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Review article

Environmental and Socio-economic implications of pesticide applications on green economy of Central African Subregion by 2035- A Review

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Abstract

A pesticide is any agent used to kill or control a pest (insects, rodents, birds, weeds, fungi). Pesticides have contributed to the standards of living enjoyed by humankind and will continue to play a major role in food security, environmental and human health, economic growth and to an extent, human peace. Central African subregion is made up of six developing countries (Cameroon, Chad, Central African Republic, Gabon, the Democratic Republic of Congo, Equatorial Guinea and The Republic of Congo) where pesticide use is still in its infancy. This article reviews published articles written about central African Sub region, major projects and prospects of pesticides playing a major role in its development as they implement the green economy principles of green economy from now to 2035. Pesticide application in the control of insect-borne disease such as black fly and mosquitoes will be very important but care must be taken to preserve the environment. The management of pests and diseases in second generation agriculture will be advantageous if applicators are trained to limit pesticide exposure to man and his environment. The governments are identified to be at the centre of this system by regulating, enforcing and communicating issues on the judicious use of pesticides in agriculture (food security and quality assurance) and public health. By so doing, these chemicals will assist in making Central African subregion to become a green economy by 2035.

Key words: economic growth, environmental growth, pesticide, environment, social growth, green economy

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Introduction

Broadly defined, a pesticide is any agent used to kill or control any pest. Technically, a pesticide is any substance or mixture of substances, intended for preventing, destroying or controlling, any pest, including vectors of human and animal disease, unwanted species of plants and animals causing harm during or otherwise interfering with the production, processing, storage, transport or marketing of food, agricultural commodities, wood and wood products or animal feeds, or which may be administered to animals for the control of insects, arachnids or other pests in or their bodies. The term includes substances intended for use as plant-growth regulator, defoliant, dessicant or agent for thinning fruit or preventing the premature fall of fruit, and substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport (FAO, 1986). Pests can be insects, rodents or birds, unwanted plants (weeds), fungi, bacteria or viruses. In Cameroon, pesticides are used mainly on vegetables (Fontem & Aighewi, 1993; Fontem & Bouda, 1998; Fontem 2003;Tarla *et al*., 2011a; 2013a), banana (Tetang & Foka, 2008), cocoa (Ambang *et al*., 2013), cotton (Tourneux, 1994) and storage of cereals (Sonchieu, 2012) in agriculture and to decontaminate animal houses in animal breeding. In public health, pesticides are very useful in the management of black flies (vector of river blindness) (Baleguel, 2012) and mosquitoes (vector of malaria) (Tarla *et al*., 2013b).

Obsolete pesticides are stocked pesticides that can no longer be used for their intended purpose or for any other intention and therefore require disposal. Pesticides become obsolete and unwanted when they can no longer be used for their intended purpose because they are banned, because of their prolonged impact on the environment and/or because they cannot be used due to age, deterioration or a change of specification of currently applied pesticides (Rwazo, 1997; NEPAD, 2003; Manda & Mohamed-Katerere, 2006; ASP, 2012). Stockpile accumulation has been attributed to excessive or inappropriate pesticides donations to developing countries, large procurement of pesticides products by governments, inappropriate policies, poor management of stocks, reluctance to change and delays in receiving pesticides (sometimes in years). Appropriate products are not available in developing countries and multinational companies cause over-purchasing through aggressive marketing (OECD-FAO-UNEP, 2000; Haylamicheal & Dalvie, 2009). Obsolete pesticide also include unidentified pesticide products, damaged and degraded products, unusable formulations of products , other contaminated materials and equipment, such as contaminated empty containers, or old application equipment, buried pesticides and containers and heavily contaminated soils (via visible inspection) (Tarla *et al*., 2014a).

