Agroecology: a viable option to phasing out Highly Hazardous Pesticides from Ethiopia

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PESTICIDE ACTION NEXUS ASSOCIATION (PAN-Ethiopia)

IPEN for a toxics-free future

Contents

1. Introduction

Agriculture in Ethiopia is the foundation of the country's economy. In an effort to increase production and productivity, the agriculture sector puts the use of inputs like pesticides and fertilizers as driving forces. Input use and distribution is, mainly, conducted through agriculture development agents who are working at the grassroots level with smallholder farmers.

In Ethiopia, the use of agricultural inputs, including pesticides, was introduced to smallholder farmers from the 1960s through agricultural extension systems. Since then, pesticide use by smallholder farmers showed a steady growth. Currently, special emphasis is given to agriculture investment and the development of the flower sector which has contributed a lot to the import and use of pesticides. This increasing trend in the use of pesticides as part of a development plan poses threats to human health and the environment.

Moreover, highly hazardous pesticides (HHPs) are being widely used by smallholder and commercial farmers in Ethiopia. Progressive ban of the use of HHPs has been recommended by the Food and Agriculture Organisation (FAO) since 2006 due to the confirmed adverse impacts they can cause on people and the environment, and the threats to biodiversity. This brochure reveals the level of HHPs use in Ethiopia; the human health, environmental and economic impacts of using HHPs; the availability of tested alternatives to HHPs; and it recommends the progressive phase out of HHPs from Ethiopia.

2. Trends of HHPs use in Ethiopia

In 2016, the Ministry of Agriculture and Livestock Resources, Plant and Animal Health Directorate registered 409 pesticides by 53 registrants for different purposes, of which the majority (29.5%) were insecticides (121 in number). The other types of pesticides included 49 fungicides, 36 herbicides, 9 household pesticides, 7 public health pesticides, 5 rodenticides, 4 miticides, 2 avicides, 2 adjuvants, stickers, plant growth regulators and defoliants and 1 nematicide (MoANR, 2016).[1]

The list of registered pesticides in Ethiopia was cross checked with the Pesticide Action Network (PAN) HHPs list and it was found that 236 (58%) of the registered pesticides being used in Ethiopia are HHPs and listed under the 2019 PAN HHPs list.

The lack of proper assessment of pesticide poisoning and their environmental impacts in the country made it difficult to indicate the actual hazard that the products are posing to human health and the environment. However, with HHPs being widely used in the country, and due to the poor management of reduction of exposure (with a special emphasis on end users), pesticide-related hazards are evident.

1 MoANR. 2016. The list of pesticides registered and used in Ethiopia, Addis Ababa, Ethiopia

3. Human health impacts of HHPs

According to the information requirements for notification of severely hazardous pesticide formulations made pursuant to article 5 of the Rotterdam Convention[2] and other health-related studies, pesticide poisoning is classified into mild, moderate or severe poisoning.

The symptoms of mild pesticide poisoning are head ache, fatigue, skin irritation, loss of appetite, weakness, perspiration, eye irritation, thirst and irritation of nose and throat.

The symptoms of moderate poisoning include those mentioned above and additionally trembling, excessive salivation, blurring of vision, chest pain, difficulty of breathing, flushed (yellow) skin, abdominal cramps, vomiting, mental confusion, twitching of muscles, weeping, excessive perspiration, profound weakness, rapid pulse and persistent cough.

The symptoms of severe pesticide poisoning include the symptoms of mild and moderate poisoning as well as severe stages of inability to breathe, constriction of pupils, convulsion and secretion from respiratory tract, fever and death.

Acute effects of HHPs on health range from seemingly mild symptoms to much more severe symptoms, some leading to chronic disability or death. Chronic effects may result with no acute symptoms and little outward effect, yet still can undermine a person's health for the rest of their lives, and may also affect future generations.

