

PESTICIDE MONITORING SYSTEM IN LAMPUNG AND SOUTH SUMATERA: CASE STUDIES IN KABUPATEN TANGGAMUS, WEST LAMPUNG, AND SOUTH OGAN KOMERING ULU

Hamim Sudarsono¹, Purnomo¹, dan Wagianto²

¹Jurusan Proteksi Tanaman, Fakultas Pertanian Universitas Lampung

²PT Indo Cafco Lampung

ABSTRACTS

Chemical pest control is the most common method utilized by farmers to control agricultural pests and diseases in Indonesia. Unfortunately, majority of Indonesian farmers are not well informed with the danger of pesticide applications which has serious impacts on human health and agricultural ecosystem. Various reports indicates that illegal and banned pesticides are available for sale in the market. Considering the hazardous effects of illegal pesticides uses in the long run, this case study was aimed to study monitoring system for the application and distribution of banned pesticides in two region, i.e. Lampung (Tanggamus) and South Sumatra (South Ogan Komerling Ulu). The survey was mainly focused to gather facts about the implementation of **Chapter 13, Permentan No. 107/Permentan/SR.140/9/2014**. Farmers perception on pesticide regulation was also gathered through interviews and questionnaires. Our iinterviews and document confirmation indicated that *Fertilizer and Pesticide Supervisory Commission* (Komisi Pengawasan Pupuk dan Pestisida, KP3) has been established in Lampung dan South Sumatra. The commission, however, was not effective in supervising the implementation of pesticide regulation since only 1-2 provincial pesticide supervisory meetings were held annually. Our interviews also revealed that the meeting topics were more focused on fertilizer cases: distribution, subsidized fertilizer, fertilizer forgery, fertilizer quality etc. Pesticide cases were rarely discussed in the meeting. Responses from questionnaires shows that majority of farmers obtained information about pesticide from retailers (47%) and from other farmers (39%). Only 14% of respondents acknowledge that they received pesticide information from agricultural extension officers. Our questionnaires also indicate that personnel of the pesticide industry have a significant role in transferring information related pesticide to farmers (47%).

Key words: monitoring, pest control, chemical pesticides

INTRODUCTION

Chemical pest control is the most common method utilized by farmers to control agricultural pests and diseases in Indonesia. Hundreds of chemical products from various formulators are available throughout the country with various degrees of toxicities. Unfortunately, majority of Indonesian farmers are not well informed with the danger of pesticide applications and farmers knowledge on pesticides is mostly obtained from formulator representatives. Despite the serious impacts of pesticide applications toward human health and agricultural ecosystem, involvement of government officials in educating farmers and Indonesian communities concerning

various aspects of pesticide use in Indonesia is very minimum compared to the huge sales of pesticides in the country. This condition is not only occurring in Indonesia, but is also happening throughout developing countries in Asia. According to a study conducted by the international Pesticide Action Network (PAN), the use of some pesticides in Asian countries has exposed communities across the region to unacceptably high health risks. Interviews with peasant farmers in eight Asian countries revealed that 66 % of pesticide-active ingredients used on vegetables, paddy and other crops were highly hazardous, presenting unacceptably high risks to communities, and especially to sensitive sub-populations such as women, children, the malnourished or those suffering from diseases. Some pesticides that have been documented to have health effects or are subject to bans or restrictions elsewhere, such as paraquat, endosulfan, and monocrotophos are still used by farmers (PAN Asia Pasific, 2010; Pesticide Action Network Asia Pasific, 2010).

Modern agriculture has so much dependent on the use of agrochemical. The largest share of the world agrochemical market was dominated by herbicides which accounted for 45.4%, followed by insecticides 27.5%, fungicides 21.7% and other products 5.4% (Agrow, 2005). In 2012, Indonesia's pesticide market was valued at approximately 2 billion USD. The largest pesticide utilization was for rice cultivation (41%) and palm plantation crops (27%). From the perspective of product category the most utilized products were herbicides (42.5%) with glyphosate and paraquat reaching almost 120 thousand tons followed by insecticide (37.5%) and the most used active ingredient was carbofuran (40,000 tons). Fungicide accounted for about 18% of the market and the most popular active ingredients were mancozeb and propineb. In terms of Indonesia's pesticide trade balance, about 90% of the technical materials processed in Indonesia are imported from China. These products are subsequently processed into finished product formulations before finally being exported to many of Indonesia's neighboring countries including to China, making Indonesia simultaneously the ninth largest importer of Chinese pesticides and the seventh largest exporter to China. During the first half of 2014, Indonesia imported 35,935 tons (167.8 million USD) of pesticide from China and exported 1,788 tons (22.57 million USD) of pesticide back to China (Fang Lin, 2015).

