Harnessing soil and water resources for increased rice productivity in Africa

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My research focus is in two major areas. The first focal area is harnessing soil and water resources for ensuring increase in food (rice) productivity in order to attain self-sufficiency. The choice of rice is due to its strategic importance to Nigeria and the huge amount of money being used for its importation when adequate land and water resources are available for its production at self-sufficiency levels. Rice is ranked third globally after wheat and maize in terms of production and it is the sixth major crop in cultivated land area after sorghum, millet, cowpea, cassava and yam in Nigeria. Although, Nigeria is West Africa's largest producer of rice, producing an average of 3.2 million tons of paddy rice for the past 5 years, it is also the World's second largest rice importer, spending over US$300 million on rice imports annually which rose to US$1 billion in 2010.

Recent statistics released by Nigeria's Federal Bureau of Statistics (FBS) and confirmed by the Governor of Nigeria's Apex bank, Central Bank of Nigeria (CBN) indicated that the country actually spent the sum of US$1 billion daily on rice importation alone and despite that, self-sufficiency has not been attained. Some of the factors responsible for decline in yield apart from soil and water are climate change-related issues. Photosynthesis had slowed down as thermometer rises, rice yields are declining by 10% for every degree Celsius increase in night-time temperature while increased carbon dioxide (CO_2) had reduce crops' protein content by 20%.

Greenhouse gas (GHG) mainly produced from agricultural fields have contributed to global warming and yield reduction by methane (CH_4) emission has been reported to be the strongest on rice fields. Upland rice was specifically chosen due to farmers' preference for paddy (lowland rice) as a result of water demand which infers that its production during dry season is in all time low. Several studies have shown the type of land best suited for upland rice production (which

was verified and confirmed during my study) but the issue of crop water use was avoided as it was erroneously believed that rice water demand is high.

My study estimated and validated the range of consumptive water use levels of upland rice under specific scenarios. This is in conjunction with the Africa Rice Centre formerly West Africa Rice Development Association (WARDA) and concluded that an optimum yield or about 15% or more increase in production could be achieved during dry season farming provided the issue of weaver birds invasion of rice fields are addressed. Also, more crops could be grown per drop as a result of painstaking estimation of crop water use at different growth stages and with improved varieties that has higher yields, tolerant to diseases and water stress as well as shorter maturity period.

This infers that the number of planting cycles of upland rice can be increased from two (local varieties) to four (improved varieties) per year thereby resulting in higher yield and lessen the cost of its importation into Nigeria. However, issues surrounding birds' invasion of rice fields, adaptation strategies of global warming resulting in temperature rise which is also responsible for increasing rate of seed abortion during germination remain unresolved. Also, the damaging effect of greenhouse (GHG) emission especially from rice fields and optimization of crop water use to reduce losses are under serious consideration in our on-going research. With the approval of research grant recently won under COMSTECH-TWAS scheme, a study on the "Spatial variability of methane emissions and yield from rice fields under different water management strategies in Nigeria" will be carried out to ascertain the contribution of GHGs from Agriculture and specifically from rice fields.

The underlying factor here is to optimize all factors of production to increase rice production for food security and self-sufficiency moreso now that Africa popluation which as at 2011, was put at 1.03 billion, is expected to be doubled by 2050 at a growth rate of 24 million per annum with Nigeria responsbile for one-third of the growth. If this is not done, the chances of reducing poverty and hunger by 2015 remained very slim.

The second part of my study is using biological techniques in the treatment of liquid wastes for the purpose of recycling, re-use and discharge of effluents which have been treated and harmless into water bodies. Waste, which is the bye-product of most human activities daily are generated everywhere; cities and towns are commonly referred to as municipal solid waste (MSW). Dealing with wastes demand great attention because it becomes harmful to man and animals when it becomes an environmental pollutant. Significant proportions of waste generated globally are from densely-populated regions such as in Africa with poor sanitation, hygiene and absence of efficient technology for recycling and reuse.

Several methods have been known to be used for treating liquid wastes from stabilization ponds, trickling filter, activated sludge (aerobic) to anaerobic digesters. These methods essentially reduce the high value of Biochemical Oxygen Demand (BOD), which is an indication of excess amount of organic carbon but not designed to remove biodegradable organic pollutants and mineral nutrients such as nitrogen and phosphorus salts and other toxic chemicals. Disinfection (chlorination) which is the final step in treatment process designed to kill bacteria and viruses not eliminated during previous stages leave salt residue behind such as chlorinated hydrocarbons that are toxic and difficult to mineralize. This makes the effluent very harmful and injurious to human and aquatic lives in discharging water bodies.

