PESTICIDE AVOIDANCE: RESULTS FROM A SRI LANKAN STUDY WITH HEALTH AND ENVIRONMENTAL POLICY IMPLICATIONS[1]

Abstract

In this paper the contingent valuation method (CVM) is used to elicit bids/values to avoid direct exposure to pesticides and the resulting illnesses among subsistence farmers in a developing country, namely Sri Lanka. Farmers using pesticides on their farms suffer from short-term as well as long-term illnesses. Deaths from direct exposure to pesticides are not uncommon. The CVM is used to determine the yearly value to an average farmer of avoiding the costs of direct exposure to pesticides and to calculate the pesticide cost scenarios for the entire country. The last section of the paper examines the factors that influence the willingness to pay (WTP) to avoid direct exposure to pesticides and the resulting illnesses and discuss the health and environmental policy implications stemming from the regression analysis.

1. INTRODUCTION

Farmers handling and spraying pesticides using hand sprayers suffer from numerous morbidity effects (Jeyaratnam, 1990; Siyayoganathan et al. 1995; Hoek et al. 1997). According to 1990 World Health Organization (WHO) estimates, occupational pesticide poisonings affect as many as 25 million of the agricultural workforce each year in developing countries. As the World Resources Institute (1994, p.114) points out pesticide poisoning is a major occupational hazard for farmers and their families. The environmental costs of pesticide use are also high (WRI, 1994, p.113; Wilson, forthcoming). Furthermore, deaths resulting from direct exposure to pesticides are not uncommon (Chandrasekera et al. 1985; Fernando, 1991; Wilson, 1998). The direct, indirect and intangible costs arising from exposure to pesticides incur substantial costs to farmers. In this paper we use the contingent valuation method (CVM) to determine the yearly value to an average farmer in Sri Lanka of avoiding direct exposure to pesticides and the resulting illnesses. In other words, the CVM is used to obtain willingness to pay (WTP) bids for a year of avoiding the costs arising from direct exposure to pesticides and the resulting illnesses. CVM is employed because this method captures both the tangible as well as the intangible costs such as discomfort, stress, pain and suffering. These are important costs that are associated with exposure to pesticides. From the CVM bids obtained, the cost scenarios for farmers in Sri Lanka can be calculated to show the magnitude and severity of pesticide poisoning. From the field data collected it is also possible to identify the factors that influence the WTP to avoid direct exposure to pesticides and the resulting illnesses among subsistence farmers.

The plan of this paper is as follows. In section two of this paper, the use of pesticides and the resulting health problems in Sri Lanka are briefly discussed. In section three, the CVM and the valuation of morbidity effects are discussed. Section four discusses the manner in which the CVM was used to elicit the contingent valuation bids and estimate the average WTP bids

[1] I wish to thank Professors Clem Tisdell, Nick Hanley, Felix Fitzroy and Dr Darrel Doessel for helpful comments on an earlier draft of this paper. However, all remaining errors are mine.

to avoid direct exposure to pesticides and the resulting costs. Section five examines the reasons for farmers to remain in subsistence agriculture despite the large costs arising from exposure to pesticides. In section six, we estimate the contingent valuation cost scenarios for Sri Lanka. Section seven examines the factors influencing the WTP bids to avoid direct exposure to pesticides and the resulting illnesses among subsistence farmers. In section eight, the health and environmental policy implications stemming from the regression analysis are discussed. The conclusions of the paper are summarized in section nine.

2. PESTICIDE USE AND HEALTH PROBLEMS IN SRI LANKA

Since the first use of pesticides in Sri Lanka in agriculture in the 1950s and their increasing use after the introduction of high yielding varieties (the so called Green Revolution technology) and commercially grown cash crops (e.g. vegetable crops), the health of farmers, too, have been greatly affected from exposure to pesticides during handling and spraying on the farms, even leading to death (Wilson, 1998). Hospital statistics show that on average 14,500 individuals were admitted to government hospitals and around 1,500 individuals a year died from pesticide poisoning in Sri Lanka during the period 1986-1996 (National Poisons Centre, 1997). However, not all hospital admissions and deaths were due to occupational poisoning (i.e. due to handling and spraying on the farms) but include cases of self ingestion (suicides), accidental ingestion and homicides as well[2]. Apart from these hospital data, various field studies carried out have also confirmed high levels of morbidity from direct exposure to pesticides ranging from faintish feelings, headaches, nausea, diarrhoea, muscle twitching, rashes and cramps (Jeyaratnam et al. 1987; Dharmawardena, 1994; Sivayoganathan et al. 1995; Hoek et al. 1997). These are the short-term symptoms recorded during or soon after spraying pesticides. There are many short-term illnesses that arise on non-spraying days as well. Numerous studies in the United States have also documented long-term illnesses arising from exposure to pesticides [e.g Hoar (1986); Neilson and Lee (1987); Blair and Zahm (1993); Collins et al. (1993)]. The severity of short-term illnesses experienced by farmers on spraying and non-spraying days can be grouped into three categories, namely severe, moderate and mild[3]. In all of these categories, respondents suffer private[4] direct, indirect and intangible costs. The direct and indirect costs can be further subdivided into medical costs which include doctor visits, hospitalization costs, laboratory costs, emergency room visits and medication/drug costs. These are categorized as direct costs. Other direct costs include dietary expenses resulting from illnesses, travel costs associated with medical treatment, hired labour due to inability to work and any other direct costs incurred due to inability to stay on the farm such as crop damage from pests and diseases, due to inability to look after the crops from animals, theft, etc. The indirect costs

[2] No dis-aggregated data are available from the National Poisons Centre. Bed head tickets of all the government hospitals have to be examined for this task to isolate cases resulting from direct exposure to pesticides from handling and spraying on the farms. However, the bed head tickets of a selected number of hospitals in the study area were examined and it was found that a considerable number of the cases were due to occupational poisoning, although the majority of the cases were due to self-ingestion (suicides).

