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What Do Romanian Farmers Think about the Effects of Pesticides? Perceptions and Willingness to Pay for Bio-Pesticides

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Abstract: Farmers' knowledge and perception of risks associated with pesticides are core issues in adopting sustainable behavior related to pesticides. This study aimed to find out if Romanian farmers' perceptions regarding the effects of conventional pesticides on pests, health, and the environment can predict farmers' willingness to replace conventional pesticides with bio ones and to pay a higher price for the latter. This is the first investigation of Romanian farmers' perceptions regarding pesticides, thus providing information useful both from the market and environmental protection perspectives. Binary logistic regression was performed to test the relationship between the perceived effect of pesticides, on the one side, and willingness to change conventional with bio-pesticides and willingness to pay for bio-pesticides, on the other side. It was found that the efficiency of conventional pesticides on combating pests and their effects on a farmer's health can predict farmer willingness to replace conventional approaches with bio-pesticides. Conclusions disclose entry points for interventions aimed at improving communication and information strategies at the country level for raising awareness of the adverse effects of pesticide products, both at the food consumer and farmer levels.

Keywords: bio-pesticides; farmers; perceptions; willingness to pay; willingness to replace

1. Introduction

Maintaining a sustainable quality of the environment in the context of population growth and of the increase of food needs is a topical issue of the agriculture–environment relationship [1–3]. It is self-evident that the use of pesticides and their impact on water, soil, air, and biodiversity is a worldwide challenge [4–6]. For example, the risk of falling numbers of pollinator colonies increases annually along with spraying of crops with new, chemically active substances persistent in the environment, leading to "pollination crisis" that causes the fall of crop yields [7], an alarming situation considering that, worldwide, 75% of crop species relay to some degree on animal pollinators [8]. A study of Williams et al. [9] demonstrated that in pesticide-exposed queens, reproductive anatomy and physiology were compromised. In the modern notion of integrated pest control, pesticides occupy an important position, especially the selective ones, and the use of chemicals in agriculture to reduce losses caused by diseases, pests, and weeds and to increase agricultural output is a topical challenge. The increased dependence on chemical pesticides was called "pesticide treadmill" [10] and it included two responses to pesticide resistance: increase of dose and of use frequency of the less-effective pesticides (which caused pest resistance) and development and commercialization of new pesticides [11].

Types of pesticides such as insecticides, herbicides, fungicides, and organophosphates represent large classes of pesticides used mainly in agricultural practices. The term "pesticides" refers to plant protection products as defined in Regulation No. 1107/2009 of the European Parliament and of the Council [12]. In the present paper, they are named "conventional pesticides" to differentiate them from bio-pesticides. The latter is a group of products that contain biocontrol agents—such as natural organisms or substances derived from natural materials, including their genes or metabolites—that are used to manage agricultural pests by means of specific biological effects rather than as broader chemical pesticides [13].

Using different groups of conventional pesticides leads to direct contamination and to intentional or unintentional exposure, with almost all people inevitably exposed. As a result, pesticides are involved in many cases of professional poisoning, intensifying concerns about their impact on human health. Memory loss, reduced speed of response to stimuli, poor motor skills, and reduced visual ability are neurological effects of human exposure to pesticides [14,15]. Endocrine, dermatological, gastrointestinal, carcinogenic, and reproductive effects of pesticide exposure are also often reported in the literature [12,14–20]. In this context, the adoption of solutions to reduce pesticide pollution and to increase the quality of farmers' and consumers' lives becomes strategic objectives at the European Union (EU) level. Thus, the EU Directive on the sustainable use of pesticides (SUD, Directive 2009/128/EC) [21] represents the framework towards the reduction of risks and impacts of pesticide use on human health and the environment, and for promoting the use of Integrated Pest Management (IPM). Based on this regulation, member states are obliged to set up National Action Plans that promote low-pesticide-input pest management and nonchemical methods, including integrated pest management and organic farming [22]. Of course, other EU pieces of legislation such as the Water Framework Directive, Groundwater Directive, Drinking Water Directive refer to pesticides. The Seventh Environment Action Programme [23] targets a sustainable use of plant protection products by 2020, which implies no harmful effects on human health or unacceptable influence on the environment.

Consumer sustainable behavior can be seen as the backbone of the sustainable society because of the role that consumers play in developed economies through the quantities of purchased products and the choices they make between available options. The diversity and complexity of consumer motivations that support their choices open the way to marketing interventions in favor of sustainable behavior [24]. From food to technology, or from cultural services to the living environment, consumers can always be guided towards more sustainable options. Thus, for example, marketing interventions can target motivations, given that consumers are driven to organic food by their health concerns or by social motives [25]; religious orientation supports more sustainable food consumption [26,27]; manipulation of visual and verbal horizons increases advertising effectiveness [28]; the size of the display area and quantity of displayed products increase the purchase of sustainable products [29]; sensory attributes influence consumers' willingness-to-pay for more natural products [30]; perception of water quality influences community well-being and choices [31]; awareness of a health risk related to indoor living environment stimulates people to pay more for safer options [32]. In relation to the subject of the current paper—pesticides, farmers' knowledge and perception of risks associated with pesticides are considered core issues in adopting a pesticide protection behavior [33,34]. Moreover, when developing pesticide hazard reduction programs, the first step should be directed towards investigating farmers' knowledge, attitudes, and behaviors on agricultural pesticide practices [35]. Farmers' perceptions on bio-pesticide use become even more important as, according to a Eurostat analysis [36] based on data available in 20 countries, Romania is ranked in the top of pesticide sales (after Spain, France, Italy, and Germany which are the main agricultural producers in the EU).

In response to this reality, it was considered that a study on farmers' perceptions of conventional pesticide effects is necessary as it forwards information related to farmers' decisions on the type of pesticides used and, implicitly, on possible effects on health and the environment [37]. To the authors' best knowledge, this is the first attempt to investigate Romanian farmers' perceptions and willingness to use and pay for bio-pesticides. Thus, the objectives of this study are:

(i) To identify Romanian farmers' behavior (actions and perceptions) related to conventional and bio-pesticides;

(ii) To find out if farmers' perceptions regarding the effects of conventional pesticides on pests, health, and the environment can predict farmer willingness to replace conventional pesticides with bio ones under equal price conditions;

(iii) To find out if farmers' perceptions regarding the effects of conventional pesticides on pests, health, and the environment can predict farmer willingness to pay a higher price for bio-pesticides.

The paper is organized as follows: After the Introduction, the Literature review section introduces the readership to the current state of pesticide use in Romania and it presents different aspects related to farmers' knowledge, attitudes, and practices regarding the use of pesticides at the global level. The Methodology section describes the study area and it presents the survey design and data collection methods. The Results and Discussion sections include the results obtained through the application of the questionnaire and their analysis in the context of the current market and environmental challenges. The Conclusions section presents several ways of reducing the negative effects of farmers' exposure to pesticides and it provides practical implications of the study.

2. Literature Review

In Romania, data on environmental contamination and human exposure to pesticides are still limited and most of the studies are mainly focused on organochlorine pesticide class. Organochlorine pesticides such as DDT (dichlorodiphenyltrichloroethane) have been banned for over 30 years (since 1985), while HCHs (hexachlorocyclohexanes) have been banned since 2002. Nevertheless, the results of a study of Cioroiu et al. [38] showed the presence of persistent, bioaccumulative, and toxic HCB (hexachlorobenzene), DDTs and HCHs in colostrum samples at concentrations that can impose public health concerns. Ene et al. [39] reported that, in southeast Romania, the level of PAH (polycyclic aromatic hydrocarbons), HCH, and DDT contamination is high according to the Romanian soil pollution legislation, mainly because of agricultural activities.

