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Cooperation through Tech-Based Practices to Struggle Invasive Species and Climate Change for a Sustainable and Resilient Agriculture

AGRICULTURAL PRODUCT COTALOGUING STUDY

PP2-VEDA BULGARIA

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Bsb01005-AGRICOOP Project

A1.1 – Catalogue of Agricultural Products

Identification of Agricultural Crops Most Affected by Climate Change and Invasive Alien Species (IAS)

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Cataloguing of the Selected Priority Crops

Introduction

This report presents the **Catalogue of Agricultural Products** developed by PP2 – Varna Economic Development Agency (VEDA), Bulgaria, within Activity A1.1 of the AGRICOOP project. It builds on the multi-criteria crop prioritisation undertaken for the Bulgarian pilot territory and provides a structured profile of the agricultural crops considered most relevant for further monitoring of climate-related vulnerability and invasive alien species (IAS) and other crop-health pressures.

The catalogue covers five priority crop groups comprising eight individual crops: **wheat and maize, cherries and plums, tomatoes, apples and pears, and walnuts**. Together, these crops represent the main agricultural production systems selected for monitoring within the AGRICOOP pilot zones in **Aksakovo, Valchi Dol and Vetrino municipalities**.

For each crop group, the catalogue considers its agronomic and socio-economic importance, climate sensitivity, associated IAS and crop-health organisms, potential types of damage, monitoring indicators and relevance to the individual pilot zones. Particular attention is given to the strength of available evidence, distinguishing between national occurrence of harmful organisms, recognised crop–host relationships, observations within the pilot territory and confirmed crop impacts at individual sites.

In this way, the catalogue provides a practical and scientifically structured basis for the next stages of AGRICOOP monitoring and for progressively integrating **crop, pest/IAS, climate and spatial information** within the Bulgarian pilot territory.

1. Purpose and Evidence Base

Following completion of the multi-criteria crop prioritisation, presented in Section 7.3 of the Bulgarian National Report, the selected priority crops were catalogued in order to establish a structured basis for subsequent AGRICOOP monitoring, crop–IAS assessment and climate-related analysis in the Bulgarian pilot territory.

The cataloguing does **not constitute an additional crop selection or ranking exercise**. Rather, it consolidates the available evidence for the five priority crop groups selected for the Varna Region pilot area:

Field crops – wheat and corn/maize;
Stone fruit crops – cherries and plums;
Pome fruit crops – apples and pears;
Tomatoes;
Walnuts.

The catalogue integrates information derived from the AGRICOOP desk research, stakeholder consultations, available agricultural information and field-level observations from the selected pilot zones in **Aksakovo, Valchi Dol and Vetrino municipalities**.

For each crop or crop group, the profile considers its agronomic and socio-economic relevance, climate sensitivity, associated IAS and other crop-health organisms, potential types of damage, appropriate monitoring indicators and relevance to the individual Bulgarian pilot zones.

Particular attention is given to distinguishing between **confirmed or reported occurrence of harmful organisms, potential crop–pest associations, and organisms of surveillance relevance**. The occurrence of a harmful organism affecting a selected crop should not automatically be interpreted as confirmation of its formal status as an invasive alien species. Taxonomic identity, establishment and invasive status, regulatory status and crop-specific impact should therefore be considered separately when interpreting monitoring results.

To strengthen the scientific basis of the Bulgarian crop–IAS catalogue, the pilot evidence was cross-checked against available European and Bulgarian plant-health information, particularly the European and Mediterranean Plant Protection Organization (EPPO) Global Database, Bulgarian plant-health and risk-assessment publications, and relevant scientific literature.

This complementary evidence is used primarily to verify:

- the established or emerging presence of selected IAS and pest species in Bulgaria;
- recognised host–pest relationships;
- the nature of the principal damage caused to the selected crops;
- the relevance of individual species for surveillance in the Bulgarian pilot zones; and
- appropriate monitoring indicators.

External scientific evidence does not replace field validation within the AGRICOOP pilot territory. National or European occurrence of a species confirms its broader relevance but should not, by itself, be interpreted as proof of its occurrence or crop-specific impact on an individual pilot site.

2. Summary Catalogue of the Selected Priority Crops

Table 1: Summary Catalogue of the Selected Priority Crops

Catalogue code and crop	Principal affected product	Overall score / priority	Principal IAS or crop-health organisms identified in the Bulgarian evidence	Relevant pilot zones
BG-CROP-01 – Field crops: Wheat and Maize	Grain	5.00 – High	Cereal bedbugs; corn rootworms	BG-PZ-1.3 Botevo; BG-PZ-2.1 Boyana; BG-PZ-2.2 General Kiselovo
BG-CROP-02 – Stone fruits: Cherries and Plums	Fresh/processed fruit	5.00 – High	*Drosophila suzukii*; *Halyomorpha halys* and other organisms recorded/mentioned in the pilot evidence	BG-PZ-1.1 Krumovo
BG-CROP-03 – Tomatoes	Fresh and processed tomatoes	4.25 – High	*Tuta absoluta*	BG-PZ-1.2 Lyuben Karavelovo
BG-CROP-04 – Pome fruits: Apples and Pears	Fresh/processed fruit	4.00 – High	*Halyomorpha halys*; *Cydia pomonella*; *Quadraspidiotus perniciosus* and other recorded/mentioned crop-health organisms	BG-PZ-1.1 Krumovo
BG-CROP-05 – Walnuts	In-shell walnuts and kernels	4.00 – High	*Rhagoletis completa*	BG-PZ-3.1 Belogradets

