EIP-AGRI Focus Group

Wildlife and agricultural production

DISCUSSION PAPER

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Introduction

The wildlife and agricultural production Focus Group (FG) aims to collect and summarise knowledge and experience on the main problems wildlife causes to agriculture production and on the innovative practices and approaches adopted to reduce damages, while minimising the impact on the fauna.
It is recognised that while wildlife is increasingly competing with human activities, the latter play a role in modifying wildlife's habitats and its behaviours, thus tensions arise. Therefore, innovative solutions to help address such situations are very much needed. It must also be noted that although wildlife related problems are widespread in European agriculture due to different production system and practices, and different physical and socio-ecological conditions, challenges are different in each country and each territory.
The FG must hence suggest and prioritise innovative actions to face these challenges. The FG should also identify ideas for applied research activities that could be tested in the field involving all the stakeholders. The final aim is to produce "guidelines" that could be adopted by all the stakeholders, including decision makers, to improve the situation and reduce the conflicts.

Description of the various interactions between wildlife and farming

Human population growth increases the demand for natural resources. This has led to wildlife habitat degradation and fragmentation with humans and livestock encroaching on natural habitats. Wildlife is increasingly competing with humans for limited natural resources resulting in an increase in human and wildlife conflicts (FAO 2020). Wildlife, particularly carnivores, ungulates, rodents, raptors, granivores and piscivorous birds, come into conflict with people in different ways and at various degrees, especially when they damage agricultural activities by feeding (killing, browsing, grazing), digging and burrowing. Moreover, wildlife are carriers of diseases that can be harmful to people and their domestic animals, but also to crops, and this is a further reason for conflict (Sillero-Zubiri *et al.* 2007). This situation has recently acquired a global concern under the COVID-19 situation, which has raised a widespread awareness about the risks and consequences of habitat loss and destruction of nature (Johnson *et al.* 2020).

Over the last decades, wildlife/human interaction and wildlife related damages to the agricultural sector have shown an increasing trend at the global scale. Both fragile rural areas and intensive production systems, especially those closer to mountains and less humanised areas or bordering well preserved ecosystems, are affected. Fragile rural areas are more likely to suffer because they usually comprise marginal lands, which have little potential for profit and are usually shared with wildlife. Moreover, these areas are being increasingly abandoned, incrementing the complexity of the relationships between farmers and wildlife. In the case of intensive production systems, damages caused by wildlife can act at a large scale with major economic consequences. The difficulties of public administrations to reduce the impact of wildlife on agricultural production and to meet the growing requests for crop and/or livestock damage compensations raises the need to identify appropriate measures to assess, manage, control and monitor this growing trend (Cozzi *et al.* 2015).

Conflicts between wildlife and humans have indeed a huge impact at a global scale. Numerous human and animal lives are lost every year with millions of livelihoods being threatened worldwide. In Europe instead, HWC has a direct impact on stakeholders operating in the agricultural sector mainly from an economic point of view. This directly impacts the conservation efforts implemented to protect endangered species and to preserve protected areas, while it negatively affects agricultural production and economic activities that guarantee food security and the sustainable use of agricultural land. Although statistics are scarce and only available for some of the richest countries, damages caused by wildlife seem to be widespread. Conover (2002) reports that over 80% of 2000 farmers interviewed in the US suffered some damages caused by wildlife. In the USA, in 2000, the federal agency that controls agricultural damages caused by wildlife spent over $60 million in operations and the agriculture industry estimated losses at nearly one billion US dollars (National Agricultural Statistics Service 2002), similar statistics are available for Europe (Breitenmoser & Angst 2001). In communities with subsistence economies, even small losses can be economically important (Sillero-Zubiri *et al.* 2007). Today, the main consequences of human-wildlife-conflict (HWC) in agriculture include: damage and destruction of crops, competition for grazing lands and water, livestock being killed by wildlife, reduced farm productivity, damage to infrastructure and increased risk of disease transmission among wildlife, livestock and crops. The result of this

