Introduction

As the Republic of Ghana enters a new millennium, a unique opportunity exists to advance natural resource conservation and environmental protection and to prepare for challenges related to population growth, economic development and emerging land use and ownership conflicts. The manner in which Ghana addresses the capacity of its resources to meet the basic needs of its people will become critical. The success of its response will depend on internal economic and political stability and on the stability of governments in the region.

The government has committed to strategies and policies through the recently formed Accelerated Agricultural Growth and Development Strategy to support its Vision 2020. The action program calls for increased economic production from small scale farming in order to achieve sustainable food security and gender sensitive activity. A heavy reliance on private sector involvement is proposed to lead investment and economic growth. Ghana plans to increase its economic growth through increased production and export of agricultural commodities. Since the availability and capacity of natural resources are key factors, this natural resources assessment and technology exchange effort of CCARD could be used as a platform to begin dialogue with the private sector.

The Republic identified the Greater Afram Plains (see map) as a priority area for economic development. This will be achieved through increased output from the establishment of commercial farms and the enhancement of small farm operations through sustained management of their natural resources.

The assessment methodology is discussed in Appendix A. The assessment was based largely on a field review in Ghana's Greater Afram Plains. USDA-Natural Resources Conservation Service (NRCS) specialists whose experience in natural resource management spans four continents and nearly every state in the United States spent an intensive week in the Greater Afram Plains. Their experiences and training were applied to observations made during field trips and information received from Ghanaian farmers, policy officials, scientists and stake holders reflecting national, regional and local interest. Traditional leader input was considered in making the assessment.

This report and its findings and recommendations should be viewed within its intended context. In some cases the assessment validated existing strategies and programs designed to increase economic output and well being of the people living in the Greater Afram Plains. On the other hand, findings and recommendations point to the complex nature of sustainable natural resource development and attempts to avoid negative unintended consequences. We conducted a comprehensive on site review to insure consistency in making the assessment. An extensive number of secondary sources were consulted in the assessment process (See References).

Findings and Recommendations

The following is a summary of the major findings of the Assessment Team. These findings and recommendations were reviewed by the members of the Consultative Committee on Agriculture and Rural Development (CCARD), Minister of Food and Agriculture, and Ghanaian Team Representatives, and Natural Resources Conservation Service team representatives in August 2001. These findings were deemed most significant to commercial agricultural development. Each of these issues must be addressed in order to shift the agricultural workforce within the Afram Plains from predominately subsistence agricultural to commercial production. Estimated costs to fund projects associated with these recommendations is $86 million over a five year period. In addition, the Republic of Ghana would direct funds to upgrade the land tenure system.

Infrastructure Rehabilitation and Development

Finding: The infrastructure needs significant rehabilitation and development. The secondary road network is inadequate to service local transportation needs and lacks maintenance. As the roads are repaired, water impoundments can be established for agricultural and other uses.

Recommendations:

1. Redirect road restoration and rehabilitation efforts to the Greater Afram Plains with priority to the Adawsu Ferry area to improve its access.
2. Add a larger second ferry at Adawsu to increase capacity and shorten waiting time.
3. Evaluate the feasibility of constructing a bridge across the lake to replace the ferry at Adawsu.
4. Evaluate the feasibility of docking facilities on the northern fingers of the lake especially on the Afram and Sene Rivers to handle small barge traffic.
5. When infrastructure and accessibility to capital is improved, develop an international marketing plan that highlights Ghana as the place of choice for investment opportunities in agriculture.

Natural Resources Sustainability and Growth

Several agricultural resource issues were identified within this category that must be addressed. These include soil resource utilization and development, conservation on agricultural lands, afforestation enhancement, nomad cattle grazing, and irrigation development.

Soil Resource Utilization and Development

Findings: Ghana soil resources support increased production for economic growth, food security and poverty alleviation.

Recommendations:

1. Initiate projects based on economic feasibility or selected commodities using mechanized agricultural technologies. Emphasize maize production as a first commodity. Soils data indicate up to 300,000 hectares are suitable for mechanized agriculture.
2. Diversify operations to include more livestock for flexibility, diversity, rotations, reduction of imports, and improved human nutrition.

3. Expand output of medium sized producers through increased technical assistance utilizing sustainable practices.
4. Coordinate a major strategic initiative including NGO's to expand output of maize and crops that support food security.
5. Institutionalize values related to producing food efficiently by starting a school garden initiative. Modules could support science and math courses. As food production increases, expand preservation technologies to reduce spoilage.

Conservation on Agricultural Lands

Finding: Additional soil and water conservation practices on agricultural lands are needed. Conservation needs will increase as production shifts from subsistence to more commercial and mechanized production.

Recommendations:
1. Require soil and water conservation on leased agricultural lands.
2. Since a majority of agricultural lands are "leased on an annual basis" required conservation farming should be incorporated into the lease agreement.
3. This requirement will promote use of more enduring cultural and management practices (contouring, crop residue management, irrigation practices, grassed waterways etc.) on agricultural lands for sustainability.
4. Increase training and education opportunities to enhance farmers and land operators knowledge and skills to use conservation treatment measures.

Afforestation Enhancement

Finding: Much of the Afram Plains forests and woodlands are being cleared with no plan for replacement. Rotational and subsistence plot farming, indiscriminate burning and demands for charcoal fuel are the principal factors contributing to deforestation.

