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IN THE FIELD

Farmers' willingness to pay for community integrated pest management training in Nepal

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Abstract. The concept of community integrated pest management (IPM), which is well developed in Indonesia and Vietnam, was recently introduced in Nepal. However, it has not been widely practiced, due mainly to lack of financial and technical support. This study determined an individual's willingness to pay (WTP) for community IPM training. Determinants of WTP were identified; and sample average estimates, opportunity costs of training, and probability values were used to estimate WTP for a group of households. Estimated WTP revealed that individuals were in favor of community IPM, hence it could be implemented with the support of local villagers. Community IPM demand functions showed that individuals' knowledge and awareness of pesticide pollution are crucial for implementation. The annual welfare gained by providing five days community IPM training was calculated to be US $25.23 per household.

Key words: Community IPM, Nepal, Pesticide pollution, Willingness to pay

Abbreviations: FFS – farmer field schools; IPM – integrated pest management; NPR – Nepalese Rupees; WTP – willingness to pay

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Environmental and health costs of pesticide use

Pesticide use can have chronic and acute impacts on human health as well as adverse environmental and ecosystem effects. Long-term, low-dose exposure to pesticides are increasingly linked to human health problems such as immune suppression, hormone disruption, diminished intelligence, reproductive abnormalities, and cancer (Gupta, 2004). Farm workers have reported day-to-day acute effects of pesticide exposure (Antle and Pingali, 1994; Dung and Dung, 1999; Murphy et al., 1999; Yassin et al., 2002; Maumbe and Swinton, 2003). Several studies have attempted to place a value the effects of pesticide use on human and environmental health. A recent study (Pimental, 2005) estimated the environmental and societal impact of pesticide use to be around $10 billion per year[1] in the US. In the UK, Pretty et al. (2000) estimated the annual costs of pesticide-related acute health effects incurred by farmers to be around £1.05 million. However, in developing countries, studies of health costs to farm workers and applicators suggest much lower numbers. For example, Yanggen et al. (2003) estimated that immediate costs equaled 11 days of lost wages per year in Ecuador. In Sri Lanka, a study using the cost-of-illness[2] and avertive behavior[3] approaches (Wilson 1998, 2003) estimated that a farmer incurs an average annual cost of $97.58 and 7.23 in handling and spraying of pesticides, respectively. The same study also used contingent valuation, in which an individual was asked an open-ended question regarding the maximum amount they would be willing to pay in order to avoid direct exposure to pesticides and the resulting morbidity effects. This inquiry yielded a value of $204.83 per individual per year. Wilson (2003) argued that when a person is asked how much he/she would be willing to pay to avoid ill health resulting from pesticides exposure, he/she would likely consider all the costs of illnesses (including money and time), intangible costs (such as pain, stress, suffering, and discomfort) and the defensive costs incurred in revealing his/her true willingness to pay to avoid direct exposure to pesticides. In West Africa, Ajayi (2000) calculated costs of pesticide use in the case of a cotton (*Gossypium* spp.) - rice (*Oryza sativa*) system to be $3.92 per household per season. In Mali, Ajayi et al. (2002) estimated that annual indirect and external costs of pesticide use at $10 million. In Zimbabwe, Maumbe and Swinton (2003) calculated the health costs of pesticide-related direct and indirect acute health effects to be, on average, $4.73 in Sanyati and $8.31 in Chipinge. In Nepal, Atreya (2005) reported that commercialization of agriculture had introduced new crops, increased application of toxic pesticides, and increased health hazards for farmers. The same study estimated annual costs of illness due to pesticide use to be around $16.80. Farmers' willingness to pay for safer pesticides was around $132.80 per household. However, another study (Atreya, 2006) showed very low annual pesticides costs to human health of around $2.05 per individual. The latter underestimated the costs because the study failed to include pain and discomfort experienced from acute symptoms, the costs of long-term illnesses such as cancer, or environmental and ecological costs. Clearly, the environmental and social costs of pesticide use are enormous. To overcome these significant negative impacts of pesticide use, integrated pest management (IPM) is a method of choice.

