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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

LP1-TCE TÜRKİYE

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Technology-based Cooperation to Combat Invasive Species and Climate Change for a Sustainable and Resilient Agriculture



ACTIVITY 1.1
CATALOGUE OF AGRICULTURAL PRODUCTS

LP1 – Trabzon Commodity Exchange (TCE)
PP4 – Ondokuz Mayıs University (OMU)

Catalogue of the Five Priority Agricultural Products Identified under Activity A1.1

2026

1. PURPOSE AND SCOPE

This document is an expanded and more detailed version of the agricultural product catalogue section included in the Türkiye National Report prepared under Activity A1.1 of the AGRICOOP Project. The catalogue covers hazelnut, tea, maize, kiwifruit, and beans, which are among the key agricultural products in Trabzon and the Eastern Black Sea Region.

The products are examined in terms of their regional agricultural and socio-economic importance, sensitivity to climatic conditions, and interactions with invasive alien species (IAS). In the National Report, the selection of these five products was based on an integrated assessment of scientific literature and institutional sources, stakeholder consultations, and field studies. The stakeholder survey results also showed that hazelnut, tea, maize, kiwifruit, and beans were among the most frequently identified individual agricultural products.

2. CATALOGUING APPROACH

The cataloguing of the priority agricultural products was undertaken to present the products identified through the multi-criteria assessment in a systematic and comparable manner. Cataloguing does not constitute a separate selection or scoring process; rather, it serves as a complementary exercise that organizes the available information on the selected products within a common framework.

For each product, information was compiled on its agricultural importance, the plant parts affected, major invasive alien species and other pests, key climate-related stress factors, observed or anticipated impacts, and potential relevance to project activities. As stated in the National Report, the assessment was based on the combined use of scientific and institutional sources, stakeholder consultations, and field findings.

Criterion	Description	Weight
A – Agricultural Importance	Production area and volume, geographical distribution, and role within the regional agricultural system	25%
B – Socio-economic Importance	Market and trade importance, producer income, employment, value chain significance, and food security	25%
C – Climate Sensitivity	Sensitivity to drought, high temperatures, frost, rainfall variability, extreme events, and phenological conditions	25%
D – IAS Exposure / Impact	Current or potential IAS pressure, impacts on yield and quality, management requirements, and potential for spread	25%

Each criterion was scored on a scale from 1 to 5, and the overall score was calculated using the formula **(A+B+C+D)/4**. A score of **1** represents a low level, **3** a moderate level, and **5** a very high level of importance, sensitivity, or exposure/impact, depending on the criterion assessed.

3. CONTRIBUTION OF STAKEHOLDER CONSULTATION AND FIELD FINDINGS TO THE CATALOGUING PROCESS

In addition to scientific literature, official statistics, and field findings, the results of the stakeholder consultation held at the Trabzon Commodity Exchange on 18 February 2026 were considered as supporting evidence in the cataloguing of agricultural products. A total of 53 participants attended the meeting, of whom 36 completed the questionnaire. The survey results contributed to the cataloguing process by providing insight into local stakeholders' assessments of key agricultural products, invasive alien species, and climate-related pressures in the region.

3.1. Stakeholder Views on Priority Agricultural Products

In response to the question, "What are the most important agricultural products in the region?", hazelnut ranked first, being identified by 34 respondents (94.44%). It was followed by tea, identified by 26 respondents (72.22%); maize by 18 (50.00%); kiwifruit by 14 (38.89%); and beans by 10 respondents (27.78%).

Product	Number of Respondents	Respondent-Based Percentage (%)
Hazelnut	34	94.44
Tea	26	72.22
Maize	18	50.00
Kiwifruit	14	38.89
Beans	10	27.78

3.2. Stakeholder Views on Invasive Alien Species

According to the survey results, the Brown Marmorated Stink Bug (*Halyomorpha halys*) was the most frequently identified invasive alien species, reported by 34 respondents (94.44%). The Citrus Long-horned Beetle (*Anoplophora chinensis*) and *Orosanga japonica* were each reported by 17 respondents (47.22%). These findings indicate that local stakeholder observations provide an important source of supporting evidence for assessing the relationship between invasive alien species and the agricultural products included in the catalogue, particularly hazelnut.

