



DELIVERABLE 2.3

COUNTRY BASELINE INVENTORY

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DATE: 30 June 2023



This project is part of the PRIMA programme supported by the European Union



PROJECT	MEDiterranean alliance for ecological PEST management (MED4PEST)
PROJECT NUMBER	122N051
TYPE OF FUNDING	RIA
DELIVERABLE	D2.3 Country Baseline Inventory
WP NAME/WP NUMBER	WP2 - Research proxies' baseline on rodent parameters and damages
TASK	2.1-2.4
VERSION	2
DISSEMINATION LEVEL	PU (public)
DATE	30/06/2023
LEAD BENEFICIARY	MMR
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DOCUMENT HISTORY

VERSION	INITIALS/NAME	COMMENTS- DESCRIPTION OF ACTIONS
1	MED4PEST_DEL2-3_V31-05-2023	First version
2	MED4PEST_DEL2-3_V30-06-2023	Final version



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1. INTRODUCTION

There have been several direct anthropogenic drivers on rodents' expansion in the Mediterranean basin. The expansion of the Roman Empire and the increase in human population in several cities, especially Rome, generated trade flows that probably facilitated rat transport across countries and islands, since the intense military and trade activities of the Roman Empire linked the Near East (Syria, Judea) and the northern African coast (Egypt, Cyrenaica) to western provinces (Brooks & Jackson, 1973). Transportation of rats on grain and military ships inevitably facilitated their introduction onto Mediterranean islands and around the continental margins of the basin. Once they were introduced on the Mediterranean islands, the mild climate may have facilitated their spread out of human settlements and away from coasts and their establishment on islands without permanent human settlement. Finally, the widespread establishment of rats on Mediterranean islands for 1,000–2,000 years has been facilitated by (1) the longstanding intensity of human activities on islands and (2) the close proximity of most islands and islets to the continent, which may also have favoured natural dispersal by rats (Ruffino & Vidal, 2010).

Rodent infestations generally are an indication of man's intrusion on the environment. Poor sanitation, food waste and harbourage are usually abundant and easily available to rodents, and as a consequence they become established in the environment. Poor sanitation thus becomes one of the basic reasons for the continued existence of rodents, especially in urban and arable areas.

Rodents is a vertebrate order with such high a diversity of pest species, widespread range and variety of impacts in agriculture, forestry, public health, that has frequently been characterized as one of the major pest species that jeopardize crop production and quality of vegetable crops and arboriculture crops such as carob trees (*Ceratonia siliqua*) (Gugliuzzo et al., 2019).

Once crops are harvested, foodstuffs are also vulnerable, and rodent damage occurs along the entire chain from 'farm to fork'. Protocols for rodent pest management strategies, which include the use of anticoagulant rodenticides, are applied within these industry standards to ensure hygiene, biosecurity and food safety, with the goal of the complete elimination of all risks derived from rodent activity (Jacob & Buckle, 2018). The imperative of public health protection through food safety is considered by many in the food industry to be paramount and above any postulated ecological side-effects, and therefore the application of mitigation measures that impair efficacy are often fiercely challenged. However, with the trends in legislation; e.g. the increasing restrictions in the use of anticoagulants in Europe (i.e. Directive 98/8/EC and successive amendments and corrections, concerning the placing on the market of biocide products) further emphasize the need for new alternative, environmentally safer methods of rodent control (Capizzi et al., 2014; Pascual-Villalobos & Fernández, 1999).

In the baseline study (deliverable 2.2) we have gained understanding of rodent species with socio-economic impact and their characteristics in the Mediterranean region. More specifically on the pest species and population dynamics, rodent inflicted damage in the agricultural sector, rodent management practices, and socio-cultural aspects, market dynamics and regulations around rodent management.



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This baseline showed that although rodent damage is prevalent and persistent, it is still an under-researched area. We quickly found there are some knowledge gaps, for instance on species identification and understanding the behaviour of species. Furthermore, we found that on damage numbers, there is also little information available for Turkey, Greece and Morocco.

Work package 2 “Research Proxies’ baseline” has the objective to present reliable empirical data on rodent pests and their impact on agro-ecosystems. And it will furthermore serve as a reference for impact monitoring. Ecologically-Based Rodent Management relies on robust knowledge and data about rodent pest species and their behaviour. But it is not only about the rodents, it is also largely about the perspective of the people who work in the agricultural field and how they deal with rodents. Therefore Knowledge, Attitude and Perceptions surveys have been conducted to gain insight in how farmers and input providers experience rodent impact and what methods they use.

This country baseline inventory (D2.3) adds a layer to the existing datasheets and overall baseline data. It presents a wealth of information from farmers and input providers. The research findings are expected to provide insights into the attitudes and willingness for implementing ecologically-based rodent management techniques in reducing crop damage and improving yields in these regions. Furthermore, the study seeks to understand the cultural perceptions of rodent management in different regions and how these perceptions may influence adoption of various management techniques. All in all, it is expected that through these surveys we can fill some crucial data and knowledge gaps, through which new patterns may emerge and strategies can be substantiated.

Overall, the study aims to contribute to the development of culturally appropriate and effective rodent management strategies that can be adopted by local farmers to reduce crop loss and improve food security.



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2. METHODOLOGY

The objectives of work package 2 are the following:

- To improve knowledge and understanding of pest rodents occurring in representative agroecosystems of the partners countries, their behaviour, population dynamics, and ecology
- To understand the magnitude of rodent inflicted damages to pre-and post-harvest crops in the representative agroecosystems
- To augment research and enhance monitoring techniques on rodent ecology and behaviour to inform pest management
- To create a baseline survey as reference for impact monitoring.

Methods:

For the country inventory report the main methods for data collection are done through various tools and approaches that will be used to facilitate dialogue among stakeholders (farmers, extensionists, experts, researchers) in selected communities and districts in Turkey, Greece and Morocco with the aim of identifying and prioritising most valued interventions for future science and technology (SI) interventions. Dialogue tools will include all/combination of, i) focus group discussions (FGDs) and visioning with farmers and local level stakeholders, ii) Key informant interviews (KII) with key extension/support service providers on what contextually appropriate SI innovations have been developed and or being used, iii) a Knowledge, Atitude and Perceptions (KAP) questionnaire survey establishing a baseline of knowledge of rodent pests and their management and levels of application of various SI interventions (50-100 farmers per country), iv) social network analysis to investigate who generates what information and how the information is disseminated to the various stakeholders especially extension staff and farmers.

In each country 50-100 KAP surveys with producers and 20-25 with input providers are completed. The market survey was conducted to collect data on socio-economic, market-based and regulatory proxies related to rodent pest management through KAP surveys with agricultural input providers. While in the farmer surveys the focus is on gaining insight into the knowledge of farmers on rodents, the influencing factors for their populations and behaviour, estimations of damage levels, their attitudes regarding what is done on management and what is feasible, and all through their perceptions around the rodent issue, what can be done and what they are willing to do. This combined gives us a good overview of the knowledge and preferences of both producers and input providers. In this way we will be able to fine-tune our final product to the end-user and market-demands and make a good fit with existing regulations.

We also conducted in-depth interviews and focus group discussions (FGDs) with 5 key informants from the targeted countries through a specific set of questions. The aim of the interviews and FGDs was to get detailed information from the respondents about rodent behaviour, management methods, damage, and which rodent species are present in their area/region. We divided them into "key informant" and "focus group discussion". Key informants were experts in rodent issues in our project countries. They provided information regarding problems related to rodents, damage, and rodent



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control management methods. Based on these information we conducted our FGDs with 10 farmers and local respondents combined. Table 1 includes all information related to our primary data sources.

Table 1 Sources of Primary data (Greece (n=2), Turkey(n=12), Morocco (n=1))

Data collection method	No. of participants	Data Source
Key Informant Interview (KII)	M=3, F=2, Total =5	Researcher in Rodent Ecology. Pest control professionals, Agricultural engineer
Focus group discussion (FGD)	M=7, F=3, Total =10	Farmers, members of the local community (both urban and villages), plant protection officers
KAP surveys producers (farmers)	50-100 per country	With producers in each of case-study areas in the target countries.
KAP surveys agricultural input providers (market)	20-25 per country	With agricultural input providers in each of the target countries.

In Cyprus the information is confined to background information and an interview with a representative of the municipality of Nicosia, since it is not a target country.

A descriptive analysis is done per country and written in this report, the statistical analysis at meta-level comparing also the different countries to draw conclusions on correlations within and between countries, will take place in the coming months aiming to publish this data and findings.

Due to seasonality of cultivation there are still gaps existing on quantification of losses for standing crops. Such field measurements for damage assessment will be incorporated in the fieldwork for task 4.2 that includes EBRM experiments in different farming systems in three partner countries. With the experiments there will be control sites assessed as well, which will provide the data-sets for quantification of losses in the field.



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3. GREECE

This chapter describes the results for Greece that is derived from KII's and KAP surveys with farmers and agricultural input suppliers.

3.1 INTRODUCTION

Crete is the largest of the Greek islands, and the 5th largest in the Mediterranean, with a total area of 8,265 km². While retaining its own local cultural traits, the island shapes a significant part of the cultural heritage of Greece, but also contributes 5% of the national Gross Domestic Product (GDP), with agriculture and tourism as its main industries. The rapid development of Crete in the last 30 years has exerted strong pressures on many sectors of the region. The growth of agriculture in the Messara plain has a strong impact on the water resources and ecosystem services of the area by substantially increasing of water demand. The economy of the region is based on agriculture with intensive cultivation mainly olive trees, grapes, citrus, and vegetables in greenhouses.

Crete, has a Mediterranean climate, with mild, rainy winters and hot, sunny summers. The bulk of the rain falls from October to March; in summer, it almost never rains. In winter, but also in spring, it can snow in the mountains of the island, the highest of which is Mount Ida, 2,456 meters (8,058 feet) high. Along the coasts and in the plains, rainfall ranges from 450 to 600 millimeters per year; given the long summer drought, the landscape is semi-arid, especially in summer. In inland areas, there are greener slopes, where forests grow, but there is also a rocky desert in the mountain range called Lefka Ori ("White Mountains"), which is located in the western part of the island. In the interior of the island, there are also rivers, lakes and deep gorges. In winter, from December to mid-March, temperatures are generally mild, although the wind can exacerbate the feeling of cold. For its southern location, Crete is less exposed to cold spells than other Greek islands, however, the temperature at night can sometimes approach freezing (0 °C or 32 °F).

On the coast, snow is very rare, however, from time to time, such as in February 1992, February 2004 and January 2017, it can snow even in Heraklion. In addition, waves of bad weather can occur in winter, with wind and rain, so the sun in this season is not always guaranteed. On the contrary, in summer, the sun almost always shines for 11-12 hours a day. The growing season in greenhouses depends on the crop and weather conditions, in general tomatoes and cucumbers are the main crops and the growing season is from the beginning of September to the beginning of July.

3.2 RESULTS AGRICULTURAL PRODUCERS

The results are derived from 79 farmers who have completed the survey, all the farmers live on the island of Crete and are doing agricultural production in greenhouses.

3.2.1 GENERAL INFORMATION

The infestation of rodents in the agricultural sector of Crete is a problem of high importance because of the resulting downgrade of crop production quality as well as the damages caused to agriculture infrastructures. Although the presence of rodents and damages in crop yield and infrastructures do exist, the farmers do not apply specific and constituted measures against them. Typically, farmers



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apply chemical rodenticides, bought from their local suppliers without following a methodology of application and without the help of the local authorities.

Recently, HMU conducted an island-wide survey of greenhouse owners in the island of Crete. The survey took place from 24/11/2021 to 08/06/2022 and involved digital questionnaires, each referring to a greenhouse property. A total of 2,179 greenhouses were surveyed, constituting a sample of 16.95% of the total number of greenhouses in Crete (12,858) with a corresponding area of almost 500 ha. The total number of respondents (greenhouse managers) was 785 and 61% of the sampled greenhouses had an area between 0.015 and 0.2 hectares. The main crops cultivated include tomato, cucumber, pepper, mini tomato and eggplant, see Figure 1.

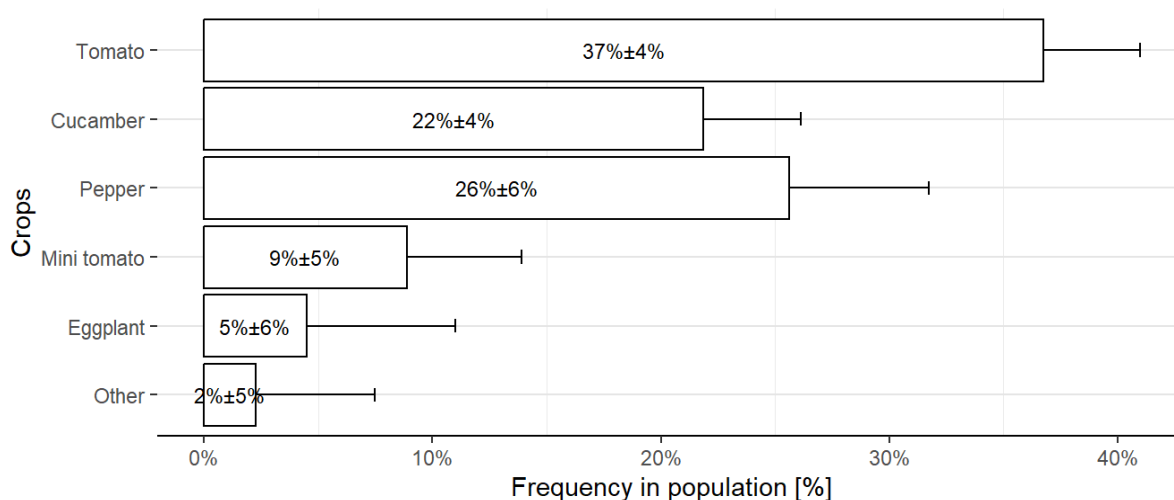


Figure 1 main crops cultivated in greenhouses Crete

Results regarding the use of pest control for preventive management, in 49.9% of the properties, owners use strictly chemical measures, in 40.6% use a combination of chemical and non-chemical measures, and only in 9.6% of the properties strictly non-chemical measures are used. At least 40.9% of the surveyed properties had a rodent infestation problem in the past 3 years, but here the picture changes. From these cases, only 28% used strictly chemical control to eradicate the problem, only 1.4% used strictly non-chemical means, and 71.1% used a combination of measures. It is noted that non-chemical measures included (a) mechanical or adhesive traps etc., and (b) predators (e.g. cats).

