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Integrated pest management: The case of Benin

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RIO+20

The United Nations Conference on Sustainable Development, also referred to as Rio+20, is an important step in ongoing international efforts to accelerate progress towards achieving sustainable development globally. The conference will mark the 20th anniversary of the 1992 UN Conference on Environment and Development in Rio de Janeiro (the Earth Summit). It will also mark the 10th anniversary of the 2002 World Summit on Sustainable Development in Johannesburg.

The 1992 and 2002 summits were headline international events and key drivers of the sustainable development agenda. Similarly, Rio+20 presents an opportunity to re-direct and re-energise political commitment to the three pillars of sustainable development: economic growth, social improvement and environmental protection. The conference is expected to be attended by a significant number of Heads of State and Government.

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Abstract

Feeding the excess 2.3 billion people set to occupy the planet by 2050 will be a paramount concern at the Rio+20 UN Conference for Sustainable Development (UNCSD) in June 2012. Effective commitments towards securing global food security and rethinking the future of commercial agriculture production will be a fundamental priority. However, the expansion of Western agricultural systems imposes a significant threat to the implementation of sustainable agriculture.

This paper highlights the devastating economic, ecological and health implications of widely-adopted Western agricultural systems within developing nations with a focus on pesticide use in West Africa and in particular, Benin. Upon evaluation of sustainable alternatives such as Integrated Pest Management, this paper found that IPM is essential to the protection of natural ecosystems, the eradication of poverty and food insecurities within West Africa and the continent as a whole. As a recommendation this paper calls for:

I. Innovative strategies for the implementation of sustainable and environmentally sound methods that reside with the restoration of the earth's biodiversity which help with the reduction of crop losses and minimisation of environmental and health hazards;
II. More stringent commitments to the implementation of IPM programs and the transition to more sustainable agricultural practices where government funding has been significantly lacking;
III. Significant government funding for research and development as well as support in the widespread deliver of IPM messages which remain largely under-financed and overstretched;
IV. Stricter pesticide restrictions that identify public health as a major concern in their application;

V. More focus to be placed on the development of Farmer Field Schools and various education programs to increase the adoption rates among small-scale farmers as well as incentives for sustainable practices; and

VI. Member nations to recognise the inherent link between of food security and sustainability, whereby these agendas are intrinsically connected and require effective governance to ensure their pursuit.

Introduction

In the face of the Rio+20 UN Conference for Sustainable Development (UNCSD), effective commitments towards securing global food security and rethinking the future of commercial agricultural production will be a fundamental priority. With the population expected to rise to 9.3 billion by 2050, the UN Food and Agricultural Organisation (FAO) recognises the profound transition needed towards sustainable agricultural systems to deliver healthy and nutritious food for the next generations to come, particularly in developing nations.[1] However, the industrialisation of Western agricultural systems and a shift towards petroleum-dependant practices since the 1950's exposes the dominant presence of fossil fuels within the majority of food systems today.[2] These Western methods of food production which heavily rely on pesticides, among other petro-based chemicals, have expanded throughout most regions of the world creating adverse effects on the health of the world's natural resources.[3] Modern agriculture arguably exploits the land with the intensification of chemical inputs, coming in at a significant cost.[4]

[1] FAO, 'The State of Food Insecurity in the World, Food and Agricultural Organization of the United Nations, Rome, Italy, 2011.
[2] Neff et al. 'Peak Oil, Food Systems, and Public Health', American Journal of Public Health, No. 9, 2011, pp. 1587-1597.
[3] Adamu, R & Banwo, O. 'Insect pest management in African agriculture: Challenges in the current millennium', Archives of Phytopathology and Plant Protection, No. 1, 2003, pp. 59-68.
[4] Tisdell, C & Wilson, C. 'Why farmers continue to use pesticides despite environmental, health and sustainability costs', Ecological Economic, No. 3, 2001, pp. 449-462.

History has shown the land is often degraded and becomes less productive. Studies reveal that the earth's natural resources have become seriously disadvantaged by the extensive use of contaminants which cause air, soil and water pollution.[5] Therefore, this paper will discuss why it critical to ensure a transition away from conventional modern agricultural methods to more sustainable practices to protect the earth's future yield capacity.

Pesticides directly impact the earth's soil capacity to grow crops as well as the affordability for small scale farmer to produce food as oil prices rise.[6] With small-holder farms providing almost 80 per cent of food for those in developing nations,[7] these ecologically and economically costly methods influenced by modern industrial systems jeopardise the viability of small-scale farm production. In particular, this paper has chosen to focus on West Africa with a case study from the agricultural hub of Benin. This is largely due to the region's potential to remove Western agricultural inputs (such as pesticides) from farming practices to create positive advancements on food security and poverty eradication witnessed in successful integrated pest management programs. Furthermore, where studies have recognised agriculture as the main sector for economic growth in West Africa, it remains largely hampered by its dependency on high-cost modern inputs which continue to contribute to the areas food insecurity and unsustainability.[8] In particular, Benin relies heavily on agriculture to deliver a significant portion of the country's GDP,[9] however pesticide application has contributed to a severe lack of biodiversity and farmer-debt in the country. These methods are therefore highly unsustainable and need to be reformed.

