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Emerging Technologies for Building Resilience to Climate Change Effect: A Case Study in Dangbe East District of the Republic of Ghana

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Abstract

The conversion of the kinetic energy in wind into electrical energy offers unique solution to the overall energy supply where resource exists as well as partial solution to the world's over dependence on exhaustible primary energy sources such as fossil fuel and their consequences which include climate change, extinction of aquatic life during spillages and so on. The coastlines of Ghana present significant wind potential which when properly harnessed could provide alternative livelihood opportunities and speed up climate change adaptation processes in those communities hard-hit by climate change effects. To establish the technical and economic potential of wind resource for energy production and productive application, there is the need to investigate the baseline frameworks and use optimized wind energy tools to generate results for effective wind energy planning. Ground wind data search and analysis, overall energy situation and energy policy environment formed the core of establishing the technical potentials and economic opportunities of wind energy in the Dangbe East District. A wind data analysis was done to establish the wind energy potential and a survey identifies innovative mechanisms adopted for building resilience and tracks changes in behavioural practices to adapt to climate change effect. A total of 360 small-scale farmers were interviewed. Phenomenal changes in weather conditions and climate events observed by respondents include erratic and unpredictable rainfall patterns with poor distributions, high temperatures with hot sunshine conditions, drought and heavy precipitations/floods. Key innovative technologies employed to adapt to climate change effects include soil management practices that reduce fertilizer use and increase crop diversification; promotion of legumes in crop rotations; use of quality seeds and integrated crop/livestock systems; avoidance of bush burning as well as burning crop residues; introduction of drought, flood and saline-tolerant crops and using improved, high yielding and drought resistant varieties. Less than 30% of the farmers interviewed had relocated close to water bodies (River Volta), especially for minor season farming while 42% had diversified into other alternative livelihood options. Farmers strongly considered provision of irrigation services by government and non-governmental organisation, credit and availability of improved agro-technologies as well as education key in building resilience to climate change effects.

1. Introduction

Climate change is the single most pressing issue facing the world today (IPCC, 2007). The poor are becoming increasingly vulnerable to the effects of climate change and their livelihoods are gradually being eroded. Millions of people are likely to be plunged into poverty and millions more will die of its effects. Ghana has just tasted its share of climate change related catastrophes: the 2007 energy crisis and the repeated patterns of droughts and floods in recent years are evidence. Over the past five years, climate change and its effects have increasingly taken centre-stage in the Ghanaian development agenda. Various stakeholders have been working to address the effects of climate change. Adaptation strategies are localized in context and are gradually being developed to enable communities and individuals build resilience to the effects of the change. Undoubtedly, agriculture is rainfall dependent. A drop in the annual precipitation rates therefore negatively affects agriculture production. Small holder and subsistence farmers in rural areas including those of Dangbe East District are mostly affected often resulting in high poverty levels.

One classical adaptation strategy that this project sought to explore is the use of renewable energy sources to push the drive for climate change adaptation in vulnerable rural communities especially those along the coast of Ghana. Wind energy can play a significant role in reducing greenhouse gas emissions, fostering sustainable economic development, enhancing energy security and accelerating adaptation to climate change where sustainable energy requirement is key. Wind resource in these rural communities could be harnessed to accelerate the adaptation process particularly in the use of new agricultural technologies for pre-production, production and post production practices. This resource could be used to develop irrigation potentials of the area. Ghana has an appreciable wind resource for power generation and the government is actively working to realize this potential. Energy is a primary requirement to drive every sector of the economy including agriculture which is currently rain-fed. The Government of Ghana, through its Strategic National Energy Plan (SNEP), has set a goal to increase non-hydro renewable energy generation to 10% (380MW) of the national generation capacity by 2020. To this end, the Government has launched initiatives to develop an appropriate regulatory and policy environment. Specifically, the Ministry of Energy (MoEn) is currently preparing a renewable energy policy and regulatory framework and drafting a Renewable Energy Bill to facilitate commercial-scale application of renewable energy technologies. Preliminary wind resource assessments results give annual average wind speeds of ca 5.6 ms-1 at 12m in locations spread along the coastal areas. It is estimated that gross wind electric potential is ca 5.6GW according to the SWERA Project (Table 1). About 2.6GW can be tapped and developed for energy production.

Table 1: Wind Resource in Ghana at 50 m

Wind Resource Designation	Wind Class	Wind Power at 50 m W/m^2	Wind Speed at 50 mm/s*	Total Area km^2	Percent Windy Land	Total Capacity Installed MW
Moderate	3	300 – 400	6.4 – 7.0	715	0.3	3,575
Good	4	400 – 500	7.0 – 7.5	268	0.1	1,340
Very Good	5	500 – 600	7.5 – 8.0	82	<0.1	410
Excellent	6	600 – 800	8.0 – 8.8	63	<0.1	315
Total				**1,128**	**0.5**	**5,640**

Source: SWERA_UNEP Project Report 2002. Assumptions: Installed capacity per km2 = 5 MW; total land area of Ghana = 230,940 km2