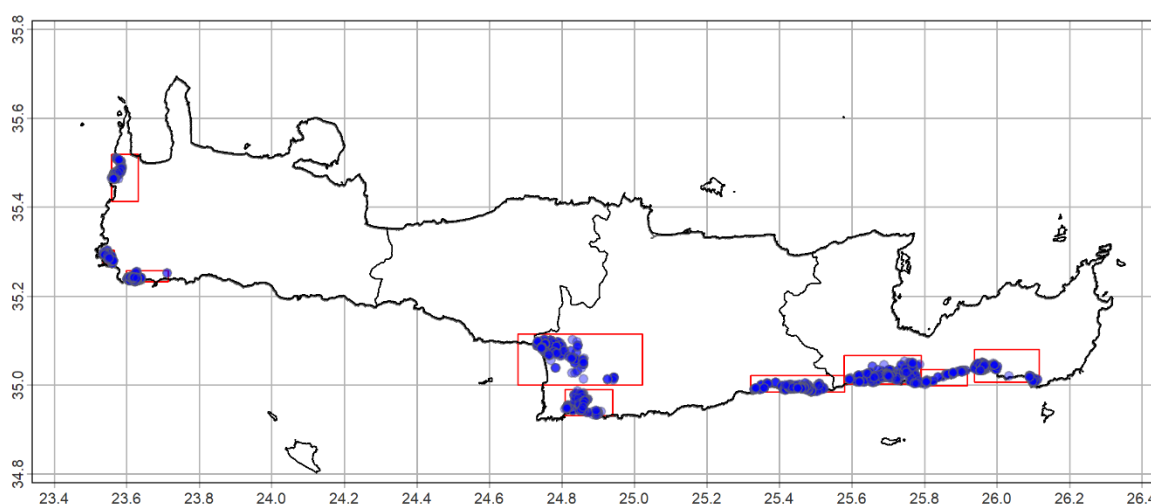


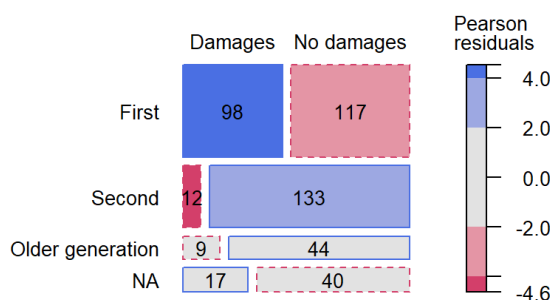
Figure 2 Locations of sampled greenhouses in Crete (blue dots). Red rectangles show distinct areas that were used for sample stratification

Within MED4PEST, the previously surveyed sample was revisited, and HMU got in touch with greenhouse managers who (a) had declared they have a problem with rodents, (b) had previously agreed to be contacted for further information, (c) were cooperative at the time of the new survey. This sub-sample amounted to 79 greenhouse managers

3.2.2 RODENT OCCURRENCE AND SOCIO-ECONOMIC LOSSES

In this section we will present and discuss the results along the themes of rodent occurrence and damage perceptions and estimations by farmers.

In Greece, the agri-food chain is a dynamic sector and important both in terms of production and employment. Particularly, fruit and vegetable industry offers opportunities to grow further and become more internationally competitive. Protected cultivations are among the most intensive farming systems and contribute significantly both to the agricultural and local income of Crete (Savvas & Gruda, 2018). The increased consumer demand for fresh vegetables attracts the interest of farmers not only to engage in the field of horticulture but also to adopt progressive cultivation techniques to increase productivity and quality of the final product and reduce the production and labor costs of their production unit (Bradley & Marulanda, 2001). However, this modern model of production is being compromised by several pest species which damage the yield of the crops and significantly reduce the commercial value of the end product, of which rodents are one.



The results from the KAP surveys show that for the majority of 63% of the farmers, rodents are an occasional problem, whereas 24% indicate it is a serious problem and only 13% say it is not a problem to them. It is interesting to see that first generation farmers report more rodent damages compared to second or older generation farmers (results from entire sample of 528 respondents), see Figure 3.

Figure 3 comparison first, second and older generation farmers for reported rodent damage

More than half of the farmers indicate that the problem is mostly encountered in their cultivation, though it is also sometimes encountered in residential areas and warehouses. In 42% of the cases where rodents are considered a problem, there are both rats and mice responsible, while in 38% of the cases it is only mice causing the problem and in 18% only rats. When comparing the issue of rodents with other pests, rodents took the 3rd place, after micro-organisms (fungi, bacteria) and insects, and before birds.

Tomato is the most efficient crop for 55 respondents, in economic terms, while this is also the crop that is most affected by rodents (48 respondents). After tomatoes comes cucumber on the 2nd spot, which again also comes at the 2nd spot for being most affected by rodents. Then there are three other crops, eggplant, pepper and olives at a distance both in terms of economic importance, as well as rodent damage. Eggplant and olives are said not to be affected by rodents at all, pepper does get affected.

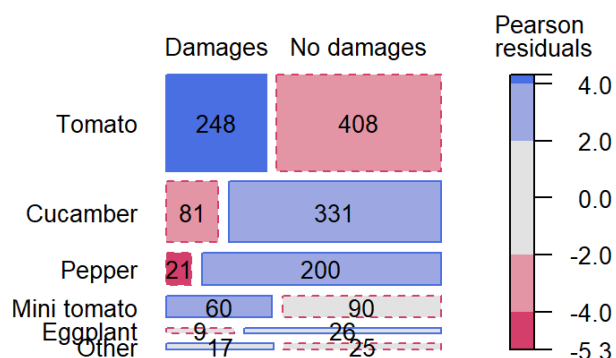


Figure 4 damage comparison for different crops

Figure 4 shows results from the entire sample (528 greenhouse managers), when comparing crops tomato cultivations have a relatively higher problem with rodent damages compared to other crops, such as peppers and eggplant. These results are significant.

The amount of money lost to rodents each year varies widely between 0 and 5,000 euros, with the average being 417 euro that farmers lose on a yearly basis. When asked how much (in percentage) a farmer would be able to prevent rodent damage if an effective management method was applied, the answers again varied widely, from 0% mostly answered by those farmers not experiencing rodents as a problem, up to 80, 90 and 100% by those who consider rats as an occasional or serious problem. The average percentage of damage reduction that farmers deem possible is 75%. This information is very interesting as it shows a high confidence that effective methods can largely curb rodent impact and improve agricultural yields and gains dramatically.

On the question “Which factors affect the risk for rodent infestation in your area?” the responses are the following:

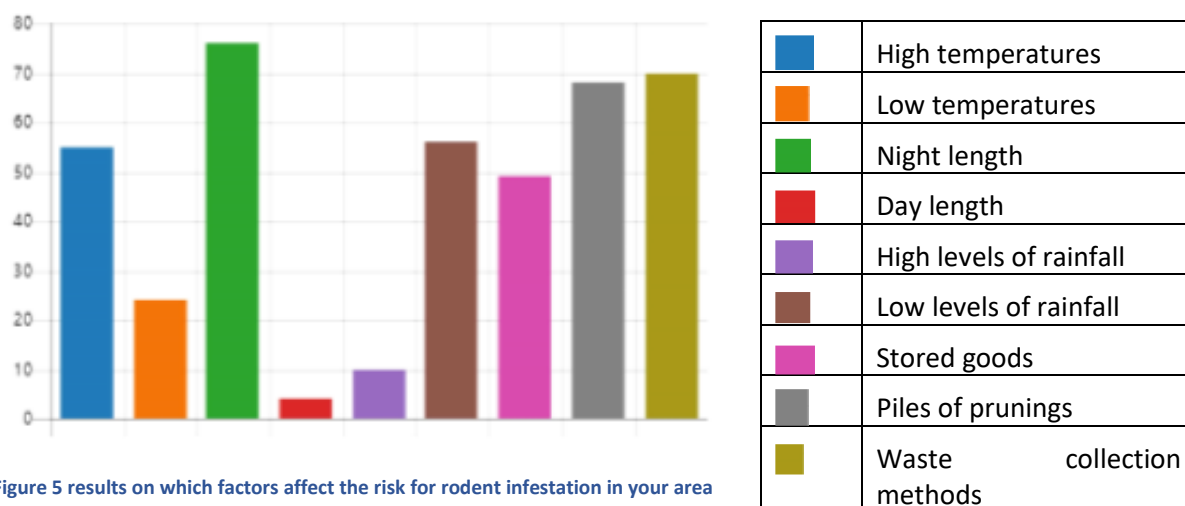


Figure 5 results on which factors affect the risk for rodent infestation in your area

Waste collection methods relate to how farmers handle the waste of their greenhouses, this is mainly the green waste. Their methods comprise of collecting green waste and use this as fodder (fresh food) for animals, using it as manure (fresh fertilizer), or transporting it to a waste facility.

It is interesting to see that a lot of factors are considered to be influencing rodent population dynamics, where only low temperatures, day length and high levels of rainfall are generally not considered a risk for rodent infestation. Meaning that there is good understanding of the large diversity of environmental (high temperatures, night length, low rainfall) and other general management factors (stored goods, piles of prunings, waste collection methods) greatly influencing reproduction rates of rats.

3.2.3 MANAGEMENT PRACTICES

In this section we dive into the different agricultural practices and rodent management methods used, known or desired by farmers. While we also touch upon information provision and services around rodent pest management.

First about waste disposal methods, 86% of the respondents say that this impacts rodent populations in residential areas and storage facilities. When asked how often they clean rodent habitats (prunings, bushes, harbourage areas, etc.) around the farm’s establishment, 43% says they clean this weekly, while 40% do this monthly, and 15% cleans on a yearly basis.

Comparing preventative and reactive measures, farmers by vast majority (92%) indicate that preventative measures drastically reduce the need for reactive measures. However, the most common method in use by the respondents are chemical rodenticides, which are also deemed the most

effective, these can be in different forms of paste, block-baits, water soluble rodenticides and pellets; out of which block-baits and paste are most often deployed. Apart from that mechanical traps, natural predators (e.g. cats), and whole wheat baits are used to a much lesser extent and their effectiveness is considered less. One farmer mentions the use of light automation with movement sensors to control rats.

The best season for rodent management in the minds of farmers is Autumn, with 73% of the respondents indicating that the months of September-November are the best for rodent management. Most greenhouse owners therefore associate the optimal time for rodent control with the beginning of the growing season.

- None of the respondents uses poisonous plants for rodent management.
- 98% of the respondents indicate that rodent management is carried out individually, whereas only 2 respondents indicate it is also done at neighbourhood/communal level.

Unknown methods and interest:

47 respondents indicate that there are rodent management methods or products that they know of, but are not applying at this moment. These methods and products include:

- Ultrasound / other sound devices
- Mechanical traps
- Marble dust
- Glue traps
- Multi-catch traps
- Sterilisation
- Bucket-traps with water
- Plaster with sugar (In the past this was used a lot in Greece, it was applied as gypsum plaster mixed with flour and sugar, the rodents ate it and died in a cruel way.)
- Predators
- Biological factors / bacteria (it was described as a kind of pathogen which can be introduced to a population and exterminates that population in the long term)
- Thorny bushes
- Naphtalene (coal tar) (some people of Crete believe that placing little spheres of naphtalene in small dishes or scattered in an area repels rodents)

62 farmers (78%) showed interest in Ecologically-Based Rodent Management and 73% is interested in a biological rodenticide product. The most common reason mentioned for both the interest in EBRM as well as in a bio-rodenticide is environmental protection. Another major reason is about efficacy, here farmers both mention that resistance built-up up to chemical products and that their concern is mainly on if a method proves to be effective. And generally farmers indicate that anything with high efficacy is of interest to them.

Whereas other factors like human health e.g. low toxicity to humans and environment, economic viability and efficiency are also mentioned.



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A few specific reasons / quotes from the respondents that show the range of perceptions:

- “I am more interested in trapping them so that they don’t smell when I find them dead in my greenhouse.”
- “I am interested in any solution as long as it is effective.”
- “I will be retiring soon, so I don’t care.”
- “I am happy with chemicals, I doubt other solution's efficacy and economic viability.”
- “Only because we will have to due to the change in the industry.”

Known biological predators that are known by the respondents include: cats, skunks, weasels, snakes, hawks, owls, hedgehogs, dogs, and vultures, with cats being mentioned almost by every respondent. This is also the animal that is seen in action by almost all the farmers. Almost all other animals are also seen in action, though to a lesser extent, except for hedgehogs.

Farmers’ perception on what should be done:

The following responses are given to the question “What do you think should be implemented for counteracting damages caused by rodents in a farm?”. The top-3 in the bullet-list is given most often, whereas the other options are shared more scarcely.

1. Communal management (regular and with contribution of every interested party in a region)
2. Regular management (all-year round)
3. Better waste management and cleaning (e.g. better farming/storage methods, better waste collection)
4. Public services (specialized staff of civil servants like agriculturalists, hygienists, veterinarians, etc.) and state contribution is required (e.g. for monitoring, baiting)
5. Wider use of rodenticides
6. No use of chemicals
7. Introduction of predators
8. Eco-friendly methods
9. Population control by sterilization
10. Education on rodents
11. Private companies to do universal rodenticide application
12. Preventative measures
13. Doing baiting in wider areas or zones

Whereas there is a huge diversity on what farmers think should be implemented there is overwhelming support for management at communal level, with a lot of emphasis on regular management by all the parties involved. Where specific expectations are there from state level to make a contribution as well. Whereas the type of methods should include better waste management and cleaning according to the respondents. Furthermore there are some other examples mentioned which are mostly towards EBRM, whereas also chemical rodenticides are preferred by a group of farmers.



