REDUCING THE NUMBER OF PESTICIDE-RELATED ILLNESSES: THE IMPACT ON HOUSEHOLD INCOMES IN INDONESIA

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The increasing number of human health problems caused by the use of pesticides serves as a warning to countries to develop preventive programs. Developing countries, however, are concerned about the effect of such programs on household incomes. With Indonesia as a case study, this paper presents a procedure to broaden a Social Accounting Matrix to include the impact of agricultural pesticide use on human health. This approach utilises the Constrained Fixed Price Multiplier method to analyse the effect, on the household incomes of different socio-economic classes, of government programs that are designed to reduce human pesticide-related illnesses. The results show that reducing such illnesses through the Safe Use of Pesticides program or the Integrated Pest Management program induces a more equal income distribution.

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INTRODUCTION

The 1950s food crisis in developing countries stimulated worldwide food intensification programs to improve the productivity of major crops such as rice, wheat and corn (Pimentel 1993). These programs included the large-scale adoption of high-yielding modern seed varieties, improved irrigation systems, and the increased use of chemical fertilisers and pesticides (Oka 1991). The impact of these intensification programs was remarkable. Total food production in developing countries grew at an annual rate of 3.2% during the 1960s, 1970s and 1980s (World Bank 1991).

At the same time, however, the increased use of pesticides has caused serious public health problems. The World Health Organization and the United Nations Environment Programme (WHO/UNEP 1989) estimated that, in the last two decades, approximately one million cases of human pesticide poisoning have occurred each year worldwide, mostly in developing countries. Of the annual one million, 20,000 have resulted in death, again mostly in developing countries (Pimentel 1993).

The seriousness of this situation dictates that developing countries consider, as a national priority, the development and implementation of programs that will reduce the number of pesticide-related illnesses. In general, however, priority is given to programs that improve income distribution.¹ In turn, only those programs considered national priorities receive the full support of government agencies, which ensures active program implementation. Thus, the crucial issue for developing countries is to determine the effect on income distribution of public health programs designed to decrease pesticide-related illnesses. The potential for an improvement in income distribution would provide the rationale for giving such programs national priority, thereby ensuring a high probability of success.

This paper analyses the impact of these public health programs on income distribution, specifically on the household incomes of different socio-economic classes in a developing country. Indonesia is used as a case study because, since the 1970s:

¹Developing countries also place a priority on programs that generate higher economic growth. Since this paper conducts only a comparative-static analysis, the impact on economic growth of programs designed to reduce the number of pesticide-related illnesses is not analysed.
1. Significant poverty alleviation has occurred in that country, the proportion of the population below the poverty line having fallen from approximately 40% in 1976 (Thorbecke 1992) to around 13% in 1995 (Kementerian Sekretaris Negara 1996); and

2. The Indonesian government has implemented two programs designed to reduce the use of pesticides and pesticide-related illnesses: the Safe Use of Pesticides program and the Integrated Pest Management program.

Since (1) and (2) occurred during the same time period, it is reasonable to analyse how these two government programs affect household incomes.

SOCIAL AND ENVIRONMENTAL (PESTICIDE) ACCOUNTING MATRIX

This section presents a procedure to expand a Social Accounting Matrix (SAM) into a Social and Environmental Accounting Matrix (SEAM) which incorporates the link from the economy to the environment as well as the feedback from the environment to the economy. The paper focuses on a SEAM which includes only the impact of agricultural pesticide use on human health as the closed link between the environment and the economy. Let us call this type of SEAM the Social and Pesticide Accounting Matrix (SPAM).

The first step in developing the SPAM (from a SAM) is to recognise the relationships among pesticides, agricultural activities, human health and health costs. Farmers (including agricultural labourers) who use pesticides face a higher risk of being poisoned by them than farmers who do not. Those who actually contract illnesses must spend money on health care. The health costs borne by these farmers (and agricultural workers) and the government are defined as the societal environmental economic cost of using pesticides.2

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2This paper certainly underestimates the total societal costs of using pesticides. Since environmental costs associated with the use of pesticides, such as animal poisonings and contaminated products, groundwater and surface water contamination, and fishery losses (Pimentel et al. 1992), are not yet available in Indonesia, limiting the scope of this research to human poisoning cases appears to be a reasonable choice.
### FIGURE 1  Principles of the Social and Pesticide Accounting Matrix