The need for research investigating the knowledge, perceptions, and behavior of farmers in relation to pesticides arises in the context of increased use of pesticides. Thus, the number of plant protection products marketed in Romania, in 2017, increased by 6.1% over the previous year [40]. The largest share of plant protection products is formed by herbicides (47.5%), followed by fungicides (39.8%), insecticides (8.2%), and other products for plant protection (4.5%) [40].

While there are several studies that refer to farmers' practices in relation to pesticides [39,41,42], there is a dearth of literature dedicated to Romanian farmers' perception regarding the effectiveness and hazards of conventional pesticides. Only one study focused on farmers' habits in relation to pesticides in small rural households, and it showed a lack of knowledge regarding environmental and health protection measures in pest control activities [43].

Unlike what has been investigated in Romania, globally, recognition of the amplified effects of pesticide use is reflected in a significant number of studies dedicated to farmers' behavior related to the use of pesticides, such as perceptions regarding health and environmental risks or their willingness to pay for healthier alternatives. Al Hasan et al. [44] investigated Ghanaian farmers' sources and choice of pesticides, their perception about the effectiveness of pesticides and their willingness to pay for a new bio-pesticide, and it was concluded that an effective, safer, and less-expensive alternative to chemical pesticides was needed. In Ethiopia, out of 719 interviewed farmers, 87.2% knew the pesticides by name and almost half of them were aware of at least one pest control method and of the negative effects of pesticide on animal health [45]. Jallow et al. [46] noted that even Kuwaiti farmers were aware of the impact of the pesticides on human health (71%) and on the environment (65%); they considered pesticides as indispensable for high crop yield (80%). In Tanzania, farmers' knowledge was not related to a perceived risk [47]. In India and Pakistan, the farmers were investigated on their awareness on health, knowledge on application of chemicals, storage, and disposal, the results being that even if they reported side effects of pesticide application, they never adopted full protective measures [48]. China, the largest consumer of pesticides in the world [49], surveyed farmers and retails from two typically agricultural areas, which showed limited awareness of the dangers of pesticides to human health and the environment [50]. The contribution of Schreinemachers et al. [51] was aimed at understanding farmers' knowledge, attitudes, and practices regarding the use of pesticides in Cambodia, Laos, and Vietnam. Their main findings contented that vegetable farms heavily depended on chemical pesticides for managing pests and that campaigns targeting reduction of pesticide dependence should be gender-sensitive as long as female farmers had an important role in pest management [51]. Waichman et al. [52] focused on the levels of farmers' understanding of pesticide handling, based on their ability to understand the information displayed on labels in the largest consumer of pesticides in Latin America—Brazil. In Turkey, 61 selected fruit-growers were interviewed to find their perceptions on the harmful effects of pesticides and to reveal their behavior regarding pesticide practices; the results suggested that characteristics such as education, age, or experience in agricultural activities influenced that behavior [53].

Coming closer to the area investigated in this study, in Europe, it was revealed that Greek farmers' knowledge of pesticides and beliefs about pesticide hazard control were associated with safety compliance [54]. A study that investigated farmers' perceptions and behaviors concerning the use of bio-pesticides in strawberry production in Italy, Germany, and Israel revealed that farmers were aware of the positive aspects of those products and they used biocontrol agents with different levels of satisfaction [55]. Remoundou et al. [56] assessed perceptions of risks associated with pesticide exposure in Greece, Italy, and the UK, targeting vulnerable stakeholders, and they found, for example, that operators and workers adopted self-protective behaviors.

At the European Union (EU) level, Common Agricultural Policy promotes the sustainable use of plant protection products through different channels: green direct payment, agro-environmental measures, cross-compliance rules, farm advisory system, or more direct payments that are no longer linked to production. Within the EU, it is considered that an optimal pesticide policy must include tax schemes that rely on standards for environmental and health quality and those taxes need classification according to toxic contents [57].

Even if significant progress has been made in relation to bio-pesticides efficiency, inconsistent field performance of these products persists, which, along with their higher costs, have generally relegated them to niche products [58]. Bio-pesticides are still considered by many farmers as unacceptable because they are evaluated for their immediate impact on pests [11]. Thus, bio-pesticides represent only 5% of the total plant protection market [59]. However, consumers demand healthier food products and the awareness of environmental impacts makes this ecofriendly alternative a solution for more sustainable agriculture and a proof towards the estimation of a bio-pesticide growth rate at 8.64% annually [59].

3. Materials and Methods

3.1. Description of the Study Area and Location of Interviewed Farmers

Romania is located in the southeastern part of Europe. Out of the total area of the country (238 391 km^2), around 87% of it is rural (207,522 km^2), 61.3% is represented by agricultural land (14.6 millions ha), 28.3% is covered by forests and other forestry vegetation lands, and 10.4% of the country area is occupied by the built area. Population living in rural territory represents 45% of Romania's total population and the highest share of rural population aged between 25 and 64 attended just secondary school (38.5%) [60].

3.2. Survey Design and Data Collection Methods

The study relies on a survey that used a convenience sample, for which we interviewed face-to-face a total of 126 farmers. Respondents were farmers that took part in agricultural events, such as fairs or exhibitions. An interview was requested to every third farmer that passed by a selected entry point of the fair and the resulting distribution of their farm location is marked in Figure 1.

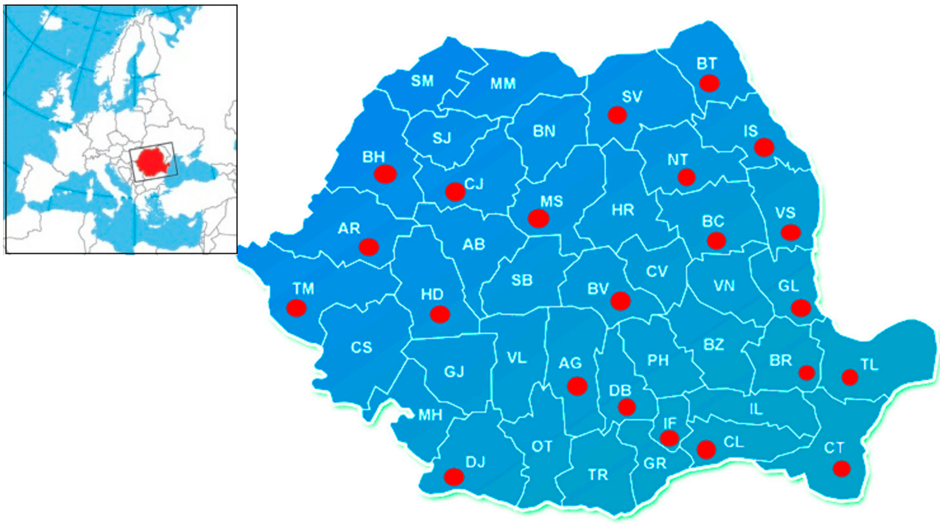

Figure 1. Study area and location of interviewed farmers on the Romania map.

Farmers' characteristics are presented in Table 1. The variables regarding their use of pesticides and their perceptions related to them were: perception of conventional pesticides effects on pests (not efficient/efficient), on farmer's health (negative/no negative effect), and on the environment (negative/no negative effect); willingness to replace conventional pesticides with bio-pesticides (yes/no); willingness to pay a higher price for bio-pesticides (yes/no); manifestation of conventional pesticides effects on their health after use (e.g., dizziness, headache, vomiting, itching, coughing, fever, diarrhea) (yes/no); type of measures taken to alleviate the symptoms generated by the use of conventional pesticides (seeing a doctor, self-care, no measure); awareness of bio-pesticides (yes/no); previous use of bio-pesticides (yes/no); perceived efficiency of bio-pesticides compared to conventional pesticides (better/not better); and decision criteria used to choose pesticides (ingredients, personal experience with the product, price, producer, warnings, friends' recommendations, seller's recommendations, and other).

