CALL FOR TENDER (CFT) FOR DEVELOPMENT OF A FRAMEWORK TO DEFINE CROP SPECIFIC RULES THAT SUPPORT IPM PRACTICES WITHIN EU CROP PRODUCTION – TASK 4

Case study for Croatia

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1. INTRODUCTION

This case study applies a structured evaluation protocol for Integrated Pest Management (IPM) to assess the economic and environmental viability of reducing pesticide use in fruit production. The analysis draws on empirical data from Božena Barić, Ivana Pajač Živković (2017)[1], a Croatian field study conducted in a commercial apple orchard, which compared conventional insecticide-based control with an alternative approach using mating disruption (MD) via pheromone dispensers. The original research found that MD, when complemented by two well-timed insecticide treatments, offered similar levels of pest control effectiveness to standard programs involving six treatments, while potentially reducing pesticide use by up to 67%.

Building on these findings, this case study aims to:

- Evaluate whether the IPM protocol can effectively assess trade-offs and synergies between pesticide reduction, economic viability, and environmental sustainability in perennial crop systems;
- Identify strengths and limitations of the protocol when applied to small-scale, high-value crops and alternative pest control technologies such as MD.

The findings of the case study aim to inform future applications of the evaluation protocol in other EU contexts—particularly in fruit and orchard crops—and support the development of scalable, evidence-based strategies for more sustainable pest management.

2. OVERVIEW OF THE STUDY

Božena Barić, Ivana Pajač Živković (2017), examined the effectiveness and economic viability of using mating disruption (MD) to control codling moth infestations in commercial apple orchards. The study compared different pest management strategies in a commercial orchard located in Čakovec (Međimurje County), Croatia, during the 2017 growing season. Specifically, it tested the performance of SHIN ETSU® pheromone dispensers applied at a density of 500 units per hectare, with an additional 50 dispensers along the orchard perimeter. Four test variants were considered: mating disruption under hail net, mating disruption without hail net, standard insecticide-based protection under hail net (six treatments), and an untreated control.

The primary focus was on comparing the costs of protection and yield losses under each pest management strategy. These two variables form the basis of the current modelling exercise:

- **Pest control costs:** For the baseline scenario (standard insecticide regime), this was reported as 3,741.50 HRK/ha. In the alternative scenario (mating disruption combined with two insecticide treatments), the cost of mating disruption was estimated based on international benchmarks, while insecticide costs were assumed to be one-third of the baseline (reflecting two of six treatments).
- **Yield losses:** The original study quantified yield losses due to pest damage for each variant, expressed in kilograms per hectare and monetised based on average apple prices. In the baseline scenario, yield losses were valued at 1,270 HRK/ha. For the mating disruption plus two-spray scenario, losses were assumed to be minimal based on cited evidence that this combination provides adequate protection.

The study did not include labour or machinery costs in its cost estimates, focusing instead on direct protection costs. These data points were used to model the economic implications of adopting mating disruption in apple production under Croatian conditions.

Table 2-1: Summary of the results from the study under review

Variable	Units	Value	Description
Baseline pest control costs	HRK/ha	3,741.50	These represent the total per-hectare costs of pest management under conventional practices, including the cost of six insecticide applications used to control codling

[1] Božena Barić, Ivana Pajač Živković (2017). The efficacy of mating disruption in the control of codling moth in Croatia, with special reference to the costs. Available at: The efficacy of mating disruption in the control of codling moth in Croatia, with special reference to the costs

Variable	Units	Value	Description
			moth infestations in apple orchards, excluding labour and machinery costs
MD scenario pest control costs	HRK/ha	1,247.17	These refer to the per-hectare costs of pest control under the MD scenario. They include only the cost of two insecticide applications (i.e. one-third of the baseline pesticide cost).

3. EX-ANTE MODELLING OF ECONOMIC IMPACTS

3.1 BASELINE ASSUMPTIONS

To assess the potential economic and environmental impacts of adopting mating disruption for codling moth control in Croatian apple orchards, a baseline scenario was constructed using official agricultural statistics. Farm-level financial data were sourced from the EU Farm Accountancy Data Network (FADN), focusing on Croatian farms classified under Type of Farming 36 – Specialist Orchards (Fruits). This category aligns closely with the apple production systems examined in Božena Barić, Ivana Pajač Živković (2017).

The baseline was built using a time series of FADN data from 2013 to the most recent available year (2023). This data includes:

- Total crop output (€/ha): representing the value of crop production per hectare.
- Specific crop costs (€/ha): including expenditures on inputs such as seeds, fertilisers, pesticides, and other variable costs directly attributable to crop production.
- Gross margin (€/ha): calculated as the difference between crop output and crop-specific input costs.

To express the figures in real 2025 euros, all monetary values were discounted to account for inflation. The time series of gross margins was then projected forward from 2024 to 2040 using the compound annual growth rate (CAGR) calculated over the historical period and assuming a constant annual benefit. This provides a consistent and realistic forecast of the gross margin trajectory in a business-as-usual scenario, serving as a reference point for estimating the financial implications of pesticide reduction.

In addition to economic indicators, FAOSTAT data on average pesticide use in Croatia (expressed in kg/ha) was used to estimate the environmental benefits of pesticide reduction. This information provides the basis for calculating avoided environmental damage under the reduced pesticide scenario described in Section 3.2.