[3] An illness is described as serious where the respondent was hospitalized, a moderate illness is where the respondent takes treatment from a physician but was not hospitalized and the mild case is where a respondent was neither hospitalized nor sought treatment, but took home-made self-treatment and incurred other private costs.

[4] We make a distinction between private and public costs because government hospital treatment is free of charge in Sri Lanka. However, certain prescriptions may have to be purchased from a pharmacy and laboratory tests may have to be conducted in a private clinic. Furthermore, some farmers also seek treatment from private clinics.

are loss of work days on farm, loss of efficiency on farm, time spent traveling/seeking treatment and leisure time losses. The intangible costs include pain, discomfort, stress and suffering.

The field study which was carried out in the summer of 1996 for this paper revealed that 96% of the respondents had suffered some form of after-effect on a typical pesticide spraying day (excluding effects on non-spraying days or long-term effects) during the past year, but not necessarily leading to hospitalization or taking treatment from a physician, but however, incurring costs such as those due to self-treatment, loss of working days, loss of efficiency at work, loss of leisure time, etc. Table 1 shows the extent of the costs arising from direct exposure to pesticides and the costs of precautionary measures taken. The costs of different categories of ill health experienced by a farmer are not mutually exclusive. In other words, a farmer who is hospitalized in a given year can, after returning to work fall sick again in the same year from exposure to pesticides and hence be re-admitted to hospital, take treatment from a doctor or home-made treatment and incur costs. In fact, the survey revealed that a farmer who has suffered a serious illness (hospitalized) was more likely to fall sick when s/he returned to work and sprayed pesticides on the farm. The table shows that on a typical spraying day or soon afterwards (usually within four hours), 20% of the farmers interviewed had been admitted to hospital and incurred costs, 30% had taken treatment from a doctor and incurred costs and another 64%, although they were not hospitalized or did not require treatment from a physician, but nevertheless took home-made self-treatment and incurred other private costs. Furthermore, 42% of the respondents incurred illness-related costs on non-spraying days and 35% incurred costs due to long-term illnesses resulting from direct exposure to pollution.

As Table 1 shows, farmers also incur precautionary/defensive costs. When all these costs are aggregated, they are substantial. Therefore, it is necessary to estimate these costs to show how large and significant these costs are to farmers. Many techniques have been suggested that can be used to estimate these costs. Three of the commonly used techniques are the cost of illness, avertive behaviour and the contingent valuation approaches. The former two approaches have several limitations including their inability to take into consideration intangible costs such as discomfort, stress, pain and suffering [see Wilson (1988) for a discussion of the limitations of these two approaches]. However, the latter approach can take into consideration the intangible costs such as pain, suffering, discomfort and stress associated with an illness. These are important costs that need to be taken into account since those suffering from exposure to pesticides undergo considerable pain, stress, suffering and discomfort. These effects are also known to result in suicides among farmers exposed to pesticides. In this paper, we use the CVM to ask farmers the value of avoiding direct exposure to pesticides and the resulting illnesses for a year, or in other words the value of avoiding the costs of direct exposure to pesticides and the resulting illnesses. The values expressed by the respondents represent the costs the individual thinks he would incur from exposure to pesticides. An individual who has suffered from exposure to pesticides would consider all the costs arising from ill health including the resulting pain, stress, discomfort and suffering and all the costs of defensive action taken to minimize exposure to pesticides. In the next section we briefly discuss the CV approach. The main strength of this technique in the field of health economics is to capture intangible and invisible costs such as pain, discomfort, stress and suffering despite the drawbacks that have been discussed in the literature on the CVM.

Table 1 Number of Respondents Incurring Costs due to Exposure to Pesticides in the Study Area

	Beligamuwa		**Ambana**		**Kandalama**		**Yatawatte**		**Polonnaruwa**		**Total**	
Respondents	42		31		46		53		31		203	
	No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Medical And Other Costs												
A	13	30%	06	19%	08	17%	08	15%	06	19%	41	20%
B	09	21%	04	13%	23	50%	22	41%	4	13%	62	30%
C	33	78%	30	97%	20	43%	25	47%	28	90%	136	64%
NSD	21	50%	14	45%	34	73%	14	26%	04	13%	87	42%
LTC	09	21%	07	22%	23	50%	25	47%	07	23%	71	35%
Defensive Costs												
PC	20	48%	31	97%	32	69%	25	47%	16	51%	123	61%
OC	04	10%	09	29%	21	46%	26	49%	03	10%	66	32%
All	22	52%	31	100%	32	69%	40	75%	17	55%	142	70%
E P	42	100%	31	100%	46	100%	49	92%	27	87%	195	96%

Survey Period: July to September, 1996

A: Respondents admitted to hospital and incurring private costs (includes all costs associated with pesticide pollution).
B: Respondents consulting a doctor and incurring private costs (includes all costs associated with pesticide pollution).
C: Respondents not admitted to hospital or consulting a doctor, but seeking some form of treatment and incurring private costs (includes all costs associated with pesticide pollution).
NSD: All private costs incurred on non-spraying days due to exposure to pesticides (includes costs of medicine, consultation and other costs).
LTC: All long-term private costs incurred due to direct exposure to pesticides (includes costs of medicine, consultation and other costs).
PC: Number of respondents incurring costs of some form of protective gear.
OC: Number of respondents incurring costs apart from costs of protective gear (for example, costs incurred on special storage and hiring labour).
ALL: Includes all respondents incurring costs on protective clothing and other defensive behaviour.
EP: Number of respondents suffering from acute illnesses described in the interview on a typical pesticide spraying day (excludes non-spaying days and long-term illnesses) and incurring costs. There were eight respondents in the sample (n = 203) who did not incur any costs.

Note: The costs of different categories of ill health experienced by a farmer are not mutually exclusive.