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[5] Eneh, O. 'Enhancing Africa's Environmental Management: Integrated Pest Management for Minimisation of Agricultural Pesticide Pollution, Research Journal for Environmental Sciences, No. 6, 2011, pp. 521-529.
[6] . Neff et al. 'Peak Oil, Food Systems, and Public Health', American Journal of Public Health, No. 9, 2011, pp. 1587-1597; Pfieffer, D. Eating Fossil Fuels: Oil, Food and the Coming Crisis in Agriculture, New Society Publishers, Canada, 2006.
[7] FAO, 'The State of Food Insecurity in the World, Food and Agricultural Organization of the United Nations, Rome, Italy, 2011.
[8] AfDB & OECD, African Economic Outlook Report: Benin, African Development Bank & Organization for Economic Cooperation and Development, Africa, 2008.
[9]The World Bank, Agriculture: Value added (% of GDP), Retrieved 15th May 2012 from <http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?page=1 >.

West African nations who remain significantly under-educated in the negative impacts of pesticide use continue to risk the vulnerability of their crops using Western pest management practices.[10] William Settle, the FAO Senior Technical Officer recognised that "trends in agriculture over the past decades in West Africa have seen an increasing use of highly toxic pesticides in higher-value, frequently irrigated crops. There is a general lack of knowledge in the region of the negative impacts of pesticides on the production, economy and health of communities and the environment".[11] Although Africa's pesticide use is minimal compared to developed nations such as Australia and the US, the global use of pesticide use by any measure, whether tonnes used or hectares sprayed, is still significantly rising.[12]

Therefore this paper will highlight the economic, ecological and health implications of widely-adopted Western agricultural systems within developing nations with a focus on pesticide use in West Africa and in particular, Benin. It will provide evidence as to the severe negative impacts of pesticide use and argue that a profound transition to more sustainable methods must be agreed upon following the Rio+20 UN Conference for Sustainable Development. Prior commitments will also be criticised and more stringent recommendations will be discussed. Furthermore, this paper will evaluate current Integrated Pest Management programs in West Africa as an effective and sustainable solution to heavy pesticide use.

Industrial Agriculture and Fossil Fuels: A Brief History

[10] Dhawan, A, Peshin, R & Vatta, K. 'Economic Evaluation of Pest Management Programs' in in Dhawan, A & Peshin, R, Integrated Pest management: Dissemination and Impact, 2nd edn, 2009, pp. 103-117; Tisdell, C & Wilson, C. 'Why farmers continue to use pesticides despite environmental, health and sustainability costs', Ecological Economic, No. 3, 2001, pp. 449-462.

[11] FAO, Fewer pesticides and higher yields and incomes: Integrated Production and Pest Management Programme in West Africa makes important progress, Food and Agricultural Organisation of the United Nations 2010, Retrieved 24th April 2012 from <http://www.fao.org/news/story/en/item/48883/icode/>.

[12] Dhawan, A, Peshin, R & Vatta, K. 'Economic Evaluation of Pest Management Programs' in in Dhawan, A & Peshin, R, Integrated Pest management: Dissemination and Impact, 2nd edn, 2009, pp. 103-117.

Before the 19th Century, local producers and small-scale farms diverse in crop production fed local communities.[13] However, farmers in Europe began to revolutionise agriculture later in the century through the employment of crop rotation and the application of manures/composts such as nitrogen rich guano.[14] As surplus was exported, the once capped populations who previously dwindled due to the limited seasonal access to food began to expand, creating an unprecedented influx in human civilisation. With a global population now double in size, 1909 saw the depletion of natural fertilisers and the introduction of ammonia-based fertilizers to cope with new demands. As farming prospered into the 20th Century with these innovations, WWII chemical engineers developed petro-chemicals to manage pests and increase crop production using petroleum and chemical agents previously used in warfare.[15] The implementation of large monoculture crops saw the expansion of these fossil fuel intensive systems that relied heavily on pesticides, synthetic fertilisers and large-scale irrigation systems to produce higher crop yields to exceed the growth of population.[16] Spreading the benefits of agricultural chemistry, industrial practices crossed the borders into developing nations, sparking what has now been dubbed the Green Revolution which led to a quantum leap in food production.[17] Fast forward to today and current levels of production require ten calories of fossil fuel energy to produce one calorie of food energy.[18] However, where industrialised food systems once thrived on the availability of cheap oil to produce, transport and package food, the looming effects of peak oil have caused an unprecedented rise in production costs and the future viability of farming in developing nations has been substantially reduced.[19]

[13] . Heinberg, R. 'What will we eat as the oil runs out?', The Lady Eve Balfour Lecture, Global Public Media, 2007.
[14] *Ibid*.; Neff et al. 'Peak Oil, Food Systems, and Public Health', American Journal of Public Health, No. 9, 2011, pp. 1587-1597.
[15] *Ibid*.; *Ibid*; Orr, A. Integrated Pest management for Resource Poor African Farmers: Is the Emperor Naked?, World Development, No. 5, 2003, pp. 831-845.
[16] Kendall, H & Pimentel, 'Constraints of the Expansion of the Global Food Supply', Ambio, No. 23, 1994, pp. 198-205; *Ibid.*
[17] Heinberg, R. 'What will we eat as the oil runs out?', The Lady Eve Balfour Lecture, Global Public Media, 2007; *Ibid.*
[18] Kendall, H & Pimentel, 'Constraints of the Expansion of the Global Food Supply', Ambio, No. 23, 1994, pp. 198-205
[19] Orr, A. Integrated Pest management for Resource Poor African Farmers: Is the Emperor Naked?, World Development, No. 5, 2003, pp. 831-845.