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Farmers furthermore indicate that there is no regulation that prevents them from applying a certain rodent management method. Two shop owners from Greece indicate that the pesticide producing companies lower the concentration of active compounds. Though the shop owners indicate they are not aware of regulations, the pesticide companies do follow regulations imposed on them from government.

3.2.4 MARKET AND INFORMATION

The majority of the respondents (81%) usually buys rodent management products from local agricultural supply stores, and 95% is satisfied with the available products in the market. Only four farmers indicate they are not happy with the available products for reasons of low efficacy and cost, one farmer mentioned the efficacy is lower than what it used to be.

Agricultural supply stores also function as the prevalent source of information on rodent management, whereas also agricultural consultants, peer producers, internet, study-background, family-circle, and agricultural unions are sources of information. About 25% mention they know enough or their personal experience is sufficient. 87% of respondents are satisfied with the information they have in their disposal. The 11 farmers indicate they are not satisfied mainly because they perceive the information as insufficient.

On what could be improved on the information provision the respondents assign roles to:

- The state and local government: to provide more and continuous information (e.g. not waiting for infestation to reach a peak). (State government concerns civil servants of central services (ministries), while local government concerns employees working for local municipalities.)
- Agricultural suppliers: better and more accurate information
- Research institutions: provide more information / hold seminars / provide handbook on management
- Private sector: to hold information sessions / seminars. (Private sector currently operates through vendors from companies that wholesale rodenticides or through local store owners who sell rodenticides at retail.)

Furthermore, it is specifically mentioned that more information on innovative methods is required,

Respondents were asked to indicate how much they are willing to spend on rodent management products per year. With 44.9% stating 10-50 euro, 34.6% willing to spend 50-100 euro and 20.5% more than 100 euro, as can be seen in Figure 6..



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Figure 6 Results on how much euros respondents are willing to spend on rodent management products per year.

The following Figure 7 shows how respondents estimate the readiness on accepting a new way of rodent management. The largest section is for 26-50%, followed by 76-100% and 51-75%. This provides scope for dialogue and development of alternative EBRM methods.



Figure 7 percentage readiness to adopt a new way of rodent management

Lastly, farmers were asked to rank the criteria because of which they would adopt a new rodent management method. The ranking is the following:

1. Effectiveness
2. Eco-characteristics of the method
3. Cost
4. Ease of application

3.3 RESULTS INPUT PROVIDERS

This section describes the results from the KAP survey with 21 Input suppliers on Crete, Greece. For all the multiple-choice questions the questions are asked in the format “to what extent...” whereas the answer options include: 1. Not at all, 2. small, 3 moderate, 4 large, and 5 very large.

3.3.1 EXTENT OF RODENT PROBLEM

Firstly, the extent of the problem is considered either very large, large or moderate by the agricultural inputs shop owners, none thinks the problem does not exist or is only small. The discrepancy with the

extent of rodent problem for farmers compared to the management is striking, the shop owners indicate the extent to which people deal with the rodent problem a lot lower, compared to the extent of the problem. It also becomes clear that rodent cause considerable damage to homes and other infrastructure, apart from crop damage. All the shop owners indicate that rodent management in the area is for a 100% done at individual basis.

No	Question	Not at all	Small	Moderate	Large	Very large
1	To what extent do you think rodents are a problem for farmers in this area?	0	0	28.6	42.9	28.6
2	To what extent do people (farmer, storage house owner, local people) deal with the rodent problem in your area?	0	23.8	61.9	14.3	0
3	In addition to crops, to what extent do rodents cause a problem in homes and other areas or infrastructure (equipment, warehouses, irrigation hoses, etc.)	0	0	23.8	61.9	14.3

3.3.2 CHEMICAL RODENT CONTROL METHODS

The majority of customers to the shops buy conventional rodenticides, with 52.4% of respondents indicating farmers buy these products all year round. Whereas generally in the months from May to October most of the rodent control products are sold.

In terms of shop owners providing advice to farmers on which type of conventional rodenticides they need, the response indicates that in a majority of cases (52.4%) such advice is required sometimes, with 23.8% indicating this often happens. While for advice on the application the numbers are a bit lower where in 47.6% of the cases it happens sometimes, and in 23.8% of the cases it rarely happens. Regarding resistance build-up by rodents towards chemical rodenticides this is sometimes (38.1%), rarely (33.3%) or never (14.3%) mentioned to the shop owners. Additionally, a large majority indicates that impact on non-target species is rarely to never mentioned by farmers.

On the question whether farmers rotate/change active substances of conventional rodenticides, the shop owners indicate this happens only sometimes (61.9%) or rarely (23.8%). The interest into, or usage by farmers of non-conventional and/or bio-based methods of rodent management that shop owners consider ranges from not at all (9.5%), to small (38.1%) or moderate (38.1%) to large (14.3%). Non-conventional rodent management products bought from the shop owners is moderate (61.9%), to small (28.6%), to none (9.5%).

The rating on whether farmers are satisfied with the efficacy of conventional rodenticides is deemed high by the shop owners, shop owners express that 66.7% of the farmers is largely satisfied, where 28.6% is moderately satisfied. This contrasts with the extent of satisfaction with the efficacy of non-conventional rodent management methods, where it is expressed that only 9.5% of the farmers is largely satisfied, 38.1% is moderately satisfied, and 38.1% is a little satisfied.

38.1% of the shop owners indicate that they do not feature bio-rodenticides in their product range, where 23.8% features this to a small extent, 23.8% to a moderate extent, and 14.3% to a large extent. The product range of the shop owners consists of: conventional rodenticides (95.2%), traps (90.5%), repellents (19%) and ultrasound (4.8%).

From here it appears that the shop owners deem that farmers are more satisfied with conventional rodenticides as compared to non-conventional and/or bio-based rodenticides. However, it should be noted that a substantial part of the shop owners does not sell bio-based rodenticides and it is not clear what other non-conventional products they sell.

3.3.3 ALTERNATIVE METHODS AND PERSPECTIVE

The non-chemical rodenticide methods that shop owners have in store are largely traps (glue traps and mechanical traps), and spray repellents. The most popular methods of non-chemical rodent management are 1. Field cleaning, 2. Traps, and 3. Cats. Other methods mentioned include better sealing of greenhouses, metal barriers, waste collection, spiky bushes around trees, planting trees in low density, covering trunks with plastic, tilling and water containers functioning as traps.

When looking into the perspectives around need and demand, we see that shop owners see a larger need for bio-based rodent management products compared to demand from farmers.

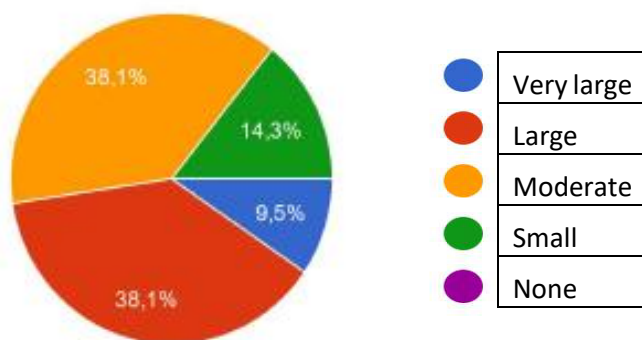


Figure 8 need for bio-based products

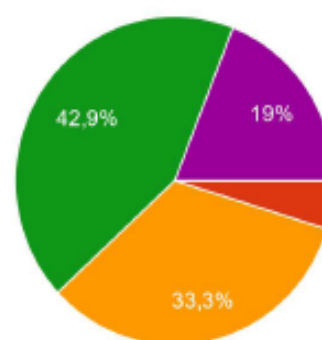


Figure 9 demand for bio-based products

The shop owners further indicate that rodent management products are for 42.9% of moderate importance, whereas 28.6 finds it largely important and 19% a little important. Furthermore shop owners are by majority satisfied (57.1%) about the rodent management products they have in store, with 23.8% being moderately satisfied and 14.3% being very satisfied. They perceive the extent of

satisfaction of their customer at 71.4% being satisfied, with 23.8% moderately satisfied and the remaining 4.8% very satisfied. 76.2% of the shop owners express their interest in providing bio- and eco-based rodent management products.

Box Interview pest controller, Crete

From an interview with a pest controller he explained that pest control companies and government departments know more about urban territories than the agricultural field. When rodent intensity increases or the urban residents see mice around the house (also from urine, and faeces) they call the pest control companies. A pest controller gets many calls from houses and hotels. It is much higher in the summer months than in the winter months. The main species are *Rattus rattus* and *Rattus norvegicus* or *M. domesticus*. It is a highly chemical-based management approach. But they don't have any specific regulations for rodenticide use both in the field and in the agricultural sector. But the pesticide companies and agricultural engineers suggest to them some procedures on how to apply poison baits or chemical spray. Also, there are regulations with the manual of rodenticide, they follow that. Though they don't have any specific rules from governments, pest control company uses per mice 3/4 gm baits in plastic tubes. Each bait is in 10 gm. They use 20gm / 2 baits per nest or rodent places. These baits aren't affected by the weather. They check on the baits after one month, if they see baits are untouched then they change them with different types of baits. Because rodents are very clever they smell and if that is unfamiliar to them they don't eat. Also, important aspects to apply baits are the bait boxes/ or traps should be placed 7-10 meters apart from each other. Otherwise, the rodent will get suspicious. If a client doesn't want poisonous baits around their house they use paper/ wood traps with attractive material like vanilla and nuts. Also, they use supersonic sounds to repel mice away from home. After applying rodent traps or poison bait they go and check the client's house and they dispose the dead rodents into the garbage bins. According to the damage, they don't think rodents are harmful to the property, they are more of a public nuisance. There are no rodent-borne diseases reported in the last 10-12 years. Also, there is no food contamination reported yet because of rodents in an urban area. But maybe in the countryside, it can be a problem, they don't know yet. He does not think rodents are getting resistant because they change the rodenticide in terms so that rodents don't get used to one drug and start adapting. But experts found *Rattus Norvegicus* is harder to kill than other ones.

3.4 DISCUSSION

Two interesting findings are that for tomato cultivations higher damage is reported, compared to other crops such as cucumber, pepper and eggplant. Furthermore, 1st generation farmers report damage from rodents more often than 2nd generation farmers.

Comparing preventative and reactive measures, farmers by vast majority (92%) indicate that preventative measures drastically reduce the need for reactive measures. However, the most common method in use are chemical rodenticides, which is an example of a reactive method. When asking for



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other methods they know of or would like to use, there are also examples mentioned of preventative methods, such as: communal and regular management, better waste management and cleaning, natural predators ultrasound, biological factors and thorny bushes. All examples of preventative measures. However, respondents also indicate they largely rely on chemical rodenticides which are also deemed the most effective. It can't be excluded that ease of application, cost and availability also play a major role that chemicals are used to this extent by the respondents. As it stems from the surveys with shop owners that they largely sell conventional rodenticides or traps, whereas it is expressed that farmers are generally satisfied with the efficacy of conventional rodenticide products. However, it is also indicated that there is a need and interest to apply biological and ecological methods, expressed by both shop owners and farmers.

Along with this, from the farmers survey it shows that a majority of >70% would be interested in applying EBRM and BR, for the major reasons of environmental protection and effectiveness. And farmers have shown a high confidence of success with effective methods, enabling them to reduce losses by 75% on average. However, there were no specific questions on ease of application in the questionnaire and we must therefore take this as an important point to consider in the upcoming dialogues with farmers and in the design process of EBRM for farmers in Greece and the other target countries.

A discrepancy between knowledge and attitude is shown in the topic of individual versus communal management. The farmers in the survey by large majority indicate that they apply rodent management methods individually, however when asked what should be done the most common answer is communal management, on a regular basis and with contribution of every interested party in a region. This shows the knowledge they have on the importance of managing rodents together, however in practice this is not done. This provides an entry point for discussion on collective management for the follow-up stakeholder dialogues.

Other interesting findings include that farmers are largely satisfied about the range of products they can buy and the information that is provided to them. The only things that come through is that more is expected from the state especially in terms of setting up regular monitoring and information provision. Whereas from the other stakeholders including agricultural suppliers, research institutions and private sector better and more accurate information is required. Overall respondents state that >50% of the farmers would be ready to accept a new way of rodent management. This is a promising number, however the criteria for ease of application and cost must be dearly taken into account, combined with the current reliance on chemical rodenticides.



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4. TURKEY

4.1 INTRODUCTION

Turkey generally has a mountainous land structure. 55.9 % of the land in Turkey above 1000 meter and 62.5 % has a slope more than 15%. Turkey is under the impact of the winds coming from the Black Sea and North and under the sea impact of which the wind brings. But the impact of sea cannot pass over the range of mountains on the north and south. For this reason, there is a strict tie between climatic characteristics and landforms of Turkey. Land structure and climatic characteristics of Turkey provided different geographical region and microclimate to be formed. There is a positive relation between land use and land structure of geographical regions, climatic characteristics in Turkey. So, forestry in humid regions, livestock in high, mountainous and arid regions and vegetative production in every region can be done in Turkey. These characteristics make it possible to produce specific agricultural products in different ecologic regions (Armağan, 2008).

Turkey is a major producer of wheat, sugar beet, tomatoes, barley, potatoes, grapes, maize, watermelons, and apples. Apricots, cherries, hazelnuts with shell, figs, quinces, and poppy seed are the most produced agricultural commodities of Turkey in the world. (Aytop, 2014).



Figure 10 KAP surveys with farmers in Southeast Turkey conducted by MMA staff

4.2 RESULTS AGRICULTURAL PRODUCERS

The KAP surveys were carried out in different villages of the Southeastern Anatolia Region / Şanlıurfa / Hilvan district. The villages include Şanlıurfa/Eyyübiye/Altınbaşak village. In the Altınbaşak village farmers generally cultivate cereals like wheat, barley and lentils mostly and grape and cotton sometimes. In the Hilvan region farmers cultivate many products like wheat, barley, lentils, cotton, pistachio, almond grape pepper. Soils in the entire region are largely clayey-loamy.