Invasive Alien Species	Number of Respondents	Respondent-Based Percentage (%)
Brown Marmorated Stink Bug (Halyomorpha halys)	34	94.44
Citrus Long-horned Beetle (Anoplophora chinensis)	17	47.22
Orosanga japonica	17	47.22

3.3. Stakeholder Views on Climate-Related Pressures

Among the climate-related factors perceived to have become increasingly problematic for agricultural production in recent years, stakeholders most frequently identified seasonal shifts and drought, each reported by 22 respondents (61.11%). Late frost was reported by 21 respondents (58.33%), heat waves by 15 (41.67%), and heavy rainfall by 13 respondents (36.11%). These findings

support an integrated assessment of the climate sensitivity of the catalogued products, taking into account multiple stress factors, including drought, frost, high temperatures, and changes in precipitation patterns, rather than considering any single climatic factor in isolation.

Climate Factor	Number of Respondents	Respondent-Based Percentage (%)
Seasonal Shifts	22	61.11
Drought	22	61.11
Late Frost	21	58.33
Heat Waves	15	41.67
Heavy Rainfall	13	36.11

3.4. Interpretation of Stakeholder Findings in Relation to the Cataloguing Process

Stakeholder consultation data were not used as the sole basis for product selection; rather, they were considered as complementary evidence alongside scientific literature, official data, and field findings. Nevertheless, the fact that hazelnut, tea, maize, kiwifruit, and beans were the most frequently identified individual agricultural products in the survey indicates that the five products selected through the multi-criteria prioritisation process are also consistent with regional stakeholder perceptions. Hazelnut, in particular, clearly stood out in terms of both its agricultural importance and its association with invasive alien species. This was considered one of the field-based indicators supporting its high priority score in the catalogue.

3.5. Contribution of Field Visits and Producer Interviews to the Cataloguing Process

Following the stakeholder consultation, field visits were conducted between June and August 2026 in the districts of Yomra, Arsin, Araklı, Sürmene, Of, Akçaabat, Çarşıbaşı, Vakfıkebir, and Ortahisar in Trabzon to assess the impacts of invasive alien species on agricultural products under field conditions. A total of 19 orchards and other agricultural production sites were examined, and field observations, expert assessments, and standardised interviews with 12 producers were considered together.

For the purposes of the cataloguing process, the field studies served as a complementary source of evidence for assessing the occurrence and relevance of the products highlighted in the stakeholder survey within actual production areas. These data did not independently determine the A–B–C–D scores assigned to the products; rather, they were evaluated together with scientific literature, official data, and stakeholder findings.

3.5.1. Pests Highlighted by the Field Findings

In the standardised interviews conducted with 12 producers, the Brown Marmorated Stink Bug (*Halyomorpha halys*) was reported by all producers (100%). *Anoplophora chinensis* was reported by three producers (25.0%), *Anisandrus dispar* by two producers (16.7%), and *Gryllotalpa* spp. and *Orosanga japonica* by one producer each (8.3%). In addition, direct field observations recorded a high presence of *O. japonica* in some production areas, particularly during the field visits conducted in August.

Pest Species	Number (n)	Producer-Based Percentage (%)
Halyomorpha halys	12	100.0
Anoplophora chinensis	3	25.0
Anisandrus dispar	2	16.7
Gryllotalpa spp.	1	8.3
Orosanga japonica	1	8.3

3.5.2. Agricultural Products Affected According to Field Findings

In the producer interviews, hazelnut was reported by all 12 producers (100%) as the agricultural product most affected by invasive pests. Beans ranked second, being reported by 58.3% of producers, followed by maize (16.7%) and tea (8.3%). Other crops, including apple, pear, tomato, eggplant, potato, pea, cherry laurel, lemon, and persimmon, were also reported at varying frequencies.
Kiwifruit was not reported as a separate product category in the standardised interviews with the 12 producers and was therefore not assigned a percentage in the field findings table. However, this should not be interpreted as indicating an absence of risk to kiwifruit.