Benefits of IPM

IPM, an ecologically based approach to managing pests, has been a growing paradigm in crop protection since the 1960s. The benefits of IPM are usually evaluated in terms of reduced pesticide expenses, increased yields, and reduced environmental and health costs (Wiebers, 1993). In Bangladesh, Mahmoud and Shively (2004) showed that access to IPM technology increased household welfare. In Australia, Herath (1998) cited the work of Grinter, which estimated the reduction of costs through reduced pesticide use by the adoption of IPM alone to be $110/ha. In Canada, a physical risk assessment approach and contingent valuation survey were used to identify the value of environmental benefits from changes in the level and types of pesticides applied in Ontario agriculture. This study found the reduction in external costs associated with the changes in pesticide use, between 1983 and 1998, to be $188 per household annually (Brethour and Weersink, 2001). Application of IPM techniques in Indonesia saved about $1200 a year per farm through reduced pesticide use, a total estimated benefit of $1 billion (ADB, 1999). In Vietnam, IPM techniques adopted by 92% of the Mekong Delta's 2.3 million rice farm households led to a reduction of insecticide applications from an average of 3.4 per farmer per season to just one application (IRRI as cited in Wood et al., 2000). Similarly in the Mekong Delta, Dung and Dung (1999) reported a 400 kg/ha increase in rice yields with concurrent lower health costs for IPM farmers ($6.82) as compared to non-IPM farmers ($6.96) in a single cropping season.

The Food and Agricultural Organization (FAO) (2002) also listed significant findings regarding IPM use in developing countries. In India, adoption of IPM decreased conventional pesticide use by 50% on average. Incomes increased by Rs 1000–1250/ha and rice yields increased by 250 kg/ha. A survey of 2000 farmers trained in and who has also implemented IPM techniques in Indonesia found increased rice yields by an average of 500 kg per hectare and the number of pesticide application decreased from 2.9 to 1.1 per season. Reduced insecticide use (2.9–0.5 applications per season for rice) and increased yields (by 12–44% for rice and 7–44% for vegetables) were observed in Sri Lanka. Cuyno et al. (2001) assessed IPM-induced reduction in environmental risks (such as risk of pesticides to humans, birds, aquatic species, beneficial insects, and other animals) in the Philippines and estimated the per capita environmental benefits to be around $32.6.

Development of community IPM

The adoption of IPM to control pests and diseases was found to be effective in terms of reduced pesticide use and increased yields (FAO, 2002). Although low rates of adoption of IPM had been observed (Morse and Buhler, 1997; Trumble, 1998), the success of IPM Farmer Field Schools (FFS) in many countries has opened up a new approach to the development of sustainable, small-scale agricultural systems in developing countries. This new approach has been identified as community IPM (Pontius et al., 2000). Community IPM is a strategy for sustainable agriculture development where farmers act on their own initiative and analysis, identify and resolve relevant pest and crop-related problems, conduct their own local IPM research and education, establish or adapt local organizations that enhance the influence of farmers in local decision making, employ problem solving and decision-making processes, create opportunities for all farmers in their communities to develop themselves, and promote a sustainable agricultural system (Pontius et al., 2000). The concept of community IPM has been successfully implemented, and is the most advanced, in Indonesia and Vietnam (Matteson, 2000). Also in Philippines, participatory IPM was noted to be a useful approach, resulting from the implementation of an IPM research program for small producers (Norton et al., 1999).

Pesticide use and community IPM in Nepal

Studies done in many countries have shown significant social and environmental costs of pesticide use. These were minimized to some extent by the adoption of IPM techniques. The consumption of pesticides in Nepal, however, is still negligible compared to that of countries such as India, Indonesia, and Vietnam. As yet, pesticides' adverse effects on human health and environment have not reached alarming proportions. A total of 176 metric ton of active ingredients of pesticides was imported, and 184 metric ton of active ingredients consumed in 2003 in Nepal (Shah, 2006). However, a few studies (Dahal, 1995; Pujara and Khanal, 2002; Shrestha and Neupane, 2002; Adhikari, 2004; Atreya, 2005, 2006; Lavaju, 2005) have emphasized pesticide pollution in the market-oriented commercial production areas and call for urgent attention to the need to implement IPM. Empirical research on IPM is completely lacking, even though Adhikari (2002) has tried to highlight its importance for sustainable agriculture. The government of Nepal has also prioritized the promotion of IPM to minimize pesticide use in various national plans and policies.

Nepal's IPM activities started only in 1997. Over 16,000 farmers have participated in 630 season-long FFSs nationwide since its inception to May 2002 (Adhikari, 2002) (Table 1). The concept of community IPM was introduced through FFSs during 1999 but was curtained shortly thereafter (in 2002) due mainly to lack of external financial and technical support. The FAO, Cooperative for Assistance and Relief Everywhere (CARE), and World Education had provided financial and technical support until 2002. At the current time, the Nepalese Government allocates local budgets for FFS through the District Agricultural Development Offices. The community IPM Program in Nepal made good progress initially, but is presently vulnerable and needs financial support to sustain its activities.