3. THE CONTINGENT VALUATION APPROACH AND THE VALUATION OF MORBIDITY EFFECTS

Since the first application of the contingent valuation technique by Davis (1963)[5], it has been widely used during the last few decades to estimate economic values for a wide range of

[5] Hanemann (1994, p.20) argues that the CVM was originally proposed by Ciriacy-Wantrup (1947).

commodities for which there is no market. In the last decade, there has been a dramatic increase in the number of academic papers and presentations using the contingent valuation technique including many studies conducted in developing countries[6]. Whittington (1998. p. 29) points out that the CVM can be applied to obtain values of pure public goods, goods with both private and public characteristics and private goods. Contingent valuation in the 1990s is a well established and widely employed technique for valuing non-market goods and is supplemented by other techniques of measuring values of non-market goods.

The appeal of the contingent valuation method is that, in principle, it can elicit WTP bids/values from a broad segment of the population, and can value causes of deaths and illnesses that are specific to environmental hazards or a specific disease category. This method has been recommended especially for the estimation of values and costs that are difficult to estimate such as non-use values (passive values/existence values) and intangible costs (pain, discomfort, stress and suffering) where there are no direct market transactions taking place which can be used to estimate economic values. This technique tries to cover such a void. In this paper, for example, we ask farmers what they would be willing to pay for a year to keep them free of health risks arising from direct exposure to pesticides during handling and spraying pesticides, or in other words the value of avoiding the costs of pesticide related illnesses.

Although initially CVM was developed to measure the value of non-market goods such as the value of recreation, environment, etc., it has been adopted by economists to measure the value of risk reductions, too, and in recent years, an increasing number of studies have been carried out by health economists to assess the value of health care and the cost of illnesses [for example, see Donaldson (1990); Johannesson et a1. (1991); Johannesson (1992); Johannesson et al. (1993); Kartman et al. (1996); Zethraeus (1998); Sloan et al. (1998)] [7].

Many contingent valuation studies have also been carried out to determine the value of avoiding symptoms associated with environmental pollution. Some studies carried out to value morbidity effects (such as headaches, eye irritation, sinus congestion, wheezing and nausea), both minor and acute, associated with air pollution include Loehman et al. (1979); Rowe and Chestnut (1985); Tolley et al. (1986); Dickie et al. (1987) Chestnut et al. (1988) and Alberini et al. (1997).

The contingent valuation survey technique, because of its ability to consider non use/passive values/intangibles, is thus widely used for the estimation of environmental and health benefits. In the next section, we discuss the manner in which the CVM was used to elicit the contingent valuation bids to avoid direct exposure to pesticides. From the bids elicited, we estimate the private costs to an average farmer for a year arising from direct exposure to pesticides and the resulting illnesses.

[6] Carson (per com. 1998) states that more than 2,500 studies have been carried out in more than 50 countries using this method. In a literature survey carried out for this paper, it was found that more than 75 studies have been carried out in developing countries alone using this technique during the last decade.

[7] For a complete review of studies carried out in the heath care field up to the mid 1990s, see Donaldson (1993); Johansson (1995) and Diener et al. (1998).

4. CONTINGENT VALUATION BIDS TO AVOID DIRECT EXPOSURE TO PESTICIDES

A field questionnaire was carefully designed to gather data on direct exposure to pesticides and a section of it was devoted to obtaining contingent valuation bids to avoid the costs of direct exposure to pesticides and the resulting illnesses. Before the CVM question was asked, a broad introduction about pesticide pollution in the country in general was given and the health hazards faced by small-scale farmers handling and spraying pesticides on a regular basis were explained by the interviewer. Reference was made to the fact that current high levels of direct exposure to pesticides have a high probability of causing many side effects and even deaths. It was explained to the farmers that the risks of ill health increase with the levels of direct exposure, i.e. due to larger hours of spraying, acreage sprayed and potency of the pesticides used, the level of precautions taken and so on. Other relevant information regarding the dangers arising from the use of pesticides was provided. Previous studies carried out to show the harmful effects of direct exposure to pesticides were quoted. Prior to asking the contingent valuation question, data on costs of illnesses and defensive behaviour were gathered. Furthermore, information on the health status of the interviewee was also obtained using the same list of illnesses used in the Siyayoganathan et al. (1995) study. In this study, a physician examined the commonly occurring short-term illnesses during spraying or soon after spraying. In this study, the farmers were asked how often they suffered from any of the 17 identified symptoms in the Siyayoganathan et al. (1995) study, or any other symptoms on an average pesticide handling and spraying day. Information was also obtained on illnesses that arise on non-spraying days and long-term illnesses arising from exposure to pesticides. Only illnesses diagnosed by physicians as arising from direct exposure to pesticides or those illnesses which farmers can strongly attribute to the use of pesticides have been considered. By the time the interviewer got to the CVM section of the questionnaire, the respondents were aware of the objectives of the study and were familiar with the health hazards posed due to direct exposure to pesticides and the costs involved.

The respondents were told that the CVM question was aimed at measuring how much people are willing to pay to avoid direct exposure to pesticides and the resulting illnesses if a programme was devised to prevent such illnesses from direct exposure to pesticides. Respondents were also informed of the economic sacrifice they would have to make to support such a prevention programme. The farmers were told that the money will have to come out of their income or some other income source. They were specifically told about the range of options available to avoid direct exposure to pesticides [for example, using safer but more expensive pesticides, adopting integrated pest management (IPM) strategies which, however, could cost more to adopt, hiring labour to spray pesticides and growing crops that involve no or less use of pesticides]. The choice of the payment vehicle to undertake prevention programs was also made as realistic as possible. Taxes were deliberately avoided because during the pre-testing of the questionnaire (pilot study), it was found that respondents disliked the idea of taxes[8] and thought that this study was being conducted to compile a register for the implementation of taxes in the future. Therefore, because of such difficulties, higher prices/costs were preferred to taxes[9]. Interestingly, Carson [per com.

[8] Loomis and Duvair (1993) point out that "the payment of higher taxes is not an emotionally neutral subject for many people and that such a payment vehicle may increase the number of protest bids" (p.288).

[9] For a contingent valuation study that uses the wording 'higher prices' to describe the payment, see Ready et al. (1996). Also see Kenkel et al. (1994).