Some of the harms result from negligence, lack of awareness, and shortage of resources – for example the death of 23 school children in India in 2013 when their free midday meal was cooked with oil contaminated by monocrotophos, thought to be a result of storing the oil in an empty monocrotophos container.[3]

Some harm results from the pervasiveness of pesticides in air, drinking water and food, and there is particular concern about the exposure of the unborn foetus or newly born child to neurotoxins such as organophosphate insecticides (OPs), resulting in neurodevelopmental deficits. Numerous studies on animals have shown that *in utero* or neonate exposure to OPs, particularly chlorpyrifos, adversely affects neurodevelopment.[4] Metabolites of organophosphate insecticides have been found in the urine of 94% of farm and non-farm children in the Bang Rieng agricultural community in Thailand.[5]

Some harm results from intentional ingestion of pesticides with suicidal intent. Pesticides account for about one third of the estimated 800,000 global annual suicide deaths, making them the single

2 www.pic.int

[3] Reuters. 2013.World Health Organisation had asked India to ban toxin that killed school children. July 22, 2013. http://www.ndtv.com/article/india/world-health-organisation-had-asked-india-to-ban-toxin-that-killed-school-children-395630; http://tvnz.co.nz/world-news/asked-india-ban-toxin-23-killed-children-5516941

[4]e.g. Flaskos J. 2012. The developmental neurotoxicity of organophosphorus insecticides: A direct role for the oxonmetabolites. *ToxicolLett* 209(1):86-93. Muñoz-Quezada MT, Lucero BA, Barr DB, Steenland K, Levy K, Ryan PB, Iglesias V, Alvarado S, Concha C, Rojas E, Vega C. 2013. Neurodevelopmental effects in children associated with exposure to 4 organophosphate pesticides: A systematic review. *Neurotoxicology*39:158-68. Eskenazi B, Marks AR, Bradman A, Harley K, Barr DB, Johnson C, Morga N, Jewell NP. 2007. Organophosphate pesticide exposure and neurodevelopment in young Mexican-American children. *Environ HealthPerspect*115(5):792-8.

[5]Panuwet P, Siriwong W, Prapamontol T, Ryan B, Fiedler N, Robson MG, Barr DB. 2012. Agricultural pesticide management in Thailand: status and population health risk. *Environ Sci Pol* 17:72-81.

most common means of suicide worldwide.[6] The fatality rate from pesticide ingestion is high, and banning HHPs in some countries has been successful in bringing down the death rate: the banning of monocrotophos, methyl-parathion, methamidophos and endosulfan by Sri Lanka resulted in a 50% fall in the suicide rate, although poisoning with WHO Class II pesticides dimethoate, fenthion and paraquat (the latter with a case fatality rate of 42.7%), remained a problem.[7]

Pesticides have been poisoning farm workers, their families and communities for over 60 years. Yet there is still no accurate estimate of the degree of human suffering from exposure to pesticides. The most authoritative study still today is one published in the World Health Statistics Quarterly in 1990, using data derived in the 1980s – nearly 40 years ago. This study[8] estimated that there are possibly one million cases of serious unintentional pesticide poisonings each year, and an additional two million cases of people hospitalized for suicide attempts with pesticides. The author notes that this necessarily reflects only a fraction of the real problem and estimates that there could be as many as 25 million agricultural workers in the developing world suffering some form of occupational pesticide poisoning each year, though most incidents are not recorded and most patients do not seek medical attention.[9] A surveillance exercise in Central America indicated a 98% rate of underreporting of pesticide poisonings, with a regional estimate of 400,000 poisonings per year, 76% of the incidents being work related.[10]

There is no reason to assume that the global pesticide poisoning rate has diminished. The figure of 25 million cited above was based on an average of 3% of agricultural workers in developing countries suffering an episode of pesticide poisoning per year,[11] yet figures from recent surveys and studies indicated the problem may well be much larger than that, with rates of poisoning ranging up to 100% of workers exposed to pesticides:

- Ethiopia, 2012 – 19.4% of 420 smallholder farmers interviewed in the Ethiopian Central Rift Valley area reported mild, moderate and severe pesticide poisoning after they apply a herbicide 2,4-Dichlorophenoxyaceticacid (2,4D); insecticides Endosulfan, Lambda-cyhalothrin, Malathion and Profenofos; and a fungicide Mancozeb.[12]
- Bangladesh, 2014 – 85% of applicators reported suffering gastrointestinal problems during and after spraying, 63% eye problems, 61% skin problems, and 47% physical weakness. Most commonly used pesticides: organophosphate and synthetic pyrethroid insecticides.[13]
- Burkina Faso, 2013 – 82.66% of farmers surveyed reported having experienced at least one ailment during or just after spraying, most commonly central

[6] WHO. 2014. Preventing Suicide: A Global Imperative. World Health Organization, Geneva.

