IITA
Research to Nourish Africa

Characterization of Maize-Producing Communities in Benin, Ghana, Mali, and Nigeria

West Africa Regional Synthesis Report

T. Abdoulaye, A.S. Bamire, A.N. Wiredu,
M.N. Baco, and M. Fofana

CIMMYT MR
International Maize and Wheat Improvement Center

www.iita.org

Drought Tolerant Maize for Africa (DTMA) Project Community Surveys

Characterization of Maize-Producing Communities in Bénin, Ghana, Mali, and Nigeria

West Africa Regional Synthesis Report

T. Abdoulaye[1]*, A.S. Bamire[2], A.N. Wiredu[3], M.N. Baco[4], and M. Fofana[5]

January 2012

[1]* International Institute of Tropical Agriculture, Ibadan, Nigeria and Corresponding Author: Tel: +234 8033898900; Email: T.Abdoulaye@cgiar.org
[2] Obafemi Awolowo University, Ile-Ife, Nigeria
[3] Savannah Agricultural Research Institute, Tamale, Ghana
[4] Institut National de la Recherche Agronomique du Bénin (INRAB), Parakou, Bénin
[5] Institut d'Economie Rurale (IER), Bamako, Mali

IITA
Africa has complex problems that plague agriculture and people's lives. We develop agricultural solutions with our partners to tackle hunger and poverty. Our award-winning research for development (R4D) is based on focused, authoritative thinking anchored on the development needs of sub-Saharan Africa. We work with partners in Africa and beyond to reduce producer and consumer risks, enhance crop quality and productivity, and generate wealth from agriculture. IITA is an international nonprofit R4D organization established in 1967 and governed by a Board of Trustees. It is a member of the CGIAR Consortium.

OAU
The Obafemi Awolowo University is a comprehensive public institution established in 1962 as The University of Ife. The University provides facilities for learning, promotes the advancement of knowledge by research and other means, and practically applies this to social, cultural, economic, scientific and technological problems in the nation. The University has a memorandum of understanding with IITA.

DTMA
The Drought Tolerant Maize for Africa (DTMA) Project is jointly implemented by CIMMYT and IITA, and is funded by the Bill & Melinda Gates Foundation and the Howard G. Buffett Foundation. The project is part of a broad partnership involving national agricultural research and extension systems, seed companies, non-governmental organizations, community-based organizations, and advanced research institutes, known as the Drought Tolerant Maize for Africa (DTMA) Initiative. Its activities build on longer-term support by other donors, including the Swiss Agency for Development and Cooperation (SDC), the German Federal Ministry for Economic Cooperation and Development (BMZ), the International Fund for Agricultural Development (IFAD), the United States Agency for International Development (USAID), and the Eiselen Foundation. The project aims to develop and disseminate drought tolerant, high-yielding, locally adapted maize varieties and reach 30–40 million people in sub-Saharan Africa with better technologies in 10 years.

CSIR/SARI
The Savannah Agricultural Research Institute (SARI) is a research institute mandated to conduct agricultural research, on food and fiber crops in northern Ghana. For the purpose of introducing improved technologies to enhance agricultural productivity, the institute, in close collaboration with typical farm households, in the various agro-eclogical zones, develops options of production techniques which are compatible with farm households and which enhance the capacity of farm families to increase crop production per unit area without injury to the environment. Given its farming systems orientation, the institute has programs for all the major crops cultivated in northern Ghana, including sorghum, millet, maize, rice, groundnut, cowpea, bambara beans, pigeon pea, soybean, yam, cassava, cotton, and vegetables.

UP
The Université de Parakou, created in 2001 is the second university of Bénin Republic. It is a public higher education institution with a mission that includes teaching, fundamental and applied research, and providing support to development. It is managed by a chancellor (Recteur) under the supervision of the Ministry of Higher Education and Scientific Research-Bénin.

IER
The Institut d'Economie Rurale (IER) is the national agricultural research institute for Mali. Its main mandate is to conduct studies and research for the development and the advancement of knowledge in the field of agriculture. To this end and in close relation with the related ministerial departments, it is charged to develop and implement agricultural research, carry out research on production systems and natural resources management programs; develop technologies; disseminate results of research and studies; contribute to training and information science; provide services; create, develop, and introduce new varieties to satisfy the needs of producers; define technical support packages for new varieties; keep plant genetic resources; contribute to training of stakeholders in the seed sector; and produce breeder and foundation seed. As at 2010, it has about 815 staff that included 10 international researchers and 246 national researchers.

IITA Ibadan, Nigeria

Telephone: (+234-2) 7517472
Fax: +44 208 7113786
E-mail: iita@cgiar.org
Web: www.iita.org

Headquarters from outside Nigeria:
IITA, Carolyn House, 26 Dingwall Road, Croydon, CR9 3EE, UK

Within Nigeria:
PMB 5320, Oyo Road, Ibadan, Oyo State

ISBN 978-978-8444-01-5

Correct citation: Abdoulaye, T., A.S. Bamire, A.N. Wiredu, M.N. Baco, and M. Fofana. 2011. Project Community Surveys. Characterization of Maize Producing Communities in Bénin, Ghana, Mali and Nigeria. West Africa Regional Synthesis Report. Drought Tolerant Maize for Africa (DTMA) 18 pp.

