LIFE11 NAT/IT/069/ Med Wolf - Best practice actions for wolf conservation in Mediterranean-type areas

Assessment of the efficacy of damage prevention structures and livestock guarding dogs in Italy

Action D2

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1. INTRODUCTION

The monitoring of the effectiveness of damage prevention measures was crucial for the project to estimate the added values of these measures in terms of damage reduction. More generally, assessing the efficacy of fences and livestock guarding dogs in reducing livestock losses, is pivotal for wolf management, since predation events and the effectiveness of damage prevention measures varies substantially; and capturing this variation through data collection can inform on the measure to adopt for a given local conditions.

Predators damage to livestock depends on several factors, especially husbandry methods and the landscape where the animals are kept Given the variability in the damages and the social aspects related to predators damages, in which farmer perception of the damage plays an important role, a common measure of effectiveness is the general satisfaction of the farmers. Here we have used a number of quantitative measure of effectiveness, as well as farmer's satisfaction. We have adopted an integrated approach and assessed the prevention tools in different ways. This implied a modification to what was originally foreseen in the project proposal where the evaluation was mainly based on questionnaires about farmers satisfaction. We collected data to test the following hypotheses: (1) the presence of fences in farms would significantly change the damage dynamics in terms of number of events and heads killed at provincial level; (2) the presence of damage prevention tools would have an impact on the number of attacks on the single farms where they were adopted; (3) livestock guarding dogs are effective if they keep a minimum distance from the flock; (4) estimate of the costs associated to the use of damage prevetion measures.

Here we aimed at providing guidance on approaches to adopt to objectively measure the effect of management interventions without relying purely on farmers' perceptions, complementing it with more objective and repeatable measures of effectiveness (Eklund et al 2017).

2. METHODS

In order to measure efficacy of fences we adopted the following complementary approaches:

- A study design based on a comparison between treatment vs control farms, where treatment farms were the ones who received the fence and the control ones were those that did not.
- Before-After-Control-Impact (BACI) approach

For both the approaches above, we evaluated the damages in terms of numbers of attacks and number of animals killed before and after fence installation.

- Farmers satisfaction

We surveyed farmers to assess their opinion toward the efficacy of the fences.

While the primary purpose of action D2 was to assess the efficacy of the prevention measures delivered by the project, we analyzed the trend of damages in the whole provincial territory.
All the farms involved in this study were sheep farms.
In order to integrate the assessment of effectiveness of damage prevention measures with an evaluation of the impacts of their use on livestock production we also made an economic analysis. We could not make a comparison between sheep management costs before and after the adoption of prevention measures, also in consideration of the other variables that might affect such economic analysis (e.g., particularly dry year that required purchase of additional hay for feeding the sheep, etc), thus the approach used was to make a focus group with 10 sheep breeders in order to have an estimate of the average costs associated to an average farm in the area.

2.1 Study design

Trends in number of attacks and number of animals killed were measured for 1 year and compared between the farms that received a fence (treatment group) and those without prevention measures (control group).
The treatment group comprised 51 farms that used the fence for at least 1 year, while the control group comprised 103 farms randomly selected in a radius of 5.6 km from the treatment farms (radius of a circle equivalent in size to the average territory size of a wolf pack) and that had a comparable numbers of sheep (±50%). The assumption is that the farms located in the territory of one pack had the same probability to be attacked. Thus, we could evaluate the role played by the use of the fence as a night protection from the wolf.
We choose to monitor attacks during one year to cover the different phases of the annual cycle of the wolf, (e.g. reproduction, breeding) as they are expected to influence the predation rate on domestic livestock.
Treatment farms were checked twice during the study period to verify that farmers maintained the fences in good operating conditions, while control farms were checked 4 times to verify they did not change their husbandry practices. The treatment group initially included 55 farms but 4 of them that did not maintain and operate the fence correctly thus were transferred to the control group. In addition, 2 treatment farms that were under the same management administration were pooled together for the analysis. One treatment farm was added later, on January 1st 2017 (fig. 1).

Originally, control farms were selected to approximate a 1:5 ratio of treatment vs control farms. We run a first random selection of farms to be used as controls, then we checked if the selected farms had a fence built with other or personal funds; we also queried agricultural associations and local vets if they believed the selected farmer would collaborate by participating to our monitoring. After these checks we eliminated 23 farms which already had a fence, and 4 which were suspected to be unlikely to join the monitoring program. During the survey, we eliminated additional 10 farms because they terminated their activity or were not collaborative. In summary, we monitored 103 control farms, with an overall observed ratio of 1:1.9 treatment vs control farms, often violating the

expected 1:5 ratio (Tab. 1). In addition, each control farm often acted as control for >1 treatment farm so that treatment-control clusters are not completely independent (i.e., multiple treatment farms may have in common 1 or more control farms). For sample size requirements, we were forced to include among control farms 32 whose heads of sheep eluded the ±50% rule with respect to the associated treatment farms.

Treatment (no.)	Control (no.)
6	1
7	2
7	3
9	4
4	5
7	6
4	7
2	8
4	9

Table1. Frequency distribution of control farms with respect to treatment farms.

For each of the two groups of farms we collected the following information:

- Numbers of animal raised, and number of groups in which the flock was usually divided
- Presence/absence of the fence and its period of use and number of animals protected by the fence
- Presence/absence of Livestock Guarding Dogs (LGD). Number of animals checked by the fence
- Age of the farmer
- Number of workers present in the farm
- If the owner lived or not in the farm

During the study period the two groups of farms were regularly surveyed after each depredation event. Information about the depredation event was received by the Local Health Authority (AUSL) and visit were made few days after the event, in order not to overwhelm the livestock owner with many visits (the AUSL staff and sometimes also Carabinieri Forestali visit the farm after each attack). Data collected, through a direct interview to the farmer, were aimed at identifying the elements that were most often associated to the predatory event (e.g. time of the attack, protection and management of the flock at the moment of the attack), so as to identify the key factors that could be addressed in the future. Data were recorded for the purpose of monitoring and evaluation, regardless of whether the attacks was officially claimed by the farmers or not.

