its overall economic size expressed in euro). Furthermore, the next 12% fall within the 8000–15,000 EUR range of SO. In spite of financial support within Common Agricultural Policy (CAP), the agricultural income of small farms is relatively low. According to Kisielińska [43], the income of Polish commercial very small farms (2000–8000 EUR) and commercial small farms (8000–15,000) was equivalent to only 15% and 38% of average wages in EU countries, respectively. Such a situation can undoubtedly expose Polish small family farms to food security instability.

But in Poland, similarly to other developed countries, the problem of food insecurity is rather neglected in scientific research, especially at the household level. There are some papers focused on the food situation at the country level in comparison to other countries [44–46]. Considering the household food situation, there are some reports devoted mainly to the situation of children. According to UNICEF research [23] in 2014–2015 in Poland, about 9.6% of households were moderately food insecure, almost 2% severely food insecure and more than 17% reported not having enough money to buy food. The shares of children under 15 living with a respondent who was food insecure were relatively higher and amounted correspondingly to 14%, 3% and almost 24%. Polish households are also investigated by Food and Agriculture Organization (FAO) [47]. The households' food insecurity in Poland was analyzed by Dudek [48]. It was indicated that in 2017, 6.3% of the Polish population could not afford a meal with meat, chicken, fish (or vegetarian equivalent) every second day. In Davis et al. [8]'s research analyzing food insecurity after the 2008 crisis, almost one-fifth of Polish households were unable to afford meat/chicken/fish in 2011 (over 14% in 2007). We found this article to be the only scientific publication focused on microeconometric analyses of food insecurity in Central Eastern Europe that included Poland. It has to be admitted that the problem of food insecurity in Poland emerged in scientific papers in relation to the agricultural sector. But the problem was rather treated as a background for other topics, such as, for example, food policy and common agricultural policy [49], agricultural production [50], environmental issues [51] or sustainable development [52]. At the same time, the bulk of the literature is devoted to small farms in Poland in the context of their overall economic and social situation [53], efficiency [54], sustainable development [55], income situation [56] or agricultural policy [57]. But there is no analysis dedicated to the food security of Polish small farms.

Besides the analysis of the prevalence of food security, another interesting research question is what are the main determinants of households' food insecurity, particularly in rural areas and among small-scale farms. The empirical papers usually assume that food insecurity is determined by a wide range of factors. Among them, household income is expected to be strongly positively associated with access to food [11,17,21,38,48,58–61]. Other research papers prove that a higher share (level) of off-farm incomes [60], remittance [58,62] and social grants [63] are significant for improving food security. Regarding socio-demographic characteristics, many papers conclude that gender influences risk of being food insecure. Generally, women and households headed by women are more exposed to being food insecure in comparison with men and households headed by men [59,64,65]. Some studies focus on the positive relationship between the age of the household head and food security [22,58,59,61,62,66] but some papers underline a negative relationship [65,67,68]. The households' food insecurity is also enhanced by a higher level of education of the household head [21,22,48,58,60,63,65,69]. In research where the role of family size [38,58,59,62,67,68,70] and the presence of children [11,13,17] were examined, the negative association was found. Studies on small farms' food security often explore the farm-specific factors. They indicated that farmers' food security is higher as farms' productivity is higher [63,65,69,71]. Research, where farms' relations with the market are investigated, proves that shorter distance to market improves farmers' food situation [38]. Hence in our study, we do not only measure the prevalence of food insecurity among small-scale farms in Poland, but we also try to test which of the aforementioned determinants have a significant influence on its level. Expected signs of parameters are presented in Appendix A.

It should be stated here that evaluation of food security at the household level is challenging because changing thoughts about food security "from the global and the national to the household and the individual; from a food first perspective to a livelihood perspective" [72] (p. 155) must be also reflected in the shift from objective indicators to subjective ones [73]. As a consequence, various measures have been applied to the latter, including derived (e.g., FAO method, household expenditure survey, dietary intake, anthropometry) and fundamental measures (experience-based food insecurity scales, for example, the Household Food Insecurity Access Scale, Household Hunger Scale, Latin American and Caribbean Household Food Security Scale, Food Insecurity Experience Scale). An overview of these indicators, their assessment and comparison can be found in the works of Ashby et al. [10], Bertelli et al. [74], Maxwell et al. [75], Maxwell et al. [76], Pérez-Escamilla and Segall-Corrêa [77]. Methods based on assessing the scale of experiencing food uncertainty and the perception of their own food situation by respondents are in line with the United States Department of Agriculture (USDA) approach, that "household experience food insecurity at times during the year, meaning their access to adequate food is limited by a lack of money and other resources" [78] (p. 7). The experience-based methods were becoming more and more popular in recent years. Initially, these methods were mainly used in the U.S., and then they were gradually used also in studies of other countries. The surveys based on those methods confirm that, despite the presence of a hunger safety net in some developed countries, the problem of food insecurity still occurs and is not marginal [11,14,22,79,80]. According to FAO research [47], in 2018, 8% of the population in Europe and Northern America was affected by moderate or severe food insecurity. In 2016–2018, lack of regular access to nutritious and sufficient food embraced over 5% of the population in Poland, Denmark, Norway and Sweden, respectively, more than 8% of the population in Hungary, Estonia and Finland adequately, and 9% of the population in the U.S. Another study using the experience-based food insecurity scales [11] presents that in 2018 about 14.3 million households in the U.S. (11.1% of households) declared at least temporary problems during the year with providing enough food for all their members (4.3% with very low food security). In the FAO report, food insecurity (prevalence of moderate or severe food insecurity) is measured by the Food Insecurity Experience Scale (FIES). FIES as a complementary indicator of monitoring progress on the eradication of hunger (next to the prevalence of undernourishment) is reported from 2017 [47] at a global scale. FIES is based on the U.S.