The catalogue demonstrates that the selected priority crops represent different but complementary components of the agricultural systems of the Varna Region pilot territory. Field crops dominate the selected sites in Aksakovo and Valchi Dol, fruit crops are represented in the Aksakovo pilot area, while walnuts provide a specific perennial-crop monitoring focus in Vetrino Municipality.

2.1. BG-CROP-01 – Field Crops: Wheat and Corn/Maize

Crop names:	***Wheat; Corn/Maize***
Scientific names:	Triticum aestivum L.; Zea mays L.
Production type:	Annual arable/field crops
Principal affected product:	Grain
Prioritisation result:	5.00 – High priority

Regional and Socio-Economic Importance

Wheat and maize represent the principal field-crop component of the Bulgarian AGRICOOP pilot territory. Their inclusion among the highest priority crops reflects their strong agronomic and socio-economic relevance and their extensive representation within the selected agricultural areas.

The Bulgarian pilot data identify field crops in **Botevo village, Aksakovo Municipality (BG-PZ-1.3)** and in **Boyana (BG-PZ-2.1) and General Kiselovo (BG-PZ-2.2), Valchi Dol Municipality**. The broader crop composition of these sites also includes sunflowers and, in Botevo, barley; however, wheat and maize were retained as the representative priority crops for the final AGRICOOP catalogue.

The multi-criteria assessment assigned the field-crop group maximum scores for agronomic importance, socio-economic importance, climate sensitivity and IAS exposure/impact, producing an overall score of **5.00**.

Agroecological Requirements and Climate Sensitivity

The productivity of wheat and maize is closely linked to temperature and precipitation conditions during critical stages of crop development. Within the Varna Region context, the principal climate-related pressures relevant to monitoring include:

- increasing temperatures and prolonged periods of summer heat;
- drought and soil-moisture deficit;
- irregular or insufficient precipitation;
- extreme rainfall events;
- changes in the timing and duration of crop-development stages; and
- interactions between climate conditions and the development, survival and spread of crop pests.

The vulnerability of the two crops is not identical. Wheat is particularly sensitive to adverse conditions during establishment, stem elongation, heading, flowering and grain filling, whereas maize requires particular attention during emergence, vegetative development, flowering/pollination and grain formation.

Associated IAS and Crop-Health Evidence

The Bulgarian pilot dataset identifies **cereal bedbugs and corn rootworms** as the principal harmful-organism groups associated with the selected field-crop sites.

Cereal bedbugs are particularly relevant to cereal production, including wheat, while corn rootworms are directly relevant to maize. The records from the pilot dataset therefore underline the importance of maintaining crop-specific

identification rather than treating all harmful organisms recorded within a field-crop site as equally associated with wheat and maize.

The pilot information indicates observed pest presence together with reported effects on yield and quality and increased crop-protection costs. These observations provide an important basis for targeted monitoring during subsequent AGRICOOP activities.

For maize, the principal invasive pest of particular relevance is the **western corn rootworm, *Diabrotica virgifera virgifera* LeConte**. The species has been recorded in Bulgaria since 1998 and subsequently expanded its distribution in the country. It is specifically associated with maize production and therefore represents a well-founded target for surveillance in maize-growing pilot zones.

The most characteristic crop damage is caused by larvae feeding on maize roots. Severe root injury may reduce nutrient and water uptake and can increase the risk of plant lodging. Adult beetles may additionally feed on maize leaves, pollen and reproductive structures. These impacts underline the importance of linking pest observations with crop-growth stage and climatic conditions.

For AGRICOOP purposes, monitoring of *D. virgifera virgifera* should therefore include:
- adult trapping during the maize-growing season;
- inspection of root systems where damage is suspected;
- recording of lodging or abnormal plant development;
- crop-rotation information;
- maize phenology; and
- temperature and rainfall conditions during key stages of pest development.

For wheat, cereal bedbugs such as *Eurygaster* spp. remain relevant crop-health organisms within the Bulgarian agricultural context. However, their treatment in the catalogue should be clearly separated from confirmed invasive alien species unless specific evidence supports an IAS classification.