Effectiveness of a pesticide is generally used as the first consideration by farmers in selecting pesticides for their crops. Unfortunately, many "effective" pesticides are related to their long persistence and wide spectrum characteristics which make them hazardous to human health as well as to the environment. For these reasons, many pesticides have been banned for use for

agriculture. Among these banned pesticides were most favorite insecticides that were used widely and intensively used around the world but now labelled as the dirty dozen: Aldrin, Chlordane, Dieldrin, Endrin, such as Aldicarb, Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene (HCB), Mirex, Toxapene, Polychlorinated biphenyls (PCBs), Dichlorodiphenyltrichloroethane (DDT), Dioxin, and Polychlorinated dibenzofurans. The Governing Council of the United Nations Environment Programme (UNEP) called the substances as the Persistent Organic Pollutants (POPs). These pollutants were identified as "chemical substances that persist in the environment, bio-accumulate through the food web, and pose a risk of causing adverse effects to human health and the environment" (Convention, 2008; Kelly *et al.*, 2007; Lallas, 2001).

Due to their serious hazards to human health and environment, governments and international agencies around the world have to be ready to cope with the growing list of banned or restricted pesticides. Hundreds of pesticides are now listed as restricted or on limited uses in many countries due to increasing awareness for healthier food and environment. Various certification programs are now becoming very important element of international trades for agricultural products. On the other hands, old stocks of banned pesticides are still available for sales and threat for their uses in our agriculture is real. These condition require authorities to improve pesticide monitoring programs. Monitoring and evaluation program to control the distribution of pesticides, therefore, is a must in order to identify and avoid the distribution of illegal and banned pesticides in Indonesia.

The legislation that governs the use and approval of pesticides in Indonesia is based on a model employed by most western countries including the US, Europe, Canada, Australia and New Zealand. The basis of the legislation is that prospective pesticides must be tested employing a battery of environmental toxicity tests by the company submitting them for approval by the governments' Pesticides Committee. The Pesticides Committee then scrutinizes the results and decides whether to recommend to ministers that the pesticide be approved for use. Indonesia also employs a quick route for approval which allows pesticides approved by countries such as the US and UK to be given approval for use in Indonesia. Despite its established regulation and approval system, pesticides distribution in Indonesia has a major drawback. Monitoring program to police the use and distribution of pesticides is lack of enforcement. Therefore anyone can use anything

with little fear of being caught and punished (<http://www.pan-uk.org/pestnews/Issue/pn44/pn44p10.htm>).

Considering the hazardous effects of illegal pesticides uses in the long run, a case study was conducted with objectives: (1) obtain firsthand information of current pesticide monitoring system and its implementation in selected districts in Lampung and South Sumatra; (2) to identify most crucial problems and to provide realistic suggestions to improve the pesticide monitoring system based on the current government regulation; and (3) to describe monitoring system and its implementation of current pesticide monitoring program in the District of Tanggamus, West Lampung (Lampung Province), and South Ogan Komerung Ulu (South Sumatra Province).

METHOD OF STUDY

The study was conducted on 1 – 25 March, 2015 in three regencies (kabupaten) in southern Sumatra, i.e. Tanggamus and West Lampung (Lampung Province) and South Ogan Komerung Ulu (South Sumatra Province) (Figure 1). This study employed survey method and interviews to the parties involved in the pesticide monitoring and distribution system. The study used the Regulation of Indonesia Agriculture Minister No. 107/ Permentan/SR.140/9/2014 as the core regulation to investigate. Interviews were conducted to investigate how the local governments implement the regulation to supervise and monitor safe pesticide distribution and application.