Although the mantra in drafts leading up to the Rio+20 UN Conference for Sustainable Development is to sustainably increase agricultural production, current industrial practices impose large challenges on the maintenance of sustained yield capacity.[20] Goldman maintains that major threats to agricultural sustainability, either through environmental impacts or resource depletion, exist within the excess use of modern inputs.[21] Many developing nations now heavily rely on petroleum derived inputs such as pesticides and other petro-based chemicals to produce food.[22] The 1990's saw a huge advance in crop production in Africa with the adoption of agricultural innovations such as fertilizer and approaches towards the intensification of crop protection with less shifting cultivation and more mono-cropping systems.[23] Pesticides manufactured in developed nations began to permeate through subsistence crops in Africa with nations such as Nigeria increasing imports 43 per cent on average.[24] However, the application of harsh pesticides and fertilisers over the past decades has degraded the soil and the crop's natural protection against the pests and others elements posing a large constraint on future crop prosperity. This highlights the severe negative impacts of these practices and why sustainable alternatives must be agreed upon and implemented.

Pesticide Dependency in West Africa

Chemical advancements in agriculture which spread to West Africa during the Green Revolution have significantly contributed to the areas reliance on environmentally and economically costly inputs in food production. With a lack of education of alternatives, farmers in West Africa who know

[20] Goldman, A. 'Threats to Sustainability in African Agriculture: Searching for Appropriate Paradigms', Human Ecology, No. 3, 1995, pp. 291-334.
[21] *Ibid.*
[22] Anonymous, 'Integrated pest management for African vegetable crops', Appropriate Technology, No. 3, 2003, pp. 30-31; Eneh, O. 'Enhancing Africa's Environmental Management: Integrated Pest Management for Minimisation of Agricultural Pesticide Pollution, Research Journal for Environmental Sciences, No. 6, 2011, pp. 521-529; Neff et al. 'Peak Oil, Food Systems, and Public Health', American Journal of Public Health, No. 9, 2011, pp. 1587-1597.
[23] Adamu, R & Banwo, O. 'Insect pest management in African agriculture: Challenges in the current millennium', Archives of Phytopathology and Plant Protection, No. 1, 2003, pp. 59-68.
[24] Eneh, O. 'Enhancing Africa's Environmental Management: Integrated Pest Management for Minimisation of Agricultural Pesticide Pollution, Research Journal for Environmental Sciences, No. 6, 2011, pp. 521-529.

little about the damaging effects of these costly inputs continue 'flogging a dead horse'. Furthermore, research has exposed the creation of a dependency syndrome which has the potential to jeopardise the affordability and productivity of food production in West Africa.[25] West Africa's long history of pesticide abuse, due to a combination of high sensitivity to pests and resistant crops, is evident within agriculture dependant nations such as Benin.[26] With relatively undeveloped agricultural systems and a lack of research or investment into alternative pest management strategies, West Africa therefore remains largely dependent on pesticides for pest control.[27]

Whilst some maintain that industrial agricultural production is the only viable way to feed the mass populations of the world, this may not be the case in African nations where these practices have proven to be severely damaging and costly.[28] Yet with the projected demand for food set to increase over the next 40 years particularly in African nations where food is already scarce, it is vital that famers in the developing world continue to increase production to address their own food security and future survival.[29] Ms. Nardos Bekele-Thomas, UN Resident Coordinator and UNDP Resident Representative in Benin, has stressed that "in order to sustainably reduce poverty, Benin needs to achieve minimum economic growth of seven per cent per year. This will happen only by increasing productivity and agricultural production."[30] The question therefore remains how this will be achieved without the continuation of devastating ecological impacts reared by the Green Revolution.

[25] 32. Williamson, S. The dependency syndrome: pesticide use by African smallholders: a report for PAN UK's pesticides poverty and livelihoods project, Pesticide Action Network UK, London, 2003, p. 126.
[26] Ball et al. 'Trends in pesticide use and drivers for safer pest management in four African countries', Crop Protection, No. 10, 2008, pp. 1327–1334.
[27] Adamu, R & Banwo, O. 'Insect pest management in African agriculture: Challenges in the current millennium', Archives of Phytopathology and Plant Protection, No. 1, 2003, pp. 59-68.
[28] Goldman, A. 'Threats to Sustainability in African Agriculture: Searching for Appropriate Paradigms', Human Ecology, No. 3, 1995, pp. 291-334.
[29] Nwanze, K et al. 'Impact of integrated pest management on food and horticultural crops in Africa', Entomologia Experimentalis et Applicata, No. 3, 2008, pp. 355-363; Pretty, J. 'Can Sustainable Agriculture Feed Africa? New Progress, Processes and Impacts, Environment, Development and Sustainability, No. 1, 1999, pp. 253–274; Van Huis, A. 'Challenges of Integrated Pest Management in Sub-Saharan Africa', in Dhawan, A & Peshin, R, Integrated Pest management: Dissemination and Impact, 2nd edn, 2009, pp. 395- 417.
[30] United Nations Development Programme, Training Beninese Youth in Agribusiness, Retrieved 15th May 2012 from