Damage Profile and Potential Consequences

Potential crop-health consequences relevant to the field-crop profile include:
- plant damage during vegetative development;
- impaired grain formation and grain quality;
- reduction in crop vigour and productivity;
- root damage and reduced plant stability in maize where root-feeding pests occur;
- increased need for crop-protection interventions; and
- increased production costs and potential economic losses

Monitoring Indicators

Priority monitoring should include:
- regular visual inspection of representative wheat and maize plots;
- recording of pest occurrence according to crop and phenological stage;
- inspection of maize plants and root systems where corn-rootworm damage is suspected;
- documentation of visible plant injury and abnormal crop development;
- recording of affected area and indicative pest abundance;
- georeferenced photographic documentation;
- comparison of pest observations with crop phenology; and

- integration of observations with temperature, precipitation and drought-related information.

Relevance to the Pilot Zones

Field crops have the widest spatial representation among the selected Bulgarian priority crop groups. They are represented in **BG-PZ-1.3 Botevo in Aksakovo Municipality and BG-PZ-2.1 Boyana and BG-PZ-2.2 General Kiselovo in Valchi Dol Municipality**.

This multi-site representation makes wheat and maize particularly suitable for comparative AGRICOOP monitoring of crop–pest–climate relationships across different locations within the Varna Region pilot territory.





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2.2. BG-CROP-02 – Stone Fruit Crops: Cherries and Plums

Crop names:	***Cherries; Plums***
Scientific names:	Prunus avium L. and Prunus domestica L.
Family:	Rosaceae
Production type:	Perennial fruit crops; orchards
Principal affected product:	Fresh and processed fruit
Prioritisation result:	5.00 – High priority

Regional and Socio-Economic Importance

Cherries and plums represent the priority stone-fruit component of the Bulgarian AGRICOOP crop portfolio. They are represented in **Krumovo village, Aksakovo Municipality (BG-PZ-1.1)** and received the maximum overall multi-criteria score of **5.00**.

Their selection reflects the combination of agronomic and socio-economic importance, climate sensitivity and exposure to harmful organisms. Fruit quality is especially important for these crops because pest damage may affect not only yield but also the commercial appearance and marketability of harvested fruit.

Agroecological Requirements and Climate Sensitivity

Stone-fruit production is sensitive to weather conditions throughout the production cycle. Relevant climate-related pressures include:

- unusually warm winter periods affecting dormancy;
- late spring frost during flowering and early fruit development;

- high temperatures during fruit development;
- drought and insufficient soil moisture;
- irregular precipitation;
- excessive rainfall around flowering, fruit development or harvest;
- extreme weather events capable of physically damaging fruit; and
- climate conditions favouring the establishment or population growth of harmful organisms.

Particularly vulnerable stages include bud development, flowering, fruit set, fruit enlargement, ripening and harvest.

Associated IAS and Evidence Status

The Bulgarian pilot dataset for Krumovo identifies harmful organisms associated with the stone-fruit production environment, including **spotted-wing drosophila (*Drosophila suzukii*)** and the **brown marmorated stink bug (*Halyomorpha halys*)** among the organisms relevant to the crop-health assessment.

The spotted-wing drosophila, ***Drosophila suzukii* (Matsumura)**, represents one of the most relevant invasive pests associated with the selected stone-fruit crops. The species was first detected in Bulgaria in 2014 and is currently recorded as present in the country.

Both **sweet cherry (*Prunus avium*) and European plum (*Prunus domestica*) are recognised major hosts**. Unlike most drosophilid flies that primarily exploit damaged or fermenting fruit, female *D. suzukii* are capable of laying eggs in ripening, apparently undamaged fruit. Susceptibility increases as fruits begin to colour and soften.

Potential consequences include:
- oviposition injury;
- larval feeding inside fruit;
- fruit softening and collapse;
- increased risk of secondary microbial deterioration;
- reduced shelf life;
- loss of fresh-market quality; and
- increased sorting and crop-protection costs.

The species is therefore particularly appropriate for **phenology-based surveillance**. Monitoring should intensify from fruit colouring through harvesting and should combine trapping with direct inspection of ripe fruit.

The **brown marmorated stink bug, *Halyomorpha halys***, should also remain within the surveillance framework for stone fruits. The species is established in Bulgaria and is recognised internationally as a highly polyphagous pest of fruit crops. Its presence within or near orchards should nevertheless be differentiated from demonstrated crop-specific economic damage.

Damage Profile and Potential Consequences

Potential impacts include:
- direct feeding or oviposition damages to developing and ripening fruit;
- softening and deterioration of fruit tissue;
- fruit deformation or discoloration;
- increased susceptibility of damaged fruit to secondary deterioration;
- premature fruit loss;

- reduction in fruit quality and marketability;
- increased sorting and crop-protection requirements; and
- increased production costs.

Monitoring Indicators

Priority monitoring indicators include:
- inspection of fruit during development and ripening;
- use of appropriate traps for target insect species;

- regular checking of traps during the ripening period;
- recording of fruit injury, softening, deformation or premature deterioration;
- inspection of orchard margins and adjacent vegetation;
- documentation of crop phenology and harvesting periods;
- georeferenced photographic documentation; and
- comparison of pest occurrence with temperature, humidity and precipitation conditions.