The term ‘pesticide waste’ is a broader definition than ‘obsolete pesticides’, for it includes waste generated during the production of pesticides. Another term frequently used is unwanted pesticides, which is also a wider term than OPs. These pesticides may be unwanted by their owner (due to surplus stock requirements, the pest problem may have passed, logistical constraints on distribution, unsuitable formulation for equipment, etc) – but they may be in good condition, and may be potentially usable without compromising environmental or occupational safety. These products should not be regarded as OPs unless it has been sufficiently established that there are no solutions to the impediments hindering their use (such as more effective distribution, repackaging, procurement of different application equipment, or alternative use) (Rwazo, 1997; NEPAD, 2003; ASP, 2012).

It is important to note that obsolete pesticides will be chemically different from the original product. In some cases, the active ingredient (which is responsible for the toxicological effects on humans and animals) may have degraded to negligible levels, reducing the potential health impacts. However in other cases, the active

ingredient may have altered into a new, potentially more dangerous chemical, which would be unidentified and could cause unpredictable effects. In some pesticides and formulations, chemical agents other than the active ingredient may also pose health risks, and transform to unpredictable products. OP stockpiles must be considered toxic waste and treated with extreme caution. (Rwazo; 1997; NEPAD, 2003; Manda & Mohamed-Katerere, 2006; ASP, 2012)

Some obsolete pesticide pesticides are persistent organic pollutants (POPs). POPs are characterised by their bioaccumulation, persistence in the environment and long distance transport. They are soluble in lipids and insoluble in water. Removing and preventing further accumulations of obsolete pesticides contributes to the achievement of the objectives of the Stockholm Convention on POPs, the Basel Convention on the control of transboundary movements of hazardous wastes and their disposal, the Rotterdam Convention on Prior Informed Consent Procedures for certain hazardous chemicals, and supports the overall objectives of the Strategic Approach to International Chemicals Management (SAICM) (POPs-GEF-UNEP, 2012).

What is green economy?

A green economy can be defined as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UNEP, 2011). In a green economy, growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services. These investments need to be catalyzed and supported by targeted public expenditure, policy reforms and regulation changes. This development path should maintain, enhance and, where necessary, rebuild natural capital as a critical economic asset and source of public benefits, especially for poor people whose livelihoods and security depend strongly on nature.

The concept of the ‘green economy’ only emerged very recently in international political discourse, but was recognized as an option likely to effectively contribute to sustainable development goals. Central Africa has enormous agricultural potential, with agro-ecological conditions conducive to the production of a wide variety of crops. Vast tracts of agricultural land are still untapped. Out of a surface area of 6.7 million km^2, 1.6 million km^2 is arable land, and yet only 3.75 % is farmed. Despite this potential, the performance of countries in the region in terms of agricultural production remains low.

The role of Green economy in Central African Sub Region

The Central African Sub Region is made up of six countries (Cameroon, the Central African Republic, Chad, The Republic of the Congo, the Democratic Republic of the Congo, Gabon and Sao Tome and Principe). It has a rich diversity of ecosystems and abundant water and forest resources and is endowed with immense wealth for furthering its development. It has the second largest reserve of dense rainforests in the world and 70 % of the humid and dense forest cover in Africa. It harbours a unique biodiversity area, home to nearly half of all species known on earth and numerous emblematic species. The governments in the sub region quickly recognized the significant economic and socio-cultural issues and critical environmental functions of these resources.

The subregion has a very high unemployment rate (23 %), with even higher rates for countries such as Chad (30 %) and the Democratic Republic of the Congo (70 %). The creation of decent jobs is a major goal for the coming years as part of sustainable development. Youth unemployment is of serious concern. Given the already special nature of this group of persons and the fragile social and political systems in the countries,

Central Africa's young unemployed have become a literal time-bomb that could explode and set the region ablaze at any time, if nothing is done to defuse it.

In many cases, there is lack of progress towards achieving the goal of poverty reduction. Cameroon, Gabon and Sao Tome and Principe are the only countries where less than one third of the population earns under $1 a day. The situation is all the more worrying as the figures shown for other countries are higher than 50 % and even exceed 60 % in Equatorial Guinea. Moreover, these rates conceal considerable disparities within countries, with pockets of extreme poverty in slums and peri-urban and rural areas. With regard to the reduction of hunger, the results are not encouraging. Central Africa, in general, recorded the highest prevalence of malnutrition in the world (UNECA, 2012; Yossa, 2013).

