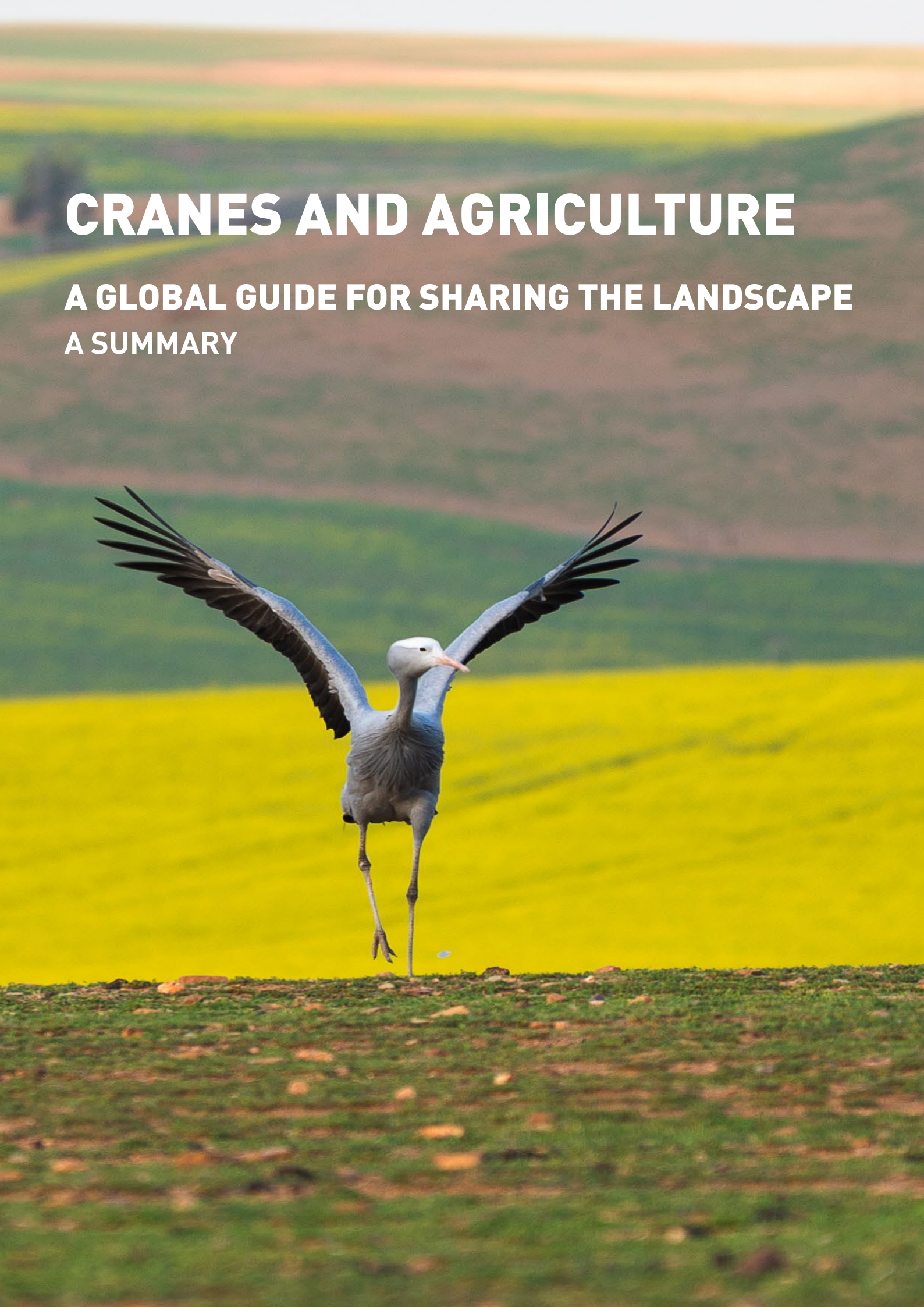
CRANES AND AGRICULTURE

A GLOBAL GUIDE FOR SHARING THE LANDSCAPE

A SUMMARY



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EXECUTIVE SUMMARY

This publication is a summary version of the 2018 document 'Cranes and Agriculture: A Global Guide for Sharing the Landscape', edited by Jane Austin, Kerryn Morrison, and James Harris, and published by the International Crane Foundation. That document synthesized the current knowledge on cranes and agriculture, sharing examples of both challenges and successes, and identifying potential solutions and opportunities so that conservation practitioners, decision-makers, communities, and farmers could address their specific local or regional conflicts or opportunities.

The full 314-page Guide includes multiple case studies, and readers are encouraged to consult the full Guide for more detailed information. By contrast, through being much shorter, this summary version of the Guide is intended to be more 'user-friendly', and therefore more accessible for practical implementation immediately, by conservationists, farmers, and locally-based decision makers, in a way that the current whole Guide was not designed to be. This shorter, summary version selects and presents the relevant information and practices that will lead to the most significant, immediate, conservation impacts that benefit both cranes and farmers.

