Alternatives to HHPs

1. Introduction

Highly hazardous pesticides (HHPs) are those that are acknowledged to present particularly high levels of acute or chronic hazards to health or environment according to internationally accepted classification systems such as WHO or GHS or their listing in relevant binding international agreements or conventions. In addition, pesticides that appear to cause severe or irreversible harm to health or the environment under conditions of use in a country may be considered to be and treated as highly hazardous.

Decisions on whether a HHP should be used in a country generally rest with national pesticide regulators. Sometimes pesticide producers or traders may decide to withdraw a product, and in other cases major buyers of agricultural products instruct their suppliers not to use certain pesticides. As a result, HHPs are taken out of use in situations where health and safety, environmental concerns and trade requirements determine that they cannot continue to be used.

Most pesticides (about 80%) are used by farmers in crop production with an estimated 13% used in industry and by government authorities and about 8% in domestic environments. When HHPs are removed from use because of health or environmental concerns, farmers and other users need alternative ways of controlling the pests or diseases that the HHP was used against. There is often an expectation that whatever replaces a HHP should be equally effective, similarly priced, easy to buy and use. Meeting all those expectations is not always possible and may also not be desirable. For example, replacing a HHP with a bio-control agent may need specialist training that makes its use initially more complex, but replacing a HHP with a chemical pesticide may bring different health or environmental risks that are undesirable. This issue is explored further in section 5.

This document is designed to do two things:

- Identify the roles of different stakeholders in the process of replacing HHPs and suggest how they can support each other to maintain agricultural productivity while protecting health and the environment.
- Provide accessible advice and pointers on how to identify and deploy alternatives to HHPs

2. Defining HHPs

A relatively small proportion of all pesticides in use are found to be HHPs. An FAO survey of pesticide registers in ACP countries found that between 6-10% of registered pesticides were HHPs[1]. The rationale for action is therefore that by stopping the use of a relatively small number of pesticides, many of the most serious hazards to health and the environment could be removed.

Eight criteria define whether a pesticide is a HHP. These criteria were developed by the Joint Meeting on Pesticides Management (JMPM) which is an international expert group that advises FAO and WHO. The criteria are:

[1] FAO presentation to BRS COP Side event *Finding alternatives to HHPs: Experiences from African, Caribbean and Pacific Countries,* 29 July 2021

• Criterion 1: Pesticide formulations that meet the criteria of classes Ia or Ib of the WHO Recommended Classification of Pesticides by Hazard; or

• Criterion 2: Pesticide active ingredients and their formulations that meet the criteria of carcinogenicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS); or

• Criterion 3: Pesticide active ingredients and their formulations that meet the criteria of mutagenicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS); or

• Criterion 4: Pesticide active ingredients and their formulations that meet the criteria of reproductive toxicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS); or

• Criterion 5: Pesticide active ingredients listed by the Stockholm Convention in its Annexes A and B, and those meeting all the criteria in paragraph 1 of Annex D of the Convention; or

• Criterion 6: Pesticide active ingredients and formulations listed by the Rotterdam Convention in its Annex III; or

• Criterion 7: Pesticides listed under the Montreal Protocol; or

• Criterion 8: Pesticide active ingredients and formulations that have shown a high incidence of severe or irreversible adverse effects on human health or the environment.

Table no: ?? (Source)

Use	Criterion 1		Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6	Criterion 7	Criterion 8
	WHO Class 1A or 1B		GHS Carcinogenic 1A/1B	GHS mutagenic 1A/1B	GHS Rep. Tox 1A/1B	Stockholm Convention POPs	Rotterdam Convention	Montreal Protocol	Other health/environmental hazards
	Class 1A	Class 1B	GHS determined nationally	GHS determined nationally	GHS determined nationally	Y pesticides	Z pesticides	W pesticides	Determined nationally
	29	60							
Acaricide		1				1	2		
Avicide			1		1				
Fumigant	1							1	
Fungicide	2	3		2	4		1		
Fungicide seed treatment	2					1	1		
Herbicide		3			3	1	3		
Insecticide	13	32				14	20		
Soil Insecticide	2	3							
Larvicide		2							
Nematicide		1							
Rodenticide	9	9			3		1		
Multiple uses		6	2		2	1	9		
	89		(EU) 3	(EU) 2	(EU) 13	18	37	1	

Here we could put a colourful table that shows how many pesticides in each criterion. We might want to go into more details and show how many insecticides, herbicides, fungicides etc are in each

category, but this does become complicated because some have more than one use, and some have very specific uses that are sub-categories of the main uses. TBD

2.1. Making decisions about HHPs

The primary role of pesticides is to protect agricultural crops from attack and losses by pests and diseases. Pesticides are also used to protect people and animals from vector borne diseases and parasites, and to protect materials such as timber and fabrics from deterioration. In almost all cases, pesticides have some additional undesirable impacts on health and the environment. HHPs have disproportionately high negative impacts on human health and/or the environment that may only have become apparent after years of use. For this reason, HHPs need special attention on the part of pesticide regulators, traders and users.