Agriculture in Benin

Africa's food production provides a profitable occupation for many smallholder farmers within local and export markets.[31] Agriculture in Benin, the West African nation approximately 110,000 square kilometres in area, provides for around half the income of its population with subsistence farming generating around 32.2 per cent of GDP.[32] The poverty stricken country which borders Togo, Niger and Nigeria produces principal food crops such as maize, cassava, sorghum, yams, millet and beans and well as important cash crops, making major contributions to cotton and groundnut production.[33] However with an economy largely dependent on agriculture, Benin shows a severe lack of biodiversity which barely feeds its growing population of 9.05 million.[34] Benin's main sector for economic growth is largely hampered by its dependency on high cost inputs and rainfall levels.[35] According to studies, pesticide use is increasing among smallholder African farmers despite its escalating costs.[36]

<http://www.undp.org/content/undp/en/home/ourwork/povertyreduction/successstories/le_benin_forme_lesjeunesalentreprenariatagricole/>.

[31] Anonymous, 'Integrated pest management for African vegetable crops', Appropriate Technology, No. 3, 2003, pp. 30-31.

[32] The World Bank, Agriculture: Value added (% of GDP), Retrieved 15th May 2012 from <http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?page=1 >

[33] Aregheore, E. Country Pasture/Forage Resource Profiles: The Republic of Benin, Food and Agriculture Organisation of the United Nations, Marfel Consulting, Canada, 2009.

[34] FAO 2012: FAO Initiative on Soaring Food Prices: Benin, viewed 10th May 2012, < http://www.fao.org/isfp/country-information/benin/en/>

[35] AfDB & OECD, African Economic Outlook Report: Benin, African Development Bank & Organization for Economic Cooperation and Development, Africa, 2008.

[36] Tisdell, C & Wilson, C. 'Why farmers continue to use pesticides despite environmental, health and sustainability costs', Ecological Economic, No. 3, 2001, pp. 449-462; Williamson, S. The dependency syndrome: pesticide use by African smallholders: a report for PAN UK's pesticides poverty and livelihoods project, Pesticide Action Network UK, London, 2003, p. 126.

Abate et al conclude that "increased population pressure and the resulting demand for increased crop production in Africa have necessitated agricultural expansion with the concomitant decline in the overall biodiversity".[37] Increased demand on food production due to escalating populations has triggered the expansion of high yielding crop varieties, monoculture crops and the intensification of synthetic fertilizers and pesticides, creating highly susceptible crops to pests and insects.[38]

Pests are a major contributor to crop loss in Africa with infestation among 20 to 40 million hectares of farmland in Central and Western regions alone.[39] Aside from current destabilising human activities such as the cultivation of large monoculture structures over crop diversity, pests and insects pose a serious challenge to food production and food security destroying between 20 to 30 per cent of all food produced in Africa each year.[40] Increased pest levels have caused farmers in Benin to upscale pesticide application as current sprays have proven ineffective. Studies report some Beninese farmers applying insecticides to vegetable crop every three to five days.[41] With incomes remaining relatively unchanged, higher production costs up 30 per cent in some areas have pushed farmers into debt, reducing food security.[42] This reveals significant evidence that these practices are highly unsustainable and costly, triggering the need for an effective alternative.

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[37] Aregheore, E. Country Pasture/Forage Resource Profiles: The Republic of Benin, Food and Agriculture Organisation of the United Nations, Marfel Consulting, Canada, 2009.

[38] Van Huis, A. 'Challenges of Integrated Pest Management in Sub-Saharan Africa', in Dhawan, A & Peshin, R, Integrated Pest management: Dissemination and Impact, 2nd edn, 2009, pp. 395- 417.

[39] Adesina, A et al, 'Production constraints on cocoa agroforestry systems in West and Central Africa: The need for integrated pest management and multi-institutional approaches', The Forestry Chronicle, No. 3, 2005, pp. 345-349; James, B et al. Integrated Pest Management: Towards 2015, International Institute of Tropical Agriculture: Benin Station, Pragati Offset Pvt ltd, India, 2005.

[40] Nwanze, K et al. 'Impact of integrated pest management on food and horticultural crops in Africa', Entomologia Experimentalis et Applicata, No. 3, 2008, pp. 355-363.

[41] Ball et al. 'Trends in pesticide use and drivers for safer pest management in four African countries', Crop Protection, No. 10, 2008, pp. 1327–1334.

[42] *Ibid.;* Williamson, S. The dependency syndrome: pesticide use by African smallholders: a report for PAN UK's pesticides poverty and livelihoods project, Pesticide Action Network UK, London, 2003, p. 126.

Significant Environmental Costs

Excessive use of pesticides has also contributed to the disruption of vulnerable ecologies as well as the health of farmers and their consumers.[43] Pesticides in Africa are not only unspecific, unsustainable and unnatural, but their application also risks the future yield capacity of small-holders farms and Africa's environmental management as a whole.[44] Crop intensification practices which resulted from the Green Revolution have severely reduced the environment's ability to continuing growing crops as the depletion of essential soil nutrients and fertility has greatly affected growing conditions.[45] As time has shown, these practices have disrupted the earth's ecological balance as the soil has become deficient due to the bio-accumulation of pesticides that have contaminated water supplies during the degradation progress.[46] This not only has adverse effects of the soil's capacity to naturally break down these chemicals, but run offs and leakage into groundwater supplies has seen the death of fish and birds in these areas where chlorinated hydrocarbons such as DDT have been applied to crops. Hidden costs occur in the death of such natural enemies as crops become more exposed to insects and other pests who continue to breed and become resistant to overused chemicals (19, 27). Therefore, this provides concrete evidence as to the adverse impacts on the environment and nature which reinforces the need for a more sustainable solution.

