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**GUIDELINES ON
THE MANAGEMENT OF
PUBLIC HEALTH PESTICIDES**

**Report of the
WHO Interregional Consultation
Chiang Mai, Thailand
25–28 February 2003**



World Health Organization
Communicable Disease Control,
Prevention and Eradication
WHO Pesticide Evaluation Scheme (WHOPES)

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1. Introduction

The Interregional Consultation on Development of Guidelines on the Management of Pesticides for Public Health was held in Chiang Mai, Thailand, from 25 to 28 February 2003. The Consultation was attended by 14 representatives of national registration authorities and vector-borne disease control programmes, from 10 Member States, from 4 WHO Regions. The Food and Agriculture Organization of the United Nations (FAO) and the International Programme on Chemical Safety (IPCS) were also represented, as was industry (Public Health Project Team of CropLife International). Vector control advisers from WHO Regional Offices for Africa (AFRO), America (AMRO), South-East Asia (SEARO) and the Western Pacific (WPRO), and the chemical safety adviser from SEARO also attended (see Annex 3, list of participants).

Dr Morteza Zaim, Scientist in charge of the WHO Pesticide Evaluation Scheme (WHOPES), welcomed the participants. He noted the increasing importance of the management of pesticides in the field of public health. This is a consequence both of the dwindling arsenal of safe and cost-effective pesticides and of the increasing challenges faced with their management under decentralized health systems. Moreover, the increasing use of pesticides by individuals and communities for personal protection and vector control requires national policies, legislation, and appropriate guidelines for the safe and effective use of these substances. Dr Zaim thanked the local organizer, the Division of Agricultural Toxic Substances of the Department of Agriculture, Thailand, for support in facilitating the meeting, and reiterated the critical need for intersectoral collaboration between ministries of agriculture and public health in the management of public health pesticides.

Dr Chusak Prasittisuk, Regional Adviser, WHO Regional Office for South-East Asia, also welcomed the participants and read the opening remarks of Dr Uton M. Rafei, Regional Director. In his address, Dr Rafei noted the challenges

associated with the management of public health pesticides, especially as they relate to post-registration monitoring of use and quality control; he requested participants to critically review the prevailing practices in Member countries and assist in development of guidelines for appropriate management of pesticides. He also stressed the need for follow-up with Member States to develop plans of action for implementing the guidelines.

Dr Gero Vaagt, Senior Officer representing FAO/HQ at the meeting, welcomed the collaboration with WHO on management of pesticides, noting the long history of collaboration between the two organizations on this issue, including the Joint Meeting on Pesticide Residues (JMPR) and more recently the Joint Meeting on Pesticide Specifications (JMPS). He also noted the revision of the International Code of Conduct on the Distribution and Use of Pesticides and the timeliness of the Consultation, which would allow changes to the Code to be considered and included in the draft guidelines on management of pesticides in public health.

Dr Nuansri Tayaputch gave the inaugural address and, on behalf of the Director-General of the Department of Agriculture, Thailand, welcomed the participants. She stressed the importance of pesticides as tools for sustainable development and public health. She also noted, however, their potential harmful effects, which may be consequences of the lack of knowledge on their proper use as well as of stringent legislative measures for supervision and management.

The Consultation convened in plenary sessions for comprehensive discussion of aspects of management of public health pesticides, appointing Mr Tan Soo Hian as Chairman and Dr Jorge F. Méndez-Galvan, Mr Tham Ah Seng, and Dr Thilaka Liyanage, as Rapporteurs. The adopted agenda is as shown in Annex 2.

The meeting reviewed and discussed critical issues relating to pesticide management in the African, American, South-East Asian and Western Pacific regions, and drafted the guidelines on management of public health pesticides.

2. Rationale

Chemical control is the most important element in the integrated approach to control of vectors and pests of public health importance. It includes the use of vector control, household and professional pest management pesticides. Diseases such as malaria, Chagas disease, dengue and dengue haemorrhagic fever, onchocerciasis, and leishmaniasis affect the health and well-being of millions of people worldwide and are an impediment to social and economic development. Correctly used, insecticides play an important global role in the prevention and control of these diseases. Since public health pesticides are used in close proximity to human beings, as well as in sensitive ecological areas, their proper management is critical.

The limited financial resources of control programmes for vector-borne diseases, added to the dwindling arsenal of approved safe and cost-effective pesticides, require selective and judicious application of these chemicals in the context of integrated vector management (IVM). Management of insecticide resistance, which has significant impact on the availability of vector control tools, is also of paramount importance. Intersectoral collaboration of ministries of health with other ministries (e.g. agriculture and environment) and other relevant partners, including industry, is essential in this regard.

The increasing complexity of evaluation and assessment of pesticides and management of pesticide use requires substantial human and financial resources, as well as an adequate infrastructure. Regulations for the control of pesticides exist in most countries but enforcement of these regulations is frequently ineffective. In general,

post-registration monitoring of insecticide use/application and of accidental poisoning is inadequate in most Member States.

Many countries are undergoing health sector reforms that pose new challenges in the selection, purchase, procurement, use, and monitoring of pesticide application. A specific guideline to assist Member States in this important area is now needed. One of the critical issues is quality control of pesticides. According to WHO (WHO, 2001a), some 30% of pesticides marketed in developing countries for agricultural and public health use, with an estimated annual market value of US\$ 900 million, do not meet internationally accepted quality standards. These pesticides frequently contain hazardous substances and impurities that have already been banned or severely restricted in some countries; they pose a serious threat to human health and to the environment. Purchase of such pesticides could also result in the waste of funds because of lack of efficacy and contribute to the accumulation of obsolete pesticide stocks in developing countries.

To address the complexity of hazards related to different pesticide manufacturing processes, which generate different impurity profiles and varying human and environmental risks, the Food and Agriculture Organization of the United Nations (FAO) and WHO have developed a “new” procedure for development of specifications (FAO, 2002b). Through this procedure the FAO and WHO specifications do *not* apply to nominally similar products of other manufacturers, or to products whose active ingredient is derived from other routes of manufacture. The scope of these new specifications may be extended to similar products when WHO and FAO are satisfied that the additional products are “equivalent” to those on which the reference specification is based.

The *International code of conduct on the use and distribution of pesticides (revised version)* (FAO, 2002a) describes the shared responsibility of many segments of society, including governments, industry, trade, and international institutions.

