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Integrated Pest Management Concept for the Kurdamir Pilot Site and ECOserve Pilot Farmers

ECOserve Environmental Programme

Concept submitted to

ECOserve, South Caucasus
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Summary

Use of synthetic pesticides is the most prevailing pest protection method in the Kurdamir area. Some of the used pesticides are classified as highly hazardous with impacts on the environment, biodiversity and health of farmers and consumers.

In order to reduce the use of pesticides in the Kurdamir area, a concept for Integrated Pest Management (IPM) for the focus crops wheat, barely, alfalfa and cotton has been developed and IPM guidelines for the major pests, diseases and problem weeds are presented. Emphasis is on preventive cultural measures and suitable alternative biological methods, if available. The IPM concept served as basis for a trainers' training and an IPM brochure.

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Abbreviations

ASA	Agrarian Service Agency
AZ	Azerbaijan
FAO	Food and Agriculture Organization of the United Nations
GAP	Good Agriculture Practice
HHP	Highly hazardous pesticides
IPM	Integrated Pest Management
MoA	Ministry of Agriculture of the Republic of Azerbaijan
PAN	Pesticide Action Network
PPP	Plant protection product
RAEIM/Azeraqrar	Regional Agrarian Science and Innovation Center of the Ministry of Agriculture of Azerbaijan. Due to reorganisation within the Ministry of Agriculture (MoA) the partner structure has changed and Azeraqrar is replacing RAEIM since summer 2021
WHO	World Health Organization

Terms and definitions

ECOserve	The programme "Management of natural resources and safeguarding of ecosystem services for sustainable rural development in the South Caucasus (ECOserve)" is part of the wider German support in the priority area "Environmental policy, conservation and sustainable use of natural resources in the South Caucasus".
Integrated Pest Management (IPM)	The careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human and animal health and/or the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms (FAO/WHO 2014).
Kurdamir pilot site	The RAEIM/ Azeraqrar farm provides a pilot area ("Kurdamir pilot site") for identifying and implementing Good Agricultural Practices in the frame of ECOserve and as a base for further implementation of promising sustainable alternatives in farmers' field.
ECOserve pilot farmers	Promising sustainable Good Agricultural Practices including Integrated Pest Management, identified on the Kurdamir pilot site, will be further implemented in farmers' fields. For this purpose, a number of Kurdamir pilot farmers have been linked to the Kurdamir pilot site in the frame of ECOserve.
Highly hazardous pesticides	The FAO/WHO International Code of Conduct on Pesticide Management (2016) defines highly hazardous pesticides (HHP) as pesticides that are acknowledged to present particularly high levels of acute or chronic hazards to health or environment.
Microbial pesticide (biopesticide)	Biologically effective agents made from microorganisms, e. g. bacteria, fungi, viruses or protozoans. Microbial pesticides can control many different kinds of pests, although each individual active ingredient is relatively specific for its target pest(s). For example, there are fungi that control certain weeds and other fungi that kill specific insects.
Pest	According to FAO/WHO 2014 definition a pest

	is any species, strain or biotype of plant, animal or pathogenic agent injurious to plants and plant products, materials or environments and includes vectors of parasites or pathogens of human and animal disease and animals causing public health nuisance. This includes insects, mites or other animal pests, plant diseases and weeds. **Be aware, that in some publications regarding plant protection the term 'pest' refers to insects, mites, nematodes and other animal pests only**.
Pesticide	Any substance, or mixture of substances of chemical or biological ingredients intended for repelling, destroying or controlling any pest, or regulating plant growth (FAO/WHO 2014). This includes also microbial pesticides.
Plant protection product (PPP)	A pesticide product intended for preventing, destroying or controlling any pest causing harm during or otherwise interfering with the production, processing, storage, transport or marketing of food, agricultural commodities, wood and wood products. This definition clearly links plant protection products (PPP) and pesticides. The terms are not, however, synonymous because pesticides are a broader category that include biocides used to control organisms not involved in plant or crop production. Both terms, pesticide and plant protection product, include insecticides, fungicides and herbicides. Both terms also include biopesticides or microbial pesticides.

1. Introduction and context

1.1 Brief information on ECOserve

The programme “Management of natural resources and safeguarding of ecosystem services for sustainable rural development in the South Caucasus” (ECOserve) is part of the wider German support in the priority area “Environmental policy, conservation and sustainable use of natural resources in the South Caucasus”, which aims at the sustainable use of natural resources, biodiversity conservation and climate protection, particularly for the benefit of the rural population, and at increasing the share of renewable energies in the energy mix and enhancing energy efficiency.

The objective of ECOserve is to improve the pre-conditions for the sustainable and biodiversity-friendly use of natural resources in the prevailing land-use systems in the South Caucasus, with a special focus on energy security for the rural population. The programme addresses the core problem in each of the three countries of the South Caucasus, Armenia, Azerbaijan and Georgia, that the predominant land-use systems are threatened by serious, progressive degradation.

In Azerbaijan, ECOserve aims to support the achievement of the Strategic Roadmap on production and processing of agricultural products in the Republic of Azerbaijan, focusing on target 7 of the roadmap, which aims to protect the environment, foster sustainable use of natural resources and build enhanced climate resilience in agriculture.

Part of the interventions of ECOserve is to implement a pilot project. The objective of the pilot project is to introduce environmental-friendly and sustainable practices of natural resource management in the agricultural sector of Azerbaijan. Therefore, activities of the pilot project will focus on Good Agriculture Practice (GAP), that will be implemented, tested and evaluated jointly with several stakeholders.

1.2 Context of developing an Integrated Pest Management Concept

To establish the pilot project, a cooperation with a local intermediator and service provider for farmers, namely Kurdamir Regional Agrarian Science and Innovation Center of the Ministry of Agriculture of Azerbaijan (Kurdamir RAEIM), has been established. Kurdamir RAEIM offered 104 ha of their farm to be used for the ECOserve pilot project. ECOserve supports RAEIM in identifying and implementing Good Agricultural Practices on the provided land as a base for further implementing of promising sustainable alternatives in farmers’ field. Due to a reorganisation within the Ministry of Agriculture (MoA) the partner structure has changed and Azeraqrar is replacing RAEIM since summer 2021.

A Farm Management Plan for the Kurdamir pilot site of the RAEIM/ Azeraqrar farm has been developed by ECOserve[1] comprising recommendations on measures and agricultural practices of climate-adapted and biodiversity friendly farm management, taking into consideration small and medium-size farmer needs. Subsequent to the Farm Management Plan, ECOserve developed an upscaling concept for implementation on the agricultural land of small farmers (GAP4AZ).

[1] Wehinger, T. 2020: Kurdamir RAEIM Demonstration Farm for Good Agricultural Practice. Farm Management Plan. Report submitted to ECOserve, 67 pp

Following environmentally friendly Good Agriculture Practices were identified in the Farm Management Plan and upscaling plan:

- Integrated soil fertility management (ISFM) based on a soil analysis with the efficient utilization of fertilizer and other means to enhance soil fertility.
- **Integrated Pest Management (IPM) – especially in highly pesticide intensive crops (e.g. cotton).**
- Development and integration of a suitable crop rotation for farmers' land.
- Introduction or use of draught and salt tolerant plants on tillage land (endemic Fabaceae, amaranth, sorghum, quinoa etc.).
- Testing cover crops and their integration in the crop rotation.
- Establishment of hedgerows and other plantation to enhance biodiversity in agriculture holding and reduce wind erosion and evaporation.
- Establishing agroforestry plantations (hedgerows with productive trees and shrubs such as olive trees, hazelnuts, pommes grenade, mulberry, etc.).
- Establishment of flower strips for pollinators (bees and other insects).
- Introduction of conservation agriculture and reduced-till technology/methods.
- Increase of soil fertility by preparation of compost and the use of other organic manure (e.g. starter culture bio-humus) or and charcoal.

The focus of the pilot project has been set on the main crops of the region:

- **Wheat**
- **Barley**
- **Alfafa**
- **Cotton.**

1.3 Objectives of an Integrated Pest Management concept for the Kurdamir pilot site and ECOserve pilot farmers

During the implementation phase of the Kurdamir pilot site it became obvious that there is not sufficient knowledge and/or documentation on the prevailing pests and diseases in the Kurdamir region. Pesticides are applied without proper monitoring and awareness of the actual infestation situation. The ECOserve IPM concept presented here has been developed to provide environmentally friendly Good Agriculture Practices and plant protection alternatives for the Kurdamir pilot site, for ECOserve pilot farmers and other small holding farmers in the Kurdamir area.

The ECOserve IPM concept was developed in a process consisting of three steps:

- **Assessment of major pest problems and commonly used plant protection measures in the Kurdamir area**
  To be able to develop relevant measures against major pest problems it was a necessary prerequisite to identify the main pests and diseases in the pilot crops wheat, barely, cotton and alfalfa in Kurdamir and the most widespread plant protection methods and plant protection products against these main pests in Kurdamir/Azerbaijan. The assessment also considered the consequences of the current plant protection practices on the environment, biodiversity, human health and other relevant side effects.

- **Development of a concept on Integrated Pest Management**
  Based on the assessment, a concept on IPM measures for the main pests and diseases of the focus crops in Kurdamir was developed. Emphasis was on preventive cultural measures and suitable alternative biological methods available in Azerbaijan. But also promising biological methods, not yet sufficiently tested or available in Azerbaijan, were considered for their potential. An additional aim was to define monitoring procedures and treatment thresholds, whenever possible, and to identify suitable, less toxic pesticides with a special focus on lowering the toxicity/ harmfulness for environment, biodiversity and human health and considering also EU regulation/standards. The IPM concept concentrated on options which are suitable for small farmers. The IPM concept includes IPM guidelines for the major pest problems in each ECOserve focus crops.

- **Training on the ECOserve IPM concept and guidelines**
  In December 2021 an IPM trainers training was conducted based on the ECOserve IPM concept and guidelines. The training lasted four days and due to the COVID-19 restrictions it was held as an online training. Feedback comments by the training participants were considered in the finalization of the concept. The IPM guidelines will be distributed in the form of an IPM brochure to relevant stakeholders.

2. Agricultural production in the Kurdamir area and on the Kurdamir pilot site

2.1 Agricultural production systems

To characterize the agricultural production systems in the Kurdamir area, ECOserve conducted a socio-economic survey among 120 farmers in the area in 2020[2]. Most surveyed farmers (63 %) are small holders with farm sizes of 1-5 hectares. Ca. 28 % of the farms have a size of 6-11 hectares, and 9 % have more than 11 hectares of land. The most common crops produced in the small households are wheat (53%), barley (39%), alfalfa (24%) and pomegranate (24%). Among all surveyed farmers in the region 43 % grow barley, 42 % wheat, 9 % cotton and other crops. The area planted with cotton has in the past decade increased from a very small share to about 9 % in 2018. Almost all households keep animals. In average a farm household keeps 5 cattle, 29 sheep, 9 goats, 48 chicken. Inappropriate agricultural practices have led to widespread soil degradation.

Detailed information on the agricultural production (inputs and outputs) on the Kurdamir pilot site is provided in the margin and profit-loss analysis of the Farm Management Plan developed for ECOserve in 2020[1] (see chapter 5.1 of the Farm Management Plan or ECOserve Excel file GAP4AZ_Mod09_Agriplan_1_1). The margin and profit-loss analysis was based on estimated yields of the focus crops on the Kurdamir pilot site. The estimated yields of the focus crops that were used for calculation are shown in Table 1:

[2] Ecoenergy LLC, 2020: Socio-economic study on resource use in agriculture and rural households in Kurdemir region. Report to ECOserve, GIZ, 41 pp.

Table 1: Estimated yields and prices used in the margin analysis of focus crops on the Kurdamir pilot site

Crop	Estimated yield	Estimated price/t in 2020	Estimated price/t incl. MoA subsidies
Wheat	3,5 t/ha	400 AZN/t	600 AZN/t
Barley	3,5 t/ha	350 AZN/t	510 AZN/t
Alfalfa	3,2 t/ha	300 AZN/t	460 AZN/t
Cotton	2,5 t/ha	700 AZN/t	920 AZN/t

2.2 Use of fertilizer and pesticides

Most small farmers in the Kurdamir area fertilize their fields with chemical N- fertilizer and with animal manure from livestock[2].

More than half of the surveyed farmers in the Kurdamir area use pesticides. The use of pesticides is, however, strongly correlated to farm size. Thus, the majority of small holders with farm sizes of less than 11 ha report, that they do not use pesticides at all. Whereas 72 % of farmers with 11 ha and more use chemicals. In their decision on the use of pesticides, farmers depend on the recommendations and the advice of neighbouring farmers and pesticide retailers. Seen over all crops (including beans, vegetables, melons a. o.) in the Kurdamir area, herbicides are the most used pesticides, followed by insecticides and fungicides[2].

Pesticide use in cereals is limited to herbicides and in rare cases to fungicides against Powdery mildew. The low input of pesticides in grain production may be due to the low yield and the very hot temperature in April until June, when the harvest starts[1].

Alfalfa is grown as green fodder for own livestock. It is sown in autumn and cut several times a year. The alfalfa crop is maintained for four-seven years in one field, before it is ploughed under.

The most intensive crop regarding the use of pesticides is cotton. The ECOserve margin analysis of cotton indicates the use of eight different pesticides (including plant growth regulators). Other means of pest management, such as crop rotation, cover crops, intercropping and bio-pesticides are not practiced or not known. Before the cooperation with ECOserve, Integrated Pest Management was not practiced on the Kurdamir pilot site. Staff members of the Kurdamir RAIM/Azeraqrar station reported, however, that the biological control method of using the parasitic wasp *Trichogramma* has occasionally been used for control of corn borer[1].

According to the survey conducted by ECOserve in 2020[2], cotton production is usually contract based. The company P-Agro LTD, for example, engages in the production, purchase, processing and sale of raw cotton in the Kurdamir area. The company is located in Baku, has representative offices in 17 regions of Azerbaijan and two processing plants in Saatli and Ujar. For the production of cotton, P-Agro provides agro-technical services to farmers. The enterprise has 24 tractors in Kurdamir. The enterprise provides farmers with seeds (local and Turkish), chemicals and fertilizers, carries out soil works, harvests and purchases the crops. Costs per hectare are approximately 650-700 AZN. The yield is

approximately 2-2,5 t /ha. The purchase price of cotton has recently been 630-650 AZN /t (depending on the variety)[2]. In the Kurdamir region, other companies such as MTK and the Kurdamir Cotton Plant are engaged in similar activities. Unlike P-Agro, these enterprises, however, do not provide agricultural services, but concentrate on the purchase of cotton from farmers.

Farmers growing cotton under a contract, have two options regarding agrochemical inputs: (1) They can use the agrochemicals recommended and provided by the contract company and pay for them at the end of the harvest season to the cotton company. This means that costs for used agrochemicals are deducted from the payment for the cotton harvest. (2) Alternatively, farmers are free to buy agrochemicals or other inputs from other sources and pay the costs directly to the retailer (S. Abbasov, 2021, personal communication).

2.3 Production of wheat, barely, alfalfa and cotton by Kurdamir pilot farmers

The agricultural production in Kurdamir has been extensively mapped in general by the ECOserve socio-economic study conducted in 2020[2]. To get additional information on the prevailing pest situation, common protection measures and farmers' perception, eight Kurdarmir pilot farmers were interviewed in summer 2021 on their production routines, experience and plant protection methods (see Table 2).

Table 2: Results of the interview of eight Kurdamir pilot farmers on their production of wheat, barley, alfalfa and cotton

Methodology of the survey

The interview was designed and conducted by Gunel Qurbanova in July 2021.
Eight Kurdamir pilot farmers were interviewed. Farmers were presented with a picture atlas of pests and diseases. For interview questionnaire see App. 1.

Alfalfa

- **Tillage:** ploughing, smooth out of soil
- **Fertilizer:** NPK

- **Seed:** from market
- **Irrigation:** after cutting, if it is possible to get water
- **Weed control:** in spring, beginning of March
- **Measure of chemical and biological:** none
- **Harvest:** min 120 - max 250 alfalfa hay bales (25kg -1hay), per ha

Alfalfa is planted to almost 25% of their total area. Farmers cut the alfalfa field 3 – 4 times/year. If the harvest is stable, they keep one alfalfa field for 4-5 years. In the views of the farmers, the main reason for decreases of quality and quantity is water shortage, another reason can be Cuscuta. Almost all interviewed farmers sow alfalfa mainly to feed it to their own livestock.

Wheat

- **Tillage:** ploughing, smooth out of soil
- **Fertilize**r: NP during seeding, Ammonium nitrate in spring, Carbamide in April
- **Seed:** from the market or Zabrad seed farming
- **Irrigation:** after seeding, if it is possible to get water
- **Weed control:** in spring-beginning of March
- **Measure of chemical and biological:** Tebuconazole against yellow rust
- **Harvest:** min1000 - max 5000 kg per ha

Most of the interviewed farmers sow wheat as main crop. They sow wheat for both, personal use and sale. The maximum and minimum yield is difficult to determine, because it is different every year. The main reason for the fluctuation of the yield level are weather conditions. All farmers complained about water shortage. If it does not rain during the season, it has a negative impact on the yield, if heavy rain occurs during the flowering period of wheat, it also has a negative impact. Farmers do not think that diseases and pests decrease the wheat yield. Therefore, they do not apply fungicides and insecticides. The interviewed farmers face very rarely rust, smut and corn ground beetle in their field.

Barley

- **Tillage:** ploughing (25-30cm), after this smooth out of soil
- **Fertilize**r: Amofos NP
- **Seed:** Tartar Scientific-Research Institute, variety Garabag 22
- **Irrigation:** after seeding, if it possible to get water
- **Weed control:** thistle-mechanically, Wild oat-herbicides, Barbarea vulgaris-herbicides after 15th April
- **Measure of chemical and biological:** Sunn pest, special mechanical measure
- **Harvest:** min 2100 - max 4500 per ha

Barley is estimated to be the 2nd main crop after wheat. The farmers prefer dryland farming and they do not have any have other option. Farmers complained about water shortage in the last year. Traditionally farmers irrigate the field once in February. They prefer local varieties as they are more robust in case of water shortage. They sow barley for both, personal use and sale. Maximum and minimum yield is changing according to weather conditions and the farmers approach to farming.

Cotton

Only one of the interviewed Kurdamir pilot farmers is sowing cotton. The interviewer was told, that farmers with larger areas (80-100 ha) rent out their fields to big cotton companies. Farmers sign a contract at the beginning of the year with one of the big cotton companies. The companies provide seed, fertilizer, pesticides, workers etc. to the farmer. At the end of the year, the companies deduct their expenses from the yield and pay

farmers in accordance with the terms of the contract.
Summary and interviewers findings
• Neighbouring farmers have similar planting habits and plant protection methods. • Farmers have formed their planting habits by applying the experience of each other, especially their neighbours, without checking its accuracy and effectiveness. • Weed control is done without assessing the magnitude of the problem. **Main problems in the view of the interviewed farmers** • Unequal water distribution of water resource. • Difficulty in finding rental equipment for sowing and applying herbicides. **Main problems in the view of the interviewer** • Local farmers do not use biological control. • Farmers had low knowledge on pest and diseases. • Some farmers even do not know/are not aware of the name and quality of the pesticide, they are using.

The most urgent problem in the interviewed farmers' perception was the water shortage and availability of irrigation water. The interview further showed, that the farmers' knowledge level regarding pests and diseases and their control was rather low. Most of the interviewed pilot farmers could not recognize or name specific diseases and pests in their fields. Some of the farmers did not know the name of the herbicide or insecticide, they used, but referred instead to e.g. "the one in the red package". Among weeds, farmers specifically complained about Dodder (*Cuscuta sp.*), thistle (*Circius sp.*) and Common wild oat (*Avena fatua*). All farmers used herbicides in the beginning of spring. One farmer used fungicides against rust diseases.

In some points, contradicting answers were given by farmers (e.g. a farmer stated not using pesticides, yet mentioned herbicide use later-on) and there were also some minor contradictions compared to the results of the ECOserve socio-economic survey. Yet overall, results were complementing each other and differences seem to underline the findings of both, the socio-economic study and the interview, that the knowledge of the farmers regarding plant protection is not very profound.

3. Assessment of major pest problems and commonly used plant protection measures in the Kurdamir area

3.1 Methodology of the assessment

In order to assess the major pest problems and commonly used plant protection measures in the Kurdamir area, a number of organisations were contacted and personal or online meetings were held with relevant resource persons and stakeholders. Additionally, publications and websites were screened. Information obtained from the following sources was evaluated:

- Azerbaijan State Agrarian University
- Agrarian Science and Innovation Centre (AEIM)
- Crop Husbandry Research Institute
- Plant Protection and Technical Crop Research Institute

- Kurdamir Regional Agrarian Science and Innovation Centre
- Azeraqro State Production and Processing Unity
- Absheron Experimental Centre under Agrarian Service Agency
- Large agricultural company producing wheat and barley in the Hajigabul district
- Large cotton company operating in the Kurdamir area
- Kurdamir State Agrarian Development Centre
- Kurdamir Biological Laboratory
- Publicly accessible information and statistical data from agricultural organizations in AZ, such as MoA , Agrarian Service Agency (ASA), and others
- Scientific literature from Azerbaijan
- Scientific literature from the world
- National consultants and staff of the ECOserve project
- Results of the ECOserve socio-economic study in Kurdamir 2020
- Results of the ECOserve interview with farmers in Kurdamir 2021.

3.2 Pests, diseases and weeds in the ECOserve focus crops in Azerbaijan and various recommendations for control from different sources

The following Tables 3-6 give an overview over lists of pests, diseases and weeds in wheat, barley, alfalfa and cotton and recommended control measures in Azerbaijan and the Kurdamir area by various sources. The individual lists can be found in the Appendices 2-17.

