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Asian Elephants as Agricultural Pests: Damages, Economics of Control and Compensation in Sri Lanka.

Abstract

Despite growing attention to crop and property damage caused by the Asian elephant, uncertainty exists about the magnitude of this problem. This paper explores the nature and magnitude of this problem of Sri Lanka. An economic analysis of individual farmers' decisions to control elephants is provided. Government policies to assist farmers to cope with the elephant pest problem are assessed. Appropriate compensation schemes for farmers are seen as potentially more effective for conserving elephants in Sri Lanka than legal prohibitions on killing of elephants. Issues raised have wider relevance than merely to Sri Lanka or Asian elephants.

Asian Elephants as Agricultural Pests: Damages, Economics of Control and Compensation in Sri Lanka.

1.Introduction

While the Asian elephant (*Elephas maximus)* captures the imagination and affection of many people worldwide for its use or non-use economic values, this species inspires animosity and fear as an agricultural pest among those who encroach on and occupy its natural habitats. Several recent studies highlight the antipathy of the local farmers to Asian elephants. For Example, Tisdell and Xiang[1] describe the dissatisfaction of the farmers living near in the boundaries of the Xishuangbanna State Nature Reserve, Yunnan in China towards the elephants. Weerakoon[2] found that farmers and local communities in the Northwestern province in Sri Lanka display ingrained hostility to elephants and they are the focus of local animosity toward wildlife. Ramakrishnan, *et al.*[3] outline the fear of and distress caused by farmers and rural communities on the boundaries of the two elephant corridors, Sujalkuttai-Bannari and Kallar-Vedar settlements in South India. Aung[4] reports that the farmers in the vicinity of the Pidaung Wildlife Sanctuary in Myanmar consider elephants to be the most destructive species of wildlife. Moreover, rural communities on the border of the Way Kambas National Park, Sumatra, Indonesia complain bitterly about

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1 C.A.Tisdell and Z. Xiang, *Protected Areas, Agricultural Pasts and Economic Damage: Conflicts with Elephants and Pests in Yunnan*, 18 The Environmentalist, 109 (1998).

2 D.K. Weerakoon, Ecology and Ranging Behaviour of Wild Elephants and Human-Elephant Conflict in Sri Lanka (Unpublished Report), Department of Zoology, University of Colombo, Sri Lanka (1999).

3 R. Ramakrishnan, N. Sivaganesan, and R. Srivatava, *Human Interference and its Impact on Elephant Corridors in Sounth India, 18 Gajah,* 18(1997).

4 A. Aung, *On the Distribution, Status and Conservation of Wild Elephant in Mynamar*, 18 Gajah, 21(1997).

elephants, except where they have been eradicated.[5] This national park provides the home range for the Sumatran elephant (*E.m.sumatranus*), a unique sub-group of the Asian elephant.

The animosity of the farmers and rural communities in the vicinity of the protected areas and other nature reserves is an unfavourable portend for future elephant survival, particularly given the trend toward decentralised wildlife management throughout the Asian elephant's range. Under current conditions, most local farmers would eliminate elephants from their environment if given the choice.[6] Therefore, conservationists need to find ways to raise farmers' tolerance of elephants in Asia. This requires gaining a better understanding of elephants as an agricultural pest as well as exploring other means including adequate compensation for farmers. The Asian elephant has experienced a greater degree of habitat loss and fragmentation than its African counterpart. Consequently, the elephant populations in Asia have become concentrated in isolated protected areas and remnant forest habitats and depend for their survival in virtually all of Asia on the use of private land or non-protected land.[7] Elephants often extend their range into human settlements, commonly to feed on a wide variety of cultivated food and cash crops but also sometimes damaging food stores, water installations or fences and barriers, and occasionally injuring or killing people. Thus farmers are more likely to regard them as a dangerous

[5] P.J. Nyhus, R. Tilson, and P. Sumianto, *Crop Raiding Elephants and Conservation Implication at Way Kambas National Park, Sumatra, Indonesia*, 43 Oryx, 262 (2000)

[6] C.M. Hill, *Conflicting Attitudes Towards Elephants Around the Budongo Forest Reserve, Uganda*, 25 Envi. Cons. 244 (1998).

[7] R. Bandara, and C.Tisdell, Conserving Asian Elephants: Economic Issues Illustrated by Sri Lankan Concerns, Ch 17. In C.Tisdell (ed), The Economics of Conserving of Wildlife and Natural Areas, Edward Elgar, Cheltenham, England (2002) (in press).

agricultural pest and retaliate by injuring, killing or using deliberate measures to displace elephants.

Further reduction in the area of natural habitat available to the Asian elephant seems likely. At present 20 % of the world's population live in and around areas inhabited by the Asian elephant. With the current annual average growth rate of 2.7 % in Asia, the human population will be doubled within another three decades or so.[8] Thus human population pressure on the Asian elephant ranges will increase with a corresponding increase in the demand for new land for human use. Further, fragmentation and the loss of natural habitats of the elephant seems likely. The elephants continue to be in conflict with their human neighbours. This situation is difficult to resolve. Elephants are generally perceived by farmers as property of the state.[9] Farmers consider state institutions responsible for protected areas to be also responsible for control of the elephant and other wildlife. These institutions are generally ill equipped to do this and in turn are blamed by farmers for losses to crops and property. Elephants, like all other wildlife, have lost so much of their original habitat that they are now forced to invade the human communities in order to survive.[10]

In Sri Lanka, as elsewhere in the Asian elephant's range, the elephants are in conflict with their human neighbours in almost all their range.[11] They are also responsible for much crop and property damage in the vicinity of the protected area network of the

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[8] World Wide Fund for Nature, Species Status Report, World Wide Fund for Nature, Gland, Switzerland (2000).
[9] *Supra*, note 5.
[10] *Supra*, note 7.

country.[12] Santhiyapillai[13] concludes on the basis of a study conducted in System G of the Accelerated *Mhaweli* Development programme argues that crop depredation by elephants is the most common cause of human elephant conflict. De Silva[14] estimates that about 30-50 people are killed in Sri Lanka annually by wild elephants, while between 100-120 elephants are lost in the wild primarily because they interfere with agriculture. Desai[15] believes that the elephant pest problem in Sri Lanka is a direct outcome of the excessive changes in land-use patterns and the continued conversion of natural elephant habitat to human uses. Land-use patterns in the former elephant range in Sri Lanka have changed remarkably and natural habitat available for elephant conservation has undergone a marked reduction over the last hundred years or so.[16] During the pre-independence era, a considerable portion of the natural habitat of elephants was utilised for the establishment of plantation agriculture in the wet and intermediate zones of Sri Lanka. As a result, elephants were almost completely obliterated from the wet zone and became restricted to the dry zone areas of the country. During the post-independence period, development of large-scale agriculture projects, such as the *Mahaweli* Development, made it possible for people to farm in the dry zone, and as a consequence a large number of settlements were established in the dry zone.[17] This has led to a further reduction and fragmentation of available elephant habitats resulting in alterations in their access to food and water and disruption of elephant home ranges and movement patterns. This situation has

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[11] M.De Silva, *Status and Conservation of the Elephant and the Alleviation of Man-Elephant Conflict in Sri Lanka*, 19 Gajah, 1(1998).