[7] Eddleston M, Adhikari S, Egodage S, Ranganath H, Mohamed F, Manuweera G, Azher S, Jayamanne S, Juzczak E, Sheriff MR, Dawson AH, Buckley NA. 2012. Effects of a provincial ban of two toxic organophosphorus insecticides on pesticide poisoning hospital admissions. *Clin Toxicol (Phila)* 50(3):202-9

[8] Jeyaratnam J. 1990. Acute Pesticide Poisoning: A Major Global Health Problem. *World Health Stat Q* 43(3):139-44.

[9] Ibid.

[10] Murray D, Wesseling C, Keifer M, Corriols M, Henao S. 2002. Surveillance of pesticide- related illness in the developing world: putting the data to work. *Int J Occup Environ Health* 8(3):243-8.

[11] Jeyaratnam, *op cit*.

12 Amera T. 2016. Pesticide risk perception among farmers in the Ethiopian Rift Valley and challenges for effective risk communication, Swedish University of Agricultural Sciemces, Uppsala, Sweden.

[13] Miah SJ, Hoque A, Paul A, Rahman A. 2014. Unsafe use of pesticide and its impact on health of farmers: a case study in BurichongUpazila, Bangaldesh. *IOSR-J Environ SciTechnol Food Tech* 8(1):57-67.

nervous system effects. Of the cases reported to a health care centre, 53% were unintentional ingestion, 28% suicides, and 19% occupational use.[14]

- Pakistan, 2012 – in a small study of female workers picking cotton 3-15 days after pesticides were last used, 100% of them experienced headache, nausea and vomiting.[15]
- Republic of Korea, 2012 – acute occupational pesticide poisoning amongst young male Korean farmers was reported to be 24.7%.[16]
- India – in 2014 a survey by the Calcutta School of Tropical Medicine and the NRS Medical College found that 30% of farmers using pesticides in a district in West Bengal were experiencing neurological symptoms.[17] In 2012 a survey of pesticide-exposed farmers in Punjab, India, reported 94.4% exhibited some symptoms of poisoning.[18]
- Brazil, 2012 – in a small survey in Brazil, 44.8% of rural workers involved in vegetable production reported health problems whilst using pesticides.[19]

These figures only reflect acute effects of pesticides. Chronic health effects are also a significant concern, but no accurate statistics exist for the incidence. Effects include cancer, birth defects, neurodevelopmental delays and behavioural effects in children, adult onset neurological diseases such as Parkinson's disease, and many other effects. Of particular concern are those effects resulting from endocrine disruption (ED). The importance of endocrine disruption is signalled by the third meeting of the International Conference on Chemicals Management (ICCM3) adopting endocrine disrupting chemicals (EDCs) as an emerging issue. All stakeholders agreed "to promote actions on endocrine disrupting chemicals". Within this broader group of EDCs, ED pesticides can be considered a specific group of chemicals meriting special attention because of the way in which they are used, their large impact on developing and transition countries due to the importance of agriculture, and because safer alternatives are readily available. The 2019 PAN HHPs[20] list contains 52 pesticides that are EDCs. It must be emphasised that these are only the worst of the ED pesticides: there are many more in addition to these.

4. Environmental impacts of HHPs

Most environmental contamination with pesticides results from the normal methods by which they are delivered to the target pests – largely spraying or seed coating. Both methods result in only a tiny fraction of the material applied reaching the target organisms, particularly in the case of insecticides, and a large proportion of the chemicals are left in the environment to affect other

[14]Toe AM, Ouedraogo M, Ouedraogo R, Ilboudo S, Guissou PI. 2013. Pilot study on agricultural pesticide poisoning in Burkina Faso. *InterdiscipToxicol* 6(4):185-91.

[15]Tahir S, Anwar T. 2012. Assessment of pesticide exposure in female population living in cotton growing areas of Punjab, Pakistan. *Bull EnvironContamToxicol* 89:1138-41.

[16] Lee WJ, Cha ES, ParkJ, KoY, Kim HJ, Kim J. 2012. Incidence of acute occupational pesticide poisoning among male farmers in South Korea. *Am J Ind Med* 55(9):799-807.

[17]Banerjee I, Tripathi SK, Roy AS, Sengupta P. 2014. Pesticide use pattern among farmers in a rural district of West Bengal, India. *J. Nat SciBiol Med* 5(2): 313-6.