Household Food Security Survey Module (HFSSM) that has been applied annually in the United States since 1995 [81]. HFSSM was used in Coleman-Jensen et al. [11]'s study.

In our opinion, changing the survey perspective and identification of food insecurity of households in affluent countries is very necessary. First of all, as the surveys mentioned above revealed, the food insecurity problem exists in the developed countries and "the food insecurity picture" at the microeconomic level is much more unfavorable in comparison to the macroeconomic level. Secondly, analysis of households' food access in developed countries is essential to formulate responsible and effective strategies dedicated to tackling the food insecurity that is hidden in some way. Thirdly, limited access to food is indicated in socially vulnerable groups, so in-depth research of factors determining food insecurity among members of such vulnerable groups is needed. Taking into account all of the above, it is interesting to find out how this looks and what determines the access to food of households that are part of the sector responsible for food production. We focused on small farms in Poland, as they are perceived as a socially vulnerable group considering their income situation and there are almost no microeconomic surveys of food insecurity in Poland—a developed country of Central and Eastern Europe. That is our main motivation for this study and hence our main aim is to analyze the prevalence and the determinants of the food insecurity among small-scale farms in Poland using the experience-based food insecurity scale method, i.e., the Household Food Insecurity Access Scale (HFIAS). Our contribution to the literature is twofold. Firstly, the literature devoted to the causes of household food insecurity among small-scale farmers in developed countries, including Poland, is limited or even none, so our research and results fill the gap. Secondly, as we are the first ones in Poland to use the HFIAS method—a relatively new experimental measure of food insecurity, our study contributes to research based on self-reported indicators measuring subjective well-being.

The remainder of this article is organized as follows: Section 2 provides an explanation of the dataset, HFIAS indicator methodology and econometric modelling strategy. The results are presented in Section 3. Section 4 discusses and concludes the paper.

2. Materials and Methods

2.1. Database

This paper is based on a primary survey distributed among 710 small-scale farmers in Poland in 2018. In our survey, we defined a small-scale farm by its economic size. We used Farm Accountancy Data Network (FADN) typology of very small and small farms (nES9 Type 1 and 2), which amount to an economic size of 4000–15,000 EUR SO. The sample was determined by the stratified selection process and collected between January and March 2018 by a network of national agricultural extension officers who provide data for the Polish FADN. For the sake of clarity, we did not use FADN data but rather FADN sampling methodology to determine the size of a sample of farms that met our size (4000–15,000 EUR SO) and labor engagement (>75% Annual Work Unit (AWU)) criteria. These households were visited and household heads were interviewed face-to-face, using a structured questionnaire that was carefully designed and pretested. Besides socio-demographic and farm-related data, the survey also covered a set of questions related to household food insecurity.

2.2. HFIAS Indicator

The food security part of the survey included the experience-based food insecurity scale based on HFIAS developed by the Food and Nutrition Technical Assistance (FANTA) program of United States Agency for International Development (US-AID). It is a brief survey instrument based on nine questions, which aim to assess whether households have experienced problems with accessing food during the last 30 days [82]. Questions are ordered in a way that they represent a generally increasing level of severity of food insecurity and can be divided into three domains: anxiety (question 1), inadequate quality (questions 2–4) and insufficient intake (questions 5–9). Questions were translated into Polish

and, after pilot studies, modified slightly to better reflect Polish conditions (for the HFIAS questions see Table 1). Cronbach's alpha coefficient was 0.79, showing good internal reliability of HFIAS.

Table 1. Household Food Insecurity Access Scale survey among Polish small-scale farms in 2018 (no. of positive responses).

Do You or Your Household Members Have the Following Problems with Ensuring Food Security Due to Financial Problems:	Last 30 Days					In the Last Year	
	1–2 Times	3–10 Times	>10 Times	Total	Total in %	It was Happening Regularly in the Last Year	in %
Worry about not having enough food	41	14	2	57	8.0%	24	3.4%
Do not eat your preferred food	160	59	14	233	32.8%	115	16.2%
Limit the diversity/quality of meals	137	55	7	199	28.0%	91	12.8%
Consume products that you would not like to eat in a better material situation	137	59	8	204	28.7%	92	13.0%
Limit the number of meals	51	11	1	63	8.9%	26	3.7%
Limit eaten food portions	30	13	1	44	6.2%	23	3.2%
Skip a meal because you could not afford to buy food	33	15	1	49	6.9%	28	3.9%
Go to sleep being hungry	20	2	0	22	3.1%	13	1.8%
Stay out of food all day	10	0	0	10	1.4%	10	1.4%

Note: No. obs. = 710, Cronbach's alpha 0.79. HFIAS category: food secure mild food insecure moderate food insecure severe food insecure. Source: [83].