The Code promotes sound pesticide management practices that minimize potential health and environmental risks. The main objective of the guidelines provided here is to assist Member States with better management of public health pesticides and with implementing the Code of Conduct.

3. Definitions

Decentralized health system

A health system in which responsibility for policy implementation and service provision has been transferred from the central level to local structures (WHO, 2001b).

Information, education and communication (IEC)

An approach that attempts to change or reinforce in a “target audience”, and in a predefined period of time, a set of behaviours regarding a specific problem. The approach is multidisciplinary and client-centred, drawing from the fields of diffusion theory, social marketing, behaviour analysis, anthropology, and instructive design (WHO, 2001c).

Integrated vector management

A process of evidence-based decision-making procedures designed to plan, deliver, monitor, and evaluate targeted, cost-effective, and sustainable combinations of regulatory and operational vector control measures, with a measurable impact on transmission risks, adhering to the principles of subsidiarity, inter-sectoral collaboration and partnership (Bos, 2001).

Obsolete pesticides

Stocked pesticides that can no longer be used for their original or any other purpose and therefore require disposal. These pesticides can no longer be used because they have been banned, have deteriorated, or are unsuitable for the original intended use and cannot

be used for another purpose or easily modified to become usable (FAO, 1995c).

Pesticide

Any substance or mixture of substances intended for preventing, destroying, or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage, transport, or marketing of food, agricultural commodities, wood and wood products, or animal feedstuffs, or substances that may be administered to animals for the control of insects, arachnids, or other pests in or on their bodies. The term includes any substance intended for use as a plant growth regulator, defoliant, desiccant, or agent for thinning fruit or preventing the premature fall of fruit, and substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport (FAO, 2002b).

Pesticide legislation

Any laws or regulations introduced to regulate the manufacture, marketing, storage, labelling, packaging and use of pesticides in their qualitative, quantitative, and environmental aspects (FAO, 2002a).

Pesticide management

The regulatory control, proper handling, supply, transport, storage, application, and disposal of pesticides to minimize adverse environmental effects and human exposure.

Professional pest management pesticides

Pesticides that are used by certified professional pesticide applicators to control pests including termites and structural pests in homes, commercial and industrial premises, and public areas.

Public health pesticides

Pesticides that are used in the control of pests of public health significance. They include vector control pesticides, household insecticides, and professional pest management pesticides.

Registration

The process whereby the responsible national government authority approves the sale and use of a pesticide following the evaluation of comprehensive scientific data demonstrating that the product is effective for the intended purposes and does not pose an unacceptable risk to human or animal health or to the environment (FAO, 2002a).

Responsible authority

The government agency or agencies responsible for regulating the manufacture, distribution, or use of pesticides and, more generally, for implementing pesticide legislation (FAO, 2002a).

Vector

An insect or any living carrier that transports an infectious agent from an infected individual or its wastes to a susceptible individual or its food or immediate surroundings. The organism may or may not pass through a development cycle within the vector.

4. Objective

The objective of this guideline is to assist Member States to develop national policies and guidelines and the legislative basis for the effective management of pesticides in public health. Guidelines for the major aspects of management of public health pesticides are provided in this document, including legislative control, administrative set-ups, product registration, procurement, storage and transport, distribution, application, maintenance and disposal, monitoring and surveillance, management of insecticide resistance, and

quality control. While some countries may already have policies on such matters, it is expected that these guidelines will significantly improve the management of public health pesticides.

5. Legislative control of pesticides and national registration and control schemes

The objective of regulating pesticides is to protect society from the adverse effects of pesticides without denying access to the benefits of their use. Registration enables authorities to exercise control over quality, use levels, claims, labelling, packaging, advertising, and disposal of pesticides, thus ensuring that the interests of end-users are properly protected. The registration legislation must provide a system that protects both the interest of the public and the rights of manufacturers. Government agencies and various sectors of the community have different responsibilities under any pesticide registration and control scheme. Guidelines on initial introduction and subsequent development of a simple national pesticide registration and control scheme have been published by FAO (FAO, 1991). FAO has also produced another set of guidelines related to registration that includes post-registration surveillance and other pesticide management activities (FAO, 1988a).

The registration process is usually carried out through the assessment of data provided by the registrant, rather than by the responsible authority. Decisions are often made by a Committee (e.g. Board, Pesticide Advisory Committee), which may be responsible for the final decision or for making a recommendation to the appropriate government officials.

The WHO Pesticide Evaluation Scheme (WHOPES) (see Annex 1), in close collaboration with the International Programme on Chemical Safety (IPCS), assesses chemical and environmental data and safety information and procedures, and evaluates the effectiveness of public health pesticides, equipment, and products, including

insecticide-treated materials The national pesticide registration system for public health pesticides/products should be harmonized, through legislative action, with WHOPES.

In view of the extensive use of pesticides in agriculture, the ministry of agriculture has generally been considered to be the appropriate regulatory authority for pesticides. This national authority should have responsibility for registration and control of all pesticides, including household insecticide products and professional pest management pesticide products. The ministry of health should be an active member of the “Pesticide Board” and take a leading role in assessment/evaluation of public health pesticides and in the assessing the safety of all pesticides intended for use in the country. The ministry of health, in collaboration with the national regulatory authorities, should develop relevant policies and guidelines and if necessary propose a legislative bases for the effective management of public health pesticides.

6. Management of vector control pesticides

The management of pesticides used in vector control is inadequate in most countries, especially where health systems are decentralized. The result is the use of non-approved or substandard products, as well as inadequate training and supervision, and leads to – among other things – ineffective application of pesticides. Moreover, routine evaluation of pesticide applications and insecticide resistance monitoring and management are often not carried out. A sound national policy, with appropriate guidelines for management of vector control pesticides in the context of integrated vector management, is therefore essential.

Similar concerns surround the development of national policies and guidelines on control of pests of public health importance, which is also critical, especially where such

activities are planned and carried out at municipal or district level.

