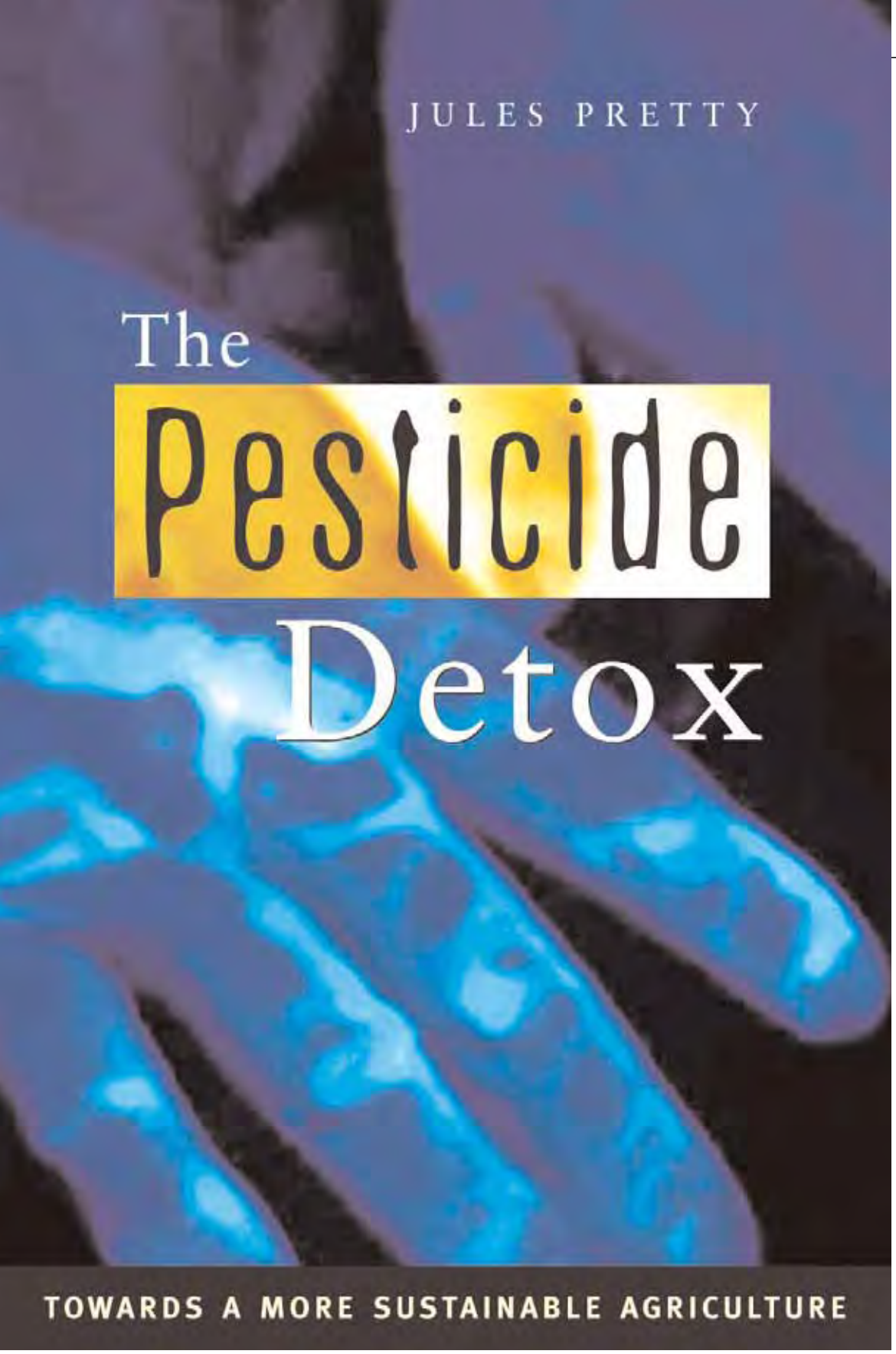
JULES PRETTY
The
Pesticide
Detox
TOWARDS A MORE SUSTAINABLE AGRICULTURE