Figure 11 location of Harran plain in Southeast Turkey

Additionally, conversations were held with farmers about the agricultural systems that farmers applied in their own lands and about the damage of rodents. Farmers living in this region generally cultivated barley, wheat and lentils with rainfed agriculture, though irrigated agriculture is catching up. Nowadays sprinkler irrigation is widely used in wheat, barley and lentils. For corn drip irrigation can be used with the plants being in early growing stages, from later stages sprinkler irrigation is applied.

4.2.1 GENERAL INFORMATION

95.8% of the farmers in the survey indicate that farming is a family tradition that dates back more than two generations, they all do open field cultivation, where 3 farmers also do cultivation in a greenhouse. The majority of farmers (52.1%) is older than 56.

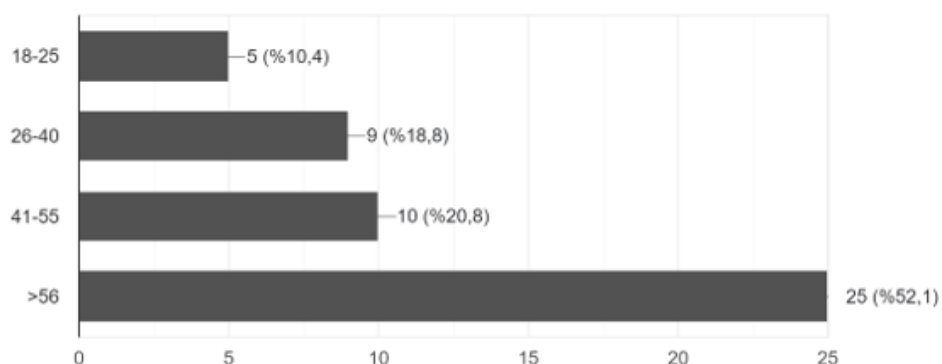


Figure 12 age groups of surveyed farmers in Turkey

The pest controllers identify rodent presence from feces. They immediately call governments and a team comes to check and apply poison baits or chemical spray after examining the area. If the rodent intensity is less, then they apply traps, but most commonly chemical rodenticides are used. Also, they put cats around the house as a control measure. They identify the species by size and shape. The rodent issues in storage areas arise more in the winter months January to February or September -February. Because in summer time mice find food in field areas and don't go to storage. In storage they are active at late night and in the agricultural field they are active at any time. Rats eat the seeds from barley and wheat, but for corn they eat the whole stem. In Turkey, there are no regulations on rodenticides. People can directly buy it from the market, pharmacy, or in agricultural departments (baits and chemicals for both urban and field). Though there are no regulations from governments companies have some regulations of their own. There are two types of pesticides available in the market. the pesticide package has a manual on how to use it to apply it in the field. Experts think they are getting adapted to rodenticides. Because the big rats don't get affected but small mice (*mus musculus*) die easily.

Box 1 interview with farmer on the practice around pest control

4.2.2 RODENT OCCURRENCE AND SOCIO-ECONOMIC LOSSES

The key informants share that in Turkey the rodents are active all year round, though highest activity is in Winter time, largely from September – February. In the summer there is enough food on the fields to be found, which makes that they don't go to urban areas or storage places. Therefore crop damage does occur as well in the summer time. Rats are found by identifying their burrows and their excrements, they are easily heard from the scratching sounds and other noise they make. Identification of the species is mostly done by identifying the size of the rodent and the body characteristics. The activity of rodents is mainly at night and around sunrise, though few local experts mention in the field there is always activity. Mostly the number of rodents are estimated by the

number of droppings and active rodent burrows / nests, and the damage that is observed, e.g. wall scratchings, cable damage, and damaged seeds and crops in the field.

In the interviews farmers reported that rats cause more damage in the dryland farming areas. Especially in the visit made to Altınbaşak village, located in the west of Şanlıurfa, it was reported by most of the farmers living in this village that they are struggling with rat damage, and face yield losses up to nearly 40% in barley, wheat and lentils. Damage is done by both rat and mouse species.

From the KAP survey results it stems that 77.1% of the farmers share that rodents are an occasional problem, for 10.4% it is a serious problem, and 12.5% shares it is not a problem at all. Serious rodent damage in the past 3 years was only experienced by 22.9% of the respondents. Most of the rodent damage occurs in both the cropping and storage areas.

Rodents and birds are the pest species that cause highest damage to agricultural production, while also fungus, insects and bacteria cause damage. The most important crops of the farmers are barley, lentils, wheat and corn. But also pistachio, almond, vegetables and cotton are produced by farmers in this region. The crops most damaged by rodents include: barley, wheat and lentils.

The damage data ranged from losing nothing at all, to losing 10.000 euro lost per year on average to rat damage, with the average being 664 euros lost per year according to the respondents. Regarding how much of these losses the respondents think they can reduce by effective rodent management, this is mainly estimated at 50-70%, with an average of 60%.

They mention that low temperature, low rainfall, night length, are the main environmental factors influencing the risk of rodent infestation in the area. Further factors affecting the risk for rodent infestation include storage materials used and garbage disposal methods, this for instance includes management of outdoor leaf piles and compost, also clearing of bushes was mentioned as an influencing factor.

4.2.3 MANAGEMENT PRACTICES

For farmers there are mainly two approaches one can take on rodent management. The first option is to do it yourself, either you buy a production from the agricultural input supplier, or you put a classic / traditional trap. The other option is to call someone from the government to come and apply rodenticides. The experts also mention that some drugs no longer work for killing rats and mice and that they need to change the rodenticide. Most of the local residents or urban dwellers we asked the in the interview don't know about this issue.

Garbage disposal methods used by farmers is predominantly burning of waste since regular garbage collection is not happening in these villages, food waste is collected as feed for animals. 68.8% of the respondents think their waste disposal methods does not contribute to rats' presence around the home and farm buildings. The majority of 53.2% clears rat harbourage areas (grasses, bushes, garbage piles) weekly, and 40.4% does this monthly.



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A majority of the respondents (71.1%) does not practice pro-active management for rodents, proactive management is aimed at prevention, thus aiming to prevent rodents to come to your area, even before you have recognized their signs or damage. Of the farmers who do preventative management, the main management methods are animal predators. The main type of management by farmers is reactive and this is largely done by application of chemical rodenticides and traps. When asked however if a difference is noticed between preventative and reactive rodent management, 87.8% indicates that they think that preventative management significantly reduces a need for reactive management.

The best season to do rodent management is considered to be spring (March-June) by 74.5% of the farmers, while 14.9% says the winter (December – February) is the best time. The respondents indicating spring is the best time to do rodent management give two main reasons, 1) This is right before the reproductive period of rats, and 2) it is right before the planting season and tillering stage of the crops. Whereas the control measures considered most effective are chemicals and traps, followed by biological or cultural methods. Poisonous plants are used by three farmers. By a vast majority of 71.1% rodent management is practiced at individual household level, the other farmers also do collective management at village/neighbouring levels. 89.1% of the respondents are not aware of other rodent control methods. However, 97.8% of all the respondents expressed their interest in other non-chemical methods to deal with rodent problems, with all farmers having interest to buy an organic rodenticide. A majority of 71.7% strongly agrees to the statement that chemical measures can have long term negative effects on people and the environment. The respondents clearly indicate that chemical rodenticides may do more harm than benefit, and that they prefer to use methods that are less harmful to the environment, and more so are harmless to soil, plant and human. Few farmers stated that if they have the choice, they would always go for an organic management option, instead of chemical.

Farmers identify several rodent predator species including fox, cat, hawk, snake and birds such as owl, and they have also seen all of them in action except for the owl, this can be explained because owls are mostly night-active.

To the question “what do you think should be done to control rat damages in farms” the answers are quite diverse, the following list provides a detailed description of the answers given:

- Need a more conscious approach
- Rat is partially useful, for instance for soil aeration
- Chemical controlling
- Trapping
- Keeping cats
- Better waste disposal and cleaning of rat harbourage sites
- Combination of methods, e.g. waste disposal, trapping, hunting and promoting natural predators.
- Storage materials should be inspected for rodents.
- Take actions before rats can do harm



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- The right precautions need to be taken, in line with recommendations of the authorities
- A combination of prevention and controlling

4.2.4 MARKET AND INFORMATION

In Turkey pest control experts and researchers mentioned that there are some government regulations on chemical rodenticides. Only legalized Agricultural Engineers are allowed to give chemical rodent baits to the farmers. The farmers in the surveys also indicate that this is the case, all of them respond that there are specific rules and regulations around rodent control that are challenging to them.

For rodent control products, farmers fully rely on agricultural supply stores, as source of information agricultural supplies stores are the most important with 95.6% using them as a source of information. However, also internet, agricultural consultants and other farmers are sources of information.

Farmers are largely satisfied with the services of the agricultural input suppliers, with 61.4% being satisfied with the rodent control products available, and 67.5% is satisfied with the information available to them through the agricultural stores and the other sources of information. Though the farmers who are not satisfied indicate that the products available are not effective enough and that the rats develop a resistance against chemicals after some time. In terms of information provision respondents indicate that the information is not enough and not detailed enough.

The most important criteria that will lead farmers to uptake a new rodent management method are cost and efficiency, after which the ease of application and bio- environmental features are considered. In terms of what farmers are willing to spend on rodent control products on a yearly basis, 76.6% indicates they are willing to spend 10-50 euro, while 14.9% is willing to spend 50-100 euro, and 8.5% is willing to spend more than 100 euro.

4.3 RESULTS INPUT PROVIDERS

This section describes the results from the KAP survey with 25 Input suppliers in Turkey. For all the multiple choice questions the questions are asked in the format “to what extent...” whereas the answers are multiple-choice being: 1. Not at all, 2. small, 3 moderate, 4 large, and 5 very large.

4.3.1 EXTENT OF RODENT PROBLEM

On the questions on whether rat control is deemed a problem in the area the following are the results, the numbers represent percentages of respondents:

Table 2 results on rodent issue perception (numbers are percentages)

No	Question	Not at all	Small	Moderate	Large	Very large
1	To what extent do you think rodents are a problem for farmers in this area?	0 %	20 %	44 %	8 %	28 %

2	To what extent do people (farmer, storage house owner, local people) deal with the rodent problem in your area?	4	16	48	20	12
3	In addition to crops, to what extent do rodents cause a problem in homes and other areas or infrastructure (equipment, warehouses, irrigation hoses, etc.)	0	4	48	36	12

From these answers it becomes clear that a majority of respondents thinks the extent of rodent problems are mostly moderate, also for homes and other areas, whereas the damage extent can be little higher. The way people deal with the rodent problem is largely in line with the extent of the problems perceived.

The input suppliers share why rodents are a problem and mention the following key points:

- rodents damage crops by eating seeds
- they damage the planted crop
- field mice are a big problem and can cause up to 100% yield loss
- they are causing root damages
- in watery areas rats are less harmful

However, some respondents also mentioned that the rat population is not as large as it used to be, and that they consider it largely as an urban pest. Also it is mentioned that the damage is periodically and not excessive.

Farmers would come to the shop for products or advice seasonal or the whole year. This varies widely, also some months are mentioned, from February to October, November and December, to May and June. Also at the first period of planting and harvest time are mentioned as periods when farmers come.

4.3.2 CHEMICAL RODENT CONTROL METHODS

Respondents however indicate that farmers buy products from them in little to moderate extent, around consultation the answers are more variable, it ranges from no consultation at all, to very much consultation, see Figure 13. The share of consultation is equally divided between consult on the need for chemical rodenticides and about its application.



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Figure 13 respondents indicate satisfaction from buyers on their products (left) and consultation (right)

When asked whether farmers inform them on resistance to chemical rodenticides, this is considered equally divided in range from a little, to moderate to much, each at 24%. However, whether they are informed on non-target harm differs stark, 36% of the input suppliers says that farmers do not inform them on non-target harm due to application of chemical rodenticides at all, whereas in 24% and 32% of the cases farmers inform them sometimes or moderately respectively. Rotation of different chemical rodenticide formulations is not done at all in 25% of the cases, whereas in 33.3% and 37.5% this is done either to a small or moderate extent.

The input suppliers perceive that about half of the farmers are moderately satisfied about the usage of chemical rodenticides. Whereas it is apparent that the input suppliers perceive that farmers are only to a small or moderate extent interested in applying non-chemical methods. The extent of interest of farmers for using non-chemical methods displays comparable results.

Majority of the respondents indicate they deem chemical products the most effective, such as zinc-phosphide. Some see zinc-phosphide as the “definitive result” or “definitive conclusion”. Other effective methods mentioned are: repellents. Whereas one input supplier mentions that “chemicals work best because it shows effect in a short time”. And one other mentions that in “old times people use methyl bromide which was very effective”.

4.3.3 ALTERNATIVE METHODS AND PERSPECTIVE

Whereas they think that a big part of farmers is either not interested (16%) or little interested (28%) in non-chemical methods, with 32%, and 12% and 12% respectively saying farmers are moderately, much or very much interested. And similar numbers represent the low interest as perceived by the market players that farmers have to use non-chemical methods against rodents. And, when asked if farmers are satisfied with non-chemical methods, this is largely perceived as to a little or moderate extent.

From these results it stems that it is perceived that farmers are not very satisfied with the usage of non-chemical methods, but at the same time a large part of the input suppliers does not have organic rodenticides in stock.

Figure 14 shows that despite having none, to a moderate amount of organic rodenticides in stock, there is a higher perceived need that such organic rodenticides are required.



Figure 14 left: to what extent do you have organic rodenticides in stock? right: to what extent do you see a need for organic rodenticide?

Rodenticides are a little to moderately important for the input suppliers, and 45.8% is moderately satisfied and 12.5% is much satisfied with the rodent control methods they have on offer. The perception on buyer-satisfaction rates is slightly higher, with 45.8% saying they are moderately satisfied, and 37.5% saying they are much satisfied.

From the open questions the input suppliers indicate that apart from rodent control products the farmers also buy insecticides, herbicides, fungicides, seeds, fertilizers, and plant nutrition products from their stores. The non-chemical methods that farmers in the area use include: field cleaning, warehouse protection, predators and trapping. Farmers come to their shops seasonally to ask for advice and/or buy products.