Relevance to the Pilot Zones

The selected stone-fruit crops are represented in **BG-PZ-1.1 Krumovo, Aksakovo Municipality**. This pilot sub-zone therefore provides an appropriate location for repeated monitoring of the interaction between perennial fruit production, IAS/crop-health pressure and climate variability.



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2.3. BG-CROP-03 – Tomatoes

Crop names:	*Tomato*
Scientific names:	Solanum lycopersicum L.
Family:	Solanaceae
Production type:	Annual vegetable crop
Principal affected product:	Fresh and processed tomatoes
Prioritisation result :	4.25 – High priority

Regional and Socio-Economic Importance

Tomatoes represent the priority vegetable crop within the final Bulgarian crop catalogue. They are recorded in **Lyuben Karavelovo village, Aksakovo Municipality (BG-PZ-1.2)**, where vegetable production in the pilot dataset also includes potatoes and onions.

Tomatoes received high scores for agronomic importance and socio-economic importance and a high IAS exposure/impact score, resulting in an overall prioritisation score of **4.25 – High**.

Agroecological Requirements and Climate Sensitivity

Tomato production is sensitive to the interaction between temperature, water availability and humidity. Relevant climate pressures include:

- prolonged high temperatures and heat stress;
- drought and insufficient irrigation water;
- irregular precipitation;
- excessive moisture and humidity;
- extreme rainfall events;
- temperature-related disruption of flowering and fruit set; and
- climatic conditions affecting pest population dynamics.

Important stages for monitoring include vegetative growth, flowering, fruit set, fruit enlargement and ripening.

Associated IAS and Evidence Status

The principal pest identified in the Bulgarian pilot dataset for tomatoes is **the tomato leaf miner, *Tuta absoluta* (Meyrick)**.

The pilot information records pest presence together with reported yield and quality losses and higher control costs. This makes *T. absoluta* a particularly relevant target for continued AGRICOOP monitoring of the selected tomato-production area.

The strongest scientifically substantiated crop–pest relationship within the Bulgarian vegetable profile is between tomato and the **tomato leaf miner, *Phthorimaea absoluta* (formerly widely referred to as *Tuta absoluta*)**.

The pest was first recorded in Bulgaria in 2009 in both greenhouse and field tomatoes and subsequently spread to additional production areas, including Eastern and Northern Bulgaria.

The larval stages develop within plant tissues and may attack:
- leaves;
- shoots;
- stems; and
- tomato fruits.

Leaf mining reduces functional photosynthetic tissue, while fruit infestation directly affects commercial yield and quality. The species can develop rapidly under favourable temperature conditions and may produce several generations during the growing season.

For AGRICOOP monitoring, particular attention should be paid to:

- fresh mines in tomato leaves;
- larvae and frass within mines;
- damaged growing points and shoots;
- entry holes and larval damage on fruit;
- pheromone-trap catches;
- crop-growth stage;
- greenhouse versus open-field production conditions; and
- temperature patterns associated with changes in pest abundance.

The established presence of the species in Bulgaria and its direct relationship with tomato production provide a strong scientific justification for retaining *P. absoluta* as the principal IAS/pest indicator for the tomato profile.

Damage Profile and Potential Consequences

Potential consequences of *Tuta absoluta* infestation include:

- mining damage to leaves;
- injury to shoots and stems;
- direct damage to developing fruit;
- reduction of effective photosynthetic leaf area;
- deterioration of fruit quality;
- reduced marketable production;
- increased crop-protection requirements; and
- higher production and monitoring costs.

Monitoring Indicators

Priority monitoring activities should include:

- regular visual inspection of leaves for characteristic mines;
- inspection of shoots, stems and fruit;
- recording of eggs, larvae and visible feeding damage where identifiable;
- use of species-appropriate traps;
- recording of pest abundance and temporal dynamics;
- documentation of crop phenological stage;
- georeferenced photographs of symptoms and specimens; and
- comparison of pest activity with temperature and other relevant microclimatic conditions.

Relevance to the Pilot Zones

Tomatoes are represented in **BG-PZ-1.2 Lyuben Karavelovo, Aksakovo Municipality**. The site provides an important vegetable-crop component within the Bulgarian monitoring network and complements the field-crop, orchard and nut-crop pilot locations.





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2.4. BG-CROP-04 – Pome Fruit Crops: Apples and Pears

Crop names:	***Apples; Pears***
Scientific names:	Malus domestica Borkh.; Pyrus communis L.
Family:	Rosaceae
Production type:	Perennial fruit crops; orchards
Principal affected product:	Fresh and processed fruit
Prioritisation result :	4.00 – High priority

Regional and Socio-Economic Importance

Apples and pears constitute the selected pome-fruit group within the Bulgarian AGRICOOP catalogue. They are represented in **Krumovo village, Aksakovo Municipality (BG-PZ-1.1)**.

The group received scores of 4 for each of the four assessment criteria—agronomic importance, socio-economic importance, climate sensitivity and IAS exposure/impact—resulting in an overall score of **4.00 and High-Priority status**.