HHPs that meet criteria 1-7 have been assessed by expert panels and international bodies and found to be highly hazardous because of their acute toxicity, chronic health effects or environmental impacts. A pesticide is listed in the relevant criterion on the basis of data provided by pesticide manufacturers, extensive research findings or experiences recorded by national authorities. Some pesticides are listed in more than one HHP criterion.

Criterion 8 allows authorities to decide for themselves that a pesticides should be treated as a HHP if it is found to have a high incidence of severe or irreversible adverse effects on human health or the environment. Listing a pesticide as an HHP under criterion 8 is a matter for national authorities or other bodies that make decisions about pesticide use, and no external validation is needed. For example, paraquat, a herbicide which is not listed on any of HHP criteria 1-7 has nevertheless been banned by many national authorities because it is extremely toxic to people, is widely used as a suicide agent, has no antidote and is suspected of causing long term health effects to people who are exposed to it in a prolonged manner.

Listing a pesticide as an HHP under any of the 8 criteria does not constitute a requirement to take action. The decision about how to control HHPs rests with national regulators or other decision makers. Recognizing that HHPs are more hazardous than most pesticides, several organizations that set policy directions or provide guidance to governments have suggested that HHPs could be phased out and replaced with less hazardous alternatives.

The FAO Council suggested that the activities of FAO could include pesticide risk reduction, including the progressive banning of Highly Hazardous Pesticides (HHPs). In 2015, the SAICM International Conference on Chemicals Management adopted a resolution that recognized HHPs as an issue of concern and called for concerted action to address HHPs, with emphasis on promoting agro-ecologically based alternatives and strengthening national regulatory capacity to conduct risk assessment and risk management. Several regional pesticide regulatory bodies have developed HHP strategies aimed at identifying and reducing harms from HHPs, and a growing number of countries are evaluating their pesticide registers and removing or restricting HHPs.

Given that HHPs are disproportionately harmful when compared to other pest management options, many pesticide regulators and other decision making bodies have acted to eliminate the harms of HHPs. This rases two key questions:

1. What is the most effective action to take?
2. What will replace an HHP if it is taken out of use or restricted?

The following sections address these questions.

2.2. Effectiveness of risk mitigation options

Figure 1 Hierarchy of risk management options for chemicals

In discussions about HHP use, strategies for risk mitigation or risk reduction often arise. These are measures applied to protect people and the environment from the harms that HHPs are known to cause while the pesticide continues to be used.

For example, in some countries HHPs are permitted for use and include label instructions that require personal protective equipment (PPE) to be used. In most Lower and Middle Income Countries (LMIC), PPE is not available or is expensive, so that farmers and other users of pesticides do not buy and use it. In hot countries, PPE is uncomfortable, so even in rare cases when it is available, pesticide applicators chose not to use it. An HHP that can be used safely when PPE is used can therefore not be used safely in countries where PPE is not available or will not be used. Other administrative or engineering controls exist and are used in some places to mitigate the health or environmental impacts of hazardous pesticides. In countries where enforcement is weak, monitoring of health or environmental risks does not exist, high quality application equipment is not available or used and pesticide applicators are not trained or licensed, engineering and administrative controls do not work well and cannot be relied upon to manage risks.

Figure 1 shows the widely recognized hierarchy of risk management options for chemicals, which applies well to pesticide use.

Taking as an example an HHP used in agriculture, the diagram shows the following:

Option 1 indicates that the most effective measure for reducing risks is to eliminate the use of the HHP altogether.

Option 2 suggests that there may be safer options with which to replace the HHP. These may be other chemicals or even different formulations of the same pesticides, but as we shall see in section 5, there are often better non-chemical options available.

Option 3 proposes engineering controls to limit exposure to the HHP. These might include application from a boom sprayer mounted on a tractor that has an isolated cabin for its operator, or delivery of the HHP in soluble sachets that reduce operator exposure.

Option 4 proposes administrative controls that may include regulations, for example, to limit who may buy and apply the HHP to specially trained individuals. Other administrative controls may include licensing pesticide applicators

2.3. Advances in knowledge and technology

HHPs are generally pesticides that were developed several decades ago. The science associated with pesticide chemistry and understanding about the health and environmental impacts of pesticides

have advanced significantly since then. Regulatory processes now require more studies at greater depth of detail than would have been required for example when the nematicide fenamiphos was first registered in 1968. These older chemicals may have been re-evaluated under current regulatory requirements in many authorities, but in others it may still be registered on the basis of its original evaluation. Current pesticide evaluation requirements have resulted in many HHPs being withdrawn by their manufacturers or rejected by regulators because they were unable to meet modern requirements.