[12] A.A. Desai, Conservation of Elephants and Human-Elephant Conflict, Technical Report, Department of Wildlife Conservation, Colombo, Sri Lanka (1998).

[13] C. Santiapillai, *Human-Elephant Conflict Management in Sri Lanka*, 2 Sri Lanka Nature, 5(1998).

[14] *Supra*, note 11.

[15] *Supra*, note 12.

[16] *Supra*, note 7.

compelled elephants to extend their range into human settlements and agricultural fields in and around the protected area network in Sri Lanka.

Despite growing attention to crop and property damage caused by the elephant around protected areas, uncertainty persists about the actual magnitude of the problem in Sri Lanka, as elsewhere in the Asian elephant range. Mostly non-economists and technical experts from the other disciplines claim that farmers universally exaggerate crop damage by elephants and other wildlife.[18] Other studies suggest that elephants and other megafauna are unjustly blamed for damage, and that smaller animals, such as rodents or primates, cause much greater losses over time.[19] The high variability of the crop damage caused by elephants and inadequate data bases hamper efforts to address this highly charged political issue. To understand farmers' complaints, the spatial distribution, frequency, extent and nature of crop loss must be examined. Moreover, the socio-economic factors, the status of public policies to assist farmers to control the elephant pest problem and resulting social welfare issues that shape local cropping strategies and perceptions of risk should be analysed. Precise measurement is needed so that leading conservationists can respond to human-elephant conflict (HEC) as a primary threat to elephant survival in Asia in general, and in Sri Lanka, in particular.

This paper explores the economic aspects of elephant pest problems and the individual farmers' decisions to control elephants as an agricultural pest. The nature

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[17] *Supra*, note 12.
[18] J.C. Daniel, *Conservation of Asian Elephant*, 19 Gajah, 1 (1996).
[19] S.W. Kotagama, Interaction its Nature and Trends, Proceedings of the Seminar on Conservation Plan for Elephants of Sri Lanka, United State Agency for International Development, Colombo, Sri Lanka (1997).

and magnitude of the agricultural damage and economic loss caused by elephants are examined in the context of a case study conducted in the Northwestern region in Sri Lanka. An economic analysis examines individual farmers' decisions to control elephants as an agricultural pest. The situation in Sri Lanka is used as a case study in assessing the status of government policies to assist farmers to control the elephant pest problem. The economic issues raised in relation to elephant crop damage in Sri Lanka are pertinent to other Asian countries, as well as to situations of other species of wildlife which cause damage for farming systems and crop production in the vicinity of protected areas and nature reserves.

2. Agricultural Damage and the Elephant Pest Problem in Sri Lanka

2.1. An overview

Crop depredation by wild elephants is a common problem across the entire elephant range in Sri Lanka.[20] However, this problem has been aggravated by the establishment of several large river diversions and irrigation schemes designed to develop commercially viable agricultural practices in the last three to four decades.[21] Fernando[22] argues that most of these development schemes did not pay adequate attention to the habitat requirements of the elephant in the adjacent nature reserves can have increased the severity of crop raiding by elephants. Desai[23] describes the level of agricultural damage caused by elephants in relation to the types of interface between human use areas and elephant habitats. He identified four types of interface: a) the

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[20] C.R. Thouless, Conflict Between Human and Elephants in Sri Lanka, Technical Report, GEF Project, United Nation Office, Colombo, Sri Lanka (1994).

[21] J. Jayawardene, *Elephant Management and Conservation in Mahaweli Project Area in Sri Lanka*, 17 Gajah 23 (1996).

[22] A.B. Fernando, *Recent Elephant Conservation Efforts in Sri Lanka*, 10 Gajah, 19 (1993).

areas where there are substantial boundaries between major human use areas and major elephant habitats such as *Mahaweli* project areas. The level of crop damage in these areas is generally low; b) the smaller human use areas in and around the non-protected areas of elephant habitats such as the western and northern boundary of *Minneriya-Giritale*. This is the most common interface and the intensity of crop raiding in these areas generally varies depending on the degree of habitat conversion and fragmentation; c) larger fragmented areas where the landscape is a mosaic of human-use areas and elephant habitats such as the northwestern region. The most serious crop depredation by elephants is reported in these areas; d) the small elephant pockets or islands amidst human-use areas. Such elephant populations are responsible for very severe crop raiding, especially when the remaining habitat is insufficient to support them.

De Silva[24] examines the distribution of crop depredation by elephants in a study conducted to assess the present HEC in Sri Lanka. In this analysis, secondary data such as the deaths of both humans and elephants collected at the divisional secretariat level, were used to describe the distribution of HEC. This study reveals that crop raiding is widespread in the northwestern region especially in the *Anurathapura* district. The other districts of this region such as the northeastern part of *Kurunagala* district and the Northwestern area of *Mannar* district also experienced severe elephant crop raiding. In the *Mahaweli* region, System C and D are critical areas of crop depredation by elephants. In the southern region, the agricultural damage from elephants was high in the *Moneragala* District and the eastern part of the *Hambantota* district. *Syambalanduwa, Galkiriyagama, Navagatthegama, Karuwalagaswewa,*

[23] *Supra,* note 12.

Galoya, Mhavilachiya are the divisional secretariat divisions also experienced a significant crop depredation problem by elephants.

Santiapillai[25] examines the major causes for crop and property damage caused by elephants in the context of HEC management in Sri Lanka. According to his analysis, four factors are responsible for elephant interference in agricultural activities in the elephant regions. These are: a) a rapidly growing human population, b) drastic changes in human land use patterns, c) loss of forest cover, and d) the ongoing civil strife in the country. The human population in Sri Lanka at the turn of the century was estimated to be 3.6 million, giving a crude density of 55 people per km^2. At that time, about 70 % of land was under some form of a forest cover. Today, the human population has increased to more than 19 million.[26] The area under forest cover has declined to about 20 percent and area under cultivation has increased substantially.[27] As a result, elephants and farmers have become incompatible neighbours in many parts of the Sri Lankan elephant range. They cannot live together without conflict where agriculture is the dominant form of land use.

Several studies have estimated the deaths of both humans and elephants in the areas where HEC prevails. The Department of Wildlife Conservation[28] estimates that a total of 1,163 elephant lost their lives in the wild between 1950 and 1970, of which 639

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24 *Supra*, note 11.
25 *Supra*, note 13.
26 Department of Census and Statistics, Statistical Pocket Book, Department of Census and Statistics, Colombo, Sri Lanka (1998).
27 Department of Census and Statistics, Statistical Compendium on Environment Statistics, Ministry of Finance and Planning, Colombo, Sri Lanka (1998).
28 The Department of Wildlife Conservation, A Preliminary Report on the Survey of Elephants in Sri Lanka, The Department of Wildlife Conservation, Colombo (1993).

(55%) were killed by farmers in defence of their crops. A total of 452 elephant deaths were reported between the early 1980s to mid 1990 in the north western and central provinces alone, of which 336 (or 74%) were killed by farmers.[29] Kem and Santiapillai[30] reported that at present between 100-120 elephants on average lose their lives every year due to crop damage caused by them. There are no proper records of deaths of farmers in relation to elephant crop raiding or crop protection practices of farmers. However, people are being killed by elephants for a variety of reasons throughout the elephant's range. De Silva[31] reports that on average 30-50 people are killed by wild elephants annually in Sri Lanka. According to Santiapillai[32] within the past seven years, over 500 people have lost their lives as a result of the conflict between humans and elephants. More men are killed by elephants than women and most of the fatal human-elephant encounters take place in the night. In all reported cases, the elephants responsible for causing human deaths were lone animals, presumably bulls.