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>TOTAL</th>
<th>5</th>
<th>SUBTOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factors</td>
<td>Institutions including households</td>
<td>Production activities</td>
<td>Other accounts</td>
<td></td>
<td>Pesticide-related illnesses</td>
<td>TOTAL</td>
</tr>
<tr>
<td></td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
<td>a</td>
<td>b</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expenditure</td>
<td>Fractional income distribution (T_{10})</td>
<td></td>
<td></td>
<td></td>
<td>Income of institutions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Income distribution to households &amp; other institutions (T_{11})</td>
<td>Transfers, taxes &amp; subsidies (T_{12})</td>
<td></td>
<td></td>
<td></td>
<td>Gross capital formation</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Production activities</td>
<td>Interindustry demand (T_{13})</td>
<td></td>
<td></td>
<td></td>
<td>Exports</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a</td>
<td>Agriculture using pesticides</td>
<td></td>
<td></td>
<td></td>
<td>Output of agriculture using pesticides</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>Other activities</td>
<td></td>
<td></td>
<td></td>
<td>Output of other activities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c</td>
<td>Pesticide -health</td>
<td></td>
<td></td>
<td></td>
<td>Output of pesticide -health</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Other accounts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a</td>
<td>Complementary goods -imports</td>
<td></td>
<td></td>
<td></td>
<td>SOP CAD (a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>Rest of world</td>
<td></td>
<td></td>
<td></td>
<td>Aggregate savings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>Expenditure of factors</td>
<td>Expenditure of institutions</td>
<td>Demand for other goods</td>
<td>Demand for treatment</td>
<td>Aggregate investment</td>
<td>Foreign exchange inflow</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Pesticide-related illnesses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cost of treatment (m_{33a})</td>
<td></td>
</tr>
<tr>
<td>SUBTOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Demand for treatment</td>
<td></td>
</tr>
</tbody>
</table>

\(a\)Balance of payments current account deficit.
The next step is to expand the SAM to capture the flow between agricultural activities, human health and health costs. Figure 1 depicts a simple SPAM. Note that the upper left portion of the SPAM (i, j = 1 to 4) is the SAM. Pesticide-related illnesses are treated as by-products of agricultural activities that involve the use of pesticides (m_{34}). The pesticide-related illnesses then cause society to provide health services (m_{53}). Finally, farmers (including agricultural workers) and the government have to bear the costs of these pesticide–health services (t_{3c2}).

**Indonesian Social and Pesticide Accounting Matrix**

This paper uses the 1990 Indonesian SAM. The original SAM has been modified in two ways. First, pesticide-related illness sectors (Acute and Chronic Pesticide Poisoning) have been created. Second, the Pesticide–Health Service sector (health activities associated with pesticide-related illnesses in agricultural sectors) has been separated from the Public Services account, as has been the Agriculture–Pesticide sector from the Chemical and Basic Metal sector.

The data needed to create the pesticide-related illness sectors are the number of acute and chronic pesticide poisoning cases, and health care costs. Achmadi (1991) provides an estimation of poisoning cases in Indonesia: in 1988 approximately 3,000 cases of acute poisoning were associated with the use of pesticides in agricultural sectors. This paper assumes that the number of acute pesticide poisoning cases in 1990 is the same as in 1988. Achmadi also estimated that each year approximately 20% to 50% of farmers who use pesticides contract chronic pesticide-related illnesses. Based on Achmadi’s estimate, this paper uses a figure of 35% as the proportion of farmers who contracted chronic pesticide-related illnesses. According to the Central Bureau of Statistics (BPS 1991), approximately 40 million people worked in agricultural sectors in 1990 and around 28 million of them were farmers (and agricultural workers) who utilised pesticides. Thus, the estimate of chronic pesticide-related illness cases for 1990 is approximately 9.8 million.

The information on health care costs is based on several interviews with medical doctors working in public hospitals and public health centres in Jakarta. The estimated total health costs associated with acute and chronic pesticide poisoning cases in 1990 are Rp 0.68 billion and Rp

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These illnesses include headaches, weakness, insomnia, difficulties in concentrating, nausea, excessive sweating and salivation, and chest tightness.
8.33 billion, respectively. Hence, the Acute and Chronic Pesticide Poisoning sectors can be created.

The next step is to separate the Pesticide–Health Service sector from the Public Service sector. The number of farmers in each socio-economic class (BPS 1991) and the above estimates of the health costs of pesticide-related illnesses provide the income of the Pesticide–Health Service sector. The spending pattern of the Pesticide–Health Service sector is estimated using the spending pattern of public health that is available in the Indonesian Input–Output (I–O) table for 1990.