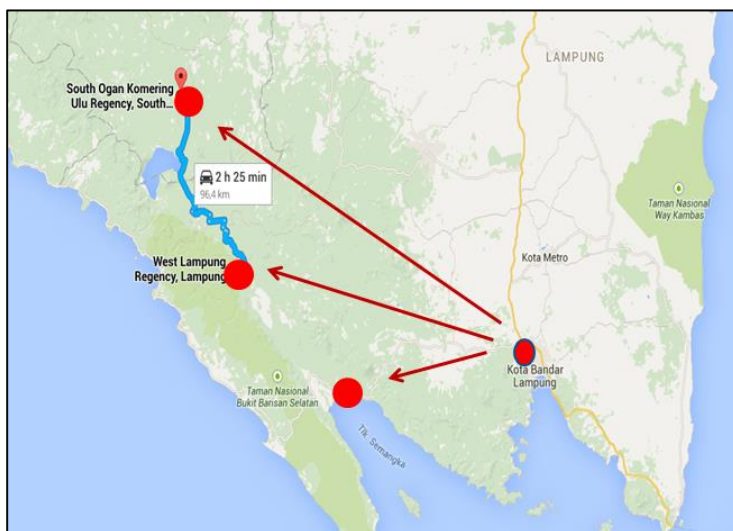


Figure 1. Location of 2015 pesticide monitoring study: Tanggamus, West Lampung, and South Okus.

Questionnaires were used to collect data of current pesticide monitoring network and information related to the implementation of monitoring of banned pesticides. A purposive sampling technique was applied to select participants involved in the pesticide monitoring network (Figure 1). Participants to be surveyed were grouped into: (1) Provincial and regency (kabupaten) officials, including extension services (Penyuluh Pertanian and Pengamat OPT) related to (responsible for) monitoring and distribution system of pesticides; (2) Pesticides distributors/representatives and sellers/retailers in the area; (3) Farmers, represented by members of farmer groups in the area.

Each group was interviewed using specially designed questionnaires developed during a preliminary survey (1 – 3 days). Surveys also identified types and specification of pesticides available for farmers in the area. When permitted by the respondents, samples of pesticide types found during the surveys were photographed for documentation and analyses.

RESULTS AND DISCUSSION

Pesticide Regulatory in Indonesia

Implementation of pesticide monitoring in Indonesia is officially based on several laws, government regulations, and ministerial decrees, i.e.: (1) Act No. 12 of 1992 on Plant Cultivation (Undang-Undang RI No. 12 Tahun 1992 tentang Sistem Budidaya Tanaman); (2) Government Regulation No. 7 of 193 on Supervision of Distribution, Storage, and Use of Pesticides (Peraturan Pemerintah RI No. 7 Tahun 1973 tentang Pengawasan atas Peredaran, Penyimpanan dan Penggunaan Pestisida); (3) Government Regulation No. 6 of 1995 on Plant Protection (Peraturan Pemerintah RI No. 6 Tahun 1995 tentang Perlindungan Tanaman); (4) Government Regulation No. 85 of 1999 on the Amendment of Regulation No. 18 of 1999 on Management of Hazardous and Dangerous and Toxic Waste (Peraturan Pemerintah RI No. 85 Tahun 1999 tentang Perubahan PP No. 18 Tahun 1999 tentang Pengelolaan Limbah Bahan Berbahaya dan Beracun); (5) Government Regulation No. 25 of 2000 on Central Government and Provincial Authority as Autonomous Region (Peraturan Pemerintah RI No. 25 Tahun 2000 tentang Kewenangan Pemerintah dan Kewenangan Provinsi sebagai Daerah Otonom); (6) Minister of Agriculture Decree No. 887/ KPTS /OT.210/9/1997 on Guidelines for Controlling Plant Pest Organisms (Keputusan Menteri Pertanian No. 887/KPTS/ OT.210/9/1997 tentang Pedoman Pengendalian Organisme Pengganggu Tumbuhan); (7) Minister of Agriculture Regulation No.

24/Permentan/SR.140/4/2011 on Conditions and Procedures for Pesticide Registration (Peraturan Menteri Pertanian No. 24/Permentan /SR.140/4/2011 tentang Syarat dan Tatacara Pendaftaran Pestisida); (7) Minister of Agriculture Regulation No. 107/Permentan/SR.140/9/2014 on the Control of Pesticides (Peraturan Menteri Pertanian No.107/Permentan/SR.140/9/2014 tentang Pengawasan Pestisida)

Among the above regulations, main focus of this research was to find out how the Minister of Agriculture (MoA) Regulation No. 107/Permentan/SR.140/9/2014 (which replaced the previous regulation No. 42/Permentan/SR.140/5/2007) was implemented in three regencies in southern Sumatra, i.e. Tanggamus, West Lampung (Lampung Province), and South Ogan Komering Ulu (South Sumatera Province). The major importance of the regulation is to administer the structure, duties, and functions of the *Fertilizer and Pesticide Supervisory Commission* (Komisi Pengawasan Pupuk dan Pestisida, KP3) at national, provincial and regency/municipal levels. Based on the description of the Regulation No. 107, procedures and hierarchy for pesticides monitoring in Indonesia is outlined as follows (Figure 2).