Besides the occurrence, respondents were asked also about the frequency i.e., if the situation had occurred rarely (once or twice in the past month), sometimes (three to ten times in the past month) or often (more than ten times in the past month). Based on the scores generated from the nine questions, two indicators were computed:

(i) HFIAS category: according to the categorization algorithm recommended by the HFIAS Indicator Guide [82], respondents were classified into four categories: food secure, mild food insecure, moderate food insecure, severe food insecure. This indicator was used to present the incidence of food insecurity in small-scale farms in Poland and their socio-demographic, farm and income characteristics;

(ii) HFIAS score: which is a count measure of the degree of food insecurity with the range from 0 to 27, where households have four possible responses to each of the nine questions, from 0 which is "never" to 3 which is "often". The higher the score, the more food insecure a household is. This indicator was used as a dependent variable in the zero-inflated Poisson model to define the determinants of small-scale farms' food-insecurity.

2.3. Econometric Strategy

As our dependent variable in the analysis of factors influencing food insecurity among small-scale farms in Poland, we have used the HFIAS score, which is a count variable. For this type of data, a Poisson regression model is the most commonly used. However, in our data, there exists a problem of excess zeros i.e., a large percentage of farmers are food secure, so HFIAS equals 0. A solution for this situation is a zero-inflated Poisson (ZIP) regression model, in which the excess zeros are generated by a separate process from the count values. In this model, it is assumed that the observation equals 0 with a probability p, while with a probability $1 - p$ it results from Poisson regression [84]. In other words, the excess zero counts result from logit model (i.e., in our research, which factor decides if a farmer is food secure or insecure) and the remaining counts result from a Poisson model (i.e., in our research, which factors decide the degree of food insecurity). We tested whether a conventional count data model or a zero-inflated count data model is preferable with the Akaike's information criterion (AIC) and Bayesian information criterion (BIC) (see Appendix A).

The final set of explanatory variables is based on the literature review presented in the introduction and results from the theory on food insecurity. Discussed research suggests that farm household food insecurity may be determined by socio-demographic factors such as farmer's age, gender, education, household size and structure. Another set of potential food security determinants includes farm-specific

variables such as production type, distance to market, level of market integration and productivity of inputs (land, labor, capital). The latter one, together with additional income from off-farm work and budgetary transfers, influences the household disposable income. As the access to food at the household level depends mainly upon income available to the household, for the logit part of the zero-inflated Poisson model that determines whether the count is zero, we have used the disposable income per capita dummy variable with a threshold of 162 EUR per person, which corresponds to the official level of existence minimum in Poland in 2018. For the dependent variables, we checked for the multicollinearity using a VIF test, which in no case exceeds the value of 5. Descriptive statistics and a detailed description of the dataset are available in Appendix A. The robustness of our results has been checked by estimating two additional models including only socio-demographic variables in the first one and only farm-specific variables in the second one (see Table A3 in Appendix).

3. Results

3.1. Prevalence of Food Insecurity by Household Characteristic Based on HFIAS Category

In the group of surveyed farms, 57% were classified as food secure (402) and 43% as food insecure (308). Among the latter, 167 farmers declared to be mildly food insecure, which was associated with the need to limit the quality of food consumed or eating less preferred food. This is in line with the fact that, in contrast to less developed regions, in developed countries, food insecurity is more commonly characterized by chronic compromises in dietary quality [20]. Moderately food insecure farmers embraced 80 entities. Being moderately food insecure is associated mainly with lower food intake. 61 farmers experienced hunger and were classified as severely food insecure (see Figure 1).

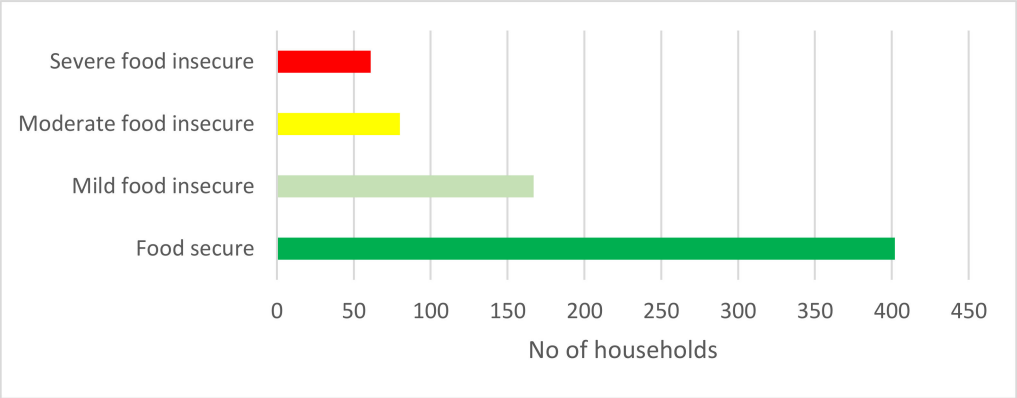

Figure 1. Count of households in Household Food Insecurity Access Scale (HFIAS) categories. Source: own survey.

When looking at associated factors (see Table 2), increasing age appears to be related to food security. The average age is decreasing in the more severely food insecure group. In addition, higher education of farm manager increases the likelihood of being in a group of food secure households. Farm producing permanent crops seemed to be affected by the food insecurity most often. Only 38.5% declare to be food secure, and more than 15% are affected by severe food insecurity. Production types experiencing the smallest problem with food security are horticultural crops and grain animals. Regarding productivity of factors of production, households struggling with severe food insecurity have the lowest land and labor productivity. As a result, households with disposable income per capita less than 162 euro per month are more affected with food insecurity, with 14% of them experiencing severe food insecurity.

Table 2. Prevalence of food insecurity severity levels by socio-demographic characteristics, income characteristics and farm characteristics.

