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Damage to agricultural yield due to farmland birds, present repelling techniques and its impacts: an insight from the Indian perspective

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In India, nearly 65% of the people are directly or indirectly dependant on agricultural sector for economic survival. The annual income of farmers is significantly influenced by the yield of the crops, which is continuously decreasing due to natural phenomena and poor technological advancement. However, the particular attention should be paid to the damage caused by birds. While the exact measure of the loss in yield associated with birds is unknown, farmers integrate a number of traditional and conventional techniques to grow and store grains and fruits. Many of the used methods result in extinction of the rare birds. Therefore, there is a need to develop alternative techniques, such as dialogue with the farmers, grain storage authorities and experts in the fields of ornithology, agricultural sectors and field visits, to avoid irreversible harm to the Indian biodiversity. This research analyzes the loss of yield of crop due to birds, explores repelling techniques adopted by the farmers, and addresses the consequences of integrated methods on the bird biodiversity in India. The project unveils the importance an interdisciplinary approach to develop an eco-friendly technique to reduce the loss of both the birds and the crops.

Key words: bird species; biodiversity; agricultural yield; repelling techniques; crop yield; India.

Introduction

India has worldwide identification for its heritage, rich biodiversity and also attempt for the conservation of environments. There are four major Bird Sanctuaries in India protecting Bird Biodiversity which are Wild Ass Sanctuary-Gujarat, Western Ghats, Namdapha-Arunachal Pradesh and Kangchandzonga NP- Sikkim.In total 9782 of bird species found in the world

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and out of these 1179 species are found in India and 147 are endemic species (Chatterjee at el, 2006) which includes 14 critical, 15 endangered, 54 vulnerable and 64 near threatened (IUCN, 2010) (Fig. 1). There are two main reasons of the bird extinction is either humans activities which may be accidental or deliberate activities and decreasing availability of food.

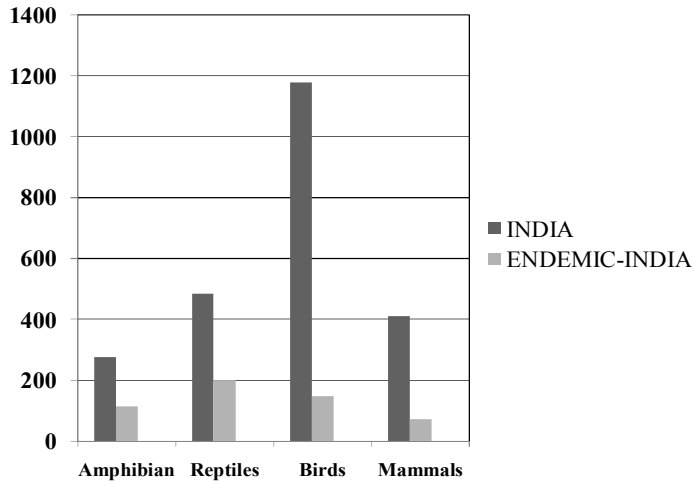

Fig. 1. Number of Endemic Species in India
Source: www.kerenvis.nic.in/isbeid/biodiversity.htm,Visited on 15 Oct 2010
Biodiversity Significance of North East India, Sundipto Chatterjee, 2006
Number of endemic birds is updated, 2010 from 140 to 147, Red List of IUCN from India Threaten Species

In India two- third of population is directly depending on agricultural sector for their livelihood which contribute the one fifth part of GDP of the country (Fig. 2). One fifth population of the world is living on only 2.4% of total land area of the world. In recent years crops productivity decreases in India due to various factors like poorly maintained irrigation system and current agriculture methods are neither economically nor environmentally sustainable (World Bank, 2008).