As a national regulation, MoA Regulation No. 107/Permentan/SR.140/9/2014 contains general rules and regulations which require a more detailed and operational instructions to be implemented at provinces and regencies/municipalities. In order to perform optimally, KP3 (Fertilizer and Pesticide Supervisory Commission) at both provinces and regencies have to adjust to local resources and conditions so that they could execute their program effectively. For this purpose, the commission at provinces and regencies could refer the *Guides to Improvement of KP3 Performance and Empowerment of State Civil Investigator (Pedoman Peningkatan Kinerja Komisi Pengawasan Pupuk dan Pestisida serta Pemberdayaan PPNS)* published by the Directorate of Fertilizer and Pesticide (2014). Instruction of the guide, however, is also too general and need to be more specifically tailored to be suitable for local conditions of KP3. In addition, KP3 resources and supporting facilities in provinces and regencies may not be adequately available to execute programs as mandated by the regulation. Unfortunately, KP3 agencies in the surveyed areas have never asked pesticide experts or laboratories which may be available in the area to participate in their programs. All of KP3 personnel are ex-officio appointees with various background not directly or technically related to pesticide expertise.

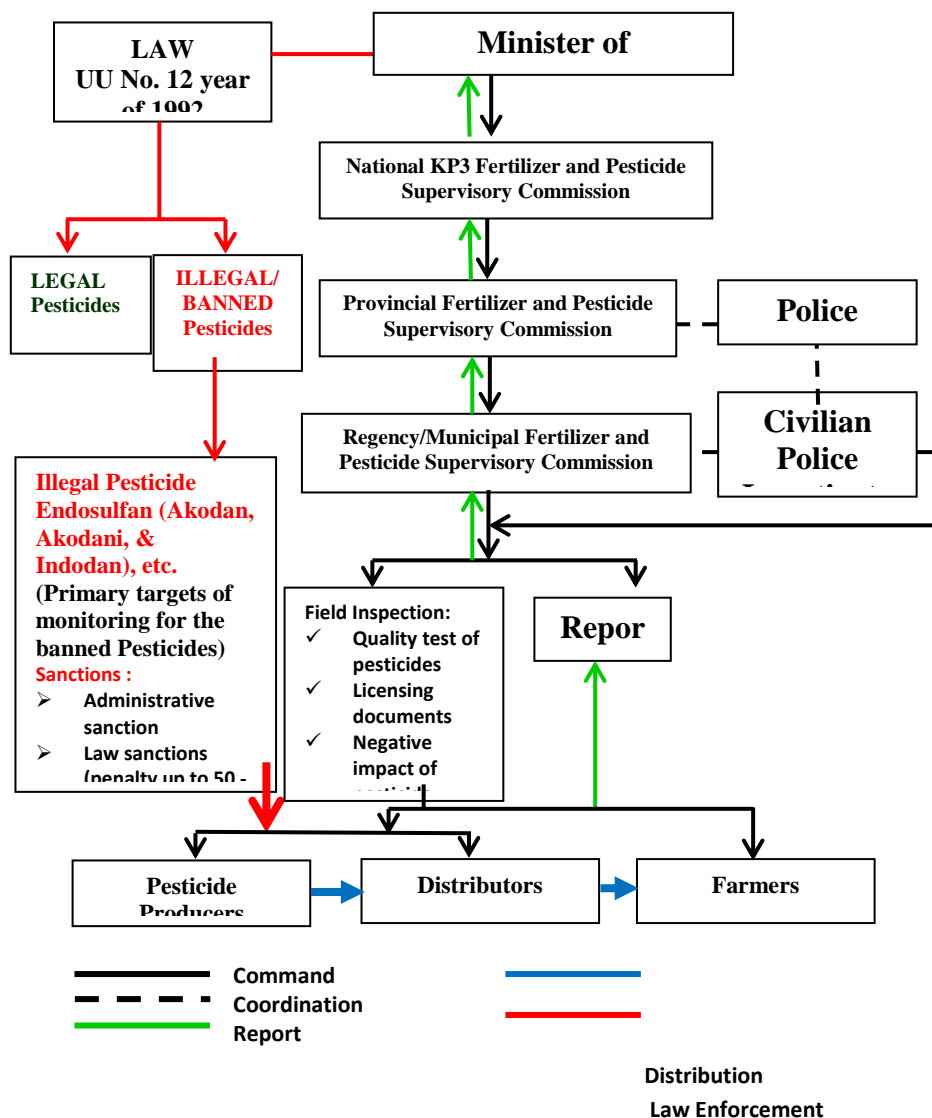


Figure 2. Flow chart of fertilizer and pesticide monitoring system in Indonesia based on various relevant regulations.