Recommendations:
1. Provide incentives to allow for more manual tree replanting and natural forest re-vegetation, especially on the steeper slopes.
2. Replace the indiscriminate rotation of small, subsistence agricultural plots with planned rotations based on land capability, management, and conforming to a national forest re-establishment strategy.
3. Adopt a strategy that reduces annual burning by establishing firebreaks. This would also support more natural re-vegetation.
4. More mechanized use of sawmill wastes will also reduce the demand for harvesting additional timber (i.e., use of wood shavings for other wood products such as particleboard production, charcoal briquetts, and other innovative uses).
5. Establish charcoal producing tree plantations closer to improved roads and urban areas.
6. Utilize female labor to establish tree plantations and a marketing strategy that allows usage of the wood and tree products at various stages of growth.
7. Invest in a system to pipe natural gas into high population areas as an alternative to charcoal.

Nomad Grazing Dilemma

Finding: Nomad cattle grazing in the Afram Plains often causes damage to agricultural lands. The herdsmen sometimes initiate uncontrolled; advance burns intended to produce succulent grazing. This random grazing also causes damage directly to agricultural crops.

Recommendations:
1. Prescribed grazing areas should be established with planned controlled burning.
2. Burn selected areas in advance of the cyclic Nomad livestock herds. These planned controlled burns (best forage) should attract the herds to prescribed grazing areas and reduce grazing and fire damage to crop areas.

Irrigation Potential

Findings: Application of agricultural irrigation systems on suitable soils is practicable. The irrigation systems can be applied on small (1 hectare), medium (5 hectare) and large (10 hectare and larger) operations.

Recommendations:
1. Promote the use of irrigation systems for small, medium and large farming operations on suitable soils. The quality and extent of water (Lake Volta and tributaries), elevation, and pumping heads are factors that would make irrigation feasible.
2. Irrigation ponds and impoundments are physically feasible to irrigate small acreage crops. Ensure these efforts are economically feasible.
3. Ground water from 50-100 meters in depth is available for small borehole systems, however more extensive analysis is needed.

Land Tenure System

Finding: : Ghana's land tenure system appears difficult and is cumbersome to potential outside investors. The system also produces uncertainties for tenant farmers in providing long term inputs on agricultural lands.

Recommendations:
1. Develop and provide a policy document that clearly and precisely explains Ghana's land tenure system .
2. Provide this explanation to prospective investors and give them legal assurances that their investments will be protected under the terms of the document.
3. With these assurances, encourage developers and tenants to follow sound production practices and to install enduring conservation practices on the developing agricultural lands.

Access to Credit Collaboration

Finding: Interest rates are extremely high, ranging from 35 to 40 percent and the inflation rate is nearly 40 percent. Increasing employment by enticing outside investments is an important factor in improving Ghana's economic conditions. Ghana should show its commitment to agriculture by making policy changes that will be essential for attracting outside investors.

Recommendations:

1. Offer concessions for a set period of time to larger outside self-financed entities and reduce their risks. As a result, outside capital may be provided for demonstrating new and different techniques, making resource improvements, and employing and training local labor.
2. One of the objectives of a pre-set proportion of new investments should be to promote greater entrepreneurship among local producers. This should be done gradually by starting with subsistence or small producers that have proven commitment to farming and slowly develop them into medium, then to large producers. A technique to consider is for Ghanaian producers to be assigned plots of productive land under a farm-to-own-arrangement. Investors would provide expert agents to council with the producers. After an agreed period of time and demonstrated success, producers would become more independent.
3. Encourage existing farmers to use more sustainable production methods minimizing inputs requiring capital. Those that emerge as most successful will likely be able to develop the capacity to work larger farms using higher levels of technology. Over time they will develop additional lands or buy out the least successful ones.
4. Initially subsidize the cost of inputs for new producers or develop new credit policies that support newly entering small to medium farming enterprises. Management techniques should be put into practice that will lead to elimination of subsidies and self-sufficiency within a set period of time.
5. Encourage better utilization of Ghana's low interest funds presently available for agricultural development through the National Agricultural Development Bank
6. Reduce risk of knowledge and skill deficiencies by encouraging local talent to work on successful private and corporate farms in other developing countries (technology and business management exchanges.)

A summary of projects and funds ($86 million) required to address the findings and implementations are outlined below:

Projects (2002-2007)	**Funds**
1. Infrastructure Rehabilitation and Development • Improve roads and establish impoundments	$60 million
2. Natural Resources Sustainability and Growth • Soil resource utilization and development • Conservation on agricultural lands • Deforestation enhancement • Nomad cattle grazing • Irrigation development	$25 million
3. Land Tenure System (Government initiative)	
4. Access to credit collaboration (1 year)	$1 million

GENERAL DESCRIPTION

Resources considered in this assessment were categorized into three general areas: natural (physical and biological), human, and the capital or monetary. The following descriptions summarize these items and provide an indication of the resource adequacy and constraints to achieve the goals and objectives of MOFA in their Vision 2020 Strategy and the concerns of other Ministries involved. Each resource rated as high in the Assessment Check Sheet is mentioned in the following narrative.

PHYSICAL RESOUCES

Soils and Geology

Geology - Nearly all of the Afram Plains area is underlain by sandstones, siltstones and mudstones of Devonian or early Carboniferous age (Junner and Hirst, l946). For most part, the rock types are not intricately mixed. Instead, large areas of the Plains are dominated by sandstones, while other areas are dominated by siltstones and mudstones.

The southern scarp-lands are a major geologic feature affecting the climate of the Afram Plains. Acting as a barrier to the south-west monsoon winds, they create a rain shadow. This rain shadow effect is believed by some to be partly account for the fact that significant parts of the Afram Plains are Savanna rather than forest.

Soils - The surface of the Afram Plains consists mostly of stable, gently undulating uplands. This landscape stability has contributed to the formation of highly weathered soils with well-differentiated profiles. The dominant upland soils (FAO System) include Luvisols, Nitrosols, Acrisols and Arenosols. These soils would classify mostly as Alfisols and Ultisols in the USDA Soil Taxonomy System. Source: Junnec, N.R. and T. Hirst, l946. The Geology and Hydrology of the Voltacian Basin. Geol. Surv. Memo No. 8, Accra.