2.4. Compliance with policy

2.4.1. Agricultural policy in many countries and regions is moving towards more sustainable approaches that aim to protect the environment from the negative impacts of agricultural activities. These include the widespread use of pesticides that contaminate the environment, reduce biodiversity and impact beneficial organisms such as pollinators. HHPs are generally incompatible with these policies and will therefore need to be removed from use.

2.4.2. Health policy will have multiple objectives and will include protecting people from unintended exposure to harmful substances. These would include HHPs at work or as contaminants in food or water. Since it is difficult, and sometimes impossible to protect agricultural workers from exposure to any pesticides they are using, particularly in LMIC, and to keep pesticides entirely out of water or food, HHPs use will likely need to be halted in order to comply with such policies.

Health policies may also aim to improve diets by encouraging greater consumption of fresh fruit and vegetables. Consumer concern about pesticide residues in food has sometimes resulted in reduced consumption of fresh produce, particularly when publicity about residues of dangerous chemicals is released. Removing HHPs from use and acting to eliminate pesticide residues from produce to the extent possible is therefore beneficial to such policies.

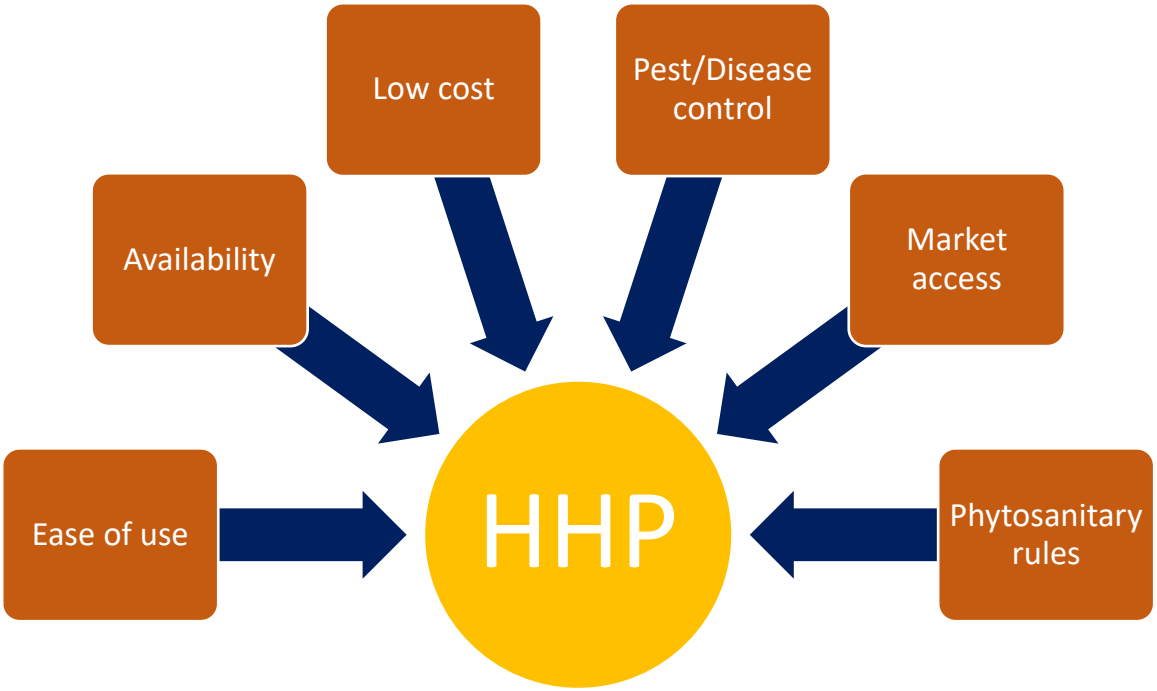
2.4.3. Environmental policy

Environmental policies will be aiming to keep pollutants out of the environment, protect and enhance biodiversity and natural resources, protect habitats and prevent poisoning of wildlife. Many such policies will be designed to comply with international agreements and support national attainment of SDG targets. The continued use of HHPs risk undermining these objectives in many ways and therefore justifies their removal from use.

3. What is being replaced?

The decision to remove a HHP from use also requires clarity about what is available to replace it, or whether it needs replacing at all. In some cases, alternative methods or products may already be available, and removing the HHP may not have any negative impact on farmers or other users of the HHP. If no alternatives are readily available, then a comprehensive understanding of what the HHP is used for is needed to ensure that its replacements fulfil all the functions of the HHP. The possible functions of an HHP follow:

(*This could be presented as an infographic*



3.1. Functions of an HHP

3.1.1. Ease of Use (application methods) – Pesticide application is generally based on the use of standard, widely available equipment such as knapsack sprayers, tractor mounted boom sprayers. Dry products such as granules can be applied manually or with simple mechanical spreaders. Mechanisms for using alternatives to HHPs should be based on existing equipment or be equally simple.