Variable	Food Secure (n = 402)	Mild Food Insecure (n = 167)	Moderate Food Insecure (n = 80)	Severe Food Insecure (n = 61)	p-Value
Age of farm manager (avg.)	**49.13**	**48.78**	**46.55**	**45.55**	**0.034** [a]
Gender of farm manager (%)					
Male (n = 581)	56.80	21.92	11.54	7.75	0.376 [b]
Female (n = 129)	55.81	25.71	10.08	12.40	
Education of farm manager (%)					
Primary (n = 41)	**51.22**	**26.83**	**14.63**	**7.32**	**0.035** [b]
Vocational (n = 560)	**56.07**	**24.64**	**10.71**	**8.57**	
Secondary (n = 21)	**52.38**	**28.57**	**9.52**	**9.52**	
Higher (n = 88)	**63.64**	**13.64**	**13.64**	**9.09**	
Number of household members (avg.)	3.06	3.08	3.29	3.18	0.631 [a]
Number of children under 18 (avg.)	0.55	0.67	0.65	0.67	0.459 [a]
Share of budgetary transfers in income (%) (avg.)	7.38	7.89	9.02	7.36	0.654 [a]
Off-farm income share (%) (avg.)	10.81	7.35	9.46	15.16	0.076 [a]
Distance to market (km) (avg.)	11.84	12.70	11.34	13.26	0.286 [a]
Market integration index (avg.)	3.97	3.89	3.94	3.97	0.490 [a]
Production type (%)					
Field crops (n = 268)	**54.48**	**21.64**	**13.81**	**10.07**	**0.038** [b]
Horticultural crops (n = 36)	**66.67**	**22.22**	**2.78**	**8.38**	
Permanent crops (n = 26)	**38.46**	**34.62**	**11.54**	**15.38**	
Dairy cows (n = 46)	**47.83**	**21.74**	**21.74**	**8.70**	
Other grazing livestock (n = 77)	**58.44**	**27.27**	**7.79**	**6.49**	
Granivores (n = 27)	**66.67**	**22.22**	**7.41**	**3.70**	
Mixed (n = 230)	**59.57**	**23.91**	**9.13**	**7.39**	
Land productivity (thousands PLN/ha) (avg.)	**5.13**	**5.21**	**4.19**	**3.60**	**0.015** [a]
Labor productivity (thousands PLN/AWU [c]) (avg.)	**46.37**	**43.69**	**49.58**	**31.02**	**0.049** [a]
Capital productivity (thousands PLN) (avg.)	178.83	158.70	159.72	143.76	0.066 [a]
Disposable monthly income per capita (euro) (%)					
<162 (n = 140)	**45.71**	**25.71**	**15.00**	**3.57**	**0.011** [b]
≥162 (n = 570)	**59.30**	**22.98**	**10.35**	**7.37**	

[a] Anova/Kruskal-Wallis, [b] Chi-sq, [c] Annual Work Unit is equivalent to one person working full-time on the holding. In Poland, AWU is equal to 2120 h of work per year. Note: bolded parameters are significant at $p < 0.05$. Source: own calculations.

3.2. Determinants of Food Insecurity Based on HFIAS Score

The distribution of farms declaring at least one positive answer in the survey, based on the HFIAS score, is presented in Figure 2. Although a HFIAS score equal to or higher than 9 was obtained only by 21 respondents, it is worth noting that 30 farmers admitted that once or twice per month they even went to bed hungry or did not eat all day. What is more, 23 farmers revealed that this happened regularly last year (see Table 1). Results of our study indicate a relatively unfavorable food situation of surveyed small-scale farms in Poland and at first glance they are quite unexpected.

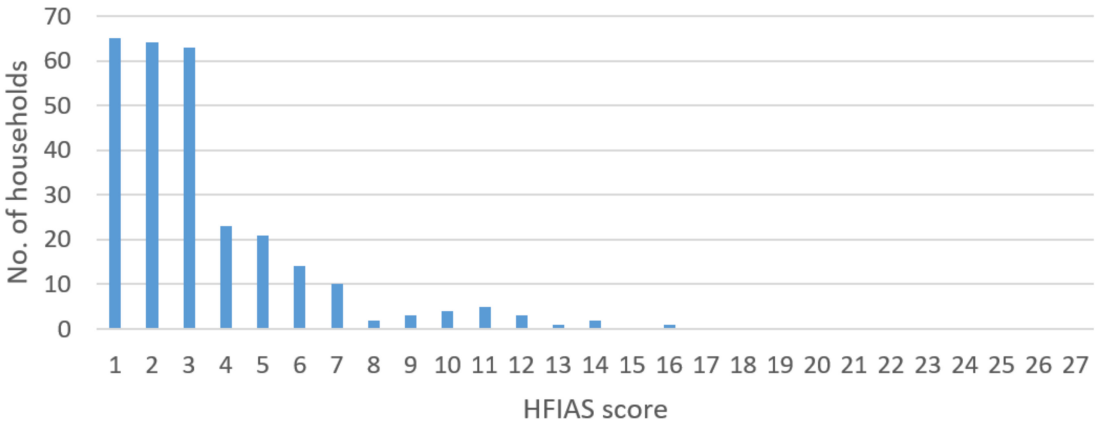

Figure 2. Distribution of food insecure households (HFIAS score > 0). Source: own survey.