Ozonation which is an alternative to chlorination uses ozone as oxidant is extremely expensive to use thereby leaving Phytoremediation as the only healthy and viable alternative disinfection process in liquid waste treatment. Phytoremediation is a bioremediation process that uses various types of plants to remove, transfer, stabilize and/or destroy contaminants in leachate and soil. Summarily, Phytoremediation uses plants to clean –up the environment. This process of treating wastes gave rise to the use of plants (bioremediator) some of whom have less economic value for the treatment.

From my study, Phytoremediation techniques have used plants such as water hyacinth (*Eichhornia crassipes*), water lettuce (*Pistia stratiotes)* and *Cyperus Haspan* on leachate with highly encouraging results. Work is on going on Kenaf as a phytoremediator and other indigenous plants with lesser economic importance. The interest is to ‘clean-up’ wastes with

most suitable environmentally-friendly method and results so far achieved in the studies conducted in Malaysia indicated that given similar circumstance, it can work well, if not better in Nigeria due to similarities in settlement, disposal method, eating habits and lifestyle, behavioural pattern and climatic inclination. However, areas of further research interests include the response of the phytoremediator under continuous loading, varying waste concentration points and the seasonal variation (dry and wet) during the treatment.

Essentially, these two are my research focus which in my own opinion could have serious impact in Africa's socio-economic development. Producing more rice with less water helps Africa to save huge foreign exchange earnings that is being lost as a result of rice importation from Thailand, China, India and other Asian countries and conserve water that is being increasingly becoming scarce and provide more jobs for Africans in Africa for self-sufficiency in food production and sustainable livelihoods.

Also, biological treatment of Africa's liquid waste reduces surface and groundwater pollution, injuries to aquatic lives in the receiving water bodies and eliminates the cost of importation of chemicals which are harmful. Water re-use and recycling is also possible while it will serve as a control for plants with less economic importance such as water hyacinth which has taken over our waterways in Africa.

Profile:

Dr. Christopher Oluwakunmi Akinbile is senior lecturer in the department of Agricultural Engineering, Federal University of Technology, Akure, Nigeria (FUTA) and also the Associate Director, Entrepreneurship Programme, Centre for Entrepreneurship and Gender Issues in Science and Technology (CEGIST), FUTA. The Centre is saddled with the responsibility of ensuring skill acquisition and entrepreneurial advancement of staff, students and interested youth in the University community for development of small and medium scale enterprises. This is with a view to reducing unemployment, promoting the emergence of small enterprises and encouraging entrepreneurship development. He obtained his bachelor's degree in Agricultural

Engineering from FUTA, while his Master's and doctoral degrees were obtained from Agricultural and Environmental Engineering, University of Ibadan, all in Nigeria.

He is a member of many professional associations such as the Nigerian Society of Engineers (NSE), registered member of Council for Regulation of Engineering in Nigeria (COREN), Nigerian Institution of Agricultural Engineers (NIAE), American Society of Agricultural and Biological Engineers (ASABE) and Fellow of African Technology Policy Strategy Network (ATPS) based in Nairobi, Kenya. He has published over forty articles in international peer-reviewed journals and attended over 27 international conferences. He has won several awards and fellowships at various times. He won the award of outstanding presentation at the first African Regional Conference on Drainage (ARCOD) in Egypt in 2004, Our Common Future (OCF) fellow 2010 by Volkswagen Foundation, Germany for partaking in the global discourse in the 'facing climate change' and Third World Academy of Science (TWAS) post doctoral fellowship at *Universiti Sains Malaysia* (USM) Penang, Malaysia from August, 2010 through September, 2011.

Dr. Akinbile also won the BiovisonNxt fellowship award for being among the 100 best young researchers globally which took place in Lyon, France in March, 2011 and was organized by the World Life Science Forum. He teaches several Agricultural Engineering courses such as Soil and Water Conservation Engineering, Rural Water Supply and Sanitation, Engineer in Society, Basic Hydrology, Irrigation and Drainage and Fluid Mechanics all at Undergraduate levels. At postgraduate levels, courses such as Advanced Hydraulics, Ground water supply, Advanced drainage and operational research. He has supervised several undergraduate and postgraduate project students and also member of supervisory team of some doctoral students at the department of Biological and Agricultural Engineering, Universiti Putra Malaysia (UPM) in Malaysia. Dr. Akinbile is married with children.