The aim of this shorter, more user-friendly version of the Guide is to improve the understanding and management of crane-agriculture interactions, which will in turn lead to increased well-being of farming communities, and reduced agricultural threats to cranes on agricultural lands.

This summary document has two sections:

1. The interactions between cranes and agriculture

Understanding how cranes and agriculture interact with and affect each other, and how changes in agricultural extent and practices alter that dynamic, helps all stakeholders work out the most effective solutions to reduce conflicts between cranes and farmers. This is because understanding crane-agriculture interactions helps explain why particular solutions may be needed, and why specific solutions may work better or less well than others.

2. Solutions to reduce conflict between cranes and agriculture

Here, nine categories of solutions are briefly presented, with some information about applicability, ease of use, and relevant considerations for ensuring that the solutions deliver the desired benefits for farmers and cranes. These solutions are intended to be suggestions; the specifics of each conflict situation will always vary, and solutions that may have worked in one instance may not always work in the same way in what looks like another, seemingly similar, situation. Equally, there are no doubt many new, effective, solutions waiting to be developed, in new contexts, by conservationists and landowners working together to find common ground.

Accordingly, the exact approach (or, rather, approaches) used, is not as important as the process that is used to consider and identify potential approaches. This section will begin by outlining a process for decision-making that will help conservationists and farmers identify the most effective and feasible approaches.

INTRODUCTION

Cranes have coexisted with agriculture for centuries in many parts of the world, and agriculture has become a key driver of crane population dynamics - at times beneficial and at others, a real or potential risk to cranes. Rapid expansion and intensification of agriculture in recent times have led to a severe loss of wetland and grassland habitats important to cranes in many areas, thus increasing the conflicts between cranes and farmers. The expansion of agriculture and more intensive practices also come with other threats to cranes, including changes in water availability, unnatural fire, chemical poisoning, human activity around nests, unsustainable use of wetland resources, and collisions with electricity or telephone lines.

Therefore, agriculture is one of the main causes behind severe population declines for ten of the 15 species of cranes in the world, and it affects all species in one way or another. However, some agricultural uses of wetlands and grasslands, such as paddy wetlands and moderate grazing, can be beneficial to both cranes and people, providing important environmental services like water and nutrient recycling and food production, at the same time as allowing cranes to flourish. Ultimately, farming in ways that keep habitats functioning sustainably benefits both humans and cranes.

Sarus Cranes engage in a unison call while a farmer watches. Photo credit: K S Gopi Sundar

SECTION 1

THE INTERACTIONS BETWEEN CRANES AND AGRICULTURE

Knowledge of crane biology and behavior can help explain why particular crops may be more or less susceptible to damage by cranes (and when), and lead to the logical identification of relevant solutions that can benefit both cranes and farmers.

WHY CRANES ARE FOUND ON AGRICULTURAL LAND

Cranes are large, long-lived birds that depend on open, shallow wetlands and grassland habitats to feed, breed, and roost. They use a wide variety of food sources, including tubers, seeds, and young seedlings, which are found both in natural habitats and farmed fields, as well as small animals such as invertebrates (like beetles and other insects), rodents, frogs, and snakes.

Cranes largely coexisted in harmony with people for centuries in many regions where agriculture was small in scale, low intensity, and sustained plentiful natural foods. In many places, however, those agricultural practices have been replaced by more modern and intensive methods of farming, which tend to simplify croplands, reduce patches of natural habitat, increase the use of agricultural chemicals, and increase harvesting efficiency. These changes can reduce food resources available for some species of cranes, which are forced to rely more on agricultural crops. However, some crane species have adapted well to intensive farming practices and the new feeding opportunities they present (e.g., Sandhill, Whooping, Red-crowned, Sarus, and Wattled Cranes) as long as conditions in agricultural fields or adjacent wetlands have not been too degraded. Sandhill Cranes, in particular, have benefited significantly from intensive agriculture throughout much, but not all, of North America. Particularly for Sandhill and Eurasian Cranes, crop fields provide abundant, predictable, and often high-energy foods that can be particularly valuable during migration and winter and have literally fueled growing populations and expanding ranges to new areas. Thus, cranes have sometimes benefited from agricultural foods, lands, and practices, but conflict with farmers can arise when cranes damage crops by consuming unharvested grains or vegetables like potatoes, uprooting young plants, trampling vegetation, or using crops to build nests.

During the breeding season, the breeding adults of some crane species can spend less time on agricultural land while they search for more protein-rich food (insects and other small animals, which can be more abundant in more natural habitats) to support egg development and the growth of chicks. However, non-breeding adults of those same species (which can comprise a large proportion of any given crane population) will not show this same differentiation in habitat preference. In the lead-up to migration, and during migration and winter, when full-grown cranes need to increase their energy stores, cranes tend to increase their feeding on energy-rich agricultural grains and tubers, and the whole population of a crane species may then spend more time on agricultural land.