[18] Singh A, Kaur MI. 2012. Health surveillance of pesticide sprayers in Talwandi Sabo area of Punjab, north-west India. *J Hum Ecol* 37(2):133-37.

[19]Preza DLC, Augusto LGS. 2012. Farmworkers' vulnerability due to the pesticide use on vegetable plantations in the Northeastern region of Brazil. *Rev Bras Saúde Ocup* (37):125.

[20]http://www.pan-germany.org/download/PAN_HHP_List.pdf

organisms.[21][22] They leach into groundwater, wash into streams, rivers and the marine environment, and drift or - after evaporating - are carried by the air hundreds, even thousands of kilometres to be redeposited in the Arctic, Antarctic, and on the peaks of mountains such as the Himalayas. Pesticides now contaminate soil, water, air, rain, fog, snow, ice, flora, fauna, and humans throughout the world.[23] The UN's Economic and Social Commission for Asia and the Pacific reported in 2002 that, in Thailand, "an estimated 70 per cent of applied pesticides is washed away and leaches into the soil and water, resulting in excessive pesticide residue contamination in the local ecosystem and food chain. It is not surprising to find a large amount of land and water in the country contaminated with pesticides".[24]

As a result of their widespread dispersal in the environment, pesticides use results in reduced survival and reproductive rates and has been implicated in mass die-offs of marine mammals, birds, and fish,[25] and population crashes of amphibians and alligators.[26][27]

In 2014 a team of 29 scientists published their analysis of the impacts of systemic insecticides on the ecosystem as a whole. This "Worldwide Integrated Assessment of Systemic Insecticides"[28] found that the neonicotinoid insecticides, together with fipronil, are posing a global threat to biodiversity and the ecosystem services on which global food production depends, such as nutrient recycling, soil respiration, leaf litter decomposition, pollination, and biological pest control. These are now the most commonly used insecticides, encompassing 1/3rd of the global market. Because of this widespread use, together with their persistence and solubility in water, they have contaminated agricultural soils, freshwater resources, wetlands, estuarine and marine systems, and non-target vegetation, so that myriads of non-target and beneficial species are now exposed to toxic concentrations of insecticides. Some of the systemic insecticides persist in the environment for years and this, together with their solubility, results in multiple routes of chronic and acute exposure.

They disrupt the functioning of diverse biological communities, including soil microbial communities that are the cornerstone of sustainable agriculture. They are causing a significant decline in beneficial insects, are a key factor in the decline of bees, and pose a serious risk to butterflies, earthworms and birds. Aquatic insects are at risk. Residues found in water around the world regularly exceed toxicological limits. Some of the neonicotinoids are up to 10,000 times more toxic to insects than DDT. Through run off and wind-blown dust from treated seeds, they have spread far beyond the farms on which they have been applied, the effects cascading through ecosystems and undermining their stability.[29]

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21 Jepson P. 2009. Assessing environmental risks. In: Radcliffe EB, Hutchison WD, Cancelado RE. 2009. *Integrated Pest Management*. Cambridge University Press

22 The Task Force on Systemic Insecticides. 2014. http://www.tfsp.info/worldwide-integrated-assessment.

23 See Watts MA. 2009. Endosulfan monograph. PAN Asia and the Pacific. http://www.panap.net/sites/default/files/monograph_endosulfan.pdf.

24 ESCAP. 2002. *Organic Agriculture and Rural Poverty Alleviation: Potential and Best Practices in Asia*. Economic and Social Commission for Asia and the Pacific, United Nations, New York.

25 Köhler H-R, Triebskorn R. 2013. Wildlife ecotoxicology of pesticides: can we track effects to the population level and beyond? *Science* 341:759.

26 Bruhl CA, Schmidt T, Pieper S, Alscher A. 2013. Terrestrial pesticide exposure of amphibians: an underestimated cause of global decline? *SciRep* 3:1135).

27 Colborn T, Dumanoski D, Myers JP. 1996. *Our Stolen Future*. Little Brown, Boston.

28 The Task Force on Systemic Insecticides. 2014. http://www.tfsp.info/worldwide-integrated-assessment.

29 van der Sluijs JP, Amaral-Rogers V, Belzunces LP, Bijleveld van Lexmond MF, Bonmatin J-M, Chagnon M, Downs CA, Furlan L, Gibbons DW, Giorio C, Girolami V, Goulson D, Kreutzweiser DP, Krupke C, Liess M, Long E, McField M, Mineau P,

Even if a systematic study on the impacts of pesticides on biodiversity has not yet been undertaken, preliminary assessments (surveys) (Amera and Abate, 2008)[30] and personal communication with residents (Wondafrash, 2013)[31] indicate that both migratory and resident bird populations in the Rift Valley of Ethiopia has been dwindling over the last 3-4 decades, with this phenomenon being partly attributed to unabated, unwise and excessive use of agrochemicals.