The Impacts on Public Health

[43] James, B et al. Integrated Pest Management: Towards 2015, International Institute of Tropical Agriculture: Benin Station, Pragati Offset Pvt ltd, India, 2005.

[44] Eneh, O. 'Enhancing Africa's Environmental Management: Integrated Pest Management for Minimisation of Agricultural Pesticide Pollution, Research Journal for Environmental Sciences, No. 6, 2011, pp. 521-529.

[45] Tisdell, C & Wilson, C. 'Why farmers continue to use pesticides despite environmental, health and sustainability costs', Ecological Economic, No. 3, 2001, pp. 449-462.

[46] Eneh, O. 'Enhancing Africa's Environmental Management: Integrated Pest Management for Minimisation of Agricultural Pesticide Pollution, Research Journal for Environmental Sciences, No. 6, 2011, pp. 521-529.

The severe health effects of excessive and under-educated pesticide use on farmers and their consumers is also a concern that is frequently ignored.[47] Farmers are often uneducated as to correct dosage, timing and targeting of hazardous pesticides in application; using inadequate and poorly maintained equipment.[48] Inappropriate use has led to hazardous consequences on operator and consumer health due to toxic exposure. The FAO has recognised the actual and potential harm of pesticide use and only recent developments have made these serious risks on human and environmental health clear to some governments who still fail to act.[49] Often pesticides used in West African farms are also unregistered due to the increased costs of registered pesticides and the liberalization of pesticide markets.[50] This has led to the misuse and exposure of toxic pesticides often banned in some developing nations with little knowledge of their effects on human health.[51]

Crops resistance to insecticides due to overuse has also proven severely hazardous to the health of farmers as malaria spread by the by Anopheles gambiae (mosquito) has increased severely. Studies have confirmed an increase in vegetable farming in urban areas of Benin which largely rely on the use of insecticides for pest management.[52] Furthermore, the improper use and control of such insecticides has resulted in the emergence of insecticide resistant Anopheles gambiae species which destroy and thrive within exposed areas. Eggs laid in agricultural fields in Benin are subjected to

[47] Dhawan, A, Peshin, R & Vatta, K. 'Economic Evaluation of Pest Management Programs' in in Dhawan, A & Peshin, R, Integrated Pest management: Dissemination and Impact, 2nd edn, 2009, pp. 103-117; Tisdell, C & Wilson, C. 'Why farmers continue to use pesticides despite environmental, health and sustainability costs', Ecological Economic, No. 3, 2001, pp. 449-462.

[48] Ball et al. 'Trends in pesticide use and drivers for safer pest management in four African countries', Crop Protection, No. 10, 2008, pp. 1327–1334.

[49] Food and Agricultural Organisation of the United Nations, 'FAO International Code of Conduct on the Distribution and Use of Pesticides', Rome, Italy, 2005.

[50] Adesina, A et al, 'Production constraints on cocoa agroforestry systems in West and Central Africa: The need for integrated pest management and multi-institutional approaches', The Forestry Chronicle, No. 3, 2005, pp. 345-349; Akogbeto M et al. 'Quantification of the efficiency of treatment of Anopheles gambiae breeding sites with petroleum products by local communities in areas of insecticide resistance in the Republic of Benin', Malaria journal, No. 1, 2007, p.56; Akogbeto, M, Djouaka, R & Noukpo, H. 'Use of agricultural insecticides in Benin', Bulletin de la Societe de Pathologie Exotique, No. 5, 2005, pp. 400-405; Asdisi, A et al. 'Development of vegetable farming: a cause of the emergence of insecticide resistance in populations of Anopheles gambiae in urban areas of Benin', Malaria Journal, No. 1, 2009, p. 103.

[51] Williamson, S. The dependency syndrome: pesticide use by African smallholders: a report for PAN UK's pesticides poverty and livelihoods project, Pesticide Action Network UK, London, 2003, p. 126.

[52] Asdisi, A et al. 'Development of vegetable farming: a cause of the emergence of insecticide resistance in populations of Anopheles gambiae in urban areas of Benin', Malaria Journal, No. 1, 2009, p. 103.

evolutionary pressures from an exposure to common insecticides which has resulted in the development of resistant breeds.[53] The same process has occurred as toxic insecticides are carried into mosquito breeding sites through crop runoffs. Historically successful programs for the malaria prevention such as indoor residual spraying and long-lasting insecticidal nets established by the World Health Organisation are now losing their effectiveness.[54] Therefore it is clear that pesticide use in Benin not only poses risks to environmental health but also the public health of West Africa. Akogbeto et al highlight the need to develop new strategies for crop protection which reduce the vulnerability of crops and communities to malaria carried by Anopheles gambiae.[55] This includes the the improvement of current methods and abandoning those to which have caused the resistant stream.