Wattled Cranes north of Bethlehem, South Africa. Photo credit: The Endangered Wildlife Trust

Wattled Cranes and local people at Boyo Wetland, Ethiopia. Photo credit: George Archibald

CHANGES IN AGRICULTURAL PRACTICES AND HOW CRANES RESPOND TO THEM

The potential for cranes to damage crops is related to what other foods are available to them. The likelihood of crop damage can therefore be significantly reduced by changing agricultural practices, such as altering the timing and method of crop planting or harvesting or the types of crops grown.

The specific ways cranes respond to such changes in agricultural practices depend on the species of cranes (as some have specific feeding preferences), current food availability (whether other natural food sources are available or not), the distance between roosting areas and crop fields, the distribution of surrounding natural habitats, how often and to what extent the cranes are disturbed by people, the structure of the population of the cranes present (how many are breeding adults, and how many are not), and the time of year (whether cranes are breeding, migrating, or wintering).

Cranes stay near their nest and chicks during the breeding season and thus tend to have more local impacts in the breeding territory's immediate vicinity, but they can range widely during the non-breeding season and congregate in large numbers near favored feeding or roosting sites or at migration stop-over sites. Also, during the breeding season, there is usually a large proportion of non-breeding adult birds, which can be as much as 30-50% of the entire population; these non-breeding birds can range widely and typically have the same impacts on crops as a wintering or migrating population might (they can quickly congregate unexpectedly, in large numbers, on a newly vulnerable crop, and may need rapid action to respond to their presence before significant impact is experienced).

Changing the timing of crop planting and harvesting has a strong effect on food availability for cranes and the likelihood of crop damage. For example, crops planted in spring after migrating cranes have left the area and harvested before they return in fall will have little or no crop damage. If left unplowed through the winter, these lands will provide feeding opportunities for cranes that could attract them away from other crops. Contrastingly, plowing right after harvest reduces the amount of leftover grain available for cranes and can result in cranes moving elsewhere to feed on other more vulnerable, newly sown crops or to unharvested fields. Some farmers have shifted to fall-sown crops that are harvested in late winter and quickly plowed to be reseeded for the next crop; such quick crop rotation may reduce opportunities for cranes to feed on leftover grains and can increase the risk of them moving elsewhere to feed on other more vulnerable crops. Changing from a type of crop that cranes eat (such as grains) to crops that cranes don't eat (such as lucerne) can also lead to them moving elsewhere in search of food and may result in higher densities of cranes on remaining vulnerable crops.

When agricultural activities reduce the amount of natural habitat available for cranes (for example, through wetland conversion), the number (and therefore density) of cranes can increase in the remaining suitable sites, sometimes resulting in more conflict with farmers unless solutions to avoid or reduce conflict are put in place. On the other hand, increasing wetland-like habitats in dry regions, such as with the development of reservoirs, irrigation canals, or livestock ponds, can actually create new habitats for cranes in areas that, in the past, they would have avoided.

Grasslands are also important habitats for certain crane species, where grazing, whether by native ungulates or by domestic livestock, is an important process for sustaining open and productive grasslands for cranes.

Fire represents a restorative component of many of the world's ecosystems, including wetlands and grasslands, but cranes can be negatively affected by fire if it is not timed correctly. Fire during the nesting, chick rearing, or molting period can negatively impact populations. Burning in the early spring pre-breeding season or in the fall post-breeding season is generally the best practice to limit the impacts on cranes.

The following table (Table 1) summarizes why and when cranes may be present across different habitat zones (biomes) globally and the potential for conflict between farmers and cranes.

Table 1: Connections between cranes and agriculture in terrestrial biomes. Seasonal importance to cranes refers to breeding (B), migration (M), wintering (W), or throughout the annual life cycle (A) for nonmigratory populations.