2. Objectives

The specific objectives of this working paper are to:

(i) Conduct Resource Data Search and Analysis for the selected community based on best industrial practice to obtain data of good quality to stimulate and boost further exploration of wind energy potential in the area;

(ii) Identify and document effective indigenous and emerging technologies and innovations for climate change adaptation in the study area;

(iii) Make policy recommendations for building climate change resilience

3. Literature Review

Ghana has regions of proven moderate to excellent wind resource. The country records average wind speeds of ca 5.6m/s at 12m in locations spread near and along the coastal areas. Studies have shown that regions of excellent wind climates are the mountainous areas spread widely in the Volta, Northern and Eastern regions. Estimated 2.6GW of electrical energy can be derived from wind[1]. The interest in wind energy exploration for energy purposes in Ghana started in 1999 through the solar wind energy resource assessment (SWERA 1999-2002) project. The relatively high investment cost in wind and other renewable technologies coupled with energy storage difficulties accounts for the low uptake in many sub-Saharan Africa countries. In the coastal areas of Ghana where agriculture is predominantly the mainstream economic activity, wind energy development offers energy production and water storage for irrigation opportunities.

The global annual installed wind capacity continues to register record highs. In 2009, a total of 37,466 MW new capacities were installed and the world cumulative installed capacity is 157,899MW. Ironically, Africa continues to be the region with the lowest wind energy penetration-most of its share come from the North and Middle East regions.

By the end of 2009, total installed capacity of wind power on the continent and the Middle East was nearly 900 MW mainly in North Africa and the Middle East. Sub-Saharan Africa SSA has not experienced any significant growth in wind power development. Africa's share represents less than a percent of the total global installed capacity. Regarding wind data availability, precise information about wind potential barely exists.

[1] *EC/SWERA 2002*

4. Methodology

4.1 Review of EC / SWERA Data

Wind data was collected using NRG Wind Explorer logger and NRG 40 anemometer and 200P wind vane (one each). The instruments were mounted on booms attached either to tilt-up tubular towers (same or similar to NRG "Tall Towers") or to existing telecommunication lattice towers. Prior to the installation, data for the Dangbe East was reviewed and analyzed to determine basic wind parameters including annual average wind speeds, directional wind roses, shearing to hub height of 80m, determination of energy yield, etc. Details are presented in the subsequent sections. All accessible data from the above measurement campaign was obtained by TMT Energy from the EC, reviewed for completeness and quality. It is important to note that this appraisal of the wind regime is for "prospecting" purposes only; the data set described in this report is far from being "bankable". It is important to understand and keep in mind the limitations of the existing data set for the study area.

These include:

> Minimal instrumentation (i.e. no redundant sensors to confirm measurements, no sensors at multiple heights to determine wind shear) and Low tower heights;
> No temperature sensor (thus not possible to calculate pressure and density adjustments for energy yield estimates);
> Very rudimentary "NRG Wind Explorer" data logger (many of the detailed wind parameters that are captured as part of standard 'bankable' WRAs cannot be recorded) and Lost or corrupted data;
> Missing or insufficient documentation trail and metadata for existing data.

4.2 Site Description

The Dangme East District is located in the Eastern part of the Greater Accra Region within latitudes 5°45 south and 6°00 north and from Longitude 0°20 west to 0°35 East. Dangbe East district shares common boundaries with Central Tongu, South Tongu and Dangme West Districts at the north, east and west respectively. At the south is the Gulf of Guinea, which stretches over 45 kilometers (27.9 miles). The District covers a total land area of about 909 sq km (350 sq miles); about 28% of the total area of the Greater Accra Region. By vegetation, the district is coastal savannah. A few stands of the mangrove tree can also be found around the Songor lagoon and the tributaries of the Volta River where the soil is waterlogged and salty (Dickson & Benneh, 1980). Dangbe East district consists of both farming and fishing communities and forms part of the eastern coastal plains of Ghana. Heavy rainfall occurs between March and September with an average distribution of 750mm but also have extreme dry spells during the harmattan. Humidity is about

60% due to proximity to the sea, Volta River and other water bodies. Figures 1 and 2 present photographs of the towers and sites, where available. Tables 2 and 3 present descriptions of the Dangbe East District which include the site coordinates and topography, access, extent and nature of habitation and/or cultivation.

Fig. 1 and 2 - Ada Foah

Table 2: WRA Site Descriptions

No.	Site Name	Coordinates Lat	Long	Anemometer height [m]	Measurement Period [date]	Topography	Access	Nature of habitation/ cultivation
1	Ada Foah	05° 79N	00° 55E	12	Jun 99-Sept 00	Flat, low vegetative growth	Good access road and about 1 hour drive from Accra	Concentrated settlements fishing, crop farming

NB: The coordinates in Table 2 are those obtained from the Energy Commission. It is important to note that the EC mast location/coordinate is today in or close to settlements or very near the sea. Hence, the exact position is therefore generally not suitable for further investigation and development.