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situation is that, unlike the rest of society, most of the farmers consistently view wildlife negatively due to the impact it has on their lives and economics (Hegel *et al.* 2009).
This is however not only an agricultural challenge but just as well a social-ecological one, and a wide range of stakeholders would need to be involved in planning and implementing appropriate solutions. Besides, it also means that if practical, long lasting solutions want to be delivered, one also needs to address the human 'conflicts' and not only the problems, measures or compensations.
As a growing number of countries face these challenges, the issue of HWC is starting to be considered in national policies, both to reduce its impact on agriculture and to develop strategies for wildlife conservation, sustainable rural development and poverty alleviation. However, despite the widespread global efforts, there is a need to improve the sharing and transfer of knowledge, to adopt a more inclusive and interdisciplinary approach, and to greatly increase cross-sectoral collaboration among forestry, wildlife, agriculture, livestock, ecology and other relevant sectors (FAO 2020).

Scope of the Focus Group

Against this backdrop, the Focus Group 'Wildlife and agricultural production' will address the following main question: "***How to promote innovative and sustainable practices to prevent and control wild animal damage on farms while at the same time protecting wildlife?"***

More specifically,

- Map the most common types of damage caused by wild animals, particularly mammals and birds, on farms across Europe.
- Identify **strengths and weaknesses of available solutions at the farm level** that can help prevent, monitor and control wildlife damage to agricultural production.
- Identify **good farming practices**, within a wider wildlife and land management approach, **that contribute to limiting harm to the local fauna**.
- Identify **opportunities to implement innovative solutions and approaches at farm or at landscape level through forms of collaboration** (including with foresters, hunters, and others).
- Identify needs from practice and possible gaps in knowledge that may be solved by further research.
- Suggest innovative solutions and provide ideas for EIP-AGRI Operational Groups and other innovative projects.

How are wild animals damaging agricultural production?

- ***Direct damages (e.g. loss of livestock in the case of attack from carnivores, and of crops through for example, depredation of grains and fruits by birds)***
- ***Indirect damage (e.g. transmission of infectious diseases to domestic animals, damages to fields or infrastructures, land abandonment, land degradation, loss of rural tradition).***

The main causes of losses and damages caused by wildlife to agricultural production are represented by predation on farm animals, game and fisheries, crop damage by wild herbivores and birds, and the spreading of diseases. Mapping the main causes of damage is amongst the priority tasks of this FG, so special attention should be paid to this section.

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Damages caused by carnivores

Figure 1: wolves feeding on a killed sheep (Source: https://laborunionreport.com/)

The prevailing source of damages from carnivores to agricultural production is predation over production animals. Wherever people exploit natural resources, rear livestock, game or fish outdoors, predation is a recurrent and controversial complaint (Figure 1). The ecology of predation is however extremely complex. Predators hunt and naturally limit the number of preys depending on a complex array of environmental variables that cannot be generalized (Ray *et al.* 2005). Poaching, along with habitat loss and habitat fragmentation, increase pressure over predators and competition, making more intense the interaction with livestock, that, in association with the reduction of preys, force predators to turn to domestic stock for food (Stander 2005; Jones and Barnes 2006). The changing balance of availability of and accessibility to livestock and natural prey can shift predator preferences and incidences of depredation (Meriggi and Lovari 1996), in complex and contingent relationship schemes that change along time and territories.

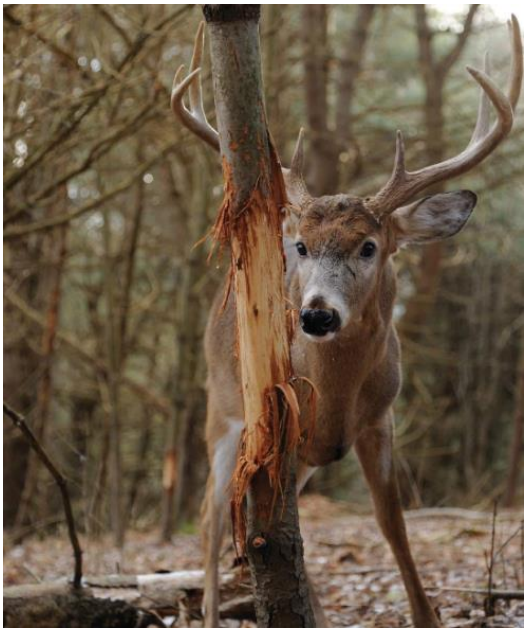

Figure 2: deer damages (Source: https://www.deeranddeerhunting.com/)