Biome	Primary crane species (season)	Conditions for agriculture	Benefits for cranes	Threats cranes	Agricultural conflicts
Boreal forest/ taiga	Eurasian (B) Hooded (B) Sandhill (B)	Cold climate, short growing season, and often poor soils limit agriculture	Vast size, low human disturbance; abundant wetlands; largely undisturbed breeding habitats	Insufficient agricultural food resources during pre-migratory season	Very limited; some conflict with grain crops during early fall migration
Temperate broadleaf and mixed forest	Eurasian (B, M) Sandhill (B, M) Red-crowned (B, W)	Few limitations; favorable climate and soils conditions for arable agriculture	Vast size; abundant agricultural food resources	Extensive conversion to human uses, high level of disturbance from human activity	Crop conflicts with large migrant flocks
Temperate grasslands, savannas and shrublands	Brolga (B) Demoiselle (B, M) Eurasian (M) Hooded (M) Sandhill (M) Siberian (M) White-naped (B, M) Whooping (M)	Favorable conditions for arable agriculture and livestock grazing, where soils and water appropriate for agriculture; insufficient water resources in some regions	Vast size; abundant agricultural food resources; livestock grazing sustains open grasslands; agricultural practices created new breeding habitat in some areas	Extensive loss and degradation of natural habitats; limited number of wetlands, high disturbance from livestock	Crop conflicts with large migrant flocks
Tropical and subtropical grasslands, savannas, and shrublands	Brolga (B) Black Crowned (A) Grey Crowned (A) Sarus (A) Wattled (A) Whooping (W)	Favorable conditions for livestock grazing and rice cultivation in some regions; often insufficient water resources, climate change impact	Vast size; sufficient agricultural food resources; some agricultural activities (e.g., rice growing and grazing) create new breeding habitat	Breeding habitat loss and degradation; limited number of wetlands; overgrazing, increased disturbance from agricultural activity	Crop damage mainly to smallholders
Montane grasslands and shrublands	Black-necked (A)	Cold climate and short growing season limit agriculture to grazing and some grains	Sufficient food resources; low human impact; largely untouched breeding habitats	Small range; changing agricultural practices and increasing human activity alter food resources, increasing disturbance on migration and winter areas	Very limited

Biome	Primary crane species (season)	Conditions for agriculture	Benefits for cranes	Threats cranes	Agricultural conflicts
Mediterranean forests, woodlands and shrubs	Blue (B) Eurasian (W) Sandhill (W)	Favorable climate and soil conditions for arable and livestock agriculture where soils and water appropriate for agriculture; dry summers	Abundant agricultural food resources; agricultural practices created new breeding habitat for Blue Cranes	Extensive conversion to cropland, habitat loss and degradation from over-grazing, soil erosion	Crop damage to both large landowners and to smallholders
Tropical and subtropical moist and dry broadleaf forests	Demoiselle (W) Eurasian (W) Hooded (W) Sarus (B) White-naped (W)	Favorable climate for agriculture where soils and water appropriate; agriculture in dry forests driven by seasonal rainfall	Creation of new foraging habitat (rice paddies, co-existence of cranes with small-scale farming); sufficient agricultural food resources	Extensive conversion to cropland, habitat loss and degradation; increasing human disturbance	Crop damage to smallholders

Eurasian Cranes feeding in pasture. Photo credit: George Archibald

SECTION 2

SOLUTIONS TO REDUCE CONFLICT BETWEEN CRANES AND FARMERS ON AGRICULTURAL LAND

OVERALL CONSIDERATIONS

The conflict between cranes and farmers has increased due to expanded agriculture, human population growth, and economic pressures. While cranes need protection to halt their decline in numbers, farmers also need to protect their crops from damage by cranes.

There is a wide variety of methods that can be used to reduce conflict, but most importantly, it is vital to understand the specific nature of each conflict when seeking the most appropriate approach. Successful solutions should consider crane behavior, their food preferences, preferred habitat, and the times or conditions they visit specific areas. Combining several solutions is often the best approach (as no one method will be effective all the time), and it is always better, if possible, to establish prevention methods before cranes damage crops.

An overall process for identifying potential solutions

The solutions below are intended as suggestions only rather than prescriptions because the specifics of each conflict situation will always vary, and solutions that may have worked in one instance may not always work in the same way in another seemingly similar situation. Equally, there are no doubt many new, effective solutions waiting to be developed, in new contexts, by conservationists, agriculturalists, and farmers working together to find common ground.

Accordingly, the exact approach (or, rather, approaches) used is not as important as the process that is used to consider and identify potential approaches. The following process will help conservationists and farmers identify what the most effective approaches are likely to be.

So, to reduce the potential for conflict, there are three possible options:

1. Is it possible to reduce the population of cranes? (If not…)
2. Is it possible to reduce the number of cranes present on a particular area of land? (If not…)
3. Is it possible to reduce their impact on the land they are currently on?

In parallel, it is vital to ask two supplementary questions:

1. Are the cranes there as breeding adults, non-breeding birds, or wintering or migrating flocks? This is important because breeding adults will likely have a more localized impact around the breeding area, and, because they are tied to their territory, they will be much harder to deter. Conversely, non-breeding adults, or migrating or wintering adults, will be much easier to disperse, but their impacts may be spread over a much larger area, along with the risk that they may occur in much higher densities with a greater impact.
2. What is the resource they are interested in? This is an important question to ask, as it may be the case that the cranes are only interested in a certain crop at a certain growth stage, and hence the mitigation measures to respond to the cranes are only needed for a certain duration. Equally, the cranes may be present quite apart from the presence of a crop and may be feeding on other resources entirely, for instance, insects, in which case it may be that no action is needed at all, and the farmer can safely concentrate on other activities.