In addition to these sectoral level studies cited above, a few case studies at the micro level have also been carried out to provide information on certain aspects of the crop depredation by elephants. Jayewardena[33] estimates the annual agricultural losses incurred by farmers in System G of the Accelerated *Mahaweli* Development Programme. According to his estimates, crop loss ranged from Rs.10, 000 ($106.4) to Rs 30,000 ($319.1) per farmer per annum. The farmers in this area predominately

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29 *Supra*, note 21.

30 E. Kem, and C. Santiapillai, Asian Elephants in the Wild, (2000 WWF Species Status Report) WWF-International. Gland, Switzerland (2000).

31 *Supra*, note 11.

32 *Supra*, note 13.

33 J. Jyayawardena, *Elephant and Mahaweli: A 15-Year Study*, 2 Sri Lanka Nature, 45 (1998).

cultivate paddy during two cropping seasons per year. De silva[34] estimates that the crop damage caused by elephants ranged between Rs. 5,000 ($53) to Rs 10,000 ($106.4) per cropping season per farmer in a sample of 200 farmers in the southern region during the *Maha* season (the main cropping season) in 1997. Munaweera[35] examines the effectiveness of crop protection measures used by farmers in the boundaries of the *Hadapanagala* wildlife sanctuary. This study found that the effectiveness of the most current crop protection measures used by farmers is deteriorating due increased resistance by elephants. Weerakoon[36] examined the nature of the crop protection practices use by farmers in a sample of four hundred and fifty farmers the northwestern region of Sri Lanka in 15 selected administrative divisions during the 1998/1999 *Maha* season. This study revealed that about 70% of the farmers in the sample practised crop protection measures. The most common methods utilised included guarding in a hut with stock of firecrackers. Some of the farmers also possessed shotguns.

2.2. A Case Study of Crop Damage, Control Measures and Incidence of Raiding by Elephants

To understand better farmers' complaints and their decision to control elephants as an agricultural pest a six week field study was carried out from 14th July to 30th June 2001 by one of the authors of this paper in the *Galgamuwa* divisional secretariat division in the northwestern region in Sri Lanka during the post-harvesting period of the 2000/2001 *Maha* season. A random sample of 300 farmers was chosen from six

[34] *Supra*, note 11.

[35] D.P. Munaweera, *Handapanagala: A Study in Human-Elephant Conflict Management*, 2 Sri Lanka Nature, 68 (1998).

[36] *Supra*, note 2.

selected villages in three *Gramaniladari* Divisions (the lowest local government administrative unit in Sri Lanka) on the basis that they experienced a high level of crop damage as estimated by Desai.[37] Three of these villages in the sample (*Karuwalagas wewa, and Raswhera, Meegalawa*) are located within the northern boundary of *Wilpatthu* National Park and the other three (*Galkiriyagama, Makulawa and Itharandeniya*) are adjacent to it. The Northwestern region supports a comparatively large elephant population of around 1500 animals.[38] However, there are only a few protected areas in this region and they are not large enough on their own to support an elephant population of this size. Data were collected by means of questionnaires, informal interviews and discussions. Supplementary information was obtained from Weerakoon.[39]

In order to understand the aspects of the issue of elephant crop raiding in the study area, farmers were asked to respond to a series of questions. These questions were asked to gather information about the vulnerability of various crops to elephants, the impact of crop raiding on different farming practices, the extent of crop damage caused by elephants, the nature and the effectiveness of crop protection methods, and farmers' general perceptions of the elephant.

Seventy seven percent (77%) of the respondents believed the elephant pest problem had grown worse over the last ten years. The rest of the respondents reported that it has been stable and the incidence of elephant crop raiding was frequent. A total of 24

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[37] *Supra*, note 12.

[38] M. De Silva and N. Attapattu, Alleviation of Wild Elephant-Human Conflict and Conservation of Elephants in the Northwestern Region of Sri Lanka, (Mimeo) Department of Wildlife Conservation, Colombo, Sri Lanka (1997).

[39] *Supra*, note 2.

different crops were reported as being cultivated by farmers in the sample. These crops include paddy, maize, millet, sorghum, green gram, soybean, cowpea, mustard, cassava, beans, green chilli, banana, coconut, and a variety of local vegetables. For the purposes of this study, we concentrate on the crops people consider central to their subsistence, namely paddy, green chilli, banana, maize, cassava and mango. Farmers were asked to rank these crop varieties in descending order according to the degree of damage that they thought was caused to these crops by wild elephants. In this ranking process, they were also asked to consider their experiences during the last five years of elephant crop raiding. Table 1 presents the farmers' ranking of the crop damage caused by elephants and the frequency of such crops being grown.

Table 1: Farmers' ranking of crop damage by wild elephants

Crops	Rank according to amount of damage caused	Rank according to frequency of cultivation
Paddy	1	1
Green chilli	6	2
Banana	2	3
Maize	3	4
Cassava	4	5
Mango	5	6

Paddy, banana, and maize were considered to be the most vulnerable crops. However, an important consideration is whether particular crops are more vulnerable to attack by wild elephant than others. There are a number of important factors that need to be considered, including the stage at which a crop suffers damage, the diversity of the farm, feeding habits of the individual elephants, the size of the elephant herd, time of the day and month of the year or cropping season. It is known that elephants raid crops throughout the year but this is intensified during certain months. Elephants

usually raid paddy fields in January when the grain is maturing and continue their raids up to April until harvesting is completed. During this period, other cereals and vegetables are grown on high grounds and in *chenas* (temporarily cleared areas in the forest), and these are also raided. After the paddy harvest, cash crops such as green chilli and onions are grown in paddy fields. Elephants raid these crops during the period of April to September. Bananas are attacked at all stages of development. Mango trees are attacked during the fruiting seasons, May-June and November-December. Elephant also attack the permanent crops, such as jackfruit and coconut particularly when other crops, are not available on their usual raiding routes. Of the elephants causing damage, 43% were solitary bulls, 38% were bull groups, 19% were herds. Most of the attacks took place between 1900 and 0100 hours and in the early hours of the day.

The extent of crop damage caused by the elephant was assessed in relation to three major farming practices. These are: home gardens, lowland cultivation (agricultural practices undertaken in irrigated farming fields in lowland areas) and *chena* cultivation (agricultural practices undertaken in temporary farming fields created for only two to three cropping seasons by clearing forest and bushland in the highland areas). The links between the issues of land scarcity and vulnerability of elephant crop raiding was examined in relation to socio-economic conditions of the farming families. Most of the farmers in the sample were small-scale and usually belonged to a lower income category. Most of them lived under difficult conditions with no proper education or health facilities. Only a small percentage of young farmers have their own farming fields. Most of the farms either belong to their parents or are illegally occupied, state owned lands. Fragmentation of the existing farming fields and land

scarcity was reported to be one of the major issues that influenced family disputes, alcoholism and crimes in this area. The farmers are blamed by the government and local authorities for not taking any serious action to resolve these problems.