Other available guides or manuals for strengthening the functioning of KP3 in provinces and regencies/municipalities are: (1) Procedures for Appointment and Dismissal of Fertilizer and Pesticide Supervisors (Tata Cara Penunjukan dan Pemberhentian Pengawas Pupuk dan Pestisida); (2) Duties, Authority and Implementation of Supervision Reporting (Tugas, Wewenang dan Pelaksanaan Pengawasan Pelaporan); (3) Guides for Pesticide Supervisory Activities (Petunjuk Kegiatan Pengawasan Pestisida) 2014.

Implementation of Pesticide Monitoring

Directorate of Fertilizers and Pesticide (2014) reported that pesticide problems in Indonesia are not only limited to the circulation of illegal/unregistered pesticides but also includes sales of various counterfeited, low quality, repacked, or illegally expired pesticides. Specifically for pesticides with limited use, common violations includes the sales, handling, and application of the restricted pesticides by non-trained or non-licensed applicators as well as retailers as mandated by Ministry of Agriculture Regulation No. 24/Permentan/SR. 140/4/2011.

The Directorate of Fertilizers and Pesticides (2014) also reported that it does not have sufficient number of personnel to run pesticide monitoring activities in provinces as well as in regencies/municipalities across Indonesia. This factor may have significantly contributed to the unsatisfactory performance of KP3 in most provinces and regencies/municipalities which in turn also explains why illegal pesticides are still reportedly available in Indonesia. In addition to personnel availability, the Directorate cited that personnel's low understanding of pesticide control mechanism may also resulted in various pesticide distribution violations in Indonesia.

Survey at provincial agriculture offices was mainly focused to gather facts about the implementation of **Chapter 13, Permentan No. 107/Permentan/SR.140/9/2014**. Responsibilities of Provincial Fertilizers and Pesticide Supervisory Commission (KP3 Provinsi) are to supervise:

1. Type and amount of pesticides, containers, wrapping, labeling and publication of pesticides.
2. Business permit documents (SIUP), registration and other administrative documents at the circulation level.
3. Provision of work safety and health.
4. Implementation and provision of facilities and equipment for pesticide management.
5. Negative impact of pesticide management to public health and environment.
6. Samples of pesticides for quality test.
7. Quality of technical materials and types of pesticides in relation with the limit of permissible concentration of the active ingredient for the distribution and use.

Similarly, surveys at regencies were also to gather facts about the implementation of **Chapter 14, Permentan No. 107/Permentan/SR.140/9/2014** which regulate responsibilities of Regency Fertilizers and Pesticide Supervisory Commission (KP3 Kabupaten), i.e. to supervise:

1. Quality of technical materials and types of pesticides in relation with the limit of permissible concentration of the active ingredient for the distribution and use.
2. Type and amount of pesticides, containers, wrapping, labeling and publication of pesticides.
3. Business permit documents (SIUP), registration, and other administrative documents at the circulation level.
4. Provision of work safety and health.
5. Implementation and provision of facilities and equipment for pesticide management.
6. Negative impact of pesticide management to public health and environment.

Based on our interviews and document examination we confirmed that both Lampung and South Sumatra have appointed Provincial KP3. The most current KP3 of Lampung Province was appointed with Governor Decree No. G/37/BIV/HK/2015; and the latest KP3 of South Sumatera Province was based on the Governor Decree No. 353/KPTS/DIS.PTPH/2014.

Members of commissions in both provinces includes: secretary of province (Sekda, chairman ex-officio), officials of various sectors: agriculture, provincial economic bureau/division, police, attorney/prosecutor, trade, plantation, animal husbandry, marine and fishery, health, workforce and transmigration, food security, environment, planning agency, agricultural extension, provincial law bureau/division, agency for agricultural technology assessment (BPTP), food and drug supervision agencies (BAPOM), and state civilian investigator (PPNS).