Printed in Nigeria by IITA

Contents

Tables

Acronyms and Abbreviations

AEZ	agroecological zone
CBO	community based organization
CIMMYT	International Maize and Wheat Improvement Center
DTMA	Drought Tolerant Maize for Africa
FGD	focus group discussion
GPS	Global Positioning System
IITA	International Institute of Tropical Agriculture
LGA	Local Government Area
masl	meters above sea level
NARS	national agricultural research systems
NGO	nongovernmental organizations
OPVs	open-pollinated varieties
SSA	sub-Saharan Africa

Acknowledgments

We acknowledge the authors of other individual country reports, Dr K.O. Gyasi, Ghana; and N. Coulibaly, Mali, Drs. D. Sanogo, A. Langyintuo, W. Mwangi, and R. LaRovere are recognized here for their efforts in initiating, supporting, and coordinating these surveys that were conducted as part of the CIMMYT–IITA DTMA project. This covers 13 African countries and is funded by the Bill & Melinda Gates Foundation. The responsibility for any error or omission, however, rests with the authors.

Executive summary

Maize is becoming increasingly important as a food security crop in West Africa. However, recurring droughts constitute a continuous challenge to its production. Attempts at addressing the drought problem resulted in the conduct of a participatory community survey of maize production systems with about 20–40% probability of drought risk in four DTMA countries (Bénin Republic, Ghana, Mali, and Nigeria). The project is part of an initiative to develop and disseminate appropriate drought tolerant maize varieties in sub-Saharan Africa. The main objectives of the community survey were to complement household survey data, capture essential qualitative information and data that are difficult to obtain through formal household surveys, and serve as a pilot application for potential expansion through the African region. The survey was conducted in selected communities in two districts with high levels of maize production in each of the DTMA countries.

Results show that maize is a major source of food and cash for smallholder farmers. Community members indicated that both positive and negative changes have taken place in the subregion over the 10-year period. Among these, the introduction and adoption of new DT maize varieties have contributed to achieving food security and poverty reduction, as well as enhanced livelihoods for the people. However, appropriate and adequate provision of production inputs (such as fertilizers, good quality seeds, and herbicides) is essential for achieving the optimum yield of DT maize. Constraints to production include long distances to input markets and the consequent high costs of transportation that make it very difficult for most farmers to get access to inputs. Bad road networks, lack of good quality drinking water, and poor health facilities which are common problems faced by farming households are also detrimental to agricultural productivity.

Women in the subregion are also committed to farming but constrained by cultural and religious factors. Women have special roles such as in the cultivation of oil seed crops and vegetables on small parcels of land to provide additional income to the household. Thus, making men within farmers' organizations more aware and appreciative of the value of women's contributory role in the household will further help to achieve improved food security in the region.

Introduction

This study is part of the Drought Tolerant Maize for Africa (DTMA) project that aims at addressing the shortfalls in maize production resulting from drought through the development and dissemination of appropriate cultivars. African countries have experienced intense climate change during the twenty-first century, as evidenced by the modification of the rainfall regime, and a reduction in annual rainfall. This has resulted in the depletion of the environment and the concomitant reduction of crop yields (Hodson et al. 2002). Cereal crops, such as maize, seem to be the most affected by climatic changes. Drought affects about 35% of the maize growing area in west and central Africa and results in a continuous decrease of the crop output from year to year. According to Smith et al. (1997) and FAOSTAT (2006), maize is one of the basic staple foods of communities in the drought prone countries in sub-Saharan Africa (SSA) where over 650 million people currently consume annually an average of 43 kg of maize/person–a 35% increase since 1960. The demand for maize for food, animal feed, and industrial use is increasing rapidly as the population expands across the region and incomes rise in some areas. Among different income groups, maize, compared with other cereals, is a relatively more important source of both calories and protein for the poorer consumers (Byerlee and Eicher 1997). With more than 50% of all SSA countries assigning to maize over 50% of their area planted to cereal crops, increasing the productivity of maize based cropping systems is strategically important for the food security and socioeconomic stability of the countries and the subregion.

The DTMA project builds upon previous successes and on-going research, and steps up the development of new maize varieties with dramatically improved levels of drought tolerance. The vision of the project is to generate by 2016 (year 10) maize varieties with 1 t/ha yield potential under drought stress conditions, increase the average productivity of maize under smallholder farmers' conditions by 20–30% on adopting farms, reach 30–40 million people in SSA, and add grain with an annual average value of US$160–200 million in drought affected areas. This project proposes to reach a greater number of poor farmers in SSA with open-pollinated (OPVs) and hybrid varieties with higher levels of drought tolerance to reduce farmers' vulnerability, increase their food security, and improve their livelihoods in drought years. In this respect, a community survey was conducted in four West African DTMA countries, Bénin Republic, Ghana, Mali, and Nigeria, which are notable for maize production.

Focus group discussion in N'dahonta community, Bénin, 2007.

Materials and methods

The community surveys were conducted in two districts with high levels of maize production in each country, and in zones where the drought probability risk was between 40 and 60% between 2006 and 2007. The districts where focus group discussion (FGD) sessions were held in each country are shown (Table 1).