Priority Product	Number (n)	Producer-Based Percentage (%)
Hazelnut	12	100.0
Beans	7	58.3
Maize	2	16.7
Tea	1	8.3
Kiwifruit	–	Not separately reported in the standardised interviews

3.5.3. Reported Impacts on Product Quality and Yield

During the field interviews, all producers (100%) reported that pests and invasive species adversely affected product quality. Yield losses were reported by 83.3% of producers, while 75.0% reported crop losses. In hazelnut, reported damage symptoms included deterioration in kernel quality, staining, incomplete development, and the formation of shrivelled and underdeveloped kernels. In some fruit crops, reported symptoms included staining, sunken areas, discolouration, and deformation.

3.6. Integrated Assessment of Stakeholder and Field Findings

In the stakeholder consultation survey, participants were first asked to identify the most important agricultural products in the region and the prominent invasive alien species, and subsequently to indicate the agricultural products they considered to be affected by these invasive species. During the field-based producer interviews, information was collected on the products that producers reported as being affected by pests within their own production areas. Accordingly, the stakeholder and field findings were considered complementary sources of evidence for assessing both the regional importance of the products and their association with invasive alien species.

Product	Stakeholder Survey: Regional Importance (%)	Stakeholder Survey: Association with Invasive Species	Field Interviews: Reported Impact (%)	Integrated Assessment
Hazelnut	94.44	Showed the strongest association with all three invasive species.	100.0	The most prominent product in terms of both regional importance and reported pest impacts.
Tea	72.22	Associated with all three invasive species, although at lower frequencies.	8.3	High regional importance, while reported pest impacts in the field interviews were more limited.
Maize	50.00	Associated with all three invasive species.	16.7	Regional importance and association with invasive species were considered together.
Kiwifruit	38.89	Associated with all three invasive species at relatively low frequencies.	–	Stakeholder prioritisation was considered together with other findings on invasive species exposure and climate sensitivity.
Beans	27.78	Associated with all three invasive species.	58.3	Although its reported regional importance was lower, field findings indicated a notable level of pest impact.

When the findings are considered together, hazelnut emerges as the most prominent product in terms of both regional importance and its association with invasive alien species. In the stakeholder survey, hazelnut was associated with *Halyomorpha halys* by 88.89% of respondents, with *Anoplophora chinensis* by 47.22%, and with *Orosanga japonica* by 36.11%. Beans and maize were also associated with all three invasive species, while the field interviews provided additional evidence of pest impacts, particularly on beans. Tea and kiwifruit were identified by stakeholders as regionally important products but were associated with invasive species at lower frequencies. Accordingly, the prioritisation of the five products was based not solely on their reported regional importance, but on an integrated assessment of stakeholder perceptions regarding invasive species–crop associations and findings obtained from the field studies.

4. PRIORITISATION RESULTS

Product	A	B	C	D	Overall Score
Hazelnut	5	5	5	5	5.00
Tea	5	5	4	3	4.25
Kiwifruit	3	3	5	4	3.75
Beans	3	3	5	4	3.75
Maize	3	3	4	4	3.50

Findings from the stakeholder consultation survey, field visits, and producer interviews, together with scientific literature and official data, supported the multi-criteria assessment. Hazelnut ranked first with an overall score of 5.00, receiving the highest rating across all four criteria. Tea received an overall score of 4.25, reflecting its high agricultural and socio-economic importance, while kiwifruit and beans each scored 3.75, and maize received an overall score of 3.50.

5. AGRICULTURAL PRODUCT CATALOGUE

5.1. Hazelnut

Priority Product	Hazelnut (Corylus avellana L.)
Affected Product	In-shell hazelnuts and hazelnut kernels
Main IAS / Pest / Climate-Related Pressure	Halyomorpha halys (Brown Marmorated Stink Bug); temperature and precipitation anomalies; other insect pests and mites in hazelnut orchards
Main Observed / Anticipated Impacts	Kernel damage, quality deterioration, production/yield losses, and income losses
A–B–C–D / Overall Score	5–5–5–5 / 5.00

Regional and Economic Importance

Hazelnut is one of the principal agricultural products of Trabzon and the Eastern Black Sea Region. According to the National Report, approximately 652,399 decares of hazelnut cultivation area and 38,321 tonnes of production were reported in Trabzon in 2024. The hazelnut-based processing and trade value chain is also considered to be of very high importance to the regional economy. Türkiye's leading position in global hazelnut production and the high economic value generated by hazelnut exports further reinforce the socio-economic importance of the crop (Trabzon Commodity Exchange, 2025; FAO, 2026; Gönenç et al., 2006).