Thus there is an urgent need to establish or strengthen the central vector/public health pest control unit to guide, support, oversee, and monitor vector control activities throughout a country. This unit should be managed by professionals trained in vector control, and its functions should also include the following:

- guidance, support, or participation in the planning, monitoring, and evaluation of vector/public health pest control activities at national level, and, in collaboration with other related units, development of an integrated action plan, including a contingency plan for the control of vectors causing outbreaks of diseases;
- establishment of links with the surveillance and information management systems within and outside the health sector (e.g. ministry of agriculture, pesticide registration authority) in order to capture relevant information and data for planning vector/public health pest control;
- procurement or advice on procurement of appropriate and approved pesticides and application equipment;
- training and certification of vector control personnel on IVM methods of vector control, including safe application techniques, proper mixing and loading practices, personal protection equipment, pesticide label instructions, precautionary measures to be taken, application equipment, calibration, storage and transport, pesticide spills, and disposal;
- collaboration with the responsible national authority to ensure that pesticides for use in the public health sector are registered and of good quality, and that packaging,

formulation, and container management are appropriate for use in vector control programmes;

- forging of partnerships for IVM, including intersectoral collaboration for the proper management of pesticides; and
- contributing to the strengthening of community mobilization through information, education and communication (IEC) for the proper management of pesticides.

In the setting up or strengthening of such a central unit, it is important – in order to increase transparency and collaboration among the stakeholders – to establish a well organized coordinating mechanism involving representatives from the relevant implementing agencies. It will also help to facilitate sharing of information and ensure both that the policies set are transmitted to the implementing agencies and that their implementation is monitored.

7. Elements of management of public health pesticides

7.1 Product registration

Each Member State should include in its pesticide legislation statutes that enable the delegation of authority for pesticide oversight, promulgation of regulations, and enforcing of compliance to reside within a single unit. This designated unit would be responsible for ensuring that governmental, commercial, and private pesticide usage conforms to written national standards. Within this designated authority it would be understood that there are some basic differences in pesticide application methods and risks between user groups (agriculture, vector prevention and control, structural pest control, etc.). Special legislative consideration should be given to public health pesticides to ensure efficient response in emergency situations involving vector-borne diseases.

Effective national registration policies will speed up the introduction of less hazardous and more effective public health pesticides.

Vector control pesticides and equipment should be exempt from customs duties, entry taxes, and special tariffs in order to reduce the cost of protecting the public from vector-borne diseases and annoyance and to expedite delivery of essential pesticide products to national, regional, and local public health and vector control agencies. These agencies should be fully responsible for compliance with national pesticide management regulations and practices in the use of these tariff-exempt items.

WHO act as the official international clearing house for determining the acceptability of public health pesticides and application equipment and practices. National legislative statutes should therefore recognize published WHO guidelines for the purpose of registration and procurement of vector control products and for operator safety. Such recognition would expedite the availability of appropriate pesticides and equipment and minimize the likelihood of acquiring substandard products. It would also reduce or eliminate the need for local product testing and assessment before registration or reregistration.

In this regard and in addition to the above discussion, national pesticide registration and control schemes should include the following:

- harmonization, through legislative action, of the national pesticides registration system for public health pesticides and products with WHOPES;
- adoption of WHO specifications for pesticides (WHO, 2002a) in the national registration process;

- designation or strengthening of the lead agency for pesticide regulation;
- seeking WHO advice and support in the development of national pesticide legislation;
- avoidance of unnecessary national duplication of WHO data collection and assessment by adopting WHO recommendations and specifications and not routinely requiring additional in-country testing of vector control-related products, and expedition of any tests deemed necessary because of lack of adequate data for special ecological situations, limiting them to the information required to confirm acceptability;
- ensuring the collection and publication of data on pesticides imported and manufactured; and
- periodic review of registration.

7.2 Procurement

Pesticide procurement is highly specialized and complex. Because of the quantities involved and the necessary lead time to ensure timely inventory replacement, experienced and knowledgeable staff should be dedicated to procurement for vector control products. In most cases, the actual purchases are more effectively conducted at the central administrative level than at regional or local levels. If local purchase is preferred, however, the national guidelines for purchase of vector control products (e.g. pesticides and pesticide equipment) should be strictly adhered to. Advice and support should be sought from the central vector control unit. The use of WHO guidelines (WHO, 2000a) is also recommended when planning vector control pesticide procurement.

Because of the professional efforts of WHO in assessing vector control products, selection of WHO-approved products

will ensure their acceptance and durability. International and local markets offer a great variety of substandard pesticide and equipment products; these may fail in operational conditions and could cause unnecessary health and environmental risks. This risk can be minimized by procuring pesticides and equipment conforming to WHO specifications.

Technical support, training, product stewardship, and disposal of used containers are essential post-sales activities of pesticide producers and should be included in tender specifications. Industry's role does not end when the product has been shipped: these activities are essential to ensure the proper use of the pesticide and application equipment. After-sales product support for pesticide application equipment should be specified in the tender contract.

In this regard and in addition to the above guidelines, procurement of public health pesticide management products should also be guided by the following policies:

- development of national guidelines for procurement of vector control products, and ensuring adherence to guidelines by all purchasing entities;
- reference to WHO and/or FAO guidelines for tenders (FAO, 1994; WHO, 2000a), FAO guidelines on labelling (FAO, 1995b), and WHO recommendations for products;
- inclusion of the specifics of after-sales support, maintenance, training, and stewardship commitments in tender documents;
- ensuring that products bear clear labelling in the local language, adhering strictly to national requirements;
- specifying appropriate packaging that will ensure efficacy, shelf-life, human and environmental safety in

handling of the packaged product in strict compliance with national requirements;

- routinely distribution of details of pesticide procurement;
- a requirement that donated public health pesticides products meet national registration requirements, comply with established WHO specifications, and are available for use within the product use dates;
- procurement of recommended protective clothing and devices to minimise worker exposure to pesticides; avoidance of products that require the use of uncomfortable (especially under tropical conditions) and expensive protective clothing and equipment;
- certification by the manufacturer of chemical and physical analysis and product acceptability; and
- independent pre-shipment and on-arrival chemical and physical analysis of the product by the procurement agency.

7.3 Formulation and repackaging

Distribution and use of public health pesticides may require local formulation and/or repackaging. In such cases, industry should ensure that, in cooperation with the government, packaging or repackaging conforming to industry standards is carried out only on licensed premises. The responsible authority should ensure that the staff working in such premises are adequately protected against toxic hazards, that the resulting product will be properly packaged and labelled, and that the content will conform to the relevant quality standards.

In this regard and in addition to the above guidelines, production and distribution of reformulated public health

pesticide products should also be guided by the following policies:

- formulators should be registered, certified, and regulated; and
- national pesticide regulations should be strictly enforced.