(1998)] points out that a major problem with contingent valuation surveys in developing countries is that of finding a plausible payment vehicle for the good in question. All the respondents in the study areas were provided with the same information, including the payment vehicles suggested. An open-ended question format asking what is the maximum amount they would be willing to pay in order to avoid direct exposure to pesticides and the resulting morbidity effects was used[10]. The data were obtained by direct interviews.

The basic objective of the sample design was to obtain data from a representative cross section of farmers to base inferences about pesticide use and the numerous health effects arising from such use and their costs. This also involved obtaining contingent valuation bids. The period from June 1995 to June 1996 was considered. Five areas were sampled from the intermediate dry zones of Sri Lanka where intensive agriculture is widespread. The regions covered were Yatawatte, Kandalama, Beligamuwa, Ambana and Polonaruwa in the Central and North Central provinces of Sri Lanka, within a 75-100 mile radius. Only farmers who are regular pesticide users and cultivate land not less than half an acre and not more than three acres were selected, because according to a census carried out in 1982 by the Department of Census and Statistics, the average size of land cultivated in the country was 1.94 acres. Therefore, as the census statistics show, a large number of farmers cultivate a land area which is less than three acres and more then half an acre. The five regions selected specialize in growing food crops. As a result, the level and intensity of pesticides used and the level of direct exposure to pesticides vary from region to region. Judgment sampling was employed to collect the necessary data for the study. Prior to the interviews, a pilot study was also carried out to determine the viability of questions prepared to collect the necessary data. The questionnaire was modified, removing questions that proved difficult to administer.

Initially, 227 farmers were interviewed, out of whom, one respondent refused to give a bid and two gave zero bids. One of the respondents who gave a zero bid was found to be the father of the owner of the pesticide shop in the village. It was believed that he had an interest in the son's business. This was because he suffered from mild symptoms from exposure to pesticide spraying, but yet gave a zero bid to avoid direct exposure to pesticides. There was another zero bid, although this respondent, too, had suffered from ill health due to direct exposure to pesticides. Because of lack of consistency of these two bidders, they were removed from the sample. The protest bid was also removed from the sample as recommended [Hanley and Spash (1994, p.55)]. Twenty one questionnaires had not recorded either household incomes, age, education, household size and acres sprayed which are important variables used in the regression analysis in the last section of this paper. They, too,

[10] The WTP bids can also be obtained by a series of questions confronting them with different prices for the program depending on their previous answers or it can take the form of a dichotomous choice or close-ended question format where respondents are told how much each would have to pay if the measure passed and are then asked to cast a simple "yes" or "no" vote. This dichotomous choice contingent valuation question format has gained popularity over the last few years. It is also a NOAA panel (1993) recommendation. This is due primarily to their purported advantages in avoiding many of the biases known to be inherent in other formats used in the contingent valuation method. However, there are many disadvantages too. For example, Whittington (1998) points out that if the amount the enumerator asks lacks credibility, the respondent is unlikely to answer the question on the basis of the prices asked. Furthermore, the type of format depends on the nature of the study and conditions prevailing in developing countries. These considerations were taken into account in selecting an open-ended question format for this study. For a detailed discussion on the disadvantages of the dichotomous choice format and the advantages of the open-ended question format for this study, see Wilson (1998).

were removed from the sample. For the entire study, the contingent valuation bids varied a great deal from bids as low as Rs 300 to as high as Rs 70,000 (See Table 2). The amounts bid varied across individuals according to the extent of direct exposure to pesticides and the severity of the illness suffered, income earned, and a host of other factors. On average, farmers who were often exposed to pesticides and who suffered a great deal made larger bids, while those with less exposure and who suffered fewer health effects bid less. Furthermore, farmers with higher incomes made higher bids. Once the necessary bids were obtained, the average WTP was calculated for the sample under study. The average contingent valuation bid for the sample group was Rs 11,471.18[11]. The payment was not in the form of a one-off payment per year but was, for example, in the form of higher prices paid for safer pesticides which they would purchase 5-8 times a year[12]. By any standard this is a large cost. When the farmers were asked why they were willing to pay this high figure, the reason given was that there is extreme suffering involved with direct exposure to pesticides.

Table 2 Contingent Valuation Bids for the Study Areas

Sample Group	**Sample Size**	**Lowest Bid Rs**	**Highest Bid Rs**	**Average Bid Rs**
Study Sample	203	300	70,000	11,471.18
Ambana	31	300	38,000	I2,829.03
Kandalama	46	500	50,000	12,834.78
Polonaruwa	31	1000	65,000	15,370.97
Yatawatte	53	300	70,000	7,548.11
Beligamuwa	42	600	50,000	11,047.62

Survey Period: July to September, 1996

5. WHAT THEN ACCOUNTS FOR THE FAILURE TO SHIFT AWAY FROM CHEMICAL PESTICIDES?

As shown in the previous section the costs arising from handling and spraying pesticides are high to farmers. In such a case the question that is often asked is why do farmers continue to remain in agriculture and use pesticides? One reason that can be given is that farmers in developing countries have no easy alternatives to subsistence farming. Subsistence farming on the other hand requires very little capital and skill. Furthermore, another advantage is that subsistence farmers use some of their produce for home consumption thus covering a large part of the family expenditure. It is also likely that in the majority of cases, the short-term health effects arising from pesticide use and the disutility from that ill health are underestimated by farmers since the costs mentioned in Section 2 accrue over a period of time (e.g. one year) and include time costs as well. It is also likely that advertising and

[11]The exchange rate prevailing during the study period (June-September, 1996) was 1$ = 55 Rs (approximately).