*Table 3: Overview over lists of pests, diseases and weeds and control measures in **wheat***

Title of list/information	Source of information	Appendix number
Statistical data on plant protection works in the Kurdamir region from 2019-2021 by the Agrarian Service, Ministry of Agriculture of Azerbaijan	Agrarian Service Agency (ASA), 2021	See App. 2
Major pests, diseases and weeds in Agrodairy LLC wheat and barley production near the Kurdamir area and applied control measures	Mammadli, T. and Aslanova, K., 2021	See App. 3
Control measures recommended by the Agrarian Service Agency (ASA) of Azerbaijan against selected pests and diseases in wheat	Agrarian Service Agency (ASA), 2021	See App. 4
Measures to control rust diseases in grain recommended by the Ministry of Agriculture of Azerbaijan	Ministry of Agriculture of the Republic of Azerbaijan, 2021	See App. 5
Diseases of wheat in Azerbaijan and recommendations to wheat growers by Crop Husbandry Research Institute (AEIM)	Karimova, Sh, Ahmadov, B, Tamrazov, X, Jahangirov, A 2015	See App. 6
Diseases of wheat in Azerbaijan and recommendations for control measures by the Azerbaijan State Agrarian University	Jafarov, Ibrahim, 2012	See App. 7

*Table 4: Overview over lists of pests, diseases and weeds and control measures in **barley***

Title of list/information	Source of information	Appendix number
Statistical data on plant protection works in the	Agrarian Service Agency	See App. 2

Kurdamir region from 2019-2021 by the Agrarian Service, Ministry of Agriculture of Azerbaijan	(ASA), 2021	
Major pests, diseases and weeds in Agrodairy LLC wheat and barley production near the Kurdamir area and applied control measures	Mammadli, T. and Aslanova, K., 2021 (Agrodairy)	See App. 3
Important disease of barley in Azerbaijan and control measures as forwarded by Namila Azizova	Novruzlu, Garib and Azizova, Namila, 2016	See App. 8
Diseases of barley in Azerbaijan and recommendations for control measures by the Azerbaijan State Agrarian University	Jafarov, Ibrahim, 2012	See App. 9

*Table 5: Overview over lists of pests, diseases and weeds and control measures in **alfalfa***

Title of list/information	Source of information	Appendix number
Statistical data on plant protection works in the Kurdamir region from 2019-2021 by the Agrarian Service, Ministry of Agriculture of Azerbaijan	Agrarian Service Agency (ASA), 2021	See App. 2
Major pests and weeds in Agrodairy LLC alfalfa production and applied control measures	Mammadli, T. and Aslanova, K., 2021	See App. 10
Quarantine weeds of alfalfa in Azerbaijan, status 2021	Agrarian Service Agency (ASA), 2021	See App. 11
Pests and diseases of alfalfa and seed clover in Azerbaijan and recommendations to Alfalfa growers by the agro-company HH-Group	Huseynov, Huseyn, 2018	See App. 12
Diseases of alfalfa in Azerbaijan and recommendations for control measures by the Azerbaijan State Agrarian University	Jafarov, Ibrahim, 2012	See App. 13
Pests of alfalfa and recommendations to alfalfa growers according to a guide book on agricultural crops in Azerbaijan from 1965	Samadov, N., Ibrahimov, H., Khalilov, B., 1965	See App. 14

*Table 6: Overview over lists of pests and diseases and control measures in **cotton***

Title of list/information	Source of information	Appendix number
Statistical data on plant protection works in the Kurdamir region from 2019-2021 by the Agrarian Service, Ministry of Agriculture of Azerbaijan	Agrarian Service Agency (ASA), 2021	See App. 2
Main diseases of cotton in Azerbaijan according to the Agrarian Services Agency (ASA) and recommendations how to control them	Agrarian services agency (ASA), 2021	See App. 15
Measures to combat pests in cotton recommended to cotton growers by the Research Institute for Plant Protection and Industrial Crops in Ganja (Azerbaijan)	Farajova Sevil, Veliyeva Mahira, 2015	See App. 16
Pests of cotton in Azerbaijan and recommendations to cotton growers by the Azerbaijan Ministry of Agriculture	Azerbaijan Ministry of Agriculture, 2021	See App. 17

3.3 Main pests, diseases and weeds in the ECOserve focus crops in the Kurdamir region and current prevailing control measures

Based on the statistical data from the Agrarian Service Agency (ASA) for the Kurdamir area (App. 2), the information from a large agrocompany on their production in the Padarchol area close to Kurdamir (App. 3, App. 10), the interview with ECOserve pilot farmers (Table 2), personal communication with an agronomist from the Kurdamir cotton company P-Agro LLC (G. Quarbanova, September 2021) and other experts, resource persons, stakeholders and ECOserve experts' information, the following pests, diseases and weeds are considered to be main problems in the Kurdamir area (Table 7). Data on the level of infestations with the main pests, diseases and weeds, such as e.g. number of specimen/plant, number of specimen/ha or percent infested plants/ha, are not sufficiently available. Likewise, data on the yield loss caused by the prevailing pests, diseases and weeds in the focus crops are not sufficiently available.

Table 7: Main pests, diseases and problem weeds in focus crops in Kurdamir small holder farms

Crop	Pests, diseases, problem weeds	Scientific name	Comments
Wheat	**Pests:** Aphids Corn ground beetle Click beetles **Diseases:** Yellow rust/Stripe rust Brown rust/Leaf rust Black rust/Stem rust Septoria	 (several species) *Zabrus tenebriodes* *Elateridae* (only young seedlings) *Puccinia striiformis f. sp. tritici* *Puccinia triticina (formerly P. recondita)* *Puccinia graminis f. sp. tritici.* *Septoria sp.*	 Aphids only problematic, if virus transmission. Zabrus very rare. Elateridae only problematic for young seedlings.
Barley	**Pests:** Aphids Corn ground beetle Click beetles **Diseases:** Yellow rust/Stripe rust Brown rust/Leaf rust Black rust/Stem rust Powdery mildew	 (several species) *Zabrus tenebriodes* *Elateridae* *Puccinia striiformis f. sp. tritici* *Puccinia triticina (formerly P. recondita)* *Puccinia graminis f. sp. tritici.* *Blumeria graminis sp. tritici (syn. Erysiphe graminis)*	
Alfalfa	**Pests:** Lucerne weevil	 *Hypera postica* syn. *Phytonomus variabilis*	Only in seed production
Cotton	**Pests:** Cotton bollworm Two-spotted/Red spider mite Aphids **Diseases:** (ASA does not monitor cotton diseases)	 *Helicoverpa armigera* *Tetranychus urticae* *Aphis gossypii* and other species	

All crops	**Broad leave weeds:** Cirsium thistle **Grass weeds:** Common wild oat Perennial ryegrass **Parasitic weed** Cuscuta/Dodder	 *Cirsium sp.* *Avena fatua* *Lolium perenne* *Cuscuta sp.*	 Mainly in alfalfa
Sources of information: Agrodairy personal comm. 2021, ASA statistic 2019-2021, ECOserve Socioeconomic study 2020, pilot farmer interview 2021, personal comm Samir Abbasov and Stephan Kroel 2021, GIZ procurement 2021, FAO 2019 Azerbaijan Cotton sector review. Agronomist cotton company P-Agro Kurdamir 2021.			

3.4 Prevailing plant protection measures in the Kurdamir area

The main control measure against any kind of plant protection problem in Kurdamir is the application of pesticides. As described in chapter 2.2, pesticide use in wheat and barley is, however, often limited to herbicides and in rare cases to fungicides against mildew or rust diseases. The crop with the highest input of pesticides is cotton, where a large number of insecticides regularly is applied. Alfalfa in farmers' fields is usually not treated with pesticides.

Weeds are in some cases removed mechanically by hand (especially in alfalfa). Biological control methods have been reported to occasionally be used as in the case of releasing the parasitic wasp *Trichogramma* sp. in cotton and corn. One of the ECOserve pilot farmers in Kurdamir reported in the interview about a traditional method to control Corn ground beetle (*Zabrus tenebriodes*). To remove the beetles feeding on the wheat ears, two persons go along the opposite borders of the field with a long string between them, wiping the string over the ears and stripping off the beetles. No information is available, how effective this method is in reducing Corn ground beetle infestation. All in all, these alternatives to pesticides seem to be very rarely used.

Table 8: Prevailing pesticides applied in the Kurdamir area

Against		**Pesticide active ingredient**
Pests	Aphids, thrips, beetles, bugs in cereals	Cypermethrin
		Deltamethrin
		Lambda-cyhalothrin
		Imidocloprid
	Butterfly larvae in cereals	Emamectin Benzoate
		Lambda-cyhalothrin
	Lucerne weevil in alfalfa	Emamectin Benzoate
		Lambda-cyhalothrin
	Insect pests in cotton	Emamectin benzoate
		Abamectin + Spirodiclofen
		Acetamiprid
		Methomyl
		Deltamethrin
		Cyhalothrin
		Carbosulfan

Diseases	Rust, Powdery mildew, Septoria in cereals	Tebuconazole
	Cotton diseases	Fludioxonil Metalaxyl-M (seed treatment)
		Thiram (seed treatment)
Weeds	Broad leave in cereals	2,4-D Amine
		Florasulam
		2,4-D 2-Ethylhexyl Ester + Florasulam
		MCPA (2-methyl-4-chlorophenoxyacetic acid)
	Grass weeds in cereals	Mesosulfuron-methyl + Thiencarbazone-methyl + Iodosulfuron-methyl-sodium + Mefenpyr-diethyl
		Clodinafop-propargyl + Cloquintocent- mexyl
	Grass weeds in cotton	Quizalofop-p-ethyl
	Parasitic weed Cuscuta	Imazomax

An overview of the prevailing pesticides used against different pest groups in the focus crops in the Kurdamir area are listed in Table 8. The information is mainly based on investigations done for the ECOserve Farm Management Plan in 2020, personal communication with Agrodairy LLC and the Food and Agricultural Organisation (FAO) report on cotton production in Azerbaijan[3]. A few of the listed pesticides (e.g. Fludioxonil Metalaxyl-M) have been ordered by the ECOserve project to replace highly hazardous pesticides on the Kurdamir pilot farm.

3.5 Impacts of pesticides on the environment, biodiversity and human health

The term pesticide covers a wide range of compounds including insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, microbial and biopesticides, plant growth regulators and others. Pesticides are substances designed to be toxic to organisms that affect plants' growth, such as fungi, insects or weeds. Ideally, pesticides should not be harmful to non-target species including man, however, this is not the case. Pesticides released to the environment affect the water, soil, air, biodiversity, farmers and consumers to a smaller or larger extend, depending on the pesticide.

Impact on the environment (water, soil, air)

Pesticides trickle into soils and groundwater and can end up in drinking water. When pesticides reach water bodies, they are absorbed or ingested by aquatic life forms, such as fish, or the chemicals may alter the water body's PH, thereby interfering with the normal functioning of aquatic life. Pesticides reaching the soil can harm soil micro-organisms and have a negative effect on microbial functions, such as breaking down organic substances. Pesticide spray can drift and pollute the air. Pesticides can be blown away, creating danger for animals and people living in nearby areas. Some pesticides survive in the environment longer than others and are called persistent. Persistent pesticides are found in soil and water and tend to bioaccumulate in the food chain and subsequently accumulate in animals and humans.

[3] FAO 2019: Azerbaijan Cotton sector review. Food and Agriculture Organization of the United Nations Rome, report number 37, Nov 2019, 112 pp.

Impact on biodiversity
In an ecosystem, interdependent populations of various species deliver so-called 'ecosystems services', such as pollination, decomposition of organic material or the retention and cycling of nutrients and water. Pesticide use can have short-term toxic effects on directly exposed organisms, and long-term effects can result from changes to habitats and the food chain. Pesticides can persist in the environment for decades and pose a threat to the ecological system upon which food production depends. Excessive use and misuse of pesticides result in contamination of surrounding soil and water sources, causing loss of biodiversity, such as destroying beneficial insect populations that act as natural enemies of pests or harming wild bees, important for pollination.

Impact on farmers' and consumers' health
Contact with pesticides can happen in a lot of ways. Farmers applying or handling pesticides can e.g. inhale pesticides or get skin contact to pesticides. Pesticide residues can be found in food products and be eaten. Pesticides in spray drift can spread over very long distances and be inhaled by people.

Pesticides can cause:

- short-term adverse health effects, called **acute toxicity,**
- in the worst-case deadly consequences after one sole consumption, breathing, or contact with the skin, called **fatal effects,**
- as well as long-term chronic adverse effects **(chronic toxicity)** that can occur months or years after exposure to low doses repeated over a period of time; chronic toxicity is in some cases suspected to cause genetic defects to body cells that can be passed on to future generations, cancer, Parkinson's disease, damage to the unborn child or other diseases.

The most at-risk population are people who are directly exposed to pesticides. This includes agricultural workers who apply pesticides and other people in the immediate area during and right after pesticides are spread. The general population – which is not in the area where pesticides are used – is exposed to pesticide residues through food and water and spray drift, though to significantly lower dosages.

3.6 International classification of highly hazardous pesticides

The **World Health Organisation (WHO**) groups the chemical agents of pesticides into four toxicity classes according to their hazard to human health:

- Class Ia - extremely hazardous,
- Class Ib - very hazardous,
- Class II - moderately hazardous,
- Class III- low hazard,
- Table 5 pesticides without acute toxicity.

Not all pesticides are classified by the WHO.

The **FAO/WHO International Code of Conduct on Pesticide Management (2016)**[4] defines highly hazardous pesticides (HHP) as pesticides that are acknowledged to present

[4] FAO/WHO 2016, International Code of Conduct on Pesticide Management. Guidelines on Highly Hazardous Pesticides. http://www.fao.org/3/i5566e/i5566e.pdf

particularly high levels of acute or chronic hazards to health or environment according to **WHO classification** or the **Globally Harmonized System of Classification and Labelling of Chemicals (GHS)** or their listing in relevant binding **international agreements or conventions**. In addition, pesticides that appear to cause severe or irreversible harm to health or the environment under conditions of use in a country may be considered to be and treated as highly hazardous. These include pesticides classified as Class Ia ("extremely hazardous") or Ib ("very hazardous") according to the WHO, as carcinogenic ("carcinogenic" 1a, 1b), mutagenic ("mutagenic" 1a, 1b) or harmful to fertility and unborn life ("toxic to reproduction" 1a, 1b) according to the GHS, listed in Annex A or B of the **Stockholm Convention**, in Annex III of the **Rotterdam Convention** or in the **Montreal Protocol**. WHO/FAO member countries are recommended to no longer register and trade these chemicals.

The international nongovernmental organisation **Pesticide Action Network (PAN)** proposes even higher standards for the definition of highly hazardous pesticides and maintains a so-called PAN-list of highly hazardous pesticides (PAN HHP-list). The PAN HHP-list is based on the **FAO/WHO criteria**, but expands them by additionally including for example active substances that are classified as "**probably carcinogenic**" according to the **US Environmental Protection Agency (EPA)** or the **International Agency for Research on Cancer (IARC)** of the WHO, or that are "**very toxic to bees"** due to their broad-spectrum effect. The PAN HHP-list is highly respected by international actors, but not binding for international, EU or national agreements.

3.7 Action modes of pesticides and impacts on the environment

Pesticides have different modes of action, that can have influence on their harmfulness to non-target organisms.

- Broad-spectrum versus selective insecticides/fungicides:
  Broad spectrum (non-selective) insecticides kill insects indiscriminately, without regard to the species. This means a broad-spectrum insecticide will also kill natural biological enemies of the pest insect and are often toxic to bees. These types of pesticides include most **neonicotinoid** (e.g. Acetamiprid against cotton bollworm and aphids)**, organophosphate, pyrethroid and carbamate** insecticides. Selective insecticides are designed to target only selected organisms, thus not killing biological enemies (e.g. Pyridincarboxamide against cotton aphids).

  Similarly, there are broad-spectrum fungicides, aiming at protection against a broad range of different diseases, and selective fungicides, designed to give protection against a specific disease.

- Broad spectrum versus selective herbicides:
  Broad spectrum herbicides are formulated to control both, broadleaf and grassy weeds and other plants (e.g. Glyphosate). Selective herbicides are toxic to some plant species but less toxic to others. This means they are designed to kill either broad leaf weeds or grasses or specific species (e.g. 2,4,D against broad leave weeds).

- Contact versus systemic pesticides:
  A 'contact' pesticide is a non-systemic pesticide that is not absorbed by the plant and sticks to plant surfaces where it has been applied. Contact insecticides must be absorbed through the external body surface of the insect and affect only the insects, that have been sprayed. Contact fungicides are likewise not absorbed by the plant. They provide a protective barrier that prevents the fungus from entering and damaging plant tissues.

  Systemic pesticides are absorbed by the plant and can move through the plant tissue from the site of application to other parts of the plant. Systemic insecticides kill insects that feed on the plants and often retain a longer residual protection against insects (e.g. neonicotinoids such as Acetamiprid). Systemic fungicides are taken up by the plant and redistributed through the xylem vessels.

- Preventive versus curative fungicides:
  Preventive fungicides work by preventing the fungus from getting into the plant. Preventive fungicides must come into direct contact with the fungus, and they have to be re-applied to new plant tissues (as leaves expand in the spring) or if the product washes off. Curative fungicides affect the fungus after infection. This means they can stop the disease after the infection has started or after first symptoms are observed.

- Persistent pesticides:
  Some of the older, cheaper (off-patent) pesticides are very slowly degraded and can remain for years in soil and water (e.g. DDT). These chemicals have been banned by countries who signed the 2001 Stockholm Convention, an international treaty that aims to eliminate or restrict persistent organic pollutants. But there are countries in which they are still used.

Generally, selective pesticides are less harmful to the environment and biodiversity, as they are mainly affecting the target pest/disease/weed and spare the non-target organisms. Selective pesticides are, however, not available for all target organisms and are often more expensive. Systemic pesticides are often less harmful to non-target organisms, as they only affect organisms attacking the plant. Contradicting examples are, however, systemic neonicotinoids, that have a long persistence in plants and are therefore highly toxic to bees. The human toxicity of a pesticide depends on its function and other factors. Insecticides tend generally to be more toxic to humans than herbicides.

3.8 Pesticides currently used in Kurdamir and their potential impact on environment and human health

Several of the prevailing pesticides used in the Kurdamir area are categorized by the WHO, FAO/WHO or PAN as highly hazardous for human health or causing relatively high damage to the environment or are not approved in the EU (Table 9).

Most prevailing insecticides are broad-spectrum, non-selective insecticides and will therefore also reduce populations of beneficial insects. **Carbosulfan** and **Methomyl** are from the chemical group of carbamates. These products are cholinesterase inhibitors and therefore highly toxic to humans. **Carbosulfan** is internationally banned by the Rotterdam

Convention and no longer approved in the EU and United States**. Imidacloprid** and **Cypermethrin** are no longer approved in the EU because of their negative environmental effects. Products containing **Abamectin** and **Emamectin** are relatively selective and potentially less disruptive to beneficial insect populations, however, **Abamectin** is highly toxic to humans, has a high acute toxicity and is suspected to damage fertility and unborn life. **All** of the listed insecticides are highly toxic to bees and may therefore not be applied when crops are flowering and bees are foraging.

Among the fungicides, **Thiram** is internationally listed under the Rotterdam Convention. In the EU a ban on Thiram has applied since January 2020. Seeds treated with this substance may no longer be marketed.

Table 9: Action modes and hazard classification of prevailing pesticides used in Kurdamir

Pesticide group	**Active ingredient**	**Action mode, specificity**	**Health hazard classification 1) 2)3)**	**Environmental rating 3)**	**EU approval (Y=yes, N=no)**
Insecti-cides	Cypermethrin (alpha, beta, zeta)	Broad-spectrum, contact, pyrethroid	Moderately hazardous[1)]	Highly toxic to bees	N
	Cypermethrin as seed treatment	Broad-spectrum, contact, pyrethroid	Moderately hazardous[1)]	Highly toxic to bees	Y
	Deltamethrin	Broad-Spectrum, contact, pyrethroid	Moderately hazardous[1)] Long term effects[2)]	Highly toxic to bees	Y
	Lambda-Cyhalothrin	Broad-spectrum, contact	Moderately hazardous[1)] High acute toxicity[2)] Long term effects[2)]	Highly toxic to bees	Y
	Imidacloprid	Broad-spectrum, systemic, neonicotinoid	Moderately hazardous[1)]	Highly toxic to bees	N
	Emamectin Benzoate Abamectin+ Spirodiclofen	Broad-spectrum, contact, Abamectin derivate	Highly hazardous[1)] High acute toxicity[2)] Suspected to damage fertility and unborn child[3)]	Highly toxic to bees	Y
	Acetamiprid	Broad-spectrum, systemic, neonicotinoid	Moderately hazardous[1)]	Highly toxic to bees	Y
	Methomyl	Broad-spectrum, carbamate, cholinesterase inhibitors and therefore highly toxic to humans	Highly hazardous[1)]	Highly toxic to bees	N
	Carbosulfan	Broad-spectrum, systemic, carbamate, cholinesterase inhibitors	Highly hazardous[1)] **Intern. banned**[2)]	Highly toxic to bees	N
Fungi-cides	Tebuconazole	Broad-spectrum, systemic	Moderately hazardous[1)] High acute toxicity[2)] Long term effects		Y
	Prothioconazole	Broad-spectrum, systemic	No acute toxicity[1)]		Y
	Spiroxamine	Selective against powdery mildew	Moderately hazardous[1)]		Y
	Thiram	(seed treatment)	High long-term toxicity[)] **Intern. banned**[2)]		N

Herbi-cides	2,4-D Amine	Broad leave	Moderately hazardous[1)]		Y
	Florasulam	Broad leave (Now off label)	No acute toxicity[1)]		Y
	MCPA (2-methyl-4-chlorophenoxyacetic acid)	Broad leave	No WHO classification[1)]		Y
	Mesosulfuron-methyl + Thiencarbazone-methyl + Iodosulfuron-methyl-sodium + Mefenpyr-diethyl	Grass			Y Y Y Not yet assessed
	Clodinafop-propargyl + Cloquintocent-mexyl (safener)	Grass	No WHO classification[1)])		Y
	Imazamox	Cuscuda	No WHO classification[1)]		Y

1) WHO 2020: The WHO Recommended Classification of Pesticides by Hazard and guidelines to classification, 2019 edition. https://www.who.int/publications/i/item/9789240005662
2) FAO/WHO 2016, International Code of Conduct on Pesticide Management. Guidelines on Highly Hazardous Pesticides. http://www.fao.org/3/i5566e/i5566e.pdf
3) See criteria for classification in PAN 2021: PAN International List of Highly Hazardous Pesticides. https://pan-international.org/wp-content/uploads/PAN_HHP_List.pdf

Several other pesticides were ordered under the ECOserve Farm Management Plan for the Kurdamir pilot farm to replace the most hazardous pesticides in Table 9 (Thiram, Carbofuran, Abamectin or Cypermethrin). These pesticides and their hazard classification and action modes are listed in Table 10. All of the pesticides in Table 10 are classified as only slightly to moderately hazardous or do not have any WHO classification. The WHO classifies not all pesticides, but concentrates on the ones suspected to be more hazardous. Hence no WHO classification most often means that the product is not considered very hazardous to human health. Also, regarding environmental ratings, except for the highly bee toxic insecticide **Spinosad**, the pesticides in Table 10 have no record for being very damaging and all pesticides in Table 10 are approved for use in the EU.

Table 10: Less hazardous pesticides ordered by ECOserve for the Kurdamir pilot farm in 2020 to replace prevailing highly hazardous pesticides

Pesticide group	**Active ingredient**	**Action mode, specificity**	**Health hazard classification [1)]**	**Environmental rating[2)]**	**EU approval Y=yes, N=no**
Insecticide	Spinosad	Broad-spectrum, microbial pesticide (bacterial), against aphids, cotton bollworm	Slightly hazardous[1)]	Highly toxic to bees[2)]	Y
	Azadirachtin	Plant product	No WHO classification[1)]		Y

	Bacillus thuringiensis	Microbial pesticide against bollworm, butterfly larvae	Slightly hazardous[1)]		Y
Fungicide	Fludioxonil	Seed treatment, non-systemic, against Fusarium, Rhizoctonia, Alternaria	No acute toxicity[1)]		Y
	Metalaxyl-M	Systemic, soil or seed treatment, against Pythium and Phytophthora	Moderately hazardous[1)]		Y
	Trichoderma sp.	Microbial pesticide (fungus) against fungal foot diseases like Fusarium	No WHO classification[1)]		Y
Herbicide	Quizalofop-p-ethyl	Against grass weeds	Moderately hazardous[1)]		Y

Pesticides from GIZ procurement 2020.
1) WHO 2020: The WHO Recommended Classification of Pesticides by Hazard and guidelines to classification, 2019 edition. https://www.who.int/publications/i/item/9789240005662
2) See criteria for classification in PAN 2021: PAN International List of Highly Hazardous Pesticides. https://pan-international.org/wp-content/uploads/PAN_HHP_List.pdf

3.9 Gaps and areas for improvement

The following gaps and areas for improvement have been identified in the ECOserve socioeconomic study, during the assessment for the IPM concept and the IPM training sessions:

Farmers' knowledge in Kurdamir and advice to farmers

- Farmers' knowledge on pests and diseases is low.
- Farmers' knowledge on resistant varieties is low.
- Farmers' knowledge on pesticides (different kinds, optimum time for application) is low.
- Pesticides are often used by routine, not by necessity.
- According to an FAO survey on the cotton sector in Azerbaijan 2019[3], on a number of occasions farmers had poor control of cotton bollworm with pesticides. Some farmers reported repeated spray failures even with application rates well above the recommended label rates, suggesting wrong timing of application or other shortcomings in application.
- Farmers seek advice from neighbouring farmers or agrochemical retailers and not from agricultural advisors.

Availability of information and access to data

- Data on the infestation levels, at which the main pests, diseases and weeds occur in Kurdamir or AZ (such as number of specimen/plant, number of specimen/ha or percent infested plants/ha) are not sufficiently available or accessible.
- Data on damage and yield loss caused by the prevailing pests, diseases and weeds

in the focus crops in Kurdamir or AZ are not sufficiently available or accessible.

- Treatment thresholds for main pests and diseases adapted to AZ are not sufficiently available or accessible.
- Access to information on resistant varieties is low.
- Some public agricultural organizations (e.g. Azerbaijan Agricultural University, MoA, o.a., see App. 2-17) give recommendations on control measures against specific pests and disease. They do not specify, however, at which treatment threshold they should be applied.
- Official data on most used pesticides (kind and quantity) are not sufficiently available or accessible.