The average size of land holding by a farming family in the study area is about 1.28 hectares, of which about 32% is represented by c*hena* land. The vulnerability to crop damage in *chena* cultivation is reported to be little higher than for the other two farming practices. This is because *chena* cultivation mostly takes place either in forest patches adjoining human settlement in the highland areas or inside the protected areas. The mean extent by type of farming fields per farming family and the value of crop damage caused by elephant according to major farming practices are presented in Table 2.

Table 2: The mean extent and the value of crop damage caused by elephants in relation to three different farming practices, 2000/2001 *Maha* cropping season.

Major Farming practice	The distribution of mean extent of the farming fields (in hectares)	Mean extent of crop damage caused by elephants	Mean value of crop damage per farming family (in Rupees)
Home garden	0.21 (16%)[a]	0.03 (14%)[b]	2863.00
Low land	0.66 (52%)	0.15 (23%)	5172.00
Chena	0.41 (32%)	0.12 (29%)	4014.00
Total	1.28 (100%)	0.30 (23.4%)	12049.00

Note: a) % of the total size of the farming field
b) **%** of the mean size of the respective farming practices

There were no major complaints about crop damage caused by other wildlife in the areas. The general impression of the farmers in the study area is that ordinary agricultural pests such as insects or other wild animals such as wild pigs, rats and monkeys can easily be managed with less effort and at a less cost. However, elephants

are not easy at all to control and they are more destructive. The farmers also explained the reasons why was low crop damage recorded in home gardens in this area. Home gardens occur in the same location as human settlements. Therefore, elephants are not inclined to risk this type of crop raiding, as the chance of farmer retaliation is definite in such locations. The farmers believe that elephants are intelligent animals and they well understand human movements and they often raid crops by avoiding the artificial barriers erected by farmers.

Strategies used by farmers to reduce crop raiding by elephants range from individual and household efforts to those that require community participation or outside support. Farmers in the sample were asked to give details of the methods they employ to deter wild elephants from destroying their crops. The majority of farmers reported they relied on “scaring and chasing” methods to control elephant crop raiding in the study area. They also stated that guarding of their own fields is one of the most effective methods in preventing the elephants entering their farming fields. Huts or watchtowers are constructed along the boundary of the farm where elephants frequently enter farming fields. When elephants are spotted, farmers use a combination of loud noises, including yelling, firecrackers, hitting metal objects and cracking whips. Bright lights, including flaming torches and powerful flashlights, are also used. Direct contact with elephants is less common, but objects are thrown and some farmers move close enough to use whips. These methods have reportedly become less effective over time. This is because, the crop-raiding elephants soon learn to ignore these deterrents and develop resistance to crop protection measures. Consequently, elephants have developed no fear of such control measures and continue to raid the cultivated fields for easy fodder.

The extent of use by farmers of methods such as poisoning, shooting (with firearms) and trapping to control elephant crop raiding in this study area is unclear. Farmers were reluctant to reveal the details of the use of these methods because the elephant is a protected species. Killing an elephant is an unlawful act; it can result in the accused being imprisoned or fined. Nevertheless, farmers do use such measures to control the elephant in this area. Weerakoon[40] revealed that this region recorded the highest mortality of elephants in Sri Lanka between 1990-1999. According to his estimates, 341 elephant deaths were recorded in this area during this period, of which 224 (66%) were male elephant (which included 12 tuskers), 68(25%) were female elephants, and 30 (9%) elephants were undetermined sex owing to degradation of the carcass. The main causes of death were gunshot injury (70%) followed by electrocution (21%), accident (4%) and land mines (3%).

The incidence of crop raiding attempts by elephants was used as an indicator to evaluate the effectiveness of the damage control methods used by the farmers in relation to main farming practices. The relative effectiveness of these methods were examined by comparing the number of incident of elephant attack with the use of control methods and otherwise. A summary of the main findings for the incidence of crop raiding attempts by elephants is presented in Table 3. A total of 224 (74%) farmers in the sample used some form of a crop protection to safeguard their crop cultivation, of which 135 (66%) still experienced crop damage. Altogether a total of 181 (60%) farmers experienced crop damage regardless of whether crop protection measures were used or not. In other words, the crop protection measures used by the

[40] *Supra*, note 2

farmers have failed to prevent elephants entering their farming fields for crop raiding to a considerable extent.

Table 3: The incidence of elephant crop raiding attempts in relation to three different farming practices and the relative effectiveness of crop protection methods (n =300)

Major Farming Practices	Crop protection measures used		No crop protection measures used		Total incidence of crop raiding
	Number of farmers	Incidence of crop raiding[1]	Number of farmers	Incidence of crop raiding [2]	
Home garden	26 (12%)	16 (62%)	49 (65%)	14 (29%)	30 (16%)
Low land	136 (61%)	82 (70%)	14 (18%)	23 (67%)	105 (58%)
Chena	62 (27%)	37 (59%)	13 (17%)	09 (69%)	45 (24%)
Total	224 (74%)	135(66%)	76 (26%)	46 (48%)	181 (100%)

Note: 1 The incidence of elephant crop raiding as a percentage of the number of farmers who used crop protection measures in relation to different farming practices. 2.The incidence of crop raiding as a percentage of the number of farmers who did not use crop protection measures in relation to farming practice.

The other important aspect noticed in this study is the importance of the stakeholder's perception of the wild elephant as a pest or an asset. Differences in perception among the stakeholder groups can easily exist and such situations can easily lead to miscalculations of the management action required to conserve or eliminate the wild animal in question.[41]

A marked difference was observed to exist between the perceptions of farmers and in local wildlife officials in the northwestern region in general and the study area in particular. The local wildlife officials unanimously believed that the current elephant population should be maintained intact in this region for ecological reasons. They argued that if elephants in this area were fragmented into small groups, the elephant

would become more vulnerable to extinction due to demographic, environmental and genetic stochasticity. They also believe that this ecological objective can easily be achieved within the limits of existing national parks in the region if human encroachments into these parks are terminated. In contrast, most farmers in this area view elephants as a major threat to their livelihood and consider them as an agricultural pest. Moreover, they unanimously supported the idea that at least half of the current elephant population in this area should be removed to reduce the pressure on national parks and to protect their agricultural fields. This difference in the perception of farmers and local wildlife officials presents a dilemma in determining the status of the elephant as an agricultural pest or an environmental resource. This also obstructs the formulation of a management plan to mitigate the conflict between elephants and the local communities in this area.

3. Economic Analyses of Individual Farmers' Decision to Control Elephants as an Agricultural Pest

Most farmers in the vicinity of protected areas and other nature reserves regard the elephant as an agricultural pest, liable to damage their crops and imperil their livelihood. However, these farmers may consider elephants positively if they remain in their natural habitat or cause very little agricultural damage.[42] Moreover, such positive attitudes of farmers towards the elephant may be influenced by the cultural or religious affiliation of this species of wildlife. For instance, still in some parts of Asia, in predominately Hindu and Buddhist cultures, the elephant has an important place in

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[41] C.A. Tisdell, *Wildlife: A National Asset or a Pest to be Managed?*, In Department of Science and the Environment, Environmental Economics, A.G.P.S., Canberra 79 (1979).