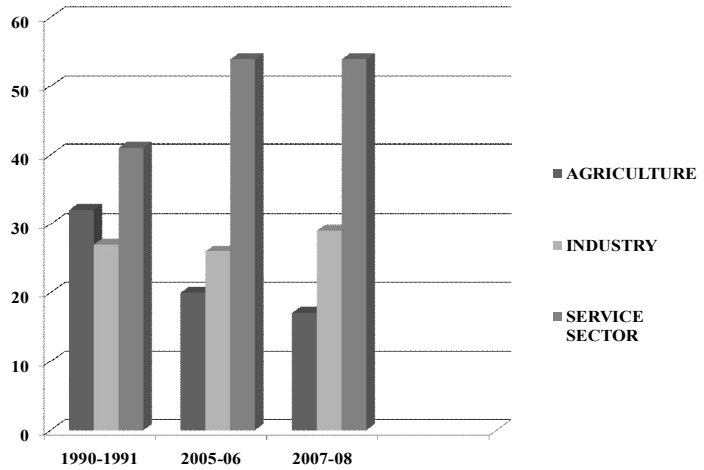

Fig. 2. Contribution of various sectors in the Indian GDP (Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India

The bird activities results the damage of crops and grains in grain stores and rice-shelling yards which vary state to state and area to area. In India most of such activities of birds are either advantageous or disadvantageous to the formers. Birds create negative impact on most of agricultural activities and some activities attract birds as special feeding opportunities (Ormerod and Watkinson, 2003). The food of the birds is of mostly three types which depend on grains, seeds, fruits, green vegetation of the crop plants and grasses, insects, other arthropods rodent, etc. found in soil, crops and other plants (O'Connor and Shrubb, 1986). Thus, birds plays duel role in Indian Agro-Ecosystem (Ali, 1949, 1971).

The systematic procedure to develop a robust statistical method for assessing bird damage to crop, particularly to fruits which provides accurate assessment data that can be used for scientific research and for evaluation of bird management method and devices (Saxton, 2006). Such methods are not yet developed and established in order to understand the intensity of the damage due to birds in different states and union territories in India.

On the other hand in order to reduce the damage of farmers and grain storage activity, various bird killing techniques are used such as chemical repellent, net, spike guards, traditional methods such as shooting the birds with gunshot, making sound with help of crackers in order to scare birds (Suubramanya, 1982). All these birds management methods are less effective and cause great damage to the certain threaten species and migratory bird which produce the adverse effect on conservation of biodiversity on a local, regional and global scale.

The purpose of this research is to understand the management which includes both the conservation of useful species and bird repelling techniques. The assessment of environmental impact of different bird repelling or killing technique, its affect on biodiversity and conservation measures is also important tool. In this investigative research, there is a great scope for methodological innovations as a result of which alternative systems of inquiry are being appreciated and operation is required in order to assess the field situation.

Through in this background paper we want to point out that there should be a rigid framework in order to avoid killing of birds and also the interdisciplinary research may be carried out with the help of experts in Ornithology, Zoology, Physics and Engineering in the direction to save the damage of farmers as well as save the life of birds and is also essential to identify the areas where the killing of birds carried out for different reasons and suitable mitigation measure should be taken by concerned authorities in order to save the lives of birds. Otherwise the insufficient mitigation measures for the conservation of threaten bird species which result in increase in their number from 140 to 147 and which may increase in future.

The main objectives of this paper are: (i) to review the magnitude of the problem of crop damage and food grain loss by various species of birds, (ii) to point out important problems and gaps in the knowledge in agro-ecosystem and bird biodiversity, and (iii) to suggest an interdisciplinary approach for future research in India in the field of applied agricultural ornithology.

Material and methods

The Study Area

Maharashtra is third largest state (in India) after Rajasthan and Madhya Pradesh, situated in north centre of Indian Peninsula which is located between $76^0$00' E longitude and $20^0$00' N latitude latitude (Fig 3). The study area is selected on the basic its importance for avian biodiversity and agricultural land and practices.