Although larger carnivores, such as wolves, bears and big cats, attract more attention, the cumulative damages caused by smaller predators, such as feral dogs, foxes, jackals, mustelids and small felids, seem to be greater (Marker *et al.* 2003; Jones and Barnes 2006). Predation on domestic stock is affected by both predator and livestock density, carnivores' individual and herd behaviour, and by farming conditions but it also depends on species, breed, stock management practices as well as on animal's previous experience of predators. Free ranging cattle and horses are more ready, and hence generally less susceptible, to face and react to predators' attacks compared to intensively bred or highly domesticated animals that never experienced contact with wild predators (Wydeven *et al.* 2004; Sillero-Zubiri *et al.* 2007). Over the past 100 years farming and husbandry practices, along with nature conservation criteria, have changed so much worsening conflicts. They have indeed increased in those areas where traditional livestock-guarding practices are now precluded or reduced and sometimes even abandoned once large predators were removed, as in southern Europe (Breitenmoser 1998; Ciucci and Boitani 1998; Vos 2000). Today, the biggest economic impact and most serious problems are on the many herding societies depending entirely on their livestock living in remote rural areas of the poorest regions of Europe, precisely where pastoralism is key for preservation of landscapes and biodiversity, but relevant damages are also reported from medium to large agricultural producers all over Europe. Small scale farmers, compared to medium and large farming enterprises, have a reduced resilience capacity, as well as limited economic resources, to respond to wildlife damages and absorb losses.

In recent years, the increase of large predators such as grey wolves, bears and large cats in many areas, sometimes supported by nature conservation plans, has led to furious reactions from farmers and even hunters, claiming compensation or carnivore population reduction. On the other end, most large carnivores and several other endangered species, experience numerous conservation initiatives supported by a more environmental friendly public opinion and enjoy a legal protection status agreed by the whole society (Breitenmoser 1998; Treves *et al.* 2002).

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Damages caused by herbivores

Damages to crop and other agricultural production tends to happen more frequent in those areas closely bordering natural habitats where higher density of wild animals live and roam. Damages to crop and trees (Figure 2) remain the main causes of conflict with wildlife, ranging in size from rodents to elks, even in industrialized countries where large herbivores are scarce. This situation is complicated by a variety of social, political, cultural and ecological factors (Conover 2002; FAO 2008; Mfunda and Røskaft 2011).

Damages caused by birds

Bird damage is a significant problem worldwide with total damage to horticultural production estimated to be over $1 billion annually. Over 60 species of birds are known to damage horticultural crops. These species possess marked differences in feeding strategies and movement patterns which influence the nature, timing and severity of the damage they cause (Tracey *et al.* 2007).
Most horticultural crops are susceptible to damages caused by birds (Figure 3). The vast majority of fruit crops are potentially at risk, but significant damages are often reported to vegetable crops. The flower market, although not strictly considered an agricultural production, is also at risk since many birds also feed and cause damages to floriculture. Most of the losses to horticulture are: damage or removal of shoots, stems, foliage, buds or fruit, but damages to infrastructure are also frequent.
The species responsible for the large majority of damages are granivorous and frugivorous, with Anseriformes, Columbiformes, Psittaciformes and Passeriformes being the most represented orders. Starlings are indeed the most serious and widespread agricultural pest, causing high levels of damage to fruit, while European blackbirds and sparrows mainly damage horticulture (Tracey *et al.* 2007).
Birds are also responsible for spreading plant diseases and weed seeds across different territories and these remain one of the most difficult problem to control (Peters *et al.* 2012; Stewart *et al.* 2020).