The number of FGDs held varied in each country, with three per district in Bénin and Mali, four per district in Ghana, and six per district in Nigeria (Table 2). The gender composition of FGD participants also varied, being either only male participants or a mix of both male and female participants with a high male: female ratio. The gender differentials may be traceable to the religious beliefs and socio-cultural background of the people that keep women indoors and constrain their access to productive resources in agriculture.

Table 1. Districts in each country where FGDs were held.

Country	District	Region/state
Bénin	Kandi	Borgou-Albori
Bénin	Tanguiéta	Atacora-Donga
Ghana	Karaga	Northern region
Ghana	Tolon/Kumbungu	Northern Region
Mali	Bougouni	Sikasso
Mali	Koutiala	Sikasso
Nigeria	Malumfashi	Katsina
Nigeria	Rano	Kano

Data were collected using FGDs and key informant interviews, complemented with secondary data from the publications of district directorates and the Ministries of Agriculture. Data collected included administrative social and physical features, as well as major changes in the communities in the past 10 years on crop production, risks, food security, environmental and livelihood conditions, and input–output data on maize.

Table 2. Number of FGDs and participants in the study districts by country in West Africa.

Country	Number of FGD held	Number of FGD participants
Bénin	6 (3/district)	66 (all males)
Ghana	8 (4/district)	105 (88 males, 17 females)
Mali	6 (3/district)	38 (all males)
Nigeria	12 (6/district)	163 (142 males, 21 females)

Maize farmer from Kano, Nigeria, 2010.

Descriptive results

General physical and agroecological features

The physical environment plays a crucial role in agricultural production in the countries. Farmers' decisions about which crops to grow, in what combinations, the location and timing of farming operations, and the tillage and storage techniques suitable under varying conditions depend on the physical environment (Ayoade 2003). According to Agboola (1987), the most important aspects of the physical environment which notably influence agriculture are soils, vegetation, and climate. The climatic factors, such as rainfall, temperature, altitude, wind, and humidity, generally have far-reaching influences on agricultural production in the DTMA countries. Ayoade (2003) defined climate as the mean state of the atmosphere of a location or an area over a period of 30 years; climate change represents a significant difference between two mean climatic states or climatic normals with a significant impact on the ecosystem. Rainfall regimes are marked by an alternation of wet and dry seasons of varying duration and the pattern of distribution varies across locations with a concentration of rains over a short period followed by a long period of drought (Jagtap 1995; Lericollais 1999). Annual rainfall ranged from a low of 54 mm in Ghana to a high of 1127.5 mm in Nigeria. The highest monthly rainfall was in Bénin and the lowest in Ghana. According to Akin-Aina and Salau (1992) and Kamara et al. (2006), the seasonality of rainfall, the duration of the rainy season, and the number of months with very low rainfall in the rainy season, all have a greater impact on agricultural production activities than rainfall totals alone. In addition, temperature indirectly affects evapotranspiration, photosynthesis, and soil temperature, as higher mean annual temperatures encourage higher evapotranspiration and consequently lower water balance levels (Agboola 1987; Akin-Aina and Salau 1992). The average minimum daily temperatures range from 13 ºC in Mali and Nigeria to 34.8 ºC in Ghana; average maximum daily temperature varied from 28.4 ºC in Ghana to 40 ºC in Bénin and Nigeria.

Total cultivable land was 34,210–54,560 ha in Bénin; 17,822–34,125 ha in Ghana; 1793–2423 ha in Mali; and 180,000–245,000 ha in Nigeria. Cultivated arable land accounted for over 70% of the total land area in all countries and the average area cultivated/household varied between 2 and 14 ha. A majority, over 70% of the farming households in the countries, have a right of access to land, usually through inheritance or as gifts but rarely through purchase. This is associated with the prevailing tenure arrangements in the countries (Agboola 1979).

Socioeconomic information on risk, poverty, livelihoods, and main changes in communities

All production implies the taking of some risk, since the cost or the effort will be incurred in advance of the final output, which may turn out to be more or less than was expected. Upton (1976) describes a risk situation as one in which the outcome is not certain, but the probabilities of the alternative outcomes are known or can be estimated. For instance, if a farmer knows that his maize crop is likely to fail one year in four, then this is a case of risk, as the farmer does not know whether the crop will fail in any particular year but he does know that over a long period it is likely to fail one year in four, on average. This is different from a situation of "uncertainty" where the farmer has no idea of the probability of crop failure.

Crop and livestock yields are highly dependent on the weather as rains may be early or late, too much, or too little for normal plant growth. Crop failure in periods of drought means that livestock production may be limited. In addition, there are risks of sickness, injury, or death among family members. Table 3 shows the risks and shocks associated with agricultural production and the intensity of occurrence in the communities.

Table 3. Risks and shocks in agriculture in the communities.

	Risk 1		Risk 2		Risk 3		Risk 4	
	Nature	Intensity	Nature	Intensity	Nature	Intensity	Nature	Intensity
Bénin	Drought	Very high	Floods	High	Weed infestation	Severe	Input/ output prices	High for input/ low for output
Ghana	Drought	High	Rainfall	Erratic	Floods	Severe	Input prices	High
Mali	Drought	High	Rains/floods	Heavy	Livestock diseases	Mild	Destruction of crops by animals	high
Nigeria	Drought	High	Input prices	High	output prices	High	Soil fertility decline	High

Source: FGDs - Districts Community Surveys, 2007/2008.