Table 3: Summary of Sites Description

No.	Name of Site	Altitude above sea level [m]	Anemo-meter Height [m]	Data period (months)	Annual mean wind speed [ms-1]	Wind speed @ 80m* [m/s]	Type of Tower	Recovery Rate (%)	Overall Data Quality	Remarks
1	Ada Faoh	N/A	12	16	5.3	7.6	Guyed Tower	90.9	Good	16 months of recorded data, Aug 99 data missing, tubular guyed tower.

* *Wind speeds at 80m based on assumed shear exponent of 0.16*

4.3 Field Survey

A total sample size of 360 farmers (82% males; 18% females with an average household size of 7) was interviewed in the Dangbe East district. This covered 12 community agricultural operational areas (Table 4). Thirty (30) farmers were randomly selected for interview in each of the selected agricultural operational areas. A structured questionnaire was used for one-on-one interview. This was supplemented with information gathered through informal interviews with key informants in the farming communities. Secondary data was sourced mainly from the internet and in-house literature depot. Data collected was cleaned, validated and later analysed with SPSS version 16 and excel.

Table 4: Operational Areas Surveyed

Operational Area	Communities Surveyed
AKJ	Hwakpo, Addokope, Ebeneza, Luhour & Nuhaley
AB	Faithkope, Manaikpo & Dogo,
DTA	Agbedrafoh, Adjumanikope, Toflokpo, Bornikope, Sege, Kpotsum & Koluedor
FA	Talebanya, Cesarkope, Tugakope, Agbenyegakope & Adodogdjikope
GA	Mangoase-Kenya, Dorgobom, English Kenya, Mangoase-Kenya & CeasarKope & Panya
IKB	Koluedov & Matsekope
ML	Asigbekope, Fantevikope, Atiadenyigba, Tojeh, Aditcherekope & Zuenor
MEO	Kadja Dornya, Tamatoku, Amanikope, Kadja Sega, Kadja Juam
MA	Tsrikopey, Gorm, Mensahkope, Obane, Attortorkorpey, Kenonya & MacCarthykope
PD	Songutsokpa, Ocansekope, Anyakpor, Adedetsekope & Totimekope
RW	Gbanave, Aborsikope, Amlakpo & Kopehem
SJJ	Korleykope, Kasseh, Bedeku & Kunyenya

5. Field Data and Analysis

This section presents the results of the wind data search and analysis for the Dangbe East District. It covers basically the wind resource assessment done by the Energy Commission as well as market potentials for wind energy investment.

5.1 Wind Distribution and Direction

Wind distribution and directions are shown in figures 3 and 4 respectively.

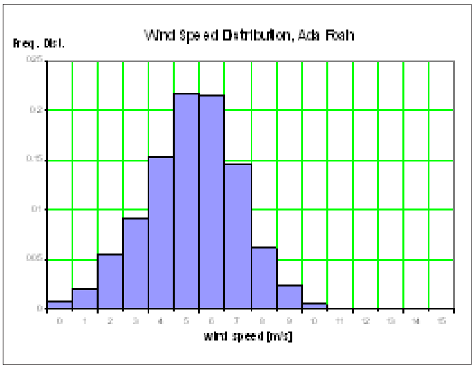


Fig. 3: Wind Distribution

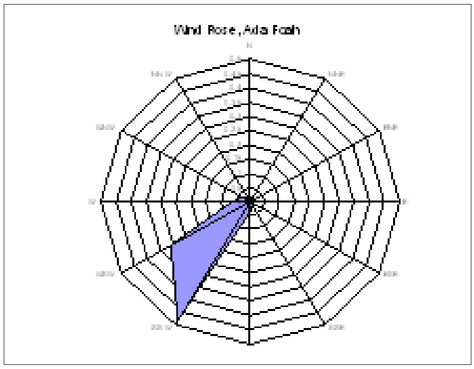


Fig. 4: Wind Directions

Table 5: Monthly Data Recovery Rate

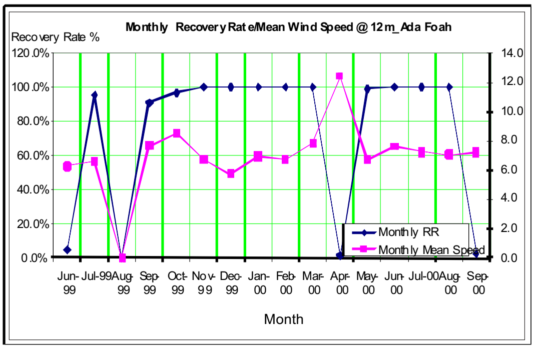
		Monthly Data Recovery Rate				Sheared Wind Speed @ [illegible]m	
	Month	Count	CountA	Rate%	Mean Speed @ 12m	0.16	0.2
1	Jun-99	209.0	4320	4.8%	4.6	6.3	6.8
2	Jul-99	4257.0	4464.0	95.4%	4.8	6.6	7.1
3	Aug-99	0.0	4464	0.0%	0.0	0.0	0.0
4	Sep-99	3943.0	4320	91.3%	5.7	7.7	8.3
5	Oct-99	4323.0	4464	96.8%	6.3	8.5	9.2
6	Nov-99	4320.0	4320	100.0%	5.0	6.8	7.3
7	Dec-99	4464.0	4464	100.0%	4.2	5.7	6.2
8	Jan-00	4464	4464	100.0%	5.1	7.0	7.5
9	Feb-00	4032	4032	100.0%	5.0	6.7	7.2
10	Mar-00	4464	4464	100.0%	5.8	7.9	8.5
11	Apr-00	75	4320	1.7%	9.2	12.4	13.4
12	May-00	4431	4464	99.3%	4.9	6.7	7.2
13	Jun-00	4320	4320	100.0%	5.6	7.6	8.2
14	Jul-00	4464	4464	100.0%	5.3	7.2	7.8
15	Aug-00	4464	4464	100.0%	5.2	7.1	7.6
16	Sep-00	93	4320	2.2%	5.3	7.2	7.8
	Overall Recovery	52323	70128	74.6%	5.3	7.0	7.5