5. Economic consequences of HHPs

Estimates of costs are difficult to make, but several studies provide some indications of the economic consequences of HHPs use.

In Brazil the costs associated with acute poisoning alone, and only for the state of Paraná, have been estimated at approximately USD 149 million per year. For each dollar spent on pesticides, the external costs from acute poisoning alone were estimated as USD $1.28.[32]

In Thailand, the average external costs of pesticide use were estimated to be USD $27.1/ha, comprised mainly of costs to farm workers' health (USD $22.42/ha); but the costs rise to USD $105.75/ ha for intensive horticulture.[33]

In developed countries the cost is huge: for the US there is an estimated USD $9.6 billion per annum in environmental and societal damages from pesticides, including $1.14 billion for public health impacts:[34]

6. Agroecology as an alternative to HHPs in Ethiopia

Despite the high use of HHPs, there are alternatives that pose no risk to users and their environment. Ecosystem-based approaches to pest and crop management can be used to replace HHPs. As part of agro-ecological farming, farmers have been using their indigenous knowledge and local innovations to devise their own local solutions to pest and crop management problems. Apart from actions taken by farmers; a number of initiatives have been put in place to develop viable alternatives to help cut the use of pesticides in general and HHPs in particular.

Using alternatives to replace highly hazardous pesticides can also play a role in the fight against food insecurity and climate change. In the booklet they compiled; Watts M. and Williamson S. pointed out that phasing out HHPs must be seen in the context not only of human health and

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Mitchell EA, Morrissey CA, Noome DA, Pisa L, Settele J, Simon-Delso N, Stark JD, Tapparo A, Van Dyck H, van Praagh J, Whitehorn PR, Wiemers M. 2014. Conclusions of the Worldwide Integrated Assessment on the risks of neonicotinoids and fipronil to biodiversity and ecosystem functioning. *Environ SciPollutRes* [Epub].

30 Amera, T. & Abate, A. 2008. An assessment of pesticide use, practice and hazards in the Ethiopian Rift Valley, Institute for Sustainable Development, Ethiopia.

31 Wondafrash, M. 2013. Situation Analysis of the Agriculture sector as part of the project "Mainstreaming Conservation of Migratory Soaring Birds along the Rift Valley/Red Sea Flyway". Addis Ababa: EWNHS.

[32] Soares WL, de Souza Porto MF. 2012. Pesticide use and economic impacts on health. *Revista de SaúdePública*46(2):1-8.

[33]Praneetvatakul S, Schreinemachers P, Pananurak P, Tipraqsa P. 2013. Pesticides, external costs and policy options for Thai agriculture. *Environ Sci Pol* 27:103-13.

[34]Pimentel D, Burges M. 2014. Environmental and economic costs of the application of pesticides primarily in the United States. In: Pimentel D, and Peshin R. 2014. *Integrated Pest Management: Pesticide Problems, Vol 3. Springer*, New York.

environmental impacts and costs, but also in the context of food security, poverty reduction, and climate change[35].

In Ethiopia, there are a number of tested means that support the process of phasing out the use of HHPs by replacing them with ecologically-based crop production systems. With the involvement of different civil society organisations and support from the government extension systems, the ecological farming initiative is building momentum. With support from the Ethiopian Ministry of Agriculture, a local NGO called Institute for Sustainable Development developed an organic agriculture implementation tool that can help organic farmers in the production and market linkages. This is one promising step forward in reducing the use of HHPs.

There are a number of best practices and success stories in reducing and /or avoiding the use of toxic chemicals by replacing them with alternatives. Below are few examples that pioneered crop production by avoiding the use of HHPs.