3.1.2. Availability – Chemicals in appropriately robust bottles or other containers are relatively easy to distribute through well established distribution chains. Pesticides can be stored for long periods (generally up to 2 years) at ambient temperature in warehouses, storerooms and on shelves. At the end of their distribution chains are vendors who often have extensive experience and are widely called upon to advise farmers on the most appropriate products and how to use them. The widespread and

easy accessibility of chemical pesticides to end users needs to be taken into account when alternatives are considered.

3.1.3. Pest/Disease control – Pesticides are generally designed and approved for use against specific pests or diseases on specific crops or environments; the so-called crop-pest combination. While many pesticides are used on several crops and against a range of pests, replacements will need to be able to respond to the full range of crop pest combinations that the HHP previously covered. That may well require a range of practices, tools and products rather than a single product. While replacing a single HHP with several solutions for different problems seems complex, it follows a growing trend for pest management tools to be more specific rather than broad spectrum in their pesticidal action.

3.1.4. Compatibility with production systems – Agricultural production systems are evolving to meet consumer demands for safer food and more environmentally and socially sound practices. National policies and the protocols of major trading organizations also require practices that increasingly preclude the use of HHPs. Using HHPs is largely incompatible with agroecological pest management practices, biological control and similar production systems. Increasingly HHPs need to be removed from use in order for farmers to be compliant with the production systems that they are required to apply by policies and protocols that they adhere to.

3.2. A solution for farmers and traders

3.2.1. Yield losses and yield reductions – pesticides are primarily used to eliminate or reduce damage by pests, diseases and competing organisms such as weeds that will result in lost or reduced yields or product quality that in turn will result in reduced income for growers. Removing an HHP is likely to concern growers unless they have confidence that equally effective and similarly priced alternatives to the HHP are available. See section 5.

3.2.2. Blemishes and cosmetic appearance – pesticides are also used to make produce look better, so that consumers will be more willing to buy it. If the HHPs that are used for these cosmetic purposes are removed, then alternatives that offer equivalent solutions will be needed. In the case of cosmetic appearance, consumer awareness programmes have been successful at increasing acceptance of blemished but otherwise undamaged produce.

3.2.3. Phytosanitary requirements – international trade in agricultural produce is subject to phytosanitary requirements that aim to prevent the transboundary movement of pests and diseases. Exporters must have the tools to comply with these requirements, otherwise their markets may be jeopardized. If HHPs are used for these purposes, it is vital that equally effective solutions that are also acceptable to importers are made available.

3.2.4. Post-harvest treatments – Pesticides are used to make produce last longer after leaving farms, during transport to markets or retail centres and while being displayed for sale. This is of particular concern for soft fruits and vegetables that are susceptible to fungal attack. Similarly, produce that is stored before sale or use is often protected with pesticides against attack by pests or disease organisms that degrade its quality. If HHPs are used for these purposes, they will need to be replaced with systems or tools to fulfil the same function of preserving produce post-harvest.

4. Who should be involved

A regulatory decision to take an HHP out of use impacts many stakeholders. It has generally been found to be beneficial to involve these stakeholders early in the decision making process so that they can prepare themselves and ensure that viable alternatives are available in good time.

4.1. Regulators

Pesticide regulators would normally lead the process of decision making regarding the removal of HHPs and the registration of their replacements. Making informed decisions requires data which is commonly absent or limited, especially in LMIC. Several of the stakeholders listed below may be able to provide or generate data that can guide regulatory decisions. Otherwise, data from other countries, international organizations or academia can be helpful.

Regulators may also lack the capacity, tools and experience to evaluate and register possible alternatives to HHPs that may include biopesticides, semiochemicals, macrobial organisms or genetically modified organisms. In such cases, the involvement of specialist organizations or advisors, specialist training and the use of new tools and methods may be necessary. Limitations related to the evaluation and registration of novel pest management products should not stand in the way of considering their viability as replacement for HHPs.

There may also be situations where an HHP is replaced by agronomic practices rather than a product. In such cases, regulators may not have a role in evaluating or registering a product, but would rely on extension services or researchers to describe and disseminate the solution.

4.2. Farmers & other users

Farmers and other users of pesticides are widely conditioned to buy pesticides from local suppliers who understand their needs, supply the relevant products in the right quantities and formulations, at the right time. Removal of an HHP which may be in widespread use is best done in consultation with its major users to ensure that they have confidence that viable, cost effective alternatives are available. When farmers and other pesticide users are not included in decisions to remove pesticides, they may resort to using illegally imported pesticides, or may face crop losses.

4.3. Vendors, importers, producers and registrants

Having agricultural input suppliers engaged in the process of removing and replacing HHPs increases the likelihood of compliance with regulatory decisions as well as the effective provision of alternatives in a timely and cost effective manner.