Resource suitability and constraints

Although there is some uncertainty in the numbers, it has been estimated that 50 to 65 percent of the soils in the Afram Plains are suitable for mechanized agriculture. This is comparable to the Middle Coastal Plain in the Southeastern USA, an area with soils similar to those in the Afram Plains, and in which mechanized agriculture is well developed. The soil resources of the Afram Plains have the potential to support the production of maize under mechanized agriculture. This finding is based on a review of soil maps prepared by the Ghana Soil Research Institute (Adu and Mensah-Ansah, l995) and on interviews with soil scientists at the University of Ghana and the Soil Research Institute

The soils on much of the Afram Plains have good physical properties and would be adaptable to mechanized cultivation. With careful management, a high level of production is possible. However, the application of fertilizer and lime will be necessary to maintain the high crop yields necessary to make mechanized agriculture economically viable. In some parts of the Afram Plains, supplemental irrigation will be needed if high input, mechanized agriculture is to be sustainable.

Conservation measures will be required to control erosion if large areas of the Afram Plains are developed for mechanized agriculture. Furthermore, soils similar to those in the Afram Plains are known to develop tillage pans in other parts of the world. Careful soil management will be needed to avoid this problem.

Specific kinds of soil on the Afram Plains differ significantly in their suitability for mechanized agriculture. For example, parts of the Afram Plains underlain by sandstone are more suitable (generally) to commercial, mechanized agriculture than are areas underlain by mudstones or siltstones. Additionally, within each of these major areas, individual kinds of soil will differ significantly in their potential due to difference in soil depth, presence or absence of ironstone pans, etc. It is recommended that an onsite soils evaluation be conducted by the Soil Research Institute or by qualified consultants prior to any significant investment on a particular tract of lands.

Climate

The climate of Ghana is the tropical, wet semi equatorial type but temperatures vary with season and elevation. The average temperature is about 26 degrees C. The relative humidity ranges from 50% during the dry season to about 90% during the wet season. The evapo-transpiration is about 1.3 meters (51 inches) per year. Combining the temperature, relative humidity, rainfall and evapo-transpiration regimes, four seasons are distinguishable.

Except in the north two rainy seasons occur, from April to July and from September to November. In the north the rainy season begins in April and lasts until September. Annual rainfall ranges from about 1,100 mm (about 43 inches) in the north to about 2,100 mm (about 83 inches) in the southeast.

The harmattan, a dry desert wind, blows from the northeast from December to March, lowering the humidity and creating hot days and cool nights in the north. In the south, the effects of the harmattan are felt in January. In most areas the highest temperatures occur in March, the lowest in August. The average annual temperature is about 26 C (about 79 F). The following table indicates country averages with the last column displaying average monthly rainfall at Accra.

Temperatures in the Afram Plain allow for a 365-day per year growing season. Since Ghana is close to the Equator, daylight is fairly constant at 12 hours per day. The main factor limiting the growing season is rainfall. The periods of high rainfall and strong winds would increase the risk of erosion on cultivated lands that are unprotected with cover crops or organic residues.

Monthly Temperature and Precipitation in Southe rn Ghana

Month	Temperature (Degrees C)	Conditions	Accra Ave. Precipitation (meters)
January	27	Sunny skies	0.6
Feb	28	Sunny skies	1.1
March	28	Sunny skies	2.2
April	28	Light rains	3.5
May	27	Heavy rains	5.3
June	26	Heavy rains	7.8
July	25	Light rains	2.0
August	24	Scattered showers	0.7
September	25	Scattered showers	1.7
October	26	Sunny skies	2.5
November	27	Sunny skies	1.3
December	28	Sunny skies (dry)	0.8

Water

The Afram Plains has water available from three sources:
1) rainfall and runoff from about 60 inches of rainfall a year;
2) surface water from the Afram and Volta Rivers (the rivers are perennial); and
3) groundwater e from the alluvial aquifer that underlies most of the Afram Plains.

The Afram Plains receives from 1370mm (53.9 inches) - 1650mm (65 inches) of annual rainfall. The rainfall pattern is characterized by a main rainy season April through the middle of July. A minor rainy season September through October is followed by a long dry hot season November through March. Monthly rainfall patterns after crop germination are unreliable resulting in seasonal droughts and crop stress.

Sandy and silty clay loam soils are available in the Afram watershed. These soils could be used to construct ponds and water impoundment basins to capture water during the rainy season. The water could be stored for irrigation use during the dry season.

The Afram Plains has good quality surface water in the Afram River and Lake Volta (quality of water was determined from interviews with local people and existing water quality analysis). Lake Volta has a surface area of 8,500-sq. km. and impounds 148.5 cubic kilometers at total dam capacity. Water use studies would need to be done to determine the effect on the water levels in the lake. The water in Lake Volta is primarily being used to generate electricity for Ghana and her neighboring country to the east, Togo. Since crops can be grown throughout the year because of high temperatures, water could

be used from the Afram and Volta Rivers by monitoring the water stages during the year and pumping water during high flows and low hydroelectricity production.

Ground water is available from 50 to 100 meters. Data was gathered from on site investigations and talking with local people. Some villages had wells with hand pumps; others carried water from ponds, streams and rivers. More information is needed to determine the effects of ground water being pumped at irrigation rates and what recharge rates are needed to sustain the underground aquifer. Studies should be done on water supply and quality during droughts.

The soil water available water holding capacity of the clay and silty loam soils ranges from about 38mm(1.5inches) to 64mm(2.5inches) per foot of soil in the root zone. Due to non-uniform monthly rainfall patterns, seasonal moisture deficits are common causing crop stress and reduction in yields.