Table 6: Simulation Results on Projected Annual Energy Output

		Hub Height 50 m		Hub Height 80 m	
		GE xle	**V82**	**GE xle**	**V82**
Capacity per turbine	MW	1.5	1.5	1.5	1.5
No. of turbines		1	1	1	1
Site capacity	MW	1.5	1.5	1.5	1.5
Ideal energy production	GWh/yr	4.0	4.0	5.1	5.2
Topographic efficiency1	%	101.9	102	101.5	101.6
Array efficiency1	%	100.0	100.0	100.0	100.0
Estimated gross annual energy output (AEO)	GWh/yr	4.1	4.1	5.2	5.3
Other Adjustments2		89.6%	89.6%	89.6%	89.6%
Estimated net AEO	GWh/yr	3.6	3.7	4.7	4.8
Estimated capacity factor (net)		27.7%	28.0%	35.5%	36.2%

Taken into account 10% wind farm, aerodynamic, electrical, operational and power curve losses and wind shear of 0.16 at hub height (50m) and (80m) respectively.

Figures 5 and 6 show monthly average wind speeds distribution and recovery rate.



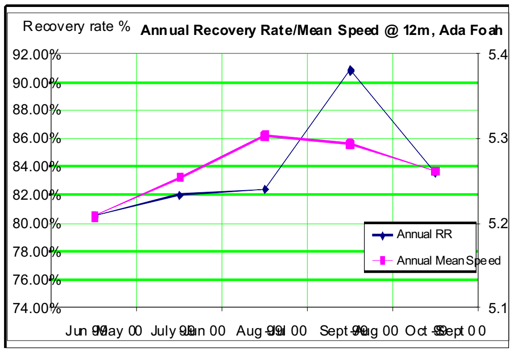


Fig. 5: Monthly average wind speeds distribution

Fig. 6: Monthly average wind recovery rate

Suggested potential wind project site

Based on the quality of available wind data, terrain and other parameters such as grid networks, road infrastructure, etc., there are several spots stretching from Sege to Ada Foah that merit further investigation. Table 7 shows a summary of the average wind speeds of Ada Foah above 7 m/s at 80m hub heights while table 8 presents the site that is suggested for further investigation as potential utility-scale wind project sites.

Table 7: Source of Wind Data for Potential Sites

Site Name	Measurement Period	Recovery Rate (%)	Annual mean wind speed @ 80m*	Turbulence intensity (%)	Remarks
Ada Foah	Sep 99-Aug 00	90.9	7.6	7.6	Good access roads, 11/33 kV grid extension exist, fairly good topography, not far from main industrial hub

**Based on assumed shear exponent of 0.16*

Table 8: Suggested Potential Project Site

Name of Site	Coordinates* (NAD 83)	Note
Tamino (closest wind data: Ada Foah)	05° 47´ 27 N 00° 33´ 14 E	Flat, exposed topography and excellent available land area for project development Site is 6km away from low/mediu m voltage distribution network and about 25km away from high voltage transmission and sub-station at Sogakofe The community is willing to lease small parcel for WRA and any size for future project development Conspicuous tree deformation by persistent wind Main obstacle to nearest high voltage transmission line is the Volta River, but a road bridge exists close to the SS at Sogakofe. The soil condition for anchor selection is sand+clay Site is about 1km away from the coast Main use of land is farming

** The coordinates shown are within a prospective project boundaries and represent preliminary suggested location where standard meteorological mast could be installed to confirm the wind resource and, if necessary, to provide 'bankable' data.*

Some of the potential wind spots are shown in figure 7. The yellow are the potential sites investigated under the SWERA initiative and the purple colour show Meteorological sites for long term wind data.