7.4 Storage and transport

Handling of public health pesticides and equipment for storage and transport may affect product efficacy or cause contamination of the surroundings. For protection against adverse events and accidental poisonings, there are specific rules and conditions for safe storage and transport. The designated governmental agency designated with responsibility for managing pesticides is obliged to promulgate and enforce rules and regulations for safe, responsible storage and transport. Areas covered by these rules include maintenance of the original product labels, spill prevention, container adequacy, proper marking in storage, facility specifications, product separation, protection from moisture and contamination by other products, restriction of access, and other measures to ensure product integrity and safety.

Pesticide stores must be located away from areas where people or animals are housed and away from water sources, wells, and canals. They should be located on high ground and fenced, with access only for authorized persons. However, there should be easy access for pesticide delivery vehicles and – ideally – access on at least three sides of the building for fire-fighting vehicles and equipment in case of emergency.

Pesticides must not be kept where they would be exposed to sunlight, water, or moisture, which could affect their stability.

Storehouses should be secure and well ventilated. Stocks should be arranged so that the oldest are used first (“first in first out” principle), to avoid the accumulation of obsolete stock. Containers should be arranged to minimize handling and thus avoid mechanical damage which could give rise to leaks. Containers and cartons should be stacked safely, with the height of stacks limited to ensure stability.

Pesticides should not be transported in the same vehicle as items such as agricultural produce, food, clothing, drugs, toys, and cosmetics that could become hazardous if contaminated. Pesticide containers should be loaded in such a way that they will not be damaged during transport, their labels will not be rubbed off, and they will not shift and fall off the transport vehicle onto rough road surfaces. Vehicles transporting pesticides should carry prominently displayed warning notices. Pesticides should not be carried in the passenger compartments of transport vehicles and should be kept tightly secured and covered at all times during transport.

The pesticide load should be checked at intervals during transportation, and any leaks, spills, or other contamination should be cleaned up immediately using accepted standard procedures. In the event of leakage while the transport vehicle is moving, the vehicle should be brought to a halt immediately so that the leak can be stopped and the leaked product cleaned up. Containers should be inspected upon arrival at the receiving station.

In this regard and in addition to the above guidelines, storage and transport of public health pesticide management products should be also be guided by the following policies:

- WHO/FAO guidelines (FAO, 1995a) should be followed for handling pesticide-related products during storage, transport, fires, and spills;

- there should be official reports to the national level and follow-up enquiries in the event of fires, spills, poisonings, and other hazardous events; and
- rules and regulations laid down in the *Recommendations on the transport of dangerous goods: model regulations* (United Nations, 2002) and by international organizations concerned with the specific modes of transport should be respected.

7.5 Distribution

National guidelines for the distribution of public health pesticides should be developed and strictly adhered to. Distribution of pesticides should be carried by trained personnel or under proper supervision. Misdirection or mishandling can result in the product falling into the hands of uninformed recipients or causing human or environmental risk.

Proper packaging is also important to ensure the confinement of the product and its safe handling. The original package is intended to ensure safe distribution; when repackaging is necessary, the new packing should meet the specifications of the original packaging as well as complying with the legislation of the country.

In this regard and in addition to the above guidelines, distribution of public health pesticide products should be guided by the following policies:

- packaging (original or repackaging) should conform to national requirements to ensure safety in distribution and prevent unauthorized sale or distribution of vector control pesticides;
- the distributor should be aware that the shipment is a hazardous product;

- the distributor must provide a timely service to ensure that products are available on an agreed date that takes into consideration the time of the original order and other related shipment matters;
- the procurement process should anticipate shipment and distribution schedules;
- a distribution scheme for pesticide products should be developed that reduces hazards associated with multiple handling and transportation;
- the distribution of pesticide products to the point(s) of storage by the supplier should therefore be included in tender documents; and
- all distributors of pesticides should be licensed.

7.6 Application

Application of public health pesticide products is a complex undertaking because of the multiplicity of target insects and habitats, seasonal variability, and the many different control strategies.

Professional expertise is required at each organizational level. Trained and knowledgeable leadership is essential to ensure that the correct application technology is safely and effectively utilized. Achievement of the necessary expertise at all levels of public health pesticide management requires formal and repeated training. Documentation for such training can be acquired from WHO and FAO. Relevant manuals and documents should be made available at all levels, and knowledge of their contents should be demonstrated through a certification process for all supervisory and managerial personnel. The only exception to these requirements is made for seasonal worker-applicators; these, usually temporary,

employees should be trained at the beginning of each season.

A basic premise of application technology is selectivity in the use of specific pesticides, so that the appropriate material is applied at the proper place and time, and in the prescribed manner, under the guidance of a certified supervisor. Public health pesticides should be used judiciously within the context of an IVM programme; their use should be based on local studies of the vector/pest bionomics and behaviour and of disease transmission to ensure the safety and cost-effectiveness of application and the management of pesticide resistance. Further discussion on this topic is beyond the scope of this document, but it is important that the on-site workforce has the required management skills.

In this regard and in addition to the above discussion, application of public health pesticides and use of approved application equipment and other products should also be guided by the following policies:

- pesticide applications should be routinely evaluated to determine effectiveness;
- provide training and resource manuals for staff (in the local language), based on WHO documents or equivalent sources;
- certification and refresher/update training should be required at all management and supervisory levels;
- protective clothing and other devices should be provided to minimize worker exposure to pesticides and their use should be enforced;
- pesticide application equipment should be maintained properly (including calibration) and should apply pesticides safely and effectively according to best

management practices as outlined by WHO (WHO, 2000b and 2003a, Najera & Zaim 2002);

- application of pesticides should be selective and targeted (in space and time);
- accurate records should be kept of application sites, amount and dosages of pesticides used, worker exposures, etc;
- procedures should be put in place to prevent unauthorized applications and to monitor poisoning incidents and misuse of pesticides;
- pesticides must be applied as instructed on the label, to ensure safety and efficacy, as well as in a manner that will prevent environmental contamination; and
- community participation in control activities (e.g. treatment of mosquito nets) should be monitored to ensure safe and effective practices.

Public health pesticide application equipment and other products require routine maintenance and calibration. Dedicated human and financial resources should be available for this purpose. Adequate inventories of pesticides, equipment, and replacement parts must be maintained: inadequacies in any of these areas could make it impossible to correctly apply the necessary materials at the appropriate times for disease intervention.