Environmental implications

On a positive note, pesticides will be very useful in preventing insect nuisance that are peculiar to the tropics. Examples of such insects are black fly that transmits river blindness and mosquitoes that transmit malaria. The Wealth Health Organization is promoting the use of long lasting insecticides mosquito nets and indoor residual spraying to reduce mosquito bites and other insects. Black flies cause the highest nuisances around the fast flowing rivers along the Sanaga basin. Baleguel (2012) has documented the use of larvicides to reduce black fly bite without killing the beneficial insects in the same ecosystem. The parliament has just adopted a vast campaign to extend the results of his study in all the dams of the country as Cameroon wants to solve its acute energy shortage by constructing dams for hydroelectricity generation.

With the increase in the number of dams in the country to solve the acute energy shortages and may be solve the problems of neighbouring countries such as Chad, central African republic and Nigeria, it is clear that mosquitoes and black flies will increase. The current method used by the Electricity Development Corporation is by larviciding in the rivers upstream to the dams. The Parliament has just contacted the Yaounde Initiative Foundation, a partner with the Ministry of Public Health in charge of black fly management in order to solve this problem. If close to a billion (approximately USD 2 million) is pumped into the project in the next three years, it means tons of insecticides will be poured into Cameroonian waters before the runoff from agricultural activities. This will be an unnecessary evil and serious environmental problem if not checked.

In agriculture, 75 % of the Cameroonian active population is employed in agriculture. The country wants to move from peasant agriculture for subsistence to second generation agriculture in which large surface areas will be cultivated using tractors and more farm inputs such as fertilizers and pesticides. Some of the projects that are involved in boosting the agricultural production include AFOP for training, AMO for infrastructure and ACEFA for funding. In a single Region during the first phase of ACEFA, over 31 million FCFA (about USD 64 000) was given to farming associations. This means an increase in pesticide (Bambe, 2010).

Environmental exposure can happen due to wind dispersion, evaporation, spillage into water, surface runoff, flooding, or leaching through soil. Escapes can result in direct toxicity to non-target organisms, as well as severe habitat or ecosystem damage, including contamination of groundwater or other drinking sources, of soils and the food chain. These environmental exposures will often find their way back into humans (Rwazo, 1997; Manda & Mohamed-Katerere, 2006; ASP, 2012).

Birds and mammals are usually harmed from pesticide use. Due to the initial stages of environmental toxicology in Cameroon, no one has dedicated time to study this subject. My trip to a pesticide store in Wum

saw fowls than laid thin shell eggs and most of them never hatched or gave viable offsprings. This pesticide store had been there for over 35 years before state cooperation collapsed due to lack of government funds. This is a clear indication that birds in this area have been suffering from the effect of these pesticides. Most of these pesticides could not be identified (Carson, 1962; Colborn *et al.,* 1996).

Aquatic life is in danger from pesticide over use. A good case is cited of Lake Dang in Ngaoundere where aquatic animals have reduced in number while some species have disappeared. The water quality has also reduced. The use of pesticide was cited as one of the causes of the problem ().Pesticide concentrations found in various aquatic compartments, with few exceptions are higher than in other parts of the world, in particular in developed countries which have a longer history of high pesticide consumption and intense use. Generally, the coastal waters, sediments and biota are less contaminated than inland water environmental compartments, with the exception of a few hot spots (Calamari & Naeve, 1994). Poor access to clean water remains a cause of child mortality in African countries. In eastern Nigeria and northern Cameroon, every one per cent increase in the use of unprotected water sources for drinking purposes is directly associated with a 0.16 % increase in child mortality (Ward *et al.,* 2010). In a green economy scenario, all Millennium Development Goals related to water and sanitation could be reached by 2015, according to the UNEP Green Economy Report (UNEP, 2011).