6.1 Production of organic cotton

Globally, cotton is one of the crops for which an extraordinary amount of pesticides is used. It is also grown in Ethiopia by large commercial farms and smallholder farmers as a source of income. Cotton is attacked by a variety of pests and diseases and production is heavily reliant on the use of HHPs for pest management. Since 2007, a pilot project on integrated pest management (IPM) has been carried out in Ethiopia. It was found to be effective in helping farmers develop knowledge-based decision-making skills on pest management. The focus of the pilot project was to help farmers learn more about and really know their agro-ecosystems and devise a way for them to harbour natural enemies to make use of the pest management services.

The cotton IPM pilot project showed a promising result in reducing the use of HHPs for cotton production by smallholder farmers. The farmers received practical trainings on the identification of major cotton pests and their natural enemies that keep pest populations low.

Following the footsteps of the cotton IPM pilot project, PAN-Ethiopia and PAN-UK continued to strengthen the effort since 2013 with a new project that brought additional alternatives for cotton pest and crop management. The new and innovative pest management option, called the "food spray technique," was introduced to smallholder cotton farmers. It helps boost the use of natural enemies and biological control agents by attracting them into the sprayed cotton field.

Smallholder cotton farmers received season-long trainings on the cotton IPM, preparation and application techniques of the food spray, and decision-making steps.

The training also included when and how to apply the food spray and other integrated approaches for pest and crop management. The season-long training was given via a farmers field schools

[35] Watts. M, and Williamson S. (2015). Replacing Chemicals with Biology: Phasing out highly hazardous pesticides with agro ecology. Pesticide Action Network Asia and the Pacific, 2015.

(FFS) approach – a learner-centred approach which concentrates in helping farmers learn more about the agro-ecosystems in their own fields.

With this practical, learner-centred and season-long training approach, more than 3000 smallholder cotton farmers cut the use of HHPs for cotton production. Despite its start as cotton IPM, farmers totally avoided the use of all pesticides and completely converted to organic. Cooperatives were set up in different villages to make way for organic certification. A total of four cooperatives were established, and 200 farmers who are members of one of the cooperatives got organic certification for their cotton. The certified farmers are selling their organic cotton wat 15% additional premium price. This is the economic case that can attract more farmers in to the organic production systems – in addition to the positive externalities of human health promotion and environmental protection.

The organic cotton production in the Southern Rift Valley area is one of the best experiences of agro-ecological farming. It was found to be economically profitable, with a higher yield and lower production costs compared to conventionally grown cotton in the area (Amera et al., 2017)[36]. With the help of the local bureau of agriculture, the food spray-based cotton IPM is being expanded to new areas.

6.2 Sustainable vegetable production

With the objective of bringing the organic cotton experience to vegetables, PAN-Ethiopia and PAN-UK have been conducting a research and development project in the Central Rift Valley of Ethiopia where there is intensive use of HHPs for vegetables production. Trials were conducted for three consecutive seasons on tomato and onion in three different villages. Farmers were engaged via season-long FFS trainings. On the other hand, IPM and farmers plots (FP) were set up to compare production practices, yield and profits.

Results of the vegetable IPM showed decent yields and profits with the use of HHPs reduced by nearly 70% compared to the conventional smallholder farmers and commercial farmers in the area. Additionally, the comparison between IPM and FP plots also showed that the IPM plots used about 50% less pesticides (not HHPs) while the yield was nearly the same in both cases. Hence, net profit was higher in the IPM plots compared to the farmers' plots.

After consecutive trials and demonstrations in farmers' plots, a number of farmers are now switching to the use of IPM methods for vegetables production. Farmers (234 in number) received trainings on the IPM methods via FFS approaches. These farmers are adopting sustainable vegetable production techniques to avoid the use of HHPs.

6.3 Ecological Organic Agriculture

Ecological organic agriculture (EOA) in Ethiopia is one of the promising options that can mainstream into the extension systems to support farmers to reduce the use of toxic and costly

36 Amera T., Mensah K.R., and Belay, A. (2017): Integrated pest management in a cotton-growing area in the Southern Rift Valley region of Ethiopia: development and application of a supplementary food spray product to manage pests and beneficial insects, International Journal of Pest Management, DOI: 10.1080/09670874.2016.1278084.

inputs. This can be done by availing non-synthetic chemical alternatives in place of HHPs. The Institute for Sustainable Development is the country lead organisation for this initiative, and has been documenting and preparing extension materials. Best practices, success stories and experiences from different parts of the country have been compiled and packaged in a customisable way to support the extension of EOA. Different NGOs have taken part in this initiative to work together and strengthen the development and dissemination of alterative pest and crop management techniques. The Ethiopian Ministry of Agriculture is a national steering committee leader of the initiative, which is an opportunity to push the EOA practices to be incorporated to the extension systems.