4.4. Extension services and other advisors

4.4.1. Government extension services – need to be prepared for the replacement of HHPs by giving advice on alternatives that work and that are actually available to farmers

4.4.2. Traders – traders in agricultural produce should be made aware of changes that may come about as a result of the removal of HHPs. For example, produce may look different as a result of superficial blemishes that may previously have been controlled by the HHP. At the same time, the produce can be marketed as being free from residues of the replaced HHPs.

4.4.3. Exporters/importers – removal of HHPs from use will contribute to greater compliance with the food safety standards of importing countries. At the same time, assurance of compliance with phytosanitary measures will need to be provided if they previously depended on the use of the HHP.

4.4.4. Standard setting bodies – A growing number of international trading platforms for important agricultural commodities are setting their own standards for pesticide use along with many other parameters. Growers that sell their produce through one of these platforms may already have been required to stop using certain HHPs, and they will have been advised on alternatives to use. National action to remove HHPs is likely to increase the number of farmers that comply with these standards and hence potentially open new markets to them. Including these standard setting bodies in discussions about the removal of HHPs is likely to accelerate processes and benefit growers.

4.5. Research bodies

HHPs are rarely replaced by a single product. There are also generally experiences of other countries that have banned HHPs and found viable replacements to control the same pests and diseases that the banned HHP was previously used against. In some cases, it may be necessary to find a control solution for some specific crop-pest combination. This is an important role for national research bodies and their involvement in as early a stage as possible is therefore important so that timely solutions are developed and made available.

4.6. Health authorities

Medical practitioners, poison information and toxicology services, data managers and others in national health systems will have a perspective on the health impacts of HHPs that pesticide regulators and users, who are primarily in the agriculture sector, may not be aware of. Their engagement in decision making processes is important in order to ensure that the pesticides of highest priority with regard to their impact on health, are being prioritized for action. It is important to note, for example, that some pesticides that have particularly high case fatalities when ingested, so not automatically feature as HHPs because they do not meet the first 7 HHP criteria as defined by WHO/FAO. Health authorities will be able to track the impact of changes tat result from the bank of an HHP, for example by comparing rates of death or poisonings from particular5 pesticides before and after bans.

4.7. Environment authorities

HHPs often contaminate environmental media and reduce biodiversity through direct or indirect poisoning of beneficial organisms including pollinators, predators of pests. It can be difficult to identify the specific environmental impacts of individual pesticides because often, many pesticides are used in the same environment. Nevertheless, environment authorities, researchers and civil society organizations may have important knowledge about the impact of pesticides that should be part of the debate on removing HHPs. Like health authorities, environmentalists can track changes that will come about as a result of HHP bans, such as increases in pollinators or other organisms.

4.8. Consumers

Consumer awareness about food safety and other sustainability measures related to agriculture, is an increasingly important driver in raising farming standards in many countries. Inclusion of consumer organizations at an early stage of decision making on pesticides not only contributes consumer opinions to the debate, but also ensures consumer support for changes that are introduced. For example, if as a result of HHP bans food is safer but also has more surface blemishes, consumers can be taught to accept such changes without complaint.

4.9. Public interest groups

Public interest, civil society, NGOs and similar organizations often have good knowledge and access to resources that can be helpful in identifying problematic pesticides and finding viable alternatives to HHPs. Involving such organizations in discussions is beneficial in terms of finding appropriate solutions to priority problems and also gaining the confidence and support of communities served by such organizations.

5. What can replace an HHP?

KEY PRINCIPLES IN IDENTIFYING ALTERNATIVES TO HHPS

Understanding the pest problem: HHPs are often broad spectrum chemicals which means that they can be used against many different pests on many crops or other situations where pest control is needed. There are also cases where HHPs continue to be used because they provide solutions to some very specific and difficult pest problems. Before any action is taken to remove HHPs and identify their replacements, it is vital to understand the pest or disease problem or problems that needs a solution.

To what extent is the HHP used?: In some cases national regulators have found that certain HHPs that are registered for use, are actually not used, may be used very little, are not imported or sold. This may be because the pesticide was registered some time previously for crops that are no longer grown or against pests or diseases that are no longer prevalent. In these cases, it is easy to de-register the HHP with confidence that there will not be any negative impacts.

Are alternatives already available?: In some cases, multiple products or solutions are available to deal with particular pests-crop combinations. In such cases it is relatively straightforward to remove an HHP from use when alternative solutions are already available. Resistance management should be considered to ensure that a narrowing of control options for particular pests or diseases will not accelerate the development of pest resistance to those control options. Resistance is significantly less likely to develop when agroecological techniques and biopesticides are used in place of or alongside chemical pesticides.