The last step is to separate the Agriculture–Pesticide sector from the Chemical and Basic Metal sector. The Agriculture–Pesticide sector represents the total quantity of pesticides used in the agricultural sector. These pesticides come from both domestic and foreign pesticide production activities. Data needed to create this account are available in the Indonesian I–O table for 1990.4

SIMULATION SCENARIOS

This section discusses several scenarios intended to simulate the two Indonesian government programs designed to reduce the number of pesticide-related illnesses.

At the beginning of the 1970s, the Ministry of Agriculture, in cooperation with the ministries of Trade, Industry, Manpower, and Health, started developing the Safe Use of Pesticides (SUP) program to minimize pesticide-related illness. The Ministry of Agriculture established a Pesticide Committee of experts in pesticide-related issues, who were drawn from research centres and directorates under the above five ministries. The committee's primary task is to ensure that pesticides are used safely and effectively in Indonesia. It controls the types of pesticides that can be distributed throughout the country and recommends techniques for their use.5 The Ministry of Health also developed a Subdirectorates for the Safe Use of Pesticides. Its main

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4 The full version of the Indonesian SPAM used in this paper can be requested from the first author. The SPAM has 23 factor inputs, 10 types of socio-economic households, and 24 production sectors.

5 At the end of the 1980s, the Pesticide Committee gained support from the National Development Planning Agency to actively control the types of pesticides that can be distributed in Indonesia. By 1991, the committee had banned 57 broad-spectrum insecticides and allowed the use of only a few relatively narrow-spectrum ones.
activities are to inform workers (including farmers) about standard safety procedures and equipment in working with pesticides, and to monitor the impact of pesticides on human health (Achmadi 1985).

In 1979 the Ministry of Agriculture launched a second program: the Integrated Pest Management (IPM) program. This program altered the reigning Indonesian pest control policy from a unilateral approach (depending solely on pesticides) to a more comprehensive one (combining various control tactics such as culture control, plant resistance, biological control, and pesticides). In 1986 the government intensified implementation of the program through Presidential Decree No. 3/86.6 Starting in that year, the National Development Planning Agency (Bappenas) took over the implementation. Bappenas invited officers and scientists from various government agencies, leading universities, and international organisations to participate. In 1989, a Working Group of Indonesian and international IPM experts was formed to guide the day-to-day implementation of the program.

The central activity of the IPM program is to educate farmers in integrated pest management using the 'learning by doing' method. The Working Group first trained extension workers and field pest observers to teach farmers. By the end of 1991, 2,000 extension workers and 1,000 field pest observers had been able to train about 100,000 farmers. Since 1991, around 200,000 farmers have been trained each year, with approximately 10% of them becoming one-on-one trainers. Each of these farmer trainers is required to train one farmer twice per year.

This paper analyses the impact on the economy of the IPM and SUP programs, using the following scenarios:

1. **SUP program**: In this scenario, an improvement in occupational safety standards results in a 50% reduction in the number of pesticide-related illnesses. The amount of pesticide use and the output of agricultural sectors remain unchanged. This scenario assumes that farmers employ better safety measures (such as safer equipment) in working with pesticides. It also assumes that new, safer equipment and other safety measures are relatively inexpensive.

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6Specifically, this presidential decree had the following objectives: develop manpower (both farmers and field personnel) at the grassroots level to implement the IPM program; increase efficiency of input use, in particular pesticides; and improve the quality of the environment and its influence on human health.
2. **Conservative IPM program:** In this scenario, a 60% improvement in the efficiency of pesticide use results in a 60% reduction in the number of pesticide-related illnesses. This scenario assumes that farmers are able to reduce the quantity of pesticides they use by 60%, while maintaining a constant level of agricultural output.

3. **Progressive IPM program:** In this scenario, a 60% improvement in the efficiency of pesticide use results in both a 60% reduction in the number of pesticide-related illnesses and a 12% increase in agricultural output.\(^8\)

These three scenarios will be applied to two categories of activities: first, to Food Crop activities only (scenarios 1a, 2a and 3a); and, second, to Non-food Crop activities only (scenarios 1b, 2b and 3b).

**RESULTS AND DISCUSSION**

To analyse the impact on household incomes of government programs designed to reduce human pesticide-related illnesses, this paper uses the Constrained Fixed Price Multiplier (CFPM) method (Resosudarmo 1996).\(^9\) This method is similar to the usual multiplier method derived from a SAM, except that in the CFPM method several outputs of the production sectors are held constant.\(^{10}\)

\(^7\)The separation of the IPM program into Conservative and Progressive is needed in order to observe the impact on household incomes if it turns out that the program is not able to increase agricultural output (conservative results), and if it does increase output (progressive results).