High intensity of drought risk was the most important risk factor across all the countries. When rainfall patterns are consistent over several years, farmers become used to a particular sequence of farming activities, the cultivation of a combination of crops following a familiar rotation, and the rearing of livestock under varying ecological conditions at different periods of the year. However, sudden and drastic changes from well-known patterns, particularly conditions of below-normal rainfall, have severe implications on agricultural production in terms of a decline in the amount of cultivated land, crop yields, and available food.

Erratic or heavy rainfall and floods ranked second in Bénin, Ghana, and Mali; high input price was second in Nigeria. The crucial role played by rainfall in agriculture includes the supply of moisture to the soil to activate plant growth, the replenishment of water in rivers to make irrigation possible, and through seepage and percolation, as well as the building up of underground water reserves. The amount, incidence, variation, and reliability of each of these parameters explain the differences in cropping patterns and livestock management practices in the agroecological zones in the various countries. There were variations in all the countries for the risk factor ranked third; severe weed infestation in Bénin, severe floods in Ghana, mild risk of livestock diseases in Mali, and huge fluctuations in output prices in Nigeria (Baco et al. 2009; Bamire et al. 2009; Fofana et al. 2009; Wiredu et al. 2009). Evidence from Olarinde et al. (2007) shows that these risks are usually the major reasons why smallholders take precautions in their choice of enterprises or when making decisions whether to adopt or not or to discontinue innovations, also in diversification, keeping food reserves, and maintaining flexibility in decision-making. In addition to the risks of yield variation or crop failure and sickness, injury or death among family members, commercial farmers who sell products and hire resources face the risks associated with unpredictable price variations and uncertainties about the behavior of others with whom they have commercial dealings. The commercial farmers, therefore, tend to avoid risk by discounting for risk (by producing less than the economic optimum level of output every year to reduce losses in bad seasons), insuring against risk, and collecting information about the costs and returns for the alternatives open to them and about market prices. This enables the farmers to predict future price trends and cycles. Advance contracts usually help to eliminate price uncertainty. The various risk factors greatly influence the livelihood and food security situation of the community members.

Table 4 shows the livelihood sources and strategies in the communities as well as the households' food security situation and coping mechanisms.

Table 4. Livelihood sources and strategies in DTMA West African countries.

	Livelihoods	Food security situation	Coping strategies
Bénin	- In general, crop and animal production, fishery, and working as hired farm labor - For women, a critical activity is shea nut collection for butter production	The period of "thin/lean cows" lasts from the beginning of the rainy season and the beginning of the planting season. During this period, 50% of the households in Kandi and 60% in Tanguiéta exhaust their stocks of food..	- Consumption of the vegetables leaves and néré flours, - Sale of small ruminants and poultry to generate cash for purchase of staple foods - Mutual aid (in cash and kind) to close relations, and - Working as hired labor in agricultural activities.
Ghana	- In general crop farming, animal rearing, agricultural employment - For women a critical activity is shea butter and spices (*dnawadawa*) production	- Community members reported a 3–5 month food insecure period (April to August) among 56%.	- Often sale of small ruminants and other household assets - In worse cases, reduction in number of daily meals, reduction of other expenditure and sometimes reliance on food aid..
Mali	- In general crop and livestock production - Petty trade and honey production for men	- Food shortages from July to August, in some cases to September.	- Selling small ruminants and cattle, working more off farm, selling firewood and charcoal, planting early maturing crops, borrowing from other farmers until harvest.
Nigeria	- In general crop and livestock production - Petty trading, craftsmanship and transportation business are also important in these areas	More than 50% of the households in the two LGAs are food insecure, with the period of food shortage from June to September in Rano LGA and from March to November in Malumfashi LGA	- Selling assets, such as small animals and cattle, engaging in paid labor work, while others received food aid. - Other strategies are petty trading and a reduction in the frequency of food intake.

Sources: FGDs - Districts Community Survey, 2007/2008.

When asked about the different changes that had taken place in the communities over the past 10 years, community members were quick to identify both negative and positive changes in the districts with variations across countries (Table 5).

Table 5. Synthesis of main changes in the study districts by country.

Country	Direction of change	Change 1	Change 2	Change 3	Change 4
Bénin	Positive	Introduction of new maize varieties	Popularization of cassava consumption and organization of producers and processors into associations	Promotion of the use of animal and motorized tractions for land preparation	Road rehabilitation
	Negative	Drought	Transportation problems	Soil fertility depletion	na
	Overall view:	More changes were positive than negative. Adopters of improved seeds / fertilizer increased their income; deteriorating conditions for poor and landless households	More primary schools have been constructed Construction of Farmers' Training Center	On average, 50% of the children are undernourished	Floods on the plots; erosion on the hillsides (Adama); extreme run-off; malaria infestation in ATJK District
Ghana	Positive	Improved education	Access to health facilities	Improved road infrastructure (easy access to input and output markets)	na
	Negative	Poor climatic conditions with prolonged drought and inadequate rainfall	Declining agricultural output	Soil fertility decline	Increasing poverty situation
	Overall	Communities are getting poorer	Improved living standard	Decreasing income	Increased numbers of poor
Mali	Positive	Introduction of mobile telephone	Diffusion of improved maize varieties	Access to information through radio	Existence of NGOs and associations covering different communities
	Negative	Reduction in the price of cotton (an important cash crop)	Increase in input prices	Decline in agricultural production	Persistent drought
	Overall	Increasing numbers of poor	Reduced income level	Reduced income	Increasing number of poor
Nigeria	Positive	Introduction of new maize varieties and improved access to agricultural inputs (e.g. fertilizer)	Increased Western and Islamic education at the primary school level	Increased number of religious worship centers, particularly mosques	Improved road network and government provision of health care facilities
	Negative	Drought	Lack of pipe-borne water	Transportation difficulties	Declining soil fertility
	Overall	Improved standard of living	Increased income	Reduction in agricultural output	Reduced income