Not simply replacing one chemical with another: Experience has shown that replacing one chemical with another can simply replace one set of problems with another – a process known as *Regrettable substitution*. Another pesticide may not be listed as an HHP but may nevertheless pose health or environmental hazardous that could be avoided by considering agroecological techniques or biopesticides that pose no health and environmental risks. Taking action to remove HHPs from use creates opportunities to rethink pest management strategies with possible shifts to less chemical and more ecologically based methods.

Providing solutions rather than products: As described above in sections 3 and 4, there are multiple perspectives to the removal and replacement of HHPs that may require input from various and several stakeholders. Pesticide regulators are often seen as a gateway for approving or rejecting pesticide products on the grounds of safety and efficacy. The role of regulators in combination with extension services, agricultural input providers, farmers and others could evolve their role into one of providing the safest and most effective solutions for agricultural pest and disease management,

which may not be a chemical, but could be a cultural practice, a resistant seed variety, a physical trap or a parasitic organism.

5.1. Ecosystem services

Nature has a way of balancing itself, and when there I an abundance of food, something will emerge that eats it. This is the reason agricultural pests exist because agriculture has accumulated vast amounts of food that the pests favour into a single location. This reduces the resources needed for the pests to forage, they can stay and feed in a single location with plenty of food, can breed rapidly and expand their populations. While pest populations expand, so do those of the animals that feed on those pests. Predatory and parasitic insects, mites, nematodes, birds and other organisms will commonly enter agricultural fields to feed on abundant pests and keep their populations in check. Plants at field margins that may be classified as weeds may provide habitats and food for beneficial organisms. The soil is an important ecosystem that harbours millions of micro and macro organisms, that vast majority of which are beneficial to agriculture or are benign.

Understanding agricultural ecosystems and working with them to benefit from their services and avoid damaging them is the basis of agroecology. Ecosystem services that control pests can often keep pest damage below threshold levels that would cause economic losses. Ecosystem services also have the benefit of being free to farmers.

5.2. Cultural practices

The distance between plants, planting and harvest times, field hygiene including crop residue management, intercropping and companion planting, plant nutrition, tree pruning, mulching, crop rotation and soil tillage practices are all examples of cultural practices that can significantly influence the occurrence and levels of pest and disease infestation in crops.

5.3. Physical controls

Physical barriers or traps can protect crops in many ways and with high efficacy. Barriers includes products such as fine mesh netting or planting field margins with barrier crops that are too high, too dense or undesirable for pests to cross. Physical removal of pests such as weeds, egg clusters and sedentary or slow animals can be effective.

5.4. Crop resistance

Some varieties of crops show resistance to particular pests or diseases and can be selected as an important prevention or control mechanism to avoid the use of pesticides, which may include HHPs. The cost of seeds or planting materials for these varieties may be higher, and that may be offset by the reduced cost of buying pesticides.

5.5. Biological control agents

5.5.1. Macrobial – Insects that eat other insects, parasitic insects or mites that lay their eggs in the eggs or larvae of pests, nematodes that infect pests, releasing sterile males of a pest that mate with females and render their eggs infertile are all examples of macrobial organisms that are raised in artificial insectories and released into the environment to control pests. Generally these are organisms that are already present in the environment where they are released. Sometimes, when no suitable predator or parasite is present, a new macro-organisms may be introduced, but this must be done with caution to ensure that the newly introduced organism does not interfere with ecosystem functionality in unpredictable ways.

5.5.2. Microbial – fungi, bacteria and toxins that they produced have been formulated into pesticidal agents that can be highly effective against pests and diseases.

5.5.3. Semiochemicals – are naturally produced chemicals that influence the behaviour or physiological responses of pests. Examples are pheromones that can be used to lure insects into traps or to confuse them so that they are unable to mate, repellents that cause pests to leave a particular area or feeding inhibitors that reduce a pest's consumption.

5.6. Botanical pesticides

Botanicals are products that are extracted from plants and which have a pesticidal affect such as toxicity, repellent or inhibition. Widely used examples are neem and pyrethrum.

5.7. Synthetic chemicals

Synthetic chemical pesticides that are not classified as HHPs are plentiful. Products that are highly target specific or that are delivered through mechanisms that limit exposure of non target organisms are increasingly available. Examples include chitin inhibitors which only affect organisms that produce chitin as exoskeletons, and chemicals that are used in combination with a lure such as a pheromone or light so that the pest comes to the poison rather than the poison being dispersed in the environment in search of the pest.

6. Evaluating alternatives

Effective pest control requires an understanding of the crop or situation where the pest occurs, the environment in which it occurs and the ecology and life cycle of the pest. For this reason, many options may exist and the best solution may need trials to test its efficacy, and may also be unique to a particular situation and therefore not replicable elsewhere.

Replacing a HHP is similar to evaluating and registering a new pest management tool such as a biopesticide, semiochemical or synthetic pesticide with the added factor that an existing tool is being removed and its replacement must provide similar solutions.

