Pesticide Residue Analysis Capacities in Ethiopia for Environmental Matrices

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Outline

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The term “pesticide” applies to a broad class of chemicals, encompassing:

- insecticides, used to control flying or crawling insects;
- rodenticides, used to control rodents;
- herbicides, used to control weeds and undesirable plants;
- fungicides, used to control fungi and plant diseases;
- nematicides, used to control nematodes (e.g., cutworms);
- antimicrobials, used to control microorganisms (e.g., bacteria, viruses, mold and fungi);
- plant growth regulators, used to accelerate or retard plant growth;
- insect growth regulators, used to affect insect growth rates; and
- biopesticides, naturally occurring compounds with pesticide properties.

Pesticide Residue

- is the traces of a pesticide which remains in or on a feed or food commodity, or soil, air or water following use of the pesticide. For regulatory purposes it includes the parent compound and any specified derivatives such as degradation and conversion products, metabolites and impurities considered to be of toxicological significance (WHO)

(http://www.pesticides.gov.uk/prc.asp?id=2673#P)

Benefits gained from use of pesticides

- Increased yields and regular production was ensured in the last five decades through advances in plant protection.
- Judiciously used pesticides - Positive outcomes.
- Pesticide benefits can be classified as effects, primary benefits and secondary benefits (Cooper and Dobson, 2007).

Effects

- are the immediate outcomes of pesticide use - for example killing caterpillars on a cabbage. These are not classed as benefits because the consequences of the effects have not manifested themselves yet.
- The three main effects of pesticides are:
  - Controlling agricultural pests (including diseases and weeds) and vectors of plant disease;
  - Controlling human and livestock disease vectors and nuisance organisms;
  - Preventing or controlling organisms that harm other human activities and structures.

Primary benefits

- are the consequences of the pesticides' effects - the direct gains expected from their use.
- For example, the effect of killing caterpillars prevents them feeding on the crop and brings the primary benefit of higher yields and better quality of cabbage.
- Secondary benefits
  - are the less immediate, less intuitively obvious, or longer term consequences. It follows that for secondary benefits, it is more difficult to establish cause and effect, but nevertheless they can be powerful justifications for pesticide use.
  - For example, higher cabbage yield might bring additional revenue that could be put towards children's education or medical care, leading to a healthier, better educated population.

Pesticides, human health and the Environment

- Similar to many technological developments that improve the quality of human lives, pesticides can pose risks if they are not used thoughtfully.
  - Persistent organic pollutants (POPs).
  - Movement of long distances, taken up the food chain, and accumulate everywhere. *Examples: DDT, Endrin, Lindane, Endosulfan.*
  - drifting and contamination of land and waterways.
  - Pesticides in contaminated crops used as animal feed eventually are found in meat and dairy products.
  - Pesticides in soil eventually contaminate ground water, the source of drinking water.
  - Pesticides kill non-target organisms, wildlife, birds, fish, bees, beneficial insects, and pest's natural enemies.

Pesticides impact on the Environment in developing countries is aggravated by

Lack of awareness

- Inadequate training,
- Lack of appropriate and timely information about the proper use and
- management of pesticides,
- Inappropriate use of Personal Protective Equipment (PPE),
- Wrong notion that pesticides is the best solution to pest problems,
- Poor guidance about the safe use and handling,
- Lack of standard safety practice, etc.

Improper use of pesticides

- Wrong mix of different types of pesticides,
- Use of pesticides for unintended purposes,
- Use of pesticides containers for domestic uses,

Weak enforcement

- Absence or late issuance of regulations and guidelines,
- In adequate implementation of the issued regulations,
- Weak monitoring or a follow-up activities,
- Lack of well defined incentive or punitive structure, etc.

Lack of Integration, weak institutional setup, and poor networking and exchange
of information among key stakeholders are some of additional factors contributing to the negative impact of use of pesticides

Need for building National Capacity for pesticide Residue Analysis

Pesticide residue is that fraction of a pesticide which has found its way into the produce or soil and is present there either in the form of a parent compound or significant degradation product(s), or as a “bound residue.”

- ❖Pesticide residues in foods are of great importance in the evaluation of food quality.
- ❖ Pesticide residue analysis is important to
  - ✓ crop protection
  - ✓ research,
  - ✓ environmental monitoring,
  - ✓ public health protection and legislative enforcement.
  - ✓to be conversant with the legislations of importing countries,
  - ✓to be competitive, exporters of agricultural crops
  - ✓ participate effectively in international and regional trade.

Pesticide residue analysis is important to:

- ✓to enhance agricultural competitiveness on the international markets and ensure that the Agricultural Health and Food Safety Systems (AHFSS) are harmonized with international standards.

Therefore, the capacity and capabilities for detection and quantitative determination of pesticide residues must develop.

Challenges

- ✓ wide range of products imported and exported
- ✓ the geographically diverse trading partners
  - Calls for developing countries to have effective AHFSS which will be applied across the whole spectrum

Challenges (cont..)

- ✓ The AHFSS should include laboratory infrastructure
- ✓ investigations should support and safeguard animal, plant and human health in the conduct and facilitation of trade
- ✓ laboratory facilities and competences of developing countries in general and Ethiopia in particular is minimal
- ✓ the existing minimal laboratories are varied with respect to their scientific capacity and capability.

Why are laboratory infrastructure are particularly challenging?

- ✓ costs of laboratory infrastructure are so prohibitive for developing countries to have a laboratory to satisfy all its testing needs

Why….? (Cont…)

- ✓ many of the laboratories operate without internationally recognized quality assurance (QA) and quality control (QC) programmes and therefore the results of test performed may not be accepted internationally
- ✓ There is no sustainable supply of consumables to perform uninterrupted testing and analysis, i.e., no trustable and dependable vendor

What should be done?

gaps should be identified to be addressed to meet international standards.