The results of the zero-inflated part of the model (Table 3) indicate, that the disposable income per capita is a significant factor which decides whether a farm household is food secure or food insecurity. The results of the Poisson regression part of the model suggest that in a case of food-insecure farms (i.e., HFIAS score > 0), the level of food insecurity is negatively and statistically significant influenced by the higher age of farm manager, secondary or higher education of farm manager, presence of children under 18 in the household and higher land productivity. It means that these factors decrease the HFIAS score. The incident rate ratio (IRR) indicates that if a farm manager is 40–60 years old, the HFIAS score is 27% lower than if a farm manager is less than 40 years old. If a farm manager is over 60, the HFIAS score is even 40% lower. Secondary and higher education reduces food insecurity by respectively 43% and 26% in comparison to no or primary education and having children in the household by 23%. In the case of land productivity, an increase by 1000 PLN reduces the food insecurity score by 4%.

Table 3. Determinants of food insecurity among small-scale farmers in Poland (zero-inflated Poisson regression model).

Variables	Coef.	Std. Err.	IRR	*p*	(95% Conf. Interval)		VIF
HFIAS score model							
Age of farm manager (dummy): <40 ref.							
40–60	**−0.319**	**0.080**	**0.727**	**0.000**	**−0.475**	**−0.163**	**1.73**
>60	**−0.522**	**0.122**	**0.593**	**0.000**	**−0.761**	**−0.282**	**1.72**
Gender of farm manager(dummy): Female ref.							
Male	−0.087	0.086	0.917	0.313	−0.255	0.082	1.04
Education of farm manager (dummy): No or primary ref.							
Vocational	0.094	0.131	1.099	0.472	−0.163	0.351	3.19
Secondary	**−0.553**	**0.252**	**0.575**	**0.028**	**−1.048**	**−0.058**	**1.54**
Higher	**−0.298**	**0.176**	**0.742**	**0.091**	**−0.643**	**0.048**	**3.06**
Number of household members (dummy): 1–2 ref.							
3–4	0.132	0.085	1.141	0.121	−0.035	0.299	1.68
5 and more	**0.414**	**0.112**	**1.512**	**0.000**	**0.193**	**0.634**	**1.95**
Children under 18 in the household (dummy): No children ref.							
Yes	**−0.263**	**0.083**	**0.769**	**0.001**	**−0.425**	**−0.101**	1.68
Share of budgetary transfers in income (%) (cont.)	0.000	0.003	1.000	0.943	−0.005	0.005	1.16
Off-farm income share (%) (cont.)	−0.002	0.002	0.998	0.383	−0.006	0.002	1.13
Distance to market (km) (cont.)	−0.004	0.004	0.996	0.306	−0.012	0.004	1.08
Market integration index (cont.)	0.087	0.055	1.090	0.116	−0.021	0.194	1.25
Production type (dummy): Filed crops ref.							
Horticultural crops	0.237	0.208	1.267	0.255	−0.171	0.645	1.41
Permanent crops	**0.447**	**0.164**	**1.564**	**0.007**	**0.125**	**0.769**	**1.25**
Dairy cows	**0.200**	**0.112**	**1.222**	**0.073**	**−0.019**	**0.420**	**1.14**
Other grazing livestock	−0.192	0.121	0.826	0.112	−0.428	0.045	1.25
Granivores	0.237	0.201	1.267	0.239	−0.158	0.631	1.09
Mixed	−0.052	0.080	0.949	0.516	−0.209	0.105	1.42
Land productivity (cont.)	**−0.042**	**0.013**	**0.959**	**0.001**	**−0.067**	**−0.016**	**2.08**
Labor productivity (cont.)	−0.001	0.001	0.999	0.254	−0.001	0.001	1.32
Capital productivity (cont.)	0.000	0.000	1.000	0.921	−0.000	0.000	2.14
cons	1.463	0.266	1.267	0.000	0.941	1.984	
Zero-Inflated model							
Disposable income per capita (euro) (dummy): <162 ref.							
≥162	**0.534**	**0.201**	**0.534**	**0.008**	**0.141**	**0.927**	
cons	−0.279	0.180	−0.279	0.122	−0.632	0.075	
Zero-inflated Poisson regression Number of obs. = 710							
Non-zero obs. = 312							
Zero obs. = 398							
Inflation model = logit							
LR chi2 (22) = 82.43							
Log likelihood = −1199.98							
Prob > chi2= 0.000							

Note: bolded parameters are significant at $p < 0.1$. Source: own calculations.

Food insecurity is increased by the number of household members of 5 or more and production types "permanent crops" and "dairy cows". These variables are linked to a statistically significant increase in the HFIAS score. The IRR indicates that the HFIAS score in households of 5 or more

members is 51% higher than in households of 1 or 2. Breeding dairy cows and growing permanent crops increases food insecurity in comparison to field crops by, respectively, 22% and 56%.

4. Discussion and Conclusions

The study found that about 43% of our respondents were exposed to food insecurity, including almost 9% to severe food insecurity. These figures are partly in line with other studies, but discussion with other research is challenging as there are only a few papers focused on the household food insecurity in developed countries and in Central and Eastern Europe especially. What is more, the classifications of food insecurity vary depending on the particular food insecurity measure applied in the survey. Even when experience-based scale measures are used, they can be based on a different number and scope of questions that can ultimately affect the obtained results. Thus, evaluation and monitoring of households food security in developed countries need not only a regular survey, but a regular survey employing the same measures. Taking into account the US experience, the HFIAS method seems to be appropriate.