Other types of pests and diseases that cause damage to agriculture production include insects, worms, septoria, yellow rust, lepidoptera pests, red spider, aphids, fungus, and rhizoctonia.

Rodent control is done both on individual as well as collective basis in equal division. Non-chemical methods that could be effective according to them include: traps, repellents and predators. About half of the respondents indicate they would like to add other products to their range, out of which 3 indicate this could be an organic product, also traps or mechanical methods are mentioned by 2.

More than 50% of the input suppliers indicate that they would be interested in becoming a service provider in biological and ecological rodent management methods.

Box 2 interview with expert at Harran university

They had severe rodent issues in the University area, the sounds they were making created disturbance in the whole environment. Also, rodents make everything dirty from their faeces. They eat food and plastic cables, they damaged many valuable machine cables, but there is no quantification done for this damage. The most common species found is *Mus musculus*. They think these mouse species are getting resistance against rodenticides because they are getting familiar with the smell and if it looks suspicious they don't eat. And also they throw out the food. Though normal people can buy rodenticide directly from the shop it is illegal. They have some kind of regulations. Only Agricultural engineers, chemists, and veterans can write or approve the prescriptions for the rodenticide, and farmers have to show it to the pharmacy to buy rodenticides. Also, only registered pharmacies can sell rodenticides. But it's not maintained all over.

The input suppliers further elaborate on why rodents are a problem in their area, the answers include:

- rodents damage crops mainly by eating seeds or causing root damages
- it is more classified as an urban problem
- field mice can be a big problem and can cause a 100% yield loss



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Lastly we share this interview with a professor at Harran university who is giving an account of important considerations for the implementation of EBRM.

To establish Ecological based rodent management first we have to find out the economic threshold. To understand rodent intensity increase in the field we have to observe the active holes. Also, the number of predatory animals around the place indicates an increasing rodent population. For example, if in a field the presence of several snakes means rodents are higher. In the Southern part of Turkey (southeastern Anatolia) field mice are one of the dominant pests, especially in wheat production. Rodents eat the vegetative parts of the wheat plant when it is in the seedling phase when the vegetative part is soft.

Rodents are active all year round but more in the winter period especially November to March (specifically winter, early spring, and late autumn). Mice live in an underground tunnel around 70 cm deep they have 5-7 holes per mouse family which they use for a different purposes. For example - they use one for storing their food, feeding hole toilet, transporting soil, etc. How much damage rodents are doing will be identified by new hole detection. The Economic threshold level is 5 active holes per 25 square meter area. The most important part of rodent management ecologically is to control the feeding hole. To understand the active hole you have to give food in all holes and check one day later to find which holes are active.

Cultural ecological methods - Deeply cultivation/plowing of soil and disrupting their hole/nest so that they can't stay in the field. We have to do it before October (before winter comes, because they take shelter in the ground and soil protects them from extreme colds). Also, we should fill the field with water, when the nest hole is filled with water the mice will come out and you can kill the mice - manual method. It has been seen that irrigated areas are less damaged than dry areas. Damage is higher in a wheat field where there is no irrigation. Irrigation has an impact on the rodent population. They cause 10-30% of damage per wheat field. Another important approach is cleaning the field after a season. We have to make sure that rodents don't find food in winter. When farmers see mice they come directly to the ministry and buy poison baits from the governments. There are regulations. Only a registered person can sell zinc phosphate for example - an agricultural engineer.

Box 3 interview with professor from Harran university

4.4 DISCUSSION

From the results relating to the usage of preventative or reactive rodent management methods, it becomes clear that farmers largely rely on reactive methods, such as chemical rodenticides and traps. However, the knowledge is there overwhelmingly by 87.8% of the respondents that preventative management significantly reduces the need for reactive management. Furthermore, farmers clearly indicate that they fully rely on agricultural shops for their rodent products. These shops mainly sell chemical rodenticides and indicate a high satisfaction about these products. This assumes an interplay between both supply and demand which largely determines choice of chemical products, despite the



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notions that they have that these chemicals cause harm to the environment and that preventative and organic methods would be more beneficial.

This showcases the need to understand better why farmers choose to use certain methods and whether they would be inclined to go for alternative preventative methods if this would be available in their areas. Also other factors like being accustomed to certain methods, ease of application, effectiveness and affordability play a role and need to be investigated in the upcoming trials. There is good scope to trial EBRM methods with the farmers to obtain practical understanding of the needs and preferences that farmers have.



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5. MOROCCO

5.1 INTRODUCTION

The promise of Morocco begins with its geographic variety, making it a rarity in the Middle East and North Africa region. From the four mountain ranges that cross the country, to its plateaus and plains, the country is resource rich, especially in its highly diverse agriculture sector. With nearly 53,000 square miles of arable land, agriculture accounts for 80% of rural employment. (1. USAID Contract #608-M-00-05-00043-01, Statement of Work, pg 7) Morocco has been an agricultural country for millennia, with early appearances of some of the first known edible grains – such as wheat and bitter vetch - being traced to the country. And the country’s riches are enhanced by its proximity to Europe and its range of climate zones. The World Bank (2001, Policy Research paper) broadly divides the country’s cereal production— the mainstay of Moroccan agriculture to date—into six agro-climatic zones according to their cereal “production potential”. The zones are favorable, intermediaries, défavorable sud, défavorable orientale, montagneuse, and saharienne. These agro-climatic zones reflect topography and, most importantly, rainfall, which decreases from north to south and from west to east.

The most abundant species in Morocco and the most adapted to different types of environments is *M. shawi*. It is particular semi-desert rodent known by its resistance to long periods of thirst. It is characterized by a desert-diet and is considered a generalist and opportunist, it causes high damage to wheat and barley crops in Morocco. From the sanitary point of view, *M. shawi* is recognized as one of the main reservoirs of the causal agent of cutaneous leishmaniasis, contagious disease in humans that affects several regions of Morocco.

The most widespread species in Morocco, which is also considered an agricultural pest is the *Gerbillus campestris*. Its most important damage is caused to the peanut crop, particularly at pod maturity. The quantities of peanut stored in the burrows sometimes reach 5 kg. These quantities may well exceed this number in case of a high pullulation.



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Figure 15 pictures of the interviews with farmers

5.2 RESULTS AGRICULTURAL PRODUCERS

The respondents in the KAP survey are from the Gharb area in Morocco. Gharb, also called Rharb, is a coastal lowland plain of northwestern Morocco. Crossed from east to west by the Sebou River, the Gharb extends about 50 miles (80 km) along the Atlantic coast and reaches some 70 miles (110 km) inland. The lowland, which is bordered by the Rif Mountains to the northeast, has gradually been silted up by alluvial deposits from a seasonal watercourse, leaving a surface suitable for agriculture centred on the town of Souq Larb'a al-Gharb (Souk-el-Arba-du-Gharb). It is a major citrus-growing region (Britannica).

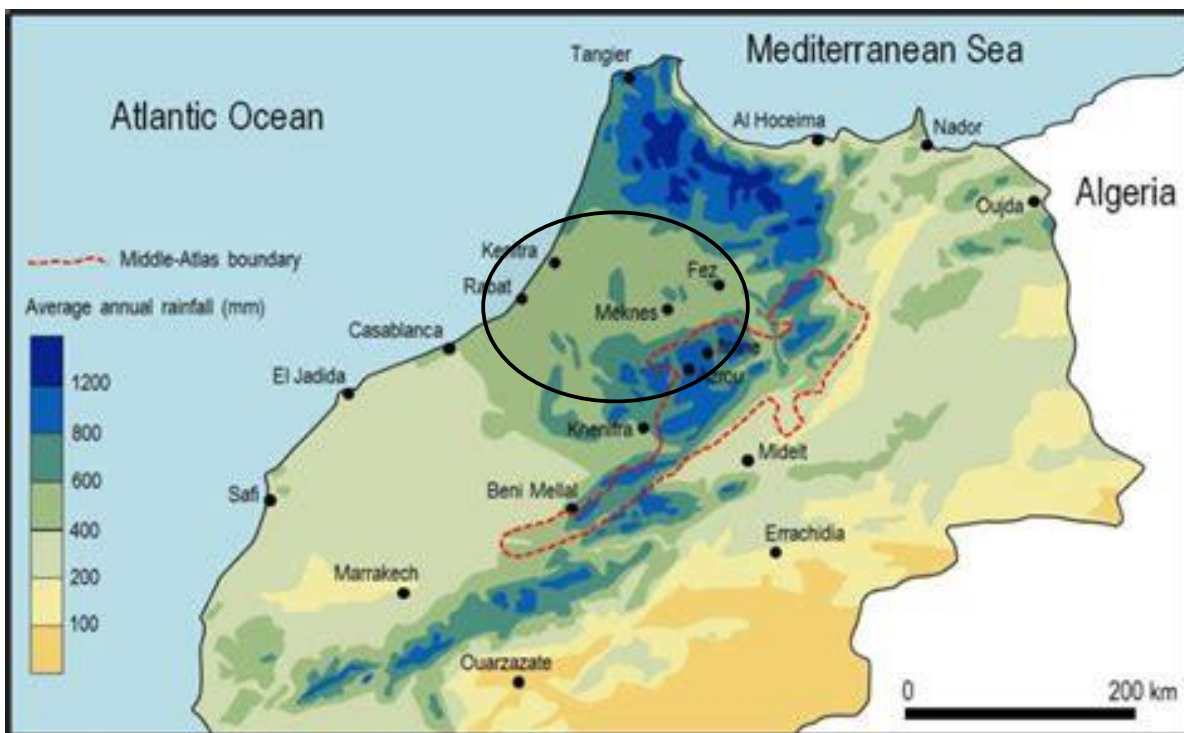


Figure 16 Morocco with in the black circle by approximation the location of the Gharb area

5.2.1 GENERAL INFORMATION

The division of men and women is 83-17, with people in all the different age brackets (20-30, 31-40, 41-55, and >56), with a higher representation of farmers between 41-55.

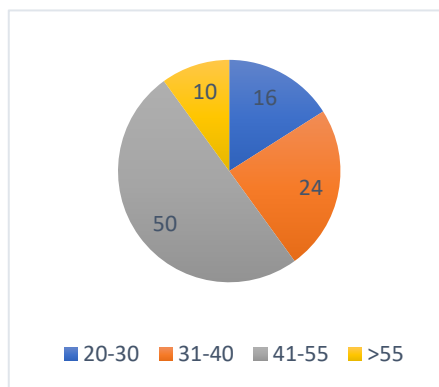
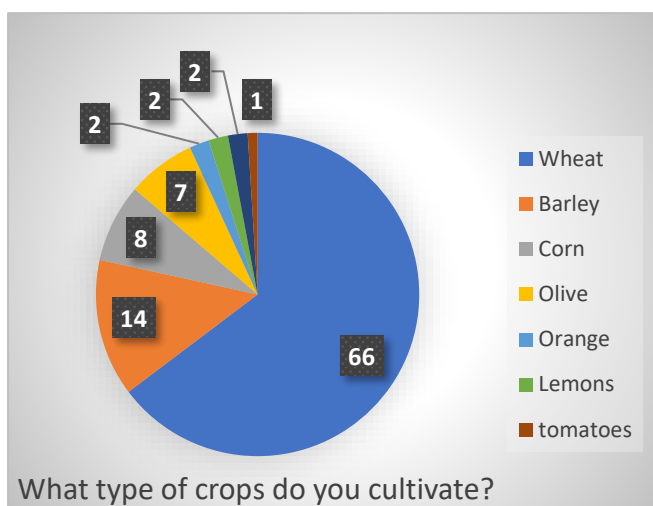


Figure 17 age groups of respondents



The main crops cultivated by the respondents are cereal crops, largely wheat, barley and corn. Also olive cultivation, citrus production and vegetables are scarcely produced in the area, see Figure 18. Open field farming is the common practice.

Figure 18 crops cultivated in the surveyed area

5.2.2 RODENT OCCURRENCE AND SOCIO-ECONOMIC LOSSES

The main rodent pests as identified by farmers in order of importance are: *Rattus rattus*, *Mus musculus*, *Merione shawi*, *Rattus norvegicus* and *Gerbillus campestris* (to a much lesser extent).

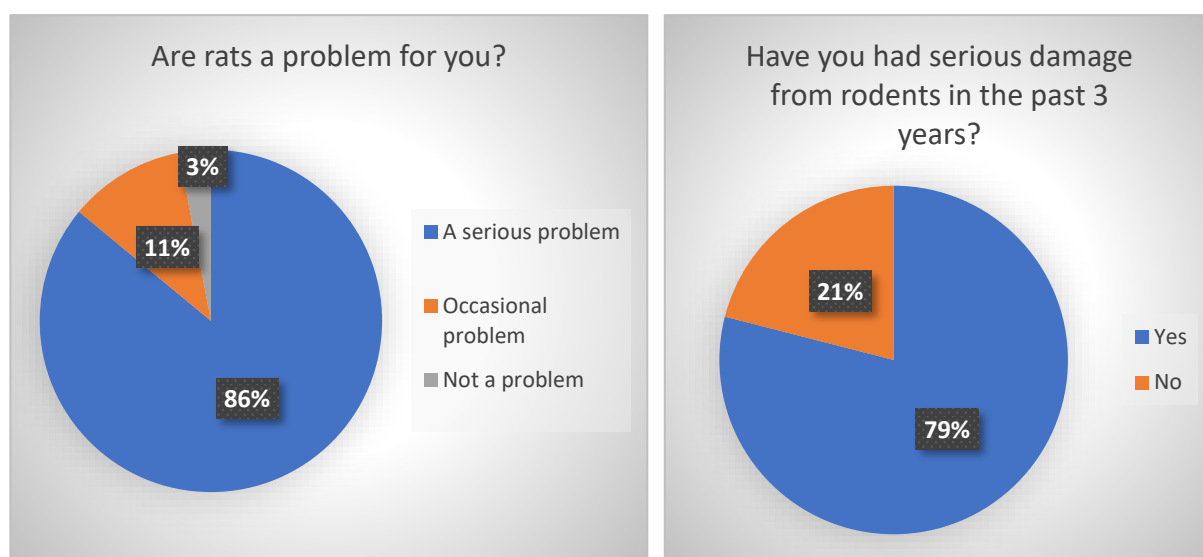


Figure 19 extent to which rodents are a problem (left) and if serious damage has occurred in the past 3 years (right)

Figure 19 clearly shows that a majority of respondents indicate that rats are a serious problem (86%), with 79% stating they faced serious damage in the past 3 years. Most of the damage happens around the homestead (62%) causing damage to houses and other properties, this happens frequently. Majority of the people differentiates rat species that occur in the field and those in the homestead and indicate these are different species. The rats mostly move around at night.