[12] Small-scale farmers cannot afford to buy inputs in bulk. Hence the reason for purchasing pesticides and other inputs from time to time. They also have limited storage facilities.

promotion by pesticide companies create a bias in favour of their use (Tisdell et al. 1984). Furthermore, although farmers in this study were willing to pay a higher price to use safer pesticides or adopt Integrated Pest Management (IPM) which includes biological control of pests and diseases, such services are not easily available to farmers in developing countries. IPM is practiced in developing countries but has been on a small-scale due to many reasons[13]. As the WRI (1994, p.117) points out, IPM in developing countries is more the exception than the rule. Tisdell (1991, 173-174) points out that when chemical agricultural systems are adopted, agricultural yields or returns become very dependent on them despite the very high costs and thus impose an 'economic barrier' to switching to organic systems. In short, agricultural practices tend to become 'locked into' such systems once they are adopted despite being unsustainable (Tisdell, 1991, p. 173; Tisdell, 1993, p. 169). Cowan and Gunby (1996), too, point out that once a pest control strategy is adopted, then it becomes the dominant strategy as this has been the case with using chemical pesticides. They point out that once the chemical pest control strategy was adopted, the amount of money spent on R&D for further development of pesticides has increased while the development of IPM has slowed down. For example, they show that " in 1937, 33% of the articles in the Journal of Economic Entomology dealt with the general biology of insects, 58% were devoted to testing pesticides. By 1947 these proportions were 17% and 76% respectively " (p. 524). As a result, in a competition between two technologies, " a lead in market share will push a technology quickly along its learning curve, thereby making it more attractive to future adopters than its competitor. A snow-balling effect can lock a market of sequential adopters into one of the competitors " (p. 523). The use of chemicals can also affect biological pest control strategies by killing the predators of pests. Hence even if some farmers decide to adopt biological pest control strategies, they would be affected due to externalities of pesticides arising from neighbouring farms. Therefore, despite the economic, social and ecological gains that could be derived from biological control of pests (see Menz et al. 1984; Tisdell 1987, 1990), pesticides once adopted as the dominant pest control strategy will continue to be used in larger quantities despite the very serious negative effects that have arisen[14]. For example, Cowan and Gunby (1996, p. 522) state that between 1964 and 1982 in the United States, the application of active chemicals increased 170% by weight. Since 1970, herbicide use has more than doubled. In Sri Lanka pesticide use has increased by almost 110 times between 1970 and 1995 (Wilson, 1998, p. 36). In addition to the increase in quantity of pesticides used, farmers use stronger concentrations of pesticides, they have increased the frequency of pesticide applications and also mix several pesticides together to combat pesticide resistance by pests (Chandrasekera, et al. 1995). Therefore, despite the advantages of biological pest control strategies, farmers both in developed and developing countries continue to use pesticides at an increasing rate and hence become 'locked in' on one form of pest control technology which has resulted in their 'entrenchment' in pesticides. As a result, it can be argued that the costs from the increasing use of chemical inputs (e.g. pesticides) in agriculture and the resulting costs from their use (e.g. ill health due to exposure to pesticides and externalities) are major factors in increasing the incidence of poverty among subsistence farmers in developing countries.

[13] See Cowan and Gunby (1996) for reasons why IPM has been slow to be adopted on farms.
[14] For a discussion on the environmental and human costs of pesticide use see Wilson (forthcoming).

6. CONTINGENT VALUATION COST SCENARIOS FOR THE ENTIRE COUNTRY

We can now use the WTP bids/values shown in Table 2 to estimate the contingent valuation cost scenarios for the entire country. We have to resort to scenarios because no government agency in Sri Lanka, including the Department of Agriculture and the Department of Health or the Pesticide Poisons Centre, know the number of farmers affected by direct exposure to pesticides during handling and spraying on the farms. For the scenarios in this study, we use 1978 employment survey data compiled by the Department of Labour which put the number of agricultural workers in Sri Lanka at 472,435. A census carried out in 1982 estimates the number of 'agricultural operators' at 1,803,99. An agricultural operator has been defined as any person responsible for operating a agricultural land or one who looks after livestock or poultry. The agricultural land defined includes all plantation crops such as tea, rubber and coconut and cash crops as well where pesticide use is minimal. This also includes home gardens and land not cultivated on a regular basis. The owner of any of these lands, or a person engaged in livestock or poultry farming, is also classified as an 'agricultural operator'. Since this definition of agricultural operators is wide, we prefer to use the employment survey data of 1978 in this paper[15]. Since these two surveys were carried out, no survey has been conducted to determine the number of agricultural workers in the country. This is due to the continuing civil war in the North-East of the country which started in 1983. Of the 472,435 agricultural workers in Sri Lanka (according to the 1978 employment survey), not all use pesticides since some of them are plantation workers. In this paper, we assume that a minimum of 50,000 and a maximum of 300,000 agricultural workers are affected each year due to direct exposure to pesticides in Sri Lanka. Table 3 shows such cost scenarios for the entire country.

Table 3 Contingent Valuation Cost Scenarios for Sri Lanka
(in Millions of Rupees)

Sample Group	**A** **Rs**	**B** **Rs**	**C** **Rs**	**D** **Rs**
Study Sample	573.559	1147.118	1720.677	3441.354
Ambana	641.451	1282.903	1924.354	3848.709
Kandalama	641.739	1283.478	1925.217	3850.434
Polonnaruwa	768.548	1537.097	2305.645	4611.291
Yatwatte	377.405	754.811	1132.216	2264.433
Beligamuwa	552.381	1104.762	1657.143	3314.286

Survey Period: July to September, 1996

Note: The average contingent valuation bids are multiplied by the number of farmers whom we believe are affected by direct exposure to pesticides. Harrington et al. (1989) study, too, adopt a similar approach to estimate costs in their study. We believe between 50,000 to 300,000 farmers are affected. Accordingly, we prepare the scenarios as follows: Scenario A =50,000 farmers. Scenario B = 100,000 farmers. Scenario C = 150,000 farmers. Scenario D = 300,000 farmers.

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[15] Jeyaratnam et al. (1982) too, use these survey data for their study.

The lowest contingent valuation bid/value estimates show that the value to farmers in Sri Lanka of avoiding direct exposure to pesticides, or in other words the cost of direct exposure to pesticides, is more than 573 million Rs (scenario A) while the high value/cost scenario (scenario D) indicates that farmers incur a cost of more than 3,441 million Rs in the form of costs due to direct exposure to pesticides. These costs include not only the direct and indirect costs of direct exposure to pesticides, but includes intangible costs as well.