7.7 Disposal

When pesticides have passed their expiry date, specific methods of disposal must be followed (FAO, 1995c; FAO/WHO/UNEP, 1999), ensuring compliance with international standards for disposal of hazardous materials. Similarly, any equipment that is no longer serviceable should

be removed from inventory, decontaminated and disassembled to ensure that it will not be subsequently diverted to other uses.

International treaties address disposal options on some pesticides. Guidelines have been developed under the framework of the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal* (UNEP, 1989). Among other things, the *Stockholm Convention on Persistent Organic Pollutants* (UNEP, 2001) addresses the special case of DDT.

In view of the hazards associated with obsolete pesticide stocks and the high cost of safe and environmentally sound disposal, the long-term solution lies in preventive measures that require proper planning and implementation for vector control including pesticide use. The WHO Expert Committee on Vector Biology and Control (WHO, 2001d) recommended the following measures to avoid accumulation of obsolete pesticides:

- provision for phasing-out when pesticides are to be banned or deregistered;
- investment in the building of proper storage facilities with sufficient capacity;
- training of staff in stock management, good storage practices, and proper handling of pesticides during transport;
- refusal of donations in excess of requirement; and
- spelling out of product specifications, including required packaging and labelling (long-life label), in tender documents or direct procurement orders.

A comprehensive set of guidelines on disposal of bulk quantities of obsolete pesticides in developing countries has been prepared by FAO (FAO 1995c). Information on the management of small quantities of unwanted and obsolete pesticides has also been published by WHO, FAO, and the United Nations Environment Programme (WHO/UNEP, 1991; FAO/WHO/UNEP, 1999).

In this regard and in addition to the above guidelines, maintenance and disposal of public health pesticides and products should be also be guided by the following policies:

- adherence to WHO/FAO guidelines for handling pesticide-related products during storage, transport, fires, spills and disposal;
- consultation with the ministry of environment and UNEP Chemicals for disposal of obsolete pesticides;
- prevention of risk to human and environmental health from emptied packaging and containers, rinsates, and outdated products;
- ensure provision of instructions for disposal of pesticide containers as label requirements, and consider inclusion in tender contracts provisions for disposal of pesticide containers by supplier; and
- disposal of unused spray solutions, as well as rinsates, in a manner that will prevent environmental contamination.

7.8 Monitoring and surveillance

Post-registration activities provide a means of measuring the validity of predictions, based on registration data, regarding efficacy, safety, and environmental effects of a particular pesticide product. Vector control units should be responsible

for monitoring and reporting the performance of the product, as well as its safe application/use. If adverse impact or reduced efficacy is recognized and reported in a timely manner, corrective action is often possible.

Operators/spraymen (applicators) must use personal protective equipment and equipment to avoid exposure to public health pesticides. This should be provided by vector control units, who should ensure that it is used properly and in appropriate circumstances, and should be responsible for ensuring the monitoring of exposure, including biological monitoring where necessary.

In this regard and in addition to the above guidelines, surveillance and monitoring of human and environmental exposure to public health pesticides and application efficacy should be also be guided by the following policies:

- development of guidelines, routine monitoring of application efficacy and vector resistance using the methodology recommended by WHO, and reporting to WHOPES any discrepancies in recommendations on use of pesticides in public health to ensure review and, if necessary, revision;
- monitoring of personnel for pesticide exposure at frequencies and with methods recommended by WHO;
- maintenance of records on poisoning events (see also 7.9), and reporting each such event to the national level; and
- maintenance of records of public health pesticide usage by product, quantity, and location.

7.9 Surveillance of pesticide poisoning

Surveillance of pesticide poisoning is a crucial component of any national programme for pesticide management. Collection of data in a standardized form, follow-up investigations, and reporting to the national registration authorities may be enhanced by establishment of poison centres in the country, which will also provide information to the medical profession on the treatment of poisoning cases. WHO guidelines for poison control (WHO, 1997a) should be consulted for the establishment or strengthening of programmes for poison control. The IPCS INTOX Programme (<http://www.intox.org>) and Pesticide Data Management System, exclusively developed for recording, collecting, and analysing the information on pesticide exposures and poisonings, also aid countries in capacity-building for diagnosis and treatment of pesticide poisonings, preventive measures, and decision-making for management of pesticides. Proper management of pesticides can also be facilitated by assistance from ministries of health with monitoring and reporting poisoning events to the national regulatory authorities.

7.10 Monitoring pesticide resistance

Resistance to pesticides is a major concern in control of vectors and pests of public health importance: extensive resistance to common pesticides has been documented. This is a matter of acute concern given the dwindling arsenal of suitable and cost-effective pesticides and the limited number of new compounds in development. The selective and judicious use of existing compounds is critical to increasing their useful life span.

Regular monitoring of resistance to pesticides would ensure continued efficacy of the products for vector/pest management and minimize both the hazards associated with use of “non-effective” products and the waste of limited financial resources. Together with an understanding of the

causative mechanisms involved, this would allow proper management of pesticides and prevention of resistance.

This crucial issue requires development of national policies and guidelines on use of pesticides in the context of integrated vector/pest management and calls for close collaboration of health and agriculture ministries with other sectors.

WHO has developed standard test kits for determination of susceptibility to pesticides of vectors and pests of public health importance. Guidelines on monitoring resistance, and on possible mechanisms of resistance, have been developed by WHO (WHO, 1998a, 1998b).

In this regard and in addition to the above guidelines, resistance management and surveillance should be also be guided by the following policies:

- development of national guidelines on the use of pesticides in collaboration with other sectors and in the context of integrated vector/pest management;
- establishment and maintenance of an information exchange between health and agriculture ministries;
- adherence to WHO guidelines for systematic monitoring and reporting of susceptibility to pesticides;
- use of WHO guidelines for pesticide resistance prevention and management (WHO, 2003b);
- use of appropriate pesticide products and application equipment (WHO, 1990) according to approved use instructions and in accordance with WHO guidelines on judicious use of pesticides; and

- publication of information on pesticide resistance in vectors and pests of public health importance.

7.11 Quality control

Good product quality is essential to the effectiveness of pesticides, and to minimizing any risk involved in their use. If the content of active ingredient in a product is less than the declared level, the results could be monetary loss and the application of sublethal doses – leading to ineffective control and potential development of resistance. Use of products or formulations with inferior physicochemical properties, such as suspensibility, or emulsification or particle size characteristics, can also result in inadequate application and possibly an increased risk for personnel who may come into greater contact with the pesticide and/or pesticide-contaminated application equipment. Impurities formed during manufacture of the pesticide, or by interaction in unstable formulations, can increase product toxicity. Inaccurate or inadequate labelling of products can also cause a variety of application and safety problems.