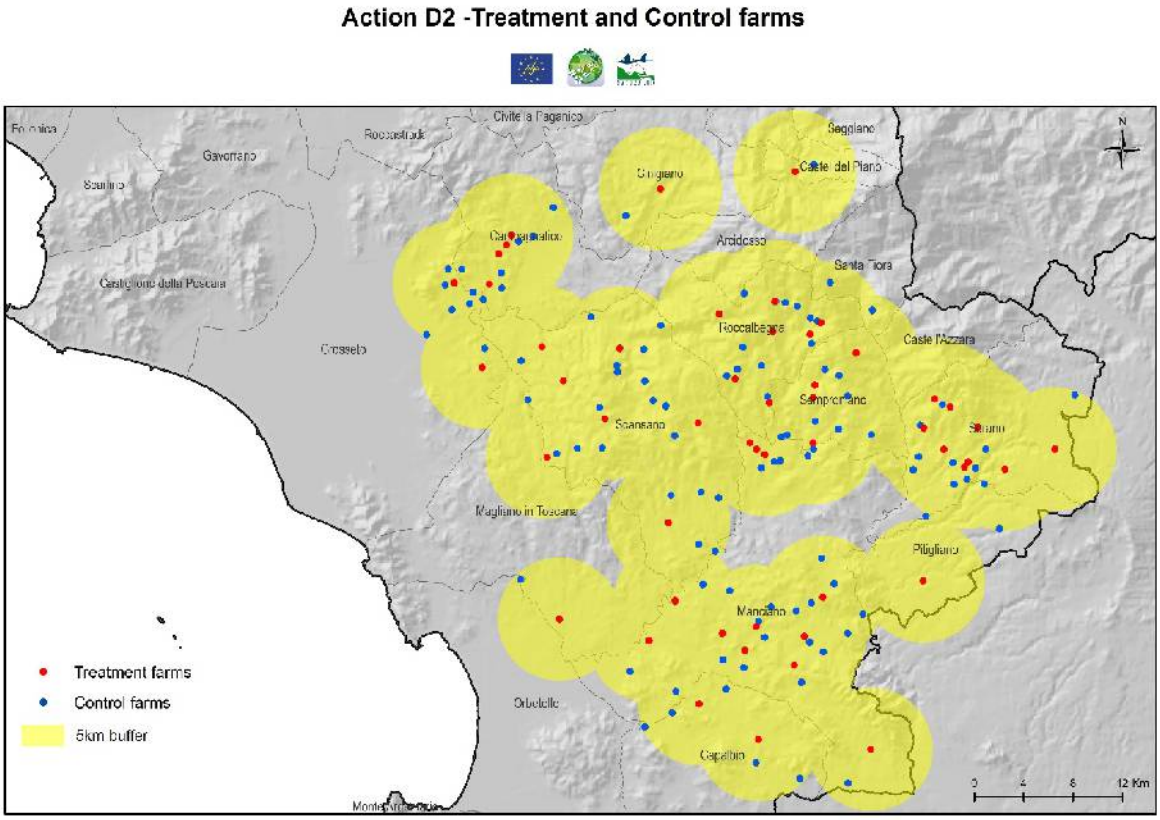

Figure 1. Distribution of treatment and control farms.

2.2 B.A.C.I. approach

In order to obtain another estimate of fences efficacy, for the treatment group, we measured the number of damages and numbers of animals killed before and after the installation of the fence.
The period "Before" was measured from 01/01/2014 to the date of the fence test by the project staff. The period "After" was measured from the date of the test to 30/09/2017. The damages of the "Before" period were obtained from the official dataset collected by the AUSL. Since the registry of predations officially became operational on 07/10/2014, for the rest of the year 2014 we considered data collected by the provincial administration.
The number of attacks and the number of killed animals in the period before and after the installation of fences has been standardized by dividing by the cumulative number of days per farm included in the period to allow comparison among farms whose observation period was unequal.

2.3 Questionnaires on farmer's satisfaction toward prevention measures

We recorded farmer's opinions and attitudes toward prevention measures through a face to face interview. The interview period started in July 2017 and ended in August 2017.
We carried out 163 interviews to 62 farmers involved in LIFE MedWolf project (farmers who received fences and or LGDs) and 101 farmers who didn't receive prevention measures from the project .
The questionnaires used for fences and LGD were composed by 11 close-ended questions about:

- the opinion about prevention measures as a tool to reduce damages to livestock;
- the cost in terms of additional work caused by the use of prevention measures

- the opinion on the possibility to establish the obligation to use prevention measures for farmers who are in area at risk of predation
- the opinion on the project action concerning the assignment of prevention measures
- the opinion on the technical assistance offered by project staff in the implementation of prevention measures

There were common questions in the two questionnaires used, plus specific questions related to the cost of maintenance of the two different prevention measures, and opinions toward the reduction of damages after the use of these prevention measures.
We obtained 158 interviews on fences and 8 on LGDs (3 farmers answered to both questionnaires because they received both prevention measures). For LGDs we considered only farmers who had adult dogs (because LGDs become effective only at 2 years of age).

2.4 LGD distance from flocks

Data were collected on 11 farms where a total of 29 adult LGDs were fitted with Tractive © GPS Pet Tracking collars (Tractive GmbH, Austria) during 20-day period sessions. At each farm, 1-3 LGDs and one sheep from their flock were fitted with GPS collars. Positions were recorded every 15 minutes when the animal was active, and every hour during resting. The distance between dog and the flock was estimated as the distance between the dog and the sheep fitted with GPS. It was measured in meters, taking into account topography and converting Euclidean distances into real distances using interpolation of z-values from a 10x10m Digital Terrain Model (DTM) of Grosseto Province. We also estimated size of ranging areas of LGDs and flocks, and estimated spatial overlap in order to assess the shared space between the dogs and the flocks.

