Better health, more wealth: the impacts of farmer training in developing countries

Concern over high rates of pesticide poisoning in developing countries have prompted restrictions on the export of the most hazardous pesticides and the development of farmer training programmes to promote integrated pest management. ***Professor Homi Katrak*** *provides an overview of the situation and examines the impact of Farmer Field Schools. Data from four countries show impressive increases in farmers' rate of financial return after field school training. Health gains have not been formally documented, and he proposes some first steps in developing a method for quantifiying such gains.*

During recent years there has been increasing awareness and concern about the effects of pesticide poisoning on the health and livelihood of farmers, particularly in developing countries. The World Health Organisation (WHO) estimate that about three million cases of pesticide poisoning occur worldwide each year leading to 20,000 fatalities[1,2]. These account for 14% of all occupational injuries and 10% of all fatal injuries. Between one and three agricultural workers per 1,000 suffer from pesticide poisoning. These health hazards are proportionately much higher in developing countries: those countries account for only 25% of pesticide use worldwide but 99% of pesticide related deaths[3].

These stark official figures may actually mask the magnitude of the problem. The majority of farmers do not report pesticide related illness or seek medical advice. Some estimates put the actual incidence of pesticide poisoning at about three times greater than that reported by farmers[4], or even higher[5]. Some recent studies substantiate this view. In Nicaragua and Costa Rica only 20% of incidents were notified and in Andhra Pradesh state, India, only 8% of affected farmers sought medical advice[6,7].

Fieldwork studies show that farmers in developing countries incur substantial health costs due to pesticide related illnesses. These costs include medical expenses and income lost while farmers are sick and unable to work. In Ghana farmers' annual expenditure on medical treatment is about 7.5–10% of their wages and 18–42 working days are lost each season, while in Sri Lanka farmers lose 10 weeks income annually due to illness[8]. In Mali health costs have been estimated at about 8% of the cost of pesticides, while in China the figure is about 15% and in Zimbabwe the figures for two separate districts were 45% and 83%[9,10,11]. In addition, expenses for treatment of pesticide related illness may be an underestimate of the overall costs to farmers' health. Some farmers cannot 'afford' medical treatment so may either forego the necessary treatment or resort to home medication[12]. Some farmers are only concerned about the acute health symptoms and ignore the chronic health effects. Exposure to many common pesticides may damage the immune system weakening resistance to infectious diseases and cancers[13].

Underlying problems

A major factor underlying these health problems in developing countries is financial poverty and lack of information. Many farmers do not use protective clothing when applying pesticides; they lack information about the health hazards and/or cannot afford to purchase the appropriate items of protection. Farmers sometimes use obsolete and more hazardous pesticides; they lack the information required to recognise the more hazardous products and/or can afford only the lower-priced and more hazardous products. They also lack information about the appropriate quantities of pesticides to use leading to 'excessive' use and reduced financial returns relative to the cost of inputs.

Lack of precautionary measures

Health hazards from pesticides use could be reduced if farmers were to wear protective clothing and take appropriate precautionary measures. Studies in Tanzania, Cambodia, Ethiopia and Thailand point to four major problems[14,15,16,17]. Firstly, many farmers do not use protective clothing[18]. They often cannot afford them or can only afford clothing that is sub-standard and unfit for use. Some are unaware why protective items should be used; some farmers in the Philippines did not consider pesticides to be a health risk[19]. Secondly, some farmers are not well informed about suitable types of spraying equipment reducing the effectiveness of spraying and bringing poor results. Thirdly, farmers ignore certain practices that would reduce health hazards; they do not spray downwind (to reduce the risks of droplets drifting) and re-enter a sprayed field before the lapse of the recommended 'safe time'. Fourthly, farmers do not dispose of empty pesticides containers safely: they simply leave the containers in fields or re-use them for domestic purposes.