Figure 20 shows how much farmers feel they lose to rat damage per year on average. This is largely between 100-500 and 500-1000 euros. The crops mostly damaged by rodents is predominantly wheat, also being the crop that is produced by a majority of 66% of the respondents. Of these losses 35% thinks that 40-60% can be reduced by effective rodent management and 30% thinks this percentage can be 60-80%.

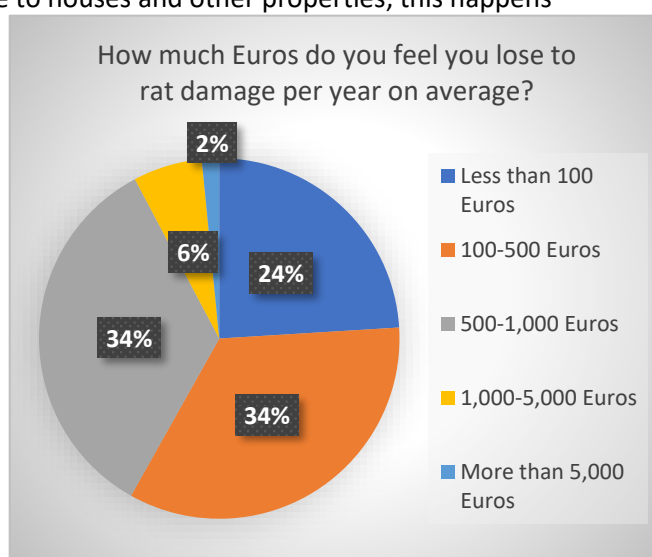


Figure 20 amount of damage perceived

When asking about the reasons for increases in rat populations that people have experienced, the main reason given by 47% of the respondents is the availability of abundant food sources for rats.

Other reasons given are the presence of adequate shelter, water availability, limited predation and control, climate and seasonal changes and resistance to rodenticides. The rat population is at its highest in the summer months, and lowest in winter months according to the respondents. Along with that the farmers think that rodent control is most effective in the summer season.

5.2.3 MANAGEMENT PRACTICES

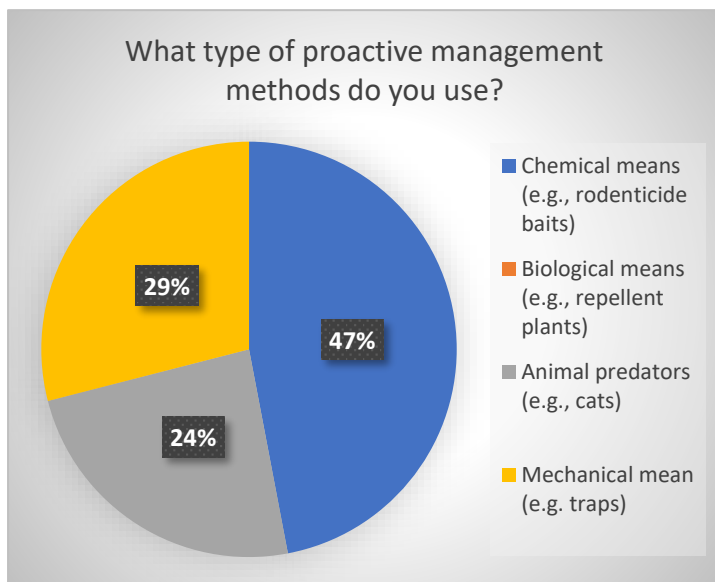


Figure 21 proactive management methods

All the farmers indicate that they practice proactive management for rodents, the methods used to do so include chemical means, animal predation and mechanical means. Only biological means are not practiced at all. Management of rodents is done both individually and collectively.

The other methods mentioned that can contribute to controlling rats in farmers include prevention and exclusion, hygiene measures, limiting rats access to food sources, traps and biological control.

Storage methods used are largely polypropylene bags, placed in secure areas of the house, whereas 33% of the farmers use plastic barrels and 11% indicates that it's necessary to use cement in storage houses to reduce rodents entering, see Figure 22.

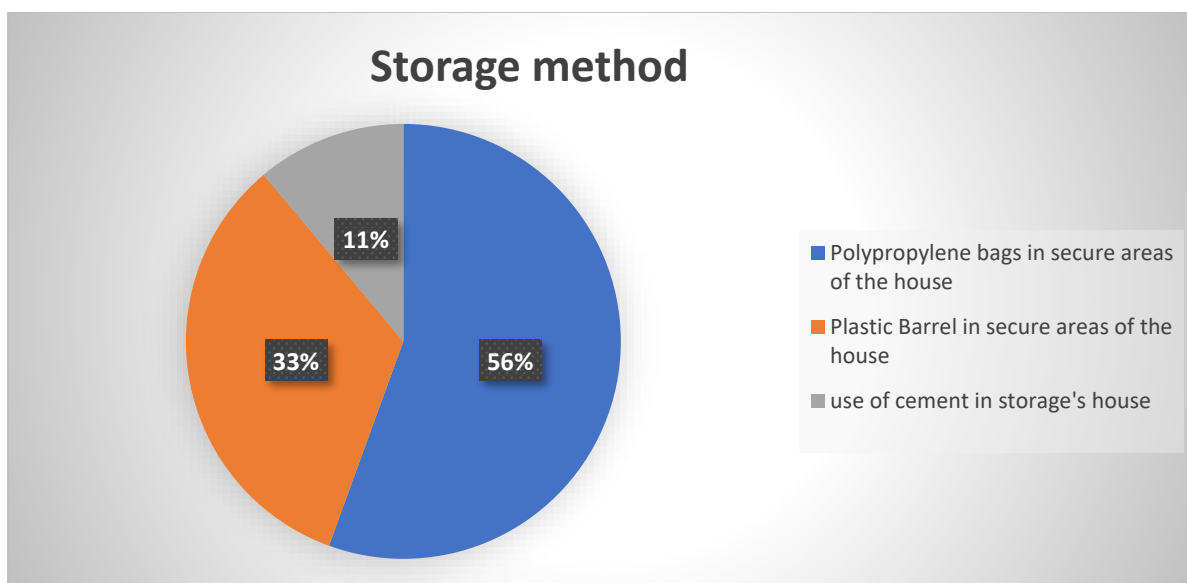


Figure 22 Storage method farmers in Gharb area, Morocco

5.2.4 MARKET AND INFORMATION

A majority of farmers go to the weekly market for buying rodent control products, their satisfaction mainly stems from the cost-effectiveness of the products. A majority of farmers expresses interest for deploying organic rodenticides and they would be happy to be involved in future sessions around the adoption of Ecologically-Based Rodent Management.

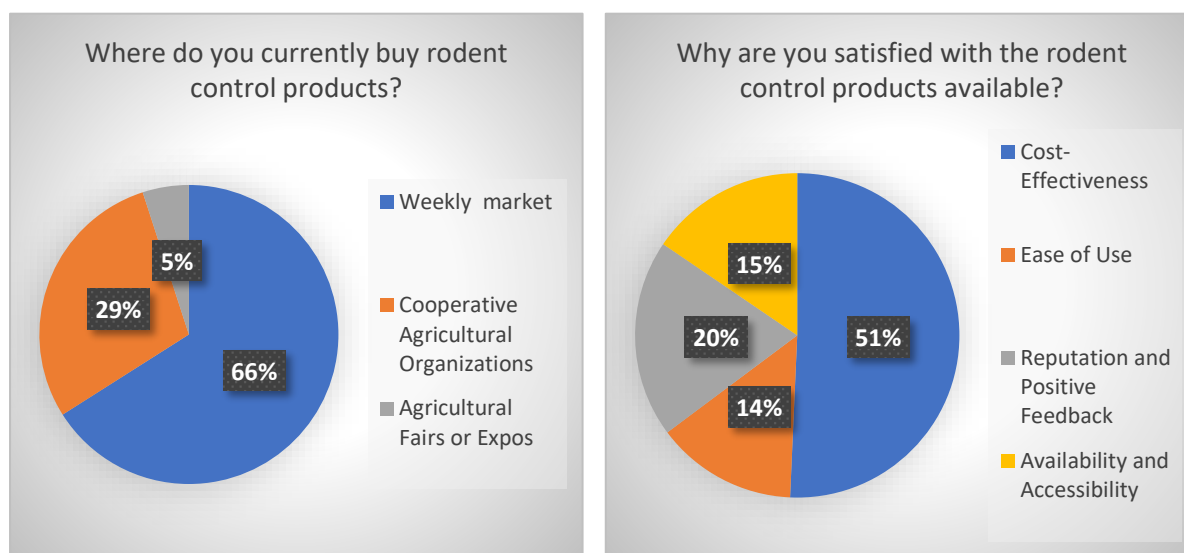


Figure 23 rodent control products source and satisfaction

5.3 RESULTS INPUT PROVIDERS

This section describes the results from the KAP survey with 24 Input suppliers from Morocco. For all the multiple-choice questions the questions are asked in the format “to what extent...” whereas the answer options include: 1. Not at all, 2. A little, 3 moderate, 4 much, and 5 very much.

5.3.1 EXTENT OF RODENT PROBLEM

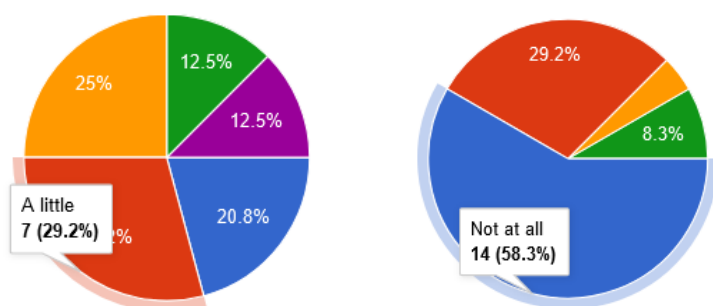
The overall extent of the rodent problem in the area is considered to be moderate by 45.8% of the respondents, while the extent to which people deal with the rodent problem is perceived to very much by 45.8% of the respondents. This indicates that the extent of management is perceived greater than the extent of the problem, see Figure 24.



Figure 24 left: extent of rodent problem in the area, right: extent that people in the area deal with it

5.3.2 PRODUCT RANGE

Whereas farmers buy chemical rodenticides from their store to a large (33.3%) or moderate (33.3%) extent, consultation about the chemical rodenticides they need appears a more important facet of the shop owners, as 20.8% indicates farmers consult them to a very large extent, and 37.5% indicates this happens to a large extent. However consultation remains largely limited to advice on the need for chemical rodenticides, as moderate to a little consultation is done about the usage of it.



The figures on the left indicate there is little information shared by farmers to the respondents about possible resistance build-up or non-target harm due to the application of chemical rodenticides.

Figure 25 left: do farmers inform you on rodents' resistance to chemical rodenticides, right: do farmers inform you of non-target harm due to application of chemical rodenticides?

Furthermore, 50% of the respondents indicate that farmers very often do rotation of formulations (active compounds) of chemical rodenticides. This is a method often applied to reduce to risk of resistance build-up by rodents.

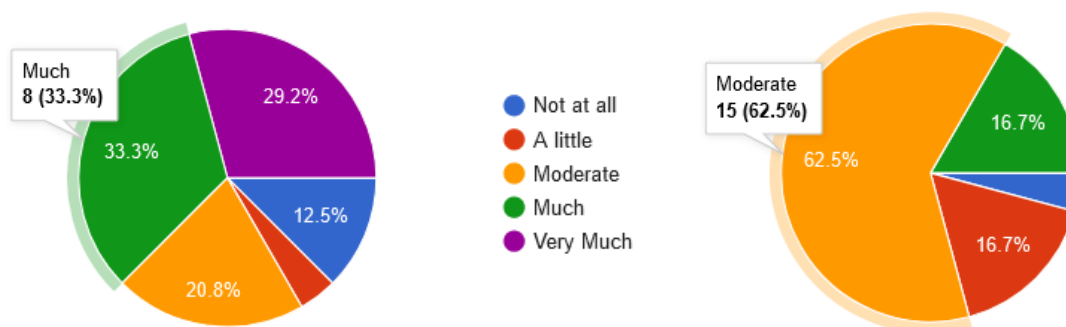


Figure 26 to what extent are farmers satisfied with chemical (left) and non-chemical products (right)

According to the respondents 33.3% and 29.2% of the farmers are much or very much respectively, satisfied with the chemical rodenticides. While the large majority of shop owners (62.5%) thinks that farmers are moderately satisfied with non-chemical rodent control products.

Furthermore, 50% of the shop owners thinks farmers are not interested at all in non-chemical methods to deal with the rodent problem. In line with this they indicate that 45.8% of the farmers does not use non-chemical methods at all, and 33.3% uses these sometimes. 54.2% of shop owners indicates that farmers do not buy any non-chemical products from their store.

Only one shop owner has organic rodenticides in stock, the other only have chemical rodenticides. However, the need for an organic rodenticide is perceived as very large by 25%, moderate by 29.2% and small by 25%. The demand however for organic rodenticides is perceived lower compared to the need. 50% of the respondents says there is no demand at all, and 25% indicating a moderate demand. Overall the shop owners indicate that the importance of rodenticides in their overall product range is of little importance (41.7%), moderate importance (20.8%) or not important at all (29.2%).