Regulators commonly take the role of gatekeepers that allow or block a product from being used in their country. They could equally and more effectively take the role of ensuring that farmers and others have solutions to their pest and disease problems. As mentioned above, those solutions are not necessarily chemicals. They may be seed varieties, cultural practices such as the timing of planting or distance between rows, mechanical tools such as traps or barriers, natural enemies and pathogens, semiochemicals such as attractants or repellents, biopesticides and also chemicals.

Regulators may not be aware of all the options that exist, which is why involving a wide range of stakeholders in the process can be valuable. Various stakeholders such as input suppliers, researchers and NGOs may have knowledge and experience of dealing with specific crop-pest relationships that can provide an effective solution to replace a HHP.

Note that stakeholders often have their own interests to protect, so for example, agricultural input suppliers may not be enthusiastic about a cultural practice that can replace a HHP if there is no product to sell. Environmental NGOs may not favour the use of chemical pesticides to replace HHPs and most importantly, farmers may not favour HHP replacements that are more expensive or need more work to use. Nevertheless, all stakeholders can also make useful contributions and bring new ideas.

In general, the following issues should be considered when considering alternatives to HHPs:

6.1. Efficacy for controlling the target pest;

Does the proposed solution work well to control the pest or disease on the specific crop concerned and under the condition in which the crop is grown in your country? Similar experience from other countries may be a good indicator for success but is not a guarantee. Testing the new solution for efficacy under local conditions is important and will build confidence among farmers and others who will be using it in the future.

6.2. Availability, and/or other measures of applicability;

Are all the elements needed for effective application of the solution available in the country? Are the products registered? Some countries have found that when a biopesticides was found to be a good alternative to a HHP, the national regulatory system was unable to evaluate and register a biopesticide. A situation of this type may provide an incentive to develop the registration system to be able to deal with biopesticides, but it will take time to do that, and interim solutions may be needed.

If live organisms are needed, can they be reared and delivered effectively? Establishing insectories or fermenters requires significant financial investment, technical knowledge and time. Operating these facilities also requires high levels of knowledge, skills and experience. Setting up such facilities can contribute to long term sustainability and to livelihoods, and while they are being established, interim solutions will also be needed. It may be that live organisms can be delivered from elsewhere. Mechanisms for transporting biopesticides across large distances and storing them have improved in recent years making it possible to buy biopesticides from distant suppliers.

In some cases a product may be available, but the mechanisms for its application in the field need special consideration. Different nozzles, filters and agitation mechanisms may be needed to spray biopesticides, the timing of applications needs to be carefully considered to maximize effectiveness, and parasitic or predatory insects are applied in very different ways to chemical sprays. In some cases different equipment is needed, in others, knowledge and guidance is needed.

6.3. Hazard/toxicity to the environment and human health;

Replacements for HHPs should not bring new hazards to health and the environment. Using other chemical pesticides that are registered in a country to replace a banned HHP will increase the use of the replacement chemicals, and their impacts on health and the environment. It will be important for regulators to consider this in their decision making. It is of course beneficial to reduce negative impacts by removing HHPs and replacing them with less hazardous alternatives, and it is even more beneficial to remove health and environmental hazards altogether by replacing HHPs with pest control options that do not pose any risks to health and the environment.

6.4. Durability with regards to resistance issues (for low-risk pesticides);

Having a limited arsenal of pest management tools increases the risk of resistance developing among target organisms. Preventing resistance is often managed by changing control strategies so that pests do not develop resistance to any one control. Removing HHPs clearly reduces the range of control options that are available. However, wider use of agroecological strategies and biopesticides reduces the risk of resistance developing in pest organisms. Resistance is significantly more common when chemical pesticides are used. Resistance to biopesticides and agroecological pest management strategies is rare.

6.5. Technical feasibility (also called practicability or ease of implementation by farmers);

Expanding on 6.2 above the question here is whether farmers are able use the alternative products, tools or strategies that are being introduced to replace HHPs. In the case of biopesticides, for example, modifications may be needed in the application equipment, in the timing of applications and in the expected results which may be slower than with chemical pesticides. Using mechanical traps or barriers requires new skills and knowledge in their placement, monitoring and repair or replacement. Agroecological practices may need new training and follow up support for farmers to learn and apply new practices effectively.

In all cases, agricultural extension or other advisory services, agricultural input vendors and other resources that farmers go to for advice and guidance need to be informed and equipped to provide support to farmers and others who are expected to replace HHPs with new methods.

6.6. Cost-effectiveness

Alternatives to HHPs should not be prohibitively expensive so that farmers suffer economic losses. It is important that farmers can continue to protect their crops from pest and disease damage with inputs that are compatible with the farming practices and the value of their crops. Calculating the comparative cots of different options is important in convincing farmers to change their practices. It may, for example, that initial outlays for materials and equipment such as barrier netting, traps or hedgerow planning are high, but over time costs are lower than frequent pesticide applications. There may be cases where farmers need help with initial investments through grants or concessional loans to encourage changes in practice.