\(^8\)IPM program farmers were reported successful in reducing pesticide use by approximately 60% and in increasing crop production by approximately 12% (Oka 1991).

\(^9\)The derivation of this CFPM method can be requested from the first author.

\(^{10}\)This paper applies the CFPM method, instead of a fully-applied general equilibrium (GE) model, for two reasons. First, since its mathematics is much simpler than that of a fully-applied GE model, the CFPM can be applied easily in developing countries. Second, the CFPM does not need parameter specifications for production activities, for which Indonesia is lacking in reliable data.
Reducing the Number of Pesticide-Related Illnesses

Table 1 presents the results from the CFPM analysis. This table shows the percentage by which the incomes of different socio-economic classes of household change due to the implementation of programs to reduce the number of pesticide-related illnesses.

SUP Program: Scenarios 1a and 1b
Scenarios 1a and 1b show that the Urban High households bear the greatest burden of the SUP program. The program also reduces the incomes of Rural Non-labour, Rural High, Urban Low and Urban Non-labour households. However, Agricultural Employee, Small-scale Farmer, Medium-scale Farmer, Large-scale Farmer and Rural Low households are better off. Note that the SUP program benefits Agricultural Employee households the most.\textsuperscript{11}

The links below explain how the SUP program affects household incomes for different socio-economic classes:

- The fall in the number of pesticide-related illnesses reduces the activity level as well as the income of the Pesticide–Health Service sector. The Clerical and Professional Paid Rural workers and the Clerical and Professional Paid Urban workers suffer the most from this reduction. The Clerical and Professional Paid Rural workers belong primarily to the Rural High households, the Clerical Paid Urban workers to the Urban Low and Urban High households, and the Professional Paid Urban workers to the Urban High households. Other important links are that the reduction in payment to the Clerical Paid Urban workers significantly decreases the total income of Urban Non-labour households, and the reduction in payment to the Professional Paid Rural workers decreases the income of Rural Non-labour households.\textsuperscript{12} These links explain why Rural High, Urban Low, Urban Non-labour, and Urban High household incomes fall.

\textsuperscript{11}To approximate the impact on household incomes of the SUP program applied to both Food and Non-food Crop sectors, one just needs to add columns 1a and 1b. The difference between the results from this addition and those from reapplying the CFPM method to simulate the SUP program simultaneously on Food and Non-food Crop sectors is trivial. This rule also applies for scenarios 2 and 3.

\textsuperscript{12}These links and relationships can be read from the matrix of marginal expenditure propensities of the SPAM.
TABLE 1 Estimated Impact of IPM and SUP Programs on Total Incomes of Socio-economic Groups\textsuperscript{a} (Rp billion, %)

<table>
<thead>
<tr>
<th>Household Classifications</th>
<th>SUP Food (1a)</th>
<th>SUP Non-food (1b)</th>
<th>Conservative IPM Food (2a)</th>
<th>Conservative IPM Non-food (2b)</th>
<th>Progressive IPM Food (3a)</th>
<th>Progressive IPM Non-food (3b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Employee</td>
<td>0.0167</td>
<td>0.0067</td>
<td>11.3674</td>
<td>6.9683</td>
<td>346.5349</td>
<td>115.6479</td>
</tr>
<tr>
<td>Small-scale Farmer</td>
<td>0.0388</td>
<td>0.0156</td>
<td>61.2046</td>
<td>21.2223</td>
<td>185.1303</td>
<td>388.4150</td>
</tr>
<tr>
<td>Medium-scale Farmer</td>
<td>0.0014</td>
<td>0.0042</td>
<td>16.1648</td>
<td>5.4645</td>
<td>473.5001</td>
<td>96.7492</td>
</tr>
<tr>
<td>Large-scale Farmer</td>
<td>0.0154</td>
<td>0.0062</td>
<td>22.2309</td>
<td>7.5834</td>
<td>643.6281</td>
<td>132.1849</td>
</tr>
<tr>
<td>Rural Low</td>
<td>0.0068</td>
<td>0.0027</td>
<td>4.8529</td>
<td>2.3697</td>
<td>262.9903</td>
<td>70.4479</td>
</tr>
<tr>
<td>Rural Non-labour</td>
<td>-0.0033</td>
<td>-0.0013</td>
<td>-0.1214</td>
<td>0.0510</td>
<td>53.7535</td>
<td>14.7526</td>
</tr>
<tr>
<td>Rural High</td>
<td>-0.1274</td>
<td>-0.0514</td>
<td>14.5848</td>
<td>6.6793</td>
<td>746.9672</td>
<td>194.2388</td>
</tr>
<tr>
<td>Urban Low</td>
<td>-0.0329</td>
<td>-0.0133</td>
<td>1.5680</td>
<td>0.5900</td>
<td>430.0833</td>
<td>108.1666</td>
</tr>
<tr>
<td>Urban Non-labour</td>
<td>-0.0167</td>
<td>-0.0067</td>
<td>1.4876</td>
<td>0.5349</td>
<td>181.7641</td>
<td>43.9768</td>
</tr>
<tr>
<td>Urban High</td>
<td>-0.3986</td>
<td>-0.1608</td>
<td>-1.9001</td>
<td>-0.8482</td>
<td>808.5150</td>
<td>204.1375</td>
</tr>
</tbody>
</table>