The Pesticide Detox

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Towards a More Sustainable Agriculture

Edited by

Jules Pretty

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Preface

> *There was once a town where all life seemed to live in harmony with its surroundings. The town lay in the midst of a checkerboard of prosperous farms, with fields of grain and hillsides of orchards. . . Then a strange blight crept over the area and everything began to change. . . There was a strange stillness. . . It was a spring without voices. . . The people had done it themselves.*

With these words Rachel Carson's fable of a *Silent Spring* (1963) became famous worldwide. She painted a picture of a healthy community in town and countryside. This idyll, which could be anywhere in the past, delights visitors and locals alike. But it falls into a mysterious silence, '*which lay over fields and woods and marsh*'. The community had withered and died, and apparently all because of the widespread use of pesticides. This simple story is so compelling that more than 2 million copies of the book have been sold, and it continues to sell well. This is impressive for any book, let alone one mainly documenting the ills of the world.

Of course, the truth behind the fable plays out rather differently in real life, as no town has died solely because of agricultural pesticides, and neither has all the wildlife been eliminated. But there is something in what she says that remains significant more than 40 years later. Since the early 1960s, the world population has more than doubled, and agricultural production per person has increased by a third. Over the same period, the use of modern inputs for farming has grown dramatically, and they have been very effective in helping to increase agricultural yields. Pesticides are now available in the remotest regions of the world. Farmers can see their short-term effect – killing insects, weeds and diseases, and leaving the crops and animals to flourish. Yet there has been a hidden cost to pay. Harm to environments and human health has accompanied some of these fundamental changes in food production systems. For far too long we have accepted these costs as the unfortunate but necessary side-effects of progress.

Yet in the last decade of the 20th century, many communities around the world have begun to see some remarkable revivals. The pesticides that harm environments and human health are increasingly being identified, and alternative, cheaper and safer management methods have been developed and now adopted by several million farmers. Food production by these farmers has not been compromised, which is a surprise to many. Something is happening. The spring may have been silent, but the prospects for the 21st century are now changing. In a small Asian village a rice farmer says '*my fields have been silent for*

30 years, now they are singing again'. Pesticides had eliminated the unnecessary wildlife, but now the frogs are back. What brought about these changes? When Asian rice farmers first began to learn about the beneficial effects of predators and parasites in field schools, and about how to grow rice with limited or no pesticides, they changed their practices by the tens of thousands. Yields were maintained or improved, and costs cut substantially – good for both families and the environment. This time, the people have done the right thing for themselves.

Remarkably, this story is beginning to be played out in different ecological and social settings around the world. But progress towards safer agriculture is still relatively rare. Each year, pesticide use in agriculture amounts to some 2.5 billion kg – about 400g for every person on the planet. Yet we still have limited knowledge about the causal relationships between harmful products and adverse health and environmental problems in the field and at home. Some people say these costs simply have to be accepted, as sustainable alternatives cannot work for both the environment and food security. Despite great progress, the world's agricultural and food systems are still not always ready to take on board the principles of sustainability.

This book seeks to address some of these difficulties and set out some new solutions. Pests, diseases and weeds eat, infiltrate and smother crops and grab their nutrients. If farmers stood back and let nature take its course, there would be insufficient food. They must do something. Pesticides are easy to use, although often costly for farmers. In addition, they frequently involve considerable costs to society in the form of public health and environmental costs. Alternatives often appear more difficult to implement, but are more sustainable in the long term. Their broad introduction, however, continues to face many challenges.

There is, perhaps, less of a choice than many may like to think. Recent food scares have underscored the importance of food safety. Contamination of water resources with pesticide residues is increasingly becoming an important issue in a growing number of countries. And recent studies are indicating that the poisoning of farmers and their families in developing countries is far worse than previously thought.