All the approaches outlined below are variations based on these questions, and the value that comes from following this process is that new approaches can be developed that may be better suited to the specifics of an individual farmer's situation.

Ultimately, only the third option above (reducing the impact of the cranes on the land they are currently on) has the potential for long-term, lasting success in resolving crane-farmer conflict. The first option does not work even in the short-term, as reducing the population of cranes is either illegal and heavily punished (most of the world), or (where it is in certain, rare cases, permitted, as in parts of North America) not feasible as the crane numbers are so large that removing a few from the population will make no meaningful difference. The second option may work temporarily, but typically shifts the problem elsewhere and does not actually solve it in a lasting way (i.e., even if cranes are, for example, successfully scared away from a particular field today, they may be back tomorrow, they may just shift from one farmer's field of vulnerable crops to another farmer's field nearby, or they may just quickly get used to and ignore a particular approach).

Working in partnership between conservationists, agriculturalists, and farmers

Solutions that are developed together with all stakeholders who know the land work better for all parties. Therefore, it is essential that conservationists listen to and work with local farmers and agriculturalists. In seeking solutions to a conflict between farmers and cranes, an important first step is to understand the specific problem clearly. This should be achieved by gathering baseline information and supporting discussions between all stakeholders (for example, farmers and conservation agencies).

Developed solutions need to be effective, affordable, and long-lasting. Generally, solutions that pay for themselves are most likely to be adopted. Farmers are more likely to embrace solutions if the measures adopted are clearly beneficial to them and provide positive benefits relative to their costs and trade-offs.

Any solution must address the needs of the target crane species and simultaneously address the needs of the affected farmer, landowner, or community while also being:

- Ecologically effective and sustainable
- Safe to the user
- Safe to the environment
- Simple to use
- Easy to access

