PhD Proposal Plan (refined)

- The PhD plan is jointly prepared by the student and the supervisor at UG.
- The PhD plan will be used for setting up a matchmaking process aiming at identifying a relevant co-supervisor at a Danish University
- The PhD plan up max. 5 pages is to be sent to Susanne Amsinck, sla@dmu.dk no later than March 5, 2012.

1. Name of the PhD student

ENOCK DANKYI

2. Project working title

SOURCES, ENVIRONMENTAL LEVELS AND FATE OF SOME PESTICIDES IN COCOA-GROWING SOILS IN GHANA

3. Abstract

The use of pesticides in agriculture has been recognized as a significant tool in the control of insect pests and weeds and has contributed immensely to the achievement of high crop yields. However the overuse and abuse of pesticides has led to global pollution with its related human health concerns. Pesticides may persist in the environment for a significant time after their application. Concerns about the serious environmental impact of these chemicals have prompted research into their ambient levels and their fate in different media such as water, soil and air.

Soil represents an important sink for pesticides due to their relative stability in this medium. The fate of pesticides in soil may depend on how strongly they are sequestered to soil components and how readily they are degraded. The behaviour of pesticides in soils is controlled by a variety of complex physical, chemical and biological processes including sorption-desorption; degradation; volatilization; uptake by plants; run-off and leaching. The relative importance of these processes varies with the chemical properties of the pesticide and the nature of the soil.

The understanding of the dynamics of various pesticides in different types of soils is needed as it is essential in decision-making regarding the type and application of pesticides and will also help in the maintenance of the quality of crop produced from the aspects of food safety and human health.

4. Project background (including state-of-the-art)

Cocoa has served as the main backbone of the Ghanaian economy for over eight decades and continues to occupy a key role in Ghana in terms of foreign revenue and employment. Ghana is the second largest exporter of cocoa with a reputation of high quality cocoa beans. The nation currently produces over 800,000 metric tons of beans per annum with a target of over 1 million metric tons per annum. However the yield of Ghana's cocoa per hectare is low as compared to other countries such as Indonesia, Brazil and Malaysia. Ghana seeks to substantially increase its cocoa yields through a number of measures including the use of high-yielding and disease resistance varieties of plants and increased application of fertilizers and pesticides on cocoa farms.

Since the year 2000, there has been a rapid increase in the application of pesticides in Ghanaian agriculture. According to the Ghana Statistical Service, between 2002 and 2006 for instance, pesticide importation into the country increased from 7,763 metric tons to 27,886 metric tons with over 141 different types of pesticide products registered [1].

However research has indicated that, there is an overuse, misuse and abuse of pesticides in farming mainly due to illiteracy and ignorance of the health effects of these chemicals [2]. Yeboah *et al.,* (2004) has reported that about 82% of tomato farmers are illiterates and do not adhere to safe agronomic practices [3]. A number of unapproved pesticides are used on farms in Ghana most of which have been banned from use due to their environmental persistence. Pesticides such as Lindane, DDT, Aldrin, Dieldrin, Heptachlor, HCB and endosulfan found to be environmentally persistent. However due to a combination of factors including weak enforcement of bans on pesticide importation and application as well as ignorance of harmful effects, these chemicals are available to the farmer and often used on cocoa farms.

The abuse of pesticides in agriculture in Ghana has led to significant levels of pesticides being reported in food and different environmental media [4, 5, 6]. The pesticides most often used in Ghana include the organochlorines and organophosphates. Once these chemicals are released into the environment, they may remain for long periods being held in the soil, water or air.

Soil represents a significant pathway of exposure of pesticides. The fate of pesticides in soils as well as their mobility and transfer to other environmental compartments depends on mechanisms and sorption and desorption from soil particles. The soil type and properties thus play a significant role in determining the fate of pesticides in soils and subsequent availability to plants and ultimately to man. Degradation of pesticides is also fundamental in the understanding of pesticide fate and residue levels in soils [7].

The physical and chemical mechanisms controlling the fate of the organic pollutants are often poorly understood. Their presence in the soil/ availability to the plant may depend on a number of factors including the organic matter content, pH and the physical and chemical characteristics of the soil. Soils on which the plants are grown may play an important role in determining the levels of pesticides that may be taken up by the plant. Soils are heterogeneous mixtures composed of a large variety of organic, organo-mineral, and mineral components as well as soluble substances. This composition brings about a high variability in chemical solubility, binding and leaching

properties influencing the concentration of pesticide availability to plants.