Interviews and document confirmation at regencies also indicated that KP3 have been established in Tanggamus, West Lampung, and South Ogan Komering Ulu. The committees were established based on the following decrees: Keputusan Bupati Tanggamus No. B.05/12/11/2015; Keputusan Bupati Lampung Barat No. B/77/KPTS/II.09/2015; Keputusan Bupati OKUS No. 108/KPTS/TPH/2014. Among three surveyed regencies, Tanggamus is the only regency which also appointed the heads of the sub-district (camat) to chair KP3 at kecamatan (Annex 3 of the Bupati Tanggamus Decree No. B.05/12/11/2015). Members of commissions in regencies are more less similar to those in the provinces including secretary of regency secretary (Sekda, chairman ex-officio), and heads or officials from various offices in the regencies.

Programs/Activities of Pesticide Monitoring at Provinces and Regencies

Our interviews with officials from Lampung and South Sumatra revealed that 1-2 provincial pesticide supervisory meetings were held annually. In both Lampung and Sumatera Selatan Provinces, however, KP3 meeting focused on fertilizer cases: distribution, subsidized fertilizer, fertilizer forgery, fertilizer quality etc. Pesticide cases were rarely discussed in the meeting. Implementation of Provincial KP3 responsibilities as stated in Chapter 13, Permentan No. 107/Permentan/SR.140 /9/2014, therefore, was very minimum; especially if pesticide monitoring is considered. Similar to the practices of the provincial commission, regency commissions also held meeting 1 – 2 times in one year period. Focuses of the program are fertilizer cases: distribution, subsidized fertilizer, fertilizer forgery, fertilizer quality etc. Lampung Barat, for example, officially appointed a team for fertilizer verification, but not for pesticides monitoring. As a result, implementation of regencies KP3 responsibilities as stated in Chapter 14 of Permentan No. 107/Permentan /SR.140/9/2014 was very minimum. Practically no PPNS are at work (not available) in Tanggamus, West Lampung, and OKUS. This condition certainly hampered the performance of KP3 in the regencies. As the results of the lower priority for pesticide monitoring, contrary to the expected responsibilities as mandated by the regulation, reports about pesticide forgery and distribution of counterfeited pesticides was very rarely filed. When confirmed on the availability of pesticide list produced by the local KP3, Tanggamus and West Lampung did not have the list of pesticide distributors nor the types of pesticides sold in the districts. South OKUS has the list of pesticides sold in the area (2013), but it did not record the common names of active ingredients of pesticides.

By regulation, governor and bupati decrees related to KP3 appointment have prescribed the necessary measures to prevent violation of pesticide distribution. Bupati Tanggamus Decrees No. B.05/12/11/2015, for instance, explicitly authorizes the commission to exterminate fertilizers and unregistered pesticides found in sales. Bupati Oku Decrees No. 108/KPTS/TPH/2014 also authorizes the commissioner to report violation of pesticide and fertilizer distribution to the police and/or other law enforcement agencies. The decree further instructs the officials to exterminate illegal fertilizers and pesticides. Despite those authorizations, only limited numbers of the executions were confirmed in the surveyed regions, especially related to pesticide violations. In

2014, a number 10 cases of fertilizer related violations were processed/investigated by authority compared to two pesticides related cases on the same year.

The governor and bupati decrees also authorize the local commissioner to execute other pesticides monitoring responsibilities as described in the MoA Regulation No. 107 of 2014. Again, these facts indicate that the formal regulation on pesticide monitoring for regencies territories has been established. The execution/implementation of this instruments, however, need to be improved significantly.

Findings on Illegal/Banned Pesticides

The team did not survey directly to retailers or farmers to find out if banned or illegal pesticides were available for sales or used by farmers. The findings of this reports were based on direct interviews with state civilian pesticide inspector (PPNS) and other respondents related to our study. In all surveyed areas, several banned pesticides were reported/mentioned by our respondents. In Lampung, the PPNS revealed that endosulfan insecticides were still used, especially in shrimp producing areas. The trade name for endosulfan includes: Akodan 350 EC, Indodan 350 EC, and Akodani 200 EC which were allegedly introduced from other provinces of Indonesia. The illegal pesticides were not sold in official stores/resellers, but through illegal retailers. The substances were only sold for trusted buyers.