Climate Sensitivity

Hazelnut yield and quality are sensitive to temperature, precipitation, and particularly to meteorological conditions during critical developmental stages. The frost event experienced in Türkiye in 2014 resulted in substantial losses in hazelnut production, while the effects of climate variability on crop yield have also been demonstrated in various studies (Balık & Kayalak, 2015; İrdem, 2021; Ray et al., 2015; Ahmadov, 2024).

Association with IAS and Other Biotic Pressures

The principal invasive pressure affecting hazelnut is associated with the Brown Marmorated Stink Bug (*Halyomorpha halys*). The distribution of this species in the Black Sea Region and its potential to cause quality and yield losses in hazelnut have been documented in scientific studies. In addition, the recorded presence of *Anoplophora chinensis* in hazelnut orchards in Trabzon further highlights the relevance of hazelnut in the context of multiple biotic risks (Ak, Uluca, & Tunçer, 2023; Demir, 2024; Kan, Akgün, & Turan, 2024; Turan & Erdoğan, 2022).

Summary of Evidence and Sources

In the National Report, hazelnut was identified as the product that most prominently emerged from both stakeholder consultations and field findings. The association between hazelnut and *H. halys* was therefore considered one of the key reference relationships for the cataloguing process and subsequent monitoring activities.

5.2 Tea

Priority Product	Tea (Camellia sinensis)
Affected Product	Fresh tea leaves / processed tea
Main IAS / Pest / Climate-Related Pressure	Orosanga japonica; changes in temperature and precipitation patterns
Main Observed / Anticipated Impacts	Changes in yield and product quality; increased or altered pest and disease pressure; production stress
A–B–C–D / Overall Score	5–5–4–3 / 4.25

Regional and Economic Importance

Tea production in Türkiye is largely concentrated in the Eastern Black Sea Region. Tea cultivation in Artvin, Rize, Trabzon, Giresun, and Ordu is of considerable economic importance in terms of producer income, the tea-processing industry, and regional employment. The National Report highlights Trabzon as one of Türkiye's major tea-producing provinces and notes that the concentration of tea production within a relatively limited geographical area increases the sector's regional vulnerability (FAO, 2026; Ministry of Agriculture and Forestry, 2025; Öztürk & Dilek, 2025).

Climate Sensitivity

Tea growth and yield are closely associated with temperature, precipitation, and humidity conditions. Significant relationships between tea yield and temperature variables have been reported in Türkiye, while climate variability in the Eastern Black Sea Region has also been assessed in relation to disease and pest dynamics (İrdem, 2022; Bayramoğlu et al., 2026). Accordingly, tea was considered to have high climate sensitivity. However, its sensitivity to multiple extreme climatic events was assessed as relatively lower than that of hazelnut and kiwifruit, resulting in a climate sensitivity score of **C = 4**.

Association with IAS and Other Biotic Pressures

Regional evidence of direct and widespread economic damage caused by IAS in tea is more limited than for hazelnut. Nevertheless, *Orosanga japonica* is an invasive pest recorded in the Eastern Black Sea Region and was identified as a species requiring attention in tea-growing areas (Ak et al., 2015). Therefore, the IAS exposure/impact criterion was assigned a score of **D = 3**.

Summary of Evidence and Sources

In the catalogue, tea is characterised by the combination of high regional economic importance and climate sensitivity. From a monitoring perspective, the integrated assessment of climate data and field-based pest reports is particularly relevant.