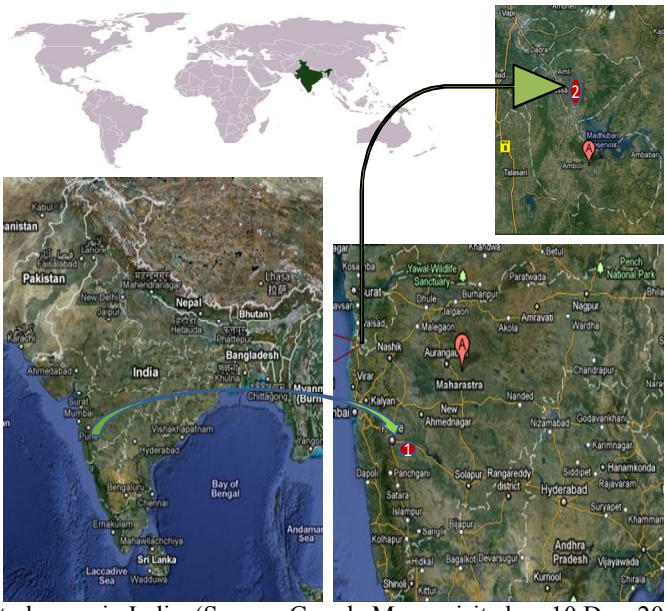

Fig. 3. Map of study area in India. (Source: Google Maps, visited on 10 Dec. 2010)

Field study and visits

The methodology of data collection is based on field evidence and analysis of the issues from the field experience of the study area Pune and Dadra and Nagar Haveli. This is one of the methods that helps identify certain gaps in the research field. The purpose of field studies and visits is to realize the need by learning-and-doing. Accordingly, weekly field visits were carried out to the farms during the ripening and sprouting seasons of the year 2009 and 2010 in the study area and farms and grains stores of village Randha from Dadra and Nagar Haveli and Indapur from Pune district were continuously monitored and damage assessment was carried out.

Questionnaires survey

The Questionnaire survey was conducted in 10 villages from the district Pune Maharashtra state and 5 villages from Dadra and Nagar Haveli. The questionnaire is distributed to 35 farmers from each village in order to understand the needs of the research and to evaluate the demand in the agricultural sector for statistical analysis of crop and grain damage due to birds. This survey was conducted after the harvesting season of year 2009 and 2010. The farmers who actually worked in the farms during these seasons are selected for the questionnaire. It is also an important tool for understanding the extent of

awareness about birds as part of the agro eco-system. Questionnaires on these issues were distributed among farmers, workers in grain store departments and other related elements of the society who depend directly or indirectly on agriculture for their food and livelihood. In this process we interviewed 175 farmers from Dadra and Nagar Haveli and 350 farmers from Pune district. The questionnaire was aimed at obtaining the percentage damage of crops and grains due to birds and learning the traditional and modern techniques used by farmers and workers in order to avoid the loss and their effectiveness.

Statistical Analysis

In order to analyze the result of survey, Delphi Method is use to calculate the impact of birds on the damage of agricultural yield This analysis leads to the conclusion that 73% farmers considered that damage produced by birds is serious problem and 85% expressed the need of modern ecofreindly bird scaring techniques Table 1. Most of the farmers expressed that this damage is dependent upon types of crops and seasons and it varies area to area while 40% of farmers considered that damage of crops and grains is about 35-60% and 25% farmers expressed that this damage is 0-35% in certain area (Fig 4) while 65% farmers consider that traditional techniques of bird scaring are not effective (Fig 5).