Agroecological Requirements and Climate Sensitivity

The productivity and quality of pome fruits may be affected by:
- winter temperature variability;
- late spring frost;
- high summer temperatures;
- drought and soil-moisture deficit;
- irregular or excessive precipitation;
- extreme weather during flowering and fruit development; and
- climate-mediated changes in pest development and seasonal activity.

Key phenological stages include bud development, flowering, fruit set, fruit enlargement and ripening.

Associated IAS and Other Crop-Health Organisms

The Bulgarian pilot dataset identifies several organisms relevant to the pome-fruit crop-health profile, including:
- ***Halyomorpha halys*** – brown marmorated stink bug;
- ***Cydia pomonella*** – codling moth;

- ***Quadraspidiotus perniciosus*** – San José scale; and
- ***Capnodis tenebrionis*** – recorded/mentioned within the pilot crop-health evidence.

These organisms should not automatically be assigned identical IAS status. Instead, the catalogue records them as crop-health organisms identified or mentioned in the Bulgarian evidence base, while formal IAS, regulatory and establishment status should be maintained as separate analytical attributes.

Among the organisms relevant to apples and pears, ***Halyomorpha halys*** deserves particular attention as an invasive surveillance target.

The species was first reported from Bulgaria in 2016 and is now considered present in the country. Its broad host range includes numerous fruit-tree species, and EPPO has developed specific guidance for *H. halys* on fruit crops as well as inspection standards applicable to **Malus, Pyrus and Prunus** production systems.

Feeding by adults and nymphs may result in:
- external fruit depressions or discoloration;
- internal corky or necrotic tissue;
- fruit deformation;
- premature fruit drop; and
- deterioration in market quality.

Because *H. halys* is highly mobile and polyphagous, observations should include not only the orchard itself but also orchard margins, hedgerows, buildings and surrounding vegetation that may serve as seasonal refuges or alternative hosts.

Other important organisms listed for apples and pears in the Bulgarian evidence base, such as ***Cydia pomonella*** and ***Quadraspidiotus perniciosus***, are important crop-health pests but should be reported separately from the IAS category unless their invasive or regulatory status is specifically relevant to the assessment.

This distinction will improve the scientific clarity of the crop–IAS catalogue by separating:
(a) invasive alien species of surveillance relevance;
(b) established agricultural pests; and
(c) other crop-health organisms recorded during fieldwork.

Damage Profile and Potential Consequences

Depending on the organism concerned, potential impacts include:
- direct feeding damage to fruit;
- internal fruit damage;
- fruit deformation and discoloration;
- premature fruit drop;
- reduced fruit quality and storage potential;
- weakening of trees;
- reduction in marketability; and
- increased monitoring and crop-protection costs.

Monitoring Indicators

Priority monitoring indicators include:
- visual inspection of leaves, shoots, branches and fruit;

- inspection for characteristic feeding or fruit-entry damage;
- appropriate trapping of target insect pests;
- recording of damaged and prematurely fallen fruit;
- inspection of orchard margins and potential overwintering locations;
- documentation of phenological stages;
- georeferenced photographs and field observations; and
- comparison of pest observations with climatic conditions.

Relevance to the Pilot Zones

Apples and pears are represented in **BG-PZ-1.1 Krumovo, Aksakovo Municipality**, together with stone-fruit crops. The coexistence of several fruit-crop groups within the same pilot sub-zone provides an opportunity to compare the occurrence and potential impact of polyphagous pests across different host crops.





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2.5. BG-CROP-05 – Walnuts

Crop names:	***Walnut***
Scientific names:	Juglans regia L.
Family:	Juglandaceae
Production type:	Perennial nut crop; orchard/tree plantations
Principal affected product:	In-shell walnuts and kernels
Prioritisation result :	4.00 – High priority

Regional and Socio-Economic Importance

Walnuts constitute the priority nut crop selected for the Bulgarian AGRICOOP pilot area. The crop is represented in **Belogradets village, Vetrino Municipality (BG-PZ-3.1)**.

Walnuts received scores of 4 across all four prioritisation criteria, producing an overall score of **4.00 – High Priority**. Their inclusion extends the Bulgarian crop portfolio beyond annual arable and vegetable crops and conventional fruit orchards and provides an important perennial nut-crop component for IAS and climate monitoring.

Agroecological Requirements and Climate Sensitivity

Walnut production can be affected by a combination of temperature and water-related stresses, including:

- late spring frost;
- prolonged high temperatures;
- drought and soil-moisture deficit;
- irregular precipitation;
- extreme rainfall and storms; and
- climate-related changes in pest phenology and population development.

Relevant phenological stages include bud break, flowering, fruit development, kernel filling and maturation.

Associated IAS and Evidence Status

The principal pest identified in the Bulgarian pilot dataset in association with walnuts is the **walnut husk fly, *Rhagoletis completa***.

Its occurrence in the walnut-production context of the Vetrino pilot area makes the species a particularly important target for continued monitoring. The Bulgarian dataset specifically distinguishes *R. completa* from related *Rhagoletis* species attacking other host plants, emphasising the need for reliable species-level identification.