Due to wrong handling methods, such as poor packaging, transport and storage, use by industrial plantations, spillage in the order of 15 % of total purchase quantity have been recorded. Since most plantations and farms lie along water courses which in turn drain into the Wouri estuary, the apart from pollution of underground aquifers, food and surface waters, pollution of the Gulf by pesticides and fertilizers is considerable leading to a decrease in fish population (about 15 %/ year) either due to migration, deaths or over harvesting (Sama, 1996).

As Cameroon increases the number of sea ports, imports and exports will increase by sea. Wood will be exported as well as foodstuffs. Wood from neighbouring countries like Congo and Central African Republic is treated at the sea shore before export. The report of Tcheukam *et al.* (2011) demonstrates that the overuse of pesticides to treat wood logs is a serious environmental hazard. If nothing has been done to solve the problem in Douala, increasing road infrastructure and railway for wood export will create serious problems to soil organisms and aquatic life around the sea shores.

Obsolete pesticides/unwanted pesticides/pesticide waste:

Obsolete pesticide stocks not only present a hazard to public health but can also contaminate natural resources and stand in the way of socio-economic development (NEPAD, 2003; Manda & Mohamed-Katerere, 2006; Pidlisnyuk & Stefanovska, 2012). The more we wait to address the problem with effective measures, the more expensive and difficult will be the solution later. A good example of a problem resulting from obsolete pesticides is the Nitrofen food scandal in which the German Farmers Association incurred direct and indirect damages that exceeded €500 million (approximately 327.5 billion FCFA). In this line, unless serious actions are quickly taken to tackle these very monumental problems with commitment in an internationally, concerted manner, any delayed efforts would be only too little, too late (Vijgen & Egenhofer, 2009). If nothing is done to counter this, many of the stocks will sooner or later end up in the soil, in the water table and be released into the atmosphere. Their release into the environment increases clean-up costs and multiplies the risks (Manda &

Mohamed-Katerere, 2006; Dimas, 2007), if they have not yet entered Cameroonian water by today. The problem is therefore of considerable urgency.

Case of stored products:

The main crops grown in the Northern parts of Cameroon are cotton, maize, millet, rice, cow pea and vegetables. The use of pesticides in agriculture has become more and more intensive. Small scale farmers, who are the main users, abusively spray those chemicals to protect crop and harvested products from pests (Madibe, 2010; Sonchieu *et al.,* 2013; Sonchieu, 2012). Pesticides are sold everywhere on the streets without any strict control while the farmers also apply the pesticides without any knowledge of the products (Tourneux, 1993). An examination of hospital records at Ngaoundere in Cameroon showed that there were 51 reported cases of pesticide poisoning in a 27-month period (January 2004 to April 2006) and of those, only two deaths were attributed to insecticides. One feature was that apart from a high proportion of unidentified poisons, rodenticide poisoning was reported more often than other pesticides. Many cases of poisoning might go unrecorded if an individual does not go to hospital (Sonchieu & Ngassoum, 2007).

Case of banana:

Njombe is one of those areas where pesticides have been used for close to half a century. Newspapers, non Governmental Organisations and films have demonstrated the evil that pesticides have done to the population (Tetang & Fonka, 2008; Njobe, 2009; Liale & Ndih, 2010; Amouh, 2011; Bieleu, 2011; Kamnge *et al*., 2012). Pesticides are spread regularly to control banana pests and diseases. The helicopter that sprays the products can spray when the population is passing through the plantation or the population can get the pesticides as their houses are less than 50 metres from the last banana row. Farmers still some of the products and manipulate them at their own risk. Farmers collect snails from the banana field for human food. Vegetable burning have been reported. Plastics that are used in protecting young banana bunches from insects are reused by the population to store food. This is the same for empty pesticide containers. Many reports talk of water pollution while illnesses registered have not been attributed solely to pesticides due to lack of equipments, lack of pesticide diagnostic specialists among other reasons. To avoid future disaster, the African Front for the Protection of Nature and Man against agricultural pollution (FADENAH) had been on the field to educate the population and the banana plantation managers. To this end, banana rows have been withdrawn from workers' dwellings, pesticide spraying does not take place when workers/population are around the field, reforestation is taking place in the area among other initiatives. The case in Fako Division is not different (Fon, 2011).