The Afram Plains has predominately small farms (less than 5 hectares), some medium farms (from 5 to 10 hectares) and a small number of large farms (10 hectares and greater).

Surface pumping plant systems could be installed on the above sized farms ranging from about $3,000.00 to $10,000.00 US dollars. An analysis would need to be done on a case by case situation to determine feasibility and cost effectiveness.

The average yields of crops in the Afram Plains are very low. The average yield of maize is about 1.5 tons per hectare nation wide. Yields could be doubled, tripled or possibly quadrupled by planting improved varieties and adding the necessary inputs including irrigation water management.

Rice farmers in the Afram Plains produce about 50 bushels per acre(137.1 bushels per hectare) and could improve yields with improved varieties and better management.

Adding irrigation water can reduce crop stress and provide insurance against crop losses during droughts. However, certain other limiting factors would need to be addressed, specifically soil fertility, improved varieties, pest management, erosion control, crop residue management , crop harvesting, storing and hauling to market.

After all the crop production inputs are added, an economical analysis would need to be done to assure cost effectiveness.

With additional stored water, the land, water and climatalogical resources are available for increased crop production. Certain areas are more economical than others and should be developed on a priority basis. Ghana imports over 300 metric-tons of rice per year, maize is also imported. Although Ghana is a developing nation and increased crop production creates many unique challenges. Ghana has the natural and human resources to make it happen.

BIOLOGICAL RESOURCES

Biological resources were considered from perspectives of plants and animals. Both were assessed from several perspectives.

Plants

About two thirds of the Afram Plains consists of Transitional Semi-Deciduous Rain Forest. This area is potentially suitable for production of cereals, legumes, root crops, vegetables, cashew, and mango.

Suitable crops - More specifically, plantain, maize (corn), beans, tomatoes, okra, peppers, garden eggs (eggplants), (all warm season vegetables), cassava, rice, bananas, yams, sweet potatoes, pineapples, carrots are all presently grown and are well adapted to the area. Other crops would be feasible, but since these are already familiar to Afram Plains farmers, early emphasis should focus on these.

Productivity of crops – (sustainability w/o supplemental nutrient). Plants would do much better with fertilization. The seed corn and rice farms visited required fertilization and could have experienced higher production with larger applications. The rice producer was applying 15 kilograms of NPK and 15 kilograms of urea. One of the constraints of using fertilizer is developing the infrastructure and delivery system that will provide it on a timely consistent basis for commercial production. Commercial production will not succeed without application of additional plant nutrients.

Landscape/landuse components - Forest depletion for farming and charcoal production is a big concern. Significant decreases are occurring in the number of forested hectares. Ministry and District officials would like to devise a program to stabilize or reverse these trends. The demand for cooking fuel pushes buyers and distributors to travel on almost impassable roads to deliver this product to the cities. Strategies need to be considered for replanting. Teak trees seem to hold much potential. Overall, the Forest Research Institute is studying 10 species.

Damage by nomadic cattle – During dry periods, out-of-area nomadic herdsmen bring their cattle in the Afram Plain. They travel at night and often severely damage crops. Herdsman also set fire to elephant grass just before the spring rains to induce new more tender edible shoots to grow.

Susceptibility to disease – More knowledge needs to be assimulated about plant diseases and pests and the role of native plants serving as host to these. A field of okra had leaf spots while a field of groundnuts had large spots that were wilting. This is to be expected as disease will be a concern in any intensive crop growing area, especially in subtropical climates with such a long growing season. The rice looked good but needed flooding for weed control

Plant nutrients – Natural sources of plant nutrients such as livestock manure is presently limited. Goats are the main livestock. Quantities of manure presently do not warrant accumulation. Diversification of commercial operations should include livestock and legumes to provide supplemental plant nutrients.

Animals

Diversity – Goats are the main hoofed meat animal and chickens as the main poultry animal. Agriculture practiced by villagers could be diversified for addition of red meat and potentially dairy for adding protein in the diet. The addition of animals could create manure that would serve as a plant nutrient source. A few ducks and turkeys, and guinea were noticed. Markets next to the Lake Volta had dry/smoked fish. Draft animals not observed. Bush meat consist mainly of the grasscutter, a rodent.

Any agricultural development program should include poultry and small ruminant production. Livestock development must be considered also. This will reduce poverty in rural communities and provide some potential income support for resource poor farmers.

Grazing areas – Nomadic cattle are likely to feed on crops which cause conflicts with intensifying cropping in the Afram Plains. Better management of these cattle will be required for successful commercial agriculture to develop.

Fisheries - Efforts need to be made to improve fishing within the region. Fisheries development could be linked to irrigation development where controlled reservoir fisheries in these impoundments may increase fish production.

HUMAN RESOURCES

A high value was placed on planning concerns from the Human Resources section of the Assessment Check Sheet high significance.

Managerial skills and ability – Potential producers with the necessary skills and knowledge to generate sufficient profitability to pay back loans probably only consists of 20 percent of the producers presently. Number of producers with this ability would be low initially. Project officers would need to work very closely with new farmers.

Sufficient numbers of skilled extension agents are needed in order to raise farmer knowledge and skills. This could result in an acceptable level of successful producers that farm above 2 hectares.

Land tenure – Land is not legally recorded and owners are not clear on the process they need to follow to protect and exercise their rights. A need exists for development of a clear explanation of the process and for written instructions. This would encourage landowners and support personnel to provide assistance to landowners in getting clear title to their land.

CAPITAL AND MONETARY RESOURCES

Resources in this category not only involve money but also include systems improvements that require investments by governments, corporate, or private sources.

Capital and access to it – Credit availability is very limited to non-existent. Incomes are low and security for loans is low to non-existent. Ministry leaders are consequently looking for infusion of capital from outside investors.