The **walnut husk fly, *Rhagoletis completa* Cresson**, represents an especially important **emerging risk** for the Bulgarian walnut profile.

The species is native to North America and has progressively established in a number of European countries. In Europe, **common walnut (*Juglans regia*) is its principal host**. Recent Bulgarian professional and scientific sources identify *R. completa* as a newly emerging threat to walnut production, while recent scientific work has reported first records of the species in Bulgaria.

For this reason, the AGRICOOP catalogue should treat *R. completa* as an **emerging invasive pest of high surveillance relevance**, while distinguishing national-level evidence from confirmation at the specific Belogradets pilot site. Female flies oviposit in the walnut husk. Larvae develop within the husk tissue, resulting in:

- small oviposition marks followed by expanding brown or black areas;
- softening and decomposition of the husk;
- adherence of damaged husk tissue to the shell;
- shell staining;
- deterioration of kernel quality in more severe infestations;
- premature fruit fall; and
- reduced commercial value.

Monitoring should be focused on the adult-flight and fruit-development period and should combine:

- baited or yellow sticky traps;
- regular recording of adult catches;
- inspection of green walnut husks for punctures and discoloration;
- examination of damaged husks for larvae;
- photographic documentation of symptoms;
- collection or preservation of specimens where species confirmation is required; and
- recording of temperature and seasonal development.

Because *Rhagoletis* species can be difficult to distinguish reliably, **species-level identification should be supported by appropriate diagnostic expertise whenever possible**.

Damage Profile and Potential Consequences

Potential impacts of walnut husk fly include:
- damage to the green walnut husk;
- deterioration and darkening of affected husk tissue;
- reduced commercial quality;
- possible effects on nut development where infestation is severe;
- difficulties associated with harvesting and post-harvest handling; and
- increased monitoring and management costs.

Monitoring Indicators

Priority monitoring should include:
- deployment of appropriate traps during the period of adult activity;
- regular recording of trap catches;
- visual inspection of developing walnut fruits;
- documentation of husk discoloration, softening and other characteristic symptoms;
- examination of affected husks for larvae where appropriate;
- recording of fruit-development and maturation stages;
- georeferenced photographic documentation; and
- comparison of pest activity with temperature and seasonal climate data.

Relevance to the Pilot Zones

Walnuts are represented in **BG-PZ-3.1 Belogradets, Vetrino Municipality**. This location provides the principal Bulgarian AGRICOOP monitoring site for the walnut–*Rhagoletis completa* relationship and enables the project to include a perennial nut-production system in its comparative crop–IAS assessment.



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3. Integrated Cataloguing Outcome

The final cataloguing process produced **five standardised priority crop profiles**, collectively covering eight individual crops: wheat, maize, cherries, plums, tomatoes, apples, pears and walnuts.

The profiles integrate four central dimensions of the AGRICOOP assessment: **agricultural importance, socio-economic relevance, climate sensitivity and IAS/crop-health exposure**. They also establish crop-specific monitoring priorities and connect each crop group to the relevant Bulgarian pilot zones.

The resulting crop portfolio provides broad representation of the principal agricultural production systems selected for monitoring in the Varna Region:

annual field-crop systems – wheat and maize;
perennial stone-fruit systems – cherries and plums;
perennial pome-fruit systems – apples and pears;
vegetable production systems – tomatoes; and
perennial nut-production systems – walnuts.

The available **pilot evidence** identifies several particularly important crop–pest relationships for subsequent monitoring: **wheat/cereals–cereal bedbugs; maize–corn rootworms; stone fruits–*Drosophila suzukii* and other relevant polyphagous pests; tomatoes–*Tuta absoluta*; pome fruits–*Halyomorpha halys* and other fruit pests; and walnuts–*Rhagoletis completa*.**

The **scientific cross-check** of the Bulgarian crop–IAS profiles confirm that the five selected crop groups provide a strong basis for AGRICOOP monitoring because they represent several distinct pathways through which invasive and emerging pests may interact with agricultural production.

Three crop–IAS relationships are particularly well supported at Bulgarian or European level:

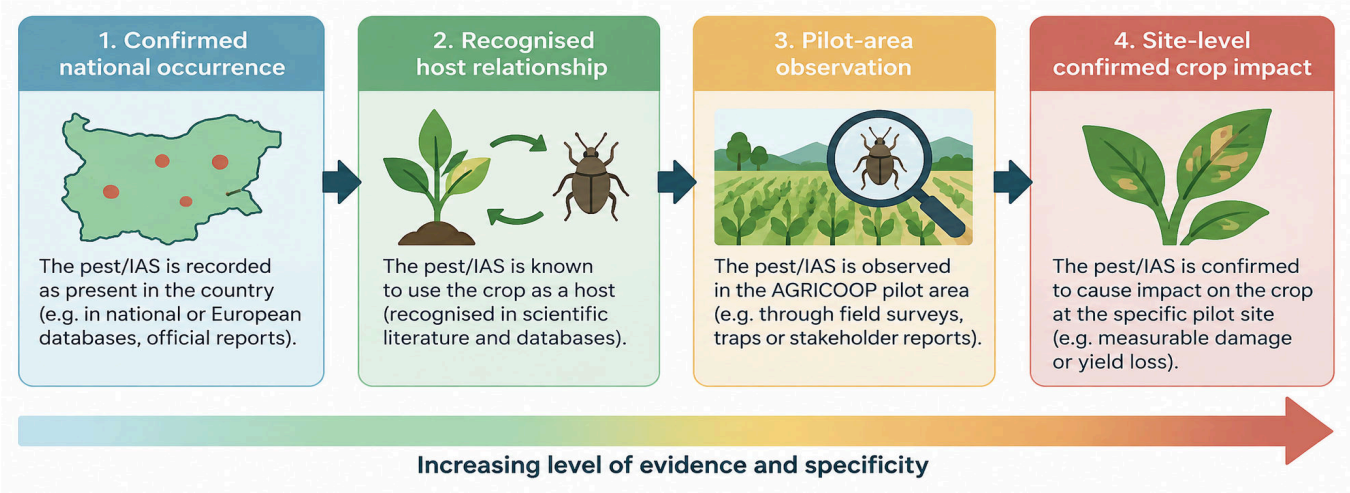
1. **Maize – Diabrotica virgifera virgifera;**
2. **Cherries and plums – Drosophila suzukii;**
3. **Tomatoes – Phthorimaea absoluta (Tuta absoluta).**

For **apples, pears and stone fruits**, ***Halyomorpha halys*** represents an important polyphagous surveillance target because the species is already present in Bulgaria and is recognised as a significant fruit-crop pest.

For **walnuts**, ***Rhagoletis completa*** should be treated as an emerging invasive threat whose recent detection in Bulgaria warrants enhanced surveillance and careful local validation.

These relationships should form the core of the crop–IAS component of future AGRICOOP field monitoring. Other harmful organisms recorded in the pilot areas remain relevant to crop health, but their formal IAS, regulatory and establishment status should continue to be documented separately.

By applying this distinction, the Bulgarian catalogue will provide not merely a list of crops and pests but a scientifically structured **evidence hierarchy**, differentiating: **confirmed national occurrence → recognised host relationship → pilot-area observation → site-level confirmed crop impact.**



This evidence hierarchy will make it possible to update the catalogue transparently as AGRICOOP field monitoring progresses and will reduce the risk of attributing IAS status or crop damage beyond what the available evidence supports.

From a spatial perspective, **Aksakovo Municipality provides the greatest diversity of selected crop systems**, incorporating fruit crops, vegetables and field crops. **Valchi Dol Municipality provides the principal comparative field-crop monitoring territory**, while **Vetrino Municipality provides the specific walnut monitoring component**.

The catalogue should be treated as a **living and updateable evidence system** throughout AGRICOOP implementation. New field observations, trap records, georeferenced photographs, validated species identifications, crop-damage observations and climate data should progressively be incorporated into the corresponding crop profiles. Each new record should preserve traceability regarding **source, date, location, crop, organism, validation method and evidence status**.

This approach will enable the Bulgarian AGRICOOP pilot to move from an initial crop and IAS inventory towards an integrated **crop–IAS–climate monitoring framework**, supporting the identification of emerging risks, comparison between pilot zones and development of practical recommendations for farmers and other agricultural stakeholders in the Varna Region.

4. Bulgarian AGRICOOP Pilot Zones and Priority Crops

The Bulgarian GIS framework comprises **three municipal pilot zones and six village-level sub-zones** distributed across the agricultural territory of the Varna Region.

Table 2. AGRICOOP Pilot Zones – Varna Region, Bulgaria presents the geographical location of the three pilot municipalities, the six selected village sub-zones and their principal crop profiles.

Pilot zone	Sub-zone and location	Coordinates	Main crop relevance
Zone 1 – Aksakovo Municipality	BG-PZ-1.1 – Krumovo Village	43.386638 N; 27.775600 E	Fruit crops – cherries, plums, apples and pears
	BG-PZ-1.2 – Lyuben Karavelovo Village	43.345668 N; 27.762894 E	Vegetables – tomatoes, potatoes and onions

	BG-PZ-1.3 – Botevo Village	43.314215 N; 27.719635 E	Field crops – wheat, maize, sunflower and barley
Zone 2 – Valchi Dol Municipality	BG-PZ-2.1 – Boyana Village	43.433988 N; 27.645607 E	Field crops – wheat, maize and sunflower
	BG-PZ-2.2 – General Kiselovo Village	43.457971 N; 27.591991 E	Field crops – wheat, maize and sunflower
Zone 3 – Vetrino Municipality	BG-PZ-3.1 – Belogradets Village	43.356321 N; 27.317243 E	Nut crop – walnuts

The spatial distribution demonstrates a useful differentiation of agricultural production systems across the Bulgarian pilot territory.