The first question was a filter one aiming to select farmers that take decisions concerning the use of pesticides. All farmers who agreed to be interviewed responded "yes" to this question. The investigation of farmers' behavior took into account the following variables: awareness of manifestation of conventional pesticides effects on their health after use; type of measures taken to alleviate the symptoms generated by the use of conventional pesticides; awareness of bio-pesticides; previous use of bio-pesticides; perceived efficiency of bio-pesticides compared to conventional pesticides; and decision criteria used to choose pesticides. Farmers' perceptions regarding the effect of conventional pesticides were investigated by taking into account three reference points: the effect on pests (efficiency), the effect on farmer's health, and the effect on the environment. These were considered the main criteria that influence the decision to use pesticides, following the approach of Sharifzadeh et al. [61], who included the effectiveness of pesticide and pesticide hazards in the assessment of farmers' criteria for pesticide use. Also, prior to the elaboration of the questionnaire, three focus group sessions with 13 farmers in total were organized to observe which types of pesticide effects were taken into account by farmers. An open question was asked, asking them to say which categories of effects should be considered in relation to the use of pesticides. All participants indicated effects on pests, on human health, and on the environment. Two of them also mentioned the effect of farmers' budget and one named separately the effect on farmers' health and the effect on food consumers' health. The authors asked them to evaluate the effect of pesticides on soil, water, air, and biodiversity, separately. We observed that it was difficult for them to make a clear difference between the effects of various components of the natural environment (air, water, soil, biodiversity). Consequently, only one general question about the environment was introduced in the questionnaire. A first draft of the questionnaire (which included the five questions about pesticides) was tested on a sample of 17 farmers. All questions were kept, but their wording was improved based on the pre-test results. Some variables were collected using 5-point Likert scales and they were transformed into dichotomous variables for the analysis. Willingness to pay is usually investigated by asking whether consumers are willing to pay a higher price, by asking them to choose among several price intervals, or by using an open-ended question about how much more are they willing to pay for a product.

Table 1. Characteristics of the sample.

Variable	Frequency	Mean	Standard Deviation
Gender (% men)	94	-	-
Age (years) (M/SD)	-	50.5	12.2
Type of farmer (%)		-	-
Young farmer (up to 35 years old)	10.3	-	-
Member of agricultural cooperatives and of farmers associations	4	-	-
Beneficiaries of climate, environment, and organic agriculture subsidies	2.4	-	-
None of the above	83.3	-	-
Type of culture (%)		-	-
Cereals (maize, wheat, barley, oat, two-rowed barley)	84.1	-	-
Vegetables, leguminous plants, tubers and non-tree-fruits (cucumbers, tomatoes, potatoes, leek, carrots, garlic, onion, cabbage, green peas, beans, zucchini, watermelon, parsnip, parsley, turnip, etc.)	29.4	-	-
Technical plants (sunflower, rape, sugar beet, soy)	80.2	-	-
Fruit trees and shrubs	12.7	-	-
Alfalfa	17.5	-	-
Other (vine, lavender, medicinal herbs, seedlings)	11.1	-	-
Cultivated area (ha) (M/SD)	-	413.9	1364.9

Chi-square test was used to explore differences between pairs of the following variables: the effect of conventional pesticides on pests, their effect on farmer's health, and their effect on the environment. Also, the chi-square test was applied to find out if there was a difference regarding perceptions of the effect of bio-pesticides compared to conventional ones between people who previously used bio-pesticides and those who did not. Binary logistic regression was performed using SPSS to test the relationship between the perceived effect of pesticides—on pests (efficiency), on farmers' health, and on the environment, on the one side, and willingness to change conventional pesticides with bio-pesticides, on the other side. This regression was used because the dependent and independent variables were coded as dichotomous variables. Also, binary logistic regression was run to observe whether the effects of conventional pesticides on health and environment influence the willingness to pay for bio-pesticides (Figure 2).

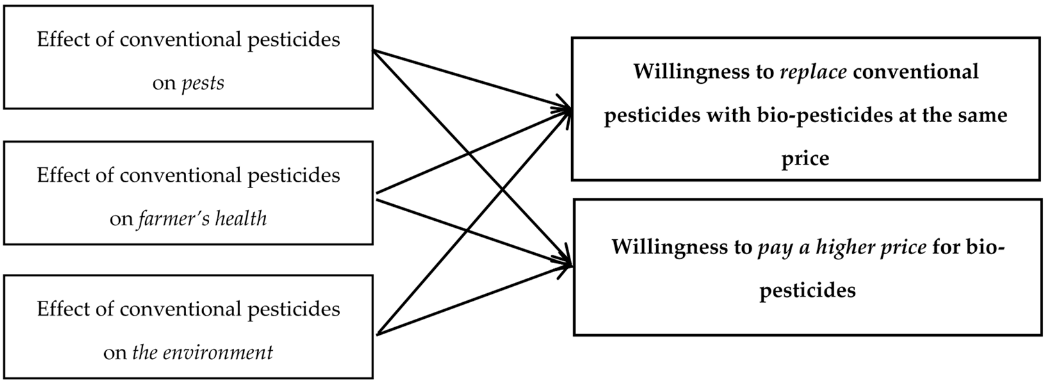

Figure 2. Hypothesized model of determinants of willingness to replace conventional pesticides with bio ones at the same price and of willingness to pay a higher price for bio-pesticides.

4. Results

Farmers' perceptions related to pesticides and their use are presented in Table 2. Definitions of pesticides and bio-pesticides were provided to them to ensure a common understanding of these concepts among sample members.

Table 2. Farmers' actions and perceptions related to pesticides.

Variable	% of the Total Sample
Effect of conventional pesticides on pests	
1 = perceives conventional pesticides as inefficient on pests	6.3
0 = perceives conventional pesticides as efficient on pests	93.7
Effect of conventional pesticides on farmer's health	
1 = perceives conventional pesticides as having a negative effect on farmer's health	31.2
0 = perceives conventional pesticides as having an acceptable/good effect on farmer's health	68.8
Effect of conventional pesticides on the environment	
1 = perceives conventional pesticides as having a negative effect on the environment	31.0
0 = perceives conventional pesticides as having an acceptable/good effect on the environment	69.0
Willingness to replace conventional with bio-pesticides	
1 = Yes	69.8
0 = No	30.2
Willingness to pay for bio-pesticides	
1 = Yes	54.8
0 = No	45.2
Efficiency of bio-pesticides compared to conventional pesticides	
Better or the same	73.0
Effect of direct pesticides use on farmer health	
Felt sick (vs. no effect)	24.6
Action taken in case farmer felt sick (% of the 31 farmers who felt sick)	
Saw a doctor	41.9
Self-care	45.1
Nothing	13.0
Awareness regarding the existence of bio-pesticides	
Yes	81.2
Previous use of bio-pesticides	
Yes	17.5
Factors with the highest influence on farmer's choice of pesticides (max. 3 selected of all choices)	
Ingredients—judged by their efficiency on pests	54.8
Ingredients—judged by their impact on their health	12.7
Ingredients—judged by their impact on the environment	2.4
Personal experience with the product from previous use	38.9
Price	72.2
Producer	41.3
Warnings regarding the effects of the product (on the package)	4.0
Friends' recommendations	42.9
Seller's recommendations	26.2
Other factors	0.0

Chi-square test revealed that there was not a statistically significant difference between the share of farmers who considered conventional pesticides efficient on pests and those who did not, according to their perception on the effect on nature (negative effect vs. no negative effect) ($p = 0.079$). Similarly, there was not a statistically significant difference between the share of farmers who considered conventional pesticides efficient on pests and those who did not, according to their perception of the effect on their health (negative effect vs. no negative effect) ($p = 0.093$). However, a statistically significant difference was observed between the share of farmers who perceived a negative effect on nature and those who did not, according to the perceived effect on their health ($p < 0.001$). Also, 83.3% of farmers who did not perceive a negative effect on their health did not perceive it on nature either, while 16.7% did. Also, 71.4% of farmers who perceived a negative effect on their health considered that conventional pesticides had a negative effect on the natural environment, too, while 28.6% did not see a negative effect.