3.2 ESTIMATED IMPACTS

To estimate the ex-ante economic and environmental impacts of adopting MD as a pest control strategy in Croatian apple orchards, we modelled a scenario in which this technique replaces conventional insecticide-based control of codling moth. The estimated net present value (NPV) of the intervention reflects three main components: implementation costs, pesticide savings, and avoided environmental damages.

Implementation costs were estimated drawing on published evidence from a study conducted in Turkey (Baris, O., 2017)[2], which reports total costs of mating disruption—including the cost of pheromone dispensers, labour for installation, and trap monitoring—at approximately $320 per hectare. Converted to euros at the 2017 average exchange rate of 1.13 US$/€, this corresponds to €283.19/ha.

Pesticide savings were derived from the Croatian case study, which compares a standard regime of six insecticide treatments with an alternative MD-based approach involving two insecticide treatments. Assuming pesticides account for 12 per cent of crop-specific input costs, a two-thirds reduction in applications translates into a 67 per cent reduction in pesticide expenditure, or 8 per cent reduction in total specific crop costs (i.e., 67% × 12%). These savings were assumed to apply uniformly across the 2025 - 2040 time horizon and directly increase gross margins under the intervention scenario.

[2] Baris, O. (2017). Comparison of the costs of Mating Disruption with traditional insecticide applications for control of codling moth in apple orchards in Turkey. Available at: [(PDF) COMPARISON OF THE COSTS OF MATING DISRUPTION WITH TRADITIONAL INSECTICIDE APPLICATIONS FOR CONTROL OF CODLING MOTH IN APPLE ORCHARDS IN TURKEY]

Environmental benefits were calculated using a shadow pricing approach based on avoided pesticide use. National-level pesticide use in Croatia (kg/ha) was sourced from FAOSTAT, and the 67 per cent reduction was applied to derive the estimated pesticide savings (in kg/ha). To monetise the environmental impact of this reduction, we used the average of two national pesticide tax rates in Europe.[3]

- Sweden, which applies a high externality-based pesticide tax of 3.25 €/kg, reflecting strong environmental pricing;
- Belgium, where the pesticide tax is considerably lower at 0.32 €/kg, representing a more conservative valuation.

By averaging these two values, we adopt a mid-range shadow price of 1.785 €/kg, capturing both the upper and lower bounds of plausible external costs associated with pesticide use in EU Member States. This provides a transparent and balanced estimate of the societal benefits of avoided pesticide pollution, including impacts on biodiversity, water quality, and human health.

The Net Present Value (NPV) of these gains is then calculated over a 15-year time horizon (2025–2040), using the standard NPV formula. A real discount rate of 5 per cent was used, aligned with European Commission guidelines for Cost-Benefit Analysis (CBA) for projects in Cohesion countries:

$$NPV = \sum_{t=0}^{T} \frac{(\Delta Gross\ Margin_t)}{(1+r)_t}$$

Where:

- ∆Gross Margin is the annual increase in gross margin from reduced pesticide use
- r is the discount rate (5%)
- T is the time horizon (15 years)

The results obtained are summarized in the table below.

Table 3-1 Results obtained from the analysis

Scenario	NPV (in 2025€/ha)	Change from Baseline
Baseline	49,007	-
MD Scenario	49,433	426

4. CONCLUSION AND REFLECTIONS

The results suggest that implementing MD as an IPM strategy for codling moth control in Croatian apple orchards can lead to modest but positive economic and environmental gains. Specifically, the Net Present Value (NPV) of the MD scenario—where pheromone-based disruption is combined with two insecticide applications—was estimated at €49,433 per hectare over the 2025–2040 period, compared to €49,007/ha under the baseline (six insecticide applications). This reflects a net benefit of €426/ha in real terms, primarily driven by reduced pesticide costs and monetised environmental benefits.

While the financial advantage per hectare is relatively modest, the results demonstrate that MD-based strategies can be economically viable when appropriately implemented. Importantly, these figures do not account for potential long-term benefits such as improved resistance management, reduced environmental externalities beyond pesticide pollution (e.g., impacts on pollinators or biodiversity), or improved market access for low-residue produce.

This case study also highlights a few broader reflections relevant to the evaluation of IPM intervention:

[3] Skevas, T. et al. (2013). Designing the emerging EU pesticide policy: A literature review. Available at: [Designing the emerging EU pesticide policy: A literature review - ScienceDirect]

- **Scalability and viability depend on context.** The findings are rooted in a specific crop (apples), pest (codling moth), and country context (Croatia). Transferability of these results to other crops or regions will require careful calibration of assumptions and costs.
- **Environmental valuation methods can tip the balance.** Even modest estimates of avoided environmental harm—based on EU pesticide shadow pricing benchmarks—help reinforce the case for low-input systems. As environmental costs are largely borne by society, there is a clear rationale for public support to offset transition costs.
- **Protocol applicability confirmed.** The evaluation framework applied here effectively integrates empirical agronomic studies with FADN-based financial baselines, offering a structured and replicable method for assessing the viability of specific IPM measures.

In sum, the Croatian case reinforces that well-designed IPM strategies can reduce pesticide use while preserving profitability. Continued refinement of cost and benefit assumptions—particularly for environmental valuation—will be key to informing robust, evidence-based decision-making at national and EU levels.

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