2.5 Cost estimation

We adopted the apporach of participatory survey, with:
-brainstorming,
-semi-structured interviews to 20 farmers
-a focus group with 10 participants.

The first phase of brainstorimng was done with the representatives of the agricultural associations, who provided a schematic description of the local productive system and chain.
For the interview we selected 20 farmers within the 200 that expressed their interest to receive a damage prevention measure from the project. Their selection was based on the following criteria:
-Age of the owner
-Surface of productive area
-N of heads
-N of grazing groups
-Orientation and production specialisation.

Once the productive chain was described, a semi-structured interview was conducted during a visit to the selected farmer, who was initially contacted by telephone. The interview had 7 main themes that were freely described by the interviewee:
1- general presentation of the farm: surface, type of productive activity, subdsidies received, etc
2- description of the raised animals: number of heads, type of production, transformation of primary products, etc

3- Main issues related to wolf presence. Quantitative (heads lost) and qualitative (stress, production quality, etc) elements.
4- description of the damage prevention measures adopted.
5- Main modifications of the farm management as a consequence of implementation of damage prevention measures
6- Quantification of costs associated to the use of damage prevention measures (increased hours of labour, increased quantity of feeding products, etc)
7-Necessary support: technical assistance, training for damage prevention, etc.

The quantification of the costs were then estimated using the RICA database, that offers micro-economics data on a sample of over 11,000 farms in Italy. The preliminary results of this estimation were then presented and discussed at the focus group.
The focus group was made of 5 farmers, 2 representatives of the main milk transformation cooperatives, 1 representative of the local administration, 3 representatives of the agricultural associations.
Considering the high level of variation in the results obtained through the interviews, the aim of the focus group was to provide an estimate of the costs associated to the implementation of damage prevention measures within an average local farm.

3. RESULTS

3.1. Treatment vs Control design

Overall we recorded 139 depredation events during the study period comprising 94 officially reported and 45 unreported. Ninety-three (67%) depredation events occurred in control farms (n = 45 control farms, 1-8 depredation events/farm), while 46 (33%) in treatment farms (n = 18 farms, 1-10 depredation events/farm). Only one attack on treatment farms took place in on flocks inside the fence. The remaining ones occurred in presence of LGDs (17%) or without any prevention method (74%), with a shepherd (2%) and with other prevention tools (e.g., sound emitting avdersive devices, 4%).

A totoal of 107 attacks (77%) occurred during daylight, 32 (23%) during the night. Up to 63% of the attacks during daylight occurred in control farms and 37% in treatment farms. The difference between the two groups was much higher if we analyzed the attacks during the night, where the effect of the fence in flock protection is significant: 81% of the night attacks occurred in control farms and the remaining 19% in treatment farms (fig. 2).

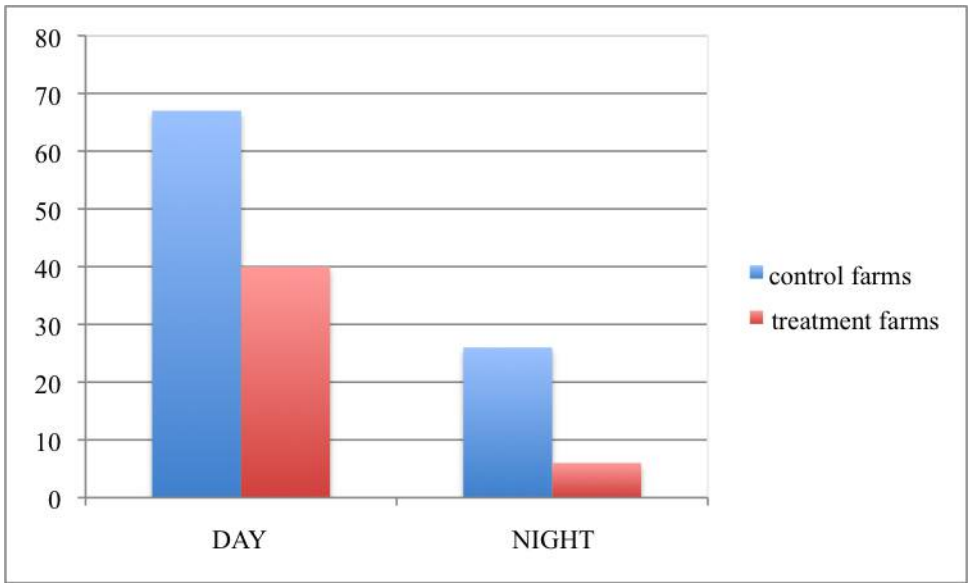

Figure 2. Distribution of the attacks (n=139) between control and treatment farms during the survey period.

Of the 6 night attacks that occurred in treatment farms, only 1 occurred inside a fence but the predator passed under the gate that was not correctly installed; the remaining 5 attacks were registered on sheep kept outside the fences.

We registered the same trends when comparing the number of animals killed in the 2 groups of farms. Of the 367 animals killed, 66% were in control farms and 34% in treatment farms; 272 (74%) animals were killed during daylight, while 95 (26%) during the night. The percentage of animals killed during daylight was 58% in control farms, and 42% in treatment farms, while during the night was 81% and 19%.

In addition, the number of animal killed/attack during the night was significantly lower in the treatment farms than in the control ones ($W = 2427$, p-value = 0.04).