Chi-square test indicated that there was not a statistically significant difference between farmers who considered that bio-pesticides are more effective than the conventional ones and those who did not, according to their previous use of bio-pesticides ($p = 0.060$).

The first regression analysis tested how well three perception variables (effects of pesticides on pests, farmers' health and the environment) can predict farmers' "willingness to replace conventional pesticides with bio-pesticides" when they have the same price. The Omnibus Tests of Model Coefficients, which show how well the model performs, generated a highly significant value ($p < 0.005$) and a chi-square value of 20.888 with 3 degrees of freedom. The values obtained through the Hosmer and Lemeshow Test support the model, too, with a good fit revealed by a p value greater than 0.05 ($p = 0.344$). The Cox & Snell R Square and the Nagelkerke R Square values show that between 15.3% and 20.5% of the variability in the willingness to replace conventional with bio-pesticides is explained by the perceived efficiency of conventional pesticides and by their effects on farmers' health. The variables that contribute significantly to the predictive ability of the model are the "effect of conventional pesticides on pests" and the "effect of conventional pesticides on farmers' health." The "effect of conventional pesticides on nature" did not have predictive power (Table 3; Figure 3).

Table 3. Results of binary logistic regression analysis for the impact of perceptions regarding the effect of conventional pesticides on willingness to replace them with bio-pesticides.

Independent Variable	Dependent Variable	B	S.E.	Wald	df	*p*	OR
Perceived effect of conventional pesticides on pests (their efficiency)	Willingness to replace conventional pesticides with bio-pesticides at the same price	2.394	1.098	4.751	1	0.029	10.955
Perceived effect of conventional pesticides on farmer's health		1.472	0.499	8.704	1	0.003	4.356
Perceived effect of conventional pesticides on the environment		0.399	0.477	0.698	1	0.404	1.490
Constant		−0.448	0.251	3.175	1	0.075	0.639

Note: B is Regression Coefficient; S.E. is Standard Error; Wald is Wald Statistic; df is degree of freedom; p is Significance; OR is odds ratio.

A second binary logistic regression test was run to predict farmers' "willingness to pay for bio-pesticides" from their perceptions of the effect of pesticides on farmers' health and on the environment. The "efficiency of conventional pesticides on pests" was not introduced in the model because we did not obtain significant value for the univariate analysis, performed previously to the logistic regression (between the "effect on pests" and "willingness to pay a higher price"). The Omnibus Tests of Model Coefficients, which show how well the model performs, generated a highly significant value ($p < 0.005$) and a chi-square value of 30.077 with 3 degrees of freedom. The values obtained through the Hosmer and Lemeshow Test support the model, too, with a good fit revealed by a p value greater than 0.05 (p = 0.734). The Cox & Snell R Square and the Nagelkerke R Square values show that between 21.2% and 29.9% of the variability in the willingness to pay a higher price for bio-pesticides is explained by the perceived effects of conventional pesticides on farmers' health. There is only one variable that contributes significantly to the predictive ability of the model, which is the "effect of conventional pesticides on farmers' health." The "effect of conventional pesticides on nature" did not have predictive power on "willingness to pay a higher price for bio-pesticides" (Table 4; Figure 3).

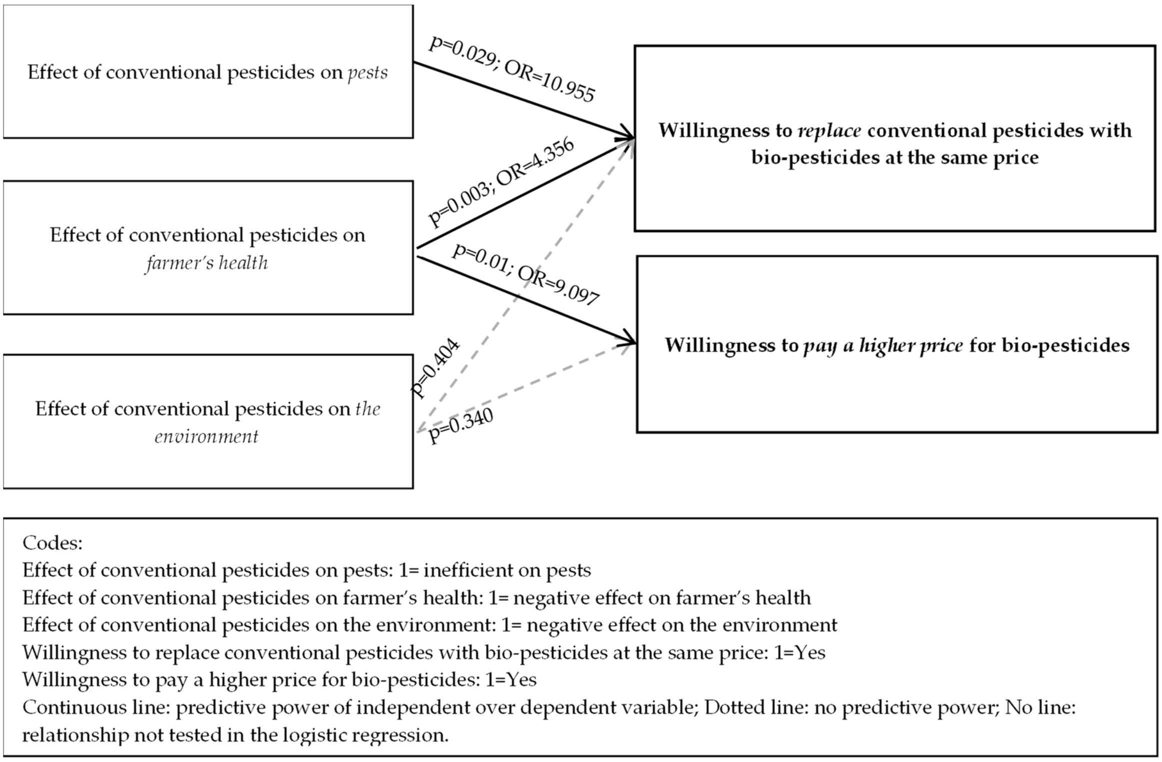

Figure 3. Model of observed determinants of willingness to replace conventional pesticides with bio ones at the same price and of willingness to pay a higher price for bio-pesticides, based on the results of logistic regression.

Table 4. Results of binary logistic regression analysis for the impact of perceptions regarding the effect of conventional pesticides on willingness to pay a higher price for bio-pesticides.

Independent Variable and Intercept	Dependent Variable	B	S.E.	Wald	df	*p*	OR
Perceived effect of conventional pesticides on farmer's health	Willingness to pay a higher price for bio-pesticides	2.206	0.687	10.302	1	0.001	9.079
Perceived effect of conventional pesticides on the environment		0.521	0.546	0.910	1	0.340	1.684
Constant		0.012	00.250	0.002	1	0.963	1.012

Note: B is Regression Coefficient; S.E. is Standard Error; Wald is Wald Statistic; df is degree of freedom; *p* is Significance; OR is odds ratio.