Quality control of pesticides to minimize risks associated with their handling and use, as well as their efficacy and stability in storage, is crucial in view of increasing number of manufacturers and the growing trade in pesticides.

In this regard and in addition to the above, national pesticide management should be guided by the following policies:

- introduction or updating of the necessary legislation for regulation of pesticides in line with FAO/WHO procedures for the development of pesticide specifications (WHO, 2002b);
- requiring a manufacturer's certificate of analysis of product and formulation acceptability for every batch (production lot) purchased, accepting only those

products that meet specifications and have acceptable expiry dates;

- adherence to WHO specifications for chemical analysis and formulation and performance of all relevant quality control tests (WHO 2002a); and
- pre-shipment and on-arrival analysis of pesticides at the national level, as is warranted, utilizing WHO Collaborating Centres where necessary.

7.12 Capacity building

Capacity building for pesticide management should form an integral part of national capacity-building plans for integrated vector management, addressing each of the specific elements of the pesticide management cycle. Capacity building will include development of the necessary legislation and regulations, recruitment and training of adequate numbers of suitable staff, making available technical resources and establishing infrastructure, and proper resource allocation.

Planning for capacity building should be based on a critical analysis of the existing resources and infrastructure, and should take into consideration WHO and FAO guidelines. In this regard:

- adequate legal instruments for proper infrastructure, as well as adequate human resources, should be available for effective management of public health pesticides;
- the central vector/public health unit should be strengthened, to support and coordinate activities for the management of public health pesticides;

- efforts should be made to recruit skilled personnel and to train technical staff in various aspects of pesticide management as provided in this guideline; regular on-the-job training, at different levels and certification scheme for staff and operators engaged in pesticide related activities should be developed;
- the vector control unit should have, or have access to, adequate infrastructure including a national entomology laboratory and where possible, a laboratory fully capable of the quality control of pesticides;
- national policies, technical guidelines, and protocols for data collection and use should be available at all levels of the health systems, and potential users should be fully acquainted with them;
- pesticide management, like most vector control operations, requires good logistics (transport and storage facilities, communications systems, etc.); it is essential to ensure that logistic support of the vector control programme is adequate to address the specific needs of pesticide management; and
- specific financial resources should be allocated to vector control programmes (for activities that include evaluation of effectiveness of pesticide applications and monitoring of insecticide resistance) in accordance with the national health financing policy; some resources should be specifically allocated to pesticide management activities.

7.13 Public education

Public support for the use of public health pesticides is an important factor both for the effective management of vector-borne diseases and for control of pests of public health importance. Long-term strategies and effective approaches are required to educate the public and relevant parties and

obtain their support for vector control programmes and pesticide management practices. Health education and communication should aim to create general public awareness and understanding and to elicit support for safe and effective use of pesticides in public health. Active programmes that provide accurate public and providing accurate information on vector/pest control activities are thus essential.

In this regard and in addition to the above guidelines, public education efforts should also be guided by the following policies:

- use of multi-media approaches to inform the public of reasons for pesticide use, any risks involved, and the possible consequences of not using pesticides;
- provision of information throughout the year, not only at the start of control activity;
- advising the public on reasons for selecting specific pesticides and for targeting specific diseases;
- informing high-level government and community decision-makers on options available for vector control, the risk of pesticide use versus that of failure to use pesticides when required, and critical issues related to pesticide management; and
- training of management and field personnel on interacting with the public and serving as public education messengers.

7.14 Information exchange

The timely availability of information on pesticides is a basic and critical requirement in pesticide management. From time to time, most authorities face problems in obtaining the

information required for good decision-making, often as a result of the inadequate flow of information between different groups of stakeholders. Strengthening of national information system should therefore be a priority aim of Member States facing such problems. The national responsible authority for registration and control of pesticides would be best placed to play a leading role in the establishment of the information system. The key to success in establishing an information system is to ensure effective coordination and networking among national stakeholders. For the system to be sustainable, stakeholders must be aware of, and able to benefit from, the system. The sophistication of the system will vary from country to country but computerization will inevitably play an important role.

Exchange of information at the regional and subregional level, is equally important, through links established with ministries of health and/or other responsible authorities in neighbouring countries. At the international level, information links with IGOs, NGOs, and the pesticide industry will also be valuable.

The responsible national authority should establish a multi-agency committee on pesticide information management with the following terms of reference:

- to organize and establish a national pesticide information system and develop mechanisms for sharing of information resources;
- to conduct a thorough information management needs assessment to address issues that include information infrastructure and accessibility of sources, availability of resources, and legal requirements;
- to ensure that all stakeholders are aware of the work done by the committee and of the benefits to be gained from information sharing and collaboration; and

- to review critically the information necessary for vector control and pesticide management and its use for effective implementation of vector control activities.

Throughout the process of addressing weaknesses of the existing information system, there will be a need to set priorities for action in different sectors, particularly making information from those sectors available to the country programmes.

7.15 Licensing

Licensing of pesticide manufacturers, distributors, retailers, and pest control operators is an important aspect of pesticide management. Member States should develop regulations and implement licensing procedures to strengthen pesticide management (FAO, 1989), particularly with a view to ensuring that only approved pesticides are sold and that sound advice is given to purchasers. Proper storage conditions and safety feature of storage premises should be among the prerequisites for licensing. Industry should ensure that distributors are adequately trained and have access to sufficient information (FAO, 1988b). Licensing is the responsibility of the regulatory authorities but active involvement of the ministry of health is important.

8. Recommendations

WHO

1. WHO should distribute the draft guidelines widely among Member States and relevant institutions for comments, suggestions, and finalization.
2. WHO should take steps to assist Member States to develop national policies, plans of action, and appropriate national guidelines for the implementation of the guidelines.

3. WHO should expand the existing network of collaborating centres for quality control of pesticides and take steps to strengthen the capacity of Member States, particularly through proficiency testing.
4. WHO should take steps to assist Member States to strengthen national capacity for pesticide information exchange and to establish networks with other countries and relevant institutions.
5. In collaboration with FAO, WHO should assist Member States in harmonizing pesticide registration requirements.
6. WHO should promote inter-country collaboration on public health pesticide management.