Fig. 7: Potential wind spots

5.2 Effective indigenous and emerging technologies and innovation for climate change adaptation

Climate change affects agricultural productivity and at the same time agriculture and land-use changes (deforestation) contribute significantly to climate change effects. Agriculture including crop production, pasture and livestock contributes to 13% of total anthropogenic greenhouse gas emissions (IPCC 2007). The IPCC reports that climate change will affect agricultural systems especially those in developing countries which have less adaptive capacities. The IPCC regional assessment of climate change impact in Africa revealed that by 2020, yields from rain-fed crops with particular reference to maize production in Ghana, will reduce by halve. Other negative impacts of climate change include land degradation, soil erosion, and changes in water availability, heavy precipitation, severe drought, biodiversity loss and outbreaks of pest and disease. Despite the heavily debated climate change threats to agricultural production systems at different scales, levels and frames there are indeed some opportunities. This section gives a situational analysis of climate change impacts on agriculture, adaptation measures, the opportunities and challenges (constraints), institutional support systems and suggestions by affected small scale farmers whose main economic sustenance is tied to the agriculture sector.

Climate Change Effects as perceived by respondents include erratic and unpredictable rainfall patterns with poor distributions, high temperatures with hot sunshine conditions, severe drought and heavy precipitations/floods. These phenomenal changes in weather conditions and climate events had been observed by over 80% of the sample interviewed over the past 10 years. Respondents had also experienced acid rainfall and strong wind (gust) conditions although very limited in occurrence. Table 9 presents details of percentage response to climate change effects by operational areas while Table 10 shows climate change effects on agriculture.

Table 9: Response to climate change effects

Operational Area	% Responding to Climate Change Effects						
	Erratic and poor rainfall distribution	High Temp.	Drought	Floods/Heavy Precipitation	Hot Sunshine	Acid Rain fall	Strong Winds
AKJ	100	46.7	100	96.7	50	-	-
AB	100	50	86.7	83.3	10	-	-
DTA	100	93.1	100	13.3	65.5	-	-
FA	93.3	100	100	3.2	100	6.7	-
GA	100	100	90.0	73.3	-	-	-
IKB	100	100	83.3	70.0	3.3	-	-
ML	100	90	100	6.7	3.3	-	16.7
MEO	100	100	100	13.3	-	-	-
MA	100	96.7	100	100	100	-	3.3
PD	100	100	100	100	100	-	83.3
RW	100	83.3	-	-	50	-	-
SJJ	100	100	3.3	43.3	20	-	-
Overall	99.4	88.3	80.3	50.1	41.9	0.6	8.6

Source: Survey compilation 2010. N=360; n =30/operational Area

Table 10: Climate Change Effect on agriculture enumerated by respondents in the surveyed area

Climate change effects	Observed/experienced impacts on agriculture
Insufficient rainfall Erratic and unpredictable Long period of drought followed by excessive rainfall	Affects crop development, decreased yields; increased insect pest outbreaks cause delayed planting time in some communities. Insufficient rainfall when crops actually need water and too much water when the crops do not need that much water. Cassava root formation is negatively affected by climate change effect Fishing activities are reduced drastically Livestock production is negatively affected by climatechange (lack of water and graze/feed)
High temperatures	There are heat waves associated with high temperatures. High temperatures cause bushfires, low yield and sometimes complete crop failure. High temperature disrupts activity of living organisms in the soil, low soil fertility which negatively affect crop development Crops wilt and die off especially tomatoes.
Heavy precipitation/ Floods	Damage to crops; soil erosion; inability to cultivate land due to waterlogging of soils A lot of pest and diseases emerged after heavy rains, heavy rains destroyed crops in the lowland areas The swampy areas are no longer in use. Excess water render the swampy areas unproductive; Not much value for vegetable production Heavy Precipitation caused rotting and dieback, root knots disease, flower abortion, cracks in water melon, nematode diseases and fungal diseases
Strong winds	Strong winds that come along with heavy rains caused flowers and fruits to abort or drop. Dropping of immature flowers, vegetables and fruits.
Severe Drought	Land degradation and soil erosion; lower yields from crop damage and failure; increased livestock deaths; increased risk of wildfire; loss of arable land
Sea levels increase	Salinization of irrigation water, estuaries and freshwater systems; loss of arable land and increase in alternative livelihoods Most uplands and arable lands have become saline and no more suitable for crop production

Source: Survey compilation 2010.

5.2.1 Opportunities and Constraints

Although climate change effects and impacts present diverse challenges to small-scale farmers, these farmers also appreciate some opportunities that come along with climate change. Climate Change opportunities listed by respondents can be categorised into improved farm maintenance and cultural practices (timely planting, regular weeding, timely harvesting); improved soil management practices (use of cover crops, mulching and application of organic manure,); varietal development (development of drought resistance varieties, high yielding varieties, disease resistant varieties); Additional livelihood options (cultivation of vegetables and fruits like okro and watermelon, fishing, petty trading etc, etc.) use of agro-chemicals; use of "neem extract" to control pest and disease outbreaks and improved irrigation practices (Sinking tube wells for regular water supplies). Others are construction of drainage systems in the lowlands and construction of fence against sea breeze to limit the flow of saline water on cultivable lands.