Table 1. Statistical Analysis of Result of survey

Question	Yes	No	Can't say
Are birds producing damage to the crops and grains?	73%	22%	5%
Is there a need of modern ecofreindly bird scaring techniques?	85%	2%	13%
Is damage percentage depending upon type of crops?	90%	8%	2%
Is damage percentage depends upon seasons?	93%	4%	3%

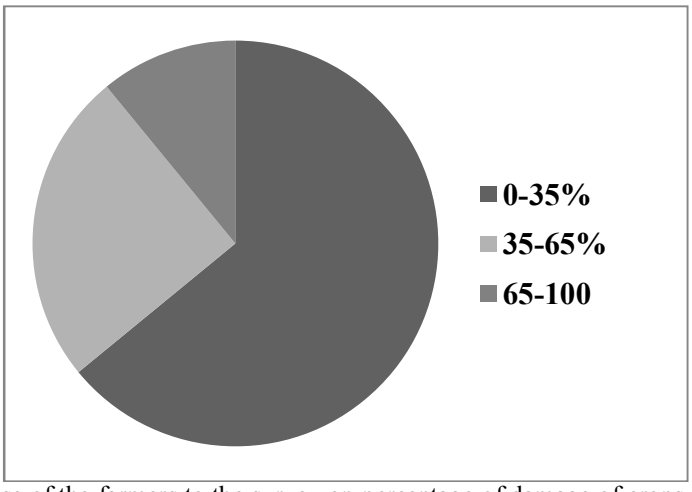

Fig. 4. Response of the farmers to the survey on percentage of damage of crops and grains due to birds from *Silvassa (DNH*, India) and *Indapur (Pune*, Maharashtra)

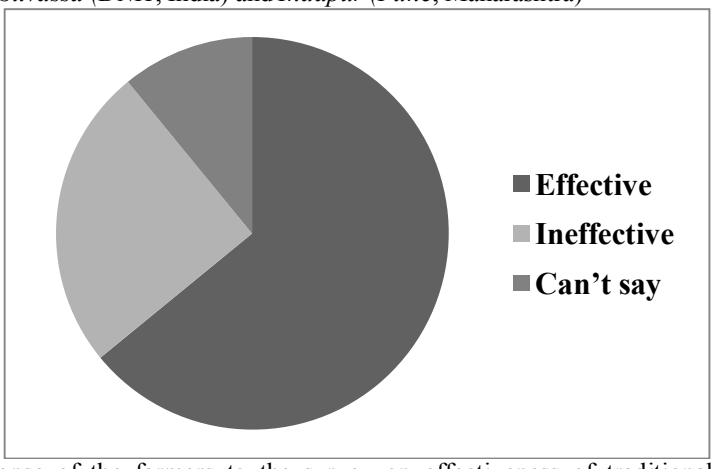

Fig. 5. Response of the farmers to the survey on effectiveness of traditional bird scaring techniques from *Silvassa (DNH*, India) and *Indapur (Pune*, Maharashtra)

Result and discussion

Case study

Many crops are damaged by birds, with a little knowledge available of actual economic loss is done by House Sparrows, House Crow, Common Myna, Asian Koel, Greater Coucal, Red – Vented Bulbul and Red Wattled Lapwing graze on the crop and most of the time uprooting them in search of wireworm and other soil invertebrates (Porter *et al.,* 1994; Boyce *et al.,* 1999; Tracey and Saunders-2003 and Dewar-2006). The great damage to the crop is noticed when they are in mature stage by the Baya and Munias during the

observations carried in Hyderabad, India and these birds with house crow can reduce the crop yield by more than 55% (Bruggers, 1986). In addition to above list of birds, the rose ringed parakeet, Psittacula Krameri is the most common and the destructive birds of India which inflicts huge damage to grain of standing crops, orchard fruits and vegetable crops.(Kushwaha and Prabhat,2004) A single Parakeet consume about 15.0 gm of sunflower seed per day. These birds can cause 10% to 40% damage and may cause 90% in isolated area in the field of sunflower where sunflower is an important edible oil seed crop in India. Continues research in Karnataka, India is going on evaluation of high yielding sunflower varies with less prone to bird depredation (Prakash at el, 2008). Birds like common Myna, jungle Myna, Brahminy Myana, jungle Crow and white cheeked Bulbul damage the crops of grapes in a great extent of grapes in Himachal Pradesh, India (Patyal and Rana, 2003). These damages can result not only limited to yield loss but also affects on grapes which decrease the quality of the wine (Loinger *et al.,* 1977). Thus bird pests constitute a significance limitation of productivity.