Member States

7. Member States should adopt and implement the finalized guidelines.
8. Member States should establish or strengthen vector control units/core groups at the central level of the ministry of health to effectively implement the guidelines.
9. Member States should take steps to strengthen their capacity for management of public health pesticides and should use WHO recommendations for registration, procurement, and quality control, as well as effective application, of pesticides, supporting this with legislation where necessary.
10. Where necessary, Member States should review/revise their guidelines on labelling, packaging, and disposal of pesticides in line with the FAO recommendations.

11. Member States should strengthen the monitoring and evaluation components of their vector/public health pest control programmes to include routine assessment of pesticide applications and to ensure their selective and targeted use.
12. Member States should routinely monitor development of resistance to pesticides as a crucial element in vector/public health pest control activities.
13. Member States should strengthen post-registration monitoring of pesticides, including monitoring of pesticide exposure and poisoning, and use the information to develop national guidelines for pesticide use.
14. Member States should take steps to establish effective intra- and inter-sectoral collaboration, especially with ministries of agriculture and the environment, as a crucial requirement of public health pesticide management.
15. Member States should ensure that the elements of public health pesticide management are incorporated into national activities for health promotion, preferably within the context of community involvement in IVM.

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WHO Pesticide Evaluation Scheme (WHOPES)

The WHO Pesticide Evaluation Scheme (WHOPES) was set up in 1960 and remains the only international programme that promotes and coordinates the testing and evaluation of pesticides intended for public health uses. The *International Code of Conduct on the Distribution and Use of Pesticides* (FAO, 1990) constitutes the framework for WHOPES in promoting the safe handling and use, efficacy, cost-effective application and quality control of pesticide products/formulations for public health use. The development of specifications for pesticides and application equipment, for use in international trade and quality control, forms an integral part of the WHOPES programme.

WHOPES functions in close collaboration with national disease and pest control programmes and national pesticide registration authorities, many international and regional organizations and institutions concerned with pesticide management, legislation and regulation, research institutions and with industry.

WHOPES recommendations take account of existing published and unpublished data and are based on consideration of different factors which may influence performance of products for a given application.

WHOPES recommendations on the use of public health pesticides expedite the local registration of products to be used for the control of vectors and pest of public health importance and minimize requirements for local testing of products that have given satisfactory results in similar circumstances. Reports of WHOPES evaluations of public health pesticides are available on request from WHO Communicable Disease Control, Prevention and Eradication, 1211 Geneva 27, Switzerland, and are available on the Internet at <http://www.who.int/ctd/whopes>.

The global objectives of WHOPES are to:

- facilitate the search for alternative pesticides and application methodologies that are safe and cost-effective; and
- develop and promote policies, strategies and guidelines for the selective and judicious application of pesticides for public health use, and assist and monitor their implementation by Member States.

In its present form, established in 1982, WHOPES consists of a four-phase evaluation and testing programme.

Phase 1. Technical or formulated pesticides are tested for efficacy and persistence using laboratory-bred arthropods. This phase also incorporates the study of cross-resistance with the various classes of pesticides currently available and the establishment of tentative diagnostic concentrations for the detection of vector resistance in the field. Compounds are also evaluated, in close collaboration with the WHO Programme on Chemical Safety (WHO/PCS), for their safety for humans and the environment. Minimum laboratory experimentation to allow the confirmation of the basic toxicological and ecotoxicological information available from the manufacturer or other sources, in the light of the particular requirements of WHO, may also be carried out by appropriate WHO collaborating centres.

Phase 2. This phase consists of studies on natural vector populations in the field, on a small scale and under well-controlled conditions, to determine application doses and assess the efficacy and persistence of the pesticide. Where appropriate, the action of products on non-target fauna is verified. Phase 2 is also the first opportunity to document any harmful effects of the product upon operators in a field situation.

Phase 3. WHO, industry and one or more institutions located in disease-endemic countries undertake to assess the efficacy of the product on a medium or large scale against a specified disease vector. Phase 3 consists of entomological, safety and, where appropriate, epidemiological evaluation. The institution supplies qualified staff for implementation, while the manufacturer supplies the insecticide and the funds needed for the trial. WHO bears the technical responsibility for the operation and is involved in the field through independent consultants. All three parties participate in drafting the trial protocol in accordance with an established model that should be adapted to each situation. The final report is drafted by the institution, submitted to WHO for evaluation and then to the manufacturer for review.

A scientific committee, the WHOPES Working Group, assists WHOPES in reviewing evaluation reports and assessing current knowledge about products and their intended applications, and makes recommendations to WHOPES on their public health use. The reports of the WHOPES Working Group are issued as WHO documents and are widely distributed.

Phase 4. This phase is concerned with the establishment of specifications for the technical product and the formulations evaluated. Before 2002, draft specifications proposed by industry were reviewed by the WHO Expert Advisory Panel on Vector Biology and Control and WHO collaborating centres and were then issued as interim specifications. These were then reviewed every five to six years by the WHO Expert Committee on Vector Biology and Control, which could recommend their publication as full WHO specifications. At its meeting in 1999, the Expert Committee on Vector Biology and Control (WHO, 2001) recommended harmonization of the specifications development procedures and processes with those of FAO. From 2002, all specifications for technical grade active ingredients and most specifications for formulated products will be developed

through the FAO/WHO Joint Meeting on Pesticide Specifications (JMPS), using the “new” procedure.

Under the new procedure, WHO recommendations on use and WHO specifications are restricted to the data package and product evaluated by WHOPES. Where a technical material/technical concentrate of a subsequent proposer has been found “equivalent” and the formulations derived from it meet all criteria of WHO specifications for the reference product, WHO recommendations on use are expected to apply. Any potential differences in safety and efficacy, due to formulation-specific properties, are determined in small-scale field studies, normally carried out to determine performance under specific local conditions and against target pest species.