Figure 3: pigeons feeding on crops (Source: https://www.ift.org/)

Disease transmission by wildlife

The link between pathogens, environment and human activities creates a dynamic situation where new diseases or new hosts emerge. The new consumer requirements are affecting animal welfare politics and forcing the livestock industry toward more extensive and sustainable farming systems, but this situation joins the growing

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density of wildlife that are increasingly managed through feeding, translocations and even fencing, making these animal populations more like extensively raised livestock with limited sanitary control. These situations increase the exchange of pathogens or vectors (Laddomada *et al.* 1994; Gortázar *et al.* 2006). In addition, changes in population density or host behaviour also affects disease prevalence and old or new pathogens can suddenly boost their virulence and widen their host range. The new wildlife and livestock management approaches and changes in disease dynamics are making disease transmission at the wildlife livestock interface increasingly difficult to control (Gortázar *et al.* 2007).

The following factors are the most relevant risks for livestock: 1. introduction of diseases through movements or translocations of wild animals, 2. wildlife overabundance, 3. free ranging livestock breeding, 4. vector expansion and 5. sharing water points, salt rocks and other resources with wildlife and 6. expansion or introduction of hosts.

What measures to limit damages to crops and farm animals exist and how successful they are? Are there any downsides when implementing these existing measures?

In the past, damages to agriculture caused by wildlife were considered accidents, and damages to assets referred to as incidents. Indeed, cultural and social aspects that influenced problem perception changed over the years. Together with the innovations brought into the agricultural sector and the abandonment of rural areas and rural life, there has been a progressive loss of past knowledge on how to deal with wildlife. Some of the solutions adopted in the past (like exterminating wolves with traps or through hunting) are not acceptable and cannot be adopted anymore, especially due to societal changes. A more urban society, which is generally more aware of the importance of living in a healthy ecosystem is also more concerned about wildlife preservation. All of this is accompanied by population decline in rural areas and therefore lack of people that, thanks to their continuous presence in the area, guarantee a more active monitoring of the situation and the capacity to organise the implementation of those practices that limit or avoid conflicts. Moreover, as farmers are no more used to deal with wildlife they are also not willing to assume the costs of adopting solutions that were normal in the past.
After many years, during the 20th century, over which we observed a significant decline of wildlife populations and its resulting impact on agricultural activities, nowadays, human/wildlife conflicts are a common occurrence. What was once considered a production risk, leaving response to the problem to personal initiative, has become ordinary and requires a coordinated and organised response from multiple stakeholders (FAO 2008). Identify strengths and weaknesses of the solutions adopted to limit damages is also one of the priority tasks of this FG.

Wildlife is not more invasive, more dangerous or crueller than in the past, although sometimes more abundant, but human activities have expanded so much into and at the border of remote wilderness that encounters and interactions have become common. Communication of these events has also become easier and internet made spreading of the information worldwide instant. However, different species have different psychological impacts, causing different reactions and resulting in more severe response versus certain species instead of others, even though the consequences of their actions are the same (FAO 2010).

Unfortunately, data, even in many European countries, are scattered and not collected in a complete and uniform way, making statistics and planning very difficult to interpret. Deficiencies in data collection and analysis should be addressed as a priority in order to better assess the efficiency of strategies to manage wildlife damage.

The following paragraphs will describe the most common methods and techniques used to provide relief for farmers (Knight 2015). Before acting, at any level, is however necessary to check with local and/or national wildlife authorities to determine if targeted species are protected and if permits can be granted for removal. A complete understanding of the biology of each of the targeted species is fundamental.
Economic and social measures, such as subsidies and damage compensation or the creation of multi-stakeholders' platforms, as well as training activities, are not specifically described in each paragraph below due to their transversal value and possible use on a broad scale.