Pesticide registration, pesticide related information and availability of alternatives

- Some of the control recommendations of official agricultural organisations include pesticides which are highly hazardous for human health and the environment (e.g. Diazinon, see App. 4)
- Several of the pesticides used in cotton production in the Kurdamir area are highly hazardous, either because of their toxicity to humans or to the environment. One of the pesticides registered in Azerbaijan and used in Kurdamir is internationally banned (Thiram). Carbofuran, which also is internationally banned, was still used in 2019[3] but is as of June 2020 not registered as pesticide in Azerbaijan anymore. Whether it is still used, is not sufficiently known.
- Frequent and widespread routine use of broad-spectrum pesticides can lead to pests/ diseases/weeds developing pesticide resistance. If pesticide resistance has developed, the respective pesticide is no longer effective. Whether there is pesticide resistance in the Kurdamir area, is not sufficiently known.
- Pesticide label instructions, containing information on for example recommended dosage or range of target pests and crops etc., are not sufficiently openly accessible.
- Information on alternative control measures is not sufficiently available.
- Biological or alternative plant protection measures are not sufficiently available (or affordable) for all plant protection problems.

4. Concept on Integrated Pest Management

4.1 Introduction to Integrated Pest Management (IPM)

Both, intensive and smallholder farming systems all over the world suffer significant yield

losses due to pest or disease infestation and weeds. Up to 40% of global food production is estimated lost to pests, disease and weeds[5] [6]. In Azerbaijan the yield loss in cotton as a result of Cotton bollworm is estimated to range from 20-60 percent (FAO 2019[3]). Regardless of geography and cropping systems, farmers regularly take preventive or curative pest management measures during crop growth or after harvest to protect their yields and associated investments, especially when intensifying production. Depending on the cultivation system, these can be mechanical, biological or chemical measures. In the Kurdamir area, data assessment showed, that the prevailing plant protection method is the use of synthetic pesticides, often with high hazards for human health, environment and biodiversity.

The FAO definition of IPM
"Integrated Pest Management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human and animal health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms."

FAO/WHO (2014): The International Code of Conduct on Pesticide Management

The guiding principle of **Integrated Pest Management (IPM)** is to combine preventive, agronomic, physical, biological, and other agro-ecological measures to minimize the occurrence of pests and thus the use of synthetic pesticides, in order to protect human and animal health and the environment[7]. Ideally, as in organic farming, chemical plant protection should be dispensed with altogether.

Effective IPM should not be seen as a stand-alone measure, but as part of a broad agroecological approach to pest management that includes several components. IPM should provide farmers with information and tools to proactively implement measures to reduce pest infestation (e.g. crop rotation and diversification and creation of natural habitats for beneficial insects), thereby improving the health of their crops and the surrounding landscape and reducing vulnerability to pests.

IPM does not provide for a fundamentally complete elimination of synthetic products, but IPM aims to achieve greater resource efficiency of the inputs used and thus a reduction in external inputs that are harmful to health or the environment. IPM can thus represent an essential component in agroecological transformation.

Plant protection products (PPPs): **Pesticides** are all substances consisting of chemical or biological components that are intended to repel, destroy or control harmful organisms or regulate plant growth. **Plant protection products (PPPs)** are pesticides used in plant production to combat pests. They also include biologically active agents made from microorganisms, which are used, for example, in organic farming (also known as **biopesticides** or **microbial pesticides**).
FAO/WHO (2014): The International Code of Conduct on Pesticide Management

[5] Oerke E-C (2006) Crop losses to pests. J Agric Sci 144:31–43. https://doi.org/10.1017/S0021859605005708
[6] CABI, Heeb L., Jenner E., Cock M. J. W. (2019): Climate-smart pest management: building resilience of farms and landscapes to changing pest threats. Journal of Pest Science (2019) 92:951–969,
[7] FAO/WHO (2014): The International Code of Conduct on Pesticide Management. https://www.fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/Code/Code_ENG_2017updated.pdf

4.2 Central elements of IPM

The most effective and lasting way to manage pests is by using a combination of methods that work better together than separately. Central for the design of an IPM concept are the following elements. The IPM pyramid in Figure 1 demonstrates the build-up of an IPM strategy based on these central elements of IPM.

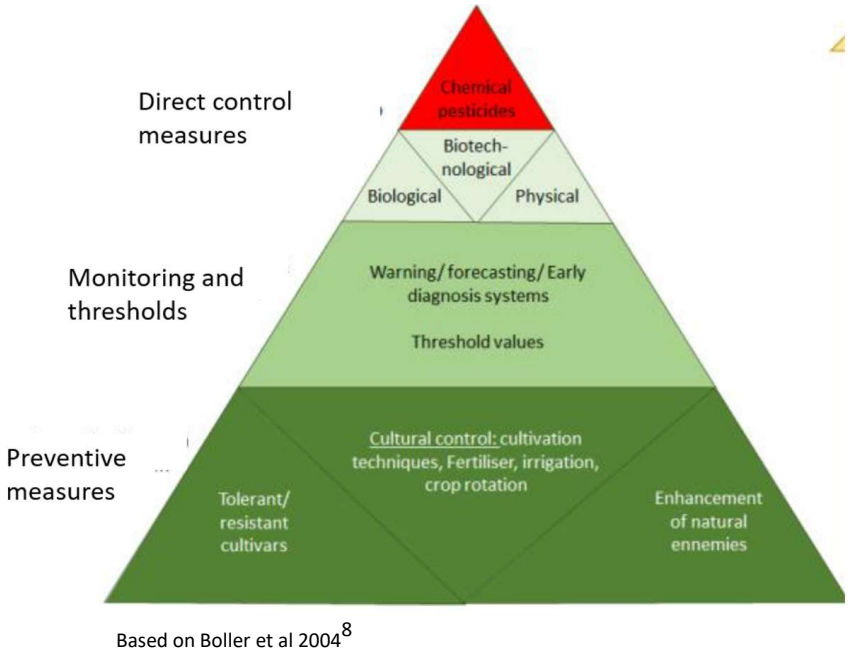


Figure 1: Pyramid of central IPM elements

- **Prevention of harmful organisms through cultural practices and managing the ecosystem.**
  Cultural methods are practices that reduce pest establishment, reproduction, dispersal, and survival. For example, crop rotation can decrease soilborne diseases by avoiding accumulation of crop specific diseases. As another example, changing irrigation practices can reduce pest problems, since too much water can increase root diseases and weeds.
- **Use of resistant varieties and locally adopted varieties**
  Resistant /tolerant varieties have a genetic quality, that results in the plants being less damaged than a susceptible plant. The selected varieties must ideally fit the location (e.g. drought tolerant). The better a variety is adapted to local conditions, the better the crop can outgrow weeds or tolerate pest infestation. Therefore, improved local varieties are often more robust and elastic compared to for example high yielding hybrid varieties.
- **Protection and enhancement of beneficial organisms**
  Each pest organism is part of a complex ecosystem and has a number of natural enemies (= beneficial organisms). Those agricultural measures should be considered

[8] Boller EF, Avilla J, Joerg E, Malavolta C, Wijnands FG, Esbjerg P, 2004: Integrated Production. Principles and Technical Guidelines, 3rd edition. IOBC/WPRS Bull 27

that best conserve or enhance these beneficial organisms, such as planting flower strips near the crop to create natural habitats or treating only heavily infested plants with pesticide instead of the whole field.

- **Monitoring and assessing pest numbers use of treatment thresholds**
  Correct pest identification, monitoring the severity of infestation and the use of treatment thresholds are important to decide whether and which pest management is needed.
- **Use of biological control**
  Biological control is the use of natural enemies—predators, parasites, pathogens, and competitors—to control pests and their damage. Biological control methods are unfortunately not commercially available for all pest problems. Biological plant protection products made from microorganisms are also known as biopesticides or microbial pesticides.
- **Use of mechanical and physical control**
  Mechanical and physical control measures kill a pest directly, block pests out, or make the environment unsuitable for it. Traps for rodents or insects are examples of mechanical control. Physical control measures include mulches for weed management, steam sterilization of the soil for disease management, or barriers such as nets to keep birds or insects out.
- **Use of chemical control as last resort**
  Chemical control means the use of synthetic pesticides. In IPM, pesticides are used only when needed and in combination with other approaches for more effective, long-term control. Pesticides are selected and applied in a way that minimizes their possible harm to people, nontarget organisms, and the environment. Use pesticides in bait stations rather than sprays; or spot-spray a few weeds instead of spraying an entire field.
- **Post treatment assessment**
  After action is taken, the effect of pest management is assessed by monitoring again.

IPM concepts cannot be given as a fixed recommendation for a crop, but have to be adapted to the individual situation of a given area and a farmer, production system and other local settings. IPM measures for a given situation depend also on the availability of for example resistant varieties, specific biological or other control measures, selective pesticides and more.

4.3 Monitoring for pests and diseases

Not all pests and diseases in a crop make a treatment necessary. Many pests and diseases are kept on a level, where they do not cause serious damage or economic loss, by e.g. their natural enemies, by the crop plants being tolerant or resistant to the pests or by crops outgrowing the pest.

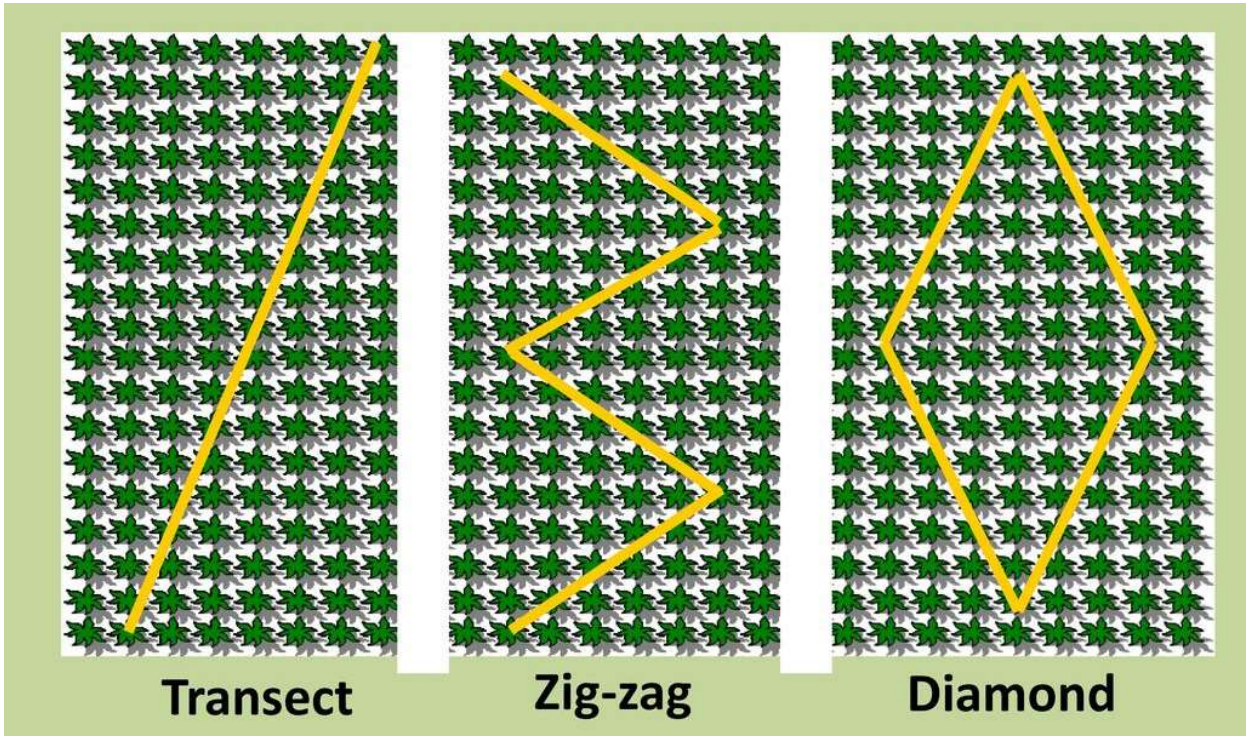
The fundament of all plant protection actions in IPM is to have a precise picture of the pest and disease situation in each field. This is being done by regularly **monitoring** the situation. Monitoring means checking the field to identify which pests and diseases are present, how many there are, or what damage they have caused. Correctly identifying the pest and diseases is the key to knowing whether a pest is likely to become a problem and to determining the best IPM strategy. Monitoring and considering information about the pest,

its biology, and environmental factors, will help to decide, whether the pest can be tolerated or control measures should be taken. If control is needed, this information also helps to select the most effective management methods and the best time to use them.

For pest sampling you will need to identify the pest, to know what to sample (e.g. specific areas of the plant, percent injury, numbers of insects, an assessment of weed population, etc.), when to sample, how frequently to sample and what constitutes a sample.

Monitoring patterns

Diseases, pests, and weeds are often unevenly distributed in fields and for most pests it is important to walk a few rows into the field before sampling the first plant to avoid edge effects. To get a representative picture of the infestation situation in a field, try to cover all areas of the field with a sampling pattern, you follow. For **transect (diagonal), zig-zag** or **diamond monitoring** patterns, see Figure 2. Monitoring patterns and methods can vary from pathogen to pathogen. Edge sampling can be appropriate for pests like spider mites that commonly invade into the field from the field borders.



(Source: Scouting fields one)

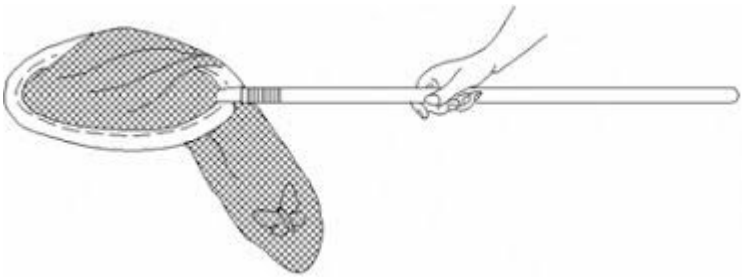
Figure 2: Monitoring patterns

Sampling with a sweep net in alfalfa

Sampling with a sweep net is commonly used to monitor alfalfa pests when alfalfa plants are at least 15-25 cm tall (for shorter alfalfa, do not rely on sweep net sampling to determine pest numbers; instead estimate plant damage visually). Sweep net sampling is also used for estimating numbers of lady beetles. A 35 cm diameter sweep net is the standard sampling tool used in alfalfa. See Figure 3.

To use a sweep net, swing it in a 180º arc such that the net rim strikes the top 15 - 20 cm of alfalfa plants. Hold the net slightly less than vertical so the bottom edge strikes the alfalfa before the top edge. This will facilitate getting the insects into the net. Each 180º arc

counts as one sweep. A common practice is to take a sweep from right to left, walk a step, and take another sweep, left to right. For more instructions on how to sample with sweep net and how to count samples, see the video from University of California on sweep net sampling[9].



(Source bugwood.org)

Figure 3: Sweep net sampling

Monitoring with traps

Several kinds of traps can be used to monitor pests, such as:

- **Light traps**: Are attractive to some insects, but are bulky and need electricity. Light traps catch many different insects, that need to be separated from the insects under observation.
- **Sticky traps:** Some insects are attracted to bright yellow or other colours. They can be caught on coloured sheets of plastic or cardboard that is coated with glue. Sticky traps are often used as a monitoring tool in greenhouses and orchards. By regularly checking the sticky traps a farmer can determine the initial presence of a potentially damaging insect population. Yellow sticky traps attract adult whiteflies, flower thrips, fungus gnats, and leafminers (see Figure 4). Bright blue sticky traps can be used to monitor flower thrips.
- **Pheromone trap or dispensers**: Pheromone traps are available for monitoring some species of moths. The traps are baited with a lure that mimics the odour given off by female moths to attract males for mating (see Figure 5). The traps are often used to monitor the main flights of adult insects so that management tactics can be instituted early to have the greatest effect. Orchard growers often use pheromone traps to time codling moth sprays so that spraying is done when most moth eggs are hatching into caterpillars. Pheromones are also used against the Grape berry moth in grape production by using the so-called “Confusion technique”: Dispensers are used to release large amounts of pheromones so that the males get confused and can no longer find the females and mate. This control method only affects the target species and thus spares the beneficial insects, but is available only for a few pests. Pheromone traps offer more flexibility in deployment and specificity compare to light traps.
- **Plastic pitfall traps** are used for crawling pests in the field as well as in stored grain bins.

[9] University of California, video sweepnet sampling. https://youtu.be/hVDgA7DWh0c, accessed October 2021.

(Picture: Gunel Qubanova 2021)

Figure 4: Sticky traps

(Picture: Gunel Qubanova 2021)

Figure 5: Pheromone trap

Monitoring after treatment

The effectiveness of a plant protection measure must be verified by infestation checks before and after the plant protection measure. In case of fungicide treatments, installing a "**no spray window**", that means a small area that is left unsprayed, will help to check one's own decision and provide information about the further development of the infestation.

National or regional surveillance

The spread and intensity of fungal diseases can vary a lot from year to year and region to region depending on seasonal weather conditions such as temperature and humidity. Additionally, especially rust fungi are known to frequently develop new races that rapidly spread. Many countries therefore establish forecasting systems that monitor and predict fungus-specific epidemiological thresholds for the economically important fungi and provide current information on coming outbreaks to the extension service or farmers.

4.4 Treatment thresholds

In IPM the decision to take control measures is ideally based on “treatment thresholds” and “economic damage thresholds”. A **treatment threshold** is the pest or damage level at which control is initiated to avoid significant damage or loss of yield. An **economic damage threshold** is the lowest population or damage density that is expected to cause so much yield loss, that the cost of the expected yield loss is equal to the cost of a control treatment. Both kinds of thresholds depend on many factors, such as individual pests and diseases, level of cropping intensity (variety, fertilisation, cultural methods), soil and climatic conditions, costs of farm inputs, price for farm products a.s.o. and are therefore difficult to establish.

The examples in Table 11 demonstrate, that the relationship between infestation level – damage level – yield loss - economic loss cannot be determined once and for all situations. For Farm A (low yield level) the rust incidence, that causes economic damage, is higher than for Farm B (high yield level). Decisions on control treatments demand farmers’ knowledge, training and experience.

Table 11: Example for economic damage thresholds for fungicide treatment in two wheat farms

	**Farm A (low yield level)**	**Farm B (high yield level)**
Expected yield in t/ha	2 t/ha	5 t/ha
Price for wheat incl. subsidies/t	600 AZN/t	600 AZN/t
Total revenue/ha	1200 AZN/ha	3000 AZN/ha
Expected yield loss from rust infection low level (5 % yield loss) in t/ha	0,1 t/ha	0,25 t/ha
Expected price of yield loss (yield loss in t/ha x product price/t)	60 AZN/ha	150 AZN/ha
Price for chemical treatment (12 AZN/ha for application, 50 AZN/ha for fungicide)	62 AZN/ha	62 AZN/ha
Cost: benefit of fungicide application in AZN/ha	62 cost : 60 benefit (AZN/ha)	62 cost : 150 benefit (AZN/ha)
Economic damage threshold	The economic threshold for Farm A is a rust incidence, that causes ca. 5% yield loss.	The economic threshold for Farm B is a rust incidence, that causes ca. 2% yield loss.

Treatment thresholds are established for a number of pests and diseases in some countries (e.g. Germany, USA, Australia). Treatment thresholds for AZ are not sufficiently available. Treatment thresholds in the following guidelines are therefore only meant as approximate

references and have to be verified and adjusted for Kurdamir conditions and for individual farm conditions.

4.5 Precautions for using pesticides

Pesticides are poisonous and must be used with caution. Among others, the following precautions must be taken:

- Follow label directions carefully. Avoid splashing, spilling, leaks, spray drift, and contamination of clothing. Apply pesticides only on the crops or in the situations listed on the label.
- Use protective measures when handling pesticides as directed by the label, such as wearing impermeable gloves, googles, long pants, and long-sleeve shirts. Change clothes and wash your hands immediately after applying pesticides.
- Never eat, smoke, drink, or chew while using pesticides.
- Keep pesticides in original containers until used. Store them in a locked cabinet, building, or fenced area where they are not accessible to children, unauthorized persons, pets, or livestock.
- Dispose of empty containers carefully. Never reuse them. Make sure empty containers are not accessible to children or animals. Never dispose of containers where they may contaminate water supplies or natural waterways.
- Follow pesticide label instructions and adhere to the required time between last application and harvest.

4.6 IPM and climate

Agriculture is a major contributor to climate change. According to the International Panel on Climate Change[10] it accounts for up to 12% of all man-made greenhouse gas emissions. The use of synthetic nitrogen fertiliser is the biggest contributor to climate change in agriculture owing to the potent greenhouse gas N_2O. IPM can contribute to climate change reduction and to climate change mitigation and adoption in different ways.

An increase in global temperature or change in rain fall pattern and quantity is expected to lead to changes in the spread and abundance of diseases or the susceptibility of crops. IPM elements such as crop rotation, crop diversification or mulching will increase the healthiness of the soils, the resilience and robustness of the crops and the abundance of beneficial organisms. Agrochemical inputs such as fertilizer and pesticides will be used more efficiently (= less agrochemicals) and this will contribute to reduce greenhouse gas emissions. And lastly, farmers who understand the agroecological principles of IPM will be better equipped to cope with the effects of climate change and will be better prepared to develop sound and location-specific adaptation strategies.

4.7 IPM guidelines for Kurdamir focus crops

In the following, guidelines are presented for the main pests, diseases and problem weeds in the focus crops of Kurdamir. The guidelines are based on Kurdamir and AZ experience and on international knowledge. The guidelines are structured into the sections (1)

[10] ICCP 2019: Global warming of 1.5°C- An IPCC Special Report. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf

Preventive measures, (2) Assessment of pest situation and (3) Direct control measures.

Treatment thresholds for individual pests and diseases are taken from other cropping areas outside AZ, ideally with similar growing conditions. The limitations of the thresholds are discussed in chapter 4.4. References for selected sources and information used for the IPM guidelines are listed in chapter 6.

Because of the rapid development of new fungus races (especially rust races), the resistance of varieties has to be confirmed every season through breeders or agricultural institutes.

All pesticides mentioned in the guidelines are classified as not highly hazardous and are approved in the EU (see chapter 3.5). If trade names of pesticides are mentioned, they only serve as example and are not meant as recommendation for a product. Also, the rapid development of pesticide resistant diseases and pests make it necessary to regularly check the effectiveness of a given pesticide. With all use of pesticides, precautions for the handling and applying of pesticides must be observed (see chapter 4.5).

A list of fungicides and their effect on rust, mildew, Septoria and other fungal diseases for German races in 2021 is provided at the end of the concept in App. 18. Be aware, that the fungicide Epoxiconazole is no longer approved in the EU since 2020 (only left-over stocks may be used in 2021).

Before the guidelines for each crop, the currently used pesticides in Kurdamir in the respective crop are presented. The highly hazardous pesticides are highlighted in red and should urgently be replaced by less hazardous pesticides as a first step.