Attracting outside capital without a good transportation system and infrastructure will be difficult. Legal assurances on land tenure would also serve to reduce the risk of potential outside investors.

Banking and monetary support system - Additional banks will be needed to handle money, make loans, and keep money safe as development occurs. These are only available in the less accessible larger towns. Mechanisms to manage inflation are essential to protect income and savings. Borrowing is infeasible since inflation is in the high 30's and interest rates are approaching 40 percent. Development of affordable credit and money handling facilities will need to be developed.

Interest rates, inflation, and length of loans – Interest rates are very high being in the 30-40 percent range. Borrowing is infeasible since inflation is in the high 30's. Producers will need access to low interest loans. They will need to make enough profit to pay back production loans on an annual basis. They will also need managerial skills enabling them to save and accumulate money.

Transportation – From the standpoint of moving goods outside of the Afram Plains, farm to market roads are extremely rough and need major improvements. Surfacing or resurfacing and erosion control are big factors. In some cases new roads must be built. Alternatives or supplemental components to truck hauling could be barges on Lake Volta and reinstating service on the existing railroad between Kamasi and Accra.

Moving materials internally within the Afram Plains is highly labor intensive. Transport vehicles observed on the roads consisted mainly of trucks hauling sacked charcoal and to a much lower extent, local produce or locally crafted goods. No draft animals were observed. Water, food, firewood, and other goods were carried mostly by women and children in containers on their head. A few small 4-wheel carts made from the axles of automobiles welded to a bed were used to transport heavier or bulkier loads short distances. These were pulled/pushed by people. For successful commercial agriculture, construction and improvement of feeder and major roads is essential for moving goods and produce within and externally of communities and performing farming operations. Capital and equipment to improve main roads and alternative means of transportation will be required.

Processing – Facilities to process farm produce and local value adding are limited. The team visited one seed corn farm where a crew was shelling and bagging seed to bring to a drying facility outside the area. Other than domestic food preparation, corn shelling for seed and smoking fish were the most evident value adding processes. One farmer had a small hammer mill and in addition to milling his own rice, he milled that of other farms in the area. One fairly modern grain handling facility laid idle having been constructed but never put in operation.

Facilities to dry, can, or refrigerate were not observed. Fresh produce with no refrigeration may have only a 2-3 day shelf life. For example, pineapples is an introduced crop and is not presently widely used by the people indigenous to the Afram Plain. Shipping and handling could easily consume one-to two-thirds of the shelf life giving vendors only one day to sell the product to the more sophisticated consumers in larger cities. Capital to install and skills to operate and manage processing, drying, and other value adding facilities will have to be developed for commercial agriculture to succeed.

Power – The main source of electricity is presently hydro-generated. Pipelined natural gas may be another alternative source. Electrical lines are fairly well distributed but incomes are too low for the locals to buy power. Small solar power units that would store electricity in batteries may be an alternative for some residential uses once income levels increased from commercial agriculture. Accessible and affordable power for processing and value adding processes will need to be increased.

Resource Capability and Farming Systems

Present Situation for Agricultural Production

The Afram Plains, with its sub-tropical climate, good soils and availability of a rural work force, has potential for expanded agricultural production.

Ghana is comprised of 5% arable land; 7% permanent crops; 15% pastureland; 37% forest and woodland and 36% other land. The average annual rainfall in the Afram Plains is from 1,200 to 1,500 millimeters. The annual average temperature range in the area is 25-28 Celsius. The natural vegetation is Guinea Savanna - high grass to Tropical forest – deciduous forest. The region is predominantly devoted to agricultural crops, forest-woodland, livestock and fishing. Volta Lake provides an abundance of fresh water for fishing, potential irrigation, and hydroelectric power. The region has a good potential for sustainable and exportable agricultural production of livestock and crops of particular interest.

The Afram Plains experiences many constraints to expanding agricultural production. The predominant individual farm consists of small plots carved out of the savanna and woodland-shrub lands and farmed by hand only for 2-3 years. This type of farming is practiced to acquire limited nutrient capability from natural vegetation. Thereafter, the small agricultural plots are abandoned (fallow) because of low fertility and additional plots are rotated. This type of farming also degrades the woodland-forestry resource base because it does not allow regeneration of native hardwood species. The type of farming in the region is 80% smaller scale operations (subsistence); 15% medium scale operators and 5% larger scale operators. The crops grown are usually root crops, maize and isolated plots of fruits and other vegetables.

Another constraint is the practice of Nomads cattle grazing. The Nomads randomly crosses the region with large livestock herds while grazing grasses. Fires are set in advance to generate fresh growth of grass vegetation, often damaging small agricultural plots. This random grazing also damages agricultural crops.

The existing Ghana land tenure system is a tremendous hindrance to expanding agricultural production. The land is owned by families and controlled by prevailing tribe Chiefs. Individual farmers seek permission to farm the agricultural plots scattered in the woodland and shrub land usually on a limited, yearly basis. The system is often cumbersome and does not encourage long term inputs in fertility improvement and conservation practices. Outside investors in agriculture can also be easily confused in the tenure system.

Another obstacle to increased agricultural production is limited use of soil and water conservation practices. A number of agricultural plots, even larger, mechanized fields are farmed “up and down

slopes." With tropical rainfalls soil erosion occurs in the fields thus threatening damage of the resource base. Lack of complete fertility management also limits agricultural crop production. During the seasonal growing periods there is usually limited options to limit crop stress due to drought.

Ghana including the Afram Plains is highly based on small agricultural plots and subsistence farming. The growing population and desire for more agricultural exports have increased demand on the land for crop production. During the review we only noted two examples of more mechanized farms. One was a farm practicing maize production for certified seed. Another area comprising a former commercial maize operation – at least a larger, 30+ acre farming operation was being employed. In the future many more farming operations utilizing hand cultivation should give way to more mechanized farming if the country and region is to maintain sustainability and agricultural export opportunities. The lack of adequate transportation facilities to take crops to market also contributes limited agricultural growth.