(Dhindsa and Saini, 1994) carried out research in this field in state of Punjab, which is one of the most important agricultural states in India. Almost 90% of the agricultural land is facilitated with sound irrigation system with adequate tube well and cannel arrangement and it produces 22% of country's wheat, 9% of rice and 6 % of cotton. According to estimation of damage potential it is found that loss due to bird is considerably large (Fig 6). These birds are also responsible for the activities like spoiling the site area, damaging the gunny bags and contaminated grains with their droppings in the grain stores. Such research indicates that the need of research in damage estimation in Maharashtra, which is also most important state in the field of agriculture and to develop the concerned measure. Indian Peafowl was accessed by (Sathyanaryana, 2004) in Tamil Nadu, and conclude that Peafowl consumed 0.99 gm/m^2 area/day and total damage is estimated 1.9 % paddy tiller/m^2 per day and he also suggests mitigation measure which is reflective ribbons as a bird scaring device which can save paddy, ground nut, onion and ladies finger.

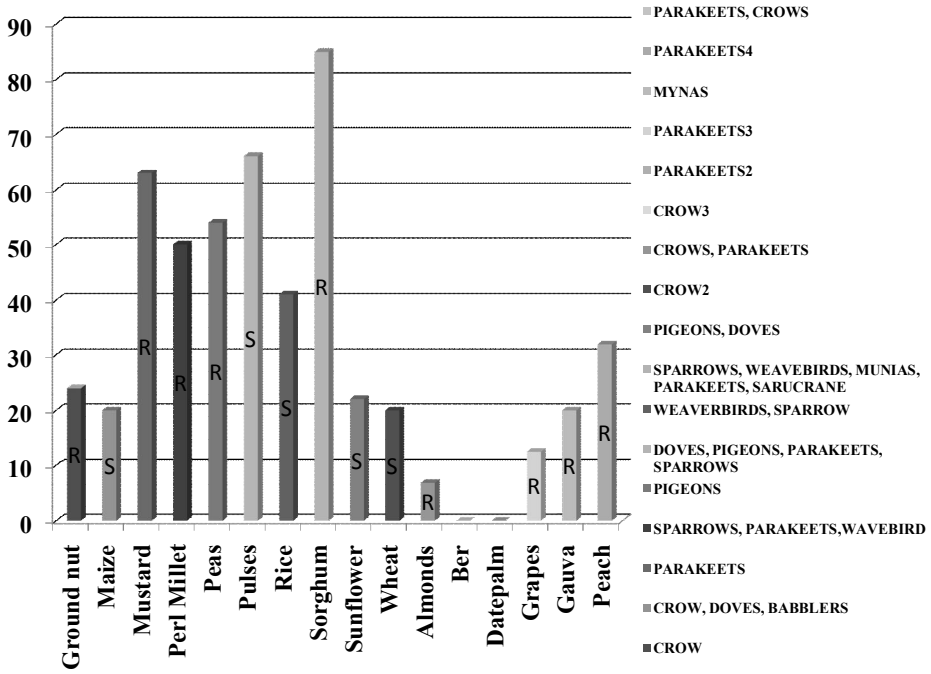

Fig. 6. Extent of damage made by different bird species to crops and fruits (Perl Millet is recorded -10-100; Sorghum is recorded-12-85 in Ripening Season), R-Ripening Season and S-Sprouting (Dhindsa and Harjeet, 1994) \

In one of the nebhouring state, Gujarat, it found that population of Indian Sarus crane (which is one of the global threaten species) has declined at the alarm which is considered as one of the pest by farmers and it produces damage in the range of 0.2 to 13.6% to the paddy crops (Borad *et al.,* 2001). He also expresses the need to educate the farmers regarding the conservation of this most endangered species. In order to solve such problems and protect the loss of biodiversity, there is need of accurate damage assessment and identification of the ecofreindly solution. Shivankar (2008) reported that Pune, Maharashtra and nearby area is known for its principal product of sugar cane and it is also known as sugar belt. Yield of sugar crop is affected by birds like House Sparrows, House Crow, Common Myna, Asian Koel, Greater Coucal, Red Vented Bulbul and Red Wattled Lapwing because of their abundance and produce damage to crop which is considerably large (Fig 7). This indicated that there is a need of development of proper techniques which can save the birds and also the loss of farmers.