4.7.1 Prevailing pesticides in wheat and barley

*Table 12: Prevailing insecticides and fungicides used in Kurdamir in **wheat and barley** and hazard classification and action modes*

Pesticide group	Active ingredient	Pest to be controlled	Action mode, specificity	Health hazard classification [1) 2) 3)]	Environmen-tal rating[3)]	EU approval Y=yes N=no
Insecti-cides	Cypermethrin (alpha, beta, zeta)	Aphids, thrips, beetles, bugs	Broad-spectrum, contact, pyrethroid	Moderately hazardous[1)]	Highly toxic to bees	N
	Deltamethrin	Aphids, thrips, beetles, bugs	Broad-Spectrum, contact, pyrethroid	Moderately hazardous[1)] Long term effects[2)]	Highly toxic to bees	Y
	Imidocloprid	Aphids, thrips, beetles, bugs	Broad-Spectrum, systemic, neonicotionoid	Moderately hazardous[1)]	Highly toxic to bees	N
	Lambda-Cyhalothrin	Aphids, thrips, beetles, bugs, butterfly larvae	Broad-spectrum, contact	Moderately hazardous[1)] High acute toxicity[2)] Long term effects[2)]	Highly toxic to bees	Y
	Emamectin Benzoate	Butterfly larvae (in corn)	Broad-spectrum, contact, Abamectin derivate	Highly hazardous[1)] High acute toxicity[2)] Suspected to damage fertility and unborn child	Highly toxic to bees	Y

Fungi-cides	Tebuconazole	Rust, mildew, Septoria	Seed treatment, broad-spectrum, systemic	Moderately hazardous[1]) High acute toxicity[2]) Long term effects		Y
	Prothioconazole	Rust, mildew, Septoria	Broad-spectrum, systemic	No acute toxicity[1])		Y
	Spiroxamine	Rust, mildew, Septoria	Selective against powdery mildew	Moderately hazardous[1])		Y
(used by ECOserve)	Fludioxonil	Fusarium, Rhizoctonia, Alternaria	Seed treatment, non-systemic,	No acute toxicity[1]		Y
(used by ECOserve)	Metalaxyl-M	Pythium and Phytophthora	Soil or seed treatment, systemic,	Moderately hazardous[1])		Y
(used by ECOserve)	Trichoderma sp.	Fungal foot diseases like Fusarium	Microbial pesticide (fungus)	No WHO classification[1]		Y

1) WHO 2020: The WHO Recommended Classification of Pesticides by Hazard and guidelines to classification, 2019 edition. https://www.who.int/publications/i/item/9789240005662
2) FAO/WHO 2016, International Code of Conduct on Pesticide Management. Guidelines on Highly Hazardous Pesticides. http://www.fao.org/3/i5566e/i5566e.pdf
3) See criteria for classification in PAN 2021: PAN International List of Highly Hazardous Pesticides. https://pan-international.org/wp-content/uploads/PAN_HHP_List.pdf

4.7.2 IPM guidelines for wheat and barley

Aphids (several species, only if risk for virus transmission)	
Preventive measures	Justification
Promotion of natural enemies	Natural enemies such as lady beetles, parasitic wasps, hoverfly and psyllid larvae, and fungal diseases of aphids are promoted by the preservation and creation of field surrounding biotopes such as hedges and field margins as habitats and overwintering sites. The establishment of fallow strips or the sowing of special flowering strips around the crops also fulfil the habitat function for natural enemies.
Soil preparation/ Removal of volunteer plants	After the harvest of the cereal crop, volunteer cereals must be removed timely and as completely as possible, in order to prevent them from functioning as an intermediate host for aphids.
Crop management	Excessive nitrogen fertilisation, especially with fast-acting N-forms in high undivided doses favour aphid infestation and should be avoided.
Assessment of the pest situation	
Infection risk	Aphids can transmit e.g. barley yellow dwarf virus (BYDV). Virus diseases are, however, not reported a problem in Kurdarmir. Only in rare cases aphid infestations in the grain filling stage have the potential to directly compete with the grains for resources and cause serious yield loss.
Treatment threshold	**Object of monitoring**: Whole plant. **Threshold** (only when risk of virus transmission): 60 -80% infested plants or 3-5 aphids/ear. **Evaluation period**: From beginning of flowering.

	Adjustments should be made depending on the abundance of natural enemies, as their performance must not be underestimated.
Direct control measures	
Insecticide application	Use approved insecticide preferably with low bee toxicity. If high bee toxicity, do not spray in flowering crop. E.g. insecticides with active ingredient Acetamiprid
Avoidance of insecticide resistance	Insecticides must be applied in such a way that the development of resistance to individual active substances is prevented. Generally, a regular change of active ingredient groups should be made and an appropriate application rate should be used to prevent resistance.

Corn ground beetle (*Zabrus tenebrioedes*) in wheat and barley	
Preventive measures	Justification
Crop rotation	Sowing cereals after a previous cereal has to be avoided. Intercropping without grass or cereals will reduce the risk of the pest establishing.
Soil preparation/ Removal of straw residues	After the harvest of winter cereals, straw and grain residues left on the ground allow the adult Corn ground beetle to settle in the field and lay eggs. If the next crop is a cereal or a grass, it will have a high probability of getting damaged. Deep tillage (>15 cm) after harvest can destroy some of the eggs and young larvae. It is at these stages that the Corn ground beetle is the most fragile.
Assessment of the disease situation	
Infection risk	Corn ground beetle can in rare cases be damaging in wheat and barley in Kurdarmir. Eggs of the beetles are laid in the soil and young larvae overwinter in the soil. Larvae live in the upper layer of soil, within burrows adjacent to host plants. Larvae can damage young seedlings in autumn and this is the most serious damage caused by Corn ground beetle. A larva, during its nocturnal sorties, cuts and drags the young leaves into its burrow in the soil. Adults feed on cereal ears that are at the doughy stage. They remove the grain from the ear to eat it more easily and only the hull remains on the outside. During summer heat and drought, beetles bury themselves into the ground to a depth of 40 cm.
Treatment threshold	**Object of monitoring**: Missing/dead seedlings in autumn, leaf damage in spring, grain damage in doughy stage. **Threshold**: Not established for missing plants. ASA recommends 1-4 larvae/m2, however, this is difficult to monitor. **Evaluation site**: Damage starts either in the centre of the plot, on the site of old straw left overs, or at the edge of the plot. Evaluation period: from autumn in seedling stage of the crop to doughy stage in spring.
Direct control measures	
Insecticide application	Seed treatment (e.g. with the active ingredients Tefluthrin and Fludioxonil (e.g. Austral Plus®)) is the most effective chemical treatment against Corn ground beetle in the early seedling stage in autumn. A treatment with broad-spectrum contact insecticides as, e.g. Deltamethrin, for curative control is often not very effective. ASA recommends several insecticides for use against Corn ground beetle (see App. 4). E.g. Mostar 20 SP (Acetamiprid). Make sure, to select an insecticide with low

	human and environmental toxicity and do not spray, when cereals are flowering.

Click beetles/wireworms *(Elateridae)* in wheat and barley	
Preventive measures	Justification
Crop rotation	If alfalfa is grown over several years, there is a risk that several generations of click beetles accumulate in the soil and crop damage to the following crop can be severe and long-lasting. In areas with high incidence of wire worms (Click beetle larvae), alfalfa should not be grown for more than 2 years. Various cruciferous plants, such as e.g. white cabbage, have negative effects on wireworms if grown in crop rotation.
Soil preparation	Click beetle larvae live in the soil and can occasionally cause damage in cereals, where they totally destroy young seedlings by feeding on their roots underground. Shallow stubble cultivation in July or August kills fresh egg clutches and young larvae.
Biofumigation	Biofumigation is a biological method that is intended to reduce pathogens, pests and weed seeds in the soil. It relies on plants with a high content of glucosinolates. Examples for these plants are the cruciferous plants Black mustard *(Sinapis nigra),* White mustard *(Sinapis alba*), Indian mustard (*Brassica juncea*) and Oil radish *(Raphanus sativus).* If the cells of these plants are destroyed, e.g. by chopping into pieces, the glucosinolates in the plants dissociate to gaseous substances that are toxic to some soil organisms. The desired effect is achieved within 48 hours. The soil should not be too dry, so that the dissociation can take place quickly. The effect of biofumigation can be obtained by cultivating these crops as intercrops between two main crops. Pre-cultivation of white cabbage in crop rotation may have a similar effect.
Assessment of the pest situation	
Treatment threshold and monitoring	**Monitoring:** - Digging: Soil is dug with a spade at the beginning of the growing season (one spade depth and spade width). Take samples spread over the entire field to obtain a representative sample. The soil material is collected in a bucket and finely crumbled between the fingers in order to find all wireworms in the sample. - Bait traps: Wireworms are attracted by bait. Sprouting wheat or maize or mixture of both are very suitable. The bait can either be loosely put in the soil or placed in a container with many small holes. The grains should be soaked in water for at least 6 hours, before burying them in the ground at a depth of 20 cm. Cover the bait with soil and mark the spot so that it can be found again. After 10 days, the buried baits can be checked for wireworms. The baits should be placed on an uncultivated area, as vegetation can distract wireworms from the bait. - The Research Institute for Plant Protection and Industrial Crops in Ganja recommends another bait method to trap click beetle larvae in cotton, which can be used for inspiration in wheat (see App 16). However, use other pesticides, as the ones mentioned are no longer approved the EU. **Object of monitoring**: Wire worms in different stages. **Threshold**: There are no reliable thresholds established, as wireworms develop over several years and environmental influence is complex. **Evaluation period**: Before seeding.
Direct control measures	
Biological	- Neem cake: The insecticide Azadirachtin contained in Neem cake inhibits the

insecticides	larval development of Click beetles and can be applied to the soil. However, be aware, that concentration of the active ingredient can vary from batch to batch. - *Beauveria bassiana*: A biological insecticide on the basis of the the spores of the fungus *Beauveria bassiana* (strain ATCC 74040) (e.g. Naturalis®). The strain is naturally occurring. The mode of action is repellent/deterrent. The effect lasts between 6 and 8 weeks, after which it fades out. This can be enough to protect young seedlings in a vulnerable phase. - *Metarhizium sp.:* The application of entomopathogenic fungi of the genus *Metarhizium* is investigated as promising alternative strategy to control wireworms. A commercial product is, however, not yet available.
Insecticide application	Seed treatment with Cypermethrin (e.g. Signal®). Use of Cypermethrin is permitted in the EU only for seed treatment, field spraying is not allowed. Treatment of the seeds with Cypermethrin is only allowed by certified seed companies. Treated seeds may not be seeded at wind speed of more than 5 m/s.

Yellow/Stripe rust, Brown/Leaf rust, Black/Stem rust *(Puccinia sp.)*	
Preventive measures	Justification
Crop rotation	Rust is little affected by crop rotation because its spores are spread over long distances by wind (airborne). However, due to the complex nature of the disease, the proportion of wheat and barley in the rotation should not exceed 66 %.
Soil preparation/ Removal of volunteer cereals	Like powdery mildew, rust is an obligate parasite, i.e. the rust fungus grows only on living host plants and survives between seasons on volunteer wheat or barley plants and some wild grasses. Under favourable weather conditions, it infects young cereals from volunteer cereals. For this reason, the removal of volunteer cereals (green bridge) is of particular importance.
Variety selection	The selection of resistant varieties is the most important preventive measure for the control of rust. It may even be possible to dispense with fungicide measures altogether. Due to the ability of rust to form new races which can infect previously resistant varieties, it is best not to concentrate cultivation on just one variety. Varieties with rust resistance can be bought from certified seed suppliers in Azerbaijan. A selection of wheat and barley varieties resistant to rust (and mildew) disease can for example be found on the website of the agricultural company Agrodairy LLC. Resistant varieties named here are for example: - Autumn wheat Balaton, bred by Probstdorfer Saatzucht, resistant to bending, shedding grains, yellow and brown rust - Autumn wheat Girmizigul, bred by the Azerbaijan Scientific-Research Institute of Agriculture, resistant to mildew, yellow rust and fusariose - Autumn barley Dayanatli, bred by the Azerbaijan Scientific-Research Institute of Agriculture, resistant to yellow rust, brown rust, mildew, and other diseases. The MoA lists the following wheat varieties as resistant against Brown rust: Gobustan, Murov-2, Fatima, Askeran, Golden wheat (see https://www.agro.gov.az/az/news/taxilda-pas-xesteliklerine-qarsi-muebarize-tedbirleri and App.5) The Crop Husbandry Research Institute (AEIM) mentions the following resistant wheat varieties: Vrn 1/ Arzu, NBKO 935-29-15/K-590W077-2-2/VBF 0589-1, HBA 142 A / HBZ 621 AABILENE/3/ BURBOT-6, Ferrygineum 2/19x Bezostaya-1 (See App. 6). Further resistant barley varieties are mentioned in App. 8.

	Since rust resistance quickly can be rendered ineffective by the occurrence of new rust races, breeders continuously adjust varieties to the new rust races and the resistance of varieties has to be checked with the seed companies regularly. Regional variety recommendations should be taken into account. Overall, the choice of variety can significantly reduce the number of treatments or increase the potency of the selected active substances, if fungicide treatment is necessary.
Sowing time	Very early sowing dates of winter cereals promote the risk of increased Yellow and other rust infestation. The longer the growth period in autumn, the better Yellow rust can establish itself in the crop and form the initial potential for further development in the spring.
Crop management	Rust is not as conditioned by nitrogen as powdery mildew, but its development is also favoured in crops over-supplied with nitrogen and in high crop densities.
Assessment of the disease situation	
Infection risk	The spread and intensity of rust varies a lot from year to year and region to region depending on seasonal weather conditions such as temperature and humidity. In Kurdamir, rust diseases often start occurring end of February/beginning of March. If Azerbaijan has established a forecasting system that monitors and predicts fungus-specific epidemiological thresholds for the economically important fungi, it should be used to determine the time of fungicide application, if necessary. Yellow rust can rapidly spread and develop as soon as the first infection in a field occurs. Brown rust causes most damage when severe rusting covers the upper leaves before flowering. The disease should therefore be managed before infection reaches the upper leaves and the flag leave. Brown rust is more heat-loving than Yellow rust, so that control usually only becomes relevant when flag leave is visible.
Treatment threshold	- Yellow/Stripe rust: **Object of monitoring:** Whole plant. **Threshold**: Occurrence of first infestation nests with rust symptoms. **Evaluation period**: From start of shooting to start of flowering. - Brown/Leaf rust: **Object of monitoring**: Main stem. **Threshold**: 30% of main stems with symptoms. **Evaluation period**: From flag leave still rolled/emerging to beginning of flowering, first anthers visible. - Black/Stem rust: Black rust occasionally can occur late in the season, when flag leaves already are developed. **Threshold and evaluation period**: (see Brown rust).
Direct control measures	
Fungicide application	In the event that new rust races render current resistant varieties obsolete, foliar fungicides can be applied to control disease outbreaks. Application timing will depend on when initial infections occur and on the specific label restrictions for each fungicide. Non-spraying windows (=small unsprayed areas) are advised to check whether the fungicide is effective and to observe the further development of the infestation.

<table>
<tr><td></td><td>
- Yellow Rust: Fungicides from the Azole-group are best for early control. Fungicides from the Strobilurin group or combinations of the Azol- and Carboxamid (SDHI) groups are better for late treatment, when flag leave is showing. Applied at this stage they have a longer effect.
A second treatment at the earliest 21 days after the first treatment.

- Brown rust: Fungicides from the Azol- and Strobilurin groups or Azol- and Carboxamid groups. Applied at a later stage, as is typical for Brown rust, they have a longer effect.
A second treatment at the earliest 21 days after the first treatment.

- Black rust: Foliar fungicides can assist with Black rust control, but are of limited effectiveness by the time plant head infection occurs. While fungicides may work on Yellow and Brown rusts, which affect the leaves more than the stems, they are less effective on Black rust, especially in thick canopies where they may have trouble penetrating and contacting the stems.

Products containing Mefentrifluconazol + Pyraclostrobin have been effective against Yellow and Brown rust and Septoria in Germany. Be aware, that fungal races in Azerbaijan can be different and therefore the fungicides might react differently. Check AZ research stations, local suppliers/growers for their experience.

<table>
<tr><th>Fungicide groups</th><th>Effect</th><th>Risk for resistance</th></tr>
<tr><td>Strobilurins</td><td>Protective; long-term effect</td><td>high risk</td></tr>
<tr><td>Carboxamides (SDHI):</td><td>Protective and conditionally curative; long-term effect</td><td>medium to high risk</td></tr>
<tr><td>Azoles</td><td>Protective and curative; short-term effect</td><td>medium risk</td></tr>
<tr><td>Contact fungicides</td><td>Protective</td><td>low risk</td></tr>
<tr><td>Special fungicides (e.g. against mildew)</td><td>protective + curative; different long-term effect</td><td>medium to high risk</td></tr>
</table>
</td></tr>
<tr><td>Avoidance of fungicide resistance</td><td>Effective fungicides must be applied in such a way that the formation of resistance to individual active substances is prevented. Generally, a regular change of active ingredient groups should be made and an appropriate application rate should be used to prevent resistance.</td></tr>
</table>

Powdery mildew *(Blumeria graminis sp. tritici* syn. *Erysiphe graminis*) mainly in barley	
Preventive measures	Justification
Soil preparation/ Removal of volunteer cereals	Powdery mildew is as rust diseases an obligate parasite, i.e mildew requires living host plants to survive. The fungus overwinters in tiny spore-forming structures that release airborne spores in spring. It also can overwinter as mycelium on volunteer wheat, barley or oat plants and wild grasses and produce spores that cause initial infections. Spores will later on in the season been transported by air to other plants (airborne). For this reason, the removal of volunteer cereals (green bridge) is of particular importance.
Variety selection	The selection of resistant varieties is the most important preventive measure for the control of Powdery mildew. It may even be possible to dispense with fungicide measures altogether. Due to the ability of Powdery mildew to form new races which

	can infect previously resistant varieties, it is best not to concentrate cultivation on just one variety. Varieties with Powdery mildew resistance can be bought from certified seed suppliers in Azerbaijan. A selection of wheat and barley varieties resistant to mildew disease can for example be found on the website of the agricultural company Agrodairy LLC. Resistant varieties listed here are for example: - Autumn barley Jalilabad 19, bred by the Azerbaijan Scientific-Research Institute of Agriculture, poorly infected with mildew and rust diseases. - Autumn wheat Girmizigul, bred by the Azerbaijan Scientific-Research Institute of Agriculture, resistant to mildew, Yellow rust and fusariose. - Autumn barley Dayanatli, bred by the Azerbaijan Scientific-Research Institute of Agriculture, resistant to Yellow rust, Brown rust, mildew, and other diseases. Resistance of varieties has to be checked with the seed companies regularly. Regional variety recommendations should be taken into account. Overall, the choice of variety can significantly reduce the number of treatments or increase the potency of the selected active substances, if fungicide treatment is necessary.
Sowing time	Very early sowing dates of winter cereals promote the risk of increased mildew infestation. The longer the growth period in autumn, the better mildew can establish itself in the crop and form the initial potential for further development in spring.
Crop management	Powdery mildew develops particularly strongly in dense crops that are excessively supplied with nitrogen. If the variety is susceptible to mildew and the probability of infestation is high in the region the sowing rate should be in the lower range of the recommendations and the fertilisation adjusted accordingly.
Assessment of the disease situation	
Infection risk	The occurrence of mildew is primarily dependent on the weather and mildew appears often, when crop density is getting higher. If Azerbaijan has established a forecasting system that monitors and predicts fungus-specific epidemiological thresholds for the economically important fungi, it should be used to determine the time of fungicide application, if necessary.
Treatment threshold	**Object of monitoring:** The 3 upper most leaves of main stem. **Threshold**: 60% of main stems with symptoms. **Evaluation period**: From start of tillering to beginning of flowering, first anthers visible.
Direct control measures	Justification
Fungicide application	Due to the different susceptibility of varieties, the different stand densities, the site-specific nitrogen regime and the weather-specific infestation probability, Powdery mildew is one of the pathogens for which treatment recommendations must be very situation specific. Even if heavy infestation occurs in autumn, mildew control is not recommended. In the case of less tolerant varieties and infestation in spring, treatment is usually advisable from the stage of stem elongation. Often, the application of a specific mildew fungicide is sufficient to keep mildew under control until the end of vegetation. A second treatment, if necessary, at the earliest 14 days after the first treatment.

	A specific mildew fungicide is e.g. Proquinazid. Non-spraying windows (=small unsprayed areas) are advised to check whether the fungicide is effective and to observe the further development of the infestation
Avoidance of fungicide resistance	Effective fungicides must be applied in such a way that the formation of resistance to individual active substances is prevented. Generally, a regular change of active ingredient groups should be made and an appropriate application rate should be used to prevent resistance.

Septoria *(Septoria sp.)* in wheat	
Preventive measures	Justification
Crop rotation	The lower the proportion of wheat in the crop rotation, the lower is the probability of infection with Septoria. Wheat after wheat is most at risk. The proportion of wheat in the crop rotation should not exceed 66 %.
Soil preparation/ Incorporation of straw residues	Septoria fungi overwinter in wheat stubble of previously diseased crops or on infested seed. The incorporation of straw residues from the preceding wheat crop and volunteer plants significantly reduces the potential for infection. Therefore, ploughing should be preferred to minimum tillage in such cases, except when there is a risk for soil erosion.
Variety selection	Depending on the preceding crop, soil cultivation, regional probability of infestation, tolerant or resistant varieties should be selected for cultivation. Overall, the choice of variety can significantly reduce the number of treatments or increase the potency of the selected active substances, if fungicide treatment is necessary.
Crop management	Very early sowing dates of winter cereals promote the risk of increased Septoria infestation. This is especially true if the previous crop was also wheat. If early sowing cannot be avoided, use resistant varieties.
Assessment of the disease situation	
Infection risk	Spores are produced during wet weather in fall and spring, but spring infections, especially during crop heading, cause the greatest yield damage. The occurrence of Septoria is primarily dependent on the weather. Due to the long latency period of the pathogen, determining the highest probability of infection is very important for the best timing of fungicide application, if needed. If Azerbaijan has established a forecasting system that monitors and predicts fungus-specific epidemiological thresholds for the economically important fungi, it should be used to determine the time of fungicide application, if necessary.
Treatment threshold	**Object of monitoring**: The 4 upper most leaves of the main stem. **Threshold**: 30% of main stems with symptoms. **Evaluation period**: From stem elongation to flag leave just visible.
Direct control measures	
Fungicide application	Septoria infection can in some seasons be so heavy, that fungicide applications are necessary to avoid great yield loss. Fungicides containing carboxamides are still effective. For reasons of resistance avoidance, they may only be used once in the vegetation. In the case of a double treatment in wheat, the final treatment at ear emergence is the most important one, so that products containing carboxamide should be used

	then. An important component in the anti-resistance strategy, and thus for the control of Septoria, is the use of a contact fungicide at the beginning of the shooting, e.g. from the Azole group. Non-spraying windows (=small unsprayed areas) are advised to check whether the fungicide is effective and to observe the further development of the infestation.
Avoidance of fungicide resistance	Septoria fungicides are strongly affected by the development of resistance. Effective fungicides must be applied in such a way that the formation of resistance to individual active substances is prevented. Regular change of active ingredient groups should be made and an appropriate application rate should be used.