Despite the appreciable exposure level to the above listed innovative and improved technological packages, there are challenges or constraints to their applications. As reported by Hazell and Wood (2008), agricultural systems may have considerable capacity to adapt to climate change, but there are challenges. The Constraints and or challenges (Figure 8) include high cost of production as a results of escalating input prices, high prices of food crops as farmers switch from food crops production to cash crops which contribute to market dependency for household food security (cultivation of vegetables and fruits over cereals and tubers), price threats from over-supply of certain crops, post harvest losses which aggravate poverty and health risks associated with agro-chemical applications. Others are availability and accessibility of organic manure on relatively large farms. As most farmers put it frankly animal droppings are not easily available; its application is also constrained when farm size is large. Some of the technologies are actually beyond the reach of resource poor farmers. Farmers lack the resources and money to enable them apply corrective measures effectively and efficiently. Examples cited are high cost of irrigation facilities, high cause of double nursery establishment and cost of improved varieties.

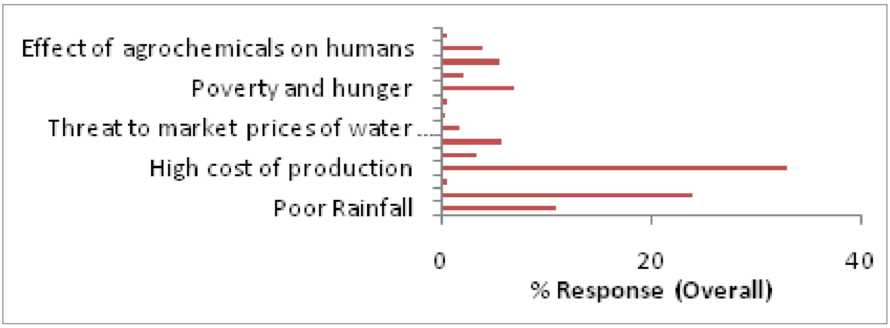


Fig. 8: Constraints due to climate change effects

5.2.2 Mechanisms for building resilience/adaptation to climate change

Fussel (2007) defines adaptation to climate change, as measures which moderate the adverse effects of climate change through a wide range of actions that are targeted at the vulnerable system or population. A variety of adaptation options contribute to mitigation. Among these measures are: soil management practices that reduce fertilizer use and increase crop diversification; promotion of legumes in crop rotations; increasing biodiversity, the availability of quality seeds and integrated crop/livestock systems; promotion of low energy production systems; improving the control of wildfires and avoiding burning of crop residues; as well as promoting efficient energy use by commercial agriculture. Others are introducing drought, flood and saline-tolerant crops, improving breeding and farming techniques, developing local food banks for people and livestock, and improving local food preservation.

Climate change affected crop development and had caused decrease in productivity of both crops and livestock. Crops badly affected included vegetables only (44%) and vegetables and others like maize (56%). Therefore small-scale farmers need to build resilience/adaptive capacity to adapt to climate change impacts. Climate change effects are wide spread and interrelated. Climate change effects experienced by farmers interviewed include Pest & Disease outbreaks, changes in water availability, severe drought, land degradation, reduction in arable lands, soil erosion and floods/heavy precipitation in decreasing order of importance. In this report details of responses on the first four climate change effects are presented.

5.2.3 Pest and Disease outbreaks

From farmers interviewed in the Dangbe East district, pest and disease outbreaks are prevalent in severe drought conditions and also heavy precipitations (examples are leaf curl and blight diseases in tomatoes). In decreasing order of importance (Figure 9), the most commonly used innovations or technologies adopted to reduce impact of pest and disease outbreaks include the use of agrochemicals (fungicides, pesticides), use of "neem tree" extract, crop rotation and the use of disease free seeds for planting as well as hygiene practices on farms. Some farmers also mentioned nursing of maize seed before transplanting because rodents pick maize seeds sown directly. Maize seeds are nursed for 7-10days for the cotyledons to establish before transplanting.

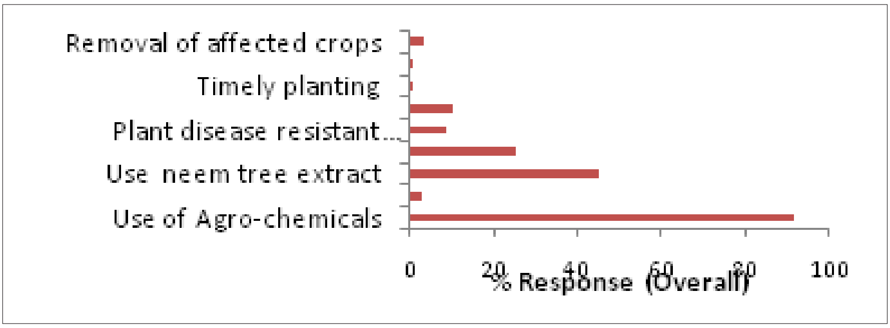


Fig. 9: Response to innovations to check pest & disease outbreak

5.2.4 Severe Drought

Severe drought conditions as a result of climate change effects cause land degradation, soil erosion, increased risk of bush fires, loss of arable lands, crop damage and lower yields, sometimes complete crop failure. Commonly adaptive innovations/technologies used by farmers interviewed include storage of water for irrigation, mulching and application of organic manure to improve water holding capacity of soils, cultivation of short maturity crops and varieties as well as drought resistant crops and varieties. Other innovative adaptation strategies are the use of water satchel rubber under crops as a check against severe drought. However most farmers considered drought as natural and seasonal occurrence and therefore are not encouraged to apply adaptive measures. At the community level tree planting on farmlands is encouraged to reduce severe drought impact.