IPM and vegetable cultivation

Vegetable cultivation has emerged as a preferred enterprise for income generation (Brown and Shrestha, 2000; Brown and Kennedy, 2005) in the mid-hills of Nepal due to favorable climatic conditions for both winter and summer season vegetables. Brown and Kennedy (2005) estimated significantly higher annual gross margin from farms growing vegetables ($137) compared to farms growing only staple crops ($12). Farmers growing vegetables are likely to place a high demand for IPM because pesticide use is considerable higher in vegetables than in cereals. The present study tested the hypothesis that local households could be a possible source of funding for community IPM. Due to lack of external funding for community IPM in vegetable crops, this paper postulated the following research questions: (a) Would local individuals be willing to pay (WTP) for community IPM? (b) If so, how much? (c) What factors determine the individual's WTP?

Methods and procedures

For this investigation, an agriculturally intensified area in a mid-hill watershed of Nepal was selected. The Jhikhu Khola Watershed has the highest cropping intensity (three crops/year) in Nepal (Brown and Shrestha, 2000), covers 11,141 ha, is located at an elevation ranging from 800 to 2200 m above sea level, and has humid subtropical to warm temperate climates. The watershed is located 40 km east of Kathmandu and is accessible via the Arniko Highway. Total population of this watershed was 48,728 with an average family size of six in 1996. Brahmin, Chettri, Tamang and Danuwar are the major ethnic groups represented and all the farmland is privately owned. The Jhikhu Khola Watershed consists of 17% khetland (irrigated low land), 38% bariland (sloping upland terraces), 30% forest, 6% grassland, 7% shrub land, and 3% other land use. The major cash crops grown at the time of the study were potato (*Solanum tuberosum*), tomato (*Lycopersicon esculentum*) and other vegetables like cucumber (*Cucumis sativa*), bitter gourd (*Momordica charantia*), cabbage (*Brassica oleracea* var. *capitata*) and cauliflower (*Brassica oleracea* var. *botrytis*). Water availability is the main limiting factor for winter crops. This study selected Panchkhal and Deubhumi Baluwa Village Development Committees regions within the watershed. These are the mostly intensified areas of the watershed; use of pesticides is very high, ranging

Table 1. Farmer field schools (FFS) conducted by Government of Nepal and partners.

Organizations	1998	1999	2000	2001	To May 2002	Total
Government of Nepal	–	20	30	46	–	96
Food and Agricultural Organization	35	66	56	65	–	222
Cooperative for Assistant and Relief Everywhere	–	–	3	19	–	22
World Education	–	–	15	76	23	114
Farmer-to-Farmer	–	2	34	140	–	176
Total	35	88	138	346	23	630

Source: Adhikari (2002).

from 2 to 15 applications for tomatoes and potatoes. The share of pesticides in the cost of production of various crops ranged from zero percent for wheat to 8.4% for bitter gourd (Shrestha and Neupane, 2002). Unwillingness to risk economic losses, ease of availability, and comparatively low share of production costs are the forces driving individuals to opt for pesticides.

Sampling procedures

Each Village Development Committee is composed of nine Wards – the smallest administrative unit in Nepal. The government of Nepal (Election Commission) maintains household information like individual name, age, sex, village and address at the ward level. Thus, the voter list was the sampling frame for this study. Each ward may be comprised of many villages. The village with the highest number of households was selected in those wards that had less than 100 households. Similarly, two villages (with the highest and second highest household number) were selected from those wards that had more than 100 households. It was assumed that villages with the highest and second highest household numbers were representative of populations of the wards and conclusions could thus be generalized. A total of 292 households were randomly and proportionately selected from these villages. This study interviewed only one member of each household – the individual who sprayed pesticides most of the time.

Elicitation methods for WTP

The WTP question was based on the assumption that a behavioral linkage exists between a change in the supply of environmental goods and its effects. The measurement of benefits from a change in the supply of environmental goods is calculated based on the behavioral response of users in the hypothetical situations. Among different elicitation methods for valuing hypothetical non-market goods, dichotomous choice and open-ended bidding techniques were used due to simplicity in administration of the survey.

The WTP question consisted of three parts: (a) background, (b) selection of a specified amount of WTP options, and (c) an open-ended maximum WTP for a 5-day community IPM training per year. The background contained five paragraphs, each of which provided general information about the study. The first paragraph informed an individual about the negative externalities of pesticides on human health and environment including livestock, birds, wildlife, air, water and soil. The second paragraph highlighted community IPM and provided information about training modules and their importance. The third paragraph explored the necessity of community IPM training for an individual. The fourth paragraph examined the adequacy of community IPM in the study area. The final paragraph explored community IPM characteristics as well as implementation processes through community groups. In this case, CIPM referred to community-managed resources, organized by community groups at monthly intervals. Each individual was informed that they would have the opportunity to attend only one 5-day community IPM training event in a year; and for this he/she would have to pay on a monthly basis throughout the year. The background section was followed by "willingness to attend" community IPM training. If an individual expressed willingness, he/she was interviewed further; otherwise, individuals were requested to state reasons for their unwillingness to attend.