[42] *Supra*, note 1.

their history, religious beliefs, folklore, mythology and ceremony. Nevertheless, non-farming communities such as tourists, nature-lovers and conservationists world-wide consider the elephant to be a valuable resource for recreational purposes, for its contribution to biological diversity and for non-use values. Thus the individual farmers' decision to control the elephant as a pest certainly would conflict with the interests of non-farming communities who regard the elephant as valued resource. However, a problem is how these two broader objectives can be reconciled.

Tisdell and Xiang[43] present an economic analysis based on Kaldor-Hicks criterion in determining an economically optimal level of control of a population of a species of pest that is also an asset. In this analysis they argued that the optimal level of the population of a species, to maximise its net social economic benefit (its value as an asset less its economic damage as a pest) is a function of its population taking into account the cost of varying the level of its population. Thus, if a species is on balance a pest, at its current level of population, it is optimal to reduce its population to the level where the marginal cost of the value of reduction in its population equals the marginal reduction in economic damage caused by a population of wildlife less any loss in value experienced by those who favour an increased population of the species. Figure 2 illustrates the application of this analysis in the context of elephant conservation.

[43] C.A. Tisdell and Z. Xiang, *Protected Areas, Agricultural Pest and Economic Damage: A Study of Elephants and other Pests From Xishuangbanna State Nature Reserve*, Working Paper No.16, Department of Economics, The University of

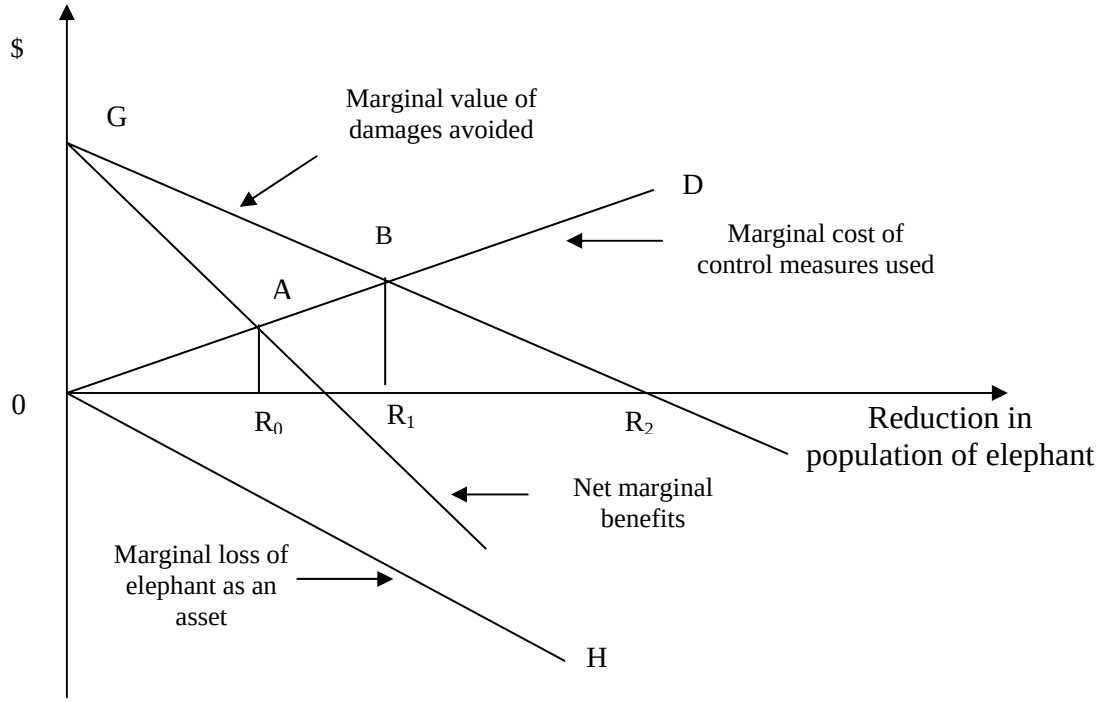

Figure 1: Determining the socially optimal level of control of elephant populations using the Kaldor- Hicks economic criterion (Based on Tisdell & Xiang, 1995)

The line OABD represents the marginal cost of reducing the elephant population and holding it at its reduced levels. Line GB represents the marginal value of damage avoided as a result of this reduction of elephant population. The marginal loss for people who consider the elephant to be an asset is depicted by line OH. The line GA represents the marginal net benefit to the community in the reduction of the number of elephants present on farming lands. Line GA is found by subtracting the relationship OH from GB. The Kaldor-Hicks socially optimal level of a reduction of elephant population therefore is denoted by the point R_0, that level for which the marginal net benefit of the reduction equals its marginal cost. However, in this analysis the authors point out that the optimal level of reduction will be higher than the point R_0 if that particular species of wildlife is solely regarded as an agricultural pest. In this case the optimal level of reduction of the elephant population is R_1.

Queensland, QLD 4072, Australia (1995).

The available evidence suggests that the farmers who suffer agricultural and property damages in the boundaries of nature reserves in Asian elephant ranges consider the elephant as an agricultural pest or dangerous nuisance.[44] The negative attitude, the unpleasant experience and economic damage resulting from elephant crop raiding often provides the necessary motivation for farmers to treat on crop-raiding elephants harshly. The farmers' decision to control such problem elephants as an agricultural pest or otherwise is largely economic and does not significantly differ from their decision to control any other ordinary agricultural pests. The selection of crop protection methods and the level of reduction of elephant numbers present on the farm is determined by the individual profit maximisation attitudes of the farmer. The farmers' preferred level of reduction of elephant often exceeds the socially optimum level of reduction. Therefore, to regulate farmers' decisions about elephant control, the wildlife authorities rely on existing laws that restrict the farmers' selection of elephant control measures. This compels farmers to undertake relatively ineffective crop protection measures in defending their crops if they decide to control elephants.

The basic economics of decisions by individual farmers to control elephants can be illustrated by Figure 1. If cost curve 1 control applies, no control is optimal by the individual farmer. If cost curve 2 applies, a reduction in the presence of elephants by x_1 maximises the farmers' net gain. The first situation is more likely to prevail if control techniques are relatively ineffective, if the value of crop damage is low, or if elephant raids on crops are infrequent, other things equal. The survey results reported in Table 3 seem to accord with this statement. Those farmers not adopting measures to

[44] *Supra*, note 1, *Supra*, note 3, *Supra*, note 4.

protect crops against elephant raids had a lower incidence of crop raiding attempts by elephants (48%) compared to those taking control measures, the latter reported an incidence of attempted raids of 66%. The loss avoided function would be lower in the former case than the latter case, and control would be less likely to be optimal in the former case, other things remaining equal.