Use of highly hazardous pesticides

These problems are aggravated by the use of more toxic and hazardous pesticides. About 30% of the pesticides marketed in developing countries do not meet internationally acceptable standards of quality and safety. Some of the pesticides classified by the WHO as extremely, or highly, hazardous to human health have been officially banned in some developing countries. However these bans are often ignored and the agrochemical industry has even recently used international agreements to block such bans[20]. Moreover governments of some developing countries lack the human and financial resources to implement bans. Consequently some of banned items are still available on the black market. In Cambodia 40% of banned products are still available and in Iran farmers continue to use 25 types of pesticides that have been banned[21,22,23].

Some efforts are being made to help farmers distinguish between the extremely hazardous and relatively safer pesticides but unfortunately these measures have not always been successful. In Zimbabwe a simple colour code designed to help farmers distinguish between pesticides of different degrees of toxicity was not readily understood by 22–58% of the small farmers[24].

Excessive use

Further problems are caused by 'excessive' use of pesticides. The amounts used exceed the 'optimal' amounts recommended by government officials, agricultural extension agencies and manufacturers. This increases the health hazards and consequently the health costs. Moreover, the increased expenditure on pesticides leads to diminished financial returns.

Excessive use has three main causes. Firstly, many low-income farmers cannot read printed instructions about the optimal amounts to be used[25,26]. Some farmers rely on the advice given by pesticides vendors and/or rely on their own perceptions about the amounts to be used[27]. Secondly, farmers lack information about the health hazards and do not take health costs into account. They underestimate the overall costs of using pesticides and consequently overestimate potential financial returns. Thirdly, in earlier years excessive use had also been caused by government subsidies for pesticides.

Empirical evidence of excessive use is reported from a number of countries. In China the level of pesticides use is about 40% greater than that recommended, in India and Iran the corresponding estimates are 60–75% and 70–80% respectively, and in Benin, West Africa, the figure is about 50%[28,29,30,31].

International initiatives

Concern about these issues has led to two main types of initiatives by governments, international agencies and non-governmental organisations (NGOs). Firstly, efforts have been made to restrict the export of the most hazardous pesticides to the developing countries. Secondly, programmes for Integrated Pest Management (IPM) and Farmer Field Schools (FFS) have been established to make farmers aware of the health hazards and encourage them to reduce their use of hazardous pesticides and enhance their production skills.

Regulating export of hazardous pesticides

The International Code of Conduct on the Distribution and Use of Pesticides sets voluntary standards of safety and quality for exporters while the convention on Prior Informed Consent requires exporters of certain pesticides to obtain prior approval from the importing country. However, the success of these initiatives rests on cooperation by the exporters and on adequate monitoring by the importing countries[32].

Farmer training

Some of the problems of pesticide use may be greatly reduced by providing training through Farmers Field Schools (FFS) and Integrated Pest Management (IPM) programmes[33]. Through these programmes farmers are made aware of the health hazards, are trained to phase out the more hazardous chemical pesticides and use non-chemical pesticides (for example, neem), and are taught new skills and improved production methods. For example, in Mali the performance of IPM plots was compared with that of Farmer Practice plots (where normal applications of chemical pesticides were followed). Production costs on the IPM plots were 73.91% lower. Yields were also lower by 90.46% while net incomes were increased by 32.74%[34]. Some studies on the utility of FFS programmes in teaching new skills show mixed results. A follow-up study of FFSs in Indonesia found little evidence of improved skills amongst participating farmers[35]. In comparison, in Sri Lanka the skills of participating farmers were reported to have improved although there was little evidence of spill over benefits to other farmers[36].

Estimating benefits of FFS

This paper uses published data from IPM programmes in four countries to estimate their benefits to farmers. Two significant benefits are examined. Firstly, we examine the farmers' increased rate of financial return. Our procedure for estimating this allows for savings in pesticide costs and increases in farmers' incomes. The second benefit is the improvement in farmers' health that may result from the decrease in pesticide use. This may include the decrease in medical expenses and in the number of days lost off work. A comparison of the financial and health benefits may provide a broader basis to evaluate IPM programmes.

