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# Assessment of Farmers' Attitudes Toward Pest Control Services Provided by Birds

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**Abstract.**
Sustainable, conservation-oriented agricultural practices like pest regulation by insectivorous birds can decrease agrochemical use and enhance efforts on maximizing biodiversity. Previous research has shown that attracting insect-eating bird species can improve pest control in fruit crops and have a positive impact on fruit yield. We conducted a survey among fruit farmers to analyze the determinants of the potential adoption of biological pest control (BPC) provided by insectivorous birds on their farms. Quantitative analysis showed that their willingness to implement the innovative practice, favoring farmland wildlife, is influenced by both economic and noneconomic factors. Farmers' overall interest in attracting birds to their farms was related to a variety of factors, including their understanding of the beneficial role of insectivorous birds in biodiversity, their desire to reduce production costs, and their personal characteristics. These factors influencing farmers' motivations for participation in biological pest control should be taken into account to clarify the barriers that prevent, and the incentives that might draw them into adoption of an eco-friendly approach for insect pest control.

**Keywords:** environmental benefits, innovative practice favoring farmland wildlife, farmers' perceptions

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## 1. INTRODUCTION

Biodiversity loss in agricultural landscapes is linked with the loss of ecosystem services and jeopardizes the persistence of wildlife species [1, 2]. Pest control by chemical means and a shift toward specializing in one or a few crops, are among practices that pose threats to wildlife. According to De et al. [3], the worldwide consumption of pesticides is about 2 million tonnes per year, about half of which is used by Europe, 25% is consumed in the USA, and 25% in the rest of the world. Indeed, agrochemicals have become an important component of agriculture and have enabled food production to more than double during the last century [4]. Although pesticides are beneficial for crop

production point of view, their widespread use can possess serious consequences not only on the environment and the biodiversity, but also on the human health. This is referred mainly for agricultural workers, as their direct exposure to pesticides could cause various types of health problems [5]. Moreover, the widespread use of pesticides applied by conventional farmers is neither ecologically, nor economically sustainable solution. It was estimated that the world pesticide expenditures valued at more than $39.4 billion in 2007 [6].

To mitigate the impacts of pesticide use some conservation-oriented agricultural practices, like BPC provided by insectivorous birds, proposed to offer a sustainable solution to pest problems. There are bird species that benefit farms by suppressing crop pests. These natural enemies of agricultural pests could provide control to pest problems, lowering their populations on farms. Therefore, reduction of pesticide use could help increase wildlife numbers and diversity for birds. In this way, not only farms benefit birds, but also birds might aid farmers to lower insect pest populations on their farms. Previous works have highlighted the benefits gained from attracting insectivorous birds in diminishing pests and enhancing crop yields [7, 8, 9, 10, 11]. Nesting of insectivorous birds (*Parus major*), and sparrows (*Passer domesticus* and *P. montanus*), *Falco naumanni*, *Falco tinnunculus* and *Upupa epops* can be implemented successfully in the vineyard and fruit orchards [12]. The food consumption of the aforementioned insectivorous birds demonstrates insectivorous diet [13, 14], that do not harm crops but regulates pests as an alternative to pesticides.

Apart from the surveys state the benefits of insectivorous birds on pest regulation in fruit crops, there are others related to consumers' attitudes towards these products. According to them, consumers were willing to pay more for fruit grown with bird management methods, compared to fruit grown using fewer natural practices [15, 16].

The most crucial factor for implementing the described bird-friendly farming practice is farmers' perceptions and knowledge toward bird conservation. Thus, through this survey we investigate fruit growers' attitudes towards enhancing bird populations on farms. We also assessed farmers' willingness to adopt the innovative practice favoring farmland wildlife.

## 2. METHODOLOGY

The data utilised in this study comes from a national survey conducted between August 2021 and January 2022. It carried out in areas of Pella, Imathia, Naousa-Region of Central Macedonia Greece, where exist extensive fruit cultivations. The study was

conducted through convenient field sampling method to obtain information of 261 fruit growers.

Data were collected using a structured questionnaire, which is the result of a qualitative research and secondary sources. The questionnaire was pretested (*n*= 30 random farmers) to refine the questionnaire design and questions clarity. It comprises the following components. The first section contained questions regarding participants' agricultural holding data. In the second section participants were asked to provide their overall rating of attitudes and perceptions about the current agricultural practices, the use of insecticides and the pest control services provided by insect-eating bird species. There were numerous questions in this section, allowing farmers to give their personal views and to declare their willing to implement the proposed biological pest control practice. The last section consisted of questions regarding the farmers' profile. Most of farmers' responses were obtained on a seven-point Likert scale (where 1 means strongly disagree and 7 strongly agree).