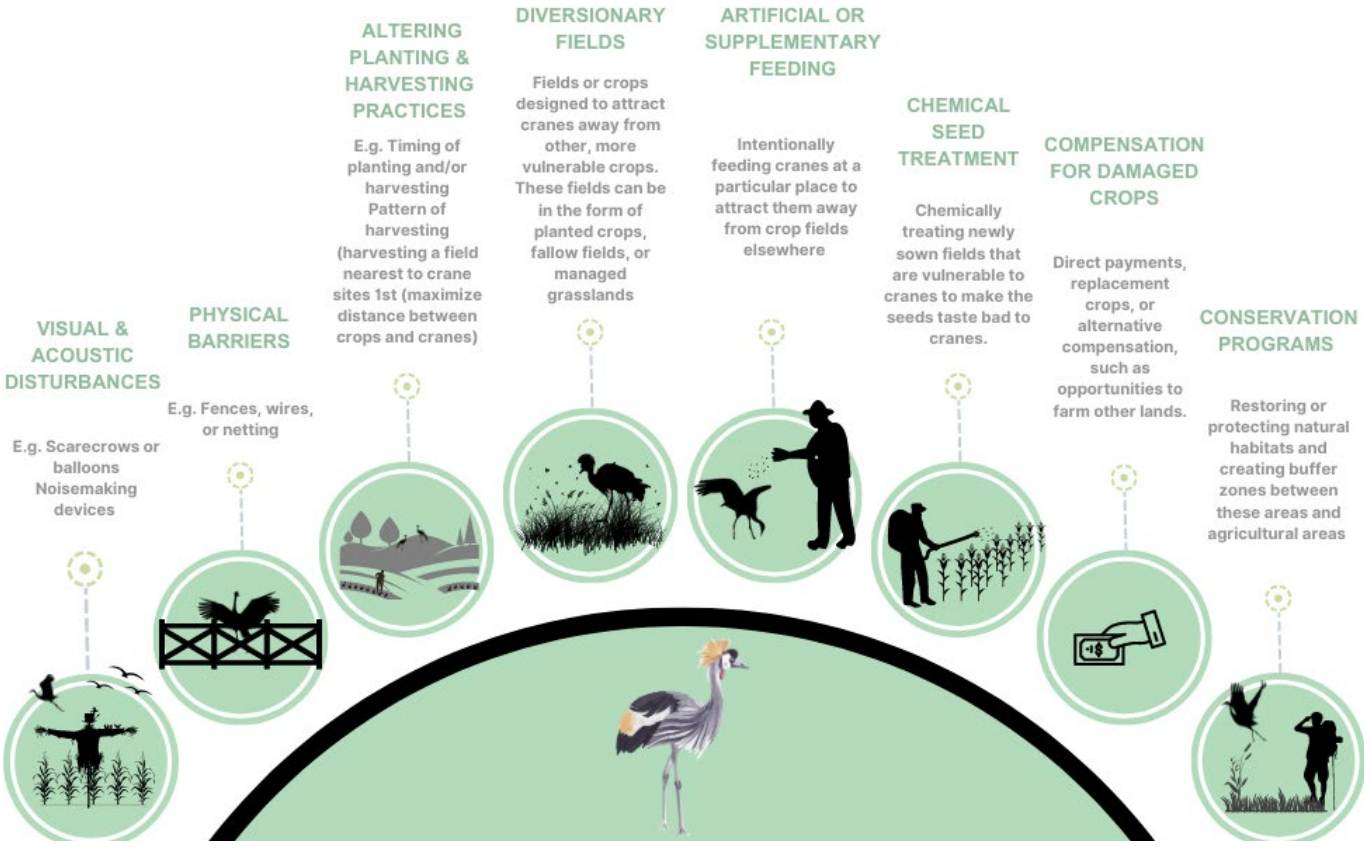

Figure 1: Solutions to reduce conflict between cranes and farmers on agricultural land

Catalyzing solutions through partnerships, ecotourism, and educational opportunities

Because cranes are so mobile, changing or improving agricultural or conservation practices in one area can lead to changes in crane distributions, affecting the situation in other areas. As a result, deciding the best approaches to reduce conflicts with cranes may require partnerships with various stakeholders. Such collaborations provide a way to explore different solutions that balance the interests of farmers, communities, and cranes. Partnerships with industry can also be important to reduce other man-made threats to cranes on agricultural land (for example, fitting bird flight diverters to reduce the risk of collision with overhead electricity or telephone lines), as well as to identify solutions to specific agricultural problems (for example, the development of seed treatment chemicals to make seeds unpalatable to cranes).

While cranes' attraction to agricultural fields can lead to conflict with farmers, it can also provide opportunities for farmers and other landowners to develop additional sources of income through ecotourism. Of course, successful ecotourism needs careful planning to ensure it does not harm both cranes and agricultural production and requires collaboration and open communication between local farmers and communities, conservation agencies, and government officials.

Education and awareness-raising is an important component of partnerships and ecotourism. Conservationists can assist communities in raising awareness and building pride in their natural resources, which can benefit ecotourism. This can also increase the willingness of farmers to consider changes to their agricultural practices to benefit cranes specifically.

Below are suggestions for different approaches which can be used to reduce conflict between cranes and farmers. Approaches range from simple, cheap tactics of scaring birds away, to more complex methods on a larger scale.

SUMMARIES OF NON-LETHAL SOLUTIONS

Approach: visual and acoustic disturbances

The simplest and most direct approach is using visual or sound disturbances timed to match when cranes are present in crop fields. In small crop fields or gardens, cloth strips, scarecrows, or brightly colored balloons may be placed in fields to deter birds. Shiny or reflective objects are also effective in small areas. Such scaring devices are most effective for breeding pairs or small groups of cranes in small fields or gardens; however, the birds may get used to them over time, so the methods used need to change regularly (for example, in terms of where they are sited, or the type of disturbance used).

Loud noises, like from firearms or noise-making devices, can also keep birds away and can be used for larger flocks and are best when protection is needed over days or a few weeks, but the birds may get used to the disturbance if the sound stays the same.

Blue Crane caught in a fence. Photo credit: George Archibald

Approach: altering planting and harvesting practices

Cranes prefer to feed in open areas with little or low-growing vegetation and that have abundant, accessible food. They are therefore attracted to crop fields that are newly sown or recently harvested, with leftover grain or tubers. Farmers can manage the attractiveness and availability of food for cranes by altering their planting and harvesting practices. Some methods which may be effective are presented in Table 2.

Whooping Cranes and tourists at Aransas National Wildlife Refuge, Texas, USA. Photo credit: George Archibald

Old compact discs strung between stakes are used to try to deter cranes from feeding in a field. Photo credit: The ICF/ EWT Partnership

Approach: physical barriers

Physical barriers include fences, wires, or netting, which stop birds from flying or walking into a crop field. These measures can be effective for very small areas, but it is important to consider the potential for birds and other animals to collide or become trapped in the barrier. Fences can be combined with visual deterrents like those mentioned in the previous section.

Blue Cranes and Ostriches feeding in open crop fields. Photo credit: Jim Harris

Approach: altering crop location relative to crane use patterns

Proximity to areas where cranes nest or roost is one of the most important factors influencing the likelihood of cranes using those fields (the closer the cranes are to the fields, the less energy they have to expend getting to them). If farmers know which fields are most at risk of damage, they can focus their efforts more efficiently. They could, for example, consider whether it might be possible to locate more vulnerable crops further away from cranes' preferred breeding or roosting sites (subject, of course, to the practical realities of particular fields being better for specific crops). Considering crane behavior, we know that:

- breeding cranes look for food close to their nests (so that their chicks can access food easily and the parents don't have to travel too far from the nest)
- non-breeding cranes range more widely (so altering the crop location may not be so effective in this scenario, and even during the breeding season, there will always be a proportion of non-breeding adult cranes that range widely)
- and a high density of cranes (perhaps because there are no suitable feeding areas elsewhere) may increase competition for food among cranes and force them to travel over a wider area (again making altering crop location less effective).