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Carnivores

Although there is a large number of carnivores that can damage agricultural activities, the major concern is often larger carnivores, like wolves, bears, lynx and jackals due to their impact on livestock. Losses are usually greater in the spring and summer because carnivores demands are greater due to pup-rearing and the fact that wild prey are not as vulnerable as in deep snow conditions. During colder months, young livestock are the most vulnerable instead.
Prevention and control of damages caused by carnivores requires consideration of a variety of tools:

- Habits and cultural changes: many conflicts are due to farming practices that do not consider and do not accept the presence of predators in the environment. Reducing these conflicts often relies in the capacity of farmers to adapt to this situation and change their habits. Reducing the exposure of vulnerable animals by shortening lambing or calving periods may indeed reduce predation. Hiring a herder and using guard dogs has proved to work well in many countries. Confining animals at night remains one of the most effective means of reducing losses to predation. Removing carcasses is an important practice that eliminates attractions for scavengers and opportunistic carnivores, while keeping them from getting used to feeding on livestock.
- Exclusion: carnivores can be kept out of livestock pens using a net-wire fence attached tightly to the ground and by adding a charged wire to the top of the fence to prevent climbing (Figure 4). Digging can be avoided by placing barbed wire at ground level or burying a wire apron. Electric fencing may also be used, although it is effective, it is difficult to maintain and some predator species are very good at spotting holes or defects on the fence to pass through.
- Frightening devices: most of these methods have a short time efficacy, being primarily useful to deter predation until other practices can be put into place. Lights over corrals are one of the most effective short-term frightening devices. Propane exploders and sirens will scare carnivores, but their use should be limited because of the disruption to livestock. Radios tuned to stations with human voices rather than music will temporarily deter some of the less habituated species.
- Trapping: traps are amongst the most common methods used to hold carnivores until they are removed or euthanised. However, most of the species, especially in Europe, are protected and attention must be paid to have all the required permits before starting.
- Hunting: regulated hunting can be used for carnivore control in areas where it is legal. This control method is however not final and different longer-term solutions should be considered.

Herbivores

Herbivores are the most widely distributed large animals in Europe. Their habitat includes wildlands, agricultural areas and residential areas. Most herbivores favour early vegetation stages that keep brush and sapling browse within reach and use dense cover for shelter and protection. Because they are so adaptable, almost any area can host a large enough population that might damage agricultural activities.
Prevention and control of damages caused by herbivores requires consideration of a variety of tools, accompanied where possible by adequate measures for habitat preservation, such as passage corridors and areas that wild animals can still use for feeding and nesting:

- Habitat modification: choose plant species that are less favourable to herbivores in the area. Plant susceptible crops as far as possible from wooded cover and harvest as early as possible to reduce the period of vulnerability to browsing species. Diversification of crop species is also an effective option.
- Exclusion: protect fruit trees from browse and scrape damages with plastic tubes or wraps. Trees should be protected up to 1-1,5 meters from the ground.
- Wire fencing: they are the best year-round and long last protection solution in areas subject to herbivores pressures. Although investments to realise these infrastructures are high, they are long lasting and easy to maintain. Fences should be at least 1,8 meters high to be effective. Wild boars are

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however very difficult to contain since the weak point of most fencing is at the base, near the ground, where wild boars can dig underneath (Figure 5).

- Electric fencing: they are effective at protecting from moderate to high herbivores pressures. However, this fencing is quite expensive and requires a moderate effort to be maintained.
- Repellents and frightening devices: repellents are generally more effective on less preferred plants. Contact repellents are applied directly to plants, causing them to taste bad, while, area repellents are placed in a problem area and repel with foul odour. They should be applied, only on dry days with temperatures above freezing, to treat young trees and up to height of 1,8 meters. The use of dogs may also be effective to repel herbivores, although ineffective on large areas. While ultrasonic devices are mostly ineffective, motion-activated scare devices work well to keep deer out of an area. Most spray water devices are connected to a water reservoir.
- Hunting: regulated hunting can be used for herbivores control in areas where it is legal. Hunting, however, requires careful planning and landowners should be involved in harvest decisions such as hunter numbers, hunting locations, safety rules, and sex and age of harvested animals. This practice is indeed only a temporary solution and may cause other problems, like new or younger animals moving into the area with the risk of introducing diseases and disrupt natural equilibria.
- Neutering: it is mostly useless to reduce damages, but it could be used instead of hunting to keep an "habituated" population under control while avoiding the number to raise year after year.