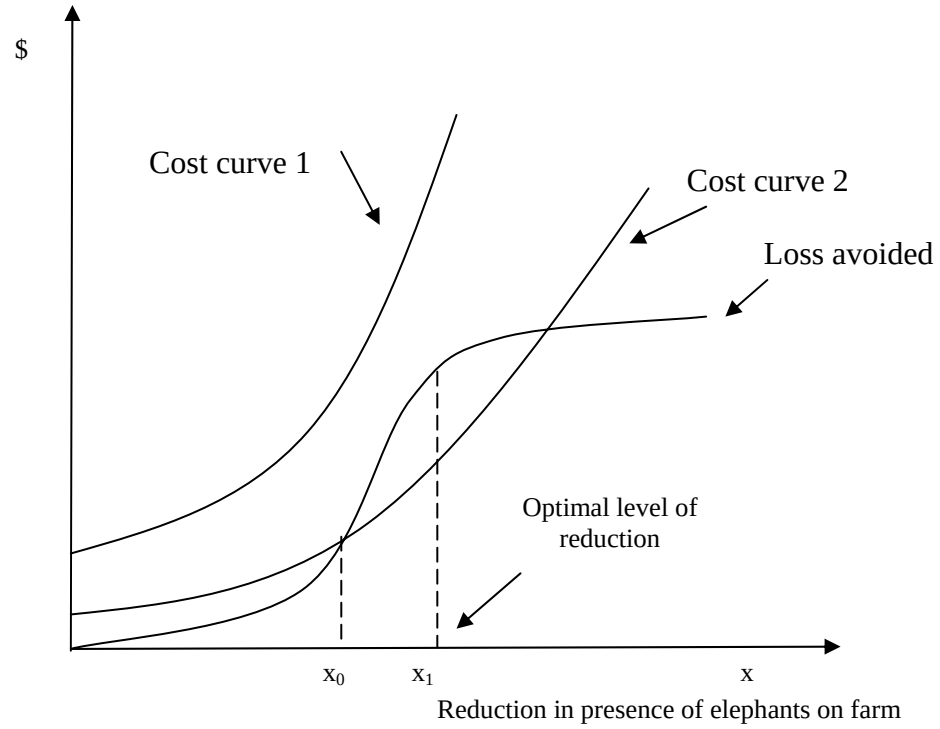

Figure 2: Individual farmers decision to control elephant as an agricultural pest

The optimal control condition can be further elaborated mathematically. Assume that *x* represents the reduction in the presence of elephants on a farm. Then the net benefit of control can be expressed as

$$R = f(x) - C(x) \qquad (1)$$

where R is net benefit to the farmer, *f(x)* is the value of loss avoided by the farmer and *C(x)* is the cost of control measures.

For control to be profitable, *f (x)* must exceed *C (x)* for some value of *x*. If there is a positive profit-maximising level of control, then *x* should be chosen so that,

$$f'(x) = C'(x) \qquad (2)$$

that is, so that the marginal net benefit from reducing the presence of elephants on the farm equals the marginal cost of doing this. In addition, the second order condition for a maximisation should be satisfied.

Now, total cost will usually consist of a fixed and variable cost component. Thus;

$$C(x) = A + g(x) \qquad (3)$$

where *A* is the fixed or start-up cost and *g(x)* is the variable cost. Other things being equal, *C(x)* is more likely to exceed *f(x)* for all *x* the larger is *A* or the greater is *g(x).* Alternatively, the lower is *f(x)*, the value of loss avoided by the farmer, other things equal, the more likely that no control is profitable from the point of view of the individual farmer.

If the control methods are unprofitable or relatively ineffective in achieving the expected level of reduction of elephants in e farms, it is difficult to expect farmers to have positive attitudes towards the government policies for elephant conservation. For instance, farmers frequently express their anger towards the injustice of receiving little remuneration should they be injured or killed by an elephant, while facing stiff jail terms and fines if they hurt elephants. When there is significant agricultural damage or loss of life occurs, farmers near the boundaries of the nature reserves believe they should compensated for bearing the brunt of the cost associated with having large populations of elephants in the vicinity of their agricultural fields and settlements. However, at present, many countries in the Asian elephant range do not

have regular systems or public policies to assist farmers to protect their crop production from wild elephants or to compensate them for the crop losses and human injury or deaths caused by elephant attacks.[45] Some countries, such as Sri Lanka have some programs to compensate for crop damage and human injury or deaths caused by crop raiding elephants, but they are perceived by farmers to be inadequate. Therefore, it is a timely to review compensation issues.

4.The Present Status of Government Policies to Assist Farmers Adversely Affected by Elephant Damage in Sri Lanka.

In Sri Lanka, a comprehensive national policy for elephant conservation and mitigation of human-elephant conflict has yet to be developed. Desai[46] sees the absence of a such policy and clearly defined management strategies as the major reasons for unresolved HEC in the country. However, several government agencies, such as the Department of Wildlife Conservation, *Mahaweli* Authority and the Department of Social Welfare have been involved in polices to alleviate elephant crop raiding and the resulting HEC over the last three decades.[47] Most policy actions taken by these organisations seem to be transient measures and have been taken largely to tie over a particularly critical time on an *ad hoc* basis.[48] Kotagma[49] summarises actions taken by the Department of Wildlife Conservation (DWC), the primary agency in charge of conservation in Sri Lanka to assist farmers in the HEC affected areas since the mid 1970s. These measures include: a) capturing and translocating problem elephants known to be habitual crop raiders or the cause of human deaths and

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45 *Supra*, note 8
46 *Supra*, note 12.
47 *Supra*, note 21.
48 *Supra*, note 11, *Supra*, note 2.

injuries, b) promulgating protected areas, c) establishing deterrents to elephant movements such as the erection of electrified fences, elephant–proof trenches to keep elephants away from human settlements and cultivated areas, d) rehabilitating elephant drives and traditional migratory paths, and e) compensating for loss of life and damage to crops and property.

The overall effectiveness of these actions is still largely unknown. So far no sustained effort has been made to evaluate the effectiveness of these actions. However, some useful information con be found in the progress reports and internal evaluations carried out by the staff members of the DWC. Fernado[50] believes that most of these actions have been in the main ineffective. Weerakoon[51] observes that the problems experienced by the farmers in HEC affected areas have remained unchanged over the last two decades. Crop depredation by wild elephants remains a major problem. De Silva[52] argues that the actions of DWC would be far more effective if they were part of an overall plan for elephant conservation.

The general impression of the policy makers and other interested parties is that Sri Lanka needs new policies and programmes for elephant conservation and mitigation of farmer-elephant conflict. Such policies must address adequately the payment of compensation to farmers as recompense for the economic losses of the agricultural and property damage caused by raiding elephants. Otherwise, farmers will not tolerate elephants near or on their farms. Most farmers in the HEC affected areas are small-scale and have low-incomes. Therefore they require consistent and quick recovery

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49 *Supra*, note 19.
50 *Supra*, note 22.
51 *Supra*, note 2.

plans for their economic losses and agricultural damage caused by elephants. Elephants and other wildlife will decline and eventually disappear from agricultural areas in Sri Lanka, unless the damage they cause is adequately and promptly compensated for. The other actions such as the construction of electric fences, translocation of problem animals and rehabilitation of elephant drives could be used as part of medium-term solution to the elephant pest problem. The long-term conservation of wild elephants and mitigation of the elephant pest problem in Sri Lanka calls for integrated policies involving both public and private landholders.

The DWC of Sri Lanka manages the only scheme in the country to pay compensations for the farmers for loss of life, injuries, crops and property damage caused by elephants in HEC affected area. Earlier, there was also an additional scheme under the Department of Social Services to pay the compensation for the elephant damage. This was operated through the Divisional Secretary's offices in respective districts. However, this payment scheme has been suspended for the last three years for some undisclosed reasons. At present, the highest payment is paid for the loss of life of the head of the household is about Rs. 50,000 ($ 532). If an adult who is not the chief householder is killed, the maximum amount paid is Rs. 35,000 ($ 373). For injury or damage to property, the compensation is less.