7. Resources

FAO

The International Code of Conduct on Pesticide Management provides a comprehensive framework for life cycle management of pesticides. Guidelines that elaborate on various articles of the Code are developed and published on-line. The Guideline on Highly Hazardous Pesticides is particularly helpful in the context of this document.

Pesticide Registration Toolkit is a comprehensive web based system designed to help pesticide regulators to gather and interpret all the information required to make informed decisions about pesticides. It includes a section on Information Sources which links to many useful sites, some of which are described here. A Special Topic within the toolkit addresses HHPs and provides links to further helpful guidance and resources.

IPM is the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations. It combines biological, chemical, physical and crop specific (cultural) management strategies and practices to grow healthy crops and minimize the use of pesticides, reducing or minimizing risks posed by pesticides to human health and the environment for sustainable pest management. IPM can be a useful approach to replacing HHPs and promoting sustainable agriculture.

Agroecology is based on applying ecological concepts and principles to optimize interactions between plants, animals, humans and the environment while taking into consideration the social aspects that need to be addressed for a sustainable and fair food system. By building synergies, agroecology can support food production and food security and nutrition while restoring the

ecosystem services and biodiversity that are essential for sustainable agriculture. Agroecology can play an important role in building resilience and adapting to climate change

WHO

IPCS – chemical safety is a key health topic for WHO and pesticides are an important component of that work with many publication, guidelines and other helpful material available

Pesticide Hazards - The WHO Recommended Classification of Pesticides by Hazard and guidelines to classification, 2019 edition is the document that defines criterion 1 of the HHP criteria. It is a useful reference to determine the acute toxicity of all pesticides.

Suicide prevention –pesticide self poisoning accounts for 14-20% of global suicides, or approximately 150,000 each year. Pesticide suicides are particularly common in low and middle income countries (LMIC). Evidence has shown that banning HHPs tat are commonly used in suicides is a very cost effective way of saving lives and reducing suicides.

The Rotterdam Convention defines criterion 6 of the HHP criteria through the listing of pesticides and industrial chemicals that have been deemed to be particularly hazardous and therefore requiring prior informed consent from importing countries in international trade. Within its website is a section devoted specifically to alternatives to hazardous pesticides which includes some specific

examples of replacements for Rotterdam Convention listed pesticides.

The Stockholm Convention defines criterion 5 of the HHP criteria through the listing of pesticides and industrial chemicals that have been deemed to be persistent, environmentally dispersed, bioaccumulative and toxic. A section of the website addresses alternatives to POPs.

The Globally Harmonized System of Classification and Labelling of Chemicals (GHS) is an internationally agreed system for classifying and labelling chemicals to clearly indicate the hazards they present to users and others. Determining which hazards and the degree of severity that relate to individual chemicals is a matter for national authorities. There is no centralized database of GHS classifications for chemicals, but publicly accessible databases from other regulatory authorities can be referred to for guidance. For example, GHS classifications are listed in the EU pesticides database. It can be difficult to find information about national listings of GHS classifications. A useful resource that links to a number of countries' GHS listings is CheSafetyPro which is compiles by chemical regulators who recognize the value of this information and the difficulty in finding it.

EU pesticide database allows searches by active ingredient, MRL and emergency authorizations. Within the active ingredient database, searchers can be refined for low risk and candidates for substitution. The information retrieved indicated the regulatory status in the EU and links to relevant documents.

US EPA

Pesticide Regulatory bodies

The Asia Pacific Plant Protection Commission (APPPC) links 25 countries on common issues of phytosanitary standards under the International Plant Protection Convention (IPPC) and on pesticide regulatory matters.

SAPReF

EAC

CILSS/COAHP

CGPC

CABI

Plantwise Knowledge Bank CABI has gained extensive experience running advisory plant health clinics in many countries around the world. Much of the knowledge they have accumulated is on this website where searches can be made according to pest, crop or country. This is useful for understanding control options for various crop-pest combinations. The site also contains links for other useful CABI resources and to other organizations.

CABI BioProtection Portal is an online open-access resource, available on four continents, that helps growers and agricultural advisors to identify, source and correctly apply biocontrol and biopesticide products against problematic pests in their crops. The Portal is currently available for 15 countries but the target is that we have 25 countries included by the end of 2021.

Sustainable Agriculture Network (SAN)

Pesticides and Alternatives App launched in 2020 by the IPM Coalition this android app provides information on pesticide restrictions in (currently 5) countries and under several ISEAL member trading standards. The app also includes control options from the CABI Plantwise protocols and approved pesticide for the control of many pests on specified crops in the 5 countries whose data in included. The app will be expanded with time to include more data.