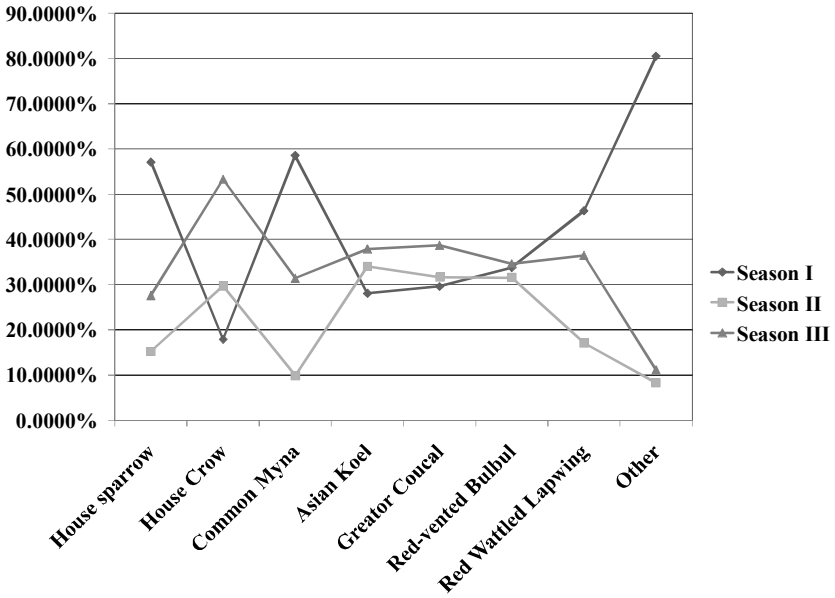

Fig. 7. Relative abundance of birds in various seasons in sugarcane beet fields in Pune, Maharashtra, India. (Season I-Winter (2005-06); II-Summer (2006); III-Winter (2006-07)) (Data source: Shivankar, 2008)

Bird scaring, repelling and killing techniques presently use to reduce damage of crops and grains.

The management of harmful birds consisted of number of techniques which is mentioned in Table 2. Out of these methods few were non-effective and most of methods were non-ecofreindly and produce direct harm to the biodiversity. These technique consisted of mainly different bird repellent technique such as visual repellent, chemical repellent, bioacoustics repellent, optical repellent.

Table 2. Existing bird repelling techniques used in agricultural sectors on India

Technique	Bird	Crops	Reference
Polypropylene pelene metallic shining ribbon	G	G	S. Suubramanya, 1982
The white cloth banging	Egret	Paddy	Kiruba et al 2007
Erection of Scare crows, noise-making devices like crackers and carbide guns with polythene bags	G	G	Subramanya, 1982
Chemical bird Repellents are use like Trimethacarb, Methiocarb and Curb	G	Broadcasting wheat seeds and ripening grains	Bruggers et al. 1984
Spraying of neem kernel powder solution	G	G	Suubramanya,1982
Pre- recorded distress call of parakeet (Bio-acoustic method)	Parakeet	G	Suubramanya, 1982
Killing and catching of birds	G	G	Singh and Dungan, 1955
Methicarb(4Methylthio)3, 5 xylyl-N-methyl carba-mate, a pesticide and Thiram (tetramethythiumram sulphide), a fungicide	G	G	P.SSandhu and Toor,1987
Poisonous chemical	G	G	Bhatnagar, 1976