Nevertheless, these results are striking when considering "non-significant" problems in developed countries. These results, however, are not so shocking and surprising when compared with somewhat similar studies in other developed countries. In Nordic countries, over 37% of Finnish, 28% of Norwegian, 29% of Danish and almost 28% of Swedish respondents declared having experienced food insecurity [61]. Of these, a lower number of reported persons did not have enough food to eat (4%, 1.5%, 1.7% and 1.9% in Finland, Norway, Denmark and Sweden, respectively). In Davis and Geiger [8]'s survey, over 41% of respondents in Hungary, 28% in Estonia, 26% in Slovakia, 21% in Greece and 20% in Poland were exposed to food insecurity. Among the twenty one investigated European countries, the Eastern countries performed significantly worse. The high level of food insecurity in our research sample can be partly explained by the place of living. Dudek [85] assessed that Poles living in villages have a worse perception of their own financial situation when it comes to purchasing a sufficient amount of food. Smith et al. [73], however, revealed that although the rural households in low-income economies are more food insecure in relation to urban households ([60] as an example), in middle- and high-income economies such differences were not statistically significant. According to Tarasuk et al. [13], Canadian urban areas were slightly more food insecure than rural areas.

Concerning the age of the farm manager, we found a positive relationship between the age of the farm's manager and food security level of his household. This variable was significant in both the cross-table analysis (see Table 2) and the econometric model (see Table 3). Our results are in line with studies that confirm that older household head means more farming experience, more risk-averse and more diversified production, which transfers into being more food secure [58,59,62]. Older people are perceived as better and more experienced in managing the household resources. Therefore, a higher risk of experiencing food insecurity among young people was found in Nordic countries [61] and in France [66]. Food insecurity also decreased with increasing age in Germany [22]. In contrast, some papers present the opposite results. Older farmers mean less productive farmers with more dependence on social transfer [67], and finally, who are more likely to be food insecure [65,68]. Smith et al. [73] have drawn interesting conclusions. They "indicated an inverted U-shape relationship between the age of household head and the prevalence of food insecurity in middle-income and high-income economies, but no such relationship has been found in low-income economies". In Visegrad Group (V4) countries, households lead by a younger and older head were less food insecure in comparison with middle-aged household heads [48].

Education appears to protect from food insecurity. The probability of experiencing food insecurity among Polish small-scale farmers is decreasing with a higher level of education of the household head (see Table 2). In comparison to primary education of the farm head, secondary education reduces the risk for food insecurity better than higher education (see Table 3). The number of schooling years negatively affecting farmers' food insecurity was observed among small farmers in e.g., Ethiopia [65], Benin [69], South Africa [63]. Such a relation can also be found in the households in developed

countries such as Poland, The Czech Republic, Hungary, Slovenia [48], Portugal [21] and Germany [22]. Among other socio-demographic variables, gender turned out to be statistically insignificant for the level of food insecurity. This may be due to the fact that in developed countries women have similar educational opportunities or other possibilities affecting the quality of farm management. Some studies indicate that women are central in the learning and fostering of multifunctional entrepreneurship [86].

Partly, as we expected, family size is negatively correlated with the food security level of surveyed farms, as this negative relation is significant only for households of more than five members (see Table 3). The number of household members determines the consumption-level needs of households. As other researchers [38,58,59,62,63,67,68] claimed, a bigger household means more problems with the assurance of food security. On the other hand, having more members in the household can overcome labor and capital constraints, especially in more labour intensive agriculture [62], and the lack of diversity of income (work out of farms), to reduce being affected by food insecurity. Some of our results, however, are quite unexpected. In most of the studies, the correlation between food insecurity and the number of children is rather positive, i.e., presence of children increases food insecurity. For example, having a child under 3 years doubled the risk of food insecurity among the poorest investigated households in France, but it was not significant in higher-income groups [17]. Most at risk were also households with children in Canada [13] and the US [11]. Our study indicated that the presence of children under 18 in the household positively influences food security (see Table 3). This phenomenon can be partly justified by the new social program "500+" (budgetary transfer) within which a household receives a monthly lump sum of around 120 euro per each child under 18 and also through school feeding programs for children, because the eating of meals at school by children is less of a burden on the household's food budget.

Another important finding is the negative relationship between the disposable income per capita and households' food insecurity (see the zero-inflated part of the model in Table 3). In the group of households with disposable income above the 162 euro threshold, the share of food insecure households is significantly lower (see Table 2). This finding is consistent with study results reported for small farmers in developing countries [38,58,59,69]. The positive relation between household food security and income was observed in the V4 countries survey [48], France [17], the US [11], Portugal [21] and Nordic countries [61]. It is interesting, however, that the structure of income, i.e., the share of budget support in income and off-farm income does not significantly affect the level of food insecurity. This is not in line with some studies, where the relationship between social (financial) transfers and food security were investigated. For example, net transfers [68], remittance [58,62] or social grants [63] received by farmers influenced food insecurity in a negative way. Increased income in terms of pension, social grants, and remittance, improved food access and, finally, household food security level. However, in the case of the surveyed sample, the average share of off-farm income is relatively low (10%), and the average share of budgetary transfers even lower (8%), so these variables are not expected to be a major determinant shaping the total income and food security level. Hence, the results of our study suggest that social policy in Poland should be better targeted if it is to reduce the scope of food insecurity among small-scale farmers.