Individuals were informed about the funds required to implement IPM training at the local level. An individual was then asked whether he/she would be willing to pay Nepalese Rupees (NPR) 20 per month[4] to community group for implementing community IPM training. If an individual answered positively, he/she was further asked to bid a maximum WTP >20. If an individual answered negatively to the initial amount, he/she was also asked to bid a maximum WTP <20/month.

Data and method of collection

The data were collected using a structured questionnaire during August and September 2005. Household demography, personal characteristics, farm size and characteristics, history of pesticide use, history of chronic illness, and property of the households were collected. Five field staff members, continuously involved in dose–response assessment of pesticide use since January 2005, were employed for the survey. The staff first attended a 2-day intensive training on administration of the survey instrument. The research team piloted the survey questionnaire with 20 individuals in the presence of all staff before handing over full responsibility. A field office was established at the center of the study area, and weekly meetings, including all field staff and the research team, were held. During these meetings, completed survey forms were checked for missing data, codes, and spelling; and if necessary, were corrected.

Statistical analysis

It was paramount to identify factors determining individuals WTP for the new environmental good. Therefore, in addition to frequency tabulation and descriptive statistics, this study used Probit[5] regression for identifying determinants of WTP NPR 20 per month for community IPM training. The econometric model specification was:

$$y_1^* = \beta_1 x_1 + \varepsilon_1, \quad y_1 = 1 \text{ if } y_1^* > 0, \quad 0 \text{ otherwise}$$

The binary dependent variable y_1 is whether or not an individual was willing to pay NPR 20 per month for the community IPM training. The x_1 is the vector of explanatory variables and ϵ_1 is random error. The vector of explanatory variables and expected signs are listed in Table 2 and the model was specified as:

$$y_1 = \beta_1\text{GENDER} + \beta_2\text{AGE} + \beta_3\text{EDU} + \beta_4\text{IPM} + \beta_5\text{ENVIRON} + \beta_6\text{LABEL} + \beta_7\text{PROPERTY} + \beta_8\text{GROUP} + \varepsilon_1$$

This study also used an Ordinary Least Square (OLS) regression to identify factors affecting an individual's maximum WTP for community IPM training. The dependent variable here was the maximum rupees (NPR/month) that an individual would be willing to pay for community IPM training. The explanatory variables were the same as for Probit regression.

It is argued that men in Nepalese society have control over resources and enjoy more income opportunities than women. Men may also have better knowledge on the alternatives to pesticides because of higher mobility in the society. It was, therefore, assumed that males would express greater prefer for participating in community IPM training compared to females; and that men would be willing to pay NPR 20 or more. Also, older individuals were expected to pay less for community IPM. This is because age reduces farm work ability, especially when the work involved was labor intensive (Wilson, 1998). Age of an individual (AGE) was, therefore, included in the regressions; assuming that the higher the age, the lower would be the likelihood of WTP NPR 20/month, and would also lower the bidding value for community IPM training.

Formal education was assumed to be positive, because well educated individuals were likely to have knowledge on the environmental impacts of pesticide use, as well as enjoy better job opportunities (Adhikari et al., 2004) than less or uneducated people. Furthermore, educated individuals may have developed leadership roles within the society. Therefore, due to the knowledge about the environment, job opportunities, and leadership characteristics, an educated individual had a higher probability of accepting NPR 20/month and would also be expected to bid higher for community IPM. In the study area, government and non-government organizations had already trained some individuals on IPM through FFS. These IPM-trained individuals were assumed to have better knowledge on sound use of pesticides and their alternatives. They may have even tried farming with such technology. Therefore, because of prior training and knowledge, IPM-trained individuals were assumed to perhaps to be unwilling to pay for addition training. Thus, it was assumed that "IPM" was negatively related to the WTP for community IPM training of those individuals with prior training.

The bid value for community IPM training also depended on an individual's knowledge of the negative externalities of current pesticide use, especially on the environment and subsequently human health. An individual who believes that pesticides are harmful to environment may accept the specified amount for community IPM training, and he/she may even bid higher. Therefore, it was hypothesized that whether or not an individual knew that pesticides affected the environment (ENVIRON) positively determined his/her probability of accepting WTP NPR 20 and the maximum WTP bid for community IPM training.