Case of vegetables:

West Region grows 57.32% of total vegetable production in Cameroon (Abang *et al*., 2013). Due to high humidity and low temperatures, numerous pests and disease destroy vegetable crops (Amouh, 2011; Tarla & Fontem, 2010). Overuse of pesticides is driven by the efficacy (Fontem, 2003; Fontem et al., 2003) and the high rate of return to investment (Tarla et al., 2011a). In the newspaper called The Equation of N° 095, Dzudie (2013) wrote about the situation in vegetable growing parts of the west Regions where no precautions are taken during pesticide application. This report collaborates with Amouh (2011) and Tarla *et al.* (2013) describing the scenario of pesticide application without respect of the nature and the health of the worker himself. Tomenson

and Matthews (2009) give an estimated average of 2% incidents/spraying hours. Manfo *et al* (2010) further suggest that male farmers of Djutitsa (West Cameroon) who are exposed to agropesticides with inappropriate handling and improper protective tool might have impaired reproductive function.

Social implications

Poverty is more than a disease. The United states is one of the highest user of pesticides followed by France. Among countries with economies in transition, brazil is one of the first user of pesticide and surprisingly, its economy has just been ranked ahead of the united kingdom. It shows the relationship between pesticide and poverty. Poverty is the first social problem in Africa. It is because of chronic poverty that there are more thieves, inaccessibility, poor infrastructures and brain drain.

Illnesses and death is causes a lot of social problems in Cameroon. An unhealthy person cannot contribute to the growth of the country. On the contrary, he suffers and causes other family members to suffer: physically, financially and otherwise. With the increase in pesticide application, more cases of pesticide illnesses will increase if particular measures are not taken. Manfo et al (2010) demonstrated that misuse and/or overuse of pesticides in Djutittsa has led to sterility and many other diseases. Pesticide poisoning is a commonly under-diagnosed illness because they may go unrecognized due to the failure to take a proper exposure history in developed countries like the US and worst in developing countries like Cameroon. The highest tragedy so far register include the death of 5 persons in North Region from contaminated stored grains, 2 deaths in Batcham and 3 deaths in Douala.

Economic implications

According to CropLife Asia (2012), counterfeit and illegal products can impact farmers and consumer health, environment, farmer's income and reputation, economic damage, crop losses and industry damage. To the farmer and consumer, counterfeit pesticides are rarely tested and may contain impurities which can be carried into harvested food, thus pose a health threat to the farmer and consumer. In the environment, toxic impurities may compromise water purity, impact wildlife and leave residues in soil that can be detrimental to future crops. For reputation, illegal products can severely damage crops, decrease yields and/or destroy land and the resulting produce may be of low quality food while the soil may be contaminated. Counterfeit act as economy deterrents. Innovation is stifled and revenue through taxes and levies from the sale of genuine products lost. This will lead to economic retardation and unemployment. Counterfeit products can cause loss of sales, patent and trademark infringement, erosion of data protection, reputation damage and industry stewardship activities undermined. Cameroon losses 7 billion FCFA yearly from illegal sales of pesticides (Fosso, 2010).

About 60% of the active population in Cameroon depends on agriculture. The country is gradually moving from peasant agriculture to second generation agriculture in which the youths are encouraged to cultivate large surface areas. Programmes like AFOP are involved in the training of the farmers while other programmes like ACEFA are funding the farmers. In ACEFA Phase I, over 31 million FCFA (USD 62 000) was shared to a single town for agricultural investments (Bambe, 2010). Agricultural mechanisation and irrigation are important components of the initiative but other farm inputs such as seeds and pesticides cannot be left out. As certified seeds are gradually getting into the practice .

Case of cocoa:

Cocoa remains the most important agricultural product, representing about 25% of the total value of non-oil revenues (although crude oil and petroleum products are the main export sector). The crop is grown in 8 out of 10 regions in an area estimated to average 450,000 hectares. The cocoa sector has around 600,000 cocoa producers, and involves "a total population of 5 million people living directly or indirectly on the cocoa economy". A national objective for Cameroon is to increase production of quality cocoa to 300,000 tonnes by the year 2015. As with all participating countries, cocoa in Cameroon suffers heavy attacks of black pod and insects (especially mirids) and the "uncontrolled use of fungicides and insecticides is a matter of great concern to the government".