Research indicates that marketization and the development of various forms of farm integration have a positive impact on their economic results [87–89], which should translate into increased food security. However, such conclusions apply to all farms, while this study covered a group of small-scale units. Meanwhile, this group is generally weakly connected with the market [90,91]. It is similar in the case of the analyzed farms. It is enough to mention that over 77% of them sell their agricultural products without previously signed contracts or directly to the consumer. 98% of these goods are exclusively or mostly raw materials. This approach does not reveal the benefits of market integration, shortening the supply chain and taking over the economic surplus in the processing of agricultural products.

Distance to the market is also statistically insignificant in our research. The irrelevance of this variable in Poland may be due to the fact of a relatively well-developed transport infrastructure,

allowing the transport of agri-food products both from the perspective of a farmer as a food producer, and a farmer as a food consumer.

We have tried also to evaluate the relationship between the production types of farms and their probability to be food insecure. We found that the farms specialized in dairy cows and permanent crops are more exposed to food insecurity in comparison to crops farms (see Table 3). To the best our knowledge, there are no surveys where the farmers' household food insecurity was evaluated by comparing farms of different types of production. Available studies were carried out only among farms specializing in particular production types (e.g., rise farmers, maize farmers). It is worth noticing that in our sample the dairy cow farms are characterized by the lowest level of land productivity, which can explain their related food insecurity situation. However, there are publications that present the relationships between the production type of farms and their sustainability. For example, Stępień et al. [92] indicate that the highest level of socio-economic sustainability is achieved by mixed-type farms. If we consider that one of the key elements of sustainability is the size of agricultural income, we can conclude that the mixed type positively affects the latter. In turn, income has a positive impact on food security. Czyżewski et al. [93], in their research, showed that among the farms in the European Union, those with a mixed production type were the most sustainable. It can, therefore, be assumed that mixed production type, especially in countries with fragmented agriculture, contributes to increasing sustainability and improving food security, which is confirmed by Brodt et al. [94]. Other authors argue that agricultural production systems, combining crops and animal production, increase long-term sustainability due to the availability of raw materials for production and less vulnerability to price fluctuations [95]. In addition, the mixed type of production guarantees to some extent the self-supply with agricultural products, which improves food availability for farm members.

Food security among the farming community is, to some extent, determined by agricultural productivity. Enhancing the productivity of a small farm can affect household food security in three ways: by a higher amount of food for home consumption, by bigger agricultural output sold on the market, or by higher value-added boosted by growth in eco-efficiency [96] that can also improve household income. In our research, land productivity of investigated farms improved food security. To the best of our knowledge, there is no survey directly examining the impact of land productivity on food insecurity in developed countries. Our results, however, are in line with some surveys conducted among farmers in developing countries, although in an indirect way (see Tables 2 and 3). For example, Salazar et al. [71] indicated that smallholder farmers in Bolivia participating in agricultural technology adoption programs improved their land productivity and food security as a consequence. Land productivity can be enhanced by better access to an irrigation system that minimizes the weather variability risks, which affects the use of other technologies like improved seeds or fertilizers and agrochemicals. The positive relation between irrigation and food security of small farmers was found in South Africa [63]; Ethiopia [65] and Benin [69]. Food security of farmers' households was also increased by using fertilizers [63], herbicide, improved seeds [69] or farming experience that improved farming skills and affected the probability of adoption of innovations [63]. All these factors indirectly improve food security through positive impact on land productivity. At the same time, production in small farms is based primarily on the use of labor inputs, primarily including family members [97]. The level of equipment with capital resources is relatively low [98], hence there is little or no impact of this factor on the volume of agricultural production and income, which in turn translates into the level of food insecurity.

Our research confirms that the food insecurity problem exists in developed countries and should not be neglected. It should be underlined that the problem has become visible slightly more as more studies focused on household food security in developed countries have appeared. We investigated the food security of small-scale farm households in Poland, so we concentrated on a country and a group of households that are strongly neglected in contemporary research. Our results confirmed that food insecurity is an essential, underestimated and challenging problem in developed countries.

Moreover, there is a need to identify vulnerable households exposed to food insecurity and to carry out a systematic, continuous and repeatable survey of their food insecurity.

Results of our research, somewhat surprising, should motivate to launch the discussion about food insecure households in rural areas. They also point to the need for wider and more in-depth research on the lack of food security in developed countries, also among small farms. Conducted studies at the country level can be misleading, as the availability of food at the household level is not always correlated with the supply of food at the national level. It means that there is a need to focus on the household-level (socially vulnerable groups) when assessing the food and nutrition situation. Only then can one see the different household characteristics that determine the household risk of food insecurity, which is critical to formulating and assessing food security policy.

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Appendix A

Table A1. Descriptive statistics of the variables.