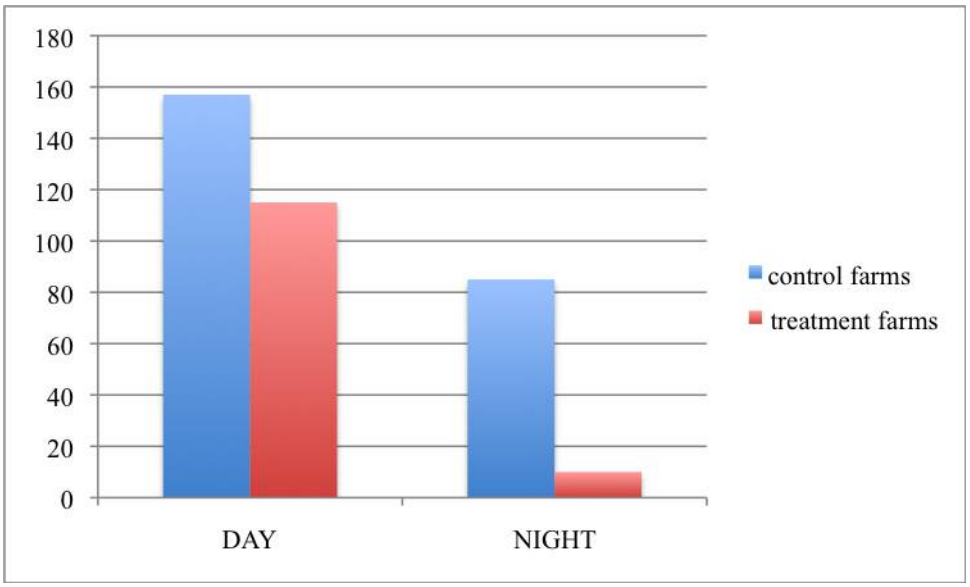

Figure 3. Distribution of the animals killed (n=367) between control and treatment farms during the study period.

Sheep flocks guarded by a dog were less prone to attacks, specifically amongst the day-time attacks (n = 107) only 21% were to flocks guarded by an LGD while for night attacks (n = 32), 34% were to guarded flocks in the treatment group.

3.2 B.A.C.I. Approach

In the period before the installation of the fences in the treatment farms we registered 137 attacks and 324 killed animals in a total cumulative of 30,802 days, while in the ex-post period 83 attacks and 188 killed animals occurred in cumulative 36,230 days.
This means that damage reduction after fence installation was 47% if we consider the number of attacks and 50% if we consider the number of animals killed (fig. 4).

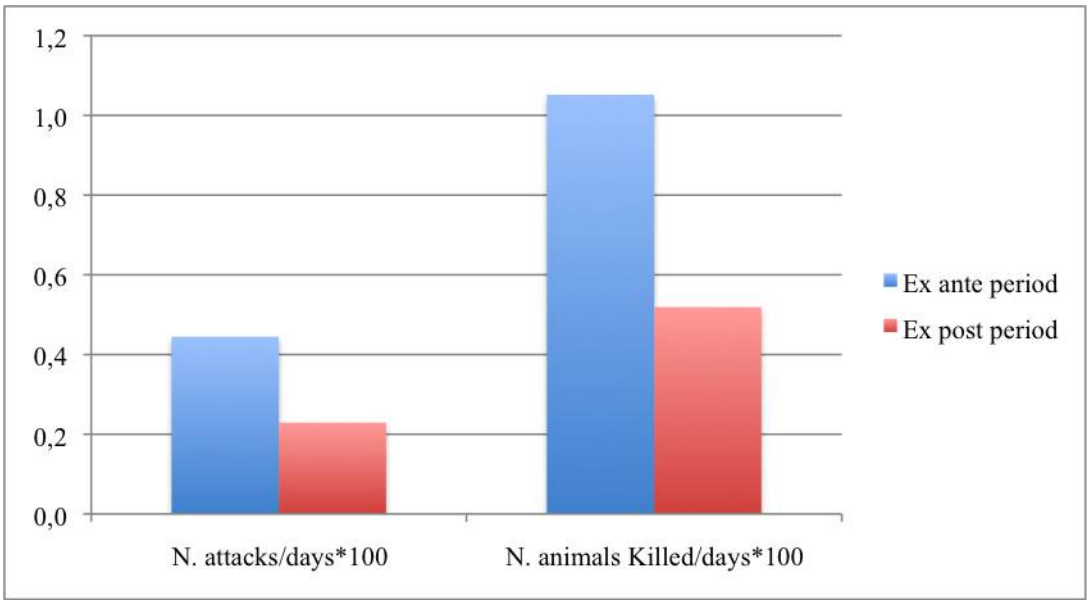

Figure 4. Comparison between number of attacks and number of animals

3.3 Farmers satisfaction toward prevention measures

We analyzed 161 answers regarding farmers' satisfaction of fences (2 did not reply to this question). Fences were judged a valid tool to reduce the risk of predation by 81% of the respondents (n =130) (fig. 5), and a similar percentage (74% of farmers) answered similarly for LGDs (sample size = 163) (fig. 6).

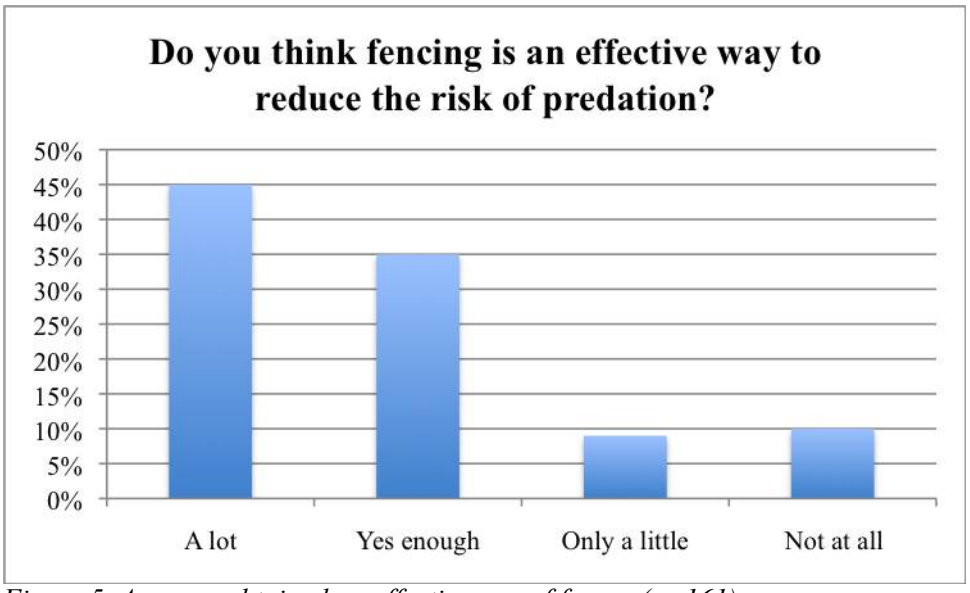

Figure 5. Answers obtained on effectiveness of fences (n=161)