5.3 Maize

Priority Product	Maize (Zea mays)
Affected Product	Maize grain / maize biomass
Main IAS / Pest / Climate-Related Pressure	Halyomorpha halys; high temperatures and water stress; potential pest pressures identified in the report
Main Observed / Anticipated Impacts	Yield loss, plant/stalk damage, deterioration in product quality, and increased need for pest management
A–B–C–D / Overall Score	3–3–4–4 / 3.50

Regional and Economic Importance

Maize is a multipurpose crop in Türkiye, used for food, animal feed, and as an industrial raw material. Although its share of national production in the Eastern Black Sea Region is lower than that of hazelnut and tea, maize remains regionally important within small-scale and traditional production systems. It is also among the principal field crops cultivated in Trabzon (Bayramoğlu & Bozdemir, 2018; DOKAP, 2026).

Climate Sensitivity

Maize growth and yield are closely related to temperature, precipitation, soil moisture, and relative humidity. High temperatures and water stress may particularly constrain grain filling and ear development. Given the steep topography and high precipitation regime of the Eastern Black Sea Region, climate-related risks such as excessive rainfall, surface runoff, soil erosion, and localised flooding should also be taken into consideration (Uçak et al., 2010; Şen et al., 2012).

Association with IAS and Other Biotic Pressures

Maize is among the wide range of host plants of the Brown Marmorated Stink Bug (*Halyomorpha halys*), and pest pressure on maize has been reported in the region. The National Report considered both current and potential IAS risks; accordingly, maize was assigned an IAS exposure/impact score of D = 4 (Ak, Uluca, & Tunçer, 2023; Trabzon Provincial Directorate of Agriculture and Forestry, 2023).

Summary of Evidence and Sources

Although maize has a lower socio-economic weight than hazelnut and tea, it was retained in the catalogue due to its climate sensitivity and exposure to pest pressures. For this crop, the combined assessment of field-based pest reports and climate data is considered particularly relevant.

5.4 Kiwi

Priority Product	Kiwifruit (Actinidia deliciosa)
Affected Product	Fresh kiwifruit
Main IAS / Pest / Climate-Related Pressure	Halyomorpha halys; Metcalfa pruinosa; Orosanga japonica; temperature and water stress; extreme weather events
Main Observed / Anticipated Impacts	Fruit damage, yield and quality losses, reduced marketability, and production stress
A–B–C–D / Overall Score	3–3–5–4 / 3.75

Regional and Economic Importance

Kiwifruit is one of the high-value alternative fruit crops cultivated under the humid and temperate ecological conditions of the Eastern Black Sea Region. Production is concentrated mainly in coastal and mid-altitude areas, particularly in Ordu, Rize, and Trabzon, where it provides an alternative or complementary source of income to hazelnut and tea production. Türkiye is also among the significant kiwifruit-producing countries worldwide (FAO, 2026; Ministry of Agriculture and Forestry, 2025).

Climate Sensitivity

The annual growth cycle of kiwifruit is closely associated with temperature, precipitation, and soil moisture conditions. Chilling requirements, late spring frosts, high temperatures, drought, and disruptions in plant water balance are among its major climatic sensitivities. Prolonged exposure to high temperatures has been reported to adversely affect photosynthetic activity, water balance, cellular structure, and plant development (Tutberidze et al., 2025; Shen et al., 2023; Bovio-Zenteno et al., 2025; Rajan et al., 2024). Accordingly, kiwifruit was assigned a climate sensitivity score of C = 5.

Association with IAS and Other Biotic Pressures

The Brown Marmorated Stink Bug (*Halyomorpha halys*) has been recorded on kiwifruit and is present in the Black Sea Region. In addition, the occurrence of invasive pests such as *Metcalfa pruinosa* in kiwifruit orchards increases the crop's biotic risk profile (Ak, Uluca, & Tunçer, 2023; Güncan, 2014). As evidence of widespread economic damage is less extensive than for hazelnut, the IAS exposure/impact criterion was assigned a score of D = 4.

Summary of Evidence and Sources

Although the scale of kiwifruit production is lower than that of hazelnut and tea, it was included among the priority products due to its sensitivity to multiple climate-related stresses and its direct exposure to invasive alien species.