The contingent valuation approach used in this study conformed to all but one of the appropriate and applicable guidelines laid down by the NOAA panel for such studies, including the main guidelines as identified by Portney (1994). The contingent valuation study, however, could not adopt a referendum format, the reasons for which were given in footnote (10) earlier in this section.

There are several ways through which the validity of the contingent valuation exercise can be gauged. As Hanemann (1994) points out, one method is to replicate the contingent valuation study. For this study, this was not possible. A second approach is to compare the contingent valuation results with actual behaviour. This was not possible either for this study. A third approach is to compare the contingent valuation approach with indirect methods. For this study the results of the contingent valuation approach were compared with the results of two indirect methods, namely the cost of illness and the avertive behaviour approaches, the data for which were obtained using the same questionnaire to gather the CVM bids for this paper. The comparison shows that the contingent valuation bids obtained are valid given this comparison. This is because, as hypothesized (e.g. Harrington and Portney, 1987), contingent valuation bids exceed the sum of changes in cost of illness and defensive expenditures. Unfortunately, there are no other studies of WTP that have been carried out to determine the value of avoiding direct exposure to pesticides by farmers that can be compared with the results of this study. Furthermore, as regards 'content or face validity' the survey instrument was carefully designed and pre-tested, as described earlier, in order to make sure it adequately covered the domain of the goods it intended to measure. Another test of validity is the estimation of the bid curve that is discussed in the next section. The results show that the subsistence farmers' WTP to avoid direct exposure to pesticides increase with farmers' income, size of household, poor health resulting from direct exposure to pesticides and the length of time a farmer is involved in handling and spraying pesticides on the farm for a given year. We discuss the econometric work in more detail in the next section.

7. FACTORS INFLUENCING THE WILLINGNESS OF SUBSISTENCE FARMERS TO PAY TO AVOID DIRECT EXPOSURE TO PESTICIDES AND THE ASSOCIATED ILLNESSES

In this section we examine the relationship between contingent valuation WTP to avoid direct exposure to pesticides affecting the health of users (farmers) and the various socioeconomic, health and time variables. The aim is to determine how much of the variation in the contingent valuation WTP bids can be explained by differences in the observed characteristics. The results of the econometric analysis are relevant, not only for economic models explaining the factors affecting the demand to avoid direct exposure to pesticides[16],

[16] The contingent valuation question was framed to obtain WTP bids to avoid direct exposure to pesticides only and not to obtain WTP bids for environmental quality or environmental protection. However, in the

but also for policy decision making. For the regression analysis, two statistical techniques commonly used in contingent valuation, namely OLS and Tobit analyses are used and the results are compared. This is because Tobit analysis is the more theoretically appropriate method for WTP data sets [(Halstead et al. (1991)].

7.1 Hypotheses about the Determinants of the Valuation Bids

For the econometric analysis, the standard socio-economic measures such as income, education, household size and age are used. The socio-economic measures selected as explanatory variables are similar to those that have been used by Brien et al. (1994) who examined the relationship between contingent valuation WTP bids/values and socio-economic variables for various illnesses (not pollution related). Such work has also been influenced by the theoretical work carried out by Grossman (1972) and Feldstein (1993) on demand for health and medical care. It is the perceived view that differences in demand for health and medical care can be influenced by education, age, income and other socio-economic factors. Hence, in this paper it is hypothesized that the better educated individuals are likely to bid more to avoid direct exposure to pesticides and the resulting illnesses; and individuals with higher incomes are willing to pay more to avoid direct exposure to pesticides and the resulting illnesses. It is also hypothesized that although older individuals are expected to bid less than young people (because they are at the end of their working lives and hence the need to save for retirement years), they would be willing to pay more to avoid the extra costs associated with avoidable illnesses such as those arising from exposure to pesticides as they grow older.

It is also hypothesized that individuals in bad health are expected to bid higher amounts for improvements in their health, reflecting increasing marginal disutility of bad health [Brien et al. (1994 p.169)]. This follows Grossman's (1972) standard assumption of diminishing marginal utility of good health, where, the more healthy days an individual experiences, the less s/he is willing to pay to obtain an additional good day. This can be shown by a marginal WTP curve for improved health. As shown in Figure 1, the curve slopes downwards due to the fact that the individual (by assumption), is willing to pay less for a marginal increase in health if his or her health is good, than if his or her health is bad. A dummy variable is used to describe the health status of the respondents. The dummy variable indicates whether a respondent has suffered ill health from exposure to pesticides or not. We use 1 to indicate ‘ill health’ and 0 to indicate 'no ill health' from exposure to pesticides resulting from handling and spraying pesticides on the farms.

Another important variable used is the length of time pesticides are used on the farm in a given year. It is hypothesized that the more months a farmer is engaged in handling and spraying pesticides, the more likely that s/he is to suffer health risks. Therefore, such an individual would bid more to avoid exposure to pesticides and hence the resulting illnesses that accompany such exposure.

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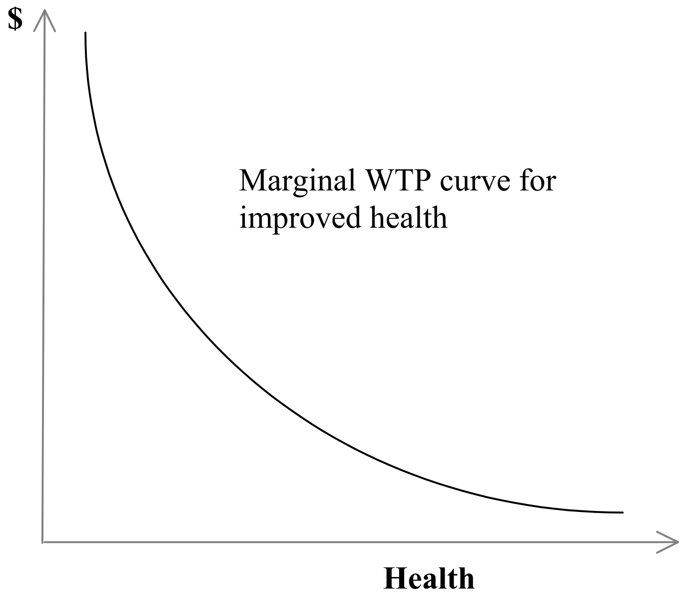
discussion, the WTP bids to avoid direct exposure to pesticides are taken to represent environmental quality/protection as well. This is an assumption made to make the interpretation of the regression results for policy implications much wider and easier.