Pesticides are grouped according to their toxicity, which is described by icons or words on the label of the containers. Reading of the pesticide label before mixing and spraying helps develop awareness of the pesticide's hazards. An individual knowledgeable about pesticide labels can classify pesticides according to their hazard to human health, and such an individual may be more attentive to the effects of pesticides on health. It was therefore assumed that an individual who was aware of

Table 2. Lists of explanatory variables and hypotheses used in the probit and ordinary least square regressions.

Variables	Explanations	Hypotheses
GENDER	Dummy for gender (If male = 1, 0 otherwise)	+
AGE	Age of an individual (years)	–
EDU	Formal education (years)	+
IPM	Dummy for IPM training (If an individual is already trained = 1, 0 otherwise)	–
ENVIRON	Dummy for an individual's knowledge of pesticides effects on environment (If yes = 1, 0 otherwise)	+
LABEL	Dummy for an individual's awareness on toxic label on the pesticide containers (If understand and aware = 1, 0 otherwise)	+
PROPERTY[a]	Natural log of the monetary value of an individual property (NPR)	+
GROUP	Dummy for whether an individual is presently involved in community group or not (If yes = 1, 0 otherwise)	+

[a] This is the sum of present market prices of all the property that a household incurred. Respondents were reluctant to provide bank balance and jewelry in the pilot study, so these were not included in the main survey. Valuation of the property was done through focus group discussions to maintain uniformity.

and could understand the label on the pesticide containers (LABEL) would be willing to pay NPR 20/month and may bid more for community IPM training.

The economic status, i.e., wealth, of an individual was likely to be correlated with their willingness to pay for community IPM training. Thus, PROPERTY was assumed to be positively related to the probability of accepting the specified amount, and the maximum WTP bid for the training. GROUP refers to whether an individual was, at the time, involved in community groups or not. An individual who was exposed to community groups, such as forest users group, vegetable cooperative, village level credit and cooperative, and so forth, was likely to have better leadership and group dynamics skills. It was therefore assumed that an individual's involvement in community groups increased the probability of accepting NPR 20/month or more for IPM training.

Table 3. Frequency of willingness to pay for community integrated pest management training (NPR/month).

Amount (NPR)	Frequency	%
5	15	6.3
10	55	22.9
15	17	7.1
20	128	53.3
30	11	4.6
50	11	4.6
100	3	1.3
Total	240	100.0

Table 4. Mean and standard deviation of WTP for community IPM trainings with respect to WTP categories.

WTP category	Individuals	Mean	Std. Dev.
WTP < NPR 20/month	87	10.11	3.048
WTP ≥ NPR 20/month	153	24.44	13.372
WTP > Zero/month	240	19.25	12.834

Results

Willingness to attend community IPM training

Out of 292 individuals, 92.5% were willing to attend community IPM, 4.8% were not, and 2.7% did not respond. This clearly shows that a majority of individuals were interested and could allocate working days for community IPM. Because the WTP question binds an individual to spend time away from other daily activities, the main reason for non-willingness to attend community IPM was time availability. In addition, if an individual was not the decision maker in the household and was illiterate, he/she was either unwilling to attend or did not respond.

WTP for community IPM

A total of 270 individuals were willing to attend community IPM training, however, only 56.7% were WTP the specified amount, while 43.3% were not. Thirty individuals were not WTP even a single rupee. The frequency (Table 3) shows that more than 50% individuals were WTP NPR 20/month. This clearly indicated a starting point bias. The average WTP that was below the cutoff amount was NPR 10/month; and WTP equal or above cutoff point was NPR 24/month (Table 4). In general, most extension organizations have so far trained individuals free of cost in Nepal. The author was also aware that non-governmental organizations, international non-governmental organizations and extension organizations even paid daily allowances for participants to attend training programs. Furthermore, some organizations freely distributed T-shirts and caps to advertise their names and logos. In the study area, FFS-IPM has, thus far, been provided free of cost. Although the intention was that the local participants should contribute one-third of the total costs of FFS, this had not happened (Ratna K. Jha, Department of Agriculture, personal communication). Thus, free availability of such training programs was the prime reason for unwillingness to pay for community IPM. Nonetheless, 82% individuals showed a positive WTP, thus indicating a high demand of community IPM training in the study area.