Integrated Pest Management (IPM)

Over the past few decades, a wide amount of research has been conducted largely by national African agricultural organisations and international research centres into the development of Integrated Pest Management programs.[56] The overall goal of IPM lies within the application of improved pest management systems that focus on maintaining and restoring the ecological balance within the soil and improving the health of farming communities.[57]

[53] Akogbeto, M, Djouaka, R & Noukpo, H. 'Use of agricultural insecticides in Benin', Bulletin de la Societe de Pathologie Exotique, No. 5, 2005, pp. 400-405; Asdisi, A et al. 'Development of vegetable farming: a cause of the emergence of insecticide resistance in populations of Anopheles gambiae in urban areas of Benin', Malaria Journal, No. 1, 2009, p. 103.
[54] *Ibid.*
[55] Akogbeto M et al. 'Quantification of the efficiency of treatment of Anopheles gambiae breeding sites with petroleum products by local communities in areas of insecticide resistance in the Republic of Benin', Malaria journal, No. 1, 2007, p.56.

[56] Abate et al. Pest Management Strategies in Traditional Agriculture: An African Perspective, Annual Review of Entomology, No. 45, 2000, pp. 631-659.
[57] Dhawan, A, Peshin, R & Vatta, K. 'Economic Evaluation of Pest Management Programs' in in Dhawan, A & Peshin, R, Integrated Pest management: Dissemination and Impact, 2nd edn, 2009, pp. 103-117.

It has grown out of the need for renewed strategies in pest management to reduce the use of synthetic pesticides which have caused avoidable loss.[58] Furthermore, its aims to optimise on the benefits of sustainable crop protection and production to achieve greater profits for the farmer and thereby, food security.[59]

Upon taking into consideration the public health hazards caused by the misuse of chemical pesticides, a reduction of health care costs often endured by the whole economy is a major benefit of IPM.[60] The flow-on effects of IPM implementation also have the potential to reduce the cost of food in West Africa where prices remain highly volatile. Reduced crop loss could contribute to greater food production and availability which significantly impacts food security in these poverty stricken areas. Furthermore, increased crop yields could potentially increase profits for small-scale farmers as surplus contributes to a growth in volume traded within the national and local markets.[61] This explicitly aims to address the Millennium Development Goal relating to poverty and hunger eradication which is a topic of serious concern in the lead up the Rio+20 UNCSD.

IPM not only reduces the costs of inputs for farmers and increases profits, but it also contributes to substantial gains in the restoration environmental health.[62] Rather than relentlessly fighting pests and insects, IPM focuses on "understanding how biophysical resources and pests and diseases

[58] James, B et al. Integrated Pest Management: Towards 2015, International Institute of Tropical Agriculture: Benin Station, Pragati Offset Pvt ltd, India, 2005.

[59] Nwanze, K et al. 'Impact of integrated pest management on food and horticultural crops in Africa', Entomologia Experimentalis et Applicata, No. 3, 2008, pp. 355-363.

[60] James, B et al. Integrated Pest Management: Towards 2015, International Institute of Tropical Agriculture: Benin Station, Pragati Offset Pvt ltd, India, 2005; Settle W & Hama, M. The West African Regional Integrated Production and Pest Management Programme, Food and Agricultural Organisation of the United Nations 2009.

[61] James, B et al. Integrated Pest Management: Towards 2015, International Institute of Tropical Agriculture: Benin Station, Pragati Offset Pvt ltd, India, 2005.

[62] *Ibid*.; Settle W & Hama, M. The West African Regional Integrated Production and Pest Management Programme, Food and Agricultural Organisation of the United Nations 2009.

interact within agro-ecosystems".[63] This approach is vital to developing sustainable agricultural systems that work in harmony with the environment.[64] Methods in the application of IPM include the education of farmers to natural pest enemies and how to recognise and integrate them into crops to reduce the need for synthetic and toxic chemicals.[65] Furthermore, this strategy has the potential to restore valuable ecosystems as natural enemies such as birds are utilised rather than unnecessarily killed due to toxic ingestion of chemicals. Other IPM practices include the optimisation of agronomic techniques, crop variation and bio-pesticides that reduce the need for harsh chemicals and costly re-application.[66] Therefore IPM can arguably seen as effective and more sustainable alternative to heavy pesticide use.

The Success of IPM

Previous trials of these IPM programs have proven highly successful, both in restoring the environments capacity to produce sustainable crops and improving the health of farmers through the reduction of chemical exposure.[67] The FAO report the employment of IPM programs has seen West African farmers successfully cutting their use of toxic pesticides in crop production.[68] This has

[63] Nwanze, K et al. 'Impact of integrated pest management on food and horticultural crops in Africa', Entomologia Experimentalis et Applicata, No. 3, 2008, pp. 355-363.

[64] Settle W & Hama, M. The West African Regional Integrated Production and Pest Management Programme, Food and Agricultural Organisation of the United Nations 2009.

[65] Eneh, O. 'Enhancing Africa's Environmental Management: Integrated Pest Management for Minimisation of Agricultural Pesticide Pollution, Research Journal for Environmental Sciences, No. 6, 2011, pp. 521-529; Van Huis, A. 'Challenges of Integrated Pest Management in Sub-Saharan Africa', in Dhawan, A & Peshin, R, Integrated Pest management: Dissemination and Impact, 2nd edn, 2009, pp. 395- 417

[66] Settle W & Hama, M. The West African Regional Integrated Production and Pest Management Programme, Food and Agricultural Organisation of the United Nations 2009.

[67] Goldman, A. 'Threats to Sustainability in African Agriculture: Searching for Appropriate Paradigms', Human Ecology, No. 3, 1995, pp. 291-334.