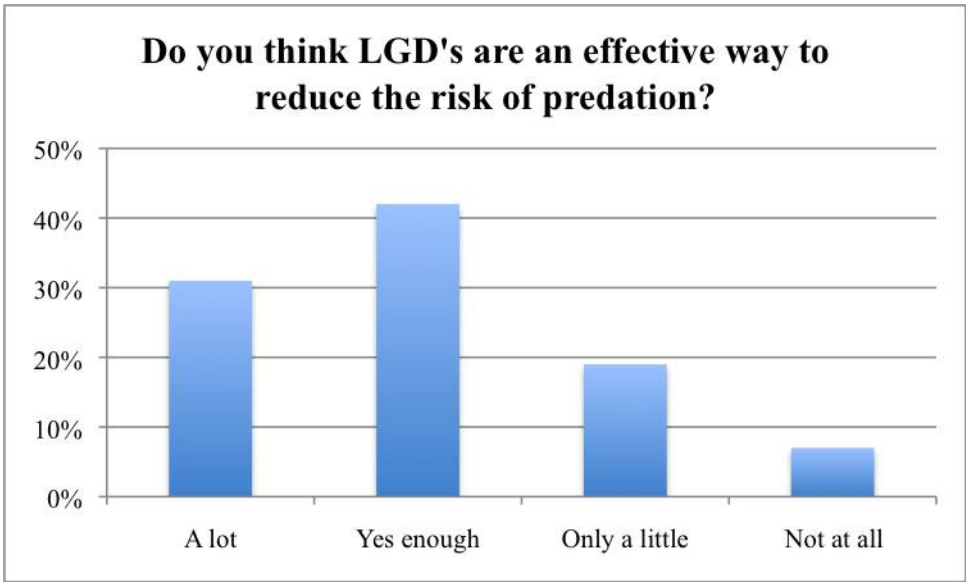

Figure 6. Answers obtained on effectiveness of LGDs (n=163)

Among the 108 farmers interviewed who had a fence, 69% answered that there has been a decrease in the damages since they started to use the fence (fig. 7); however, 59% responded that the use of the fence involves additional work in livestock management (fig. 8).

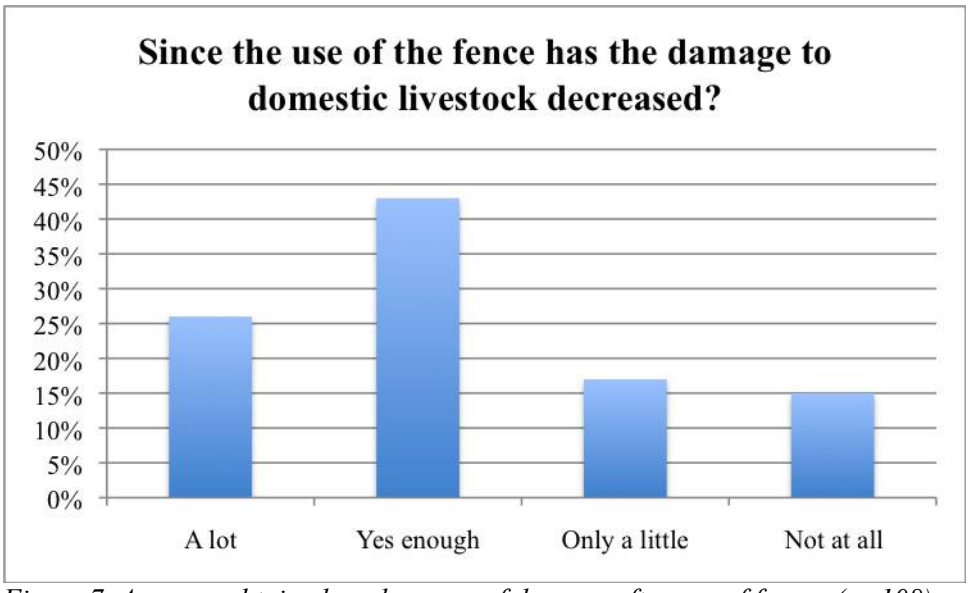

Figure 7. Answers obtained on decrease of damage after use of fences (n=108)