And the shop owners are very much to much satisfied about the rodent control methods they have on offer. Their satisfaction is higher than the perceived satisfaction of the buyers of rodent control methods. See Figure 27

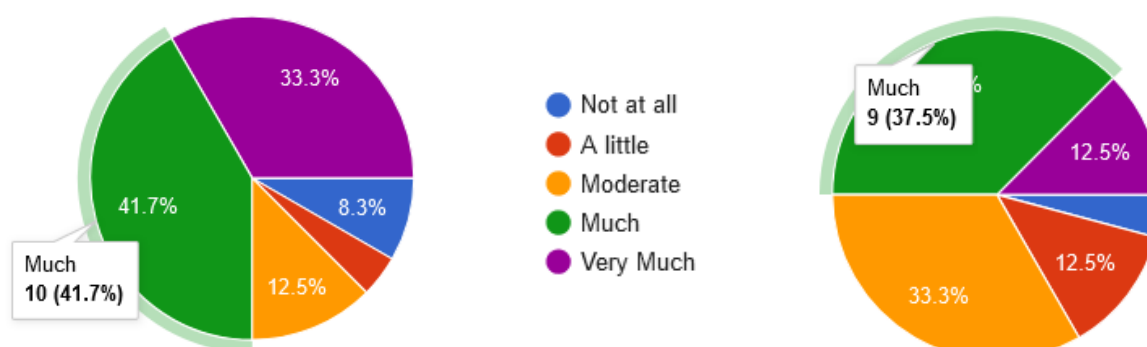


Figure 27 satisfaction of rodent control products in store (left) and satisfaction of buyers with these products (right)

As non-chemical products a few shop owners sell glue traps or mechanical traps. According to a majority of shop owners such traps are the most common non-chemical methods in use by farmers. A few farmers also mentioned different methods being in use, such as field cleaning, deep ploughing, denying rats food and shelter (e.g. cleaning the fields), crop rotation and metal barriers.

In the shops herbicides, insecticides, fungicides, acaricides and nematocides are mostly sold, rodenticides only belong to the top 5 of highest sales in two shops. Although about 1/3 of the shop owners indicated that what they sell depends on the season.

The pests and diseases that cause the highest damage to agricultural production include: powdery mildew, downy mildew, fungal diseases, mites, weeds, aphids, bugs, nematodes and rodents.

5.4 DISCUSSION

From the results it stems that there is a great reliance on chemical rodent control products, the shop owners greatly perceive it this way. Though the farmers also mention other non-chemical control products to be more effective, such as keeping fields and premises clean. It is important to do the management continuously according to the farmers, while they have a preference for individual management.

For the shop owners the story appears to be slightly different, they share the notion that the extent of management by farmers is higher compared to the extent of the problem. Furthermore, it becomes clear that the share of rodenticide sales is only little for shop owners and that they hardly have any other non-chemical products in store. And according to them farmers are also largely satisfied with the chemical products, more so than non-chemical products. Here again it can play a role that the shop owners almost only have chemical rodenticides on sale, leaving the farmers no choice. The results hint that the shop owners are satisfied with the chemicals on sale for two reasons, they indicate farmers are largely satisfied with it, and rodent control products make up little share of their sales and are little or not important to the shop owners, thus presumably limiting the need to expand the product range.

According to the shop owners farmers have very little interest in non-chemical products, however a large share of the farmers indicates they would be interested to promote alternative rodent control approaches in the area. Moreover, they already combine several practices that are part of Ecologically-Based Rodent Management approach, for instance combining both individual as well as collective management in combating rats.



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6. CYPRUS

For Cyprus we still like to share a general introduction to the country, despite it not being a target country for EBRM implementation.

6.1 INTRODUCTION

Cyprus is an island nation in the eastern Mediterranean Sea. It is the third largest and third most populous island in the Mediterranean, and is located south of Turkey; west of Syria; northwest of Lebanon, Israel and the Gaza Strip; north of Egypt; and southeast of Greece. The physical relief of the island is dominated by two mountain ranges, the Troodos Mountains and the smaller Kyrenia Range, and the central plain they encompass, the Mesaoria. The Mesaoria plain is drained by the Pedieos River, the longest on the island. The Troodos Mountains cover most of the southern and western portions of the island and account for roughly half its area. The highest point on Cyprus is Mount Olympus at 1,952 m (6,404 ft), located in the centre of the Troodos range. Cyprus contains the Cyprus Mediterranean forests ecoregion. Cyprus has a subtropical climate – Mediterranean and semi-arid type with very mild winters (on the coast) and warm to hot summers. Snow is possible only in the Troodos Mountains in the central part of the island. Rain occurs mainly in winter, with summer being generally dry. Cyprus has one of the warmest climates in the Mediterranean part of the European Union. A wide range of crops are grown on Cyprus, cereals (wheat and barley), legumes, vegetables (carrots, potatoes, and tomatoes), fruit and other tree crops (almonds, apples, bananas, carobs, grapes, grapefruit, lemons, melons, olives, oranges, and peaches). Cyprus is becoming associated with high-value products such as pomegranates, carobs, aloe vera and others that grow well in the island's dry climate.

The administrative zone of Nicosia, at the sub-urban region between the city of Nicosia and the mountain of Troodos (Figure 4), is a region with large agricultural activity and generally notorious for rodents' and rodents-caused damages.

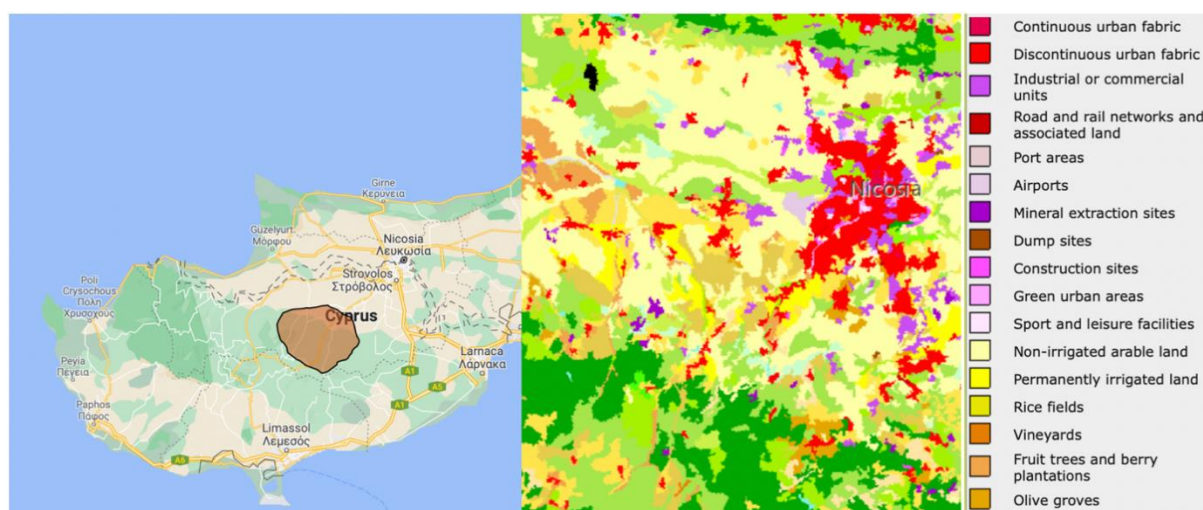


Figure 28 administrative zone of Nicosia

6.2 RESULTS

These results are a combination of secondary research and interview.

6.2.1 RODENT OCCURRENCE AND SOCIO-ECONOMIC LOSSES

Cyprus has four different species of rodents [website 1]

1. *Rattus Norvegicus* (Norwegian rat, has a brown color, largest in size, it is very destructive)
2. *Rattus Rattus* (roof rat, it has a black color)
3. *Mus Musculus* (domestic mouse)
4. *Acomus Nesiotes* (field mouse, spiny mouse)

All these species are abundant through the island, but their populations are unknown. There are complaints for being out of control [website 2], [website 3]. Some of these species constitute endangered species.

The damage caused by rodents relates mainly to agricultural fields: destruction of cables in agricultural machinery and equipment, annual yield loss of 5–10% of maize (corn), rice and alfalfa. Also, damages have been reported in greenhouses and vegetables/spices. Moreover, in villages and towns, there have been recorded important damages in horticulture each year, while the local population is generally afraid of transmission of diseases via rodents. In some regions, rodents are known to attack trees when they can't find water, e.g., carob trees. This is a persistent problem in Cyprus during the last 70 years, as the report by Watson indicates (Watson, 1951) this problem is particularly evident at the demilitarized zone between Greek-Cypriot and Turkish-Cypriot territory (a narrow zone patrolled by UN forces that separates the northern and southern parts of the island), where rodents thrive and damage the carob trees by eating their roots. We believe that more than 2,000 carob trees are currently in danger because of rodents in that area (also called “dead zone” or “green line” or “the divide”. Moreover, locations near the divide increased the possibility of murine typhus infection, which is a serious public health problem in Cyprus (Psaroulaki, 2012). These locations have been characterized as “high-risk areas” in the study.

In the municipality of Nicosia our interview respondent indicated that there are rodents in his municipality, for instance in old or abandoned buildings, and in areas with dense vegetation. In their work rodents are mainly identified from their faeces / excrements. By the size, shape and colour the rodents specifically are identified. From the quantity of droppings then the population quantity is estimated, combined with appearance of tablets/baits and how much is eaten, as well as from damages, such as broken wires. The most active period for rodents is during spring, mostly active at night.

6.2.2 MANAGEMENT PRACTICES

Recently, a Nicosia district village applied a biological control of rodents with the placement of artificial nest boxes for barn owls [website 4], which will help reduce the use of chemical. The increase in the population of barn owls is expected to contribute to the reduction of rodents, as rodents are food for the owls. Each barn owl consumes four to six rodents every night, while a family of human birds



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consumes up to 6,000 rodents per year. Barn owls, together with snakes, have been recruited also to protect carob trees from rodents [website 5].

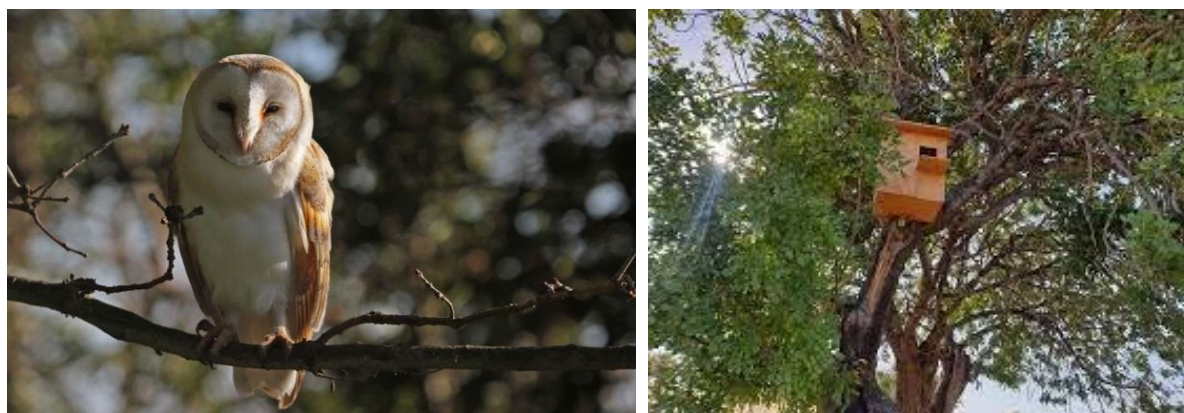


Figure 29 owl and owl nest box can help to control rodent populations

The public health department of Nicosia municipality implements pest control services. It has its own trained team of workers that are dedicated to prevention, control and extermination of rodents and other pest species. They for instance place rodent bait stations and traps that are small enclosures that only rodents can enter. This is done on a regular basis, and is based on the season as well as other parameters that may favour or attract rodents.

The department handles citizens' complaints and implements prevention programs in many areas/points and along buffer zone in cooperation with the United Nations. In Nicosia Municipality (and on the whole island) there are abandoned houses, empty plots and other cases/phenomena that may potentially promote the appearance of rodents.

All members of the team take part in pest control training seminars. Moreover the department cooperates with the responsible departments of the Ministry of Health and of the Ministry of Agriculture, Rural Development and Environment. Noted that the food businesses e.g. restaurants, snack bars etc. have to have a contract with a private and licensed pest controller (they pay for pest control services).

7. CONCLUSION AND DISCUSSION

Through this survey we have been able to greatly improve knowledge and understanding on pest rodents occurring in representative agroecosystems of the partner countries, especially to understand the magnitude of rodent inflicted damage to pre- and post-harvest crops and to understand the management practices from both the demand and supply side. So in short, what can we conclude?

- Magnitude of rodent damage across the board largely ranges from an occasional to serious problem for most farmers. And it is clearly focused on a few of the crops that are production mainstays, such as tomatoes and wheat.
- In all the countries there is a large reliance on chemical rodenticides, and although it is generally said by input providers and shop owners that they are satisfied with these products, they also by vast majority indicate that there is a need for alternative products, for example organic rodenticides. While the need for such alternative rodent control products is recognized, and farmers are ready to try alternative methods, the availability of alternative methods lag behind.
- The large majority of farmers and input suppliers is interested in alternative non-chemical methods for rodent control, such as organic ways of control. Though knowledge of organic plants with rodenticide potential is hardly available, only in Turkey there is traditional knowledge around this topic.

7.1 DISCUSSION

The results from the KAP surveys with producers and input suppliers in the three countries showcase a lot of different perceptions and practices. This report presents a descriptive analysis of the results of each of the countries for the results from the KAP surveys from producers and input providers. A statistical analysis combined with correlation of data within and between the countries will be conducted for purposes of publication. For this reason this is not included in this deliverable as of now. This means there are certain analytical gaps in this document, e.g., on damage level comparison and understanding correlations between knowledge, attitudes and management practices. For instance, the perceived monetary losses can be correlated to production and cultivation types. Such statistical analysis is expected to give bigger depth in understanding.

Gaps still exist that now appear from the survey, e.g. importance of the ease of application. Also gaps exist between countries due to differences in surveys and different understanding of some questions. These gaps will be addressed in the coming months to align the data for comparison purposes. Also in the dialogue with stakeholders in the areas discussion on these topics will be facilitated.