Source: FGDs - Districts Community Survey, 2007/2008.
+ positive change; - negative change; = both positive and negative changes occurred

The first major positive changes that took place include the introduction of new maize varieties in Bénin, improved access to agricultural inputs in Nigeria, improved education in Ghana, and the introduction of the mobile telephone system in Mali. However, poor climatic conditions, particularly drought, were the common negative change in Bénin, Ghana, and Nigeria; in Mali, the reduction in cotton price was reported. In general, communities in Bénin and Nigeria experienced improved income and enhanced living standards, while many communities in Ghana and Mali became poorer over the period. The second major changes included the popularization of cassava consumption and the organization of community producers and processors into associations in Bénin, improved access to health facilities in Ghana, diffusion of improved maize varieties in Mali, as well as increased Western and Islamic education at the primary level in Nigeria. The second negative changes in the countries included transportation problems in Bénin, declining agricultural output in Ghana, increases in input prices in Mali, and lack of pipe-borne water in Nigeria. However, despite the negative changes reported in all the countries except Mali, respondents agreed that there was a general improvement in people's living standard over the period. The third major change involved the promotion of animal and mechanized traction for land preparation in Bénin, improved road rehabilitation in Ghana, improved access to information through radio in Mali, and increased number of religious centers in Nigeria. In general, negative changes resulted in decreasing living standards in the communities. In most cases where the negative effect are enormous, community members generally migrate to other communities where they can earn more income and improve their living standard.

Access to inputs and outputs markets, and communication / transport / marketing

By its very nature, agriculture must remain widely dispersed over a large area, implying the need for a transport network to move produce from the farms to the markets and to bring supplies (inputs) to the farms. The length of the distance to input/output markets is expected to have a negative impact on adoption because the greater the distance from these markets, the less likely it is that the farmers would be willing to purchase improved, high yielding crop varieties that allow them to produce large quantities of output for which they may not find markets (Doss 2006). In other words, the location of farms in relation to the markets and the transport network has an important influence on the farming systems.

Harvested drought-tolerant maize cobs in Nigeria, 2010.

Market access, transport and communication are therefore important livelihood quality measures. The access of community members to markets, transport, and communication in the four countries are as shown in Table 6.

Table 6. Summary situation on markets, communication and transport in the districts.

	Market access	Transport	Communication
Bénin	Ready access to local markets	Use motor cycles and foot	Less than 2% have functional telephone; Roads not motorable all year round
Ghana	Easy access to market centers	Use motor cars/buses	No established communication facility
Mali	Easy access to both local and urban markets	Use motor cycles, bicycles and carts driven by donkeys	Good communication network – access to functional telephones; good road infrastructure
Nigeria	Uneasy access to market centers	Mini-buses/pick-ups are used; high transport costs due to long distance to market centers	< 20% households have functional telephones; no service points in most communities

Source: FGDs - Districts Community Survey, 2007/2008.

Community members had easy access to input and output markets in all countries except Nigeria. This is indicative of the nature of the roads linking the markets. Different methods of transportation were used to reach farms and markets. These were motor cycles, motor cars, buses, bicycles, and carts drawn by donkeys. However, most of the roads are seasonal and in general not motorable during the rainy season, leading to increased transportation costs of materials to/from the main markets. In addition, there were communication difficulties in most of the communities across the DTMA countries, as less than 20% of the members had access to functional telephones. These challenges generally threaten the livelihood of community members.

Focus group discussion in Bougouni, Mali, 2008.

Crop production

There were variations in crops grown and their uses in the districts across DTMA countries (Table 7).
In Bénin, the important crops grown in Kandi district were cotton, maize, sorghum, groundnut, and cowpea in descending order of importance; in Tanguieta district, sorghum, cowpea, maize, millet, and yam were grown. However, the crops were used for the same purpose in both districts: cotton and cowpea were cultivated mainly for sale; maize and sorghum were cultivated for consumption. In Ghana and Nigeria, maize and sorghum were grown in the districts; cotton and sorghum were grown in Mali. Consumption was the main reason for community members growing maize in these countries even though any small portion sold earned them more profit. In general, maize and sorghum account for the major crops grown across DTMA countries in West Africa. Maize ranks highest in profitability ratings. This supports the findings that maize is both a basic food that ensures food security and also serves as cash crop (Smith et al. 1997; Kamara et al. 2006; Onyibe et al. 2006).