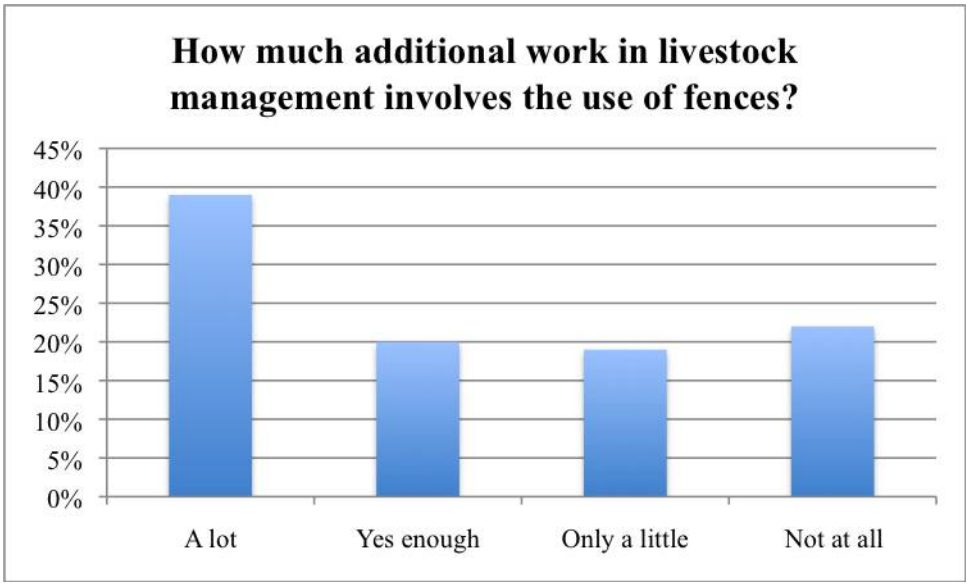

Figure 8. Answers obtained on additional work after use of fences (n=108)

All of the 8 farmers specifically interviewed about LGDs reported a decrease of damages since the use of the dogs, and that the use of the dogs involves additional work in livestock management.
Even if the majority of respondents believed that fences were useful to reduce damages, 92% of the farmers answered that the lower losses did not result in a higher earning margin (fig. 9). This result could be interpreted by the fact that the crisis in the sector is independent from wolf presence.
The situation is quite different if we consider the survey about LGDs. Five farmers answered that there was a higher earning margin since the use of dogs, while 3 had an opposite opinion.

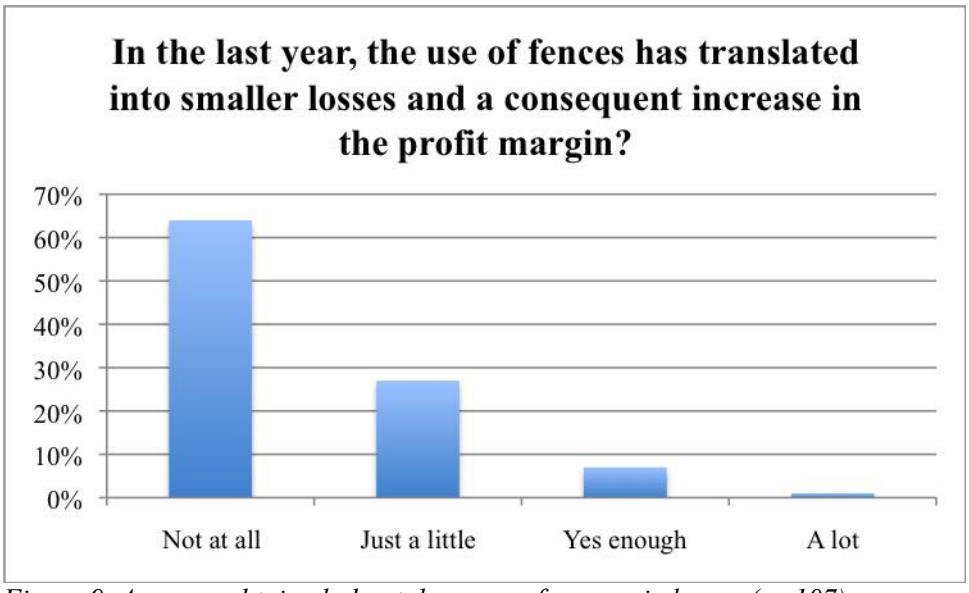

Figure 9. Answers obtained about decrease of economic losses (n=107)

The majority of the respondents about the fences (60%, n=158) agreed with the statement that farmers who are in an area at risk of predation should use the fences for livestock's protection, 11% answered that this is only appropriate under particular conditions, while 32% disagreed with the statement (fig. 10). On the contrary all the farmers interviewed about LGDs, answered that their adoption should be mandatory.

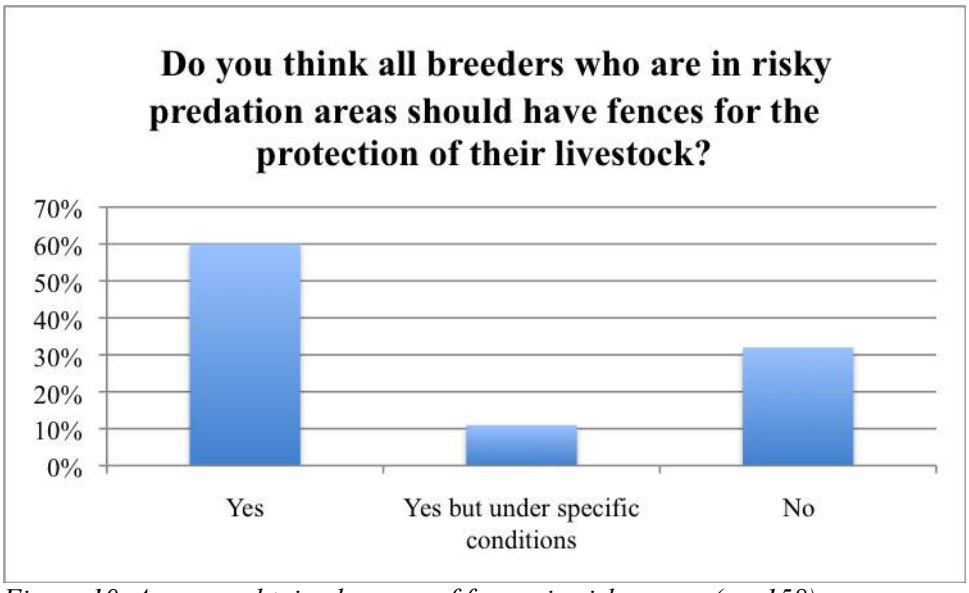

Figure 10. Answers obtained on use of fences in risky areas (n =158)

Considering both surveys (fences+LGDs) 55% of the farmers answered that as a prevention measures they would suggest to other farmers the use of fences and LGDs, 20% only fences, 12% only dogs, 13% other solutions (including "I don't know") (fig. 11).