4.7.3 Prevailing pesticides in alfalfa

*Table 13: Prevailing insecticides and herbicides used in Kurdamir in **alfalfa** and hazard classification and action modes*

Pesticide group	Active ingredient	Pest to be controlled	Action mode, specificity	Health hazard classification [1) 2)]	Environmental rating [2)]	EU approval Y=yes, N=no
Insecti-cides	Lambda-Cyhalothrin	Lucerne weevil	Broad-spectrum, contact	Moderately hazardous[1)] High acute toxicity[2)] Long term effects[2)]	Highly toxic to bees	Y
	Emamectin Benzoate	Lucerne weevil	Broad-spectrum, contact, Abamectin derivate	Highly hazardous[1)] High acute toxicity[2)] Suspected to damage fertility and unborn child	Highly toxic to bees	Y
Herbi-cides	Imazamox	Cuscuda	Grass and broad leave	(no WHO classification)		Y

1) WHO 2020: The WHO Recommended Classification of Pesticides by Hazard and guidelines to classification, 2019 edition. https://www.who.int/publications/i/item/9789240005662
2) See criteria for classification in PAN 2021. Long-term effects could be such as suspected to cause cancer or suspected to have negative effect on reproduction. PAN 2021: PAN International List of Highly Hazardous Pesticides. https://pan-international.org/wp-content/uploads/PAN_HHP_List.pdf

4.7.4 IPM guidelines for alfalfa

Lucerne weevil *(Phytonomus variabilis* syn. *Hypera postica)*	
Preventive measures	Justification
Promotion of natural enemies	Natural enemies such as ladybirds, parasitic wasps or fungal diseases of weevils are promoted by the preservation and creation of field surrounding biotopes such as hedges and field margins as habitats and overwintering sites. The establishment of fallow strips or the sowing of special flowering strips around the crops also fulfil the habitat function for natural enemies. However, weevil damage typically occurs before first cutting in spring, when populations of natural enemies often are not yet sufficient to provide control.
Crop management	Alfalfa should be seeded early after the previous crop in autumn, so that the crop is well established, when winter comes. Maintain a dense stand in vigorous growing conditions, as thin stands accelerate egg laying and the growth of larvae and thus increase the possibility that weevil damage may develop before the first alfalfa crop reaches the flower-bud stage. Cut first cutting early. In the first year of

	establishment, alfalfa should be allowed to flower before the second cutting. This will make alfalfa robust.
Resistant varieties	When choosing an alfalfa variety, in areas with high incidence of lucerne weevil preference should be given to more tolerant/resistant varieties.
Assessment of the pest situation	
Infection risk	Lucerne weevil in the Kurdamir area is only reported an occasional problem in alfalfa seed production. Both the larvae and the adults feed on the foliage of alfalfa, the larvae doing the most damage. Young larvae damage alfalfa by feeding on terminal buds, larger larvae feed on the leaflets. Feeding by older larvae is the most damaging and is characterized as skeletonization and bronzing of the leaves in spring. Damage is most commonly seen before the first cutting. Weevil management in alfalfa is focused on the period before the first cutting.
Treatment threshold	**Monitoring**: After alfalfa weevil larvae begin to appear, check fields regularly. Sweep fields weekly when alfalfa is at least 15-25 cm tall after weevil larvae begin to appear in early spring; or look for signs of feeding damage on the leaves, if plants are shorter. Take five sweeps in four sections of the field. **Threshold**: Currently the recommendation is that a control treatment is warranted when the weevil larvae count reaches an average of 20 or more larvae per sweep. **Evaluation period:** From early spring to first cut.
Direct control measures	
Cultural control	Cutting the crop as soon as most of the plants are in the bud stage can sometimes prevent serious damage by the weevil. Short cutting at this time and prompt removal of the hay leave the weevil larvae on the bare fields, where nearly all of them, together with eggs and pupae, die of starvation or heat exposure. Closely monitor alfalfa before second cutting to detect feeding damage, because both larvae and adults can cause injury.
Biological control	Spraying of the microbial pesticide Spinosad, which is approved for organic farming.
Insecticide application	Use approved insecticide, preferably with low bee toxicity. If high bee toxicity, do not spray in flowering crop. If alfalfa is cut for fresh fodder to cattle or hay, observe the waiting period after application of the insecticide as indicated on the product label. E.g. insecticides with active ingredient Indoxacarb are approved in the EU, but may not be sprayed in flowering fields, as the substance is highly toxic to bees.
Avoidance of insecticide resistance	Insecticides must be applied in such a way that the development of resistance to individual active substances is prevented. Generally, a regular change of active ingredient groups should be made and an appropriate application rate should be used to prevent resistance.

4.7.5 Prevailing pesticides in cotton

*Table 14: Prevailing insecticides and fungicides used in Kurdamir in **cotton** and hazard classification and action modes*

Pesticide group	Active ingredient	Pest to be controlled	Action mode, specificity	Health hazard classification [1) 2)3)]	Environmental rating[3)]	EU approval (Y=yes, N=no)

Insecti-cides	Cypermethrin (alpha, beta, zeta)	Cotton bollworm	Broad-spectrum, contact, pyrethroid	Moderately hazardous[1)]	Highly toxic to bees	N
	Deltamethrin	Cotton pests	Broad-Spectrum, contact, pyrethroid	Moderately hazardous[1)] Long term effects[2)]	Highly toxic to bees	Y
	Lambda-Cyhalothrin	Cotton pests	Broad-spectrum, contact	Moderately hazardous[1)] High acute toxicity[2)] Long term effects[2)]	Highly toxic to bees	Y
	Emamectin Benzoate Abamectin+ Spirodiclofen	Cotton pests	Broad-spectrum, contact, Abamectin derivate	Highly hazardous[1)] High acute toxicity[2)] Suspected to damage fertility and unborn child	Highly toxic to bees	Y
	Acetamiprid	Cotton pests aphids	Broad-spectrum, systemic, neonicotinoid	Moderately hazardous[1)]	Highly toxic to bees	Y
	Methomyl	Cotton pests	Broad-spectrum, carbamate, cholinesterase inhibitors and therefore highly toxic to humans	Highly hazardous[1)]	Highly toxic to bees	N
	Carbosulfan	Cotton pests	Broad-spectrum, systemic, carbamate, cholinesterase inhibitors	Highly hazardous[1)] **Intern. banned**	Highly toxic to bees	N
	Indoxacarb	Cotton bollworm	Broad-spectrum	Moderately hazardous[1)]	Highly toxic to bees	y
(used by ECOserve)	Spinosad	Aphids, Cotton bollworm	Broad-spectrum, microbial pesticide (bacterial)	Slightly hazardous[1)]	Highly toxic to bees[2)]	Y
(used by ECOserve)	Azadirachtin	Cotton bollworm	Plant product	No WHO classification[1)]		Y
(used by ECOserve)	Bacillus thuringiensis	Cotton bollworm	Microbial pesticide	Slightly hazardous[1)]		Y
Fungi-cides	Thiram	cotton diseases	(seed treatment)	**Intern. banned** due high long-term toxicity		N
(used by ECOserve)	Fludioxonil Metalaxyl-M (seed treatment)	cotton diseases	Broad-spectrum, systemic	Moderately hazardous[1)] High acute toxicity[2)] Long term effects		Y

4.7.6 IPM guidelines for cotton

Cotton bollworm *(Helicoverpa armigera)*	
Preventive measures	Justification
Promotion of natural enemies	Natural enemies such as lady beetles, predatory bugs, parasitoid wasps, Green lacewing, or spiders are promoted by the preservation and creation of field surrounding biotopes such as hedges, field margins or flowering strips as habitats and overwintering sites. Alfalfa fields adjacent to cotton can serve as a 'nursery' for beneficial organisms.
Crop management	Cotton bollworms are attracted to succulent, rank-growing cotton plants. Too much nitrogen creates excessive cotton growth toward the end of the season. This makes the crop more attractive to pests and might require additional pest control measures. The last irrigation (when all bolls have been set) is to ensure that boll maturity is completed without water stress. Be aware to prevent the occurrence of

	lush vegetative cotton growth late in the season, as this will make cotton being attractive to Cotton bollworm. Because bollworm populations seldom reach damaging levels before late summer, manage the crop for early maturing.
Resistant varieties	When choosing a cotton variety, preference should be given to more tolerant/resistant varieties and to varieties that are adapted to the Kurdamir climate. Okra leaf varieties have a degree of resistance to both, Cotton bollworm, spider mite and whitefly, and potentially reduce sprays for each pest per season. Genetically modified cotton varieties producing the insecticidal toxin of *Bacillus thuringiensis* (B.t) are available in AZ. These B.t.-cotton varieties are highly resistant to cotton bollworm, but not to other cotton pests. Be aware, that also resistance against B.t.-cotton varieties has been reported in several countries. Be furthermore aware, that while the B.t.-toxin used in biological fungicides is classified as having a low human toxicity, possible effects on animal health of B.t.-cotton plants when fed to cattle are not yet fully investigated.
Assessment of the pest situation	
Infection risk	Cotton bollworm larvae damage squares and bolls. Larvae chew holes into the base of bolls and may hollow out bolls. Larvae attacking fruiting bodies can cause severe shedding. Fifth-instar larvae are the most destructive; they not only damage more fruit than do earlier instars, but they damage larger fruits that are harder for the plant to replace. The larvae have a habit of moving from boll to boll and damage much more than what they actually consume. Although large larvae do most of the damage, it is not possible to kill a significant proportion of them once they are older than the third instar. Monitoring and control must therefore be aimed at the eggs and small larvae.
Treatment threshold	**Monitoring:** Check 5 adjacent plants at each stop as you pass through the field. Choose the first plant at random; then check its mainstem terminal and those of the four plants next to it. Check at least 100 plants/field. **Threshold**: In fields that have not been treated with broad-spectrum insecticides, treat when you find 20 small bollworms per 100 plants. In fields that have been treated previously, treat when you find 8 small bollworms per 100 plants. **Evaluation period**: Start sampling plant terminals for bollworms 1 to 2 weeks after peak squaring or as soon as bolls are present. Continue until most bolls have matured.
Direct control measures	
Biological control	- *Bacillus thuringiensis* ssp. Kurstaki (B.t.): The toxin produced by B.t. is toxic only to Leptidoptera larvae, such as Cotton bollworm or other cotton worms. Products based on the microbial pesticide B.t. have a high selectivity and are not harmful to beneficials. Their persistence is rather low. - *Nuclear polyhedrosis virus* (NPV) or *granulose virus* (GV): Baculoviruses are highly specific insect pathogenic viruses with a very narrow host range. They have a great potential as highly selective biocontrol agents of lepidopterous pests. In the EU granulovirus CpGV is authorised and widely used against Codling moth (*Cydia pomonella*). The virus infects caterpillars and is particularly important in biological apple production. In China and India, several baculo/granulose viruses are authorized as commercial insecticides against Cotton bollworm, e.g. HaNPV, and widely used. They are very selective and do no harm to beneficials.

	- *Trichogramma sp*.: Mass reared egg parasitoid of cotton bollworm. *Trichogramma* has to be applied, when the first eggs of Cotton bollworm are laid, as *Trichogramma* can only attack eggs. The parasitoid wasps have a high selectivity and do no harm to beneficials. Timing of application and the quality of the product are crucial for the success of the method. The AZ Ministry of Agriculture recommends *Trichogramma* sp. should be released 3-4 times per crop with 60.000 -70.000 Trichogramma/ha/release (see App. 17). - *Habrobracon hebetor*: This larval parasitoid is successfully released in augmentation biological control programs against lepidopterous pests of field crops in different countries (e.g. Iran) or for inoculative releases (e.g. in the Sahel zone). The MoA recommends releases against Cotton bollworm at a density of 500-2000 parasitoids/ha/treatment in 3 treatments.
Insecticide application	Consider alternatives to pyrethroid insecticides for controlling bollworms when aphids are present, as pyrethroids will kill natural enemies of aphids and can drive aphid populations up. Insecticides with the active ingredient Chlorantraniliprole are highly selective, have a very low toxicity to human health, but are very persistent in water, soil or sediments and should only be used as exception. Indoxacarb is a moderately hazardous broad-spectrum insecticide with high toxicity to bees and may not be applied in flowering cotton. Control of Cotton bollworm has heavily depended on the use of chemical pesticides in many years. Resistance to all commercially available insecticides has been detected in Cotton bollworm. Consult local pesticide experts on possible pesticide resistances. Be aware, that also resistance against B.t. products and B.t. cotton varieties has been reported in other countries.
Avoidance of insecticide resistance	Insecticides must be applied in such a way that the development of resistance to individual active substances is prevented. Generally, a regular change of active ingredient groups should be made and an appropriate application rate should be used to prevent resistance.

Cotton aphids (*Aphis gossypii* and other species)	
Preventive measures	Justification
Promotion of natural enemies	During the pre-squaring period of the crop, natural control of aphids is generally strong. Parasitic wasps and aphid predators (including lady beetles and the predatory larvae of syrphid flies) are important natural enemies. Natural enemies are promoted by the preservation and creation of field surrounding biotopes such as hedges, field margins or flowering strips as habitats and overwintering sites. During the period of square and boll production and continuing until harvest, parasitic wasps and lady beetles may still be present, but in most fields they are rare. The most common aphid natural enemies at this time are minute pirate bugs (*Orius tristicolor*) and other bugs, Green lacewings and the entomopathogenic fungus *Entomophthora* sp. Although these natural enemies do provide some control, they are not always able to suppress high aphid populations.
Crop management	Higher cotton aphid numbers consistently develop on late-planted cotton when compared to early-planted cotton. Additionally, aphids prefer cotton plants that are well watered and highly fertilized. Thus, avoid excessive or poorly scheduled nitrogen applications or excessive irrigation that stimulate growth late in the cropping season.
Resistant or	Cultivar selection can influence aphid population growth. Extra-long staple

tolerant varieties	cultivars appear to be more susceptible to aphid infestations. Hairy-leaf varieties, which comprise the majority of the market, are more susceptible to aphids than smooth-leaf varieties. When choosing a cotton variety, preference should be given to more tolerant/resistant varieties and to varieties that are adapted to the Kurdamir climate.
Assessment of the pest situation	
Infection risk	Aphid infestation is only occasionally reported to be problem in Kurdamir. Aphids are most abundant on the edges of fields, so these areas should be checked, especially after the bolls have started to open. Aphids are rarely yield limiting to seedling cotton plants. Cotton seed treated with insecticides will control cotton aphids in the seedling stage. The first aphids are an important food source for natural enemies such as lady beetles and parasitoids. Thus, insecticide treatments for aphids in pre-blooming cotton should be avoided if possible Low aphid numbers (<25/leaf) on mid-season cotton often do not generate any obvious damage symptoms. High aphid numbers (>50/leaf) create symptoms as cupped, crinkled leaves, honeydew accumulations, sooty mold, and in extreme cases, limited defoliation. High aphid numbers at this time can decrease the size of bolls, stunt plant growth, and may increase square and boll shedding. However, aphid populations of 50 aphids/leaf are rarely found. From the opening of the first boll until harvest (late Season) the cotton crop is most sensitive to cotton aphid damage, because honeydew can contaminate the exposed cotton lint, creating "sticky cotton". Aphid populations as low as 5 /leaf can result in honeydew deposition on lint.
Treatment threshold	**Monitoring**: Select the 5th mainstem node leaf from the terminal. Turn the leaf over and check for aphids and mites on the underside (called leaf-turns). Repeat on 10 plants, each 10-15 m meters away from each other, repeat in 4 areas/field (total of 40 sample plants). For other monitoring patterns see chapter 4.3. Sample once or twice a week. **Thresholds and evaluation periods**: Treat for aphids if high populations persist for 7 or more days. From crop emergence to seedling growth: 50 aphids/seedling. Early squaring to boll development: 50 aphids/ 5th mainstem node. From first open boll to preharvest: 5 to 10 aphids/5th mainstem node leaf. When maturing grain sorghum or corn fields are nearby, natural enemies often move into cotton where aphid populations are increasing. If the number of mummies or fungus-killed aphids is 20 percent of the total aphid population (live and dead aphids), or if the lady beetle population reaches 0.3 adults or 0.2 larvae per 1 plant, then an insecticide application may be unnecessary.
Direct control measures	
Biological control	The following substances are acceptable for use on organically grown cotton: - Spray of insecticidal soap against aphids/mites/fungi: E.g. M-Pede, active ingredient potassium salts of fatty acids. A contact insecticide with smothering and barrier effects. Spray to wet all infested plant surfaces and repeat treatments at weekly to biweekly intervals. Rotate sprays to avoid more than three consecutive sprays of this material. Not selective.

	- Spray of mineral oil 80% against aphids, mites, fungi: E.g. Tritrek. Contact pesticide, including smothering and barrier effects. Works by suffocating eggs, nymphs, and adults. Requires total spray coverage. Not selective. - Spray Azadirachtin: E.g. Neemix. Botanical pesticide derived from the neem seed of the Indian neem tree *Azadirachta indica*. Moderate selectivity. Low toxicity to biocontrol agents, predators, and parasitoids. In an organically certified crop, restrictions apply regarding the use of this substance.
Insecticide application	Chemical management of cotton aphid can be very erratic and unpredictable. Part of the problem is that the Cotton aphid has developed resistance to many chemical classes, including organochlorine, organophosphate, carbamate, and pyrethroid insecticides. In addition, these broad-spectrum pesticides kill the natural enemies of the Cotton aphid. Examples for insecticides: Flonicamid (IKI 220) (Pyridincarboxamide) is a systemic insecticide for foliar application. Good aphid control, low human, bee and environmental toxicity. Flupyradifurone (Butenolide group), broad spectrum, highly toxic to bees. Acetamiprid (Neonicotinoid), broad spectrum, highly toxic to bees.
Avoidance of insecticide resistance	Resistance against neo-nicotinoid insecticides is a serious concern. Repeated applications of any neonicotinoid can result in resistance to all neo-nicotinoids. Insecticides must be applied in such a way that the development of resistance to individual active substances is prevented. Generally, a regular change of active ingredient groups should be made and an appropriate application rate should be used to prevent resistance.

Two-spotted/Red spider mite *(Tetranychus urticae)*	
Preventive measures	Justification
Promotion of natural enemies	Preserve natural enemies of mites by avoiding early season, broad-spectrum insecticide applications. The most important predators early in the season are the western flower thrips, lateron bugs, predaceous mites, and others. Natural enemies are promoted by the preservation and creation of field surrounding biotopes such as hedges, field margins or flowering strips as habitats and overwintering sites.
Crop management	Managing spider mites requires preserving natural enemies as long as possible each season and anticipating outbreaks following insecticide applications. Water-stressed plants stimulate spider mite outbreaks. Be sure to keep the crop properly irrigated.
Resistant or tolerant varieties	Extra-long staple cultivars (Pima cotton) appear to be less susceptible to spider mite infestations. When choosing a cotton variety, preference should be given to more tolerant/resistant varieties and to varieties that are adapted to the Kurdamir climate.
Assessment of the pest situation	
Infection risk	Mite infestation is only occasionally reported to be problem in Kurdamir. Spider mites live in colonies, mostly on the lower surfaces of leaves, and produce a webbing that can cover much of the undersurface of the leaf. Spider mites can cause leaves or parts of leaves to turn yellow or red and to drop. The critical time for monitoring spider mites is between crop emergence and first open boll. Sometimes, field margins are much more severely infested than the remainder of the field, particularly when another host crop, such as alfalfa, beans,

	or safflower is grown next to the cotton. In such cases, treatment of a field margin may be justified. Monitor field margins.
Treatment threshold	**Monitoring**: Select the 5th mainstem node leaf from the terminal. Turn the leaf over and check for aphids and mites on the underside (called leaf-turns). Repeat on 10 plant, each 10-15 m meters away from each other, repeat in 4 areas/field (total of 40 sample plants). For other monitoring patterns, see chapter 4.3. Sample once or twice a week. **Threshold/Evaluation period:** From crop emergence to seedling growth: If defoliation is occurring. Early squaring to boll development: 30% of leaves show mite presence. From first open boll to preharvest: Stop sampling for spider mites.
Direct control measures	
Biological control	The following substances are acceptable for use on organically grown cotton: - Spray of Spinosad against mites, caterpillars, leafminers, thrips, and foliage-feeding beetles. Low human and environmental toxicity. Not as broad-spectrum nor as long-lasting as many synthetic insecticides, but it can kill beneficial insects. - Spray of insecticidal soap against aphids/mites/fungi: E.g. M-Pede, active ingredient potassium salts of fatty acids. A contact insecticide with smothering and barrier effects. Spray to wet all infested plant surfaces and repeat treatments at weekly to biweekly intervals. Rotate sprays to avoid more than three consecutive sprays of this material. Not selective. - Spray of mineral oil 80 % against aphids, mites, fungi: E.g. Tritrek. Contact pesticide, including smothering and barrier effects. Works by suffocating eggs, nymphs, and adults. Requires total spray coverage. Not selective.
Insecticide/acaricide application	The use of pyrethroids or organophosphates is not recommended for spider mite control. These broad-spectrum pesticides usually result in short-term population reduction, followed by a rapid resurgence of the population that can quickly exceed pre-treatment levels (as they also kill natural enemies of mites). Examples for acaricides (miticides): Etoxazole (Diphenyloxazoline), narrow spectrum systemic acaricide used against spider mites. Has also insecticidal activity against aphids. Low human toxicity and rather low environmental toxicity. Alternative to carbamates. Spiromesifen (Butanolide), contact insecticide-acaricide, selective against mites and white flies, low human and environmental toxicity.
Avoidance of insecticide resistance	Resistance against several acaricides has been observed and can change even during one field season. Acaricides must be applied in such a way that the development of resistance to individual active substances is prevented. Generally, a regular change of active ingredient groups should be made and an appropriate application rate should be used to prevent resistance.

4.7.7 Prevailing herbicides

*Table 15: Prevailing **herbicides** used in Kurdamir and hazard classification and action modes*

Pesticide group	Active ingredient	Action mode, specificity	Health hazard classification [1)]	Environmental rating[2)]	EU approval Y=yes, N=no
Herbi-cides	2,4-D Amine	Broad leave in cereals	Moderately hazardous[1)]	-	Y

	Florasulam	Broad leave in cereals (Now off label)	No acute toxicity[1)]	-	Y
	MCPA (2-methyl-4-chlorophenoxyacetic acid)	Broad leave in cereals	No WHO classification[1)]	-	Y
	Mesosulfuron-methyl + Thiencarbazone-methyl + Iodosulfuron-methyl-sodium + Mefenpyr-diethyl	Grass in cereals	Moderately hazardous[1)]	-	Y Y Y Not yet assessed
	Clodinafop-propargyl + Cloquintocent-mexyl (safener)	Grass in cereals	No WHO classification[1)])	-	Y
	Imazamox	Cuscuda, broad leave and grasses	No WHO classification[1)]	-	Y
(used by ECOserve)	Quizalofop-p-ethyl (5,4%)	Grass weeds in cotton	Moderately hazardous[1)]	-	Y
1) WHO 2020: The WHO Recommended Classification of Pesticides by Hazard and guidelines to classification, 2019 edition. https://www.who.int/publications/i/item/9789240005662 3) See criteria for classification in PAN 2021: PAN International List of Highly Hazardous Pesticides. https://pan-international.org/wp-content/uploads/PAN_HHP_List.pdf					

4.7.8 IPM in problem weeds

Common wild oat *(Avena fatua)*	
Preventive measures	Justification
Crop rotation	Common wild oat is one of the most common and economically threatening grass weed species of cereal crops worldwide. Tight crop rotations with a high proportion of winter cereals should be avoided. If necessary, crop rotation should be supplemented with root crops or legumes. Three or more years of perennial alfalfa growing suppresses Wild oat without herbicides.
Soil preparation	Mechanical tillage contributes to the suppression of weed infestation. Delaying post-cereal harvest cultivations for as long as possible will allow freshly-shed Wild oat seeds on the soil surface to lose their viability through germination, predation and fungal attack; the longer the delay, the greater the benefit. Incorporating freshly shed seed can induce dormancy for up to six years. Ploughing is generally less effective at controlling Wild oats than other annual grass weeds both, because Wild oats can emerge from greater depths and as it is more likely to bring their longer-lived seeds back to the surface.
Crop management	The introduction of Wild oat to an area should be prevented by using Wild oat-free seeds. The growth of cultivated plants should be ensured with as little competition as possible.
Assessment of the weed situation	
Infection risk	Wild oat occurs more often in summer crops, but may occasionally occur as an overwintering or summer-germinating plant in winter crops.

Treatment threshold	No threshold. Avoid all spread of Wild oat.
Direct control measures	
Mechanical control	The first immigrant plants should be pulled out before flowering.
Herbicide application	Chemical control in cereal crops is carried out in spring with suitable foliar herbicides (active ingredients: e.g. Pinoxaden (AXIAL 50), Fenoxaprop-P, Mesosulfuron), in leafy crops with herbicides against grasses (e.g. Pinoxaden and in maize with Sulfonylureas effective against grasses.
Avoidance of herbicide resistance	The most effective Wild oat herbicides are either ACCase or ALS inhibitors. Wild oat can develop resistance to ACCase inhibitors (e.g. Clodinafop, Pinoxaden) and ALS inhibitors (for example Mesosulfuron). Proper resistance management is necessary for regular control of Wild oat.