Table 7. Summary of main crops in the districts, with notes on profitability and main uses.

	Crop 1	Crop 2	Crop 3	Crop 4	Crop 5
Bénin					
Kandi					
Crop	Cotton	Maize	Sorghum	Groundnut	Cowpea
Main Use	Sale	Consumption and sale	Consumption	Sale	Sale
Profitability	2	1	3	na	na
Tanguiéta					
Crop	Sorghum	Cowpeas	Maize	Millet	Yam
Main Use	Consumption	Sale	Consumption and sale	Consumption	Consumption
Profitability	1	3	2	4	5
Ghana					
Karaga					
Crop	Sorghum 2800 ha	Maize 2450 ha	Soybean 2262 ha	Groundnut 2240 ha	Cowpea 2000 ha
Use	Consumption – only a small part is sold in the event of a surplus	Consumption – only a small part is sold in the event of a surplus	Sale	Sale	Sale
Profitability	na	na	na	na	na
Tolon/Kumbungu					
Crop	Maize 7462 ha	Sorghum 5944 ha	Cassava 5200 ha	Rice 5200 ha	Groundnut 9304 5040 ha
Use	Consumption – only a small part is sold in the event of a surplus	Consumption – only a small part is sold in the event of a surplus	Consumption – only a small part is sold in the event of a surplus	na	Sale
Profitability	na	na	na	na	na
Mali					
Bougouni					
Crop	Cotton	Sorghum	Maize	Millet	Rice
Use	Sale	Mainly Food	Food and sale	Mainly Food	Food
Profitability	na	4	1	5	2
Koutiala					
Crop	Cotton	Sorghum	Maize	Millet	Rice
Use	Sale	Mainly Food	Food and sale	Mainly Food	Food
Profitability	na	4	1	5	2

Table 7. Summary of main crops in the districts, with notes on profitability and main uses...continued.

	Crop 1	Crop 2	Crop 3	Crop 4	Crop 5
Nigeria					
Malumfashi					
Crop	Maize	Sorghum	Rice	Sweet potatoes	Groundnuts
Use	Consumption and sale	Mainly consumption	Sale and Consumption	Mainly for sale	Mainly for sale
Profitability	1	2	3	5	4
Rano					
Crop	Maize	Sorghum	Rice	Sweet potatoes	Groundnuts
Use	Consumption and sale	Mainly consumption	Mainly for sale	Mainly for sale	Mainly for sale
Profitability	1	2	3	na	4

Source: District Community Survey, 2007/2008.
Profitability: 1 min - 5 max.

Maize production

Farmers generally cultivated both local and improved maize varieties in all the communities. Of these, 95TZE and local varieties were cultivated mainly for home consumption; Acr 97 and Oba Super 1, that are high yielding with preferred grain color and size, were mainly for sale. The reasons why the farming communities grow different maize varieties are shown in Table 8.

In evaluating maize varieties, farmers used a wide range of selection criteria such as grain yield, grain size, color, and taste, flour quantity and quality, and maturity period. In Bénin, for example, varieties used for food are DMR, Lazare, Kamboessé, EVDT-97STR, TZEE, and TZPB; QPM (Faaba), TZL, and TZB are grown as cash crops because they are high yielding and have good grain characteristics. The yield of improved varieties varies from 3 to 5 t/ha; local varieties yield between 700 kg and 1.5 t/ha (Baco et al. 2009). In Ghana, Obatanpa had the best yield, with a minimum yield of 5 bags (500 kg/ha) and a maximum of 15 bags (1500 kg/ha) on farmers' fields. In Karaga district, Okomasa follows Obatanpa with a minimum yield of 4 bags (400 kg/ha) and a maximum of 12 bags (1200 kg/ha). The yield of Dorke was between 6 and 10 bags. The lowest yielding variety, according to the farmers, is the local yellow maize variety with a minimum yield of 2 bags and a maximum of 5 bags/ha (Wiredu et al. 2009). The major maize varieties grown in Mali include improved varieties (Sutubaka, Denbaniuman, Tiémantié, and TZE) and local (Pounfré) (Fofana et al. 2009).

In Nigeria, Bamire et al. (2009) have shown that the improved varieties grown include OPVs, TZE and Acr-9, hybrids, Oba Super 1-W, and local, Yar acre/Yar kasa. According to Jaffee and Srivastava (1994) and Louwaars and Marrewijk (1999), most of the maize seeds planted by farmers come from local sources, including the farmers' own crop, neighbors, relations, and local markets. The majority of households cultivated farmers' varieties (which are actually improved varieties that have been recycled over the years) but between 30 and 80% of households have adopted improved OPVs promoted in the surveyed communities. Evidence from Phillip (2001) showed that varietal adoption rates among farmers in the savanna zone of Nigeria were 7.9% (for local), 82.6% (for OPVs, particularly ACR 97) and 9.5% (for hybrids) during the period 1996–1997. The adoption rate of maize cultivation relative to all other crops averaged 49.5%. However, between 20 and 80% of households in the communities discontinued growing one of the promoted OPVs (95 TZE). Decreasing yield of this cultivar and non-availability of inorganic fertilizers were the main reasons for the discontinuing the variety. When farmers discontinued growing hybrid varieties, this change was associated with the non-availability of sufficient quantities of good quality seeds. This agrees with the reports of Obinyan (1994) and Omaliko (1998) that only 5 to 10% of the total amount of seeds required is available. In Bénin, DMR was the most popular variety with an adoption rate of 80%; EVDT-97STR followed with 75% adoption. The highest adoption rate was 90% in Ghana and Mali.

he production constraints associated with maize production include drought, shortage of rainfall, and pests and diseases. Other constraints relate to crop management, the non-availability of good quality seeds, as well as soil fertility depletion. This implies that any attempt made at addressing these constraints will enhance maize production in the DTMA countries.