A national priority is therefore to ensure that the country complies with the European Union Regulation 149/2008/EEC on MRLs for pesticides in cocoa beans, in order to minimise the risk of rejection of cocoa that does not meet these limits. Furthermore, Good Agricultural Practices (GAP) and Good Warehousing Practices (GWP) are seen as important for marketing of quality cocoa, under the label "Cocoa Made in Cameroon". Among the major constraints in the cocoa sector in Cameroon to achieve this objective, one can mention illiteracy that prevents the farmers to read the labels attached to pesticide packages and the poor understanding by small retailers of critical information about active ingredients. This, in the past, has caused serious problems including, in some instances, human poisoning (Sonwa *et al*., 2008; ICCO, 2014).

There are many barriers to preventing and eliminating obsolete pesticides (Manda & Mohamed-Katerere, 2006). The most important hindrance is the lack of awareness of the problem leading to low priority politically. This hindrance is followed by sheer magnitude of the problem. Developing countries do not have money to clean up stockpiles, yet many of the stocks do not have clear owners to take responsibility. The third barrier is the difficulty of breaking old habits such as dependence on donors, reliance on chemical pesticides and reluctance to refuse donations. Lastly, communication, coordination and collaboration between aid agencies and developing countries is insufficient (Rwazo, 1997; OECD-FAO-UNEP, 2000).

Research

Ngamo (2004; 2010) recommended the use of integrated pest management as a solution to the environmental damage caused by the hazardous use of pesticides. Resistant varieties are the cheapest, safest and most effective means of plant disease management (Tarla et al., 2011b) but yields of most resistant varieties are always low (Tarla & Fontem, 2010). If plant disease is aimed at feeding the ever growing population and alleviating poverty by increasing farm income, then the cultivation of resistant varieties may not meet these criteria.

As cultural practice, Tarla *et al.* (2014b) conducted a trial on the efficacy of planting dates in the management of taro late blight that has been a serious problem to the crop since 2010. Good results were obtained but many farmers may not have access to water during the dry season and if they do, the few available streams that flow all year round may be heavily polluted with chemical contaminants (such as heavy metals) and assorted microorganisms. Vegetables can absorb heavy metals from heavily contaminated irrigation water (Stasinos & Zabetakis, 2013).

Earlier trials on the use of plant extracts in plant disease management were successful in the laboratory (Tarla & Fontem, 2009) but due to lack of funds, efforts in this direction have not been successful. However, Ambang *et al.* (2013) made allusion to the use of plant extract and marijuana by farmers. The question is to

know the efficacy, the secondary effects and acceptance by the authorities when products have not gone through the normal registration process.

Other trials on the use of compost in the management of plant diseases were also excellent in the screen house (Azia, 2011; Nibod, 2012) but field trials have not been reported. From the ongoing analyses, it can be accepted that pesticides remain the recommended and best method of pest management for large scale cultivation but the judicious use is needed (Aktar *et al*., 2009).

Conclusions and recommendations:

If the credits of pesticides include enhanced economic potential in terms of increased production of food and fibre, and amelioration of vector-borne diseases, then their debits have resulted in serious health implications to man and his environment. There is now overwhelming evidence that some of these chemicals do pose potential risk to humans and other life forms and unwanted side effects to the environment. No segment of the population is completely protected against exposure to pesticides and the potentially serious health effects, though a disproportionate burden is shouldered by the people of developing countries and by high risk groups in each country

Awareness of the public (Amouh, 2011; Matthews *et al*., 2003, Tarla et al., 2013a). Information, education and communication in chemical-related issues are needed. More training of medicine specialists; building and equipping a poison centre and training personnel in poison management will be useful in Cameroon. A poison centre will serve for research in quality control of pesticide products and harvested produce for local consumption and export. Environmental monitoring will also be assigned to such a structure.

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