5.2.5 Changes in Water availability

Innovations/technologies adopted by farmers to contain changes in water availability were largely irrigation, construction of wells for water storage, mulching to improve water holding capacity of soils, planting of soil covers crops, cultivation close to water bodies, cultural practices such as regular weed control, early ploughing and planting (Figure 10).

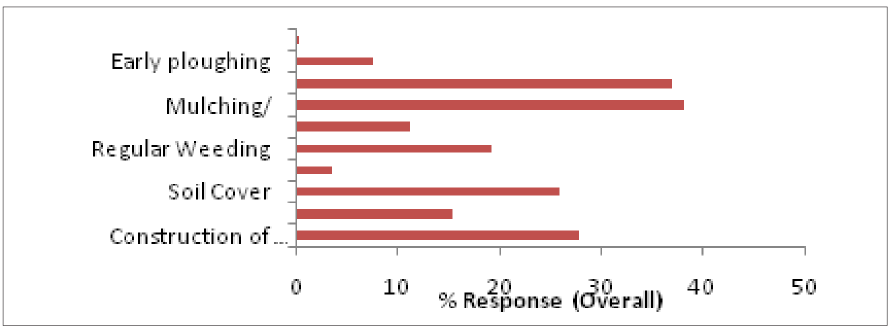


Fig. 10: Response to innovations to check changes in water availability

5.2.6 Land Degradation

From literature, there are many and complex linkages between agriculture and land degradation. Farming in areas of fragile soils, poor management of crop, soil and water interaction, and unsustainable exploitation of soil nutrients are some of the major causes of land degradation (Lal 1997). According to Wood et al (2000) only some 16% of croplands globally are inherently free of soil constraints, and that figure is as low as 6–7% in Southeast Asia and sub-Saharan Africa. However this survey focused on the climate change effects on land degradation and not causes from agricultural practices although the two are highly interlinked. Figure11 presents emerging innovations/technologies adopted by farmers interviewed to reduce land degradation caused by climate change effects

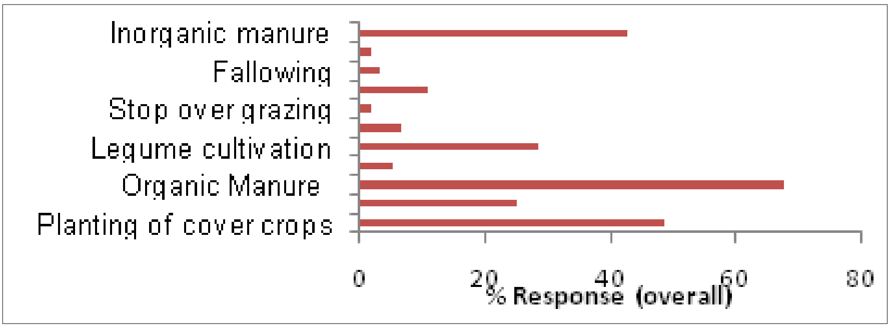


Fig. 11: Response to corrective measures against land degradation

5.3 Changes in Behavioural Practices to Adapt to Climate Change

From literature, in many cases people will adapt to climate change simply by changing their behaviour. This may involve relocation and/or changing occupation. Often farmers affected by climate change effects and impacts will employ different forms of technologies such as new irrigation systems or drought-resistant seeds which are considered 'hard technologies', or 'soft' technologies, such crop rotation patterns. In most situations a combination of hard and as insurance schemes or soft technologies are employed. Farmers interviewed in the Dangbe East district had either relocated their farms and/or diversified into alternative livelihood options. None had changed occupation completely since they explained that farming is part of their culture. As some farmers put it "farming is the only occupation we have there is no other alternative". However changes in crop type cultivated were observed. Currently most farmers cultivate crops that do not need much water for growth like water melon. Less than 30% of the farmers interviewed had relocated close to water bodies (River Volta), especially for minor season farming. Farmers relocated to fertile lands and also moved to Yeiji to fish in addition to farming (seasonal migrants). Farmers relocate when there is flood or heavy precipitation but come back later (after a while; leave the land to fallow). Farmers relocate from marshy areas to higher grounds

Majority (97.5%) indicated that their farmlands could not have supported crop development but for the application of improved agricultural practices. Corrective measures applied include organic manure (92%), use of inorganic fertilizer (90%) and Crop rotation (28%). Diversified economic activities among farmers interviewed include fishing, mushroom cultivation, livestock rearing, grasscutter rearing, salt mining and bee keeping. Others are petty trading, artisanal jobs, gari processing, hairdressing and soap making, basket weaving, bricks making. Some farmers migrate to urban centres in search for off-farm jobs.