APPENDIX A - Assessment Methods

METHODOLOGIES

This assessment was limited to a week of intensive field reviews. A team comprised of USDA-NRCS specialists with experiences ranging from 20 to 30 years of service representing various regions of the United States and four Continents collaborated with Ghanaian technical specialists from the government, research institutes, districts, and local producers. We conducted field observations in the Eastern Region and Ashanti Region portions of the Afram Plains. d from Ghanaians representing policy and science ranging from the national to the local district levels and from local producers.

SITE VISITS

Field sites visits were conducted on Tuesday, Wednesday, and Thursday. Research institutes were visited on Friday. See the work schedule.

The sites identified were visited as scheduled. Briefings and questions and answer sessions were conducted at each location. No standard interview instrument was employed. During vehicle travel to various sites within the Districts, team members were able to visit with the local representatives and obtain data, interpretations, perceptions, and opinions on natural resources conditions and the feasibility of expanding agriculture in their respective Afram Plain Districts.

Selected members met for 1-2 hours in the evenings to share information, perceptions and observations gathered during the day. Materials received during the site visits are listed in the References section. In some cases, the team member was referred to an office in Accra for the information sought.

In addition, team members conducted Internet searches prior to coming to Ghana as a means of getting somewhat familiar with the country and its natural and human resources. Reference material was assembled in 5 folders in the following subject categories, Land and Soil, Water, Climate, Country Information, Country Information and References.

An Assessment Check Sheet was devised early during the visit as a means of adding consistency to subjective interpretations. These interpretations were based on accumulated knowledge and past experiences of team members conducting similar activities in North America, Africa, Asia, and Australia. These generalized non-quantitative findings are summarized for each site. These items were categorized as having high, medium, or low significance. The findings in this report and the recommendations mostly consist of those items classified as having high significance.

APPENDIX B

Meeting World Maize Needs: CIMMYT Report Synopsis

Maize: Increasing Production Via Mechanization

The CIMMYT, an internationally funded, nonprofit, scientific research organization conducted a study on the rapid growth in maize demand that is anticipated during the next 20 years. They indicated that the demand for maize in developing countries is projected to surpass both wheat and rice by 2020. Therefore, maize supplies in those areas must nearly double. Sub-Saharan Africa, Central America, and parts of South Asia were the focus areas of this study. Specifically, the annual maize demand in sub-Saharan Africa is expected to double to 52 million tons by 2020 relative to its 1995 level.

Policy Planning Monitoring and Evaluation Department, MOFA provides the statistics to show an increase in Ghana.

Ghana Maize Production (000 metric Tons)

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Maize	932	731	961	940	1,034	1,008	996	1,015	1,015

Average Yields (metric tons/hectare)

	1991	1997	1999	Achievable Yield
Maize	1.5	1.54	1.46	5.0

Area Planted (000 hectares)

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Maize	610	607	637	629	669	665	663	697	697

Mechanization of agricultural production will increase sizes of farms and yields. It will also control weeds, pests and diseases associated with harvesting, drying, and storage. One of the constraints to mechanization is that serious damage to the soil resource can result if not properly managed.

The CIMMYT identified the following as dominant constraints to bridging the yield gap between potential and actual yields in Sub-Saharan Africa:

1) Low and declining soil fertility
2) Drought/moisture stress
3) Striga
4) Streak virus
5) Borers

<u>Low and Declining Soil Fertility</u>

Tropical soils have low soil fertility, particularly low nitrogen. Intensified land use and the rapid decline in fallow periods, coupled with the extension of agriculture into marginal lands, have contributed to the rapid decline in soil fertility. Even when fertilizers are applied, the quantities are often so low that they contribute little to long-term fertility management. The CIMMYT suggested a three prong strategy for enhancing fertilizer use efficiency in small holder maize production systems:

- the type of inorganic fertilizer and its use are carefully tailored to the conditions faced by small holders
- the production of locally produced organic materials is increased, which reduces the cash cost of fertilizer while increasing the efficiency of inorganic fertilizer use; and
- agronomic and economic factors must receive greater consideration in breeding priorities for maize and legumes, so that future improved materials fit small holders' circumstance.

Drought

Most tropical maize is produced under rainfed conditions. Drought affects production, but maximum damages is inflicted when it occurs around flowering. Strategies offered to combat drought must be based on the use of tolerant cultivars and appropriate management options. These include planting on the optimum date to align critical stages of plant development with rainfall; tillage to promote greater rooting depth, better entry and storage of water in the soil, and reduced competition from weeds, prevention of run-off and better direction of available water to the crop and crop and water management strategies that are environment and location specific. In Ghana, there is a tremendous opportunity for irrigation systems and water impoundments to supply needed water.

Striga

Striga hermonthica and S. asiatica are parasitic weeds that negatively affect the livelihood of more than 100 million Africans and inflict crop damage totaling approximately US $7 billion annually to the African economy. Striga attaches to growing maize roots beneath the ground and siphons off nutrients that would normally feed the plant. The most short term approach to suppressing or delaying Stiga parasitism is the application of minuscule rates of herbicide to the seed of herbicide resistant maize varieties. Striga control may be achieved through the development of tolerant germplasm. The consensus is that resistance does not exist within commonly used African germplasm. However, variability does exist for tolerance. Agronomic practices that could help control Striga include trap crops (cowpea, sorghum, etc) that lower Striga seed germination and weed count in the field. For long term control, a deeper knowledge of the physiological, biochemical, and molecular basis of the host-pathogen interaction will be the best insurance policy against Striga.