Variable	Mean	SD	Min	Max	Median	Description	Expected Sign (Influence on HFIAS Score)
Dependent variable							
HFIAS score	1.66	2.71	0	17	0	Count measure of the degree of food insecurity with the range from 0 to 27 based on the HFIAS questionnaire	
Explanatory variables							
Age	48.45	10.80	22.00	67.00	50.00	Age of farm manager	−/+
Family size	3.10	1.50	1.00	9.00	3.00	Number of household members	+
No. of children	0.60	0.96	0.00	5.00	0.00	Number of children in the household	+
Share of budgetary transfers in income	7.71	12.82	0.00	80.00	0.00	Share of budgetary transfers (incl. social assistance, pensions, 500+ and other benefits) in the total household income (incl. CAP), in%	−
Off-farm income share	10.22	17.28	0.00	80.00	0.00	Share of off-farm income in the total household income (incl. CAP), in%	−
Distance to market	12.11	7.52	0.00	54.00	11.00	Distance to the nearest town, in km	+
Market integration index	3.95	0.64	1.95	5.70	4.00	Count measure with the range from 0 to 6, based on various dimensions of market integration: distribution channels, sales contract, purchase contact, farmer's position in sales contract, farmer's position in purchase contract, portion of agricultural production sold	−
Land productivity	4913.94	6338.76	347.29	124,293.80	3636.41	Ratio of total farm output to agricultural area (PLN/ha)	−
Labor productivity	44,786.08	52,631.54	4200.00	493,500.00	30,135.43	Ratio of total farm output to number of Annual Work Unit (PLN/AWU)	−
Capital productivity	168,221.70	164,161.30	11,400.00	1,650,000.00	124,625.00	Ratio of total farm output to capital index (calculated as the weighted average of the farm assets divided by their average market price) (PLN)	−

Table A1. *Cont.*

Variable	Mean	SD	Min	Max	Median	Description	Expected Sign (Influence on HFIAS Score)
Dummy variables							
Variable	***n***	**%**				**Description**	
Gender							
Male	581	81.8				Gender of the farm manager	Male − Female +
Female	129	18.2					
Education							
Primary	41	5.8				Education of the farm manager	−
Vocational	560	78.9					
Secondary	21	3.0					
Higher	88	12.4					
Production type							
Field crops	268	37.8				Prevailing type of production	no research
Horticultural crops	36	5.1					
Permanent crops	26	3.7					
Dairy cows	46	6.5					
Other grazing livestock	77	10.9					
Granivores	27	3.8					
Mixed	230	32.4					
Disposable income per capita							
<162	140	19.7				Estimated monthly disposable income (from all sources) per family member, threshold of 162 euro is the official level of existence minimum in Poland in 2018	−
≥162	570	80.3					

Source: own calculations.

Table A2. Comparison between conventional Poisson regression and zero-inflated Poisson model—Akaike's information criterion and Bayesian information criterion.

Model	Obs	Ll (null)	Ll (model)	df	AIC	BIC
Poisson reg.	708	−1731.205	−1634.742	23	3315.485	3420.421
ZIP	708	−1241.193	−1199.98	25	2449.96	2564.021

Note: The ZIP model has smaller AIC and BIC values, thus it fits our data better than the standard Poisson model. Source: own calculations.

Table A3. Robustness check: socio-demographic (model 1) and farm-specific (model 2) determinants of food insecurity among small-scale farmers in Poland (zero-inflated Poisson regression model).

Variables	Model 1—Socio-Demographic Variables			Model 2—Farm-Specific Variables		
	Coef.	Std. Err.	*p*	Coef.	Std. Err.	*p*
HFIAS score model						
Age of farm manager (dummy): <40 ref.						
40−60	**−0.307**	**0.077**	**0.000**			
>60	**−0.419**	**0.118**	**0.000**			
Gender of farm manager (dummy): Female ref.						
Male	−0.106	0.078	0.176			
Education of farm manager (dummy): No or primary ref.						
Vocational	0.061	0.127	0.632			
Secondary	**−0.483**	**0.248**	**0.051**			
Higher	−0.264	0.170	0.120			
Number of household members (dummy): 1−2 ref.						
3−4	**0.178**	**0.082**	**0.030**			
5 and more	**0.445**	**0.105**	**0.000**			
Children under 18 in the household (dummy): No children ref.						
Yes	**−0.270**	**0.081**	**0.001**			
Share of budgetary transfers in income (%) (cont.)				0.002	0.002	0.349
Off-farm income share (%) (cont.)				0.000	0.002	0.872
Distance to market (km) (cont.)				−0.003	0.004	0.511
Market integration index (cont.)				0.066	0.053	0.213
Production type (dummy): Filed crops ref.						
Horticultural crops				0.179	0.204	0.379
Permanent crops				**0.413**	**0.154**	**0.007**
Dairy cows				**0.229**	**0.108**	**0.035**
Grassland animals				−0.154	0.119	0.197
Granivores				0.103	0.200	0.607
Mixed				−0.019	0.079	0.805
Land productivity (cont.)				**−0.037**	**0.013**	**0.003**
Labor productivity (cont.)				−0.001	0.001	0.438
Capital productivity (cont.)				0.000	0.000	0.817
cons	1.546	0.165	0.000	1.217	0.224	0.000

Table A3. *Cont.*

Variables	Model 1—Socio-Demographic Variables			Model 2—Farm-Specific Variables		
	Coef.	Std. Err.	*p*	Coef.	Std. Err.	*p*
Zero-Inflated model						
Disposable income per capita (euro) (dummy): <162 ref.						
≥162	**0.520**	**0.197**	**0.008**	**0.544**	**0.198**	**0.006**
cons	−0.239	0.176	0.175	−0.261	0.179	0.144
Model 1 Number of obs. = 710 Non-zero obs. = 312 Zero obs. = 398 Inflation model = logit LR chi2(22) = 46.01 Log likelihood = −1219.26 Prob > chi2 = 0.0000				Model 2 Number of obs. = 710 Non-zero obs. = 312 Zero obs. = 398 Inflation model = logit LR chi2(22) = 32.33 Log likelihood = −1225.16 Prob > chi2 = 0.0021		

Note: bolded parameters are significant at $p < 0.1$. Source: own calculations.

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