Figure 4: electric fencing dividing properties in a mountain area (Source: https://chemvet.co.za/)

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Figure 5: electric fencing with reinforced wire mesh at the base (Source: https://chemvet.co.za/**)**

Bird control

Most bird damage occurs when large flocks feed on crop or garden products. Removal and damage to grain, fruits, seedlings and other produce can be significant. Even bird droppings can pose a health hazard, because some of the diseases transmitted with bird faeces can be a human and crop health concern. Birds can also bring weed seeds to the crops. Prevention and control of bird damage requires consideration of a variety of tools:

- Exclusion: excluding birds from a small crop area with nets can be effective and quite inexpensive, but unfeasible on a very large scale (Figure 6). Nets must have no openings, otherwise even a small number of animals penetrating and unable to escape may cause huge losses.
- Habitat modification: eliminating suitable roosting sites and cover, like dense tree areas, that might attract bird is an option, although the environmental impact of these actions must always be carefully evaluated.
- Repellents and frightening devices: many species of birds are repelled by the presence of monofilament fishing lines stretched between two points. The perceived appearance and disappearance of the line is what scare birds. The line is not a barrier but still effective when used with large spaces between strands. Frightening devices such as recorded distress or alarm calls, gas-operated exploders, battery-operated alarms, pyrotechnics (shell crackers, bird bombs), lights (for roosting sites at night), bright objects, and various other stimuli are effective in dispersing birds from roosts, fruit crops, and other grouping sites. However, most species usually get used to these devices and they lose effectiveness. Some of the newest devices include motion-activated water sprayers that have been developed to spray birds when they break the motion-detecting barriers and green lasers that have proven to scare numerous species. A combination of several frightening methods used together works better than a single technique used alone. Varying the location, the intensity, and the type of devices increase

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effectiveness. To achieve the desired success, it is important to adopt any of the above measures early, before birds build a strong attachment to a site.

- Trapping: trapping is often the best, if not the only, solution and it is amongst the most widely used method in attempting to reduce bird populations across the globe. Most traps are designed to catch live birds allowing to release non-target species (Figure 7). Trapping, however, is regulated and limited by law in many countries, and local authorities must always be consulted. The disposal of trapped birds should be quick and humane. Releasing birds back to the "wild" is impractical, since they are likely to return even when released over 100 kilometres from the problem site or they may become pests in other areas. Therefore, the disposal of trapped birds should be quick and humane. Although ethical aspects must be carefully evaluated, for large-scale control projects, the most cost effective and humane method is to use a carbon monoxide (CO) or carbon dioxide (CO2) gas chamber;
- Shooting: where laws and local regulation permit, shooting with air guns or low-powered firearms can be used. However, birds quickly become wary of a human holding anything resembling a firearm making this method mostly ineffective to control large populations;
- Predators: encouraging predators to use a specific area is often attempted, but it is difficult and rarely successful.

A non-exhaustive description of the situation in Europe is reported in Table 1 with the information provided by Focus Group experts.

Figure 6: net cover on an apple tree field (Source: https://www.spinazzegroup.com/**)**

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Figure 7: funnel trap for crows (Source: https://thefarmingforum.co.uk/**)**

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Table 1: report of the questionnaire filled by FG experts on damages caused by wildlife to agriculture and the adopted preventive measures