Streak Virus

Maize steak virus (MSV) is a major disease of maize in Africa and is the most prevalent in tropical lowlands. The pathogen is transmitted by leafhoppers and causes serious yield losses, but its occurrence is sporadic. Practices such as timely planting and treatment of seed with systemic insecticides can help control yield losses. A more practical solution for subsistence farmers is high yielding maize that carries genetic resistance to the disease.

Borers

Stem borers have been the most damaging group of insect pests in maize cultivation. Stem borers first establish on leaf tissue, but in later stages of development, they bore into vascular structures of the plant (midribs, stalk, pedicle) which reduces the ability of the plant to move assimilates into the grain. Control of these pests through insecticide sprays is difficult given their cryptic nature.

However, stem borer resistance has been developed and involves conventional breeding and genetic engineering. Germplasm that resists "second generation attack" larvae attacking maize during flowering warrants further research. Selection for resistance at this stage has been slow because the borers feed on diverse plant tissues at this time.

To reduce second generation damage, researchers are screening plants for reduced feeding damage in the tissues firs fed upon by larvae, specifically, the sheath, husk, and ear. The use of Bt maize in developing countries could also provide effective control of stem borers.

APPENDIX C - Assessment Participants

USDA Natural Resources Conservation Service (NRCS)
Lawrence Clark, Team Leader and Deputy Chief for Science and Technology
Wavey Austin, Irrigation/Environmental Engineer
Daniel Conrad, Natural Resources Manager
Wildon Fontenot, Natural Resources Specialist
Dr. Berman Hudson, Senior Soil Scientist
Renna Owens, Agricultural Economist

Ghana Ministries and CSIR
Major (rtd.) Courage Quarshiga - Minster, Ministry Of Food & Agriculture (MOFA)
Dr. Francis Ofori - MOFA
Dr. Bertha Gana - MOFA

Prof. Dominic Fobih - Minister, Ministry of Environment, Science & Technology (MEST)
Dr. Kwaku Afriyie - Minister, Ministry of Lands & Forest (MLF)
Dr. P. Tweneboah - MLF
Dr. Blay - MLF
Dr. O.K. Gyarteng - Irrigation Development Authority (IDA)
Dr. J. Cobbina - Council For Scietific Industrial Research (CSIR)
Dr. J.R. Cobbinah - Foresty Research Institute (FORIG) Director
Dr. J.N. Asafu-Agyei - Crops Research Institute (CRI) Deputy Director
Dr. R.D. Asiamah - Soils Research Institute (SRI) Director

Regional and District Participants:
Dr. A. Asante - Eastern Region Director
Dr. J. Bogee - Afram Plains District Director
Mr. Opoku - Forestry Officer
Mr. Nana Duku - Agricutlural Engineer
Mr. Adomako Osei-Frimpong - Ashanti Regional Diretor
Mr. Osei Akoto - MOFA Ashanti Region
Mrs. E. Tekpety - Chief Director
Mr. C.A. Atiemo - Director (Finance & Administration)
Mr. Tachie-Menson - Technical Director (Lands)
Mr. James Adjei - Technical Director (Mines)

United States Embassy Participants:
Yaw Asante-Kwabiah - Foreign Agriculture Service (FSA)
Dr. Fenton Sands - United States Agency on International Development (USAID)
Hans Wechsel - United States Embassy

APPENDIX D - Work Schedule

ASSESSMENT TRIP TO GHANA AUGUST 18-28,2001

Friday, August 17, 2001

- Larry Clark and NRCS Team depart Washington, D.C., Dulles Airport (NW)

Saturday, August 18, 2001

- NRCS Team arrives in Accra, Ghana (Check in at La-Palm Royal Beach Hotel

Sunday, August 19, 2001

- Briefing by Yaw Asante-Kwabiah (at La-Palm Royal Beach Hotel)

Monday, August 20, 2001

- Breakfast meeting : NRCS Team, Mr. Hans Wechsel - ECON OFF; Dr. Fenton Sands, Chief TAPS, USAID at La-Palm Royal Beach Hotel

- NRCS Team meets with Dr. Francis Ofori, Ag. Chief Director, Ministry of Food and Agriculture (at Chief Director's Office - MOFA. Ghanaian Team members introduced.
- Team meets with Dr. Kwaku Afriyie, Minister, Lands and Forestry
- Team meets with Prof Dominic Fobi Minister, Environment, Science, and Technology
- Team meets with Major Courage Quarshiga, Minister, Food and Agriculture
- NRCS Team returns to La-Palm Royal Beach Hotel for Lunch and check-out and departs Accra for Koforidua (enroute to the Afram Plains); NRCS Team arrives in Koforidua (lodging at ST. JAMES HOTEL)

Tuesday, August 21, 2001

- Team departs Koforidua for the Afram Plains
- NRCS Team arrives at Donkorkrom, Afram Plains (lodging in a GUEST HOUSE arranged by MOFA)
- Lunch for Team (either on the road or at Donkorkrom)
- Team starts field and site reviews on the Afram Plains

Wednesday, August 22, 2001

- Team departs Donkorkrom for Agogo
- Team arrives in Agogo; Lunch for the NRCS Team
- Team conducts field and site reviews on the Afram Plains in the Agogo District
- Team arrives in Kumasi (lodging at HOTEL GEORGIA and other areas)

Thursday, August 23, 2001

- Team departs Kumasi for Kumawu
- NRCS Team meets Chief Barima Asumadu Sakyi II and the people of Kurnawu Paramount. Chief of Kumaw Traditional Council will preside.
- Team conducts field and site reviews on the Afram Plains in the Kumawu District
- Team departs Kumawu for Kumasi (lNRCS Team lodging at HOTEL GEORGIA)