[68] FAO, Fewer pesticides and higher yields and incomes: Integrated Production and Pest Management Programme in West Africa makes important progress, Food and Agricultural Organisation of the United Nations 2010, Retrieved 24th April 2012 from <http://www.fao.org/news/story/en/item/48883/icode/>.

not only significantly increased yields and incomes but also the diversification of farming systems and restoration the soil fertility. IITA studies have shown up to 90 per cent decreases in yield loss with the implementation of IPM programs in Benin alone.[69] Specific cases of success include the adoption of natural enemy pest control methods through the utilisation of the Encyrtid wasp (Gyranusoidea tebygi) to assist with crop loss caused by the Mango mealybug (Rastrococcus invadens). This project alone has saved Benin agriculture US$53 million.[70] Other trails include the use bio-pesticides such as the locus eating fungus, Metarhizium anisopliae var acridum, which have significantly aided crop protection against lotus[71].

However, considering its success, it is unfortunate that the adoption rate amongst farmers across Africa is typically low.[72] It is therefore crucial of programs such as the UN Farmer Field Schools to further educate West African farmers as to the alternatives that are available and how IPM strategies could revolutionise their food production.

Farmer Field Schools

FAO's Farmer Field Schools (FFS) and other IPM education programs are an essential part of implementing sustainable agricultural practices. These programs feature learning-by-doing and hands-on field experience with smallholder farmers in the development and adoption of environmental sustainable agricultural practices.[73] Furthermore, the programs foster farmer participation, self-confidence building and collaborative decision making which has been shown to

[69] James, B et al. Integrated Pest Management: Towards 2015, International Institute of Tropical Agriculture: Benin Station, Pragati Offset Pvt ltd, India, 2005.

[70] *Ibid.*

[71] *Ibid.*

[72] Van Huis, A. 'Challenges of Integrated Pest Management in Sub-Saharan Africa', in Dhawan, A & Peshin, R, Integrated Pest management: Dissemination and Impact, 2nd edn, 2009, pp. 395- 417.

[73] FAO, Fewer pesticides and higher yields and incomes: Integrated Production and Pest Management Programme in West Africa makes important progress, Food and Agricultural Organisation of the United Nations 2010, Retrieved 24th April 2012 from <http://www.fao.org/news/story/en/item/48883/icode/>.

empower small-holder farmers and cultivate a sense of self-determination.[74] "Capacity building at community level is key to the sustainable intensification of food production, which will contribute to increased food security and improved livelihoods in the region, an important step towards achieving the first Millennium Development Goal, reducing hunger and poverty," stresses William Settle, the FAO Senior Technical Officer.[75] Whilst the FAO recognises the need to intensify crop production, reports stress the importance of farmers to start understanding what conditions, inputs and natural systems can either compliment or disadvantage their crop's ability to work in harmony with the local ecosystems.[76] Within FFS, farmers who would otherwise have limited access to any information crucial to maintaining the ecological balance of the environment are offered life changing education to improve their crop yields and reduce their exposure to damaging chemicals.[77] Understanding the risks of exposure to highly toxic and often banned chemicals also plays a dominant role in FFS and farmers are shown the benefits and availability of sustainable and practical alternatives.

The Challenges of IPM

The potential for IPM to assist environmental conservation and food security in Africa has been harshly disadvantaged by current pesticide regimes, inappropriate agricultural policies, inadequate deployment of high-yielding crop varieties and conflicting political and social values.[78] Issue Brief 9 for the Rio+20 UNCSD on Food Security and Sustainable Agriculture highlights that the progress

[74] Abate et al. Pest Management Strategies in Traditional Agriculture: An African Perspective, Annual Review of Entomology, No. 45, 2000, pp. 631-659.
[75] FAO, Fewer pesticides and higher yields and incomes: Integrated Production and Pest Management Programme in West Africa makes important progress, Food and Agricultural Organisation of the United Nations 2010, Retrieved 24th April 2012 from <http://www.fao.org/news/story/en/item/48883/icode/>.
[76] Aregheore, E. Country Pasture/Forage Resource Profiles: The Republic of Benin, Food and Agriculture Organisation of the United Nations, Marfel Consulting, Canada, 2009.

[77] Settle W & Hama, M. The West African Regional Integrated Production and Pest Management Programme, Food and Agricultural Organisation of the United Nations 2009.

[78] Nwanze, K et al. 'Impact of integrated pest management on food and horticultural crops in Africa', Entomologia Experimentalis et Applicata, No. 3, 2008, pp. 355-363; Orr, A. Integrated Pest management for Resource Poor African Farmers: Is the Emperor Naked?, World Development, No. 5, 2003, pp. 831-845.

made towards the adoption of IPM practices and programs has remained limited since agreements made in Agenda 21 at the 1992 United Nations Conference on Environment and Development[79]. In fact, some government extension programs continue to encourage the use of pesticides in African agricultural production.[80] Similarly, current market systems encourage the use of environmentally damaging practices that boost production in the short run at a low cost but prove unsustainable and costly in the long run.[81]

African farmers who are often persuaded by these markets have therefore been reluctant to embrace IPM strategies with a fear of exposing their crops to pests if they discontinue pesticide usage.[82]