Governments are now beginning to tighten their pest and pesticide management policies, supported by a growing body of evidence to show that food can be produced in more sustainable ways. There is enormous scope for further reductions in pesticide use, and where pesticide use remains justified, there are often less hazardous alternatives to the products currently being used. This book describes the problems associated with pesticide use and highlights a range of initiatives that provide viable alternatives, with special attention given to integrated pest management (IPM).

The International Code of Conduct on the Distribution and Use of Pesticides defines IPM in this way:

> *IPM means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to*

> *human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms*.

In this book this approach to IPM is sometimes called community-IPM, low-toxicity IPM, ecological IPM or even just ecological pest management (EPM), implying that the approach is something more than just a reduction in pesticide use. Despite many positive national and international intentions and commitments, and even though less hazardous alternatives are often readily available, large quantities of undesirable pesticides continue to be used in many parts of the world. These include products with acute toxicity hazards or chronic health hazards. Some are persistent in the environment and/or disrupt ecosystem functioning.

This book explores the potential for the phasing out of hazardous pesticides and the phasing in of cost-effective alternatives already on the market. The priority criterion for phasing out is acute mammalian toxicity in view of the high incidence of farmer poisoning, especially in the tropics where protective clothing is not available or is too costly or uncomfortable to use. Other criteria include chronic health hazards and hazards to ecosystems. But such phasing out of undesirable products and the phasing in of new ones will need to be accompanied by supportive policy measures. Policy changes may include: the removal of subsidies on products scheduled for phase-out; taxation of products with high social costs; financial incentives to encourage local development and the production of new products; incentives to encourage partnerships between local producers in developing countries and producers of non-toxic products in Organisation of Economic Co-operation and Development (OECD) countries; a review of lists of registered pesticides; the establishment, monitoring and enforcement of maximum residue limits; and investment in farmer training through farmer field schools.

There has been promising progress, with many of these policy measures now implemented in various countries. But what is still missing is a comprehensive and integrated approach by all countries, in which the idea of agricultural sustainability is placed centre-stage. What would happen if this occurred? Would there be sufficient food to meet growing demand? Would the rural towns come to life? Would the birds and frogs sing again? The answer could be a resounding yes, if we come to appreciate that fundamental changes in pest management in agriculture are beneficial for farmers, consumers and the environment. Such collective successes are clearly very hard to achieve, but this book sets out some of the opportunities to make progress.

This book is a compilation of chapters on selected subjects that together constitute a larger picture about the changes necessary for pest and pesticide management. It describes the current concerns about the side-effects of pesticides, and demonstrates the feasibility of change on the basis of a number of concrete cases from both developing and industrialized countries.

In Chapter 1, Jules Pretty and Rachel Hine review pesticide use and the environment. Pesticides are now widely used in food production systems across

the world, and increasingly, in some countries, in the home and garden. Some 2.5 billion kg of active ingredients are applied each year, amounting to an annual market value of some US$25–30 billion in the 1990s and 2000s. Just over a fifth of all pesticides are used in the US. However, most pesticide markets in industrialized countries are no longer expanding, and companies are looking to developing countries to increase sales. More than 800 products are in regular use worldwide. Pesticides have become ubiquitous in environments worldwide, some reaching hazardous levels for humans. Pest resistance has become increasingly common, with 2645 cases of resistance in insects and spiders recorded in the late 1990s. The problem for regulators is that causality is very difficult to establish. This is graphically shown by the amount of scientific effort required to understand the effects of pesticides on wild bird populations. A further reason to be cautious now comes from concerns about the endocrine disrupting properties of some pesticide products.