Perennial ryegrass *(Lolium perenne)*	
Preventive measures	Justification
Crop rotation	Tight crop rotations with a high proportion of winter cereals should be avoided. If necessary, crop rotation should be supplemented with root crops or legumes. Rotating into summer leafy crops, such as cotton, soybean, sunflower and sesame or corn and alfalfa offer a similar advantage. Rotation to summer annual crops will reduce ryegrass populations that emerge over the fall and winter months with tillage and/or non-selective herbicides.
Soil preparation	A sowing delay of only a few days after preparing the seed bed can significantly reduce the emergence of ryegrass, as the germination of the ryegrass is negatively influenced by this delay.
Crop management	Use ryegrass free (certified) seed. Clean harvesting equipment from ryegrass infested field, before harvesting non infested fields. Row-placed phosphate is readily accessible to seedling wheat and it enables the wheat plants to rapidly gain a competitive advantage over seedling ryegrass emerging between the rows. Vigorous, well-nourished wheat seedlings are very competitive with ryegrass seedling plants. This early advantage to wheat is critical, as ryegrass becomes more competitive as the growing season progresses.
Assessment of the weed situation	
Treatment threshold	No treatment threshold. Avoid all spread of Perennial ryegrass.
Direct control measures	Justification
Mechanical control	Ryegrass seeds begin to germinate in the fall as soil temperatures cool down, and rainfall returns. Therefore, late tillage will destroy more ryegrass seedlings. Occasional deep tillage may bury seeds, but it can take up to seven years for seeds to stop germinating. If adequate time is available before planting, shallow tillage may be used to encourage seeds to germinate, which promptly will be destroyed by an additional tillage (or by spray with an appropriate herbicide).
Herbicide application	In some instances, herbicide treatment will be needed to reduce in-season ryegrass competition with wheat and to minimize ryegrass seed production. Chemical control in cereal crops is carried out in spring with suitable foliar herbicides

	(active ingredients: e.g. Pinoxaden, Fenoxaprop-P, Mesosulfuron), in leafy crops with herbicides against grasses (e.g. Pinoxaden) and in maize with Sulfonylureas effective against grasses. New soil-active and Sulfonylurea-free herbicides for pre- and post-emergence in winter cereals with the active ingredients Flufenacet and Diflufenican have an effect lasting several weeks and thus also control later germinating grassy and broad leave weeds. Herbicides containing a combination of Pinoxaden and Pyroxasulfone showed good results in controlling grasses such as Perennial ryegrass.
Avoidance of herbicide resistance	The most effective ryegrass herbicides have so far been either ACCase or ALS inhibitors. However, as they are widely used, resistance to both groups has developed in some regions. Proper resistance management is therefore necessary for maintaining the effectiveness of the herbicides.

Cirsium thistle *(Cirsium sp.)*	
Preventive measures	Justification
Crop management	Creeping thistle is a persistent weed, which overwinters as a root and sprouts again in spring. In natural, undisturbed growing conditions, the thistle develops into a biennial plant. Once established, the thistle plant quickly forms an extensive, complex root system with roots running horizontally and vertically. Thanks to its vertical roots, it is capable of reaching more than 3 m into the ground. If disturbed in its development by agricultural interference, such as cutting and harrowing, it reacts by intensified production of roots and shoots. Once established, mechanical removal of thistle plants is difficult. Energy reserves in the root enable creeping thistle to defy several years of mechanical control. A large proportion of the thistle seeds are eaten by insects and birds. Nevertheless, the importance of seed dispersal for first colonization should not be underestimated. Thus, measures should be taken early to prevent extensive spreading. Mow or cut ripening thistle flowers in edge strips and nearby areas before seed formation.
Crop rotation	Restrict the proportion of cereals in the crop rotation to maximum 50 %. Incorporate intensive (at least) 3-year alfalfa or grass-clover crop in your crop rotation, especially after competitively weak crops such as field vegetables. If possible, incorporate root crops in your rotation. Shift from winter to summer crops.
Soil preparation	Spring ploughing is significantly harmful to thistles. Before ploughing, perform a stubble tillage in order to cut newly sprouting thistles and the still green thistle stubbles of older plants and to exhaust reserve materials in the thistles' roots. Prevent soil compaction. Loosen compacted soils or plough zones with deeper tillage, reaching at least 5 cm deeper than the compaction zone.
Assessment of the weed situation	
Treatment threshold	No treatment threshold. Avoid all spread of thistles.
Direct control measures	
Mechanical control	Hoe cereals instead of harrowing them. If single thistles or nests of thistles protrude from the field, seed formation must be prevented. As a minimum, remove flower heads. Better, pull out or mow the aboveground thistle plant. New growth must be removed again in the same year after a growth of 5 cm, in order to prevent a renewed storage of reserve material.

	With heavy infestation of thistles, repeated tillage after an early harvested crop in combination with a densely growing perennial crop can solve the problem. The aim is to keep the thistles from building up reserve substances in late summer/ early autumn.
Herbicide application	Herbicide applications are most effective whilst the plant is actively growing and before the flower heads show colour. Established infestations may require several treatments. For thistle control, preparations based on Clopyralid (e.g. Ariane C), Amidosulfuron (e.g. Hoestar Super), Tribenuron (e.g. Pointer SX, Dirigent SX) and Tritosulfuron (e.g. Biathlon 4D) are approved in the EU. The proven thistle standard herbicide active ingredient MCPA (e.g. U 46 M-Fluid) can also be used for targeted thistle control due to its approval against leafy weeds. When using the Sulfonylurea active ingredients Amidosulfuron, Tribenuron and Tritosulfuron, it is recommended to supplement with MCPA (e.g. 1.0 l/ha U 46 M)Fluid. Clopyralid and Tribenuron can only be used in winter cereals.
Avoidance of herbicide resistance	Proper resistance management is necessary for maintaining the effectiveness of the herbicides.

Dodder *(Cuscuda sp.)*	
Preventive measures	Justification
Crop rotation	Grasses and cereals are nonhost plants of dodder. Planting of cereals can therefore be an effective means of managing a dodder infestation. However, certain broadleaf weeds, such as e.g. lambsquarter, serve as dodder host plants and need to be controlled as part of a successful dodder management strategy. Furthermore, due to the longevity of dodder seed, once a host crop is planted again, fields need to be monitored regularly, and new dodder plants must be removed immediately.
Soil preparation	Soil cultivation will uproot host plants and leave attached dodder stems and dodder seedlings on the soil surface to dry and die. However, if freshly removed dodder come in contact with new host plant, a new connection can occur. If the dodder plants have set seed, remove the plants from the area to prevent future infestations. Place plants in a plastic bag, and dispose of them in the trash. Burning kills only some of the dodder seed and its effectiveness depends on the duration and intensity of the fire.
Crop management	Effective dodder management is only achieved by control of the current population, prevention of dodder seed production, and suppression of new seedlings in subsequent years. The use of dodder-free seed is the primary way of preventing the spread of dodder infestations. Clean and inspect clothing and equipment before moving from infested to “clean” areas. Fields with a history of dodder infestation need to be monitored frequently, and new dodder plants must be removed as soon as possible.
Assessment of the weed situation	
Infection risk	Dodder is a parasitic annual plant that is mainly a problem in alfalfa production in Kurdamir. Dodder spreads primarily by seeds which have the capability of surviving in the soil up to sixty years. When dodder seeds germinate, establishment is dependent upon host plant availability. A dodder seedling can survive 5-10 days without a host, but if it doesn’t come into contact with one, the seedling will die.

	Also dodder stems attached to a host plant can survive several days, even after being detached from the host plant. Dodder is a quarantine pest in AZ and its occurrence has to be reported to ASA. Experts of the Regional Agrarian Science and Innovation Center will help farmers to control dodder.
Treatment threshold	No treatment threshold. Avoid all spread of dodder.
Direct control measures	
Mechanical control	Isolate small spots with dodder infestation, and remove plants by hand before they produce seed. Monitor larger infestations, and mow, cut, burn, or spray herbicides to prevent seed production. If you see dodder soon after it has attached itself to a host, cut the infected portion of the host plant 1-2 cm below the point of attachment, otherwise the dodder can regenerate from the haustoria left embedded in the host plant. In alfalfa, close (short) mowing is an effective management tool for dodder.
Biological control	Several disease organisms are known to infect dodder including *Fusarium tricinctum* and *Alternaria* species. There is, however, no commercialized microbiological product available.
Herbicide application	Generally chemical control is not necessary in small holder fields. Where dodder is a persistent problem, apply preemergent herbicides (e.g., Propyzamide) before dodder seed germinates and follow up with close mowing, burning, or spot removal of parasitized host plants to control dodder plants that escaped the herbicide application. If using postemergence herbicides, make sure to select a herbicide, that does not harm the host plant. Imazomax can be used as postemergence herbicide in alfalfa.

5. Recommendations

IPM is a complex agroecological approach, that needs support on several levels in order to be successfully implemented. Following recommendations will - among others- support the transition to reduce the use of synthetic pesticides (especially highly hazardous ones) and to increase the uptake of IPM.

Competencies and skills of farmers

- Education in basic biological and agricultural knowledge and training of farmers in IPM are the most important preconditions to empower farmers to take informed, knowledge-based decisions.

- Agrochemical retailers, employees of chemical companies and neighbouring farmers play at the moment a critical role in Kurdamir as source of advice to farmers. There is a need for independent, decentralized plant protection advice.

Governmental and institutional support

- Strengthening a seed sector that provides locally adapted high quality seeds as a fundament for robust crops that are more tolerant to pest infestation.

- Strengthening regional and national public research to provide locally adapted pest

resistant varieties and easy and open access to up-to-date information on resistant varieties.

- Definition of treatment thresholds for main pests through public research.

- Strengthening public research in adapted alternative plant protection measures, such as biological methods.

- Provision by public institutions of regularly updated information on effective pesticides, such as for example fungicides against prevailing races of rust diseases.

- Provision of regional monitoring and early warning systems for certain diseases, such as for example Powdery mildew in cereals. Using the best and fastest communication way, for example by smartphone or radio transmission.

- Fast disapproval/deregistration of internationally banned or severely restricted highly hazardous pesticides and enforcement of taking them from the market.

- Improvement of open access to public data.

Policies supporting IPM

- Policies to favour biological control in crops, where biological methods are available. Provision and, if necessary, subsidising of biological control measures.

- Definition of safety and quality standards for pesticide application equipment and policies for regular inspection of appropriate functioning to secure effective treatment and to avoid pesticide spilling and overuse.

- Support landscaping elements that serve as habitats for natural enemies of pests, such as for example planting of hedge rows or flowering strips, through incentive policies.

- Proper soil management to avoid soil depletion and IPM measures could be mandatory elements of production schemes for large cotton contract or cereal companies, that the companies could be requested to follow before being entitled to governmental price subsidies for the produce.

6. References

The following selected sources were among others used for the IPM guidelines. For additional specific references see footnotes in the concept.

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7. Appendices

Appendix 1: Interview questionnaire for Kurdamir farmers (G. Qurbanova, July 2021)

Name:

Last name:

Your position / specialty:

Contact number:

The organization you work for:

Location:

Date:

1. Which crops have you planted in your field in the last 2 years? (Wheat, barley, alfalfa, cotton, others). What is the reason for planting - needs (e.g. alfalfa for cattle) or sale?

a. Wheat

b. Barley

c. Alfalfa

d. Cotton

c. Others (which?)

Note:

2. Where do you obtain the seed? What is the name of the variety?

a. From the market

b. Order from abroad

c. Locally certified seeds

d. Every year I save the seeds for the next sowing

3. Which of the following agro-technical procedure do you do during or before planting?

a. Deep plowing, ice plowing, other procedures

b. Fertilization

c. Weed control (what do you do for weed control?)

d. Irrigation (how many times)

Note:

4. How many times do you go to the field from sowing till harvesting?

a. Every two days

b. Once a week

c. Once a month

d. harvest time

5. Do you apply medicine to protect the seeds from diseases before sowing?

a. No (because 1. We do not need, 2. we do not believe it will be useful, 3 pesticides are expensive)

Note:

b. Yes (If yes: what do you apply?)

Note:

c. Some years

d. Other reasons (e.g. we can't find a spraying machine, we don't are needed, we have doubts about the quality of the pesticide, it is difficult to find the consultant, etc.) know what drugs

6. Which kind of problems do you mostly face in plants? (See disease atlas)

a. Fungi

b. Bacteria

c. Pests (insects, mice, etc.)

d. Weeds

7. Which of the following preventive measures do you apply during the season?

a. Application of fungicides? When (in May and April)?

Note:

b. Application of insecticides? When? How often?

Note:

c. I use pheromone traps (for what?)

Note:

d. Chemical or agro-technical (manual or machine) measures for weeds

e. Monitoring the area with experts at different times

8. How do you decide, whether to spray pesticides or use mechanical control ?

a. I do not believe that the problems I observe will seriously damage my product

b. I use same pesticide which I use every year

c. I spray pesticide every year when the plant has a certain stage

d. I spray pesticide every year at a certain month (which?)

Note:

e. I go to the field and inspect the situation. If I see much disease or pests, I spray (If I see a certain number of XXX) . Otherwise, I do not spray.

Note:

f. I hire an agronomist at my own expense

g. I apply to the State Agrarian Development Centers

g. Others

9. To which diseases or pests is pesticide (pesticide) applied most often? How many times a crop and in what month and in which growth stage (see crop stage atlas)?

For example. 1 time in May for driving, etc.

10. Where do you get the necessary equipment for spray?

a. I rent from private companies

b. I rent from people who rent it

c. I have own

d. in other ways (e.g. I made a simple spraying machine)

Note:

11. What is your purpose in planting this plant?

a. For sale

b. A certain part is for sale, a certain part is for personal needs (e.g. alfalfa for cattle, wheat for poultry)

c. Only personal need

d. Other reasons

12. What was the maximum and minimum amount of yield during these years (per ha) How much the diseases and pests reduce plant productivity? Is it important to have plant protection?

Note:

Appendix 2: Statistical data on plant protection works in the Kurdamir region from 2019-2021 by the Agrarian Service, Ministry of Agriculture **of Azerbaijan**

Plant protection works carried out in Kurdamir region til 27.12.2019 (ha)

Agricultural crops / pests, diseases and weeds	Field			Forecast for 2019	Implemented until December 2019				Forecast for 2020
						including			
						At the expense of the business entity		At the expense of the budget	
	sowing	Observation was made	Infected		Total	Mechanical, biological and other	Chemical		
Feeding on various plants - total		19863	12054	20500	8672	1765	269	6638	7500
Rodent		17643	10826	20000	8018	1765	38	6215	7000
Locust		2220	1228	500	654		231	423	500
Hyphantria cunea									
Cereals	48581	3435	1705	400	905		905		850
Eurygaster intergriceps				200					200
Zabrus tenebriodes elongatus		465	102						
Elateridae		235	120		40		40		50
other pests		835	435	100	265		265		250
diseases		1380	618	100	390		390		350
The sum of the alfalfa pest	123377		1726	1000	954		954		950
Cotton plant	2809		7651	11000	5545		5545		5200
Helicoverpa armigera			4573	8000	3229		3229		3500
Tetranychus urticae			1191	2000	934		934		800
other pests			1887	1000	1382		1382		900
Weeds		11284	7670	5400	5706	2541	3165		6100
Ambrosia artemisiifolia									
Cuscuta sp.-		261	176	300	97	97			100
Acroptilon repens									
Solanum rostratum				100					
Other weeds		11023	7494	5000	5609	2444	3165		6000

Plant protection works carried out in Kurdamir region from 01.01.2020 to 31.12.2020 (ha)

Agricultural crops / pests, diseases and weeds	Field			The density of the pest	Implemented in the range of 01.01.2020-31.12.2020 2020				
					Total	including			
						At the expense of the business entity		At the expense of the budget	
	sowing	Observation was made	Infected			Mechanical, biological and other	Chemical	Mechanical, biological and other	Chemical
Feeding on various plants - total		11211	559	0	184	24	0	0	160
Rodent		9945	251	0	24	24	0	0	0
Locust		1266	308	0	160	0	0	0	160
Elateridae				0					
Cereals	38877	995	580	0	488	0	488	0	0
Eurygaster intergriceps				0					
Zabrus tenebriodes elongatus				0					
Other pests				0					
Diseases		995	580	0	480	0	480	0	0
The sum of the alfalfa pest		199	153	0	123	0	123	0	0
Cotton plant	2510	3955	3489	0	3179	0	2277	902	0
Helicoverpa armigera		3305	2955	0	2725	0	1823	902	0
Tetranychus urticae		535	439	0	389	0	389	0	0
other pests		115	95	0	65	0	65	0	0
Other weeds		2131	1742	0	1553	57	1496	0	0
Quarantine weeds		800	694	0	634	0	300	0	334
Ambrosia artemisiifolia				0					
Cuscuta sp.-		800	694	0	634	0	300	0	334
Acroptilon repens									
Solanum rostratum									

Plant protection works carried out in Kurdamir region from 01.01.2021 to 30.06.2021 (ha)

Agricultural crops / pests, diseases and weeds	Field			The density of the pest	Implemented in the range of 01.01.2020-31.12.2020 2020				
					Total	including			
						At the expense of the business entity		At the expense of the budget	
	sowing	Observation was made	Infected			Mechanical, biological and other	Chemical	Mechanical, biological and other	Chemical
Feeding on various plants - total		6953	2415	0	1111.8	294	0	0	817.8
Rodent		4555	1211	0	599.3	294	0	0	305.3
Locust		2398	1204	0	512.5	0	0	0	512.5
Elateridae									
Cereals	38877	726	193	0	150	0	150	0	0
Eurygaster intergriceps					0				
Zabrus tenebriodes elongatus		464	0	0	0				
Other pests					0				
Diseases		262	193	0	150	0	150	0	0
The sum of the alfalfa pest	0	450	320	0	238	0	238	0	0
Cotton plant		976	862	0	764	0	764	0	0
Helicoverpa armigera									
Tetranychus urticae									
other pests		784	603	0	479	0	479	0	0
Other weeds		2754	2149	0	1546	157	1389	0	0
Quarantine weeds				0	0				
Ambrosia artemisiifolia				0	0				
Cuscuta sp.-				0	0				
Acroptilon repens				0	0				
Solanum rostratum				0	0				

Appendix 3: Major pests, diseases and weeds in Agrodairy LLC wheat and barley production near the Kurdamir area and applied control measures

Reference in English	Mammadli, T. and Aslanova, K., 2021: Major pests, diseases and weeds and their control in Agrodairy LLC production in the Padarchol area (close to Kurdamir area). Personal communication through online meeting, 16th June 2021.
Reference in Azerbaijan	Məmmədli, Tofiq, Aslanova, Konul, 2021: Padarçöl ərazisindəki (Hacıqabul və Şəmkir rayonları) AgroDairy MMC-nin istehsalında əsas zərərvericilər, xəstəliklər və alaq otları. Şəxsi görüş-MS team onlyan platfoması vasitəsi ilə, 16 iyun 2021.
Comment on the reference	T. Mammadli is chief agronomist for Agrodairy LLC in the Padarchol area (between Hajigabul and Shamkir regions). K. Aslanova is crop protection specialist. Agrodairy LLC is one of Azerbaijans leading agricultural companies, producing wheat, barley, corn, forage (hay/silage) and sugar beets. Agrodairy LLC produces both, grains and seeds.

Common name of pest, disease and weed in wheat and barley	**Scientific name**	**Control measures**
Pests		
Aphids	(no specific species mentioned)	1) Cypermethrin 250 qr/l (cheaper, try first) 2) Deltamethrin 100 ec 3) Lambda-cyhalothrin 4) Imidocloprid (systemic)
Scarab beetle	*Anisoplia Austriymca*	(See above)
Sunn pest (Shield bug)	*Eurygaster integriceps*	(See above)
Corn ground beetle	*Zabrus tenebriodes*	(See above)
Wheat thrips	*Haplothrips tritici*	(See above)
Common vole	*Mikrotus arvalis*	Zinc phosphide
Diseases		
Yellow rust/Stripe rust	*Puccinia striiformis f. sp. tritici*	Tebuconazole %25 53 g / L prothioconazole, 148 g / L tebuconazole 224 g / L spiroxamine (broad spectrum) When first symptoms are seen, spray, as rust is are airborne and spreads easily
Brown rust/Leaf rust	*Puccinia triticina (*formerly *Puccinia recondita)*	(See above)
Black rust/Stem rust	*Puccinia graminis f. sp. tritici.*	
Septoria	*Septoria sp.*	(See above)
Powdery mildew (mostly in barley)	*Blumeria graminis sp. tritici (*syn*. Erysiphe graminis)*	(See above)

Leaf blotch/scald (mostly on barley, when crop density is high)	*Rhynchosporium commune (*formerly known as *R. secalis)*	(See above)
Weeds		
Scotch thistle	*Onopordum acanthium*	1)2,4-D amin 2)Florasulam 3)MCPA
Wild mustard	*Sinapis arvensis*	(See above)
Common sowthistle	*Sonchus oleraceus*	(See above)
Dock/Sorrel/ Evelik-Labada	*Rumex sp.*	(See above)
Common mallow	*Malva sylvestris*	(See above)
Perennial ryegrass	*Lolium perenne*	1) Mesosulfuron-methyl + Thiencarbazone-methyl + Iodosulfuron-methyl-sodium + Mefenpyr-diethyl 2) Clodinafop-propargyl ve 60 g/L Cloquintocent- mexyl
Crested wheatgrass	*Agropyron ciristatum*	(See above)
Common wild oat	*Avena fatua*	(See above)

Appendix 4: Control measures recommended by the Agrarian Service Agency (ASA) of Azerbaijan against selected pests and diseases in wheat

Reference in English	Agrarian Service Agency (ASA), 2021: Pests and diseases. http://axa.gov.az/bitki-xestelik-ve-zererverici leri/xestelikler. Accessed 3 Sept 2021.
Reference in Azerbaijan	Aqrar Xidmətlər Agentliyi (AXA), 2021: Zərərvericilər və xəstəliklər http://axa.gov.az/bitki-xestelik-ve-zererverici leri/xestelikler
Comment on the reference	The reference is a compilation of control measures recommended by the Agrarian Service Agency (ASA) of Azerbaijan against selected pests and diseases in agricultural crops. 

Common name	**Scientific name**	**Control measures**
Pest		
Ground beetle	*Zabrus tenebriodes elongatus*	Based on the results obtained on the harmful ability of the common Caucasian grain beetle, the economic damage limit of the pest was determined as 5% crop loss. In autum, if it is found 1.6-2.2 units larvae in 1 m2 in ordinary crop field and 0.8-1.0 units larvae in seed crop field till leaf development stage, while in spring if it is found 3-4 larvae on tillering stage, it should be chemically treated with one of the insecticides listed below: Mostar 20 SP, Goldplan 20 SP, Pascal SP, Hekplan 20 SP, Devaplan SP with active ingredient acetamiprid (200 g / kg) Diazinon aria EC with active ingredient diazine (600 g / l), Hectas Diazinon Dumble EC, Korumagor EC, BI-58 NEW EC, Dingo 40 EC with active ingredient dimethoate (400 gr / l) Akdara 25 WGD with active ingredient thiamethoxam (250 g / kg); Cypermight 250 EC, Royal EC 250, Athletic EC, Cyrux 25 EC, Siperkor EC, Arrivo with active ingredient cypermethrin (250 g / l) Borey SC, Perfecto SC with active ingredient Imidacloprid 150 gr / l + lyambda-sigalotrin 50 gr / Azerbaijan does not take measures to control adult insects

Moroccan locust	*Dociostaurus maroccanus Thunb*	Mechanical method: Mechanical damage (for example, with a heavy object) can destroy some of the adults, making this measure useless during locust swarms of crops. Deep plowing Soil softening, mulching and cultivation in autumn Disking of gaps between plantings, roadsides and slopes of irrigation canals in early spring Early sowing, ice cream plowing and weed control Creating dense grass cover by sowing fodder crops in areas not used for agricultural crops Turning pastures into pastures by improving pastures Drying of depressions around lakes and rivers. Chemical method: Desis-ekstra, Karate Zeon, Konfidor və İmidc Qladiator , Dimilin for useful adults Synthetic pretroids (Fastak, Caesar, Tsunami, Karate Zeon, Gladiator, Fury, Arrivo, Taran and others). Insecticides containing Imidacloprid (Tanker, Konfidor, Imidc and others) are more effective against locusts. They can provide protection from pests for several weeks. During 2013-2017 years in Azerbaijan for normal spraying is used Fastoks (0,2-0,25 l/ha), Xlorban (0,5 l/ha), Siraks (0,2-0,25 l/ha), Kingor (0,6 l/ha), Superhard (0,15-0,2 l/ha) and Kral (0,15-0,2 l/ha), for small value spraying is used Xlorsirin ULV, Cypermectin ULV, Faskil ULV and Alpach ULV. These drugs were effective against locusts - biological efficiency ranged from 81 to 96%. Preparation of larval balls with drugs before the start of spring sowing is considered to be the optimal time of struggle. Chemical control measures (spraying) will start in Azerbaijan on April 11. The presence of 5-7 locust larvae per 1 m2 in the spring is considered to be economically harmful.
Rodent		
Common vole	*Microtus arvalis Pall.* *Microtus sosialis Pall*	Mechanical control measures:Bags, surface adhesives and ordinary mechanical traps Physical control measures: the use of high-frequency ultrasound, which scares away rodents Agrotechnical control measures:In order to reduce the environmental conditions in the rodent habitat (destroy nests and shelters, limit the fodder base, carry out disease-causing irrigation, etc.) and mechanically destroy the mice, the following agro-technical control measures should be applied in the following sequence:

		Plowing and irrigation of raw lands and fallow lands; Regular weeding of fields, roads and waterways; Timely harvesting of grain, lossless collection, non-storage of straw bales in the field; Cultivation of intercropped crops and deep plowing in autumn; Biological control measures:Prokhorov bacteria at 5170 N ° and Isachenko bacteria (Salmonella enterilitis are present. Issatschenko, strain 29/1) are used to prepare the bait. Isachenko bacterium (Salmonella enterilitis is present. Issatschenko, strain 29/1) causes specific typhus (typhoid fever) in mice and causes death in 4-15 days. Birds (owl, harrier, yellow bird), predators (weasels, polecat, fox) Chemical control measures: Zn3P2-Highly effective second-generation anticoagulants, such as brodifacum, bromadiolone and flocumafen, are currently used indoors and outdoors against rodents.
Disease		
Black rust/Stem rust	*Puccinia graminis*	One of the important measures against Black rust/Stem rust - It is necessary to harvest the crop on time, not leave harvest or remains (they are a source of disease) on field and to carry out deep summer plowing. - choose optimal sowing time, and try complex application of nitrogen, phosphorus and potassium fertilizers (N, P, K); - crop rotation; -destruction of carrier and intermediate host plants; -destruction of weeds and plant remains; -use of fungicides against the disease during the growing season.
Brown rust/Leaf rust	*Puccinia recondita f. sp. tritici*	One of the important measures against Brown rust is the planting of resistant varieties; - It is necessary to harvest the crop on time, not leave harvest or remains (they are a source of disease) on field and to carry out deep summer plowing. - choose optimal sowing time, and try complex application of nitrogen, phosphorus and potassium fertilizers (N, P, K); - crop rotation; -destruction of carrier and intermediate host plants; -destruction of weeds and plant remains; -Chemical control measures are the same as for yellow rust..