## 2.1. Statistical analyses

All analyses were carried out using SPSS 27 (Statistical Package for Social Sciences). The data were analyzed using descriptive and logistic regression model. The logistic regression analysis was performed to ascertain the effects of demographic and attitudinal factors on the likelihood that farmers will adopt the innovative practice favoring farmland wildlife. Logistic regression is a widely used statistical modeling technique in which the probability of an outcome is related to a series of potential explanatory variables by an equation of the following form [17]:

$$\log [p/(1 - p)] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_i X_i, \quad (1)$$

where p, is the probability of the outcome of interest, $\beta_0$ is an intercept term, $\beta_2, \ldots, \beta_i$, are the p coefficients associated with each variable, $X_1, \ldots, X_i$ are the values of the potential predictor variables, and *i* is a unique subscript denoting each variable (Hosmer and Lemeshow, 2000). In order to study the reliability (internal consistency) of the instrument used, Cronbach's alpha test ( ) applied for each multi-item scale, with values greater than 0.70 considered acceptable [18]. Significance was set at $a<0.05$ for all statistical hypothesis testing.

## 3. RESULTS

Based on structured interviews, this survey examines fruit growers' willingness to undertake practices favoring farmland wildlife and enhancing bird populations on farms. The demographics of the survey respondents and the descriptive statistics for the explanatory variables included in the logistic regression analysis are presented in Tables 1 and 2.

Table 1: Survey respondents' demographics.

| Variable | Variable definition | N | Min | Max | Mean | Std. dev. |
|---|---|---|---|---|---|---|
| Gender | Binary variable equal to 1=Male; 2=Female | 261 | 1 | 2 | 1.7 | 0.254 |
| Income | Annual income sources from agriculture | 165 | 5,000 | 60,000 | 18,776 | 9,659.5 |
| Experienc | Experience in fruit cultivation (years) | 261 | 4 | 48 | 19.7 | 8.35 |

*Source*: authors (2022)

Table 2: Descriptive statistics for the explanatory variables included in the logistic regression model (n=261).

| Variable | Variable definition | Min | Max | Mean | Std. dev. |
|---|---|---|---|---|---|
| Age | Binary variable equal to 1=Male; 2=Female | 24 | 79 | 49.92 | 10.53 |
| Education | (1=Elementary school; 6=Master's/Doctoral degree) | 1 | 6 | 3.08 | 1.14 |
| Farming as main occupation | Binary variable equal to 1=Yes; 0=others | 0 | 1 | 0.70 | 0.46 |
| Birds contrib. to product cost reduction | (1=Extremely disagree; 7=Extremely agree on a 7-point scale) | 1 | 7 | 4.63 | 1.68 |
| Birds contrib. to biodiversity | 1=Extremely disagree; 7=Extremely agree on a 7-point scale) | 3 | 7 | 5.24 | 1.19 |

*Source*: authors (2022)

As cited in the above Tables, the mean age of the respondents was about 50 years old and the mean experience in fruit cultivation in this study was 19.7 years. Findings show a low women's representation (6.9%) in the survey. According to the official statistics, in Greece, one-third of the agricultural holdings belong to female farmers. However, it does not reflect the reality, where the proportion of real female farmers is still very low. Most of the women who are declared as farm heads in the official statistics, are not really managing these in Greece [19, 20].

The majority of participants in the survey have attained high school (37.9%), followed by secondary school graduates (26.1%). Of the total 261 respondents surveyed, 165 respondents accept to reveal their income, therefore there is a percentage 36.7% of missing values to the income questions. Finally, most of the participants (70.1%) declare that exert farming as a main occupation.

Table 3 summarizes the results of the binary logistic regression model. The model is a strong predictor for estimating the probability for farmers to adopt the innovative practice favoring farmland wildlife, putting up nest boxes for birds of prey and installing perches. The variables included in the logistic regression model indicate which factors have an impact on farmers' decisions, as well as the extent of the impact. The overall percentage of cases that can be correctly classified is 86.6%, which is high.

TABLE 3: The results of logistic regression analysis (n=261).

| Variables | B | S.E. | Wald | Sig. | Exp(B) |
|---|---|---|---|---|---|
| Age | -0.063 | 0.027 | 5.394 | 0.020 | 0.939 |
| Education | 0.926 | 0.259 | 12.891 | <0.001 | 2.524 |
| Farming as main occupation | -1.549 | 0.476 | 10.576 | <0.001 | 0.213 |
| Birds contrib. to product cost reduction | 0.430 | 0.202 | 4.546 | 0.033 | 1.538 |
| Birds contrib. to biodiversity | 1.733 | 0.320 | 29.308 | <0.001 | 5.659 |
| Constant | -11.580 | 2.871 | 16.264 | <0.001 | 0.000 |
| -2 Log likelihood | 160.600 | | | | |
| Cox and Snell $R^2$ | 0.470 | | | | |
| Nagelkerke $R^2$ | 0.659 | | | | |