In Chapter 2, Misa Kishi questions what we know about the health impacts of pesticides, and shows that pesticides do harm human health, although their effects are not widely recognized and their full extent remains unknown. This is true in both industrialized and developing countries, and for both their acute and long-term effects. However, the extent of the problem is far greater in developing countries. In industrialized countries, the focus has shifted from occupational exposure to the effects of long-term low-level exposure to the general population. While the problems of acute effects in developing countries have been recognized to a certain extent, the perception promoted by the pesticide industry is that the number of acute pesticide poisonings due to suicides is greater than occupational poisonings. However, this is not supported by the evidence. For a variety of reasons – including the underutilization of health facilities by agricultural workers, the inability of health personnel to diagnose pesticide poisoning, and the lack of understanding of the importance of reporting – the underreporting of occupational poisoning is very common. This in turn misleads policy-makers. Furthermore, even when no data exist on the adverse effects of pesticides, it cannot necessarily be assumed that there are no problems.

In Chapter 3, Jules Pretty and Hermann Waibel provide a comprehensive analysis of the full cost of pesticides. Unfortunately, the external environmental and health costs of pesticides are rarely addressed when calculating whether or not pesticides should be used in agriculture. Data from four countries is incorporated into a new framework for pesticide externalities, and this shows that total annual externalities are US$166 million in Germany, US$257 million in the UK, US$1398 million in China (for rice only) and US$1492 million in the US. These externalities amount to between US$8.8 and $47.2 per hectare of arable and permanent crops in the four countries – an average of US$4.28 per kg of active ingredient applied. This indicates that the 2.5 billion kg of pesticides used annually currently impose substantial environmental and human health costs, and that any agricultural programmes that successfully reduce the use of pesticides that cause adverse effects create a public benefit by avoiding such costs. A total of 62 IPM initiatives from 26 countries are analysed to illustrate the trajectories that yields and pesticide use have taken. There is promising evidence

that pesticide use can be reduced without yield penalties, with 54 crop combinations seeing an increase in yields while pesticide use fell. A further 16 crop combinations saw small reductions in yield with large reductions in pesticide use, and 10 saw increases in yields accompanied by increases in herbicide use.

In Chapter 4, Barbara Dinham discusses the role of corporations in shaping modern agricultural production. The products of their research and development dominate the agricultural input market, and the industry is now highly concentrated into six research-based companies, with a large number of generic companies seeking to gain a greater foothold on sales. The health and environmental side-effects of many of these products have been acknowledged, and some have been removed from the market as a result. Nevertheless, many hazardous pesticides, and others associated with chronic health concerns, continue to be freely available in developing countries. Workers and farmers who are not able to protect themselves are still using these products under inappropriate conditions. The major companies have signed up to the FAO code of conduct, and its implementation is crucial to reduce the adverse effects of pesticides. More assertive action may be needed in developing countries to find less hazardous and more sustainable pest management solutions for poor farmers. The most important step companies could make would be to remove the most toxic pesticides from the market, particularly in countries where conditions are unsuitable for their use, and introduce less hazardous products and technologies.

In Chapter 5, David Dent provides an overview of agrobiologicals and other alternatives to synthetic pesticides. Some attempts have been made to substitute pesticides with agrobiologicals, the biological equivalents of synthetic pesticides. These include biopesticides based on bacteria, fungi, viruses and entomopathogenic nematodes and a range of other off-farm inputs, including pheromones and macrobiological agents such as predators and parasistoids. Many agrobiologicals represent safe and effective alternatives to pesticides, but systems of registration and regulation tend not to favour them. IPM requires the availability of a range of options to farmers so as to ensure the long-term control of pests, diseases and weeds. Pest management can be made safer by eliminating the most hazardous products, substituting them with safer biocontrol agents and biopesticide products, implementing administrative controls that emphasize training and education in the safe use of existing products and improved agroecological knowledge, and making available personal protective equipment only as a measure of last resort.

In Chapter 6, Catrin Meir and Stephanie Williamson analyse farmer decision-making for ecological pest management. Farmers in both developing and industrialized countries are increasingly faced with rapid and profound changes in production technologies, processing and purchasing systems, and market requirements. These changes require new management skills and knowledge if farmers are to remain competitive in global markets. Sound decision-making about pest management strategies and pesticide use is critical, even for those farmers growing mainly subsistence crops for local consumption, since most farmers face rising production costs, increased competition and growing consumer concerns about food quality and safety. This chapter reviews what is

known about farmer decision-making for pest management and why it is important if farmers are to be motivated to reassess their approaches to pest management, as well as to make them more aware of alternatives to pesticides. Farmer perceptions are described, together with external influences on farmer decision-making, and the training and agricultural extension methods that aim to influence farmers' pest management knowledge and practices.