Yellow rust	*Puccinia striiformis*	- Use of disease-resistant varieties; - In order to destroy the source of infection of the disease, immediately after the end of the harvest, the fields should be cleared of weeds, deep plowing should be carried out; -plant rotation; - Phosphorus-potassium should be applied under the plowing of grain fields in autumn, and nitrogen fertilizer in the form of fodder in early spring; -nitrogen fertilizer should not be given separately; - timely control of grain weeds; - seeds should be treated; - Chemical control measures should be taken as soon as signs of severe disease appear. If a delay is allowed, the event will have no effect. As a chemical control agent, 25% Tilt (250 g / liter Propyconazole) 0.5 l / ha, 25% Bayleton (250 g / kg Triamidefon) 1.0 kg / ha or 25% Folicur (250 g / kg Tebuconazole) should be sprayed at a consumption rate of 0.5 kg / ha. The norm of spraying preparations for one hectare should be mixed with 250-300 liters of water and applied by surface sprayers.

Appendix 5: Measures to control rust diseases in grain recommended by the Ministry of Agriculture of Azerbaijan

Reference in English	Ministry of Agriculture of the Republic of Azerbaijan, 2021: Measures to control rust diseases in grain. https://www.agro.gov.az/az/news/taxilda-pas-xesteliklerine-qarsi-muebarize-tedbirleri Accessed 3 Sept. 2021
Reference in Azerbaijan	Azərbaycan Respublikası Kənd Təsərrüfatı Nazirliyi, 2021: Taxılda pas xəstəliklərinə qarşı mübarizə tədbirləri. https://www.agro.gov.az/az/news/taxilda-pas-xesteliklerine-qarsi-muebarize-tedbirleri
Comment on the reference	Ministry of Agriculture of the Republic of Azerbaijan

Common name of diseases	**Scientific name of diseases**	**Recommended control measures**
Brown rust/Leaf rust	*Puccinia triticina syn. recondita f. sp. tritici*	It is recommended to use disease-resistant varieties (many high-yielding wheat varieties with high resistance to this disease (Gobustan, Murov-2, Fatima, Askeran, Golden wheat) are planted. -Application of regular crops and predecessors; - Phosphorus-potassium should be applied under the plow in the areas where grain will be planted in autumn, and nitrogen fertilizer in the form of fodder in early spring; - Timely control of grain weeds; - Seeds should be treated; - Chemical control measures should be taken as soon as signs of severe disease appear. If a delay is allowed, the event will have no effect. As a chemical control agent, Alto-super 330 EC 0.4 l / ha, Rex-doo 0.5 l / ha, Altis-premer 2 l / ha and 25% Tilt (250 g / kg Propyconazole) 0.5 Spraying should be carried out using l / ha consumption rate. The norm of spraying preparations for one hectare should be mixed with 250-300 liters of water and applied by surface sprayers. The Agrarian Services Agency informs farmers that if they come across this disease in grain fields, they can apply to the local branches of the Republican Center for Plant Protection.
Yellow rust/Stripe rust	*Puccinia striiformis*	Same as Puccinia recondita

Appendix 6: Diseases of wheat in Azerbaijan and recommendations to wheat growers by Crop Husbandry Research Institute (AEIM)

Reference in English	Karimova, Sh, Ahmadov, B, Tamrazov, X, Jahangirov, A 2015: Infection and resistance to rust diseases in autumn wheat samples at Gobustan Regional Experimental Station, 4 pages, Azerbaijan Scientific-Research Institute-Scientific Works Collection XXVI tome, Baku, 272 pp
Reference in Azerbaijan	Kərimova,Ş, Əhmədov,B, Təmrazov,X, Cahangirov,A 2015:Payızlıq buğda nümunələrində Qobustan Bölgə Təcrübə Stansiyasında pas xəstəlikləri ilə sirayətlənmə və davamlılığı 4 səh, Azərbaycan Elmi-Tədqiqat İnstitunun-Elmi Əsərləri Məcmuməsi XXVI cild,Bakı, 272
Comment on the reference	Reference forwarded by Namila Azizova - Head of the Laboratory of Disease and Pest Control, AEIM - Crop Husbandary Research Institute. Associate Professor and ToT consultant of Ecoserve.

Common name of disease	**Scientific name of pest**	**Control measures**
Disease		
Stem rust	*Puccinia graminis f. sp. tritici*	Impact (0.4-0.5 l / ha), Tilt (0.4-0.5 l / ha), Alto Super (0.4-0.5 l / ha), 25% Bayleton (0.5 kg / ha)
Yellow rust	Puccinia striiformis	same as Stem rust
Brown rust	*Puccinia recondita f. sp. tritici*	same as Stem rust

Note: Vrn 1/ Arzu, NBKO 935-29-15/K-590W077-2-2/VBF 0589-1, HBA 142 A / HBZ 621 AABILENE/3/ BURBOT-6, Ferrygineum 2/19x Bezostaya-1-these varieties have resistance.

Appendix 7: Diseases of wheat in Azerbaijan and recommendations for control measures by the Azerbaijan State Agrarian University

Reference in English	Jafarov, Ibrahim, 2012: Phytopathology. East-west Publisher, Baku, 566 pp.
Reference in Azerbaijan	Cəfərov İbrahim, 2012: Fitopatologiya. Şərq-Qərb nəşriyyatı, Bakı, 566 s.
Comment on the reference	The reference is a textbook for agricultural students and available to the public. Focus of the book is on wheat and barely. Ibrahim Jafarov is rector of the Azerbaijan State Agrarian University (since 2013). Doctor of Agricultural Sciences, Professor, corresponding Member of the Azerbaijan National Academy of Sciences.

Common name of disease	**Scientific name of pest**	**Recommended control measures**
Fungal disease		
Common bunt/Stinking smut/Covered smut/Hard smut	*Tilletia laevis* and *Tilletia caries (syn T. tritici)*	Tetramethylthiuram disulfide (TMTD). (1,5-2,0 kg/ton); Vitavaks (3 l/ton); dividend (2 kq/ton); Premis (1,0-1,2 kq/t); Raksil (0,4-0,5 l/t); Skarlet ME (0,5 l/ton)
Dwarf bunt of wheat	*Tilletia controversa*	(same as Hard smut)
Loose wheat smut	*Ustilago tritici*	(same as Hard smut)
Karnal bunt of wheat	*Tilletia indica (Urocystis tritici, Turisina tritiki)*	(same as Hard smut)
Black rust/Stem rust	*Puccinia graminis f. sp. tritic*i	Tilt (25%) 0.5 l/ha Folicur BT 1 l/ha
Yellow rust/Stripe rust	*Puccinia stiiformis*	(same as stem rust)
Brown rust/Leaf rust	*Puccinia recondita f. sp. tritici*	(same stem rust)
Root Rot	*Bipolaris sorokiniana (syn. Helminthosporium sativum)*	Tilt (0.5l/ha), Bayleton (0.5 kq/ha)
Wilt	*Fusarium spp.*	Folicur BT (1l/ha), Winner, Ferazim, Strike
Alternaria leaf spot	*Alternaria alternata*	Tilt, Bayleton, Topsin-M
Septoria	*Septoria tritici*	Folicur BT 1 l/ha
Barley powdery mildew	*Blumeria graminis tritici (syn. Erysiphe graminis)*	Tilt (0,5 l/ha), Bayleton (0,2-0,3 kg/ha), score (0,1 l/ha)
Bacterial diseases		
Spike blight	*Rathayibacter tritici*	The control of insects which can be source of bacteria, must be carried out on a scientific basis, and a set of agro-technical measures must be followed. It is recommended to spray the seeds before sowing
Wheat glume rot	*Pseudomonas syringaye pv. atrofaciens*	
Black rot	*Xanthomonas campestris pv.*	

Appendix 8: Pest and diseases of barley in Azerbaijan and control measures by Crop Husbandry Research Institute (AEIM)

Reference in English	Novruzlu, Garib and Azizova, Namella, 2016: Diseases and pests of barley, control against it, 2016: Azerbaijan Agrarian scientific-theoretical magazine, printing house of "Taragi" LLC, Baku, 4 pp
Reference in Azerbaijan	Novruzlu, Qərib və Əzizova Namella 2016: Arpanın xəstəlik və zərərvericiləri, ona qarşı mübarizə, Azərbaycan Aqrar elmi-nəzəri jurnal, "Tərəqi" MMC-nin mətbəəsi, Bakı, 4 səh
Comment on the reference	Reference was forwarded by Namila Azizova, Head of the Laboratory of Disease and Pest Control, AEIM Crop Husbandary Research Institute. Associate Professor and ToT consultant of Ecoserve.

Common name	**Scientific name**	**Control measures**
Disease		
Barley brown rust	*Puccinia hordei*	The study found that barley varieties showed different tolerances against diseases and pests depending on the genotype. However, among the studied varieties, genotypes resistant to powdery mildew, rust, helminthosporiosis and pests such as Hessian and Swedish flies were selected and recommended for use as a starting material in selection. Selection work carried out in 2011-2015 showed that in the fight against diseases and pests of barley, in contrast to various methods of control (agro-technical, chemical, etc.), the cultivation of high-yielding and high-quality varieties is more ecologically important.
Powdery mildew	*Erysiphe graminis f.sp. tritici*	
	Helminthosporium gramineum	
Pest		
Hessian fly	*Mayetiola destructor*	
Swedish Fly	*Oscinella frit Lin*	

Note: Resistant varieties against above mentioned diseases and pests: Karabakh 22, standard, Nutas 67/91, CVVB 117-77-9-7 // Alpha / Dura, Nutas 0208/1, Boldo / ALOE-CIMMYT, Tarim-92 / Sararood ICB 05-1447-CAP , Nutas 45/88, Novoir 1ICB 91-0343) OAR-241, Rihane-03, Bulbul etc.

Appendix 9: Diseases of barley in Azerbaijan and recommendations for control measures by the Azerbaijan State Agrarian University

Reference in English	Jafarov, Ibrahim, 2012: Phytopathology. East-west Publisher, Baku, 566 pp.
Reference in Azerbaijan	Cəfərov İbrahim, 2012: Fitopatologiya. Şərq-Qərb nəşriyyatı, Bakı, 566 s.
Comment on the reference	The reference is a textbook for agricultural students and available to the public. Focus of the book is on wheat and barely. Ibrahim Jafarov is rector of the Azerbaijan State Agrarian University (since 2013), Doctor of Agricultural Sciences, Professor, corresponding Member of the Azerbaijan National Academy of Sciences.

Common name of disease	**Scientific name of disease**	**Recommended control measures**
False loose smut	*Ustilago nigra*	Vial TT 0,4 0,5 l/t (content Tebukonazol 60 qr/l + Tiabendazol 80 qr/l), Bunker 0,5 l/t, Vitara 2-3 l/t (seed fungicide) etc.
Covered smut of barley	*Ustilago hordei*	(See above)
Loose wheat smut	*Ustilago nuda*	(See above)
Barley brown rust	*Puccinia hordei*	Tilt (0.5 l/ha)
Stem rust of cereals	*Puccinia graminis f.secalis*	(See above)
Septoria nodorum blotch	*Septoria nodorum* syn. *Parastagonospora nodorum*	Folicur BT, (1 l/ha), Tilt 0.5 1 l/ha, Score 0.2 l/ha
Root rot	*Bipolaris sorokiniana*	Vitara 2-3 l/ha, Bunker l/ha
Early blight or brown spots	*Alternaria spp*	
Barley powdery mildew	*Blumeria graminis f. hordei*	Tilt (25%) 0,5 l/ha, Kumulusi DF (90%) -4 kq/ha , Folicur BT (22,5%)-1 l/ha

Appendix 10: Major pests and weeds in Agrodairy LLC alfalfa production near the Kurdamir area and applied control measures

Reference in English	Mammadli, T. and Aslanova, K., 2021: Major pests, diseases and weeds and their control in Agrodairy LLC production in the Padarchol area (close to Kurdamir area). Personal communication through online meeting, 16th June 2021.
Reference in Azerbaijan	Məmməldi Tofiq, Aslanova, Konul, 2021: Padarçöl ərazisindəki (Hacıqabul və Şəmkir rayonları) AgroDairy MMC-nin istehsalında əsas zərərvericilər, xəstəliklər və alaq otları. Şəxsi görüş-MS team onlyan platfoması vasitəsi ilə, 16 iyun 2021.
Comment on the reference	T. Mammadli is chief agronomist for Agrodairy LLC in the Padarchol area (between Hajigabul and Shamkir regions). K. Aslanova is crop protection specialist. Agrodairy LLC is one of Azerbaijans leading agricultural companies, producing wheat, barley, corn, forage (hay/silage) and sugar beets. Agrodairy LLC produces both, grains and seeds.

Common name	**Scientific name**	**Control measures**
Pests		
Beet armyworm	*Spodoptera exigua*	Insecticide application when ca. 2-5 insects/m2: 1) Emamectin Benzoate or 2) Lambda cyhalothrin
Cotton bollworm/Corn earworm	*Helicoverpa armigera*	(See above)
Lucerne weevil	*Phytonomus variabilis* synonym *Hypera postica*	(See above)
Diseases		
(No major problems with diseases are observed)		
Weeds		
Cuscuta/Dodder	*Cuscuta sp.*	Herbicide application as spot application 1) % 50 Propyzamide or 2) 40 g/l Imazomax
Fat hen/ Lamb's quarters/ Goosefoot	*Chenopodium album*	(See above)
Perennial ryegrass	*Lolium perenne*	150g/l Fluazifop-P-Buty

Appendix 11: Quarantine weeds of alfalfa in Azerbaijan, status 2021

Reference in English	Agrarian Service Agency (ASA), 2021: Quarantined weeds. http://axa.gov.az/bitki-xestelik-ve-zererverici leri/alaq-otlari, accessed 22.8.2021
Reference in Azerbaijan	Aqrar Xidmətlər Agentliyi (AXA), 2021: Karantin alaq otları http://axa.gov.az/bitki-xestelik-ve-zererverici leri/alaq-otlari, accessed 22.08.2021
Comment on the reference	The reference is the official list on quarantined pests of the Agrarian Service in Azerbaijan

Common name of weed	**Scientific name of weed**	**Control measures**
Ragweed	*Ambrosia artemisiifolia*	If farmers have quarantine weeds in their fields, they must contact the experts of the Regional Agrarian Science and Innovation Center (ASA/AXA) to help them to control them. The ASA/AXA center is located in Baku city, Najaf Narimanov Street, 7A AZ 1106. E-mail : info@axa.gov.az. For fumigation services: Tel: +994-12-562-85-34 (ext: 152)
Buffalo-bur	*Solanum rostratum*	(see above)
Russian knapweed	*Acroptilon repens*	(see above)
Cuscuta/Dodder	*Cuscuta sp.*	(see above)

Appendix 12: Pests and diseases of alfalfa and seed clover in Azerbaijan and recommendations to alfalfa growers by the agro-company HH-Group

Reference in English	Huseynov, Huseyn, 2018: Technical support to agricultural producers of HH-Group. Ideal Print LLC- Publisher, Baku, 30 pp
Reference in Azerbaijan	Hüseynov, Hüseyn, 2018, "HH-Groupun kənd təsərrüfatı istehsalçılarına texniki dəstək" İdeal Print MMC- Nəşriyyat, Bakı, 30 səh
Comment on the reference	The HH group is a large private company in Azerbaijan, selling seeds, agro-chemicals, agricultural equipment and offering technical advice to farmers. The brochure is mainly for alfalfa seed producers, as more plant protection measures are applied in seed production. The reference was forwarded by Ms. Mahire Aliyeva, Head of Dept. of Agrotechnology, Plant Protection Institute, Ganja, PhD, Crop production Agronomist.

Common name of pest/disease	**Scientific name of pest**	**Control measures recommended by HH group to alfalfa seed and clover seed producers**
Pests		
Lucerne weevil	*Phytonomus variabilis* Hrbst Synonym *Hypera postica* (Gylh.)	Coragen 150-300 ml, Sumi alpha 1,5 l, Alfanilin 17,6% K.C and Ladex 400 ZW (Information on the time of application is not provided)
Tychius weevils	*Tychius flavus* Beck *Tychius haematopus* Hrbst *Tychius quinquuepunctatus* J.	• First of all, it should be taken into account that Tychius flavus moves easily from one area to another. Therefore, the fight should be carried out on all seed clover. • To prevent mass reproduction of insects, keep alfalfa for only one year and use a second crop of alfalfa for seed. • The seed clover area should be 1 km away from the old clover.
Clover seed chalcid	*Bruchophagus gibbus* Boh.	• Wild legumes should be harvested immediately before fruiting, harvested from the field, bean plants left in the fall should be harvested and fed to livestock, and seeds should be prevented from falling to the ground during harvest. • Healthy seeds should be separated, sorted and sown with healthy seeds by seed sorting machines. • The pre-sowing material should be poured into a 15% solution of salt water and the seeds which stay up of should be collected and destroyed, and the seeds should be sown after drying. • Should be sprayed Druspan 25%-2 l/ha, Coragen-150-300ml or Sumi alpha
Alfalfa plant bug	*Adelphocoris lineolatus* Geoze	In order to prevent the eggs from overwintering inside the stem of the plant, alfalfa should be cut at the bottom. Dry plant stems left in the field in early spring should be mowed with special mowers and collected

		and destroyed as soon as possible. Spray with Druspan 25%
Alfalfa /Lucerne flower midge	*Contarinia medicaginis*	• Seed areas should be 1 km away from old plots. • A second mowing alfalfa should be kept for seed. • Spray with Druspan25% in the budding phase of plants • Biological pesticides include Bitoksibaksilin. Boverin can also be used.
Alfalfa sprout midge	*Dasineura ignorata*	A second mowing alfalfa should be kept for seed. Seed fields should be located 1 km from the old fields. Coragen 150-300 ml or Bye-bye 2,0-2,5 l-during the budding phase of alfalfa.
Diseases		
Powdery mildew	*Erysiphe communis* Grev. f. sp. *medicaginis* Dietr	TMTD (3-4 kg/t) (for seed treatment 30 days before sowing Topas-0.5 l/ha Topsin M-0.5l/ha Score – 0.2 l/ha 25% Tilt -0.8 l/ha 37.5 % Tilt -0.33 l/ha
Yellow leaf blotch of alfalfa Alfalfa leaf spot	*Pseudopeziza jonesii* Nannf. *Peudopeziza medicaginis*	Ridomil gold-2 kg/ ha Cupric oxide -0.4 kg / ha Manica bordeaux mixture -5-6 kg/ha Bordeaux mixture -6 kg/ha Destruction of plant residues in the spring, use crop rotation with alfalfa, other legumes and cereals, use of sustainable varieties, application of fertilizers (especially potassium) and proper agronomic techniques. The use of fungicides is also allowed when growing alfalfa for seed purposes.
Alfalfa rust	*Uromyces striatus* Schr.	Topas-0.5 l/ha Topsin M-0.5l/ha Skor – 0.2 l/ha 25% Tilt -0.8 l/ha 37.5 % Tilt -0.33 l/ha 25% Tilt (0,5 l/ha)

Appendix 13: Diseases of alfalfa in Azerbaijan and recommendations for control measures by the Azerbaijan State Agrarian University

Reference in English	Jafarov, Ibrahim, 2012: Phytopathology. East-west Publisher, Baku, 566 pp.
Reference in Azerbaijan	Cəfərov İbrahim, 2012: Fitopatologiya. Şərq-Qərb nəşriyyatı, Bakı, 566 s.
Comment on the reference	The reference is a textbook for agricultural students and available to the public. Focus of the book is on wheat and barely. Ibrahim Jafarov is rector of the Azerbaijan State Agrarian University (since 2013). Doctor of Agricultural Sciences, Professor, corresponding Member of the Azerbaijan National Academy of Sciences.

Common name of disease	**Scientific name of pest**	**Recommended control measures**
Powdery mildew	*Erysiphe communis* Grev. f. sp. *medicaginis* Dietr	Score (0,1 l/ha)+ 400 l/ha , Kumulus 4 kq/ha+400 l/ha- spray field
Downy mildew	*Peronospora aestivalis* Syd	1% Bordeaux mixture (4kg/ha $CuSO_4 \cdot 5H_2O$), Manica bordeaux mixture (5 kq/ha), Ridomil gold (1,5 kg/ha)
Ascochyta blight	*Ascochyta imperfecta* Peck	It is important to treat the seeds, destroy the plant residues, cultivate the soil well, use resistant varieties.
Alfafa anthracnose	*Colletotrichum trifolii* Bain et Essary	It is important to destroy plant residues, deep plowing, seed treatment, crop rotation, treatment of seed fields with fungicides, harvesting in optimal time, use of healthy planting material.

Appendix 14: Pests of alfalfa and recommendations to alfalfa growers according to a guide book on agricultural crops in Azerbaijan from 1965

Reference in English	Samadov, N., Ibrahimov, H., Khalilov, B., 1965: Pests and diseases of agricultural crops in Azerbaijan. Baku-publisher, Baku, 402 pp
Reference in Azerbaijan	N.Səmədov, H.İbrahimov, B.Xəlilov,1965:Azərbaycanda kənd təsərrüfatı bitkilərinin zərərvericiləri və xəstəlikləri (sorğu kitabı) Bakı-nəşriyyat, Bakı, 402 səh
Comment on the reference	The reference is a guidebook and available to the public. N. Samadov is Doctor of Biological Sciences, H. Ibrahimov is Doctor of Agricultural Sciences, B. Khalilov is Candidate of Biological Sciences.