Determinants of WTP

In order to identify factors determining individual's demand for community IPM, Probit regression was constructed for WTP NPR 20/month, and an ordinary least square regression was constructed for maximum WTP. The summary statistics of the variables used in both regressions are shown in Table 5. Males dominated the sample, the average individual's age was 34 years, formal education was very low, and only 9% of individuals had prior IPM training. Most were aware of negative effects of pesticides on environment, and nearly half of the individuals were aware of the pesticide labels on containers. A lower number of individuals (29%) were involved in community groups. In general, the descriptive statistics showed that respondents in the sample were middle-aged men with low levels of formal education, IPM training, and group activities who possessed medium level of awareness on the pesticide label but a high level of understanding on negative impacts of pesticides on environment.

Table 5. Mean and standard deviations of the dependent and explanatory variables used in the probit and ordinary least square regressions.

	Mean	Std. Dev.
Dependent variables		
Willingness to pay NPR 20/month (If yes = 1, 0 otherwise)	0.57	0.4965
Maximum WTP (including zero values)	17.11	13.530
Explanatory variables		
GENDER	0.860	0.345
AGE	33.720	10.580
EDU	5.660	4.043
IPM	0.090	0.280
ENVIRON	0.890	0.310
LABEL	0.480	0.501
PROPERTY	5.985	0.339
GROUP	0.290	0.453

The Probit regression (Table 6) indicated that GENDER was positive and significant at the 10% level. Men were more likely to be willing to pay the specified amount than female counterparts, which was expected. Also as anticipated, AGE was a negative determinant, but was not statistically significant. The effect of formal education (EDU), though postulated to be positive, turned out to be a negative and significant (at 5% level) determinant of WTP. An individual already trained in IPM was more likely to be willing to pay for community IPM training. For IPM-trained respondents, the probability of willing to pay increased by 0.25. This was contrary to our expectation. Another notable results from Table 6 was that ENVIRON and LABEL positively and significantly (at 1% level) determined the WTP. An individual who was aware of the adverse impacts of pesticides on environment and understood the pesticide labels was more willing to pay than those who were unaware. The marginal effects of ENVIRON and LABEL on WTP indicated that individual's knowledge on ENVIRON and LABEL increased the probability of willing to pay by 0.28 and 0.22, respectively. This suggests that before launching community IPM, it is necessary to make local farmers aware of the harmful effects of pesticides on human health and the environment and to familiarize them with pesticide labels. Greater the property owned and involvement in community group, although increased WTP, but were not significant for predicting WTP.

Table 6. Determinants of WTP NPR 20/month for community IPM training.

Variables	Coefficient[†]	Std. error	*t*-test
GENDER	0.4408 (0.1744)	0.2571	1.71*
AGE	−0.0118 (−0.0046)	0.0089	−1.33
EDU	−0.0546 (−0.0214)	0.0273	−2.0**
IPM	0.7134 (0.2503)	0.3347	2.13**
ENVIRON	0.7322 (0.2841)	0.2797	2.62***
LABEL	0.5603 (0.2168)	0.1940	2.89***
PROPERTY	0.3770 (0.1480)	0.2598	1.45
GROUP	0.1940 (0.0754)	0.1996	0.97
CONSTANT	−2.7927	1.5111	−1.85*

Log likelihood = −164.477, pseudo R^2 = 0.10, No. of observation = 267

[†] Marginal effects are given in parenthesis.*, ** and *** indicates significant at $\alpha = 0.10$, 0.05 and 0.01, respectively.

The ordinary least square regression for maximum WTP for community IPM (Table 7) also showed similar results as those of Probit. Men were willing to pay more than women. EDU negatively determined the maximum WTP while IPM and ENVIRON positively and significantly determined the maximum WTP. Two contrasting results however, were observed for the ordinary least square regression. The first one is LABEL, which was not significant; and the second one is PROPERTY, which was significant at the 1% level. This indicated that economic status was an important factor in determining a respondent's maximum WTP. The monetary value of the property was taken as a proxy of income or economic status of the individual in society. More property meant higher income, and relatively well-to-do. Therefore, economically well-off individuals showed higher WTP for community IPM than poorer respondents.

When interpreting and discussing the above results, caution must be exercised in comparing the two analytical methods, Probit and ordinary least square. Probit framework models the probability of an individual's WTP while controlling other explanatory variables; whereas ordinary least square is a simple linear regression. Our analysis showed that men had greater probability of

Table 7. Determinants of maximum willingness to pay for community IPM training.

Variables	Coefficient	Std. error	*t*-test
GENDER	4.6369	2.5193	1.84*
AGE	−0.0772	0.0850	−0.91
EDU	−0.4703	0.2613	−1.80*
IPM	12.6324	2.9523	4.28***
ENVIRON	7.1270	2.6529	2.69***
LABEL	2.9477	1.8667	1.58
PROPERTY	6.6753	2.5424	2.63***
GROUP	−1.2803	1.9147	−0.67
CONSTANT	−30.1145	14.7464	−2.04**

R^2 = 0.1495, adjusted R^2 = 0.1231, standard error of the estimates = 12.739
F (8, 258) = 5.67, p = <0.000, No. of observation = 267

*, ** and *** indicates significant at $\alpha = 0.10$, 0.05 and 0.01, respectively.