Table 8. Main maize varieties, yields, and main constraints by districts, country and region.

	Variety 1	Variety 2	Variety 3	Variety 4
Bénin				
Kandi	DMR (2)	EVDT-97STR (2)	TZEE (2)	TZPB (2)
Constraints / risks	Drought	Shortage of rainfall in April and May or late August and September	Na	Attack by predators because of its height / excess rainfall
Adopting (A) / dis-adopting (D) households	A: 80%; D: 20%	A: 75%; D: 25%	A: 50%; D: 50%	A: 25%; D: 75%
Yield range (kg/ha)	1500–3000	2000–4500	1200–3000	2000–4000
Tanguieta	DMR (2)	TZEE (2)	TZPB (2)	EVDT-97STR (2)
Constraints / risks	Drought/shortage of rain		Attack by dogs because of its height	
Adopting (A) / dis-adopting (D) households	A: 75%; D: 25%	A: 50%; D: 50%	A: 50%; D: 50%	A: 25%; D: 75%
Yield range (kg/ha)	1000-2500	2000–3500	1000–2000	2000–3000
Ghana				
Karaga	Kikamba (1)	Pioneer (2)	Local (1)	CG4141
Constraints / Risks	Weeds (Striga)	Diseases, drought, soil fertility, striga	Diseases, drought, low soil fertility	Not estimated
Adopting (A) / dis-adopting (D) households	A: 90%	A: 51% D: 36%	A: 50%; D: 50%	A: 40%
Yield range (Kg/ha)	300-500	1100-1200	300-500	Not estimated
Tolon/Kumbungu	Local (1)	Kinyanya (1)	Pioneer (2)	Pannar (2)
Constraints / risks	Drought	Low soil fertility, diseases, drought, weeds (striga)	Diseases, drought, weeds (striga)	Drought
Adopting (A) / dis-adopting (D) households	A: 96%; D: 5%	A: 80%; D: 10%	A: 7%	A: 4%; D: 26%
Yield range (kg/ha)	500-800	1200-2250	900–1300	1200-2250
Mali				
Bougouni	Sutubaka, (2)	Denbaniuman, (2)	Tiémantié (2)	pounfré (1)
Constraints /risks	Drought	Drought Wild animals	Drought	Drought, disease, production
Adopting (A) / dis-adopting (D) households	A: 90%	A: 50%	A: 50%	A: 40%
Yield range (kg/ha)	1500-3500	1300-3000	700-1600	na
Koutiala	Sutubaka, (2)	Denbaniuman, (2)	Tiémantié (2)	pounfré (1)
Constraints / risks	Drought	Disease / price Wild animals	Drought / disease	Storage pest
Adopting (A) / dis-adopting (D) households	A: 50%	A: 30%	A: 15%	A: 5%
Yield range (kg/ha)	1200-3000	1000-2600	650-1500	600-950
Nigeria				
Malumfashi	ACR-97 (2)	TZE (2)	Obasuper 1-W (2)	Yarkassa (1)
Constraints / risks	Drought	Drought	Drought	Drought
Adopting (A) / dis-adopting (D) households	82.6% (A)	82.6% (A)	9.5% (A)	80% (A)
Yield range (kg/ha)	2000-4000	2000-4000	3000-5000	1000-3000
Rano	ACR-97 (2)	TZE (2)	Obasuper 1-W (2)	Yarkassa (1)
Constraints / risks	Drought	Drought	Drought	Drought
Adopting (A) / dis-adopting (D) households	80% (A)	30% (A)	50% (A)	80% (A)
Yield range (t/ha)	2000-3000	3000-4000	2500-4000	1000-2000

Source: Districts Community Survey, 2007/2008.
Type 1= Local; 2 = Improved

Maize farmer in his field in Mali.

Changes in maize input and output prices

Individual actions may have no perceptible influence on market prices under pure competition; however, the combined decisions of a large number of individuals may bring about sizeable price changes. The direction of changes in maize input and output (grain) prices in the communities are shown in Table 9.

Both input and output prices of maize have been increasing over the years in all the countries. Major maize production inputs are seeds, fertilizers, labor, and pesticides/herbicides, and the use of these inputs has been increasing over the past 10 years.

According to Echekwu (2000), farmers' increased awareness of the superiority of improved seeds over local varieties has resulted in an increased demand for improved seeds and associated inputs, such as fertilizer, so that satisfying demand has become difficult. This is capable of increasing input prices and reducing the income generating potentials of the producers.

Table 9. Price of maize and maize seed in the surveyed communities.