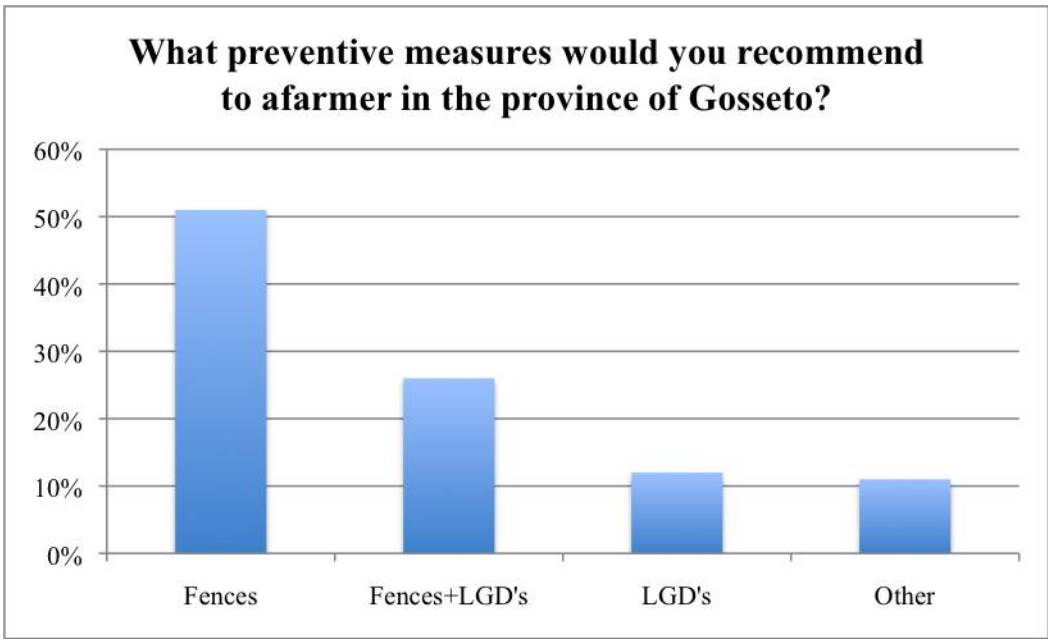

Figure 11. Answers obtained on prevention measures to suggest (n = 157)

The last questions of both questionnaires were related to the attitude towards the project.
The opinion on the delivery of fences was judged positively or very positively by 77% of the respondents (n= 149, we excluded 8 missing answers, fig. 12), while the delivery of dogs was considered a positive action by all the interviewees.

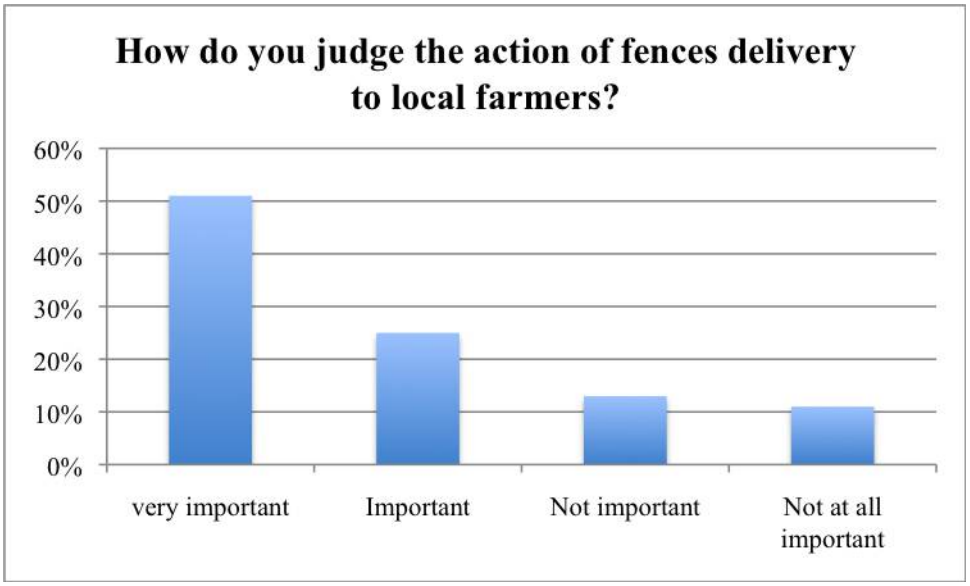

Figure 12. Answers obtained on importance of delivery of fences (n = 149)

The technical assistance provided by project staff for the installation and use of the fences was judged positive or very positive by 66% of respondents, in contrast, 100% of respondents were satisfied judged positively the assistance in managing the guarding dogs (fig. 13).