Estimation procedures and results

Data on percentage decrease in pesticide applications (or use) and on increases in net incomes was found for four countries that have recently implemented IPM programmes[37,38].

- In Vietnam the frequency of pesticide applications decreased by about 60% while net incomes increased by 20%[39].
- In Indonesia the frequency of insecticides applications decreased by 80% while yields increased by 23%[40].
- In Ghana the quantity of pesticides used decreased by 95% while profits increased by 30%[41].
- In Sri Lanka pesticides use decreased by 81% while profits increased by only 41%[42].

Note that these four studies use different measures, that is, net income, profit and yield. The former two may have a similar coverage and the third could also be closely related. Thus a comparison of the four countries' data is still of interest.

Rate of financial return

This data is first used to calculate the increase in the rate of financial return which is defined as the farmers' net income per unit of expenditures on pesticides. The increase in the rate of return will then depend on the *increase* in net incomes and/or the *decrease* in pesticide costs. In turn, the increase in net incomes could be due to a decrease in pesticides costs, a decrease in the number of days lost off work, an increase in yields and or a higher quality of product (that helps fetches a higher price). The rate of financial return is thus a more comprehensive measure than the increase in farmers' incomes. The former measure allows for two ways in which farmers may benefit from training programmes, namely a decrease in pesticides use and an increase in incomes resulting from increased yields.

The procedure to calculate the increase in the rate of return is illustrated for the case of Vietnam. Income has increased by 20% and so the level of income following the start of the IPM programme is 1.2 times higher than the initial level. Pesticide use has decreased by 60% and so the amount used is now only 40% of the initial level. Therefore the increase in the rate of return equals $[(1.2)/(0.4)] = 3.0$. The IPM programme has enabled a three-fold increase in the rate of return.

The three other countries have recorded even greater decreases in pesticides use and also higher increases in incomes and so have had even greater increases in the rates of return. The increases in rates of return in Indonesia, Sri Lanka and Ghana have been 6.0, 7.4 and 26.0 respectively

These gains seem quite impressive but should be qualified in one respect. The above data uses the decrease in pesticide applications (or use) and so does not allow for any changes in the unit costs (or prices) of the pesticides used. As IPM programmes train farmers to use less hazardous pesticides it is possible that the unit costs of pesticides use may increase. This could lead to an over-estimate of the increase in the rate of return.

Health gains

Health gains from IPM programmes can arise in three ways. Firstly, a decrease in pesticides use could help bring direct health gains: these would include a decrease in the number of days lost off work and a decrease in medical expenditure on pesticide related illness. Secondly, there may be long-term improvements in health, or at least a slowdown in the deterioration of health. Thirdly, an indirect benefit could arise if the increased incomes enabled farmers to obtain some medical treatment that they would not otherwise have been able to afford.

The magnitude of these gains will be related to the decrease in pesticide use. The greater the decrease in pesticide use the greater the likely increase in direct health gains, the greater the long term benefits and also the greater the increase in incomes and hence in indirect health benefit.

A full-scale estimation of these gains would require detailed data about: (i) the magnitude of the direct health gains, (ii) the monetary value that farmers attach to the long-term health benefits and (iii) the share of the increased income that is spent on medical treatment.

Such data is presently not available for the IPM programmes in the above four countries. However, pending the availability of such data, we can illustrate the broad orders of magnitude by using a set of alternative though purely hypothetical numbers. This will enable us to examine how the magnitude of direct health gains in our four countries are likely to compare with the reported increases in farmers' incomes.

The first step is to consider the relationship between a decrease in pesticides use and the direct health gains (defined above). We postulate that a decrease in pesticide use will lead to a less than proportionate decrease in medical expenses and/or in income losses due to days off work. The reason for suggesting this 'less than proportionate' relationship is that farmers' health may not fully recover from pesticide related illness even if the quantities of pesticides used have been significantly reduced. Health would not be fully restored to its previous level.