These payments are financed by the Insurance Corporation of Sri Lanka. According the DWC sources, the Ministry of Home Affairs pays Rs. 2 million ($0.021 million) as annual insurance premium to the Insurance Corporation from its annual budgetary allocation. In 1999, this company paid Rs. 2.9 million ($0.031 million) as a

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[52] *Supra*, note 11.

compensation for the farmers in the HEC affected area. When this amount is compared to the annual elephant damage estimated by Jayawardena[53] and De Silva[54], the compensation paid by this company only covers about 3 - 8% of the actual economic losses caused by elephants. Therefore, there is little doubt that this scheme is inadequate. Note also that the Insurance Corporation made a loss on this insurance.

Farmers in the sample interviewed in north-western region of Sri Lanka expressed five main grievances about the existing for compensating for damages done by elephants:

(1) There is a long delay before any compensation is paid.

(2) Compensation payment is very low for the property damage suffered.

(3) Compensation for loss life is unbalanced as the death of a young person who is not the head of the household but who has potential future earning capacity, is not taken into account. The overall amount is also not adequate.

(4) There is a lengthy documentation and assessment process.

(5) No compensation payment for perennial and semi-perennial crop damage is made.

(6) There is no provision in this scheme to compensate the death of a female including a female head of household.

The issues of long delay and inadequacy of compensation payment made by the DWC were analysed by using secondary data. A sample of 650 cases of elephant attacks reported to the six-selected *Grama Niladahri*'s office (GNO) between January 1997 and January 2001 was used in this analysis. The supplementary data was gathered

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53 J. Jayawardene, *Elephant Management and Conservation in Mahaweli Project Area in Sri Lanka*, 17 Gajaha, 23 (1997).

54 *Supra,* note 11.

from the Divisional Secretariat office (DSO) and the Regional Wildlife Office (RWO) at *Galgamuwa* in the northwestern region of Sri Lanka.

Table 4: The delay between the date of damage and the date of approval of payment (n = 650)

Duration (in weeks)	Number of complaint to GNO	Number of reports received at DSO	Number of reports received at RWO	Number of payment approved at WDC
1 – 8	164	69	24	-
9 – 17	152	107	56	14
18 – 26	158	123	49	79
27 – 35	176	87	68	93 (47%)[c]
Total	650	386 (59%)[a]	197(51%)[b]	

Note: a - % of the total number of complaints received by the GNO.
b - % of the total number of reports received by the DSO.
c - % of the total number of reports received by the RWO.

From Table 4, it is apparent that there is a very long delay between the date of damage and the actual date of payment approved by the DWC in Colombo (see Table 4). It was revealed that the DWC approved about 50 % of the reports received from the RWO within 10-12 weeks, there was a long delay at the local GNO, DSO and RWO. When there is elephant damage, the complaint has to be made at the GNO. The *Grama Niladahri* (the official government representative at the village level) sends his report to the DSO. The officer in charges in the DSO forwards the *Grama Niladahri*'s report to the regional wildlife office for assessment who forwards it to DWC head office in Colombo. In this process, first there is delay in time at the GNO for the preparation of the report which is then sent to the Divisional Secretariat office. This delay is about 4 - 6 weeks on average and sometimes it takes a little longer if there are many complaints, particularly during the dry season. It takes about 4 - 8 weeks on average for the DSO to forward the *Grama Niladahri*'s report to the RWO. It takes another 8 - 10 weeks on average for the RWO to send his assessment of the farmers'

complaint to the DWC head office in Colombo for payment approval. The officer in charge at the DWC head office takes at least 10-12 weeks, on average, to grant approval for the payment. These long delays at each of these government agencies are attributed mainly to the bureaucractic rigidities and lack of inter as well as intra agency communication. However, the long delay in payment of compensation minimises its benefits and aggravates the farmers' disappointment about this compensation scheme. Delays of 4-6 months in payment of compensation seem to the rule.

Despite the long delay in making payments, the amount paid as compensation for real property damage is also very small. Table 5 presents the differences between the amounts claimed by the farmer and the amounts actually paid. What is very clear is that there is a decreasing amount paid as compensation irrespective of how high the claim is. The average claim was Rs. 5,944 ($63) while the average amount paid was Rs 1,082 ($11.50). This brings to light the problem of paying compensation; the affected people usually inflate their claims in the hope of getting a reasonable compensation knowing that the DWC will always pay less. Our assessment in the field showed that the affected people always claimed high amounts that they could not justify at the site of damage. However, they gave examples of compensation paid where the amounts received were far less than the actual damage. This too adds to the frustration of the people.

Table 5: Percentage of claimed amount paid as compensation for crop and property damage (n =93)

Compensation claimed by farmers (in Rs)	Actual amount paid (in Rs)	% of claimed amount paid as compensation
1000 - 2000	410 - 820	41%
2001 -5000	420 - 1050	21%
5001 - 8000	850 - 1360	17%
8001 - 10000	1040 - 1300	13%
10,001 - 25,000	1100 - 2750	11%
25,001 - 50,000	1750 - 3500	7%

Compensation for crop damage was very low. It involved the same problems as that of the property damage claims with the added burden of the need for additional verification, paper work and thus, further delays in a system that is already slow. Our preliminary discussions with local farmers in the northwestern region during the fieldwork for the case study indicates that the amount of compensation paid in general is far from adequate. The farmers believe that compensation for crop damage is quite inadequate and takes too long to reach those affected; sometimes taking more than two years after reporting the damage.

Finally, we sought from farmers their attitudes to alternative compensation scheme. Most farmers expressed their willingness to contribute an equivalent of Rs 100 ($1.06) per month, if a self-financed compensation scheme is developed in the area. Such a scheme could be developed by the local authorities such as provincial council or local multipurpose co-operative society along with non-governmental organisations. This may entail setting up a committee (including a few farmer representatives) to manage the funds and decide the compensation rate and would surely be an improvement on the existing scheme. Such a fund might be strengthened

with corpus grants (where the capital remains untouched and only interest is spent) from national and international conservation agencies or from other groups that view the elephant as a positive resource.

This raises the question, however, of whether farmers should bear the cost or most of the cost involved in conserving elephants that do not respect their private property. If the beneficiaries from conservation of elephants are non-farmers, including conservationists, a case can be made out for them to pay a substantial amount of the cost imposed on farmers. Their contribution is likely to be important as a step towards the long-term survival of Asian elephants in Sri Lanka because this depends on elephants being able to use areas additional to protected areas. Without such compensation, the type of Kaldor-Hicks economic optimum shown in Figure 1 is unlikely to be achieved.

Crop insurance, however, and insurance in general, usually involves at least two problems. There is moral hazard problem – the possibility that the insured will take less care to protect the crop from environmental damage if it is insured. Secondly, the insured and the insurer usually have different sets of information – asymmetry of information exists. This makes it difficult for the insurer (and others) to know whether the insured ahs take reasonable care to protect the insured property and whether the claims of the insured for damages incurred have been inflated.