WTP NPR 20/month and bid higher maximum WTP for community IPM than women. This may be due to their control over household resources as well as better knowledge about pesticide hazards to environment and health. Furthermore, this is likely a result of the patriarchal society prevalent in Nepal; the male population is more mobile, whereas women are traditionally more confined to the household. A study on WTP for cataract surgery in Nepal (Shrestha et al., 2004) also found that men were more willing to pay than women.

The education of a respondent negatively determined the probability of WTP NPR 20/month and maximum WTP for community IPM training at the 10% significance level. This was contrary to our hypothesis, but can be explained. Educated individuals do not necessarily have a better understanding of pesticide damages to health and the environment, especially since the traditional Nepalese educational curriculum lacked a focus on environmental education. Although the Curriculum Development Centre, Government of Nepal, recently introduced a course entitled "Population and Environment" in the primary and secondary school levels, there is a dearth of chapters that deal with pesticide use or its externalities and alternatives. Additionally, due to lack of job opportunities in Nepal, educated individuals may also lack sufficient earnings to indicate WTP for IPM training.

It was also hypothesized that an individual already trained in IPM would not be willing to pay NPR 20 or more, but the empirical results showed the opposite. IPM-trained individuals had a higher chance of WTP NPR 20/month and they bid higher values for community IPM training. This strongly suggests that these respondents were more aware of negative effects of pesticide use on their health and environment, and thus, favored ecological pest management approaches. Similarly, an individual who perceived that pesticides were harmful to environment was more likely to accept the specified amount or higher for such training. During the survey, numerous respondents offered examples to the author about environmental degradation due to pesticide use, such as a reduced number of honeybees, snakes and birds; and hardening of soils. A study in Nepal also showed that a positive perception with regard to technology significantly increased adoption (Neupane et al., 2002).

An individual who knew about pesticide labels had a higher probability of accepting NPR 20/month; however, the same person did not necessarily bid higher for community IPM training. Many respondents believed that pesticides were more harmful to the environment than to their health. These individuals had been using pesticides for a long time, and to date had not suffered direct health impacts (with the exception of pesticides implicated in suicides). Therefore, they equated NPR 20/month to health costs, and would not bid a higher value for community IPM due to the belief that health effects of pesticides were low compared to environmental degradation. The empirical results also indicated that the monetary value of a respondent's property did not significantly predict probability of accepting NPR 20/month for community IPM, yet was a significant determinant for predicting maximum WTP. This implied that whether an individual was well-to-do or poor, the probability of WTP NPR 20/month for community IPM was similar, but for the same ecological pest management training, an individual's maximum willingness to pay significantly depended on his/her economic status.

Calculation of WTP for all households

The household WTP for community IPM for the entire area under discussion is given in Table 8. The sample was divided into two groups according to their WTP NPR 20/month. The probability estimates were derived from the sample statistics for willingness to attend community IPM, WTP zero, and WTP greater than zero but less than 20, and WTP greater than 20 for community IPM training. Finally, along with these probabilities, the average statistics of WTP calculated for the sample (Table 4) was used to estimate WTP for all the households under study area. Total annual household WTP for community IPM was NPR 1,460,455 ($20,863.6) and the opportunity cost of 5 days was NPR 5,335,500 ($76,221.4).[6] The annual welfare gain by providing 5 days of community IPM training was estimated to be $25.23 per household. This estimate is slightly higher than a household's annual costs of illness ($16.8) plus defensive costs ($1.6) due to pesticide use; and significantly lower than WTP for safer pesticides ($132.8), estimated by Atreya (2005). Additionally, this cost is significantly higher than health costs estimated by Atreya (2006) for Nepal and by Cuyno et al. (2001) for the Philippines.

The costs estimated here indirectly assess the costs of pesticide pollution on farmers' health and environment, but they do not reflect the actual/potential costs of pesticide pollution. This is because pesticide pollution has an effect on multiple interacting factors in the environment, for example soil, surface and ground water, crop productivity, micro and macro flora and fauna including human health (Pimentel, 2005). This study has not valued the effects of pesticides on these large ranges of interacting factors. The present estimated cost faced starting point bias, as shown in Table 3 where more than 50% individuals were WTP starting amount (NPR 20); therefore, may not accurately reflect WTP for community IPM. Further, the estimated cost did not estimate the benefits of IPM such as the costs of pesticide reduction or increased crops yields as claimed by other studies. Furthermore, the value did not taken into account the decreased environmental and societal costs that would

Table 8. Calculation of annual willingness to pay for community IPM training.