5.4 Organizational Innovation and Suggestions from Farmers

The most effective adaptation approaches in developing countries, as highlighted in UN Framework Convention on Climate Change (UNFCCC) meetings, are those that address a combination of environmental stresses and factors. Strategies, policies and programmes that are most likely to succeed need to link with coordinated efforts aimed at alleviating poverty, enhancing food security and water availability, combating land degradation and soil erosion, reducing loss of biological diversity and ecosystem services. Indeed farmers interviewed had benefited from organisational support from various government and non-governmental agencies/organisations. Such organisations currently operational in the Dangbe East district includes Ministry of Food and Agriculture (MOFA) and Adventist Relief Agency (ADRA); both operational in almost all the communities surveyed and involved in technology dissemination. Others are forestry department (into afforestation programmes), Wildlife (wildlife conservation), the media (Radio Ada) and other projects mostly involved in food security issues.

Farmers suggested provision of irrigation facilities and credit, availability of inputs, public education on climate change, alternative livelihoods and extension of improved agricultural practices for effective mitigation against climate change impacts.

6. Conclusions & Recommendations

The Dangbe East District has fairly flat topography, low vegetative growth, relatively good infrastructure and sufficient land mass for wind energy development and agriculture. At 80m, the area has sheared annual wind speed of 7.6m/s (based on available rudimentary wind data). The predominant wind direction is south-west. Land mass around the site where data was collected has reduced in size as a result of persistent sea erosion and new settlements. As a result, the development of utility scale wind energy project is technically impossible within the measurement site. However, towards the South-Western part of the Dangbe East (Pute,Alavanyo and Tamino) where agricultural and fishing are mainstay economic activities, there is sufficient land area that can support utility scale wind energy project. Again, since wind resource is site specific, it would be of immense help if areas with good wind resources are properly demarcated and protected. This will help monitor and control the uncoordinated use of potential wind sites for other activities. From the situational analysis of the climate change effects on agricultural practices in Dangbe East district of Ghana, most farmers are challenged by the high cost involved in adaptation of innovative technologies to build resilience. Linked to constraints posed by climate change effects are opportunities mostly in the form of improved agro-technologies and economic diversification. Some adaptation measures disrupt traditional food production systems thereby compromising their community and household food security. Farmers strongly recommended provision of irrigation services, availability of improved agro-technologies and education as key in building resilience to climate change effects. To promote climate change strategies, efficient agro-technological improvement need to be strengthened substantially in Ghana as well as efficient interface between policy-makers, researchers and the farming community through regular dialogue and institutional support. Ghana's wind potential and market opportunities, available local expertise, good democratic structures and interest and facilities for renewable energy development makes it imperative to develop adequately sustainable renewable energy path for climate change adaption in worst affected areas where renewable energy resources exist.

References

1. Dickson KB and G Benneh (1980). A new Geography of Ghana Longmans, London pp 23-45

2. FAO(2008) Climate Change Adaptation and Mitigation in Food and Agriculture Sector. Technical background document from expert consultation held on 3-7 march 2008, FAO, Rome

3. Fussel H-M (2007) Vulnerabillity: A generally applicable conceptual framework for climate change research. Global Environmental Change 17:155-167

4. Ghassemi F, AJ Jakeman and H A Nix (1995) Salinization of land and water resources: human cases, extent, management, and case studies. Wallingford, UK: CAB International

5. Hazell P and S Wood (2008). Drivers of change in global agriculture. Phil Trans R Soc B 2008, 363, 495-515

6. IPCC (2007) Intergovernmental Panel on Climate Change. Expert Meeting - Integrating

7. Lal R (1997) Degradation and resilience of soils. Phil. Trans. R. Soc. B352, 997-1010

8. Wood S, Sebastain K and SJ Scherr (2000). Pilot analysis of global ecosystems:agroecosystems. A joint study by the international Food Policy Research Institute and the World Resources Institute, Washington, DC.

9. Meyer-Renschhausen M and FH-Damstadt (2004); Investment Analysis, Energy Investment Decision Making. Strategies Unlimited with U.S. Windpower, Inc. The Potential for Wind Energy in Developing countries

10. Ahiataku-Togobo W (2005) of Renewable Energy for Poverty Alleviation and Sustainable Development in Africa, The Ghana Experience in Funding Rural/Renewable Energy Through Levies on Fossil Fuels and Electricity. A paper presented Policy Dialogue Conference

11. Ministry of Energy, Republic of Ghana (2006);Assuring Ghana's Energy Security for the 21st Century: National Energy Policy

12. Ghana Energy Commission (2006); Licensing Manual For Service Providers In The Electricity Supply Industry

13. National Renewable Energy Laboratory (1997); Wind Resource Assessment Handbook, Fundamentals for Conducting a Successful Monitoring Programme.

14. Internationale Weiterbildung und Entwicklung GmbH (2004); Wind Regimes of Africa-Comparative Evaluation of Wind Data from Selected Countries,

15. Global Wind Energy Council (2009); Global Wind Install Capacity

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