Some theoretical aspects of moral hazard and crop insurance are reviewed by Vercammen and von Kooten[55]. However, an article by Rollins and Briggs[56] is more directly relevant to the consideration of payment of compensation to farmers for damages caused by elephants in Sri Lanka. Although it is not completely relevant because it focuses only on farmers and recreational hunters and recreational hunting of elephants is not permitted in Sri Lanka, the following observation of Rollins and Briggs[57] seems to hold generally:

"The moral hazard problem arises because of uncertainty inherent in wildlife management and damage abatement techniques. Because directly monitoring on-farm abatement effort is often prohibitively expensive, uncertainty in abatement techniques generates asymmetric information between payers and recipients of compensation. The information asymmetry precludes enforcement contracts that directly specify level so abatement".

However, in the Sri Lankan case the abatement by farmers of elephants damage would not necessarily be a negative result but a desired social outcome. The compensation may be important to encourage farmers to allow elephants some access to their crops for food and survival and reduce the likelihood of the killing elephants. Still it may be difficult to ensure that access is kept to socially optimal levels and to deal with inflated claims for damages.

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55 J. Vercammen, and G. C. V. Kooten, *Moral Hazard Cycles in Individual-Coverage Crop Insurance*, 76 Ame. J. Econ. 250 (1994)

56 K. Rollins and H. G. Briggs, *Moral Hazard, Externalities, and Compensation for Crop Damages from Wildlife*, 31 J. Envi. Econ. Man. 368 (1986).

57 *Supra*, note 86, p.369.

Given the existence of moral hazard, the greater the compensation payable to the insured in the event of a loss, the less is the incentive of the insured to protect his/her asset against an unfavourable event. Thus the greater the compensation paid to farmers for damage by elephants, the less likely they are to undertake control of elephants. Their loss after compensation from elephant damage is lowered and so the after-compensation loss-avoided curve in Figure 2 tends to be lower. However, in this case, the moral hazard problem is not a problem it is socially beneficial to have less control of elephants by farmers. Elephants in Sri Lanka need to utilize some of farmers' crops to survive as a species[58]. Nevertheless, an asymmetry of information problem remains. Institutions paying compensation have less knowledge of actual damage caused by elephants on a farm than does the farmer. This adds to monitoring and agency costs generally.[59]

5. Concluding Remarks

The status of the wild elephant as a pest or an asset is quite debatable. However, it is evident that this species of wildlife causes considerable economic losses in Sri Lanka, as elsewhere in Asian and African elephant ranges. Elephants often extend their range into human settlements, commonly to feed on a wide variety of cultivated food and cash crops but also sometimes damaging food stores, water installations or fences and barriers, and occasionally injuring or killing people. Consequently, many farmers consider the elephant as a dangerous pest, similar to any other pests which disturb their crop production, farming practices and social well being. Thus, the individual farmer's decision to control elephants as a pest is purely economic and does not

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58 *Supra*, note 7.

59 R.G. Chambers and J. Quiggin, Uncertainty, Production, Choice and Agency, Cambridge University Press, Cambridge, U.K (2000).

significantly differ from their decision to control any other ordinary agricultural pests. Under current conditions, most local farmers in the vicinity of nature reserves would eliminate elephants from their environment if given the choice.

This negative attitude of the farmers towards the elephant is an unfavourable portend for the future survival of elephants in Sri Lanka. Therefore, conservationists must find ways to raise farmers' tolerance of elephants and their presence in farming fields. This requires a better understanding of the status of elephants as an agricultural pest and account to taken of farmers' perspective on the elephant. This perspective needs to be balanced against the views and interests of the non-farming communities who consider the elephant as a valued resource. However, as the damages inflicted on farmers by raiding elephants increase, farmers become more hostile to laws that attempt to limit their damages to elephants. They can be expected to flout such laws increasingly. Even now farmers often use illegal activities, such as shooting or poisoning of elephants to defend their crops. The use of adverse measures by farmers to control the elephant pest has eliminated elephants from much of their natural habitat in Sri Lanka and has interfered with their population dynamics, and is in conflict with the interests of non-farming communities in the society. Prohibition on the destruction of elephants has, on the whole, been ineffective in conserving Sri Lanka's population of elephants.

Our preliminary analysis revealed that elephants were responsible for about Rs. 12,049 ($128) worth of crop and property damage on average per farmer/per cropping season during the last five years in the study area. This is equal to little over one-third

of farmer's earnings in a given cropping season. In addition, most farmers (about 70%) in this area spend a considerable portion of their income on crop protection activities. Some farmers plant less valuable crops, such as cassava and sweet potatoes as borders to their farming fields to reduce the risk of damage to high-value crops such as rice and green chilli. Other farmers plant or harvest crops at non-optimal times to reduce the risk of losing all in one night of crop raiding. Moreover, in high conflict areas, most farmers have abandoned good cropland because of the sheer futility of raising a crop to maturity in the presence of elephants. Other farmers in these areas cultivate crops which are disliked by elephants even through they yield a lower income. When all these types of economic costs are taken into account, poor farmers in elephant raiding areas suffer large economic costs in relation to their income.

The level of compensation for the damage caused by the elephant in Sri Lanka is far from adequate. In most cases, it covers less than 10 % of the actual damage caused. As a result, affected farmers often seek credit facilities and other outside supports such as the government poverty elevation benefits to meet their family requirements. Gunathilaka *et al.*[60] examined the level of credit burden of the subsistence farmers in northwestern province where the fieldwork of this case study was undertaken. This analysis found that the level of credit burden of a farming family in this area ranged from Rs. 10,000 ($106.4) – Rs. 50,000 ($532) on average for the period of five years between 1987- 1993. Such high accumulation of credits is often attributed to the higher interest rates charged by the local moneylenders, a low rate of credit repayments by farmers, unpredictable crop losses, and a low level of income.

[60] G. Gunathilaka, M. Perera, R.A.M.C. Wanigarathne, R.E. Fernando, W.D. Lakshman, J.K.M.D. Chandrasiri, R.D, In Developing Asia (ed) M .G. Quibria, Asian Development Bank, Philippines, 433 (1994).

Elephants contribute significantly to unpredictable crop losses in this region. Kulathunga[61] examines the social impact of the elephant-related deaths in a sociological study of human-elephant conflict in southern Sri Lanka. This study identifies the type of families that suffer severe economic and social deprivation when they experience a death caused by elephants.

To conclude: It is found that elephants raids inflict severe economic losses on many farmers in Sri Lanka and that legal prohibitions on the killing of elephants are ineffective in ensuring conservation of elephants. In our view, the long-term survival of the wild elephants in Sri Lanka depends on the development of a scheme to compensate farmers adequately for the damages they suffer as a result of raids by elephants. While some of the funds for such a scheme could be contributed by farmers who are subject to the risk of damage, a case exist for the bulk of the funds being provided by non-farmers (and farmers not subject to the elephant-pest problem) who consider the elephant to be a valuable resource. Such action is especially needed because the resources available to elephants in protected areas in Sri Lanka cannot on their own support sufficiently large elephant populations to ensure the long-term survival of the Asian elephant in Sri Lanka.[62]

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[61] P.D.R. Kulathunga,, Sociological Study on Human-Elephant Conflict in Southern Sri Lanka, Unpublished Report, Open University of Sri Lanka, Colombo, Sri Lanka. (1999).

[62] *Supra*, note 7.

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