5. Discussion

The efforts in developing a technical solution to reduce the negative impact of chemicals used in agriculture represent only one part of the solution for sustainable agriculture. There are at least other two directions that must be considered. One refers to the legal framework that can stimulate or deter the use of environmentally friendly alternatives [62]. The other one is represented by consumer contribution in adopting sustainable product options. Most often, convincing consumers to consider sustainable products, such as bio-pesticides or natural fertilizers, requires extended research efforts to understand their needs, motivations, or hindering factors [63–65]. Conventional pesticides are considered efficient by 81.7% of interviewed farmers (Table 2), which can become a hindering factor for the transition to bio-pesticides. This poses a double challenge to bio-pesticides: to be objectively effective and to be perceived as such by their users. The perceived negative effects of conventional pesticides on health and on the environment are rather weak (with one-third of farmers perceiving them, Table 2). Therefore, at the sample level, they do not represent a potential strong incentive to search for an alternative solution. In China, a similar perception of the negative effect on the environment was present, too, because farmers did not believe that environmental pollution could be mitigated by reducing the use of pesticides [66]. Although it may be considered at first sight that it is encouraging to have over half of the sample willing to replace conventional pesticides with bio-pesticides or to pay more for the latter, these percentages should be treated with caution because the intensity of the willingness is not revealed and the exact amount of additional money they agree to pay is not indicated either. Future research can test the intensity of willingness to pay various prices (for instance, on a scale from "I am certain I will not pay it" to "I am certain I will pay it").

Relatively small shares of Romanian farmers perceive the negative effects of conventional pesticides on their health and on the environment (Table 2), which suggests that more must be done in order to induce a correct understanding of the positive and negative sides of conventional pesticides utilization. In line with these results are those published by Khan et al. [67], who reported that most farmers (64%) from an important Pakistani agricultural area considered that the risk from pesticides was inexistent or small.

On the one hand, a positive feature of pesticide consumers is that the majority is aware of the existence of bio-pesticides, but, on the other hand, the downside is that only a small share used them. This suggests that marketing efforts should be directed towards stimulating the use of the product, rather than raising awareness on its existence. However, in the case of pesticides, convincing a farmer to try the product has to overcome the barrier of the perceived risk of use. Here, the lack of efficiency generates not only the financial loss represented by the purchasing price but also a more important one, the loss generated by crop destruction by pests in case the new product does not generate the promised effect. Therefore, especially the latter risk must be mitigated through marketing measures, for example, selling a combined product formed by pesticides and insurance at a promotional price that covers the risk of pest attacks. The effect of this action is also supported by their concern for the price (Table 2). The second-most important factor in farmers' buying decision is the efficiency of ingredients on combating pests, suggesting that the promotion of bio-pesticides should highlight the content in specific ingredients and compare their efficiency with the efficiency of the ingredients already appreciated by farmers for their power to protect crops against pests.

The first binary logistic regression analysis showed that the perceived practical efficiency of conventional pesticides and their perceived effect of farmers' health have a good prediction capacity of farmers' willingness to replace conventional pesticides (Table 4). However, the environmental concern does not contribute to the prediction of the mentioned behavior. Capacity to control pest was an important decision factor regarding the use of pesticides for farmers in other countries, too. For instance, in China, it was observed that almost 68% of a sample of vegetable farmers would like to use them if they had similar controlling effects on pests to conventional pesticides (even if farmers had low knowledge of bio-pesticides) [53]. The model revealed that the direction of the relationship between the effect of conventional pesticides on pests (0 = efficient, 1 = not efficient) and willingness to replace them with bio-pesticides (1 = willing to replace, 0 = not willing to replace) is as follows: farmers who perceive conventional pesticides as inefficient are more likely to replace them with the bio ones. Also, farmers who perceive the negative effect of conventional pesticides on their health are more likely to replace them with bio-pesticides. The efficiency of conventional pesticides plays an important factor in replacement willingness because the odds of a farmer being willing to replace conventional with bio-pesticides are 11 times higher for persons who perceive conventional pesticides as inefficient compared to farmers who perceive them as efficient (Table 3). This perception of efficiency is influenced by various factors, for instance, expected results, previous experience, and knowledge about the efficiency of similar products. Some of them can be influenced through marketing measures, such as the modification of expected results and of perceptions regarding the efficiency of alternative solutions. The odds of a farmer being willing to replace conventional with bio-pesticides are four times higher for persons who consider that conventional pesticides have a negative effect on their health compared to farmers who do not see such an effect, all other factors being equal (Table 3). This behavior suggests that the preference for bio-pesticides can be stimulated by increasing farmers' awareness of the negative impact of conventional pesticides on their health.

In the case of willingness to pay more, only perceptions of the effect of conventional pesticides on farmers' health had a good prediction capacity, thus indicating that this one should be used in information-education campaigns to increase farmers' willingness to pay for bio-pesticides. Health concern seems to be a widely spread factor that stimulates the willingness to pay for sustainable pesticides, as mentioned in numerous studies. Thus, a survey carried out in Pakistan showed that the higher the risk of pesticides on health perceived by farmers, the higher the willingness to pay a premium for safe pesticides [68]. In Nicaragua, farmers were willing to pay up to 28% of pesticide expenditure to avoid health risks [69]. In China, farmers were willing to pay more for health risk reduction associated with pesticide use [70]. Nepalese farmers were willing to pay between 53% and 79% to protect both their health and the environment [71]. There are also variables besides health and environment that can predict willingness to pay for healthier pesticides alternatives, such as education, risk perception, social trust, and social networks use, which were proved significant in a study on Chinese farmers [70].

The second binary logistic regression model showed that the direction of the relationship between the effect of conventional pesticides on farmers' health (1 = negative, 0 = no negative effect) and willingness to pay a higher price for bio-pesticides (1 = willing to pay, 0 = not willing to pay) is positive given the assigned codes. Farmers who perceive the negative effect of conventional pesticides on their health are more likely to pay a higher price for them compared to the price of conventional pesticides. The odds of a farmer being willing to pay a higher price for bio-pesticides are nine times higher for persons who consider that conventional pesticides have a negative effect on their health compared to farmers who do not see such an effect, all other factors being equal (Table 4). Taking into account this influence of farmers' concern for health and the fact that price is very important in their buying decision (Table 2), marketers should frame the price of bio-pesticides in a way that covers both. For example, they can show how an increase in the bio-pesticides price is compensated by a decrease in expenses with the medication necessary to restore their health after using conventional pesticides.

From a consumer behavior perspective, two main paths can be envisaged to support the consumption of a sustainable alternative of pesticides: one targeting farmers as direct consumers of bio-pesticides and one targeting food consumers, as indirect consumers of bio-pesticides.

The direction dedicated to farmers has, at its turn, two components: one related to the real efficiency of bio-alternatives and one related to the impact of pesticides on health and the environment. So, firstly, one of the main hindering factors of bio-pesticides use is their low efficiency compared to the one of the conventional pesticides [72,73]. From a consumer behavior research perspective, farmers are potential consumers of bio-pesticides. When they buy a product, consumers buy, in fact, the solution to a problem they have [74]. The fact that more than half of the farmers mentioned pesticides' efficiency on pests as one important factor for buying them (while only 12.7% and 2.4%, respectively, selected health and environmental concerns), shows that the problem of farmers (as consumers of pesticides) is the damage to their crops caused by pests and not their health or environmental damage generated by conventional pesticides (Table 2). In this context, the efficiency of the product in combating pests prevails in front of other attributes. Therefore, the challenge is to create more effective alternatives of bio-pesticides, to make them available on the market and to inform farmers about their existence and benefits. Secondly, communication efforts directed to farmers must be made to improve their perception of bio-pesticides by raising awareness on the negative impact of the conventional ones on health and on the environment, and also by bringing reliable arguments that support their effectiveness. Information–education campaigns are important for sustainable agriculture, as it was already shown in other studies that trained farmers were aware to a higher degree of pesticides' harmful effects on health than non-trained ones [54]. In China, one of the world's largest users of pesticides, participants in a survey had some knowledge on the effect of pesticides and they felt that they were at risk when using pesticides [75]. Consequently, strengthening the education of farmers in relation to pesticide use and their sense of environmental protection can contribute to sustainable agricultural practices [76].