G-Not specified

Killing most of the birds are illegal in India (Singh and Dungan, 1955) in spite of that it is strong belief among the farmers that Killing the birds is considered as a surest way to free from the problem of birds and they use techniques which consist of shooting, trapping, fumigation, poison baiting, egg and nest destruction, killing with the help of gun and catching them in trap. All these will produce the damage to threaten and migratory birds and also produce damage to the conservation of biodiversity. Killing the birds is not a proper solution of the problem and such an attempt is disapproved on the international background such as mass killing of *Quelea* in Africa and *Sturnus vulgaries* in Europe (Dhindsa and Saini, 1994). Importance of discussion about bird life in ecosystem is often neglected in the consideration of economic losses and present bird management programs are not implemented in the ecofreindly way because this nature of the damage, both spatially and temporally, is due to sporadic feeding behaviour and mobility of birds.

Present status of crop damage due to birds and control techniques in field area.

The damage to sorghum and pearl millet (*bajara crop*) is a major concern by birds like sparrows (different spp.), parrot, pigeon, etc. The sunflower is being mostly damaged by parrot, crows, and pigeon. The extent of damage varies as per location and area available for damage. In general 20-22 % damage is being noted on sorghum and bajara crop. However the sunflower damage extends to 25 to 65 % depending on the location of cropped area.

Agriculture and bird management in Maharashtra

Agriculture is one the main occupation in rural area of state of Maharashtra. The major crop grown in the state include Rice, Jowar, Bajra, Wheat, Pulses, Cotton, Sugarcane, Ground nut and Soybean, Turmeric, Onions and other vegetables. Maharashtra is famous for its fruit production. The major fruits produced in the state are Mangoes, Bananas, Grapes and Oranges, Nagpur and Nasik are the major producers of fruits which are supplied to various countries in the world every year that helps grow business of export. The damage of crops, grain and fruit which cannot be weighed estimated or calculated directly in the field. Fruit crops the greatest damage occurs close to harvest when workers are busy with harvesting and have no time to see the damage due to birds. In Maharashtra, there is no such scientific method still developed which can analysis the damage and save the farmers from such loss. This is the scenario for other states of India and neighbouring country. The above aspects of need of ecofreindly technique are expected to go a long way in exploring, validating and reinforcing in the field of agriculture, ecosystem and bird management techniques. There is need of methods which can assess loss of the farmers due to which degree of accuracy can be improved and established the proper way to solve the problem.

Conclusion

India is known for its rich biodiversity and agriculture. The present bird management methods have been found to have far reaching consequences on the agro- ecosystem. They are disadvantageous to both bio-diversity and agriculture as they are neither scientific nor eco-friendly and result in endangering bird species while not making much of a difference to avoid agricultural loss. It is also found that the techniques like drum sticking, models of scares (statues like man), reflecting ribbons, crackers and catapult *(Kavan)* are not efficient enough to manage the problem permanently. After several

observations it is concluded that bird repellent like neem powder and reflective ribbons are not effective for repelling the birds, though these techniques are ecofreindly. There is a need of interdisciplinary research in the development of ecofreindly bird repelling techniques. It is also concluded that visual estimation for the crops, fruits and grains damage is not accurate damage assessment process and there is future scope for research in the development of some scientific method for the assessment of these losses in India.

If the status of bird's habitat destruction and hunting pressure continues in the similar manner, then other birds could also join the ranks of endangered species. The major threat of bird is from habitat destruction, fragmentation and hunting. In addition to this pesticide poisoning is also one of the factors for bird extinction. The rigid framework should be made in order to avoid killing of birds and also the interdisciplinary research should be carried out with the help of experts in Ornithology, Zoology, Physics and Engineering which leads the decrease in damage of farmers and also increase in the life of birds. There is a great need of environmental impact assessment to estimate the agricultural zones of India affected by such damage. It is also necessary to identify the areas where the killing of birds carried out for different reasons and suitable mitigation measure should be taken by concern authorities in order to save their lives.

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