In Chapter 7, Niels Röling sets out a radical vision for the human and social dimensions of pest management. This chapter presents an approach based not on causes but on human reasons. In trying to explain sustainability, the aim is not to look for causes and effects in the physical world but for human reasons in terms of people's 'gets', 'wants', 'knowing' and 'doing'. This translates as an exercise in reinterpreting the perfectly valid instrumental discourse about agricultural sustainability into a totally different discourse based on cognition and learning. The chapter is based on the assumption that we live not in an epoch of change, but in a change of epoch. We have successfully built technology and an economy that allowed a sizeable proportion of humanity to escape much of the misery of previous generations. However, in the process of co-evolving our aspirations and technologies, we have transformed the surface of the earth. This chapter reiterates the indispensability of a constructivist perspective for mobilizing the reflexivity and resilience required during a change of epoch. It provides a theoretical underpinning for the human predicament of having to juggle coherence and correspondence, and further analyses pressure in terms of the nature of human knowledge and its inadequacy. The challenge is not in dealing with land but in how people use land.

In Chapter 8, Kevin Gallagher, Peter Ooi, Tom Mew, Emer Borromeo, Peter Kenmore and Jan-Willem Ketelaar provide a detailed analysis of low-toxicity IPM for rice and vegetables in Asia. The powerful forces that drive these two systems could not differ more. Rice production is a highly political national security interest that has often justified heavy-handed methods to link high yielding varieties, fertilizers and pesticides to credit or mandatory production packages and led to high direct or indirect subsidies for these inputs. Research to produce new varieties and basic agronomic and biological data was well funded. Vegetable production, on the other hand, has been led primarily by private sector interests and local markets. Little support for credit, training or research has been provided. The high use of pesticides on vegetables has been the norm, due to a lack of good knowledge about the crop, poorly adapted varieties and a private sector push for inputs at local kiosks to tackle exotic pests on exotic varieties in the absence of well-developed management systems. However, other pressures are now driving change to lower pesticide inputs on both crops. Farmers are more aware of the dangers of some pesticides to their own health. The rise of Asian incomes has led to a rise in vegetable consumption that has made consumers more aware of food safety. More farmers are producing vegetables for urban markets, so driving competition to lower input costs as well. Integrated pest management programmes in both crops aim to reduce the use of toxic pesticide inputs and the average toxicity of pest management products that are still needed whilst improving the profitability of production.

In Chapter 9, Hans Herren, Fritz Schulthess and Markus Knapp analyse a variety of approaches for low to zero pesticide use in tropical agroecosystems, particularly in Africa. Agricultural production in tropical agroecosystems is greatly affected by pests with the result that synthetic pesticide use has been rising. This is particularly true for cash and horticultural crops that have a significant economic return. Recently, however, the use of pesticides is being restricted on crops destined for export, following the introduction of new maximum residue levels in industrialized countries. Six key issues for pest management decision-making are identified. These are: (i) education and information availability; (ii) economic environment and imperatives; (iii) agricultural production systems; (iv) availability and affordability of alternative pest management tools and implementation strategies; (v) market requirements, consumer education; and (vi) policy environment. Two detailed case studies are analysed: lepidopteran cereal stemborer management, and biological control in vegetables, and conclusions drawn on the practicalities of eliminating synthetic pesticides from the 'ecological' IPM toolbox without jeopardizing the quality and quantity of food production, whilst at the same time improving farmers' revenues and the sustainability of their production systems.

