FARMING SYSTEMS FOR INCREASED AND SUSTAINABLE FOOD PRODUCTION FOR OUR INCREASING POPULATION

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Summary

Estimates indicate that by the year 2025, global population will double to between 8.5 to 9.0 billion out of which 7.5 to 8 billion will inhabit developing countries. By that time, Ghana's current population of 15 million+ will possibly reach 30 million+. Concomitant with an increase in human population has been an increase in pressure on the quest for farmland and the collapse of the traditional bush fallow system of rejuvenating soil fertility; and an aggravation of the threat of increased desertification. Unfortunately, the existence of cropping systems and livestock systems that run literally parallel and unintegrated, have contributed to our poor agricultural performance. This paper discusses the paradox of the reality of the effects of increasing population and our seeming inability to increase our food production; and offers some suggestions towards solving these problems.

Introduction

It is estimated that the population of the world will double by the year 2025 to a total of 8.5-9 billion, of which 7.5-8 billion will be in the Developing Countries. Ghana's current population of some 15 million will have reached over 30 million by that time.

Our increasing population has been increasing the pressure on farming land to such an extent that the traditional bush fallow system of maintaining soil fertility and sustaining yields has almost completely collapsed resulting in continuous cropping in some areas or drastically reduced fallow periods. The outcome has been deforestation, loss of soil fertility, soil degradation and reduced yields, creating a situation where the per capita food consumption for most crops has surpassed per capita production. The rate of desertification creeping in from the Sahel and Sudan Savanna zones is even more serious because it is the product of both human and animal population pressure on the land through uncontrolled grazing, tree felling and bush fires in addition to reduced fallow periods or continuous cropping.

Strictly speaking there are no farming systems in West Africa and Ghana for that matter. We have cropping systems and livestock systems. It is only when the two systems are integrated and become interdependent that farming systems are created. So in West Africa crops are crops and animals are animals. The two rarely meet, for whenever they meet there is conflict. Our inability to integrate the two systems for mutual benefit has been responsible for our poor agricultural performance - low yields, high dependence on imported fertilizers, agro-chemicals, tractors etc. A well integrated crop-livestock system should be able to supply most of the needed soil fertility, power for farm operations, and carting of farm produce.

If our population is going to double by the 2025, we shall have to increase our current yields four fold. First of all, to wipe out our current production shortfalls then feeding twice as many mouths and storing at least a year's surplus. Fortunately, we do not have to undertake any fundamental or basic studies (which several people in Ghana are strongly against, in my view, quite erroneously) to bring this about. Thanks to Nye and Greenland (1960) and many others, the mechanisms of nutrient recycling and soil fertility maintenance under the bush fallow system are now well understood. We are also aware of the several modifications and adaptations of the systems being successfully applied in other tropical countries like ours, in the form of agro-forestry systems including alley farming which has been started here in Ghana. What we need is the will and the support to evolve suitable systems that will sustain production under our conditions. Unfortunately, the same cannot

be said for our natural grassland (rangeland), which provide the main feed for our livestock whose management at best, is still semi-nomadic.

Sustainable Production Systems

There are several definitions of sustainable systems. My favourite, simply stated, is that sustainability equals production plus conservation. In other words, sustainable farming systems which should involve the management of agricultural resources, (water, soils, crops, animals etc) so as to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving the natural resources imply that the systems we use will not in anyway jeopardize the ability of future generations to meet their own needs. Rather, the systems should enable farming to continue to produce higher yields or, at worst, sustain moderately high yields generation after generation.

Traditional Ghanaian Sustainable Farming Systems

Only two systems practiced in Ghana have been able to sustain productivity, namely the Anloga shallot farming system and the practice of importation of fertility from bush farms to compound farms via cow dung in the north Mamprusi district.

In the Anloga shallot farming system, shallots have been grown continuously for over a century, year after year on the same piece of land. Fertility is maintained by incorporating cowdung, bat manure (guano), dried fish, compost and, in some cases top soil brought in from places far away.

In the North Mamprusi District (Upper East Region) cattle are sent to common grazing grounds far away from the houses (compounds) during the day. In the evening, they are brought back and kraaled in compounds around the huts. During the cropping season, the dung becomes readily available for manuring the crops which are grown on the compound farms around the houses. These compound farms in the immediate vicinity of the huts are the first to be planted, receive the most attention and give the highest yields. Indeed, the nearer a farm is to the hut the higher the yields and *vice-versa*. This system has sustained production over many years, but with the recent droughts, bush fires, tree felling and indiscriminate grazing due to overstocking and population pressure on the land, the bush farms are no longer able to support the existing cattle populations and it is no longer possible to "import" fertility at previous levels, hence declining fertility and reduction of yields. This system has collapsed.