As indicated by the results, demographic variables have a highly significant effect on the contingent participation in the proposed BPC practice. Among all tested variables, statistically significant correlations exist for five variables, education of respondent, their age, and the engagement in off-farm work. For these variables all S.E. are smaller than two, indicating that there is no multicollinearity among the independent variables in the logistic regression model. A significant correlation exists between the educational status of respondents and the willingness to adopt the proposed eco-friendly approach for insect pest control. With respect to farmer age, the variable is significant with negative sign, showing that younger farmers are more possible to participate in biological pest control. Regarding the off-farm employment, we include a dummy variable (=1 if the respondents' primary occupation is off the farm; =0 if else) to assess its impact on the willingness to adopt the proposed measure. The off-farm employment variable indicates that respondents who are mainly engaged in another profession and have additional resources of income are more likely to accept environmental conservation

programs. There are also two attitudinal variables which are included in the logistic regression model, related to the benefits could derive from the existence of birds. Hence, respondents expect that the BPC practice may reduce the production cost in their farms, display higher possibility to accept the proposed practice. Similarly, interviewees who acknowledge the contribution of birds in the maintenance of biodiversity stated a higher probability to invest in bird attraction.

In addition, Cronbach's alpha was used to determine the internal consistency among items and to assess the homogeneity for the ratings of grouped items. The overall Cronbach's alpha assumes a value of 0.957 for all items of the questionnaire which is borderline excellent.

Analysis of the survey data provides information of the attitudes of the respondents towards pest regulation by insectivorous birds. We asked respondents about their level of agreement with five potential business goals that can be achieved through the proposed measure. Business goals were measured on a seven-point Likert scale, to quantify their level of importance (see Table 4). The statement 'BPC can strengthen the innovation in agriculture' received the highest level of agreement, with 47.5% of respondents selecting 'Extremely important' and an overall Mean of 5.41. The overall Mean of statement 'BPC can reduce the product cost in agriculture' received 4.63, with 37.9% of participants regard it as 'Somewhat important'. Interviewees consider as 'Extremely important' (28.7%) the potential penetration in new markets that can be achieved through BPC. The business goals related to the potential increase in agricultural income and the increase in products price were rated slightly lower, recorded overall Mean 4.36 and 4.27 respectively.

Table 4: Percentage of survey respondents' agreement with some business goals derive from the implementation of biological pest control provided by birds.

| Variable | Mean | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Alpha if item deleted | Cronbach's α |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | **0.957** |
| Product cost reduction | 4.63 | 4.6 | 16.1 | 1.9 | 7.7 | 37.9 | 22.2 | 9.6 | 0.953 | |
| Agricultural income increase | 4.36 | 2.7 | 28.7 | 1.5 | 19.2 | 11.1 | 18.4 | 18.4 | 0.939 | |
| Increase in product price | 4.27 | 8.4 | 23.0 | 3.8 | 15.7 | 7.3 | 30.7 | 11.1 | 0.941 | |
| Penetrating new markets | 4.43 | 10.3 | 22.6 | 0.8 | 11.5 | 16.9 | 8.0 | 28.7 | 0.937 | |
| Strengthening innovation in agriculture | 5.41 | 9.2 | 3.8 | 9.6 | 6.1 | 4.6 | 19.2 | 47.5 | 0.954 | |

## 4. CONCLUSION

The objective of this paper was to assess farmers' willingness to adopt an innovative practice to reduce chemical pesticide use, by favoring farmland wildlife. The probability of farmers accepting to adopt the pest regulation by insectivorous birds was modeled as a function of their profile and variables related to their perceptions towards conservation and economic benefits provided by birds. The present findings agree with previous outcomes suggest that lower ages are generally associated with higher willingness to undertake the risk of participation in innovative agricultural practices [21, 22]. Farmers' educational attainment is a quite common explanatory variable in the literature and is found to have a positive impact in the current survey, on the adoption of eco-friendly approaches in the farms [23, 24, 25].

A great interest for the literature presents the contribution of off-farm employment in decision-making of farmers about agri-environmental measures. Farmers' engagement in off-farm economic activities may reduce income variability and uncertainty regarding farm employment. Therefore, the positive relationship between off-farm employment and participation in conservation practices has been discussed in several publications [26, 27].

The increased costs that farmers have to pay for buying insecticides, turns them to more economical alternatives. This is demonstrated by the belief of farmers that the proposed measure will contribute to product cost reduction and their expressed willingness to apply it. In addition, the positive attitudes fruit growers show towards practices favoring farmland wildlife contribute a significant opportunity to improve bird habitat on farms. Farmers reported a positive stance for adopting biological pest regulation in fruit crops, acknowledging that it could be an effort for maximizing biodiversity in farmlands. This result is consistent with empirical findings, imply the interest of farmers to participate in biodiversity conservation actions and environmental protection practices [28, 29, 30, 31, 25].

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