The magnitude of the health gain may differ from one household to another. Farmers that have had relatively high exposure to pesticides and whose health has been severely affected may experience only limited health gains from subsequent decreases in pesticides use. This suggests that the above-mentioned 'less than proportionate' effect may differ between households.

The calculation of the health gain is illustrated with reference to the cases of Vietnam and Indonesia. Suppose that the percentage decrease in the medical expenses and income losses will have been one-fifth lower than the decreases in pesticides use. In such case, the 60 per cent decrease in pesticides use reported for Vietnam will have helped bring about a 48 per cent decrease in the medical expenses and income losses. And the 80 per cent decrease in pesticides use reported for Indonesia will have helped reduce medical expenses and income losses by about 66 per cent.

These estimates of the health gains have of course been based on a purely hypothetical assumption of the likely decrease in medical expenses and income losses. Further research based on fieldwork data could help provide a check on the above results. It would also be of interest to consider any indirect health benefits; for instance increased incomes may enable farmers to purchase some health related items that they could not otherwise afford.

Summary

The high incidence of pesticide related illnesses in developing countries and the health costs faced by farmers has been documented in a large number of recent studies. The underlying causes of these problems are mostly associated with the general conditions of poverty. Low-income farmers lack information about the health hazards of pesticide use and/or cannot afford to purchase protective clothing. Moreover, farmers tend to use the cheaper and more hazardous types of pesticides, some of which are sold by un-licensed traders, and also often over-apply pesticides.

These problems have led some governments and international agencies to implement diverse training programmes, including Farmer Field Schools and Integrated Pest Management Programmes. Farmers are instructed to switch to safer and non-chemical pesticides, make optimal use of pesticides and introduce improved methods of production. This helps farmers in, at least, two ways: (i) the decreased in pesticide use and/or increased yields increases incomes and (ii) allows for some improvement in their health.

This paper has used data of from four countries to examine two aspects of FFS and IPM programmes. Firstly, we found that in all four countries there has been an impressive increase in the farmers' rate of financial return. Secondly, we calculated a health gain index. This took account of the possibility that a decrease in pesticide use may help reduce expenses for pesticides related illnesses and/or the loss of income due to days off work but yet may not fully restore farmers' health to its previous level. We found that in all four countries the estimates of the health gain index were significant. However those gains were lower than the increases in the farmers' rate of financial return.

Future research could help provide an empirical background for the arguments postulated in this paper. Surveys based on local records and/or interviews with farmers that have participated in IPM programmes could seek answers to two main questions. Firstly, has the decrease in pesticides applications and/or the switch to safer pesticides brought direct health benefits for farmers? Has there been a significant decrease in the medical expenses for pesticides related illnesses and/or in the number of days lost off work? Secondly have the increases in farmers' incomes brought indirect health benefits? Have the increased incomes been spent, at least partly, on health related items? Empirical evidence from field surveys would be very helpful in providing a check on the estimates presented in this paper.

It would also be of interest to compare the health gains and costs of IPM programmes with the benefits-costs of some less extensive programmes. One such programme would aim to increase the use of protective clothing. A network of agencies could help inform farmers about the health benefits of protective clothing and/or governments could provide a subsidy to make those items affordable to low income farmers. The health gains of using protective clothing would have to be compared with the resource costs of disseminating information and the fiscal costs of the subsidy. A second programme would aim to discourage excessive use of pesticides by imposing a sufficiently high tax. However it would be necessary to ensure that the income reducing effect of the tax does not discourage farmers from purchasing protective clothing. A third programme would aim to increase the facilities for prompt and effective medical treatment for pesticide related illnesses. Some developing countries suffer from a shortage of physicians, particularly in rural areas, and many of those persons are not sufficiently trained to recognise the symptoms of pesticides poisoning and provide adequate treatment.