Figure 1 Expected Relationship Between Ill Health and Marginal Willingness to Pay for Improved Health



Source: Based on Johansson, 1995, p.12.

7.2 Regression Analysis

Using the primary data collected from the field survey, OLS and Tobit regressions are performed. In the regression, farmers' monthly income (INC), age (AGE), education (EDU), number of household members (NOI), whether a farmer has suffered ill health or not from exposure to pesticides (SICK) and length of time pesticides are handled and sprayed shown by the months of pesticide use (TIME) are used as explanatory variables. The dependent variable is the contingent valuation WTP bids to avoid direct exposure to pesticides. The following specification was developed for the regression analysis.

$$CV = f\,(\underset{+}{INC}, \underset{+}{AGE}, \underset{+}{EDU}, \underset{+}{NOI}, \underset{+}{SIC}, \underset{+}{TIME})$$

The variables in the above function are identified in Table 4 showing summary statistics. The expected signs of the partial derivatives are indicated beneath each argument in the above function.

7.3 Summary Statistics

Reported in Table 4 are the means and standard deviations for all variables that were included in the regression analysis. The mean contingent valuation bid is Rs 11,471 for a year which is around two and a half times the monthly income of an average farmer in Sri

Lanka. The yearly average income is Rs 56,978. The mean age is 40 years and the household size is around five per family. The average amount of education is 7.5 years.

7.4 Regression Results

The results of the OLS and Tobit estimates are presented in Table 5. For the Tobit analysis, only the t-ratios are reported. Tests carried out showed evidence of violations of assumptions such as linearity, constant variance and normality of the distribution of the residuals. This was minimized by taking the logs of the dependent variables in the regression analysis. The log transformation of the dependent variable also improved the goodness of fit. The 'tolerances and variable inflation factor and the collinearity diagnostics' for the variables showed that multicollinearity was also not a problem among the independent variables. For this regression analysis, we interpret the results using a one tailed test. The null hypothesis is H_0: $\beta = 0$ and the alternative hypothesis is H_1: $\beta < 0$ or H_1: $\beta > 0$.

Table 4 Means and Standard Deviations to Avoid Direct Exposure to Pesticides

Variable	Label Description	Mean	SD	Min	Max
CVM	Contingent Valuation Bid	11,471.18 Rs	12684.43	300	70000
INC	Yearly Income	56,978.10 Rs	53855.00	2,400	360000
AGE	Age	40.00 Yrs	11.20	20	70
EDU	Education	7.57 Yrs	3.27	0	14
NOI	Household Size	4.72 (persons)	1.62	2	12
SIC	Sickness	0.96	2.10	0	1
TIME	Pesticide Use	8.99 (months)	2.10	3	12

7.5 Discussion of Results

The OLS and Tobit analyses show that there are no significant variations in the two analyses that affect the significance of the results. This may be due to the absence of non-zero values in the contingent valuation bids. The results show that income and household size of the respondent are significant factors influencing his WTP to avoid direct exposure to pesticides.

The education coefficient, however, is small and is insignificant. These results confirm the Brien et al. (1994) study contradicting the theoretical belief that the higher the level of education, the higher is the contingent valuation WTP bids. However, this result is not surprising because in most schools environmental subjects, including harmful effects of pesticides, are not taught. Hence, the level of awareness is limited. The age coefficient is also insignificant.

On the other hand, there is ample evidence to show a strong relationship between the respondents' ill health resulting from exposure to pesticides and the bids reflecting increasing marginal disutility of illness. This variable is highly significant. The length of time a farmer is engaged in handling and spraying pesticides for a given year is also significant.

Table 5 Regression Results of the Contingent Valuation Willingness to Pay bids to Avoid Direct Exposure to Pesticides

	OLS				**Tobit**
Variable	**Unstandardized Coefficients B**	**Standardized Coefficients Beta**	**Standard Error**	**t-Ratio**	**z = b / s. e.**
INC	3.1E-06	0.1512	1.42E-06	2.190***	2.229****
AGE	-0.0076	-0.0773	0.0077	-0.993	-1.011
EDU	0.0055	0.0162	0.2636	0.210	0.214
NOI	0.0974	0.1426	0.0473	2.061***	2.097***
TIM	0.0873	0.1650	0.0377	2.316****	2.357****
SIC	1.0243	0.1995	0.3602	2.843****	2.894****
(Constant)	6.672	-	0.6053	11.022****	11.217****

R Squared = 0.11 Adjusted R Square = 0.09 Standard Error = 1.06 F = 4.35
The asterisks *** *, ***, ** and * indicate 1, 2.5, 5 and 10% level of significance respectively for a one tailed test.
No non-zero observations
n = 203
Note: We interpret the beta coefficients in the regression results rather than the B coefficients. This is because the units of measurement of the variables are not the same. Hence, the coefficients are not directly comparable. Therefore, when variables differ substantially in units of measurement, the sheer magnitude of their coefficients does not reveal anything about their relative importance. Hence, in order to make the regression coefficients somewhat more comparable, the coefficients have been standardized to take into account the differences in the various units of measurement of the variables. Therefore, the beta coefficients are the standardized coefficients while B coefficients are the unstandardized coefficients. The standardized beta coefficients can be calculated directly from the regression coefficients using the following formula: $B_1 (S_x/S_y)$ where B_1 is the regression coefficient and S_x is the standard deviation of the independent variable and S_y is the standard deviation of the dependent variable (SPSS, 6.0, 1993, p.314, 342).