The second approach targets consumers of agricultural products (e.g., food consumers), in the view of making them aware of the benefits of bio-pesticides and of determining them to appreciate those farmers and foods that use bio-pesticides. Studies have shown that consumers who appreciated products with less pesticide are willing to pay more for them, such as a sample of consumers from Benin, who were willing to pay a price premium of 38% for cabbage with lower pesticide residues [77].

The results presented in this paper must be interpreted in the context of their limitations. Thus, the use of a non-representative sample limits the validity of the results to the population tested. Results rely on self-reports and, thus, because of the desire of reporting socially desirable behaviors and the attitude–behavior gap, real behaviors may differ from declared ones. Future research directions should consider a representative sample at the country level and the investigation of a larger number of variables (including economic, social, and policy ones) that can predict more accurately the willingness to replace conventional pesticides and willingness to pay for bio-pesticides. This contribution presented only farmers' willingness to pay a higher price for bio-pesticides and future research should use various price intervals and more complex statistical analysis to evaluate more accurately how much they are willing to pay for this product. Also, a deeper investigation of the use of conventional pesticides (types, quantity, and way of use) is needed to understand their real effect on pests, farmers' health, and the environment.

6. Conclusions

The findings of the present study disclose entry points for interventions aimed at improving communication and information strategies targeting farmers (as consumers of pesticides) at the country level for raising awareness on the adverse effects of conventional pesticides products. By investigating for the first time Romanian farmers' perception regarding the effects of conventional pesticides on health and environment, and their efficiency, this study offers new information about the image of pesticides in their consumers' minds, thus showing the distance between this image and the desired one.

Tested models revealed that farmers were willing to replace conventional with bio-pesticides when the former were perceived as inefficient on pests and as damaging farmers' health. At the same time, farmers were willing to pay a higher price for bio-pesticides when they considered that the conventional ones negatively affected their health. It can also be inferred that the perceived harmful effects of conventional pesticides on the environment did not determine whether surveyed farmers would replace conventional pesticides or pay more for the bio ones, thus profiling a group of pesticide consumers which are not environment-oriented.

The analysis of the influence of conventional pesticides perception on farmers' willingness to adopt bio-pesticides represents an indicator for marketers that reveals what type of intervention is necessary to be made: change of perception regarding conventional pesticides effects, of farmers' intention regarding bio-pesticides use and acquisition, and, finally, change of actual purchase and use of bio-pesticides. The results of the analysis, which show that approximately 70% of interviewed farmers do not recognize the effects of conventional pesticides on their health and on the environment should be regarded as a red flag that shows that one main direction of any strategic plan dedicated to pesticide control must be farmers' informed choice. In line with the outcomes of the present contribution, it is mandatory to develop an effective agro-environmental and health strategy that supports the sustainable use of authorized bio-pesticides. Relying on the present study results, marketers and policymakers should step up efforts that will incorporate the perceptions highlighted here to stimulate the transition to bio-pesticides and to increase farmers' willingness to pay for them.

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References

1. Godfray, H.C.J.; Beddington, J.R.; Crute, I.R.; Haddad, L.; Lawrence, D.; Muir, J.F.; Pretty, J.; Robinson, S.; Thomas, S.M.; Toulmin, C. Food security: The challenge of feeding 9 billion people. *Science* **2010**, *327*, 812–818. [CrossRef] [PubMed]
2. Godfray, H.C.J.; Garnett, T. Food security and sustainable intensification. *Philos. Trans. R. Soc. B Biol. Sci.* **2014**, *369*, 20120273. [CrossRef] [PubMed]
3. Yu, J.; Wu, J. The sustainability of agricultural development in China: The agriculture–environment nexus. *Sustainability* **2018**, *10*, 1776. [CrossRef]
4. Brzozowski, L.; Mazourek, M. A sustainable agricultural future relies on the transition to organic agroecological pest management. *Sustainability* **2018**, *10*, 2023. [CrossRef]
5. Carvalho, F.P. Pesticides, environment, and food safety. *Food Energy Secur.* **2017**, *6*, 48–60. [CrossRef]
6. Van der Werf, H.M. Assessing the impact of pesticides on the environment. *Agric. Ecosyst. Environ.* **1996**, *60*, 81–96. [CrossRef]
7. Goulson, D.; Nicholls, E.; Botías, C.; Rotheray, E.L. Bee declines driven by combined stress from parasites, pesticides, and lack of flowers. *Science* **2015**, *347*, 1255957. [CrossRef]
8. Stein, K.; Coulibaly, D.; Stenchly, K.; Goetze, D.; Porembski, S.; Lindner, A.; Konaté, S.; Linsenmair, E.K. Bee pollination increases yield quantity and quality of cash crops in Burkina Faso, West Africa. *Sci. Rep.* **2017**, *7*, 17691. [CrossRef]
9. Williams, G.R.; Troxler, A.; Retschnig, G.; Roth, K.; Yañez, O.; Shutler, D.; Neumann, P.; Gauthier, L. Neonicotinoid pesticides severely affect honey bee queens. *Sci. Rep.* **2015**, *5*, 14621. [CrossRef]
10. Van den Bosch, R. *The Pesticide Conspiracy*; Univ of California Press: Berkeley, CA, USA, 1989; ISBN 0-520-90974-7.
11. Popp, J.; Pető, K.; Nagy, J. Pesticide productivity and food security. A review. *Agron. Sustain. Dev.* **2013**, *33*, 243–255. [CrossRef]
12. The European Parliament and the Council Regulation (EC) No 1107/2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC 2009. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32009R1107 (accessed on 26 April 2019).
13. Sporleder, M.; Lacey, L.A. Biopesticides. In *Insect Pests of Potato: Biology and Management*; Elsevier: Amsterdam, The Netherlands, 2013; pp. 463–497.
14. Sarwar, M. The dangers of pesticides associated with public health and preventing of the risks. *Int. J. Bioinform. Biomed. Eng.* **2015**, *1*, 130–136.
15. Li, Y.; Zhang, C.; Yin, Y.; Cui, F.; Cai, J.; Chen, Z.; Jin, Y.; Robson, M.; Li, M.; Ren, Y. Neurological effects of pesticide use among farmers in China. *Int. J. Environ. Res. Public Health* **2014**, *11*, 3995–4006. [CrossRef] [PubMed]