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Bt cotton growers in China lose money due to secondary pests

Bt cotton is genetically modified to resist damage from bollworms, the primary pest affecting cotton yields. When first launched onto the market in 1996 it was quickly adopted by four major cotton growing regions, the US, China, India and Argentina. It offered the promise of protecting yields with significantly reduced use of insecticides. And for a crop renowned for its heavy use of the most hazardous insecticides this promise was sure to attract attention. A number of reports published in the years following documented significant reductions in pesticide use. And despite the high costs of Bt cotton seed some even indicated that Bt cotton adoption might increase financial returns for farmers.

However, alongside those convinced of the benefits of Bt cotton stood others who harboured grave doubts. What happens in an ecosystem once one species is removed? Other species move in to occupy that niche. The naysayers in the Bt cotton debate pointed out that this is exactly what would happen in a cotton field. Without the bollworm, other pests, previously of less significance, would move in. And while the toxin produced by the Bt gene is effective at reducing bollworm infestations it is not effective at countering secondary pests.

A new study is now proving these naysayers correct. Using a 2004 survey conducted in China researchers from Cornell University studied the economics of Bt cotton adoption in China. They found that by year three, Bt cotton farmers in the survey had cut their pesticide use by 70% and had earnings 36% higher than farmers planting conventional cotton. However, by 2004 (year seven) Bt cotton farmers were spending almost an equivalent amount on pesticides (US$101 per ha) as conventional cotton farmers. And, with higher seed costs, by 2004 Bt cotton farmers were earning 8% less than conventional cotton farmers.

Sustainable alternatives to both conventional and Bt cotton exist. Organic cotton farming is reducing the health and environmental impacts of this damaging crop. And with markets for organic cotton increasing year-on-year conversion to organic cotton holds the promises of a sustainable future for growers.

Tarnishing Silver Bullets: Bt Technology Adoption, Bounded Rationality and the Outbreak of Secondary Pest Infestations in China, Wang S, Just DR, Pinstrup-Anderson P, Paper presented at the American Agricultural Economics Association Annual Meeting, Long Beach, California, July 2006.

EPA bans lindane

On 2 August, 2006, the United States Environmental Protection Agency (EPA) finally withdrew registration of the pesticide lindane for agricultural uses calling it 'one of the most toxic, persistent, bioaccumulative pesticides ever registered.' Environmental health groups have applauded the step, and are now calling for the remaining uses of lindane in pharmaceutical products to be phased out.

Lindane has been used on crops since the 1950s but can cause seizures, and damage to the nervous and immune systems. It is a suspected carcinogen and hormone disruptor with possible links to endocrine-related cancers such as breast cancer. Lindane and its breakdown products are highly persistent in the environment and in the human body. A 2003 study from the US Centers for Disease Control and Prevention found that 62% of US residents sampled carried residues of lindane in their body.

Lindane was initially targeted for restriction and phaseout by the EPA in 1977. In 1983 the EPA limited its use to grain seeds to prevent pests from eating the plants. The current decision to end its use as an agricultural pesticide is the culmination of a 10 year review of over 200 active ingredients that was ordered by Congress in 1996 under the Food Quality Protection Act (FQPA). The FQPA transformed the EPA's standards for evaluating risks requiring that food tolerance limits be based on health rather than farming practices, and that vulnerable sub-populations, particularly children, be taken into account. Lindane is currently being considered for inclusion in the Stockholm Convention on Persistent Organic Pollutants.

Lindane has already been banned in at least 52 countries. However, in the US the Food and Drug Administration (FDA) continues to approve its use in shampoos and lotions for control of lice and scabies. These pharmaceutical uses are also approved in Canada. Given the particular vulnerability of children to pesticides this use of lindane is especially risky. As Ann Heil, of the Los Angeles County Sanitation Districts says 'it is baffling why the federal government has now banned uses of lindane for farming, but still allows it to be put on children's heads.' Use of these products on young children appears to be continuing despite new labelling required by the FDA warning of its dangers. Pharmaceutical uses of lindane for lice and scabies have been banned statewide in California since 2002, and legislation promoting similar bans is moving forward in Michigan and New York.

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Cone M, EPA Bans Lindane for Use as Pesticide, LA Times, 2 August 2006.