Friday, August 24, 2001

- NRCS Team visits Research Institutions under the Council for Scientific and Industrial Research (CSIR): Soil Research Institute (SRI); Crops Research Institute (CRI); and Forest Research Institute of Ghana (FORIG)
- NRCS Team pays courtesy call on Ashanti Regional Minister, Mr. Samuel K. Boafo (at the Ashanti Regional Coordinating Council Secretariat) - cancelled.
- NRCS Team pays courtesy call on the Asantehene, Otumfuo Osel Tutu 11 (at the Manhyia Palace) - cancelled

NRCS Team returns to Hotel

Saturday, August 25, 2001

- Team departs Kumasi for Accra; NRCS Team arrives in Accra from Kumasi (lodging at LA-PALM ROYAL BEACH HOTEL)

Sunday, August 26, 2001

- NRCS Team wrap-up report

Monday, August 27, 2001

- NRCS Team wrap-up report meeting with US Embassy Officials (Mr. Michael Owen and Dr. Fenton Sands
- NRCS Team wrap-up report meeting with MOFA, MEST, MLF Officials (MOFA Conference Room)
- NRCS Team departs for the Kotoka International Airport, Accra, en-route to WASHDC (KLM FLT 590, 9:20 pm)

APPENDIX E - Resource Assessment Recommendation Classification

The following classifies Afram Plains resources as: Compatible and Contributing (C) or Essential Pre-Requisites (E)
We associated these components for attaining the objectives with a degree of importance: High (H), Medium (M), Low (L), or Not Applicable (NA).

Recommend-ations	**Natural Resource Conservation and Management**	**Agricultural Technology Development for Income Generation**	**Institutional Development and Capacity Building**	**Agricultural Trade and Market Access/Trade Information**	**Regulation and Safety of Food Products**	**Food and Nutrition**	**Extension, and Research**
Infrastructure Rehabilitation and Development							
• Improve Roads	E M	E M	E H	E H	E M	E M	E M
• Add ferry	E L	E M	E M	E H	E M	E H	E M
• Establish Impound-ments	C H	C H	C M	C M	C L	E H	C H
• Docking Facilities	C M	C H	E H	E H	E M	E H	E M
• Marketing Plan	C M	E H	C M	E H	E H	E H	C H
Conservation on Agricultural Lands							
• Conservation as part of leases	E H	C H	C H	C M	C M	E H	E H
• Training and education of farmers	E H	E H	E H	C M	C M	C H	C H

Continued - Appendix E

The following classifies Afram Plains resources as: Compatible and Contributing (C) or Essential Pre-Requisites (E)
We associated these components for attaining the objectives with a degree of importance: High (H), Medium (M), Low (L), or Not Applicable (NA).

Recommend-ations	Natural Resource Conservation and Management	Agricultural Technology Development for Income Generation	Institutional Development and Capacity Building	Agricultural Trade and Market Access/Trade Information	Regulation and Safety of Food Products	Foo Nut
Natural Resources Sustainability and Growth						
Soil resource utilization and development						
• Maize Project	C H	E H	C H	C H	C H	
• Diversify operations	C H	E H	C H	C H	C H	
• Increase technical assistance	E H	E H	E H	E H	E H	
• Increase crop production for food security	C H	C H	C H	C M	C M	
• School garden initiative	C H	C M	C H	C M	C M	
Irrigation development						
• Irrigation systems development	E H	E H	C H	C H	C M	
• Ponds and impound-ments	E H	E H	C H	C H	C M	
• Bore holes as a source of water	E H	E H	C H	C H	C M	

Continued - Appendix E

The following classifies Afram Plains resources as: Compatible and Contributing (C) or Essential Pre-Requisites (E)
We associated these components for attaining the objectives with a degree of importance: High (H), Medium (M), Low (L), or Not Applicable (NA).

Recommend-ations	Natural Resource Conservation and Management	Agricultural Technology Development for Income Generation	Institutional Development and Capacity Building	Agricultural Trade and Market Access/Trade Information	Regulation and Safety of Food Products	Foo Nut
Deforestation						
• Enhance replanting of trees	E H	C H	C H	C M	NA	
• Plan rotations	E H	E H	E H	C H	NA	
• Planned burning with firebreaks	E H	E H	E H	C L	NA	
• Use of sawmill by products	C M	C H	C H	C L	NA	
• Tree plantations for charcoal	C M	C H	C H	C L	NA	
• Better use of plantation products	C H	C M	C M	C L	NA	
• Provide natural gas						
Nomad cattle grazing						
• Establish prescribed grazing areas	C H	E H	C H	C L	NA	
• Planned burning for improved forage and animal distribution	C H	C H	C H	C L	NA	

Continued - Appendix E

The following classifies Afram Plains resources as: Compatible and Contributing (C) or Essential Pre-Requisites (E)
We associated these components for attaining the objectives with a degree of importance: High (H), Medium (M), Low (L), or Not Applicable (NA).

Recommend-ations	Natural Resource Conservation and Management	Agricultural Technology Development for Income Generation	Institutional Development and Capacity Building	Agricultural Trade and Market Access/Trade Information	Regulation and Safety of Food Products	F N
Land Tenure System (Government initiative)						
• Policy document	E H	E H	E H	C H	C H	
• Legal assurances to investors	E H	E H	E H	C H	C M	
• Install enduring conservation practices	EH	E H	E H	C H	C M	
Access to credit collaboration (1 year)						
Concessions to attract investors	E H	E H	E H	E H	E H	
Promote entrepreneurship	C H	C H	C H	C H	C M	
Minimize capital intensive inputs initially	C H	C M	C H	C M	C L	
Encourage and support newly entering producers	C M	C H	C H	C M	C M	
Change Ghanaian National Agricultural Development Bank policies	E H	C H	C H	C H	C L	
Reduce risk and skills deficiency	E H	E H	E H	E H	E H	

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