16. Blair, A.; Grauman, D.J.; Lubin, J.H.; Fraumeni, J.F., Jr. Lung cancer and other causes of death among licensed pesticide applicators. *J. Natl. Cancer Inst.* **1983**, *71*, 31–37. [PubMed]
17. Alavanja, M.C.; Ross, M.K.; Bonner, M.R. Increased cancer burden among pesticide applicators and others due to pesticide exposure. *CA A Cancer J. Clin.* **2013**, *63*, 120–142. [CrossRef] [PubMed]
18. Gunnell, D.; Eddleston, M.; Phillips, M.R.; Konradsen, F. The global distribution of fatal pesticide self-poisoning: Systematic review. *BMC Public Health* **2007**, *7*, 357. [CrossRef] [PubMed]
19. Mwanga, H.; Dalvie, M.; Singh, T.; Channa, K.; Jeebhay, M. Relationship between pesticide metabolites, cytokine patterns, and asthma-related outcomes in rural women workers. *Int. J. Environ. Res. Public Health* **2016**, *13*, 957. [CrossRef] [PubMed]
20. Georgescu, B.; Georgescu, C.; Coşier, V.; Mierliţă, D.; Mag, I. Pesticides with endocrine disrupting activities: Description and screening strategies. *Bull. Univ. Agric. Sci. Vet. Med. Cluj-Napoca–Anim. Sci. Biotechnol.* **2005**, *61*, 184–187.
21. The European Parliament and of the Council Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0128&from=EN (accessed on 26 April 2019).
22. European Environmental Agency. Pesticide Sales-Briefing. Available online: https://www.eea.europa.eu/airs/2018/environment-and-health/pesticides-sales (accessed on 26 April 2019).
23. The European Parliament and of the Council Decision No 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 “Living well, within the limits of our planet”. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013D1386 (accessed on 26 April 2019).
24. Vermeir, I.; Verbeke, W. Sustainable food consumption: Exploring the consumer “attitude–behavioral intention” gap. *J. Agric. Environ. Ethics* **2006**, *19*, 169–194. [CrossRef]
25. Petrescu, D.C.; Petrescu-Mag, R.M. Organic food perception: Fad, or healthy and environmentally friendly? A case on Romanian consumers. *Sustainability* **2015**, *7*, 12017–12031. [CrossRef]
26. D’Haene, E.; Desiere, S.; D’Haese, M.; Verbeke, W.; Schoors, K. Religion, food choices, and demand seasonality: Evidence from the Ethiopian milk market. *Foods* **2019**, *8*, 167. [CrossRef]
27. Petrescu-Mag, R.M.; Petrescu, D.C.; Robinson, G.M. Adopting temperance-oriented behavior? New possibilities for consumers and their food waste. *J. Agric. Environ. Ethics* **2019**, *32*, 1–22. [CrossRef]
28. Roose, G.; Vermeir, I.; Geuens, M.; Van Kerckhove, A. A match made in heaven or down under? The effectiveness of matching visual and verbal horizons in advertising. *J. Consum. Psychol.* **2019**. [CrossRef]
29. Coucke, N.; Vermeir, I.; Slabbinck, H.; Van Kerckhove, A. Show Me More! The Influence of Visibility on Sustainable Food Choices. *Foods* **2019**, *8*, 186. [CrossRef] [PubMed]
30. Hung, Y.; Verbeke, W. Sensory attributes shaping consumers’ willingness-to-pay for newly developed processed meat products with natural compounds and a reduced level of nitrite. *Food Qual. Prefer.* **2018**, *70*, 21–31. [CrossRef]
31. Withanachchi, S.; Kunchulia, I.; Ghambashidze, G.; Al Sidawi, R.; Urushadze, T.; Ploeger, A. Farmers’ perception of water quality and risks in the Mashavera river basin, Georgia: Analyzing the vulnerability of the social-ecological system through community perceptions. *Sustainability* **2018**, *10*, 3062. [CrossRef]
32. Petrescu, D.C.; Petrescu-Mag, R. Setting the scene for a healthier indoor living environment: Citizens’ knowledge, awareness, and habits related to residential radon exposure in Romania. *Sustainability* **2017**, *9*, 2081. [CrossRef]
33. Aldosari, F.; Mubushar, M.; Baig, M.B. Assessment of farmers knowledge on pesticides and trainings on pesticide waste management in central Punjab–Pakistan. *J. Exp. Biol. Agric. Sci.* **2018**, *6*, 168–175. [CrossRef]
34. Mekonnen, Y.; Agonafir, T. Pesticide sprayers’ knowledge, attitude and practice of pesticide use on agricultural farms of Ethiopia. *Occup. Med.* **2002**, *52*, 311–315. [CrossRef]
35. Koh, D.; Jeyaratnam, J. Pesticides hazards in developing countries. *Sci. Total Environ.* **1996**, *188*, S78–S85. [CrossRef]
36. European Comission. Sales of Pesticides in the EU. Available online: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20181015-1 (accessed on 26 April 2019).
37. Ntow, W.J.; Gijzen, H.J.; Kelderman, P.; Drechsel, P. Farmer perceptions and pesticide use practices in vegetable production in Ghana. *Pest Manag. Sci. Former. Pestic. Sci.* **2006**, *62*, 356–365. [CrossRef]

38. Cioroiu, M.; Tarcau, D.; Mocanu, R.; Cucu-Man, S.; Nechita, B.; Luca, M. Organochlorine pesticides in colostrums in case of normal and preterm labor (IASI, Romania). *Sci. Total Environ.* **2010**, *408*, 2639–2645. [CrossRef] [PubMed]
39. Ene, A.; Bogdevich, O.; Sion, A. Levels and distribution of organochlorine pesticides (OCPs) and polycyclic aromatic hydrocarbons (PAHs) in topsoils from SE Romania. *Sci. Total Environ.* **2012**, *439*, 76–86. [CrossRef] [PubMed]
40. Romanian Instiutute of Statistics. *Pesticide plasate pe piata in anul 2017 [Pesticides on the market in 2017]*; Romanian Instiutute of Statistics: Bucharest, Romania, 2018.
41. Toma, L. Analysis of Environmental Impact of Farming Systems in Romania. Agri-Environmental Indicators. In *Sustainable Agriculture in Central and Eastern European Countries: The Environmental Effects of Transition and Needs for Change*; Shaker Verlag: Aachen, Germany, 2002.
42. Toma, L.; Mathijs, E. Environmental risk perception, environmental concern and propensity to participate in organic farming programmes. *J. Environ. Manag.* **2007**, *83*, 145–157. [CrossRef] [PubMed]
43. Gurzau, A.E.; Coman, A.; Gurzau, E.S.; Penes, M.; Dumitrescu, D.; Marchean, D.; Chera, I. pesticides use in Rural Settings in Romania. *World Acad. Sci. Eng. Technol.* **2008**, *2*, 802–804.
44. Al Hasan, R.; Jatoe, J.B.D.; Egyir, I.S. Biopesticides in Ghana: Vegetable farmer's perception and willingness to pay. *IUP J. Agric. Econ.* **2010**, *7*, 17–32.
45. Gesesew, H.A.; Woldemichael, K.; Massa, D.; Mwanri, L. Farmers knowledge, attitudes, practices and health problems associated with pesticide use in rural irrigation villages, Southwest Ethiopia. *PLoS ONE* **2016**, *11*, e0162527. [CrossRef] [PubMed]
46. Jallow, M.; Awadh, D.; Albaho, M.; Devi, V.; Thomas, B. Pesticide knowledge and safety practices among farm workers in Kuwait: Results of a survey. *Int. J. Environ. Res. Public Health* **2017**, *14*, 340. [CrossRef] [PubMed]
47. Lekei, E.E.; Ngowi, A.V.; London, L. Farmers' knowledge, practices and injuries associated with pesticide exposure in rural farming villages in Tanzania. *BMC Public Health* **2014**, *14*, 389. [CrossRef]
48. Probst, L.; Adoukonou, A.; Amankwah, A.; Diarra, A.; Vogl, C.R.; Hauser, M. Understanding change at farm level to facilitate innovation towards sustainable plant protection: A case study at cabbage production sites in urban West Africa. *Int. J. Agric. Sustain.* **2012**, *10*, 40–60. [CrossRef]
49. Hongsong, W.; Yunyue, W. Factors influencing indigenous rice protection in the Yuanyang terraced rice fields of China. *J. Resour. Ecol.* **2017**, *8*, 287–296. [CrossRef]
50. Yang, X.; Wang, F.; Meng, L.; Zhang, W.; Fan, L.; Geissen, V.; Ritsema, C.J. Farmer and retailer knowledge and awareness of the risks from pesticide use: A case study in the Wei River catchment, China. *Sci. Total Environ.* **2014**, *497*, 172–179. [CrossRef] [PubMed]
51. Schreinemachers, P.; Chen, H.; Nguyen, T.T.L.; Buntong, B.; Bouapao, L.; Gautam, S.; Le, N.T.; Pinn, T.; Vilaysone, P.; Srinivasan, R. Too much to handle? Pesticide dependence of smallholder vegetable farmers in Southeast Asia. *Sci. Total Environ.* **2017**, *593*, 470–477. [CrossRef] [PubMed]
52. Waichman, A.V.; Eve, E.; Da Silva Nina, N.C. Do farmers understand the information displayed on pesticide product labels? A key question to reduce pesticides exposure and risk of poisoning in the Brazilian Amazon. *Crop Prot.* **2007**, *26*, 576–583. [CrossRef]
53. Isin, S.; Yildirim, I. Fruit-growers' perceptions on the harmful effects of pesticides and their reflection on practices: The case of Kemalpasa, Turkey. *Crop Prot.* **2007**, *26*, 917–922. [CrossRef]
54. Damalas, C.; Koutroubas, S. Farmers' training on pesticide use is associated with elevated safety behavior. *Toxics* **2017**, *5*, 19. [CrossRef]
55. Moser, R.; Pertot, I.; Elad, Y.; Raffaelli, R. Farmers' attitudes toward the use of biocontrol agents in IPM strawberry production in three countries. *Biol. Control* **2008**, *47*, 125–132. [CrossRef]
56. Remoundou, K.; Brennan, M.; Sacchettini, G.; Panzone, L.; Butler-Ellis, M.; Capri, E.; Charistou, A.; Chaideftou, E.; Gerritsen-Ebben, M.; Machera, K. Perceptions of pesticides exposure risks by operators, workers, residents and bystanders in Greece, Italy and the UK. *Sci. Total Environ.* **2015**, *505*, 1082–1092. [CrossRef] [PubMed]
57. Skevas, T.; Lansink, A.O.; Stefanou, S. Designing the emerging EU pesticide policy: A literature review. *Njas-Wagening. J. Life Sci.* **2013**, *64*, 95–103. [CrossRef]
58. Glare, T.; Caradus, J.; Gelernter, W.; Jackson, T.; Keyhani, N.; Köhl, J.; Marrone, P.; Morin, L.; Stewart, A. Have biopesticides come of age? *Trends Biotechnol.* **2012**, *30*, 250–258. [CrossRef]