Interviews with our respondents also revealed that farmers have complained about several herbicides sold in the areas do not perform as expected. According to our respondents, sellers may have allegedly reduced the amount of the active ingredients of the product by adding water or other materials. In addition, paraquat herbicides were reportedly sold freely to farmers without proper training and supervision. Several pesticides with expired permit were found in the areas.

Coffee farmers apply various restricted pesticides (especially yellow listed pesticides) due to their lack of knowledge. A more intensive socialization is required.

CONCLUSIONS AND RECOMMENDATION

Conclusions

Based on our surveys and interviews in in the three kabupaten in Lampung and South Sumatra, our findings are as follows: (1) KP3 at provinces and regencies were officially established

by the authorities but did not function optimally as expected. KP3 focuses are more on the cases of fertilizer distribution and forgery. Reports and investigation on pesticide forgeries and banned pesticides were almost nonexistent; (2) More realistic performance indicators and budgeting are required to improve KP3 performance and to enforce a more environmentally safer pesticide distribution; (3) More detailed and locally tailored guides are needed to improve pesticide monitoring implementation in district levels; (4) Out of three districts, only OKUS has the list of pesticides sold in the area (2013). The available list does not record the common names of the pesticides, hence make it difficult to identify the banned pesticides in the area; (5) Circulation of counterfeit and prohibited pesticides is made possible through unofficial distributors and retailers who sell directly to farmers. Targets of counterfeit pesticides are small farmers in the remote areas.

Recommendations

Following recommendations are suggested based on this study: (1) to conduct proper surveillance and monitoring of pesticides in accordance with government regulations, a realistic amount of budget is required for various activities mandated to provincial and districts KP3 (field visits, samples identification, pesticide residue examination, quality testing, socialization, etc.); (2) Provincial and district KP3 need to be equipped with a taskforce (personnel) with specific assignment (and budget) to run the monitoring and surveillance of pesticides. The existing KP3 is more official taskforce with no technical personnel; (3) Online National Pesticide Database established by authority (Directorate of Fertilizers and Pesticides, Ministry of Agriculture) is needed to help people accessing information about various aspects of pesticides in Indonesia; (4) Involvement or participation of pesticide experts from a local university or relevant research agency could be utilized to strengthen technical aspects of local KP3 activities. Involvement of the pesticide expert could also help the local KP3 personnel in translating or elaborating pesticide monitoring principles as designed at national level to meet the local conditions.

REFERENCES

Agrow. 2005. First growth in global agrochemical market for a decade', Agrow 466, 18 February 2005. Available at: <https://www.agra-net.net/agra/agrow/first-growth-in-global-agrochemical-market-for-a-decade--1.htm>. Accessed: 12 May 2015.

- Convention S. 2008. Stockholm Convention on Persistent Organic Pollutants. *October*, (October):1–19.
- Direktorat Pupuk dan Pestisida. 2014. *Laporan Kinerja Direktorat Pupuk dan Pestisida TA 2014*. Jakarta. 66 pp.
- Fang Lin. 2015. Indonesia Pesticide Management and Registration Procedure. Available at: <https://agrochem.chemlinked.com/agro-analysisexpert-article/indonesia-pesticide-management-and-registration-procedure>. Accessed: 1 June 2015.
- Kelly BC, Ikonomou MG, Blair JD, Morin AE & Gobas FAPC. 2007. Food web-specific biomagnification of persistent organic pollutants. *Science (New York, N.Y.)*, 317(5835):236–239.
- Lallas PL. 2001. The Stockholm Convention on Persistent Organic Pollutants. *The American Journal of International Law*, 95(3):692–708.
- PAN Asia Pasific. 2008. Health professionals and scientists warn: Endosulfan is a potential catastrophic global disaster. Available at: <http://www.panap.net/en/p/post/pesticides/315>. Accessed: 5 May 2015.
- PAN Asia Pasific. 2010. Communities in Peril: Asian regional report on community monitoring of highly hazardous pesticide use. Pesticide Action Network (PAN). Penang, Available at: <http://www.panap.net/sites/default/files/PANAP-Asian-Report.pdf>.
- Pesticide Action Network Asia Pasific. 2010. Communities in Peril: Global report on health impacts of pesticide use in agriculture. In B Dinham (ed.) Pesticide Action Network Asia and the Pacific (PAN AP), Penang, Malaysia, Available at: <http://www.panap.net/sites/default/files/PAN-Global-Report.pdf>.
- Pedigo LP. 1989. *Entomology and Pest Management*. MacMilan Inc, New York. 300 pp.