The Long Bush Fallow Systems (shifting cultivation)

Whatever the rainfall regime - from the dry tropics with annual precipitation of 1000mm or less (Savanna Regions) to the humid tropics (rain forest) with 2000mm or more and well-distributed annual rainfall, shifting cultivation or long bush fallowing is the usual farming system employed. The merits and disadvantages of the cropping cycle of selective land clearing, burning, mixed cropping for 2 or 3 years and then resting (fallowing) the land for an extended period for natural bush re-generation are fairly well known. The system depends on nutrient recycling by the fallow plants for restoring soil fertility lost during the cropping period. The practice is ecologically sound and environmentally friendly. The longer the fallow period, the greater the fertility restoring process. Also, ground cover is maintained most of the time and soil erosion and land degradation are minimized or prevented due to a build up of soil organic matter, improvement in soil physical properties and moisture holding capacity. Pest and disease incidence are also minimized. The mixed cropping itself allows crops of different growth habits, nutrient requirements etc., to be grown thereby making for efficient use of production resources. The variety of crops also goes a long way towards meeting diverse human food, economic and social requirements.

In spite of these advantages, long bush fallowing is laborious, time-consuming and restricts farm size. The system is therefore not capable of producing enough food for large populations increasing at the alarming rate of 3% per annum. It also cannot produce enough materials for export or for our local industries. The system must therefore be modified. Indeed,

modifications have already started and are being successfully practiced in several tropical countries with similar climates and vegetation. All these modified long bush fallow systems are as effective, and even better than the old traditional systems in nutrient recycling, erosion control, organic matter accumulation, weed, pest and disease control among numerous other benefits.

Modifications of The Long Bush Fallow System

The most popular and widely tested modifications are those based on agro-forestry systems, particularly alley cropping.

In Alley Cropping, the bush fallow is replaced by deliberately planted hedgerows of quick growing trees/shrubs mainly (but not exclusively) legumes spaced between 4-6m apart. The spaces, avenues or alleys between the hedgerows are then planted to crops as one would normally do under the bush fallow systems. The hedgerows are densely planted, plant spacing within rows being between 0.5-1ft apart and are so managed that they grow very deep roots to tap nutrients from below the soil, and also produce large quantities of biomass which is cut periodically for mulching the crops growing in the alleys. The only difference between alley cropping and the bush fallow is that the nutrient recycling trees are now grown in an orderly fashion (in rows) and thereby facilitate farm operations instead of the uncontrolled random distribution of trees growing under the bush fallow. On sloping land the hedgerows are planted along the contour, thereby slowing down the rate of water running down the slopes during rain storms.

Different types of crops can be grown in the alleys including perennials like citrus, mango, coconuts, cocoa etc. Rotations can also be practiced and most importantly, animals (cattle, sheep, goats) can be part of the rotation although this has yet to be popularized in Ghana because of the extra expense involved in fencing etc. If this is done, a piece of land can be permanently used and farming operations will become less laborious because there will no longer be the need for land clearing every two or three years (as in the case of bush fallowing). The energy thus saved could be used to increase farm size or to intensify production. The practice becomes Alley farming when animals are included.

In addition to providing plant nutrients in the biomass leaf mulch, the branches/stems of the hedgerows species can be used as supports (for yams), fencing materials, fuel-wood, and for charcoal making etc. A specially reserved area can also be planted and harvested systematically for fuelwood (woodlot) or feeding to livestock.

As described, alley cropping appears more suitable for medium to large scale farms - i.e., 3 hectares and above. However, there are many planting patterns/arrangements that will suit smaller farms. The most common is to plant the tree/shrub species as hedges around the farms with perhaps another row or two in the middle to divide the farms into two, three or four equal parts. Whatever arrangement is used, will depend upon the biomass required for mulching the crop or feeding animals. Such an arrangement (a field divided into two or four parts) will also facilitate the integration of animals which will follow the crops in rotation from one field to another.

Biofertilizers/organic Manures

Animal droppings together with hedge row clippings can directly be used in making compost, or after using the animal manure for biogas production (i.e., biogas residues). At the moment, all over the Winneba, Accra and lower Volta plains and most probably, in several other parts of the country, there is so much wastage of animal manure. It is usual during the rainy season to find kraaled cattle standing knee deep in their own dung with flies all over the place. The integration of animals under alley farming and biogas production should eliminate this eye sore.

Other bio-fertilizer/organic manure production systems are those that fix atmospheric Nitrogen such as the legume - Rhizobia, Azolla - blue-green algae, symbioses and the phosphorus solubilizing fungus Mycorrhiza. The role of legumes in enriching soil with nitrogen is well known. That is why most alley cropping species are legumes and leguminous crops are grown in rotation with cereals and root crops to supply some of their nitrogen requirements.

Azolla, an aquatic fern which grows in

symbiosis with the blue-green alga (*Anabaena azollae*) is a very prolific nitrogen source, and has been estimated to fix a 2-4kg N/ha/day. Azolla also supplies appreciable amounts of potassium and other micro-nutrients. It can also be fed to pigs, poultry and fish.

In the Philippines and other part of South-east Asia, paddy rice is always grown with Azolla as the main N-fertilizer supplier. Azolla is also being successfully incorporated into Colocasia cocoyam paddies in the Pacific. Azolla occurs naturally here in Ghana, but we are yet to exploit it.

When inoculated, mycorrhiza grows on the roots of most species - cassava, yam, onion etc and assists in phosphorus extraction. Growing as root extensions, as it were, they also help the plant to explore the rhizosphere for more water thus making the plant tolerant to drought.