In Ghana, cocoa grows on several soils types including acrisols, arenosols, fluvisols, ferralsols, luvisols, leptosols, luvisols and gleysols. However the most predominant soil type on which cocoa is grown in the country is ferric acrisols. These are clay-rich acidic soils often found in most humid and tropical climates. Acrisols are highly weathered soils which are often nutrient and mineral deficient but may contain toxic amounts of aluminum. An understanding of the role played by soil types and properties in influencing the fate of pesticide sorption and degradation in the soil and hence their availability to plants will not only aid in the understanding of current levels in soils but also in the prediction of future trends and levels. This understanding and the ability to predict levels are vital for evidence-based decision making by the cocoa industry.

5. Hypothesis/aim of project

This work is aimed at the following:

i. An examination of the sources, types and application of pesticides on selected cocoa farms

ii. Assessment of the levels of pesticides in soils and other related media (water and plants) in selected cocoa growing areas.

iii. Studies on the fate (sorption & degradation) of pesticides in different soils under various conditions and their mobility to other environmental media

6. Project description

This work will involve the assessment of the presence and levels of pesticides and their degradation products in soil, water and beans on cocoa farms. Farmer knowledge on sources, types, efficacy and safety of pesticides will also be examined. The fate of the major pesticides encountered will be studied in the various cocoa-growing soils to help establish their prevalence and mobility and to help predict future levels.

7. Methodologies

Levels of pesticides in soil, water and beans and air will be analysed by gas chromatography after extraction and clean-up processes. Studies on sorption-desorption of pesticides on soil types will be done by assessing the effects of soil factors such as pH, organic matter content, clay mineralisation and other soil factors. The physical and chemical properties of soils such as such pH, Cation Exchange Capacity, Organic Matter. Total Organic Carbon, particle size distribution will be obtained using standard laboratory procedures.

Studies on degradation of pesticides will be done by use of compound-specific isotope analysis.

8. Work plan

1. year Sampling and analysis of pesticides in soils, water cocoa beans and air from all sampling locations across the country

2. year Study of the fate (sorption and degradation) of pesticides in soils

3. year Write-up and completion of program

9. References

1. Ghana EPA (2008). Registered pesticides handbook, Ghana Environmental Protection Agency, Accra
2. Ntow W J, Gijzen H J, Kelderman P, Drechsel P. (2006). Farmer perceptions and pesticide use practices in vegetable production in Ghana. *Pest Management Science* **62**: 356-365
3. Yeboah F A, Mensah F O, Afreh A K (2004). The probable toxic effects of aerosol pesticides on hepatic function among farmers at Akomadan/Afrancho Traditional area of Ghana. *Journal of Ghana Sceince Association* **6**: 39-43
4. Bempah C K, Donkor A, Yeboah P O, Dubey B, Osei-Fosu P (2011). A preliminary assessment of consumer‘s exposure to organochlorine pesticides in fruits and vegetables and the potential health risk in Accra Metropolis, Ghana. *Food Chemistry* **128**: 1058-1065
5. Ntow W J (2001). Organochlorine pesticides in water, sediment, crops and human fluids in a farming community in Ghana. *Environmental Contamination and Toxicology*, **40**: 557-563
6. Acquah S O (1997). Lindane and endosulfan residues in water and fish in the Ashanti region of Ghana. Proceedings of Symposium on Environmental behaviour of crop pretection chemicals by the IAEA/FAO, IAEA, Vienna
7. Guo L, Jury W A, Wagenet R J, Flury M (2000). Dependence of pesticide degradation on sorption: non-equilibrium model and application to soil reactors. *Journal of Contaminant Hydrology* **43**: 45-62

10. Proposed PhD courses

Course title	Institution	Suggested ECTS-points

11. Time schedule (courses, stays in Denmark/abroad/at other national institutions, publishing of results).

12. Scientific competences that the student will get from the project

1. Sharpen skills in writing of articles for publications in journals
2. Broaden knowledge in analytical thinking and research
3. Exposure to state of the art analytical techniques and instrumentation

13. Date and signatures

	Date	Name	Signature
Principal supervisor			
Project supervisor			