For the sample population	Calculation	Results
Individual in the sample		292
Individual willingness to attend CIPM		270
Probability of an individual's willingness to attend CIPM (α)	270/292	0.9247
Probability of an individual's WTP zero (β)	30/270	0.1111
Probability of an individual's WTP >0 and <20/month (π)	87/270	0.3222
Probability of an individual WTP ≥ 20/month (γ)	153/270	0.5667
In the entire study area		
A total economically active individual in the selected two village development committees (3847 households), assuming that average family size is a 6 and two active member in a household (N)	3847*2	7694
Total number of individuals willing to attend CIPM (N_a)	$N \times \alpha$	7114
Total number of individuals WTP zero (N_0)	$N_a \times \beta$	790
Total number of individuals WTP >0 and <20/month (N_{0-20})	$N_a \times \pi$	2292
Total number of individuals WTP ≥ 20/month ($N_{\geq 20}$)	$N_a \times \gamma$	4031
Monthly average WTP >0 and <20 for the entire population ($MWTP_{0-20}$)	$10.11 \times N_{0-20}$	23,176.1
Monthly average WTP ≥ 20 for the entire population ($MWTP_{\geq 20}$)	$24.44 \times N_{\geq 20}$	98,528.5
Annual WTP >0 and <20 for the entire population ($AWTP_{0-20}$)	$MWTP_{0-20} \times 12$	278,112.8
Annual WTP ≥ 20 for the entire population ($AWTP_{\geq 20}$)	$MWTP_{\geq 20} \times 12$	1,182,342.2
Total WTP/year for CIPM in the study area (WTP)	$AWTP_{0-20} + AWTP_{\geq 20}$	1,460,455
Opportunity costs of time spent on 5 days CIPM training by 7114 individuals, assuming wage rate 150/day (C)	$N_a \times 5 \times 150$	5,335,500
Total annual welfare gain by attending a 5 days CIPM training for the study area (TC)	C + WTP	6,795,955
Per household annual welfare gain by providing 5 days CIPM training	TC/3847	1766.55

result from use of improved practices of pesticides management after training, and increased aesthetic value of the ecosystem due to decreased in pesticide use. If the full environmental, public health and social costs of pesticide pollution could be valued as a whole, the total costs of pollution would be significantly more than the estimated here. Therefore, it may be regarded as the lower indicator of the anticipated or perceived impact of pesticide pollution on farmers' health and environment, and can also be taken as a benchmark for implementing pesticide reduction programs in future.

Conclusion and policy recommendations

This is a pioneering empirical study in Nepal that examined farm-workers' WTP for community IPM training. The estimated WTP revealed that individuals were indeed in favor of community IPM. This study strongly suggests that the concept of community IPM can be re-implemented with the full support of local villagers. The community IPM demand functions showed that individual knowledge and awareness about pesticide impacts to human health and the environment are crucial for implementation of the program. The annual welfare gain by providing five days of community IPM training was estimated to be \$25.23 per household. This estimate can be regarded as an indicator of the impacts of pesticide pollution.

It is essential that national planners and policy makers appreciate and wisely use such information to make practical use of research data by transforming them into effective policies. Community IPM, recently curtailed due to lack of funding, should be re-implemented in a participatory manner with local farmers. Moreover, we recommend that the community IPM program be considered a preferred method for national pest management strategies, because CIPM not only minimizes use of toxic chemical pesticides, but also decreases the health, social and environmental costs of pesticide pollution. In order to achieve this goal, a government expenditure of at least \$25.23 per household per year for the adoption of IPM techniques would be economically and environmentally justified.

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Notes

1. The text implies that all $ are in US dollars unless otherwise indicates.
2. Measures direct costs such as medical expenses and indirect costs such as foregone earnings.
3. Measures the costs of precautions taken to reduce direct exposure to pesticide such as mask, handkerchief, long-sleeved shirt and pant and so on. This is also known as defensive behavior approach.
4. This was the monthly average Nepalese rupees (NPR), identified through focus group discussions that an individual was willing to pay for any community activities in the study area.
5. For the dichotomous dependent variables, the suitable models are either Logit or Probit. Between these two models, the main difference is that the logistic distribution has slightly fatter tails. That is to say, the conditional probability approaches zero or one at a slower rate in logit than in probit (Gujarati, 2003).
6. At the time of study, approximately NPR 70 equaled US $1.

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