There are also seeming contradictions coming out of the surveys, for instance between knowledge and attitudes, e.g. knowing collective action is important, but largely doing it individually. Another gap that needs to be investigated is the relation between what is available in the market and the preference of management methods in use, in comparison with the criteria attributed to rodent control methods. The availability of conventional products in shops and the factor that farmers are accustomed to using these products, can possibly influence perceptions of efficacy derived from the



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conventional products being the industry standard. This requires more dialogue with the concerned stakeholders.

It is also seen that knowledge around rodent management and behaviour differs per country, where different environmental and other factors are mentioned that would influence presence of rodents. More so, practices around rodent management differ per country, for instance in Morocco rotation of formulations is commonly practiced according to the agricultural input providers, whereas in Turkey this hardly happens.

In addition, this country baseline inventory shows that although farmers estimate their damage levels, this has not been assessed through quantitative field methods, therefore we will do cross-checking of the estimates with bio-physical parameters to be measured in the field, such as rodent included damage estimates and species identification, as will be conducted through task 4.2 “Monitoring and biophysical assessment of EBRM and BR in the living labs”.



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[1] <https://ontargetpestcontrolcy.com/service/rodent-control-deratization/>



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[2] <https://cyprus-mail.com/2019/08/05/people-urged-to-do-their-bit-in-keeping-down-rodent-populations/>

[3] <https://knews.kathimerini.com.cy/en/news/residents-across-cyprus-complain-of-rodent-invasion>

[4] <https://cyprus-mail.com/2022/02/19/denia-shows-the-way-for-eco-friendly-rodent-control/>

[5] <https://www.reuters.com/article/us-environment-cyprus-carobs-idUSKBN0NR1NK20150506>



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APPENDICES

ANNEX 1: KAP SURVEY TEMPLATE PRODUCERS

Target group: Farmers / producers

Objective: gain insight in rodent damage estimate, and knowledge, attitudes and perceptions around rodents and management.

Duration: ~60 minutes

Semi-structured questionnaire

Name of interviewer:

Name of respondent:

Date:

Exact location GPS:

Name village + area:

I. General information		
1	What is your age group?	1. 18-25 2. 26-40 3. 41-55 4. >56
2	Is farming in your family tradition?	1. No, I'm a first generation farmer 2. Yes, I'm a second generation farmer 3. Yes farming goes back more than two generations in my family tradition
3	What is your main farming activity?	
3.1	What is the main farming activity in this area?	
3.2	What type of crop do you cultivate?	
4	How do you do farming	1. Open field 2. Greenhouse 3. Other
4.1	In case you have a greenhouse: what type of greenhouse do you have? (metal, wooden, mixed, etc.)	



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5	What is your land holding size?	
6	What is the average land holding size in this area?	
II. Rat occurrence		
7	Are rats a problem for you?	<ol style="list-style-type: none"> 1. A serious problem 2. Occasional problem 3. Not a problem
7.1	If a 'serious or occasional problem', where are they more damaging crops?	<ol style="list-style-type: none"> 1. Fields 2. homestead 3. Both areas 4. Other, specify
8	Have you had serious damages from rodents in the past 3 year s?	Explain.
9	<ul style="list-style-type: none"> • Do you differentiate the rats that occur in fields and those in homesteads? 	<ol style="list-style-type: none"> 1. Yes 2. No 3. do not know
9.1	If 'Yes', are they the same or they are different?	<ol style="list-style-type: none"> 1. Same 2. Different 3. do not know
10	<ul style="list-style-type: none"> • When do the rats mostly move around? 	<ol style="list-style-type: none"> 1. During the night 2. During the day 3. do not know
11	<ul style="list-style-type: none"> • Other than crops, do rats also cause damage to houses and other properties? 	<ol style="list-style-type: none"> 1. Yes 2. No 3. Do not know
11.1	If 'yes', please mention them	
11.2	If 'yes', how frequently does this happen?	<ol style="list-style-type: none"> 1. Frequently 2. Occasionally 3. Rarely
III. Socio-economic - rat losses and income		

12	List in order of increasing damage (5-1), the types of pests and diseases that cause highest damage to agricultural production.	1. 2. 3. 4. 5.
13	What kind of agriculture related damage do you incur from rodents?	
13.1	What are the most important income crops to you?	1. 2. 3. 4. 5.
13.2	Which crops are most damaged by rodents?	1. 2. 3. 4. 5.
14	How much Euros do you feel you lose to rat damage per year on average?	
14.1	How much percentage of damage is inflicted pre-harvest? %
14.2	How much percentage of damage is inflicted post-harvest? %
14.3	Which crops are mostly damaged pre-harvest? (rank from high to low damage)	1. 2. 3.
14.4	Which crops are mostly damaged post-harvest? (rank from high to low damage)	1. 2. 3.
14.5	Can you specify per crop in 1 season per ha (or specify the unit) how much kg (or specify the unit) you lose to rodent damage?	1. 2. 3. 4. 5.

14.6	What are the current market prices per kg (or specify the unit) for each of these crops?	1. 2. 3. 4. 5.
14.7	How much of these losses you think (in percentage) could be reduced by effective rodent management? %
15	Which <u>environmental factors</u> affect the risk for rodent infestation in your area?	
16	Tell us about your garbage disposal methods <i>= all types of garbage</i>	
16.1	Do you think your garbage disposal method contributes to rats' presence around home and farm buildings?	1. Yes 2. No 3. do not know
16.2	How often do you clear rat harbourage areas (e.g., grasses, bushes, garbage piles) around home or farm buildings?	1. Frequently 2. Occasionally 3. Rarely
IV. Rat occurrence and outbreaks		
19	In your opinion, are rat numbers changing through time?	1. Yes, increasing through time 2. Yes, decreasing through time 3. Did not notice the change
19.1	<ul style="list-style-type: none"> If '<u>Increasing</u>', what do you think are the main reasons for rat's population increase? 	
19.2	<ul style="list-style-type: none"> If '<u>Decreasing</u>', what do you think are the main reasons for rat's population increase? 	
20	Do you experience seasonal rat population changes in your farm?	1. Yes 2. No 3. did not notice

21	<ul style="list-style-type: none"> Which season has the <u>highest</u> rat population? 	
22	<ul style="list-style-type: none"> Which season has the <u>lowest</u> rat population? 	
V. Rat management		
23	Are you practising proactive management for rodents?	<ol style="list-style-type: none"> Yes No
23.1	If yes, what type of proactive management methods do you use?	<ol style="list-style-type: none"> Chemical means (e.g., rodenticide baits) Biological means (e.g., repellent plants) Animal predators (e.g., cats) Mechanical mean (e.g. traps) Other, specify _____
23.2	Are you practising reactive rodent management? (i.e. only after damage is recognized)	<ol style="list-style-type: none"> Yes No
23.3	If yes, what type of reactive management methods do you use?	<ol style="list-style-type: none"> Chemical means (e.g., rodenticide baits) Biological means (e.g., repellent plants) Animal predators (e.g., cats) Mechanical mean (e.g. traps) <p>Other, specify _____</p>
23.4	How effective are the control measures that you used? Give a ranking	<p>Rank:</p> <ol style="list-style-type: none">
23.5	If you use chemical rodenticides, do you rotate formulations of chemical rodenticides?	<ol style="list-style-type: none"> Yes No
	If yes, explain why and how?	
24	Do you notice a difference between proactive and reactive rodent management?	<ol style="list-style-type: none"> Yes No
24.1	If yes, explain.	

24.2	In which season do you think rodent control is most effective? And explain why.	
25	Do you use poison plants to kill rats?	<ol style="list-style-type: none"> 1. Yes 2. No 3. do not know
25.1	<ul style="list-style-type: none"> • If 'Yes', which <u>plants</u> and <u>plant parts</u>? 	
25.2	<ul style="list-style-type: none"> • Describe the method of <u>preparation</u> of the poison – the recipe 	
26	Is rat control in your area done by <u>Individual</u> household or <u>collectively</u> by village/neighbouring households?	<ol style="list-style-type: none"> 1. Individual household 2. Collectively by village/neighbouring household 3. Both individually and collectively
27	Are there any rat control methods you have heard of, but you are not practicing it currently?	<ol style="list-style-type: none"> 1. Yes 2. No 3. do not know
27.1	<ul style="list-style-type: none"> • If 'Yes', please mention 	
28	Do you know any natural enemies (<u>predators</u>) of rats?	<ol style="list-style-type: none"> 1. Yes 2. No 3. Do not know
28.1	<ul style="list-style-type: none"> • If 'Yes', mention them 	
28.2	<ul style="list-style-type: none"> • If 'Yes', have you seen some of them <u>in action</u>? 	<ol style="list-style-type: none"> 1. Yes 2. No 3. Do not know
28.3	<ul style="list-style-type: none"> • If 'Yes', which predator did you see <u>in action</u>? Please mention 	

29	Do you agree that the use of chemical measures (from you or other farmers), can have long term negative effects on people and the environment?	<ol style="list-style-type: none"> 1. Strongly disagree 2. Somewhat disagree 3. Neither agree nor disagree 4. Somewhat agree 5. Strongly agree
30	What do you think should be done to control rat damages in farms?	
31	Are there specific rules and regulations around rodent control that are challenging for you?	<ol style="list-style-type: none"> 1. yes 2. no
31.1	if yes, explain why.	
32	What storage materials / structures do you use?	
32.1	Which of the storage materials are <u>highly</u> effective against rats?	
32.2	Which of the storage materials are <u>least</u> effective against rats?	
VI. market and information		
33	Where do you currently buy rodent control products?	
34	Are you satisfied with the rodent control products available?	<ol style="list-style-type: none"> 1. Yes 2. No
34.1	Explain why.	
35	Do you have interest in non-chemical methods to deal with the rodent problem?	<ol style="list-style-type: none"> 1. Yes 2. No
35.1	Explain why.	
36	Do you have interest in buying organic rodenticides?	<ol style="list-style-type: none"> 1. Yes 2. No
36.1	Explain why.	

36.2	What other rodent management products or services do you have an interest in?	
37	What is your major <u>source of information</u> for rodent management?	
37.1	Are you satisfied with the information available to you regarding rodent management?	1. Yes 2. No
37.2	Explain why.	
37.3	What can be improved on information provision to you as a farmer?	
38	How much are you willing to spend on rodent control products yearly?	
VII. future involvement		
39	Will you be happy to participate in future meetings, trainings and discussion on rodent management?	1. Very happy 2. Happy 3. Not interested
40	Will you be happy to adopt/adapt if a new rodent management method is introduced to you?	1. Very happy 2. Happy 3. Not interested
41	<ul style="list-style-type: none"> How much percentage of your area will accept the introduction of a new rat management method? 	1. 1-25% 2. 26-50% 3. 51-75% 4. 76-100% 5. None
42	What are your requirements/criteria to uptake new rodent management methods?	
43	Other points of interest you would like to discuss/mention?	

ANNEX 2: KAP SURVEY TEMPLATE INPUT PROVIDERS

Target group: agricultural input providers, crop protection service delivery

Objective: gain insight in the range of rodent control products sold, their market demand and the extent of rodent control being done.

Duration: 30-45 minutes

QUESTIONNAIRE

Name of interviewer:

Name of respondent:

Name of agricultural shop / service provider:

Date:

Location:

1. Evaluate the following statements by placing an X in the corresponding box

Grading scale:

Not at all	A little	Moderate	Much	Very Much
1	2	3	4	5

No	Question	1	2	3	4	5
1	To what extent do you think rodents are a problem for farmers in this area?					
2	To what extent do people (farmer, storage house owner, local people) deal with the rodent problem in your area?					
3	To what extent do farmers buy chemical rodenticides from your store?					
4	Do farmers consult you about the chemical rodenticides they need?					
5	Do farmers consult you about the use of the chemical rodenticides?					
6	Do farmers inform you on rodents' resistance to chemical rodenticides?					
7	Do farmers inform you of non-target harm due to application of chemical rodenticides?					
8	To what extent do farmers rotate formulations of chemical rodenticides?					
9	To what extent are farmers satisfied with the rodent control by using chemical rodenticides?					



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10	Do farmers show interest in non-chemical methods to deal with the rodent problem?					
11	To what extent do farmers use non-chemical methods against rodents (traps, biological repellents, etc.)?					
12	To what extent do farmers buy non-chemical products against rodents (traps, biological repellents, etc.) from your store?					
13	To what extent are farmers satisfied with rodent control by using non - chemical methods?					
14	To what extent do you have organic rodenticides in your stock?					
15	To what extent do you see a need for organic rodenticide?					
16	To what extent to you see a demand for organic rodenticide?					
17	How important is rodenticide in your product list?					
18	To what extent are you satisfied with the rodent control methods you have on offer?					
19	To what extent are your buyers satisfied with the rodent control methods you have on offer?					

2. Ranking questions:

2.1 List in order of increasing usage (3 -1), the non-chemical rodenticide products that farmers buy from your store

- 1.....
 2.....
 3.....

2.2 List in order of increasing usage (3-1), the non-chemical methods (metal barriers, crop rotation, cleaning the fields, etc) that farmers in your area, use.

- 1.....
 2.....
 3.....

2.3 List in order of increasing sales (5-1), the pesticides sold for different pests and diseases affecting crops (i.e. insects, plant diseases, rodents).

- 1.....
 2.....
 3.....
 4.....
 5.....

2.4 List in order of increasing damage (5-1), the types of pests and diseases that cause highest damage to agricultural production.

- 1.....
 2.....



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- 3.....
- 4.....
- 5.....

3. Open questions:

- 3.1 Can you elaborate on why rodents are a problem, or not a problem in your area?
- 3.2 Is rodent control in this area done by individuals, or by multiple people together?
- 3.3 What is the full range of rodent control products that you sell?
- 3.4 Which rodent control product do you consider most effective? And why?
- 3.5 do you know other methods of rat management you think could be effective?
- 3.6 Which rodent control product would you like to add to your current range? And why?
- 3.7 Are there specific rules and regulations around rodent control that are challenging for you? if so, explain why?
- 3.8 When do farmers come to your shop to buy rodent control products, or ask for advice? (i.e. seasonal, all year through, which months?)
- 3.9 Would you be interested in becoming a service provider in biological and ecological rodent management methods?

Additional notes:

Thank you for your time!