ANIMALS	SPECIES	COUNTRY	DAM. TO CROPS	DAM. TO LIVESTOCK	OTHER DAM.	DAMAGE PREVENTION
Birds	Crane (*Grus grus*), Canadian goose (*Branta canadensis*), Goose (*Anser anser*), Swan (*Cygnus cygnus*, *Cygnos olor*), Daw (*Corvus monedula*)	French Guiana	X	X		Some trials with raptor traps (mocks). Gas driven canons that scare away the birds. Farmers are paid to cultivate fields with special crops attracting wildlife, to prevent damages on Commercial crops.
Birds	Woodpigeon, Rook, Carrion crow, Western jackdaw, Common starling	France	X			Although inefficient, the current practices and ideas: - Population control or destruction by individual farmers in compliance with regulation : traditional but controversial; probably inefficient in the long run - Many empirical methods at the field level (repellents, scaring devices, physical protection, agronomy) but poorly cost-effective - More promising methods at the landscape level (sowing coordination, habitat management) but still conceptual - Need for a monitoring system at the regional/national levels to estimate damages and evaluate prevention methods
Birds	*Porphyrio porphyrio* (rice production) - Steppe birds, e.g., *Otis tarda* (other damages)	Spain	X			Implementation of agri-environmental measures that somehow compensate farmers for the damage and limitations caused by avifauna. However, these aids are not in many cases economically and agronomically attractive enough and fail to have the desirable acceptance to resolve the conflict.
Birds	Birds of Prey - Hen Harrier, buzzard	Ireland		X		
Birds	Pigeons	Ireland	X			
Birds	Pigeons	Ireland	X		X	
Birds	Crows	Ireland			X	Putting up mesh
Birds	Birds of Prey at risk from secondary poisoning from rodenticides	Ireland			X	Safe use of rodenticides - bait boxes to avoid primary poisoning and follow the code for responsible rodenticide use to reduce secondary poisoning

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ANIMALS	SPECIES	COUNTRY	DAM. TO CROPS	DAM. TO LIVESTOCK	OTHER DAM.	DAMAGE PREVENTION
Carnivores	Apennine wolf	Italy		X		Biosecurity management of waste and carcass - Organic matter (dead animal, organs and postpartum waste) when left in the fields or outside the farm building attract local predators including wolfs. Therefore, increasing the possibility of predation and reducing the fear of human contact.
Carnivores	Wolf	France		X		
Carnivores	*Ursus arctos*, *Canis lupus*	Greece		X	X	Livestock guarding dogs, electric fences
Carnivores	Wolf, brown bear	Slovenia		X		Night fences and high electric fences. Livestock guardian dog on pasture.
Carnivores	Wolves	Italy		X		Dogs and electric fences. Problem of wolves is strictly linked with the problems of wild boars. The two species together pose serious difficulties to farmers.
Carnivores	Bear	France		X		On the technical side : shepherds staying in mountains with skilled watchdogs. But in a wider perspective, the good practices take place in a socio-economic context, setting a governance system able to a) compensate the damages caused by predators b) value the image of predators c) give access to pastoral land to those shepherds able to share space with predators (which introduces a land-tenure land-access issue).
Carnivores	Foxes	Ireland		X		
Carnivores	Wolf (*Canis lupus*)	Spain		X		Guarding dogs, enclosures and fences, tracking devices, compensation payments,
Carnivores	Bears, Wolves	Romania		X		Night shelters located in an open field near the flock; specially trained dogs for bear/wolfs guard; special fences located around animals, etc
Ungulates	Wild boars	Italy				1) Fencing- especially electrical multi-file fencing. 2) Waste management: food waste, farm waste, and by-products may otherwise create a stimulus for the wild boars. 3) Population management by a wider number of stakeholders (community empowerment)- culling and trapping are currently performed by a narrow group of experts, which are not always performing up to the task.