0.00000% = less than 0.00005%

\textsuperscript{a}Based on fixed price multipliers from SPAM. Three scenarios are simulated to represent the impact.

- the SUP program is able to decrease pesticide-related illnesses by 50%. This program is applied to (1a) Food Crop sector only and (1b) Non-food Crop sector only.
- the Conservative IPM program successfully reduces the use of pesticides by 60%, while maintaining agricultural output at a constant level. This program is applied to (2a) Food Crop sector only and (2b) Non-food Crop sector only.
- the Progressive IPM program not only reduces the use of pesticides by 60%, but also increases agricultural output by 12%. This program is applied to (3a) Food Crop sector only and (3b) Non-food Crop sector only.

\textsuperscript{b}Food = Food Crop sectors.
\textsuperscript{c}Non-food = Non-food Crop sectors.
Reducing the Number of Pesticide-Related Illnesses

- The reduction in the quantity of pesticide–health services also significantly decreases the rent paid to the Unincorporated Capital Rural sector. The Rural Non-labour households suffer the most from this effect.

- The reduction in the number of pesticide-related illnesses allows agricultural households to spend more of their incomes on goods and services other than pesticide–health services. This greater demand for goods and services increases domestic production activities (except food and non-food crops).\textsuperscript{13} In the end, the increase in domestic production activities will raise household incomes for all socio-economic classes. For Rural Non-labour, Rural High, Urban Low, Urban Non-labour and Urban High households, however, the benefit from the increase in domestic production activities cannot compensate for the income reduction caused by the fall in pesticide–health activities.

**Conservative IPM Program: Scenarios 2a and 2b**

In scenario 2a (Food Crop sector), the Conservative IPM program decreases Urban High and Rural Non-labour household incomes. In scenario 2b (Non-food Crop sector), however, it reduces only the incomes of Urban High households; the incomes of Rural Non-labour households increase. Note that, in scenario 2a, Large-scale Farmer households receive the greatest benefits from the IPM program, while in scenario 2b Agricultural Employee households do.

Scenario 2 assumes that the Conservative IPM program reduces the use of pesticides and the number of pesticide-related illnesses, while maintaining a constant level of agricultural output. The impact on household incomes for different socio-economic classes of the reduction in illnesses is identical to the impact of the SUP program on household incomes. To be explained is how the reduction in pesticide use under the Conservative IPM program affects household incomes:

- The reduction in the amount of pesticide use allows agricultural households to consume more goods and services other than pesticides and pesticide–health services. This rising demand for goods and services increases domestic production activities. In the end, this demand explains why all households receive higher

\textsuperscript{13} The Food and Non-food Crop sectors are the constrained sectors.
benefits under the Conservative IPM program than under the SUP program.

- The reduction in pesticide use, however, also lowers the incomes of pesticide industries (Chemical and Basic Metal sector), mainly because of the decreased rent received by the Unincorporated Capital Urban and Rural sectors. The reduction in rent borne by the Unincorporated Capital Urban sector lowers the incomes of Urban High households, and explains why these households have to shoulder a higher burden under the Conservative IPM program than under the SUP program.

- Rural Non-labour households receive income mainly from the Unincorporated Capital Rural sector. The reduction in payment to this sector decreases the incomes of Rural Non-labour households. In scenario 2a, where the reduction in pesticide use is more significant than in scenario 2b, the income reduction in Rural Non-labour households offsets the benefits received from the increase in domestic production activities. In scenario 2b, the benefits that Rural Non-labour households receive from the increase in production activities offset the negative impact from the reduction in pesticide use.