59. Olson, S. An analysis of the biopesticide market now and where it is going. *Outlooks Pest Manag.* **2015**, *26*, 203–206. [CrossRef]
60. Romanian Ministry of Agriculture and Rural Development National Rural Development Programme for the 2014–2020 period. Official version 1 SFC–1.07.2014. 2014. Available online: https://www.madr.ro/docs/dezvoltare-rurala/programare-2014-2020/PNDR_2014_EN_-_2020_01.07.2014.pdf (accessed on 20 April 2019).
61. Sharifzadeh, M.; Abdollahzadeh, G.; Damalas, C.; Rezaei, R. Farmers' Criteria for Pesticide Selection and Use in the Pest Control Process. *Agriculture* **2018**, *8*, 24. [CrossRef]
62. Böcker, T.; Finger, R. European pesticide tax schemes in comparison: An analysis of experiences and developments. *Sustainability* **2016**, *8*, 378. [CrossRef]
63. Paredes-Labra, J.; Siri, I.-M.; Oliveira, A. Preparing Public Pedagogies with ICT: The Case of Pesticides and Popular Education in Brazil. *Sustainability* **2018**, *10*, 3377. [CrossRef]
64. Sanyé-Mengual, E.; Gasperi, D.; Michelon, N.; Orsini, F.; Ponchia, G.; Gianquinto, G. Eco-efficiency assessment and food security potential of home gardening: A case study in Padua, Italy. *Sustainability* **2018**, *10*, 2124. [CrossRef]
65. Wilde, B.C.; Lieberherr, E.; Okem, A.E.; Six, J. Nitrified Human Urine as a Sustainable and Socially Acceptable Fertilizer: An Analysis of Consumer Acceptance in Msunduzi, South Africa. *Sustainability* **2019**, *11*, 2456. [CrossRef]
66. Fan, L.; Niu, H.; Yang, X.; Qin, W.; Bento, C.P.; Ritsema, C.J.; Geissen, V. Factors affecting farmers' behaviour in pesticide use: Insights from a field study in northern China. *Sci. Total Environ.* **2015**, *537*, 360–368. [CrossRef] [PubMed]
67. Khan, M.; Mahmood, H.Z.; Damalas, C.A. Pesticide use and risk perceptions among farmers in the cotton belt of Punjab, Pakistan. *Crop Prot.* **2015**, *67*, 184–190. [CrossRef]
68. Khan, M.; Damalas, C.A. Farmers' willingness to pay for less health risks by pesticide use: A case study from the cotton belt of Punjab, Pakistan. *Sci. Total Environ.* **2015**, *530*, 297–303. [CrossRef]
69. Garming, H.; Waibel, H. Pesticides and farmer health in Nicaragua: A willingness-to-pay approach to evaluation. *Eur. J. Health Econ.* **2009**, *10*, 125–133. [CrossRef]
70. Wang, W.; Jin, J.; He, R.; Gong, H.; Tian, Y. Farmers' Willingness to Pay for Health Risk Reductions of Pesticide Use in China: A Contingent Valuation Study. *Int. J. Environ. Res. Public Health* **2018**, *15*, 625. [CrossRef]
71. Atreya, K.; Johnsen, F.H.; Sitaula, B.K. Health and environmental costs of pesticide use in vegetable farming in Nepal. *Environ. Dev. Sustain.* **2012**, *14*, 477–493. [CrossRef]
72. Isman, M.B.; Grieneisen, M.L. Botanical insecticide research: Many publications, limited useful data. *Trends Plant Sci.* **2014**, *19*, 140–145. [CrossRef] [PubMed]
73. Bahlai, C.A.; Xue, Y.; McCreary, C.M.; Schaafsma, A.W.; Hallett, R.H. Choosing organic pesticides over synthetic pesticides may not effectively mitigate environmental risk in soybeans. *PLoS ONE* **2010**, *5*, e11250. [CrossRef] [PubMed]
74. Kotler, P. *Marketing Management*, 11th ed.; Pearson Custom Publishing: Boston, MA, USA, 2002.
75. Jin, J.; Wang, W.; He, R.; Gong, H. Pesticide use and risk perceptions among small-scale farmers in Anqiu County, China. *Int. J. Environ. Res. Public Health* **2017**, *14*, 29. [CrossRef]
76. Zhang, W. Global pesticide use: Profile, trend, cost/benefit and more. *Proc. Int. Acad. Ecol. Environ. Sci.* **2018**, *8*, 1.
77. Vidogbéna, F.; Adégbidi, A.; Tossou, R.; Assogba-Komlan, F.; Martin, T.; Ngouajio, M.; Simon, S.; Parrot, L.; Zander, K. Consumers' willingness to pay for cabbage with minimized pesticide residues in Southern Benin. *Environments* **2015**, *2*, 449–470. [CrossRef]