However, with the global population on the rise and oil prices increasing the cost of petroleum-derived inputs, farmers may have no choice if they want to prosper the harsher conditions of the future. FAO reports have called for a second Green Revolution with would see the harmonisation of farmers and the environment to increase the yield capacity in African nations.[83] A lack of government support and research has disadvantaged the expansion of such programs with FFS only projected to have reached around 9000 farmers in 2010.[84] Current Farmer Field School's in West Africa therefore rely on partnerships with NGOs and farmer organisations due to a subsequent loss of government financing that previously supported the Western agricultural practices.[85] However,

[79] UNCSD Secretariat, Issue Brief 9: Food Security and Sustainable Agriculture, Rio+20 United Nations Conference on Sustainable Development, 2011.
[80] Abate et al. Pest Management Strategies in Traditional Agriculture: An African Perspective, Annual Review of Entomology, No. 45, 2000, pp. 631-659.
[81] Tisdell, C & Wilson, C. 'Why farmers continue to use pesticides despite environmental, health and sustainability costs', Ecological Economic, No. 3, 2001, pp. 449-462.

[82] Orr, A. Integrated Pest management for Resource Poor African Farmers: Is the Emperor Naked?, World Development, No. 5, 2003, pp. 831-845.

[83] Settle W & Hama, M. The West African Regional Integrated Production and Pest Management Programme, Food and Agricultural Organisation of the United Nations 2009.

[84] *Ibid.*
[85] *Ibid.*

even such programs are often underfinanced and too overstretched to deliver IPM messages effectively as it requires expensive research and development investments to fund farmer training.[86] It is then crucial that agreements made at the Rio+20 UNCSD create effective government commitments to the pursuit of IPM implementation to ensure the food security of West Africa and the continent as a whole.

Conclusion and Recommendations

As the notion of sustainable agricultural development is hot on the world's breath, Nwanze et al state quite perfectly that "sustainability involves the successful management of resources for agriculture to satisfy changing human needs, while maintaining the quality of the environment and conserving natural resources".[87] With this in mind, various reports have highlighted the significant need to address the numerous problems caused by Modern agriculture such as water and nutrient depletion, pesticide pollution and the degradation of natural ecosystems. These environmentally and economically costly methods have contributed to the degradation of crop-land jeopardizing their future yield capacity as well as the severe economic turmoil within developing nations such as West Africa due to increased dependency on modern inputs. Furthermore, where farmers in this region remain largely uneducated as to the devastating impacts of pesticide over-use and ingestion, this elevates these issues to a sense of urgency within the arena of public health.

At this year's UN Conference on Sustainable Development which will mark the 20th anniversary of the original Earth Summit, it is therefore critical that member nations create effective political commitments to the transition to more sustainable agricultural practices. This will certainly be the

[86] Orr, A. Integrated Pest management for Resource Poor African Farmers: Is the Emperor Naked?, World Development, No. 5, 2003, pp. 831-845.

[87] Nwanze, K et al. 'Impact of integrated pest management on food and horticultural crops in Africa', Entomologia Experimentalis et Applicata, No. 3, 2008, pp. 355-363.

case for nations in West Africa as increased agricultural productivity is recognised as the most viable way to sustainably reduce poverty.[88] Adamu & Banwo recognise that the major challenge will be in making of affordable, safe, effective and environmentally friendly materials for pest management available to farmers in Africa to reduce the current levels of pesticide use and its damaging effects.[89] Upon evaluation, this paper found that IPM is essential to the protection of natural ecosystems, the eradication of poverty and food insecurities within West Africa and the continent as a whole.[90]

It provides an affordable and sustainable option for farmers to increase food production with the escalating demands of an uncapped population without jeopardising the environment's capacity to grow food for the additional 2 million to arrive by 2050. Strategies call for the implementation of sustainable and environmentally sound methods that reside with the restoration of the earth's biodiversity which help with the reduction of crop losses and minimisation of environmental and health hazards.[91]

Although IPM has made its way into previous and upcoming texts for the Rio+20 UNCSD, the lack of commitment to these programs over the past 20 years undermines its existence within the outcomes of Rio. Therefore this paper calls for more stringent commitments to the implementation of IPM programs and the transition to more sustainable agricultural practices. This requires significant government funding for research and development as well as support in the widespread deliver of IPM messages which remain largely under-financed and overstretched. To achieve this,

[88] United Nations Development Programme, Training Beninese Youth in Agribusiness, Retrieved 15th May 2012 from <http://www.undp.org/content/undp/en/home/ourwork/povertyreduction/successstories/le_benin_forme_lesjeunesalentreprenariatagricole/>

[89] Adamu, R & Banwo, O. 'Insect pest management in African agriculture: Challenges in the current millennium', Archives of Phytopathology and Plant Protection, No. 1, 2003, pp. 59-68.

[90] James, B et al. Integrated Pest Management: Towards 2015, International Institute of Tropical Agriculture: Benin Station, Pragati Offset Pvt ltd, India, 2005.

[91] Nwanze, K et al. 'Impact of integrated pest management on food and horticultural crops in Africa', Entomologia Experimentalis et Applicata, No. 3, 2008, pp. 355-363.

more focus must be placed on the development of Farmer Field Schools and various education programs to increase the adoption rates among small-scale farmers who provide for 80 per cent of food for those in developing nations. Incentives for sustainable practices also hold a significant purpose here. Furthermore, member nations must recognise the inherent link between of food security and sustainability, whereby these agendas are intrinsically connected and require effective governance to ensure their pursuit.

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