**Progressive IPM Program: Scenarios 3a and 3b**

The Progressive IPM program increases the incomes of all types of households. In scenario 3a (Food Crop sector), Large-scale Farmer households receive the highest benefits from the program, while in scenario 3b (Non-food Crop sector) Agricultural Employee households do. In scenario 3a, Rural Non-labour households are the least affected by this program. In scenario 3b, Urban High households are the least affected.

The Progressive IPM program increases the output of agricultural sectors. This increase benefits all types of households. All households, therefore, receive higher benefits under this program than under the Conservative IPM program. The increase in agricultural output increases payments primarily to Agricultural Employee, Small-scale Farmer, Medium-scale Farmer and Large-scale Farmer households. The increase in payments to these groups explains why agricultural households benefit more than rural and urban households under the Progressive IPM program.

The growth in output of the Food Crop sector (scenario 3a) increases most the incomes of the Agricultural Unpaid Rural and Unincorporated Capital Land sectors. Large-scale Farmer households receive their
incomes primarily from these sectors. On the other hand, the growth in
output of the Non-food Crop sector (scenario 3b) mainly increases
payments to the Agricultural Paid Rural and Urban sectors, which are
largely composed of Agricultural Employee households. These links
explain why Large-scale Farmer households in scenario 3a receive the
highest benefits under the Progressive IPM program, while in scenario
3b the Agricultural Employee households do.

Comparison across Programs
The main concern of this paper is to search for a program that both
reduces the number of pesticide-related illnesses and generates a more
equal income distribution, in the sense that none of the socio-economic
household classes has to experience an income reduction.

First, which programs do not decrease any household income or, at
most, involve only a negligible decrease? A comparison of all three
scenarios leads to the conclusion that the Progressive IPM program is
the best: all household incomes increase. When the SUP and the
Conservative IPM programs are compared, it is clear that fewer
households experience an income reduction under the Conservative IPM
program than under the SUP program.

Second, what is the impact of the three programs on income
distribution? Under the SUP program, all agricultural and Rural Low
households increase their incomes, while all urban, Rural Non-labour
and Rural High households experience an income reduction. Since the
reduction in income of Rural Non-labour, Urban Low and Urban Non-
labour households is relatively small and the average income of
agricultural households is significantly lower than that of urban
households, the SUP program will bring about a more equal income
distribution (compared with the existing distribution).14

Under the Conservative IPM program, all household incomes, except
Rural Non-labour and Urban High, increase. Since the average income of
Rural Non-labour households is not the lowest average household
income, and the average Urban High household income is higher than the

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14We do not use any specific measure of income distribution in this paper. We
observe the impact of pesticide illness abatement programs on 10 different socio-
economic classes of households. If a program benefits the low-income
households (Agricultural Employee, Small-scale Farmer, Medium-scale Farmer,
Rural Low, Rural Non-labour, and Urban Low) more than the high-income
households, a more equal income distribution occurs.
average income of other types of households, this program will generate a more equal income distribution.

Under the Progressive IPM program, agricultural household incomes increase significantly more than rural and urban household incomes. Since the average agricultural household income is lower than those of urban and rural households, this program will also produce a more equal income distribution.

CONCLUSION

This paper shows how different types of programs designed to reduce the number of pesticide-related illnesses affect household incomes. If a reduction in illnesses results from an inexpensive SUP or IPM program, most types of households experience increases in incomes. Furthermore, an SUP or IPM program that successfully reduces pesticide-related illness induces a more equal income distribution.

It is important to note that, except for Urban High and Rural Non-labour households, the Conservative IPM program increases household incomes more than the SUP program. The best approach would be an IPM program that results in progressive outcomes—that is, the program both reduces the number of pesticide-related illnesses and increases agricultural output. Under this Progressive IPM, all households are better off, especially those in the agricultural sector.

Finally, one may conclude that it would be wise for governments in developing countries to implement the SUP and IPM programs simultaneously in a cost-effective manner. Together, the two programs may significantly improve human health, as well as inducing a more equitable income distribution.

\(^{15}\)To approximate the impact of simultaneously applying the SUP and IPM programs on household incomes, one need only add the results from the SUP and IPM scenarios. This technique will not provide the same result as using the CFPM method to analyze the impact on incomes of both programs simultaneously. In this paper, the difference between the results from these two methods is, however, very small.
REFERENCES