Agenda

TUESDAY, 25 FEBRUARY 2003

- 08.00 – 09.00 **Registration**
- 09.00 – 09.30 **Inaugural Session**
- **Message from the Local Organizer**
 - Dr Vinai Pitiyont, Head of Formulation Analysis Section, Department of Agricultural Toxic Substances Division
 - **Message from WHO/HQ**
 - Dr Morteza Zaim, WHO Pesticide Evaluation Scheme (WHOPES), Communicable Disease Control, Prevention and Eradication
 - **Message from Regional Director, WHO/SEARO**
 - to be read by Dr Chusak Prasittisuk, Regional Adviser, Vector Borne Disease Control, WHO/SEARO
 - **Message from FAO**
 - Dr Gero Vaagt, Senior Officer, Pesticide Management, Plant Protection Service, Rome, Italy
 - **Inaugural speech**
 - Dr Nuansri Tayaputch, Director, Division of Agricultural Toxic Substances, Department of Agriculture and Cooperatives, Thailand
- 09.30 – 10.00 **Group photograph and coffee break**
- 10.00 – 10.40 **Introduction of participants and objectives of the meeting**
- **Introduction of participants and nomination of Chairman and Rapporteur**
 - Dr Chusak Prasittisuk, Regional Adviser, Vector Borne Diseases, WHO/SEARO
 - **Objectives and method of work**
 - Dr Morteza Zaim, WHO Pesticide Evaluation Scheme (WHOPES), WHO/HQ, Geneva

- 10.40 – 10.50 **Adoption of the agenda**
- Overview of the management of public health pesticides**
- 10.50 – 11.05 WHO African Region – Dr L. Manga
- 11.05 – 11.20 WHO American Region – Dr C. Frederickson
- 11.20 – 11.35 WHO South-East Asian Region – Dr C. Prasittisuk
- 11.35 – 11.50 WHO Western Pacific Region – Dr Chang Moh Seng
- 11.50 – 12.30 **Discussion – Major issues relating to the management of public health pesticides**
- 12.30 – 14.00 Lunch break
- 14.00 – 14.30 **Features of the revised International Code of Conduct on the Distribution and Use of Pesticides**
Mr G. Vaagt, FAO
- 14.30 – 15.00 **Discussion**
- 15.00 – 17.00 **Review and finalization of the guidelines on the management of pesticides for public health – Chapters 1 – 5**
Chairperson
- * Coffee break 15.30 – 16.00

WEDNESDAY, 26 FEBRUARY 2003

- 09.00 – 12.30 **Review and finalization of the guidelines on the management of pesticides for public health – Chapters 6.1 – 6.5**
Chairperson
- 12.30 – 14.00 Lunch break

14.00 – 17.00 **Review and finalization of the guidelines on the management of pesticides for public health – Chapters 6.6 – 6.9**
Chairperson

* Coffee breaks: 10.00 – 10.30 and 15.30 – 16.00

THURSDAY, 27 FEBRUARY 2003

09.00 – 12.30 **Review and finalization of the guidelines on the management of pesticides for public health – Chapters 6.10 – 6.13**
Chairperson

12.30 – 14.00 Lunch break

14.00 – 16.00 **Review and finalization of the draft questionnaire on public health pesticide management practices in Member States**
Chairperson

* Coffee breaks: 10.00 – 10.30 and 15.30 – 16.00

FRIDAY, 28 FEBRUARY 2003

09.00 – 12.00 **Formulation of recommendations for the smooth implementation of the guidelines in the Member States**

12.00 – 12.30 **Adoption of the report and closure of the meeting**

12.30 – 14.00 Lunch

* Coffee break 10.00 – 10.30

List of participants

1. Mr Tan Soo Hian, Kuala Lumpur, Malaysia
2. Dr Driss Kellili, CropLife International, Antipolis, France
3. Dr Kamilia A. Mahmoud Allam, Research Institute of Medical Entomology, Ministry of Health, Cairo, Egypt
4. Dr Jorge F. Méndez-Galvan, Centro Nacional de Vigilancia Epidemiológica, México DF, Mexico
5. Mr Tham Ah Seng, Vector-Borne Disease Control Programme, Ministry of Health, Kuala Lumpur, Malaysia
6. Dr Nuansri Tayaputch, Division of Agricultural Toxic Substances, Department of Agriculture, Bangkok, Thailand
7. Ms Yong-Zhen Yang, Institute for the Control of Agrochemicals, Ministry of Agriculture, Beijing, China
8. Dr A.B.M. Siddiqui Islam, Directorate General of Health Services, Bangladesh
9. Dr G.P.S. Dhillon, National Anti Malaria Programme, Delhi, India
10. Mr U. Pyone Lwin, Vector Borne Disease Control, Department of Health, Ministry of Health, Government of Union of Myanmar, Yangon, Myanmar
11. Dr Somsak Prajakwong, Bureau of Vector Borne Disease Control, Department of Disease Control, Ministry of Public Health, Nontaburi, Thailand
12. Ms Yupa Leelaprute, Food and Drug Administration, Ministry of Public Health, Nonthaburi, Thailand
13. Dr Thomas Suroso, Directorate of Vector Borne Disease Control, Ministry of Health, Jakarta, Indonesia
14. Dr Wan Alkadri, Ministry of Health, Jakarta, Indonesia
15. Dr H.M. Fernando, Ministry of Health, "SUVASIRIPAYA", Colombo, Sri Lanka
16. Dr Thilaka Liyanage, Anti Filariasis Campaign, Colombo, Sri Lanka

FAO

17. Dr Gero Vaagt, Pesticide Management, Plant Protection Service, Food and Agricultural Organization of the United Nations (FAO), Rome, Italy

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18. Dr Chusak Prasittisuk, RA-VBC/CDS, World Health Organization, Regional Office for South East Asia, New Delhi, India
19. Mr Alexander Von Hildebrand, RA-PCS/SDE, World Health Organization, Regional Office for South East Asia, New Delhi, India
20. Dr Morteza Zaim, PVC/CPE/HQ, CDS/CPE/PVC, World Health Organization, Geneva, Switzerland
21. Dr Nida Besbelli, PCS/PHE/HQ, World Health Organization, International Programme on Chemical Safety, Geneva, Switzerland
22. Dr Chang Moh Seng, Scientist (Vector Control), World Health Organization Representative Office, Phnom Penh, Cambodia
23. Dr Lucien Manga, RA/VBC, AFRO, Harare, Zimbabwe
24. Dr Christian Frederickson, PAHO, Brasilia, Brazil

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28. Ms Nitaya Veerakul, Agricultural Toxic Substances Division, Department of Agriculture, Bangkok, Thailand

29. Ms Nunchana Luetrakool, Agricultural Toxic Substances Division, Department of Agriculture, Bangkok, Thailand
30. Ms Poonsook Saruthaithanasan, Office of Experts, Department of Agriculture, Bangkok, Thailand
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