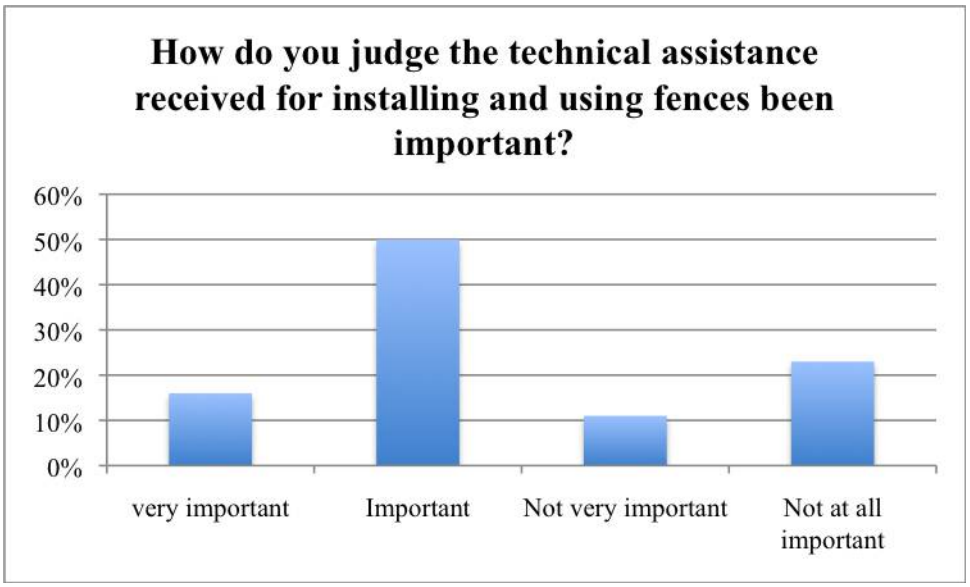

Figure 13. Answers obtained on importance of technical support provided (n = 62)

3.4 LGD distance from the flocks

The average distance between LGDs and their flock was 120+/- 135m, while the median distance was 70m (IQR: 35-146m). Dog-sheep distance ranged from a minimum of 0,62m to a maximum of 990m (Zingaro et al, 2017). No significant difference was found among sexes, while some differences were found among dogs (K-W test $p < 0.0001$) and farms (K-W test $p < 0.0001$). The age of dogs slightly influenced distance between dogs and flock, with older dogs remaining closer to flocks than young individuals.

The utilization distribution for the dogs and sheep was non uniformly distributed, but had a high degree of overlap (Zingaro et al 2017).

3.5 Livestock damages in the Province of Grosseto

The trend of damages in the province of Grosseto was analyzed from 01/01/2014 to 31/12/2017.
We didn't consider the damages in 2013 because at that time the damages compensation was restricted only to those farmers who subscribed an insurance. For this reason, the official statistics were an underestimation of the phenomenon because only 5% of the companies were insured (see also report of Action A4 and Marino et al 2016).
The number of attacks, the number of animals killed and the farms involved in the study period were presented in table 2.

Year	**Attacks (n)**	**Farms (n)**	**Animal killed (n)**
2014	241	106	610
2015	477	197	1177
2016	285	141	639
2017	318	157	816

Table 2. Livestock damages in the Province of Grosseto

A reliable comparison should be limited from 01/01/2015 to 31/12/2017 because it is only from 07/10/2014 that the register of predation events compiled by AUSL Grosseto became operative and the data were collected in a standardized way.

From 2015 to 2016 there was a reduction of 40% of the attacks, of 28% of the farms involved and of 46% of the animals killed.
From 2016 to 2017 there was a slight increase of 12% of the attacks, of 11% of the farms involved and a more significant increase of 28% of the animals killed.

However, it is important to consider the trend of damages in the period of action implementation, that is from the installation and use of first fence in the frame of the project from November 2014.
Limiting the comparison to this time-frame we observed a reduction of 33% of the attacks, a reduction of 20% of the farms involved, and of a reduction of 31% of the animals killed.

3.6 Estimation of costs associated to the implementation of damage prevention measures

The results from the interviews were highly variable, thus it was impossible to obtain the estimate of costs that usually have to be borne once the damage prevention are implemented. Such high variation was mainly due to the differneces in the combination of damage prevention measures used (only fences, only LGDs, a combinationof both in variable nimbers, etc).

The typical farm was then described during the focus group and was made of the following elements:

- Family workers (1-2 people)
- Mainly grazing on owned or rented land
- Specialised in sheep raising
- Delivery of milk to a transformation cooperative
- Part of the production was used in the farm (hay) or for self consumption
- No other activities were undertaken other than agricultural productive ones
- Use of incentives from CAP but very limited use of RDPs
- Number of heads 300-400
- Use of 3 fences
- Use of 6-7 LGDs

On average the yearly costs for having 3 fences in such a typical farm was estimated to be 38-45€/head. The main costs associated to the implementation of such measures were expressed in increased need for labour time needed for moving heads in and outside the fence (41%), additional food to be provided while inside the fences (43%), costs for the installation of the fences (12%) and for additional vet care needed in case the animals were kept in enclosure for long periods (5%).

The average yearly cost in presence of 6-7aLGDs and the fences was estimated to be 43-54€/head. The main costs associated to the implementation of such measures were expressed in increased need for labour time needed for managing and educationg the dogs and for moving heads inside and outside the fences (52%), additional food to be provided while inside the fences (12%), costs for the installation of the fences (10%), additional vet care needed in case the animals were kept in enclosure for long periods (4%), purchase of LGDs (4%), LGD food (12%), vet care for LGDs (4%).

4. CONCLUSIONS

All the approaches used to assess the efficacy of prevention measures for damage reductions agree in showing a considerable reduction of damages. We found a significant reduction in the number of attacks as well as in the numbers of animals killed following adoption of fences and livestock guarding dogs. The only exceptions were systematically related to predation of sheep that were kept outside the fence or to one case in which the fence was not properly installed, thus confirming the effectiveness of the fence provided to farmers to prevent depredation by wolves. Accordingly, the use of fences decreased the damage considerably during the night, while LGDs were particularly important to protect livestock also during the daylight.

The role of prevention measures was also recognized by farmers who appreciated the project and the technical assistance provided by the project staff. The farmers underlined the cost of prevention measures implementation and the need for technical and economic support. Our estimate of additional costs associated appears to be high and a focused analysis with BACI approach should be made in the future. Our findings suggest that continued monitoring of damage events and assessment of efficacy of damage prevention measures are needed to properly inform wolf and livestock management decisions. We have made a particular effort to provide reliable data and justify the investments made by the LIFE MEDWOLF project.

One of the main demonstrated achievement of this project was the changes in perception of farmers who felt better supported by competent technicians and no longer felt alone dealing with a relatively new issue to deal with. This capital ought not to be lost for future wolf management in the project area.

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