8. HEALTH AND ENVIRONMENTAL POLICY IMPLICATIONS

The regression results are useful for policy decision making. The results show that incomes of farmers play a significant part in the determination of the WTP bids in avoiding direct exposure to pesticides. This is consistent with general economic theory which is applicable even to a 'low income' developing country. The size of household, too, is significant. The results also show that education and age do not play a significant part in the determination of the WTP bids, while the effects of pesticide exposure on the health of the user and the length of time pesticides are sprayed for a year, play a significant role in the determination of the WTP bids. The education variable being insignificant in the determination of WTP to avoid direct exposure to pesticides has many implications. We know, as studies have shown, that exposure to pesticides cause many long-term illnesses, in addition to short-term health effects, most of which are incurable. The level of education here does not play a role in preventing such short-term and long-term illnesses. The problem is even more serious, especially because pesticide pollution that is released into the environment can be non-point in nature and is also very potent. The total effect of all the pesticide pollution generated by a very large number of users is even more lethal and is made more dangerous because of the pesticide stock in the environment. Furthermore, another implication that arises out of the results is that individuals begin to take note of the need to avoid direct exposure to pesticides only after they have suffered from ill health due to direct exposure to pesticides, until which time they may use pesticides. Hence, the damage done from exposure to pesticides, not only to human health, but to the native fauna and the environment in general is very large. By the time the victims of direct exposure to pesticides begin to pay to avoid direct exposure because of the adverse effects (ill health), the damage done would be irreversible. Also in such a situation, the results imply that even governments would begin to act only once the damage to human health and the environment has begun to take effect and the damage done is visible. Foresight in avoiding the dangers and the health effects arising from direct exposure to pesticides and/or environmental pollution does not play a role. It indicates adaptive behaviour rather than a non-myopic preventive type of behaviour.

The long-term consequences are even more frightening. We know that studies in the United States have shown a link between pesticide poisoning and long-term effects such as various cancers, loss of memory, tumors, etc. [Hoar (1986); Nielson and Lee (1987); Blair and Zahm (1993); Collins et al. (1993)]. In such a case, even if a respondent realizes that a chronic illness is due to direct exposure to pesticides and is willing to pay to avoid such exposure, it would be too late since most of these illnesses are not completely curable.

Such a trend is very dangerous. This is because not only are the health of users affected but the fauna and the environment in general also suffer due to pesticide spraying. Furthermore, the effect on neighbouring individuals is likely to be considerable since water sources and the entire environment are affected. The entire food chain can be affected as a result. The damage done to consumers of cultivated food crops, though unknown, could also be high. It has been shown that pesticides can be taken up by crop roots and end up in the food chain. Furthermore, the residues of pesticides sprayed on crops can end up in the food harvested. The cost of other negative externalities could also be high[17]. Several interesting negative externalities arising from pesticides were noted during the field study. Herbicides used on onion plots to destroy weeds, when spread to neighbouring farms due to strong winds destroyed other crops which were not resistant to the herbicides used[18]. The damage incurred was very large since it affected the crop of an entire season. There were several externalities of this nature. The damage to fish production is unknown, although, in Malaysia, the Philippines and Bangladesh, declining fish yields have been linked to pesticide pollution

[17] In the field study undertaken to gather data for this paper, the costs of negative externalities were not considered.

[18] It is interesting to note that the Pea plant in recent years has been genetically engineered for the purpose of making it completely immune to herbicides such as Roundup. This enables farmers to blitz the entire farm with Roundup which virtually kills all plants and weeds (and also other micro-organisms and insects) except the cultivated Pea crop.

(Dinham, 1993, p.69; Sudderuddin and Kim, 1970; Ministry of Finance, Bangladesh, 1992; IAD, March/April, 1990).

9. CONCLUSIONS

In this paper the contingent valuation approach was used to obtain bids/values to avoid direct exposure to pesticides and the resulting adverse health effects among farmers in Sri Lanka. The approach considered all costs incurred by farmers, including the intangible costs such as pain, discomfort, stress and suffering. The costs were shown to be high.

The regression results showed that a farmer's income and size of household do play a role in the determination of the WTP to avoid direct exposure to pesticides even in a 'low income' developing country, while the level of education and age do not influence a farmer's WTP to avoid direct exposure to pesticides. The results also show a strong relationship between poor health resulting from direct exposure to pesticides and the size of bids, reflecting increasing marginal disutility of illness. Furthermore, the results indicate the possibility of health decisions being reactive rather than non-myopic preventive in nature. The length of time a farmer is involved in handling and spraying pesticides for a given year is a significant variable in explaining the determination of the WTP bids to avoid direct exposure to pesticides. These have important policy implications. For example, government intervention in controlling pesticide use may be justified not only due to the adverse expenditures generated by such use but by the initial myopia which farmers display in applying pesticides. Their WTP to avoid pesticide damage increases with their experience of poor health from pesticide use. There are probably two reasons for this: (a) greater awareness of the health risks associated with pesticide use, and (b) the Grossman (1972) effect mentioned earlier. It seems likely that in the majority of cases, the likelihood of ill health from pesticide use and the disutility from that ill health are underestimated by farmers using pesticides. Hence the need for some form of government intervention to protect individuals from exposure to pesticides. Finally, however, the whole issue rests in the principle of caveat emptor, that the buyer/user alone is responsible. For this purpose educating the farmers about the hazards of using pesticides at current high levels without adequate precautions is of utmost importance.

Appendix 1: Wording of the Contingent Valuation Question

Question: In view of the large short-term and long-term and precautionary costs which we saw in the preceding sections of the questionnaire, what is the yearly value to you of avoiding direct exposure to pesticides and the resulting illnesses. In other words what would you be willing to pay (WTP) for a given year to avoid costs arising from morbidity effects.

Note: Just before the CVM question was asked, the respondents were told that when they pay to avoid direct exposure to pesticides, the money will have to come out of their income. They were also told how this payment would be made. For example, in the form of higher prices paid for safer pesticides, which they would purchase 5-8 times a year as explained in the paper. The respondents were also told that the costs included the intangible costs. Hence the advantage in using the CVM.

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