A composite inoculant/fertilizer comprising Azolla, Rhizobia and mychorrhiza will make a formidable bio-fertilizer for developing countries and will go a long way towards reducing our dependence on imported chemical fertilizers. I should mention that India already has a phosphorus solubilizing mycorrhiza inoculant/fertilizer. All the aforementioned systems are based on utilization of plant material and microorganisms - as mulch, compost and inoculant. They are all present locally, pose no environmental hazards whatsoever, and can be used for all crops, lowland, upland, annuals and perennial.

A Word About Animals

A major reason for the low productivity of manual labour in the tropics is the low efficiency of humans in a tropical climate. Work at the Institute for Agricultural Technology, University of Gottingen, Germany (Wieneke, 1992) reports that when the ambient temperature increased from 25-34 degree C, together with a rise in relative humidity, the ability of human beings to perform work drops by 50% of their initial value. Inadequate nutrition in the tropics aggravates the problem. It is quite clear therefore, that we cannot increase our productivity by relying solely on human power. If we should make our cost of production competitive with Asia then we have to follow Asia in their use of animal power for field operations, carting etc. Continued reliance on imported machinery with its attendant problems of spare part shortages, maintenance and fuel costs, will worsen our position.

Diseases of animals, particularly in the high rainfall areas are said to be responsible for the absence of animals in forest farming systems, inspite of the abundance of feed sources. In the savanna where the climate and vegetation appear more suitable for animals, they are still not integrated into the farming systems and diseases are still a constraint here also. Yet, there is considerable resistance towards training more veterinarians by the veterinarians themselves because they say we do not have enough animals. We need more veterinarians and animal production experts to increase our animal populations to improve our protein intake, assist in farm operations, provide manure and thereby, increase production of food and feed. Information on the productivity, composition, carrying capacity and management of our natural grasslands (range lands) is also not adequate. It appears our animals researchers will have to work harder to provide this information for the various ecological zones to enable the country develop ecologically sound and sustainable farming systems - crop dominant or animal dominant but in which crops and animals are completely integrated.

Fisheries

If I have said nothing about fisheries, it is because I know very little about the subject. I am even surprised that fisheries was tagged on to farming-livestock systems.

All I can say is that I love fish and know that fisheries, particularly marine fisheries provide almost the entire protein supplies for coastal populations, in addition to providing important job opportunities for income generation.

Current and past research activities have concentrated on production and management of fishery resources. Recently, offshore oil produc-

tion exploration has appeared on the scene and interaction between fishing and oil exploration activities should be actively researched in order to develop sound management of the resource base for sustainable production. The use of explosives, poisons etc in fishing should also be discouraged.

Now that the success rate of the fish-pond craze during the immediate post revolutionary period has amply endorsed the age-old wisdom that enthusiasm is no substitute for knowledge, we should approach fish-pond making with great circumspection. The Institute of Aquatic Biology, CSIR is still helping those who want to engage in that business. Here at Legon we have, and can supply fish pond fingerlings and Azolla, which is used extensively in fish pond culture in the Philippines, China, Taiwan etc to feed the fish and supply N to rice in rice-fish production systems.

Conclusion and Recommendations

Farming Villages/Townships

Although only about 30% of our 13 million ha of cultivable land is currently cultivated, because of the uneven distribution of farms and populations in the country, a significant proportion of currently cultivated lands is being over-cropped.

Uneven distribution of farmland is due to problems of accessibility, population pressure and proximity to urban centres. This has resulted in land degradation in the easily accessible areas while hardly any farming activity takes place in remote inaccessible areas.

To bring about a more uniform utilization of farming land, inaccessible areas should be opened up by building more feeder roads and farming villages or townships with amenities comparable to those in urban areas. Our budding Real Estate Companies should seriously consider this type of estate development to reduce the congestion in the cities. Experience elsewhere - Australia, India, Sri Lanka, Mexico, China, to name a few, shows that integration of crops and animals and adoption of innovations are readily done in such well developed rural communities.

Land for Housing vs. Land for Farming

Part of the pressure on farming land near the urban areas is their appropriation for building houses. In Accra East Legon, New Achimota, Adenta - and perhaps many other areas elsewhere, estates have been built on excellent farming land. The Soil Research Institute, CSIR has mapped all the soils in the country and ranked them according to the types of farming activities they can best support. Government through Local Councils, etc. should therefore demarcate all the country - districts, villages according to areas suitable, and therefore reserved, for farming purposes and areas suitable for building. Unless this is done the increasing pressure on farming land will eventually completely eliminate farming lands from the urban areas and spill over to the rural areas also.

Development of Agro-forestry Systems

We are only beginning to identify suitable species for agro-forestry practices and crops and cropping/farming patterns compatible with the system for both large and small scale farms. We have a very long road to travel. Research should be intensified to identify the most suitable species, their cropping, nutrient recycling, and drought tolerant abilities and above all, how best to integrate livestock for the mutual benefit of both components, and for sustained food production for our present generation and those yet unborn.

Reference

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