Aksakovo Municipality contains the most diversified pilot structure, incorporating perennial fruit crops at Krumovo, vegetable production at Lyuben Karavelovo and field crops at Botevo. This provides opportunities to monitor different crop–IAS/pest relationships within a single municipal territory.

Valchi Dol Municipality provides two field-crop sub-zones—Boyana and General Kiselovo—where wheat, maize and sunflower predominate. The two locations provide a useful basis for comparative monitoring of pest pressure and climate-related effects within similar agricultural production systems.

Vetrino Municipality, represented by the Belogradets sub-zone, provides the principal walnut-production component of the Bulgarian pilot framework and is therefore particularly relevant to monitoring emerging pest risks associated with walnut production.

5. Spatial Interpretation of Priority Crop–IAS/Pest Relationships

The GIS analysis should connect the spatial distribution of the priority crops identified in Sections 7.3 and 7.4 with confirmed, emerging and surveillance-relevant IAS/pest records.

The principal crop–IAS/pest relationships to be represented and progressively validated within the Bulgarian GIS framework include:

Field crops – Wheat and Maize

The field-crop monitoring areas are concentrated in **Botevo, Boyana and General Kiselovo**. Wheat is relevant to monitoring cereal bedbugs and other crop-health pressures, while maize provides the principal host context for surveillance of the **western corn rootworm (*Diabrotica virgifera virgifera*)**.

The occurrence of the same priority crop group in three geographically separate sub-zones provides an opportunity for comparative analysis of pest observations in relation to crop phenology, temperature, precipitation and drought conditions.

Stone fruits – Cherries and Plums

The principal stone-fruit monitoring location is **Krumovo**. The priority IAS surveillance context includes ***Drosophila suzukii***, particularly during fruit colouring, ripening and harvesting, together with surveillance for polyphagous IAS such as ***Halyomorpha halys*** where supported by field evidence.

Spatial records should distinguish between confirmed observations at the pilot site and species known from Bulgaria or the wider region but not yet locally confirmed.

Pome fruits – Apples and Pears

Apples and pears are also represented within the **Krumovo** pilot sub-zone. ***Halyomorpha halys*** is particularly relevant as a polyphagous invasive surveillance target, while other economically important fruit pests recorded through the AGRICOOP evidence base should be maintained as separate crop-health layers where appropriate.

The coexistence of stone and pome fruits within Krumovo makes this sub-zone especially useful for examining potential multi-host IAS pressure within an orchard-production landscape.

Tomatoes

The principal tomato monitoring location is **Lyuben Karavelovo**. The most relevant crop–pest relationship identified for spatial monitoring is tomato–***Phthorimaea absoluta*** **(syn. *Tuta absoluta*)**.

GIS records can progressively integrate trap observations, visible crop damage, crop phenology and climate information to assess whether pest activity shows spatial or temporal correspondence with temperature and other environmental conditions.

Walnuts

The principal walnut monitoring location is **Belogradets in Vetrino Municipality**. Particular surveillance relevance is associated with ***Rhagoletis completa***, the walnut husk fly.

Given its status as an **emerging invasive pest recently reported in Bulgaria**, the GIS should distinguish clearly between national/regional evidence of occurrence and validated occurrence at the Belogradets pilot site. Until appropriate field evidence is available, the species should therefore be represented as an emerging surveillance risk rather than automatically mapped as a confirmed pilot-site occurrence.

Concluding Notes

The AGRICOOP Catalogue of Agricultural Products establishes a consolidated framework for monitoring the priority agricultural crops and their interaction with climate-related pressures, invasive alien species and other relevant crop-health organisms in the Varna Region pilot territory.

The five selected crop groups provide a diversified representation of Bulgarian pilot agriculture and allow different crop–pest relationships to be examined under varying production and environmental conditions. Particularly important relationships identified for further monitoring include **maize–Diabrotica virgifera virgifera, cherries and plums–Drosophila suzukii, tomatoes–Phthorimaea absoluta (Tuta absoluta), fruit crops–Halyomorpha halys, and walnuts–Rhagoletis completa**.

An important outcome of the catalogue is the establishment of a clear **evidence hierarchy: confirmed national occurrence → recognised host relationship → pilot-area observation → site-level confirmed crop impact**. This approach helps prevent national or European records from being interpreted automatically as proof of local occurrence or crop damage and provides a transparent basis for validating future AGRICOOP observations.

The catalogue should therefore be regarded as a **living and updateable evidence system**. Field observations, trap records, georeferenced photographs, validated species identifications, crop-damage observations and relevant climate data collected during subsequent project activities can progressively enrich the individual crop profiles.

Through this approach, the Bulgarian AGRICOOP pilot can advance from an initial crop and IAS inventory towards an integrated **crop–IAS–climate monitoring framework**, supporting early identification of emerging risks, comparison between pilot zones and the development of practical recommendations for farmers and other agricultural stakeholders in the Varna Region.