Under the EOA initiative, thousands of smallholder farmers in Amhara, Oromia, Tigray and Southern Ethiopia regions have been involved and are pioneering the initiative. The farmers have taken a great role in packaging the indigenous knowledge and innovations that helped EOA expand. Apart from the economic benefits that farmers can gain from better market, farmers have become conscious of human and environmental health impacts of relying on HHPs. Hence, a number of farmers are now coming in groups and setting up organic inputs production centres where fellow farmers can access the products easily. Initiatives like these are promising ones that need to be nurtured to maximize their role in the fight to phase out HHPs.

6.4 Push-Pull technology

Stem borers and striga weeds are the major challenges for maize and sorghum production. Control of stem borer insects with the use of pesticides was too difficult, as the insects bore into the stems of the crop. An ecologically sound and innovative stem borers' pest management technique called Push-Pull was developed by the International Centre for Insect Physiology and Ecology (ICIPE). Central to this technique is the use of Desmodium (*Desmodium uncinatum*); a flowering plant of the Fabaceae family and Brachiaria, a grass family native to the tropics. Desmodium, which plays the push role, is planted in between the rows of maize or sorghum crop while Brachiaria, which plays the pull role, is planted around, sandwiching the main crop from every side of the farm.

Odour released from Desmodium repels the stem borer moths away; preventing them from laying their eggs on the maize/sorghum crop. At the same time the odour released from Brachiaria is an odour cue, which invites the moths to lay their eggs on. Once they lay their eggs on the Brachiaria, the tiny white spines of the grass kills the eggs, stopping the life cycle of the stem borer moth.

Since 2010, its first trial in northern Ethiopia, the push-pull technology has been implemented in maize and sorghum growing areas to help farmers avoid the use of pesticides. With ICIPE and ISD being the lead in the extension of this novel pest management technique, universities and agriculture research institutes and plant health clinics were also involved, putting concerted efforts for the technology to reach the farmers. This helped in reducing the use of HHPs for the control of stem borer insects.

7. Dissemination of alternatives

Alternatives to HHPs are available in bits and pieces from farmers' indigenous knowledge, university research works, private organizations, government institutions and NGOs. Hence, the knowledge pool, which is situated in different areas, needs to be recorded in a usable form and disseminated to the practitioners to help them avoid the use of HHPs. Dissemination of information about best practices, experiences and success stories on innovative, ecologically sound and economically viable alternatives is one pillar that supports the endeavour to phase out HHPs.

8. The need for phasing out HHPs from Ethiopia

The phase-out of HHPs and the promotion of agroecological alternatives contribute to achievement of the Sustainable Development Goals (SDGs) that call for, inter alia, efforts to promote sustainable agriculture (SDG2), healthy lives and well-being (SDG3), sustainable management of water (SDG6), decent work (SDG8), responsible consumption and production (SDG12), climate action (SDG13), life below water (SDG14) and the sustainable use of terrestrial ecosystems and halt of biodiversity loss (SDG15). Reduction and elimination of HHPs would make a significant contribution to each of these goals by reducing exposure and adverse impacts on human health and the environment.

Considering the availability of benign pesticides, IPM techniques and different agroecological approaches, the following recommendations are suggested to the Ministry of Agriculture and Livestock of Ethiopia and other stakeholders to take action.

- Incorporate awareness-raising on HHPs and their alternatives as well as information dissemination as part of the national agriculture strategy.
- Enhance knowledge of key players such as pesticide inspectors, agricultural extension staff, pesticide sellers and users on the need to phase-out HHPs.
- The government to identify and publicly disseminate lists of all HHPs that are on the national market and put emphasis on the use of agro-ecology as an alternative.
- The government to develop a roadmap to implement a progressive ban on HHPs.
- Mainstream agro-ecology research should be part of the national agricultural research agenda to build evidence on the benefits of agro-ecology and its contribution to food and nutrition security, as well as food sovereignty.
- Mainstream agro-ecology within the public extension programs to ensure that extension services are available and accessible to all farmers.
- To put capacity-building programs in place that are targeted at improving the skills and knowledge of farmers on organic farming and IPM as well as identifying appropriate technologies that can support agro-ecology.