Uprooted corn plant with germinated seed still intact (Photo credit: International Crane Foundation)

Approach: conservation programs that sustain crane habitats and agricultural livelihoods

Programs that focus on restoring or protecting natural habitats for cranes and creating buffer zones between these areas and agricultural areas can also be used to avoid conflict between farmers and cranes. Such areas help to minimize disturbances from human activities while also providing a balance of habitat use between farmers and cranes. Developing conservation policies is an important aspect of this and can be done at a local level or a regional/ national level. Increasing nesting wetlands for cranes can also increase pollinator habitat and groundwater recharge, which can also be important to farmers.

Sarus Crane and two chicks. Photo credit: K S Gopi Sundar

Approach: chemical seed treatment to prevent damage

Cranes are attracted to newly sown fields where they can easily probe and pull up planted seeds or young seedlings. This damage can be prevented by chemically treating the seeds to make them taste bad to cranes. Although there is a cost for the seed treatment, this is often cheaper than the potential cost of crop damage. A particular advantage of this solution is that because the cranes still have access to the other food resources in the field (only the treated, vulnerable crop is inaccessible to them), they will often stay in the field foraging on other resources, and the risk of them moving on to other areas containing vulnerable crops is therefore significantly reduced.

Grey Crowned Cranes and cow. Photo credit: George Archibald

Grain is distributed by tractor to support large flocks of wintering Eurasian Cranes in the Hula Valley, Israel. Photo credit: Efi Naim

Approach: artificial or supplementary feeding

This approach consists of intentionally feeding cranes at a particular place to attract them away from crop fields elsewhere (this approach is also sometimes used to attract cranes for ecotourism).

Most artificial feeding happens in areas where cranes gather in large numbers in winter. While it can be an effective short-term approach to reduce crop damage, there may be risks for the cranes: high concentrations of cranes in a small area raises the chances of disease, and there is an increased risk to the cranes from human disturbance, dogs, poisoning, and collisions with telephone and electricity lines. Artificial feeding also risks attracting more cranes than would otherwise be present. It may also draw cranes away from their natural habitats, hindering their long-term conservation by giving the impression that natural wetlands and grasslands are not important for crane conservation.

Table 2: Summary of methods to deter or prevent crop damage by cranes.

Method	Suitable conditions for application	Cautions and caveats	Examples
Visual and acoustic disturbances (three suggestions)			
Scarecrows or balloons	Small gardens or fields where people can frequently attend to them	Cranes become used to it unless moved or changed	Gardens and small crop fields in Zimbabwe
Reflective flagging or tape	Small gardens or fields where wind keeps the material in motion	Cranes become used to it	Small gardens and fields in South Africa and Uganda
Noisemaking devices (pyrotechnics, propane cannons, firearms)	Small to medium fields or roost sites	Disturbance to livestock, people, or other wildlife; cranes become used to it; may require permits	Use of propane cannons in crop fields on staging and wintering areas in New Mexico, USA, and South Africa
Physical barriers (fencing, wires, netting)	Very small fields, gardens, or livestock feeding sites	Requires careful design and placement to be effective and prevent injuries to cranes and other animals	Fencing around livestock feed troughs in South Africa
Altering planting and harvesting practices (nine suggestions)			
Timing of planting and/or harvesting	All areas	Assess timing of crop vulnerability with timing of crane activity; timing options may be limited by soil and weather conditions that are best for crop germination, growth, and harvesting.	Earlier planting and maturation of alfalfa in New Mexico, USA

Method	Suitable conditions for application	Cautions and caveats	Examples
Pattern of harvesting (harvesting a crop field first nearest crane sites to maximize distance between crops and cranes)	All areas	May be limited by field availability, crop type, and climate	Grain fields in Idaho, USA, and south-eastern Russia
Direct grain harvest (harvesting grain immediately rather than windrowing)	All areas	Availability/cost of equipment may be limiting for some areas or crops	Direct combining grains instead of windrowing in Saskatchewan, Canada
Post-harvest field treatment (instead of preparing the field for the next crop immediately, leaving it unplowed so cranes glean pickings there rather than feeding on other crops)	All areas	May limit farmers' ability to prepare field for next crop	Delayed plowing of crop fields in Hula Valley, Israel; Laguna de Gallocanta, Spain; and Civilian Control Zone (CCZ) area of South Korea
Cropping practices: rotation (which prevents crane densities building up in one place), and no-till or fallow (which leave pickings to attract cranes away from other higher-value, more vulnerable crops)	All areas	Loss of production from fallowed fields; fallowing or rotating crops often a short-term solution	Rotation of corn with other crops not attractive to cranes
Leave some waste grain to attract cranes away from other more vulnerable crops	All areas	Small reduction in amount harvested	Managed fields in national refuge, New Mexico, USA
Crop varieties that either cranes don't like, or that can be grown during periods when cranes are absent	All areas	May limit farmers' choice of crop varieties	Switch from summer to winter cereal grains, Germany
Mowing, to enhance feeding potential for cranes and attract them away from other crops	Grasslands, hay land, or harvested crops with tall or rank vegetation	Do not apply where vegetation provides valuable cover for breeding cranes	Managed wet meadows in national refuge, Oregon, USA
Grazing or burning, to enhance feeding potential for cranes and attract them away from other crops	Grasslands or rice fields with tall or rank vegetation	Do not apply intensively where vegetation provides valuable cover for breeding cranes. Moderate levels of grazing across a short time period can be used to both control invasive species and create ideal vegetation structures for cranes.	Managed wet meadows in national refuge, Oregon, USA. Used extensively along the Platte River, Nebraska, USA, to create optimal vegetation heights and control shrub encroachment in wet meadows and lowland prairies for the benefit of Sandhill and Whooping Cranes