5.5 Beans

Priority Product	Beans (Phaseolus vulgaris)
Affected Product	Fresh beans and dry beans
Main IAS / Pest / Climate-Related Pressure	Halyomorpha halys; Orosanga japonica; temperature and precipitation variability
Main Observed / Anticipated Impacts	Damage to plants and pods, yield and quality losses, and potential income losses
A–B–C–D / Overall Score	3–3–5–4 / 3.75

Regional and Economic Importance

Beans are cultivated in Türkiye both as a fresh vegetable and as a dry pulse crop. In the Eastern Black Sea Region, unlike the major production areas at the national level, bean production is predominantly carried out by small- and medium-scale farms. The crop is important for the local food system and small-scale producers (Parlak & Gül, 2016).

Climate Sensitivity

Beans are a warm-season crop that is sensitive to environmental conditions, particularly extreme temperatures, frost, and water stress. High temperatures and water stress during flowering, pollen viability, fertilisation, pod formation, and seed-filling stages can lead to yield losses (Nadeem et al., 2022; Sümbül & Sönmez, 2021). Accordingly, beans were assigned a climate sensitivity score of C = 5.

Association with IAS and Other Biotic Pressures

The Brown Marmorated Stink Bug (*Halyomorpha halys*) is a highly polyphagous invasive pest that has also been recorded on beans in the region. In addition, *Orosanga japonica* is among the other biotic pressures present in the region (Ak, Uluca, & Tunçer, 2023; Ak et al., 2015). Given the existing exposure to IAS, the crop was assigned an IAS exposure/impact score of D = 4.

Summary of Evidence and Sources

Although bean production is relatively limited in scale at the regional level, the crop was retained as a priority product in the catalogue due to its high climate sensitivity and documented exposure to IAS. Producer reports and field monitoring data are particularly relevant to the assessment of this crop.

6. COMPARATIVE SUMMARY OF PRIORITY AGRICULTURAL PRODUCTS

Product	Key Regional Role	Main Climate Sensitivities	Key IAS / Biotic Pressures	Overall Score
Hazelnut	Major economic crop and key component of the export/value chain	Frost, temperature, and precipitation anomalies	H. halys; A. chinensis	5.00
Tea	Major regional crop supporting the tea-processing industry	Variability in temperature, precipitation, and humidity	Orosanga japonica	4.25
Kiwifruit	High-value alternative/complementary fruit crop	Late frost, high temperatures, drought, and water-balance stress	H. halys; Metcalfa pruinosa	3.75
Beans	Small- and medium-scale local production	High temperatures, frost, and water stress	H. halys; Orosanga japonica	3.75
Maize	Traditional field crop used for food and feed	High temperatures, water stress, and excessive rainfall	H. halys and other potential pests	3.50

The comparison demonstrates that the products should be assessed not solely on the basis of production volume, but also by considering their climate sensitivity and exposure to invasive alien species. Hazelnut has the highest priority across all criteria, while tea is included due to its strong economic importance; kiwifruit and beans due to their high climate sensitivity; and maize due to the combined influence of climate-related and pest pressures.

7. GENERAL EVALUATION

The five products catalogued under Activity A1.1 represent different components of agricultural production in the Eastern Black Sea Region. Hazelnut and tea are key products of the regional economy; kiwifruit represents a high-value alternative fruit crop; maize is a traditional field crop; and beans constitute an important component of small- and medium-scale production systems.

The risk profiles of these products also differ. For hazelnut, both IAS pressure and climate sensitivity are particularly prominent, whereas tea is characterised by its high economic importance and sensitivity to climate variability. Kiwifruit and beans show high sensitivity to multiple climate-related stresses, while for maize, the combined monitoring of temperature and water stress together with pest pressure is particularly relevant. These differences indicate that a crop-specific approach responsive to local conditions would be appropriate for MAPPEST, CPDS, and field-monitoring activities.

This catalogue constitutes a separate output based on the agricultural product cataloguing findings presented in the A1.1 National Report. The assessments are based on the existing sources and field findings used in the National Report; no additional literature review was conducted specifically for the preparation of this catalogue.

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