Common name of pest/disease	**Scientific name of pest**	**Recommended control measures**
Pests		
Weevils (of the genus Sitona)	*Sitona inops* Gyll *Sitona humerlis* *Sitona crinitus* Hrbst *Sitona flavescens* Marsch *Sitona hispidulus* *Sitona longulus*	• Legumes should be destroyed at the edges of the fields, and the bottom of the seedlings should be plowed in early spring. • Spray with Coragen or other drugs if mass weevils appear in the field that have just started to germinate in the spring.
Seed weevils	Widespread species: *Apion apricans* *A.varipes* *A.punctigerm*	Spray-Bovrin 400 l/ha, Bitoksibaksilin 400 l/ha (no recommendation on the time of application is given)
Pea pod borer	*Etiella zinckenella* Tr.	-
Diseases		
(No diseases are mentioned for alfalfa)		

Appendix 15: Main diseases of cotton in Azerbaijan according to the Agrarian Services Agency (ASA) and recommendations how to control them

Reference in English	Agrarian Services Agency, 2021: The main diseases of the cotton plant. http://axa.gov.az/index.php/xestelikler/pambiq-bitkisinin-esas-xestelikleri Accessed 3 Sept. 2021.
Reference in Azerbaijan	Aqrar Xidmətlər Agentliyi http://axa.gov.az/index.php/xestelikler/pambiq-bitkisinin-esas-xestelikleri
Comment on the reference	The reference is a compilation of control measures recommended by the Agrarian Service Agency (ASA) of Azerbaijan against selected pests and diseases in agricultural crops. A special chapter is dedicated to the main cotton diseases.

Common name of disease	**Scientific name of pest**	**Recommended control measures**
Fungal diseases		
Verticillium wilt	*Verticilium dahliae*	**Maxim XL** For seeds: 1-1.5 liters of Maxim XL is taken for 1 ton of seeds and mixed with 8-15 liters of water **65% Fentiuram** For 1 ton of seeds: 10-12 kg of 65% fentiuram+ 15-20 l of water + glue **50% Pentaxlornitrobenzol** For soil: Immediately after application of 50% pentaxlornitrobenzol (100-200 kg/ha) to the soil, plowing is carried out at a depth of 30-35 cm
Fusarium wilt	*Fusarium oxysporum f.sp.vasinfectum*	
Rhizoctonia	*Rhizoctonia aderholdii*	Seed treatment with biopreparations containing Baccilius subtillis, Pseudomonas fluorescens and Trichoderma lignorum
Bacterial diseases		
Angular leaf spot of cotton	*Xanthomonas malvacearum*	3-chlorophenol(20 %)+copper for fuzzy seeds 7 kg, for naked seeds 6 kg +15-20 litr water

Appendix 16: Measures to combat pests and diseases in cotton recommended to cotton growers by the Research Institute for Plant Protection and Industrial Crops in Ganja (Azerbaijan)

Reference in English	Farajova Sevil, Veliyeva Mahira, 2015: Measures to combat cotton pests, Askeroglu Publishing House, Ganja, 46 pp.
Reference in Azerbaijan	Fərəcova Sevil, Vəliyeva Mahirə,2015: Pambıq bitkisinin zərərvericilərinə qarşı mübarizə tədbirləri, Əsgəroğlu nəşriyyatı, Gəncə, 46 səh
Comment on the reference	Farajova was a leading researcher of the Department of Entomology and PhD in Biology. Mahire Veliyeva is Head of Dept. of Agrotechnology at the Research Institute for Plant Protection and Industrial Crops in Ganja (Azerbaijan). PhD Crop production, agronomist, cotton growing ToT consultant of ECOserve.

Common name of pest/disease	**Scientific name**	**Recommended control measures**	
Pests		Chemical control	Biological control
Turnip moth	*Agrotis segetum*	Alban 25% WP Cruiser (seed treatment)	*Trichogramma apantelis* (5 times at 5 days intervals) *Habrobracon hebetor* (5 times at 3 days intervals)
Cotton bollworm	*Helicoverpa armigera*	1st spray: Karate Zeon (0,1 l/ha) + Actellic (0,8l/ha) 2nd spray: Karate Zeon (0,1 l/ha) + Match (0,3 l/ha) Methomyl (0,2kg/ha) and Emamectin benzoate (0,4 kg/ha); Thiamethoxam (0,2kq/ha) and Indoxacarb (0,3 l/ha); or Emamectin benzoate (0,4 kg/ha) and Cypermethrin (0,5 l/ha)	*Trichogramma sp.* (3-4 times against each generation, 60.000 -70.000 Trichogramma/ha) *Habrobracon hebetor* (3 times, 500-2.000 Habrobracon /ha)
Click beetles	*Elateridae sp.*	Cruiser, Alban 25% WP, Merkuran (0.1-0.3 kg / ha) Traps to kill beetle larvae. Traps are made from a mixture of 3.0 kg of Metaphos (softener) per hectare and 50 kg of jimix (the mass remaining after the extraction of oil from sunflower fruits). Gives a positive result for beetle larvae damaging seeds.	
Cotton aphids	*Aphis gossypii* *Aphis craccivora* *Acyrthosiphon gossypii*	Phosphamide, bi58 Rogor, Sumizidin - 1.5-2.5 l/ha, 200-300 liters of water Ramplan 20 sp.75 ml. 100 liters of water	*Coccinella, Chrysoperla carnea*-Our observations show that one female Coccinella adults destroys 3080-3544 aphids and larvae

		(If there are not so many beneficial insects in the fields, then chemical control is carried out. Chemical control of cotton aphids is carried out when an average of 8-10% of 100 plants are infected)	829-1202 aphids in 30-60 days. The larvae of *Chrysoperla carne*a kill 1090-1235 aphids
Two-spotted spider mite/ Red spider	*Tetranychus urticae*	Plitkran, Karate zeon, Bi-58 60%, Bi-58 (Rogor) 16%, Omayt 30%, Omayt 57%, Mosetam %,Ramplan 20 sp	
Beet armyworm	*Spodoptera exigua*	Karate zeon 0.5 l/ha	
Onion thrips	*Thrips tabaci*	Mosetam (0.2 kg / ha) and Aceti Super 20% WP (0.2 kg / ha), Pascal SP (0.2 kg / ha), Mostar 20 SP (0.2 kg / ha), insecticides containing asetamiprid	300-500 *Neoseiulus californicus* for 100 plants
Fungal diseases			
Verticillium wilt	*Verticilium dahliae*	Seed treatment: Maxim XL (1-1.5 liters of Maxim XL is taken for 1 ton of seeds and mixed with 8-15 liters of water) 65% Fentiuram (10-12 kg of 65% Fentiuram+ 15-20 l of water + glue for 1 ton of seeds) Soil treament: 50% Pentaxlornitrobenzol (Immediately after application of 50% Pentaxlornitrobenzol (100-200 kg/ha) to the soil, plowing is carried out at a depth of 30-35 cm)	
Fusarium wilt	*Fusarium oxysporum f.sp.vasinfectum*		
Rhizoctania	*Rhizoctonia aderholdii* syn. *R. solani*		Seed treatment: With biopreparations containing B*accilius subtillis, Pseudomonas fluorescens* and *Trichoderma lignorum*
Bacterial diseases			
Angular leaf spot of cotton	*Xanthomonas malvacearum*	Seed treatment: 3-Chlorophenol (20 %) + Copper for fuzzy seeds 7 kg, for naked seeds 6 kg +15-20 litr water	

Appendix 17: Pests of cotton in Azerbaijan and recommendations to cotton growers by the Azerbaijan Ministry of Agriculture

Reference in English	Azerbaijan Ministry of Agriculture, 2021: The main pests of cotton and control measures – Recommendations for farmers. https://agro.gov.az/az/news/pambiq-bitkisinin-esas-zererevericileri-ve-onlara-qarsi-muebarize-tedbirleri-fermerlere-toevsiye Accessed 3 Sept. 2021.
Reference in Azerbaijan	Azərbaycan Kənd Təsərrüfatı Nazirliyi, 2021: Pambıq bitkisinin əsas zərərvericiləri və onlara qarşı mübarizə tədbirləri– Fermerlərə tövsiyə. https://agro.gov.az/az/news/pambiq-bitkisinin-esas-zererevericileri-ve-onlara-qarsi-muebarize-tedbirleri-fermerlere-toevsiye
Comment on the reference	Recommendations by the Azerbaijan Ministry of Agriculture

Common name of pest	**Scientific name**	**Control measures recommended to farmers by Azerbaijan Ministry of Agriculture**	
Cotton bollworm	*Helicoverpa armigera Hb.*	1st spray: Karate Zeon (0,1 l/ha) + Aktellik (0,8 l/ha). Getting better result if adding: Metomil (0,2kg/ha) and Emamektin-benzoat (0,4 kq/ha); Tiametoksam (0,2kq/ha) and Indoksakarb (0,3 l/ha); or Emamektin-benzoat (0,4 kg/ha) or Sipermetrin (0,5 l/ha). 2nd spray: Karate Zeon (0,1 l/ha) + Matç (0,3 l/ha) İndoks Super 20% s.k., Lufoks 105 e.k., Kinfos 340 e.k. These insecticides prevent to increase load of pesticide.	60-70 thousand *Trichogramma* per hectare (3-4 times for each generation) 0.5-2 thousand *Habrobracon hebetor* (per hectare -3 times)
Aphids	Cotton aphids *Aphis gossypii* Glov. *wide spread aphids: Aphis craccivora* Koch*, Aphis gossypii Glov., Acyrthosiphon gossypii* Mordv	40% Bi-58 Novy (1.5-2.5 l / ha) or 25% Antio (2.0-2.5 l / ha)- for field spray Mosetam (0.2 kg / ha) and Aceti Super 20% WP (0.2 kg / ha), Pascal SP (0.2 kg / ha), Mostar 20 SP (0.2 kg / ha) insecticides containing Asetamiprid Terra (0.8 kg / ha) insecticides containing methyl-against aphids	

Two-spotted spider mite	*Tetranychus urticae Koch*	40% Bi-58 Noviy (1.5-2.5 l / ha) or 25% Antio (2.0-2.5 l / ha) – for field spray Abam preparation (4 % Abamektin + 2,4% Spirodiklofen)- 0,15-0,16 l/ha Massmektin EC (1,8 % Abamektin) 0,4 l/ha Hexygit e.k. (0,4-0,5 l/ha) or King Sunsay e.k. (0,6-0,8 lt/ha)- If the number of *T. urticae* in cotton crops exceeds the harmful limit again, applying a second anti- *T. urticae* treatment	

Appendix 18: Fungicides for cereals and their efficacy against important diseases 2021

(Source: Top Agrar 1/2021, Evaluation according to the experience of the LWK North Rhine-Westphalia, Germany)

(Part 1)

Fungicide	Active ingredient [1]	Content in g per l/kg	FRAC	Registration				Use EC	Amount l/kg / ha	Price[2] €/ha	Package l/kg	Frequency of use	Distance in m		
				B	W	R	T						Slope[3] >2 %	Water[4] 90 %-Nozzle	Edge[4] 90 %-Nozzle
Carboxamide (SDHI-Wirkstoffe)															
Aviator Xpro	**Bixafen** + Prothioconazol	75 + 150	7 3	✓	✓	✓	✓	30 - 61	1,0 1,25	45 57	5/15	2	5	*	0
Ascra Xpro	+ Prothioconazol + Fluopyram	65 + 130 + 65	7 + 3 + 7	✓	✓	✓	✓	30 - 61	1,25 1,5	53 64	5/15	1 2	10	*	0
Jordi	+ Prothioconazol + Spiroxamine	50 + 100 + 250	7 + 3 + 5	✓	✓	✓	✓	29 - 61	1,5	60	5	2	20	10	0
Skyway Xpro	+ Prothioconazol + Tebuconazol	75 + 100 + 100	7+3 + 3	✓	✓	✓	✓	25 - 69	1,0 1,25	50 62	5/15	2	20	*	0
Variano Xpro	+ Fluoxastrobin + Prothioconazol	40 + 50 + 100	7 + 11 + 3	✓	✓	✓	✓	30 - 61	1,5 1,75		5/15	2	5	*	0
Elatus Plus (im Pack)	**Benzovindi-flupyr**	100	7	✓	✓	✓	✓	31 - 61	0,75		7 + 2 x 5	1	0	*	0
Elatus Era	+ Prothioconazol	75 + 150	7 + 3	✓	✓	✓	✓	31 - 69	1,0	50	5/10	1	0	5	0
Revytrex	**Fluxapyroxad** + Mefentri-fluconazol	66,6 + 66,6	7 + 3	✓	✓	✓	✓	30 - 61	1,125 1,5	32 43	5	2	0	*	0
Alonty (im Pack)	+ Mefentri-fluconazol	50 + 100	7 + 3	✓	✓	✓	✓	30 - 69	1,5		5	2	0	*	0
Adexar [5]	+ Epoxiconazol	62,5 + 62,5	7 + 3	✓	✓	✓	✓	25 - 69	2,0		5/10	2	20	*	0
Ceriax [5]	+ Epoxiconazol + Pyraclostrobin	41,6 + 41,6 + 66,6	7 + 3 + 11	✓	✓	✓	✓	29 - 69	3,0		10	2	0	*	0
Vastimo	+ Metconazol	62,5 + 45	7 + 3	✓	✓	✓	✓	29 - 69	2,0		10	2	0	*	0
Priaxor (im Pack)	+ Pyraclostrobin	75 + 150	7 + 11	✓	✓	✓	✓	29 - 69	1,5		10	2	0	*	0
Bontima	**Isopyrazam** + Cyprodinil	62,5 + 187,5	7 + 9	✓				30 - 59	2,0		5/20	1	10	5	0
Seguris [5]	+ Epoxiconazol	125 + 90	7 + 3	✓	✓	✓	✓	30 - 61	1,0		5/20	1	0	*	0
Gigant	+ Prothioconazol	125 + 150	7 + 3	✓	✓	✓	✓	31 - 69	1,0	46	5	1	0	*	0
Strobilurine (QoI)															
Torero, Azoxystar, Azbany	**Azoxystrobin**	250	11	✓	✓	✓	✓	31 - 61	1,0	20/19 /19	5	2	10	*	0
Sinstar	**Azoxystrobin**	250	11	✓	✓			31 - 61	1,0			2	0	*	0
Comet (im Pack)	**Pyraclostrobin**	200	11	✓	✓	✓	✓	29 - 61	1,25	36	2,5	2	0	5	0
Viverda [5]	+ Epoxiconazol + Boscalid	60 + 50 + 140	11 + 3 + 7	✓	✓	✓	✓	29 - 69	2,5		10	2	0	*	0
Fandango	**Fluoxastrobin** + Prothioconazol	100 + 100	11 + 3	✓	✓	✓	✓	25 - 69	1,25 1,5	52 62	5/15	2	10	*	0
Thiophanate/Quinazolinone/Phenyl - acetamide/Benzopheneone/Morpholine/Piperidine															
DON-Q/Topsin [6]	**Thiophanat-Methyl**	704	1		✓			61 - 69	1,1		5,5/8,25/ 16,5	1	10	5	0
Talius (im Pack)	**Proquinazid**	200	13	✓	✓	✓	✓	25 - 61	0,25		1	2	0	*	0
Vegas	**Cyflufenamid**	51,3	U06	✓	✓	✓	✓	30 - 59	0,375	20	0,8/1/5	2	0	*	0
Property 180	**Pyriofenone**	180	50	✓	✓			31 - 65	0,5		5	2	0	*	0
Flexity (im Pack)	**Metrafenone**	300	50	✓	✓	✓	✓	25 - 61	0,5	13		2	0	*	0

1) bolt= main active ingredient; 2) Price without VAT; 3) Minimum distance in m, edge

4) when using 90%-drift reducing nozzles; 5) stocks may be used until 31.10.2021; 6) stocks may be used in 2021

	Eyespot	Mildew		Netbloth	Rynchos-porium	Ramularia	Yellow & brown rust	Septoria trit.		Septoria nodorum	Yellow leaf spot	Ear fusarium
		Stop effect	Long-lasting					curative	protective			
	••(•)		•	••	•••(•)	•(•)	•••(•)	•••	•••	•••••	•••	•••
	••(•)	•	••	••(•)	•••(•)	•(•)	••••	•••(•)	••••(•)	•••••	•••(•)	•••
	••	••	••	••	•••	•(•)	•••(•)	••(•)	•••	•••••	•••	•••
	••	•	•	•(•)	•••	•(•)	••••(•)	••(•)	•••	•••••	••(•)	•••(•)
	••(•)		•	••(•)	•••(•)	••	••••	•••	•••(•)	•••••	•••	•••
	•(•)		(•)	•(•)	•••	•	•••••	•••	•••(•)	••••(•)	•••	••
	••		(•)	••(•)	•••(•)	••	•••••	•••	••••	•••••	••••	•••
	(•)		(•)	•(•)	••	••(•)	•••	••••	•••••	•••••	•(•)	
	(•)		(•)	•	••	••(•)	•••	•••••	••••(•)	••••(•)	•(•)	
	•(•)		•(•)	••(•)	•••	•(•)	••••	•••(•)	••••	•••••	••	
	•(•)		•(•)	•••(•)	•••	•(•)	••••(•)	•••(•)	••••	•••••	••(•)	
	•		•	••	••(•)	•	••••	••(•)	•••(•)	••••(•)	••	••
	•		(•)	•••	•(•)	•	••••(•)	••	•••(•)	•••••	••(•)	
	••	•	••	•••	••	•(•)	••(•)					
	(•)		(•)	••	••	•	••••	•(•)	•••	•••••	•(•)	
	••		•	••	•••	•(•)	•••(•)	•••	•••(•)	•••••	••(•)	•••
			(•)	•	•(•)		•••(•)		(•)	•••(•)	•	
			(•)	•	•(•)		•••(•)		(•)	•••(•)	•	
			•(•)	•••(•)	•		••••		•	••••	•••	
	••••		•	•••	••(•)		••••(•)	•(•)	••(•)	•••••	•••	
	••	(•)	•	••(•)	••(•)	•(•)	••••	•(•)	••	••••	••(•)	••(•)
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		(•)	•••									
	•(•)		••									
	••		•••									

(Part 2)

Fungicide	Active ingredient [1]	Content in g per l/kg	FRAC	Registration				Use EC	Amount l/kg / ha	Price [2] €/ha	Package l/kg	Frequency of use	Distance in m		
				B	W	R	T						Slope [3] >2 %	Water [4] 90 %-Nozz	Edge [4] 90 %-Nozzle
Anilino-pyrimidine/Triazole															
Unix (Pack)	**Cyprodinil**	750	9	✓	✓	✓	✓	30 - 55	1,0		5	2	20	5	0
Kayak	**Cyprodinil**	300	9	✓				31 - 61	1,5	20	5	2	20	*	0
Mercury Pro	**Cyproconazol** + Azoxystrobin	80 + 200	3 + 11	✓	✓	✓	✓	31 - 69	1,0	27	5	2	0	*	0
Epoxion [5]	**Epoxiconazol**	125	3	✓	✓	✓	✓	30 - 61	1,0		5	2	20	*	0
Rubrik [5]	**Epoxiconazol**	125	3	✓	✓	✓		30 - 61	1,0		5/15	2	0	*	0
Osiris [5]	+ Metconazol	37,5 + 27,5	3 + 3	✓	✓	✓	✓	25 - 69	3,0		5/10	2	10	*	0
Champion [5]	+ Boscalid	67 + 233	3 + 7	✓	✓	✓		29 - 61	1,5		5/10	2	10	*	0
Revystar (i. P.)	**Mefentrifluconazol**	100	3	✓	✓		✓	30 - 69	1,5	40	10	2	0	*	0
Balaya	+ Pyraclostrobin	100 + 100	3 + 11	✓	✓	✓	✓	30 - 61	1,5		10	2	0	*	0
Plexeo/ Caramba	**Metconazol**	60	3	✓	✓	✓	✓	25 - 69	1,5		5	2	0	*	0
Imidazole/Triazole/Chloronitrile/Phthalimide															
Mirage 45 EC	**Prochloraz**	450	3		✓	✓		29 - 59	1,2	23	5	2	5	*	0
Ampera	+ Tebuconazol	267 + 133	3 + 3		✓	✓	✓	30 - 69	1,5	32	5/10	2	10	*	0
Kantik	+ Tebuconazol + Fenpropidin	200 + 100 + 150	3 + 3 + 5		✓	✓	✓	31 - 61	2,0	41	10	1	0	10	0
Eleando [5]	+ Epoxiconazol	150 + 42	3 + 3		✓			30 - 59	3,0		10	2	0	*	0
Proline/ Cubatur	Prothioconazol	250	3	✓	✓	✓	✓	29 - 69	0,8	46	3/5/15	3	10	*	0
Protendo 250 EC	**Prothioconazol**	250	3	✓	✓	✓	✓	25 - 71	0,8		5	bis 3	20	*	0
Tokyo		250	3	✓	✓	✓	✓	29 - 71	0,8		5	bis 3	20	*	0
Traciafin		250	3	✓	✓	✓	✓	25 - 71	0,8		5	bis 3	20	*	0
Pecari (Pack), Patel (Pack) Protendo		300	3	✓	✓	✓	✓	30 - 69	0,65		5	2	0	*	0
Input Classic	+ Spiroxamine	160 + 300	3 + 5	✓	✓	✓	✓	30 - 69	1,25	48	5/15	2	20	15	0
Input Triple	+ Spiroxamine + Proquinazid	160 + 200 + 40	3 + 5 + 13	✓	✓	✓	✓	30 - 51	1,25	54		1	20	*	0
Prosaro/ Sympara	+ Tebuconazol	125 + 125	3 + 3	✓	✓	✓	✓	25 - 69	1,0	37	5/15	2	10	*	0
Folicur/Balett	**Tebuconazol**	250	3	✓	✓	✓		25 - 69	bis 1,25	21	1/5/15	2	10	*	0
Orius		200	3	✓	✓	✓	✓	32 - 61	bis 1,5	16	5/10	2	10	*	0
Helocur 250 EW		250	3	✓	✓	✓		30 - 69	bis 1,25	16	5	2	10	*	0
Teson		250	3	✓	✓	✓		30 - 69	bis 1,25		5	2	10	*	0
Fezan		250	3	✓	✓			30 - 71	1,0		5/10	2	5	*	0
Magnello	+ Difenoconazol	250 + 100	3 + 3		✓			51 - 69	1,0	32	5/15	1	0	*	0
Pronto Plus	+ Spiroxamine	133 + 250	3 + 5	✓	✓	✓		25 - 69	1,5	30	5/15	2	20	15	0
Soleil/Sakura	+ Bromuconazol	107 + 167	3 + 3		✓			30 - 69	1,2	22	10	1	0	*	0
Folpan 500	**Folpet**	500	M04		✓			30 - 59	1,5	16	5	2	0	*	0
Dithane Neo Tec/Tridex [6]	**Mancozeb**	750	M03		✓			30 - 65	2,13	17/14	1/5/10	3	0	10	0

1) fett = Hauptwirkstoff; 2) Recherche top agrar, ohne MwSt.; 3) bei Pflugsaat ist ein bewachsener Randstreifen erforderlich (angegeben ist die Mindestbreite in m); 4) bei Einsatz von 90%-abdriftmindernden Düsen; 5) aufbrauchen bis zum 31.10.2021; 6) in 2021 aufbrauchen;

	Eyspot	Mildew		Net blotch	Rynchosporium	Ramularia	Yellow& brown rust	Septoria tritici		Septoria nodorum	Yellow leaf spot	Ear fusarium
		Stopp effect	Long-term					cur ativ e	prote ctive			
	••••	•	••(•)	•••	•(•)		•		•	••(•)	••(•)	
	••(•)	(•)	••	••	•		•					
		•	••	•(•)	••(•)		••••	•	•(•)	••••	•(•)	
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						••(•)	(•)		•••	•••	•	
							(•)		•••(•)	•••	•	

••••• *excellent efficacy,* •••• *special lprodukt,* ••• *very good efficacy,*
•• *good efficacy,* • *partial efficacy (efficacy to yellow rust is often better)*

ENVIRONMENT, CLIMATE,
OPPORTUNITIES
for people and nature

Management of natural resources and safeguarding of ecosystem services for sustainable rural development in the South Caucasus (ECOserve)

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