Some of these are:

(i) quantification of the levels of risk from contaminants affecting the environment;

(ii) provision of specific information on pesticide science, at all levels;

(iii) infrastructure to monitor the environment and enforce SPS and environmental standards.

(iv) Strengthen institutional capacity to “stay ahead of the game” in technical know-how concerning pesticide science, residue analysis, *etc*.:

What should be done (Continued…)?

(v) areas of weaknesses should be identified for improvement and a project proposal should be developed to help the country to comply with the international environmental standards and food safety requirements of importing countries, thus ensuring a continued market access for agricultural export.

(vi) Self sustaining schemes need to be established, funding agents, donors and all concerned body should work towards sustainable establishment of laboratory rather than focusing on 'hit and run' activities

(vii) Progresses should be regularly evaluated and all necessary intervention should be made ahead of time

(viii) Intensive training with proper incentives should be arranged for analysts involved in the actual work

Requirements for pesticide Residue Analysis

Requirements can generally be categorized into infrastructural technical and accreditation Matters

- ✓ **Infrastructure**: laboratory financial resources, business stream, management, quality of laboratory staff, accommodation, laboratory facilities and availability of consumable materials.
- ✓ **Technical**
  related to the operational procedures employed by the laboratory and problems associated with equipment supply and maintenance.
- ✓ Accreditation: initiative to generate greater confidence in the data generated by laboratories, to ensure broader acceptance of that data.

J. R. COX (2000) summarized the Experiences gained from the Natural Resource Institute's Support Program about the Pesticide Residue Analysis Facilities in developing countries in a paper presented on international workshop on Food Safety Management in Developing Countries.

Existing capacity in Ethiopia

FAO: Assessment of current analytical capacities for pesticide residues and quality control of pesticides formulations in The Federal Democratic Republic of Ethiopia 30 June-15 July, 2008

- General condition of laboratory rooms and buildings;
- General condition of laboratory equipments used for pesticides analysis;
- Education and experience of laboratory staff;
- Types of pesticides analysis performed by laboratories;
- The laboratory functionality organization;
- Quality control and assessment procedures.

Results

The Housing:

The accommodations are not always satisfactory in term of size and area separation (sometimes the residues and formulation analysis are conducted in areas not completely separated, something which is not proper).

Power supply:

- The laboratories' building, in some cases, do not have a reliable electricity supply.
- The fluctuation of supply power may affect badly the results and instrument electronics.
- Normally some instruments used in this field should be always switched on during the whole week in order to get a good stability.

Gas Management:

The quality of some gas used in the visited laboratories is not adapted to the analytical instruments requirements. The gas used in these laboratories, generally produced by specific generators, should be subject of a regular follow-up in terms of purity.

Equipment

The common remarks regarding equipment and their consumables are followed:

- Except the APHRD laboratory, the DACA laboratory and the QSAE testing laboratory have new analytical equipment which could be used for pesticides analysis.
- The DACA and QSAE laboratories have different equipments (in each laboratory there are several types of new equipments for example HPLC, GC-MS or GC with different detectors) that can be used for the analysis of organic pollutants).
- In all the laboratories cited above, the basic configuration of some equipment (particularly GCs) is not appropriate. In several cases the detectors installed on the same instrument are not compatible.
- In the APHRD department laboratory, the Gas chromatographic equipment is technically obsolete but still potentially functional. However, there is no more technical support for these equipments and it would be very difficult to find some of their spare parts in case of breakdown.
- The consumables and spare parts are not always available, and sometimes not appropriate to the actual needs. In some cases, there is a shortage of some consumables necessary for routine preventive maintenance.

Consumables and spare parts for HPLC and GC

The use of GC and HPLC requires a planned preventive maintenance and the laboratory should have basics consumable and spare parts for a proper usage of these equipment.
In all the laboratories visited, there is a large lack of consumables and spare parts, especially for chromatography equipment.

Analytical methods:

In all visited national laboratories, there is a lack of official analytical methods and/or Standardized Operating Procedures (SOPs).

Establishment of QMTL

- Pesticide Residue Issue of 2008
- DDT and Endosulfan standard from Adami Tulu Pesticide Formulation Factory
- GC-MS (QSAE)
- Japan visit
- Purchase of key laboratory items
- April, 2009 testing started
- Consultant
- mobilization of critical mass of analysts from all over the country
- Training


Kimwipes

-Purchase of key equipment

- PLE, Sonication, Rotatory Evaporator, Analytical balance, gas generator, water purifier


200


Agilent Technologies
5975C


GREEN MUNG BEAN
(ማሾ)
SESAME SEED
(ሰሊጥ)
PHASEOLS VULGARIS
(በለቀ)
CASTOR BEAN
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HONEY
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RED SESAME SEED
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The Way Forward

The laboratory envisage to come up with the following outputs after 4 yr:

1. Baseline data to implement pesticide residue analysis is accumulated and priority pesticide/agricultural products including coffee for analysis are selected.
2. Validation of residue analytical methods of target agricultural products with pesticide combination is established
3. Laboratory operation to accumulate reliable data is established
4. Residue and formulation analysis knowledge/method obtained become applicable to agricultural commodities and other environmental samples.
5. Monitoring trial activity concerning coffee contamination is conducted in pilot area using check sheet and supplemental chemical analysis through the analysis of soil, water, containers and plant samples
6. ISO/IEC 17025 accredited

Thank you all