Method	Suitable conditions for application	Cautions and caveats	Examples
Altering crop location relative to crane use patterns	All areas	Options for moving crop fields may be limited for individual farmers, but may be more doable at a community level	Crop fields moved 5–15 km from roost areas: Daurski, Russia and Idaho, USA
Diversionary fields	Areas near roost or sensitive crops	Lost productivity (income) and land for crop that will not be harvested or only partially harvested. Funding, management, and locating diversionary field may be most effective when done at a community level.	Public and private fields, Idaho and New Mexico, USA, and Mecklenburg, Western Pomerania, Germany
Artificial or supplementary feeding (to prevent cranes searching for food elsewhere, on agricultural land)	Areas where crane congregations have developed but that provide insufficient natural food (staging or wintering area) and alternative habitats are lacking	Encourages high densities of cranes, putting them at risk of stress, disease outbreak or other catastrophic event; increases likelihood of cranes becoming used to people; may lead to overall increase in number of cranes present; may reduce likelihood of protecting or restoring nearby natural habitats.	Hula Valley in Israel, and Izumi and Hokkaido, Japan
Chemical seed treatment to prevent damage	Newly planted seeds	Chemical should be approved for use on crop and cranes, and be non-toxic to other wildlife. Few chemicals available and approved for use (primarily Avipel® for field corn in the USA; not approved in Europe). Approved uses vary by state or nation, crop, and bird species covered.	Field corn seed treated with Avipel® in Wisconsin, Michigan, and some other states, USA
Financial or other compensation for damaged or partially harvested crops	All crop types, best focused on areas most critical for cranes	Requires funding source and administration. May dilute or even negate prevailing attitudes toward wildlife (shifting to valuing wildlife as a commodity rather than for its intrinsic value); farmers may come to expect compensation	Crop damage payments, New Mexico, USA; compensation for leaving unharvested grain, Aquitaine, France
Conservation programs that sustain crane habitats and agricultural livelihoods (four suggestions)			
Zoning (e.g., buffer zones)	Areas around roost sites or critical nesting habitat	Limits ability to use land; often comes with no compensation for lost or reduced agricultural use	Buffer zones limited land use activities at Yancheng Biosphere Reserve, China
Easements	All areas	May limit ability to use land, but usually involves compensation	Easements protecting wetlands or grasslands, USA

Method	Suitable conditions for application	Cautions and caveats	Examples
Habitat restoration	Habitats most critical for cranes, and more marginal for crops	Cost may be high depending on extent of damage or total area needing to be restored	U.S. Fish and Wildlife Service, U.S. Department of Agriculture, Crane Trust, Nebraska, USA
Incentives to maintain habitat or farming practices beneficial to cranes	Habitats most critical for cranes	Cost and administration; needs to balance needs of cranes and agricultural livelihoods	Subsidies for creating crane habitat, European Union

CONCLUSION

Cranes serve as ambassadors for conservation across agricultural landscapes and are flagships for integrating biodiversity conservation into agricultural practices. Cranes have adapted to agricultural landscapes, which have become a key driver in global crane population dynamics. With agriculture benefiting cranes and farmers at times, causing a decline in crane populations at others, and causing conflict between cranes and farmers at other times, the relationship between cranes and farmers will be an intimate and integrated one as the agricultural landscape changes over time. Through this summary of the more detailed document Cranes and Agriculture: A Guide for Sharing the Landscape[1], we hope that we can find integrated, situation-specific, and landscape-level approaches that reduce threats to cranes and agriculture production, and find solutions that benefit cranes, farmers, and other biodiversity that too depend on these agricultural landscapes.

[1] found at https://savingcranes.org/2018/10/cranes-and-agriculture-a-global-guide-for-sharing-the-landscape-just-published/

Farmer and Wattled Cranes at Boyo Wetland, Ethiopia. Photo credit: George Archibald