In Chapter 10, Stephen Sherwood, Donald Cole, Charles Crissman and Myriam Paredes focus on improving ecosystem and human health in the northern Andes by revealing problems and solutions in Ecuador's Carchi province. Over 60 per cent of the rural population were found to have had their nervous system functions affected by pesticides. Very high rates of human poisoning were discovered: 171 per 100,000 population, with mortality at 21 per 100,000, the highest recorded rates anywhere in the world. This high incidence may not be because the situation is particularly bad in Carchi, but because researchers sought systematically to record and document it. Meanwhile, the principal position of the national pesticide industry continues to be farmer education through 'Safe Use' campaigns. This continues, despite misgivings that the notion of the safe use of highly toxic chemicals under the social and environmental conditions of developing countries is almost impossible. The project team worked with interested stakeholders to inform the policy debate on pesticide use at both the provincial and national level. Its position has evolved to include the reduction of pesticide exposure risk through a combination of hazard removal, the development of alternative practices and ecological education. Their experience led them to conclude that more knowledge-based and socially oriented interventions are needed. These should be aimed at building farmer capacities, promoting more regenerative agricultural practices, and improving markets and policies.

In Chapter 11, Stephanie Williamson provides new evidence from Benin, Ethiopia, Ghana and Senegal on pesticide use and the opportunities for implementation of IPM in a variety of crops. Pesticide use in Africa is the lowest of all the continents, accounting for only 2–3 per cent of world sales, and averaging in the 1990s, 1.23 kg ha^{-1} compared with 7.17 kg in Latin America and 3.12 kg in Asia. This low use appears to suggest correspondingly low level health and environmental hazards. Regrettably, this assumption is wrong, as African farmers currently use many WHO Hazard Class Ia and Ib products, and few

users take precautionary measures to prevent harm. Once again, alarmingly high rates of pesticide poisoning were recorded. The research on eight cropping systems in four countries revealed increasing interest in IPM training. Integrated pest management and agroecological concepts need to be brought into the mainstream curricula in agricultural colleges and schools, with practical educational materials adapted for African cropping systems. Persuading more decision-makers and other important stakeholders to accept the IPM concept and its practical implementation is a vital priority in the transformation of African farming systems for the benefit of rural communities and their consumers.

In Chapter 12, Janny Vos and Sam Page analyse the case of cocoa management in West Africa. Concern is expressed in this area about the impact that the sudden phase-out of toxic pesticides could have on smallholder farmers. Cocoa originated in South America and is now cultivated in West Africa (Côte D'Ivoire, Ghana, Nigeria, Cameroon), South America (Brazil and Ecuador) and Asia (Indonesia and Malaysia). Up to 90 per cent of the world's cocoa is produced by smallholder farmers, cultivating on average less than 3 hectares each. As cocoa is an exotic plant in West Africa, it has contracted a number of serious new encounter diseases, which originate from the indigenous flora but to which exotics have not co-evolved defence mechanisms. This chapter shows that is it possible to phase out WHO Hazard Class I products without creating new problems. Low toxicity alternatives to pest management in cocoa production in West Africa are being developed. Smallholder cocoa farmers will need to be able to access information and knowledge to become better informed managers of their farms, whereas other stakeholders in the IPM network will need to re-focus their current strategies. A long-term process of re-education and the re-organization of farmer support systems should be considered to promote more sustainable cocoa production.

In Chapter 13, Carol Shennan, Tara Pisani Gareau and Robert Sirrine discuss an agroecological approach to pest management in the US. This involves the application of ecological knowledge to the design and management of production systems so that ecological processes are optimized to reduce or eliminate the need for external inputs. There are many potential approaches to deal with different pests in different types of cropping systems. Any single ecological approach does not provide a 'silver bullet' to eliminate a pest problem. Successful management requires a suite of approaches that together create an agroecosystem where pest populations are maintained within acceptable levels. Ecological pest management (EPM) seeks to weaken pest populations while at the same time strengthening the crop system, thus creating production systems that are resistant and/or resilient to pest outbreaks. Despite the evolution of US agriculture toward intensive, large-scale monocultures maintained by high-cost, off-farm inputs, farmers do have an increasing variety of cultural and biological management tools available that can maintain low levels of pest damage with little use of external inputs. The chapter illustrates the different methods and approaches that are being used in farming systems across the US. At the same time, it is clear that there is still a long way to go. Knowledge gaps still exist, and these are important constraints on the widespread use of EPM.