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ANIMALS	SPECIES	COUNTRY	DAM. TO CROPS	DAM. TO LIVESTOCK	OTHER DAM.	DAMAGE PREVENTION
Ungulates	Wild boar, Roe deer, Red deer	France	X			To date, prevention methods in fields are poorly effective. There is a fundamental problem of population control in connection with land use and hunting practices. Discussions are ongoing.
Ungulates	Wild boar, red deer, fallow deer, mouflon, roe deer	Hungary	X	X		Game management plans, dissuasive feeding, game crops, increased harvesting when necessary, higher harvesting pressures during times when agricultural crops are most sensitive, suitable fencing including electric fencing. With African Swine Fever (ASF) and other diseases affecting wild boar and domestic pigs, hunters are well placed to act as first-observers for ASF. Increased harvesting pressures in and around infected zones can help limit the transmission to domestic pigs.
Ungulates	Wild boar, red deer, roe deer	Poland	X	X		Steel mesh, foil tape fencing, hunting, setting up of crops for wild animals, establishing and maintaining shelters for feeding and hiding animals. Since the beginning of 2014, African Swine Fever (ASF) has been present on Polish territory. The implemented prevention methods include the creation of different risk areas. In these areas there are rules for biosecurity on farms keeping pigs and hunters performing hunting. Production of pigs is carried out in closed facilities, access to them is limited. The producer should be equipped with mats and protective clothing. Special restrictions apply to the production of feed and its supply to pigs. Hunters, in ASF areas, must follow special rules for handling the carcass of hunted wild boars.
Ungulates	Deer	Ireland	X	X		
Ungulates	Roe deer, fallow deer, wild boar, moose	Sweden	X	X		Crops selection, fencing, hunting
Ungulates	Wild boar (*Sus scrofa*) and other ungulates (i.e. Red Deer)	Spain	X	X		Fencing, electric fencing, geolocation of animals, hunting, chemical repellents, alternative food provision, segregation of water points
Ungulates	Roe Deer, Red Deer, Wild Boar	Germany	X		X	Improved hunting strategies, adapted communication strategies

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Why and where is innovation needed – to solve the issues that aren't solved by existing measures

Wildlife damage management must be based on sound economic, ecological, and sociological principles and carried out as positive, necessary components of wildlife management programs. Actions must be justified, environmentally safe, humane, and developed in the public interest.

The objectives of wildlife control are to:

a) prevent damage caused by wildlife or reduce damage to an acceptable level;
b) produce economic benefits and maintain the sustainability of farms;
c) use the most effective, least objectionable and safest methods (for both animals and people);
d) promote coexistence between agricultural activity and wildlife in a sustainable way;

To reduce damages and impact on agricultural production, four main components must be hence considered:

1. Problem definition
    a. Species causing problem
    b. Number of animals
    c. Amount of loss
    d. Nature of conflict
        i. General background of the conflict
        ii. Direct causes
        iii. Indirect causes and coadjutants
        iv. Trends and future scenarios
2. Ecology of the problem species
3. Develop of a management plan: once the problem has been defined (using 1 and 2), there are three steps in developing a management plan:
    a. define a target future scenario;
    b. define management objectives and performance indicators;
    c. select an appropriate management option;
    d. formulate a management strategy.
4. Evaluation of management effort: assess the results relative to cost and impact on target and non-target populations

Wildlife damage management is becoming increasingly important because of expanding human populations, intensified land-use practices, increasing prominence of wildlife vectoring disease, and many other reasons. Many species, sooner or later, require management actions to reduce conflicts with people, livestock, or other human or production activities, including wildlife species and conservation. There are few "silver bullet" easy remedies. Integrated wildlife damage management strategies, using a variety of techniques to dynamically target problem individuals or species, are usually preferred and most effective for long-term management.

Here proposed a non-exhaustive list of topics that the experts of this Focus Group could consider and address to find innovative solutions, or improve existing ones, to reduce wildlife impacts on agriculture while minimising the impact on the fauna and on ecosystems:

- Improve knowledge of wildlife ecology, diet and patterns of movements and damage;
- Estimate the extent, timing and costs of damage;
- Assess existing control techniques on the main species;
- Improve adoption of effective existing techniques;

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- Develop additional effective, species-specific and humane techniques and products that can be used by farmers;
- Improve cooperation between, and commitment from all actors involved (e.g. industry and farmers) at different levels (European local, and National, European);
- Conduct risk assessments;

Management of risk deriving from wildlife requires a multi-actor and multilevel consultation, especially in such a controversial scenario, where wildlife and its impact on farming and rural development cannot always be managed as a "command-and-control" mechanism where the input factor (i.e. the number of wild animals) is directly controlled in order to determine the desired output (i.e. absence of damages/losses at farm level).

Moreover, it is important, at any time and at any level, to remember that there are numerous national, European and international laws directly or indirectly affecting target and non-target species. Any initiative should therefore take into consideration the law and the goal of establishing a long-expected peaceful coexistence between human activities, nature and wildlife.

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