In Chapter 14, Stephanie Williamson and David Buffin discuss the transition to safe pest management in a variety of industrialized agricultural systems. Over the last decade or so, integrated pest and crop management has become increasingly common in North America, Europe and Australasia. However, there are many interpretations of what constitutes IPM, ICM, Integrated Production and Integrated Farming, which makes it harder to assess progress. Some reasons for the limited uptake of integrated approaches may include low levels of understanding among farmers or a lack of incentives to change established practice. However, some retailers, such as the Co-operative Group and Marks and Spencer, have prohibited the use of many pesticides on crops grown for them. Five case studies of IPM are discussed in detail: apples and pears in Belgium, pesticide-free arable in Canada, healthy-grown potatoes in Wisconsin, vining peas grown for Unilever in the UK, and arable crops and field vegetables cultivated for the Co-operative Group.

In Chapter 15, Harry van der Wulp and Jules Pretty review policy and market trends that are converging towards more sustainable production systems that will be less dependent on pesticides. The chapter describes how national policies, international conventions and aid programmes are shaping pest and pesticide management. An emerging new agenda for crop protection in the next decade indicates that there can be further reductions in reliance on pesticides. These processes encourage the phasing out of hazardous products, whilst phasing in alternative approaches and less hazardous products. The many examples described in this book demonstrate that there is an enormous potential for reductions in the use of pesticides. With the necessary political will, backed up by consumer awareness and appropriate market responses, it should now be possible to detox agriculture.

Jules Pretty
University of Essex, Colchester
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List of Terms, Acronyms and Abbreviations

ai	active ingredient
agrobiological	A biological product used for pest, disease or weed management (see www.agrobiologicals.com)
ARDS	adult respiratory distress syndrome
BC	biological control
bn	billion (a thousand million, or 10^9)
BPH	brown planthopper
Bt	Bacillus thuriengiensis
CGIAR	Consultative Group on International Agricultural Research
CIP	International Potato Center (US)
CPB	cocoa pod borer
DBM	diamondback moth
DDT	dichlorodiphenyltrichloroethane
DNOC	dinitro-o-cresol
EA	Environment Agency (UK)
EC	European Commission
EPA	Environmental Protection Agency (US)
EPM	ecological pest management
EU	European Union
FAO	UN Food and Agriculture Organization (Rome)
FFS	farmer field school
GM	genetically modified
GMHT	genetically modified herbicide tolerant (crop)
GMO	genetically modified organism
ha	hectare
IARCs	international agricultural research centres
ICIPE	International Centre of Insect Physiology and Ecology
ICM	integrated crop management
IP	integrated production
IPM	integrated pest management
IPPM	integrated production and pest management
IRM	insecticide resistance management
IRRI	International Rice Research Institute
kg	kilogramme

M	million (as in Mha = million hectares, Mkg = million kilogrammes)
mg	milligramme
MRL	maximum residue levels
N	nitrogen
NED	new encounter disease
OC	organochlorine
OECD	Organisation for Economic Co-operation and Development
OP	organophosphate
OPM	organic pest management
PAN	Pesticide Action Network
PAR	Participatory Action Research
PAHO	Pan American Health Organization
PCB	polychlorinated biphenyl
pest	This term is commonly used in the book to include insects, diseases, weeds, snails, birds and rats
pesticide	This term is commonly used in the book to include insecticides, fungicides, herbicides, acaricides, miticides and nematicides
PFP	pesticide-free production
PIC	prior informed consent
POPs	persistent organic pollutants
SSA	sub-Saharan Africa
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WHO	UN World Health Organization