Country	Output (grain)		Input (seeds and fertilizers)	
	Price	Observations	Prices	Observations
Bénin	7000 –12,000 CFA/ bag of 100 kg	Increasing	Seeds: 700 CFA/kg Fertilizer: 11,750 CFA/bag of 100 kg	Increasing
Ghana	GH¢40–60/bag of 100 kg	Increasing	Seeds: GH¢ 1.50–2.00/kg Fertilizer: GH¢40–50/bag of 100 kg	Increasing
Mali	75–95 CFA/bag of 100 kg	Increasing	Seeds: 175–200 CFA/kg Fertilizer:13,000–19,000 CFA/bag of 100 kg	Increasing
Nigeria	1800–3000/bag of 100 kg	Increasing	Seeds: ₦40–70/kg Hybrid: ₦200/kg Fertilizer: ₦1000-₦3600/bag of 10kg	Increasing use of inputs, particularly fertilizer

Source: FGDs - Districts Community Survey, 2007/2008.
Usd / Naira: 147.2 (average exchange rate between 10/20/2010 and 11/18/2010)
Usd / Gh Cedi: 80.77 (average exchange rate between 10/23/2010 and 11/21/2010)
Usd / FCFA: 1,495.28 (average exchange rate between 10/23/2010 and 11/21/2010)

Focus group discussion in Katsina, Nigeria, 2010.

Conclusion

Community members in DTMA countries recognize that over the past 10 years, their living conditions have improved (as at 2007). Important sources of household livelihoods include crop production, livestock rearing, sale of fruits from farms and forests, sale of labor, and production of handicrafts. Farming is, however, the predominant occupation of the rural households. More than 70% of the households have rights to land that range between 5 and 20 ha for farming. Both men and women are committed to farming though women's commitments are constrained by cultural and religious factors. They, however, have special roles in agriculture; apart from the cultivation of oil seed crops and vegetables on small parcels of land to provide food for the farm households and earn some additional income, they are also involved in the collection and processing of shea nuts and dawadawa (a local spice), and in the processing of soybean as in Ghana. Thus, promoting women's education and improving their access to extension services, as well as emphasizing to men within farmers' organizations the women's contributory role to household livelihood could be a veritable tool towards achieving improved food security.

Maize is an important food security crop, serving as cash and food crop, and recently replacing some crops, such as sorghum in Nigeria, as the most consumed cereal. The farmers grow both "local" and improved maize varieties. The local varieties also called "farmers' varieties" are improved OPVs that have been recycled for use by farmers over the years. The farmers' choice of particular varieties depends on the maturity cycle, quantity and quality of the flour, color, taste, and shape of the grain, as well as the available storage facilities, implying that these factors have to be considered in the introduction of new varieties to farming communities. Most households (over 50%) experience food shortages though at varying degrees in the different countries. Farmers sell their livestock and other assets, work more off-farm, reduce expenditure, and sometimes rely on food aid as the coping strategies to survive, particularly during the dry season when food shortages are pronounced.

Climatic changes (typified by erratic rainfall, floods, and drought) have become a common occurrence in the past decade. This is associated with negative changes such as declining soil fertility, declining crop output, and poverty. These constitute great challenges to farmers, making farming very risky, and the farming communities are becoming poorer over time. The introduction of DT maize varieties through the DTMA project is capable of contributing positively towards achieving food security in Africa. In this regard, farmers' access to important associated/essential inputs (such as fertilizers, good quality seeds and herbicides, and credit facilities) becomes imperative for achieving optimum production of maize. In addition, improved infrastructure and health facilities are capable of enhancing market access and improving the health status of the people and this will invariably improve the productivity of DT maize in the communities. Maize production can then be scaled-up to other areas within and outside the DTMA areas through farmer-to-farmer interactions and through private seed producers, CBOs and NGOs.

References

Agboola, S.A. 1987. An agricultural atlas of Nigeria. Oxford University Press, London, UK.

Akin-Aina, T. and T.A. Salau, 1992. The challenge of sustainable development in Nigeria. An NGO report prepared for the United Nations conference on environment and development, 1–12 June. Rio de Janeiro, Brazil.

Ayoade, J.O. 2003. Climate change. pp. 45–66. Vantage Publishers, Ibadan, Nigeria.

Baco, N.M., T. Abdoulaye, D. Sanogo, and R. LaRovere. 2009. Characterization of Maize Producing Communities in the Dry Savanna of Bénin Republic, DTMA Project Country Report–Community Survey. 17 pp.

Bamire, A.S., T. Abdoulaye, D. Sanogo and R. La Rovere. 2009. Community Assessment Report for the DTMA Project in the Dry Savanna of Nigeria. 24 pp.

Byerlee, D. and C.K. Eicher. 1997. Africa's emerging maize revolution. Lynne Rienner Publishers, UK.

Byerlee, D. and P.W. Heisey. 1997. Evolution of the African maize economy. Chapter 2 *in* Africa's emerging maize revolution, edited by D. Byerlee and C.K. Eicher. Lynne Rienner Publishers, UK.

Doss, C.R. 2006. Analyzing technology adoption using microstudies: limitations, challenges, and opportunities for improvement. Agricultural Economics 34:207–219.

Echekwu, C.A. 2000. Seed production in Nigeria: the expected role of research, government, and private sector. Sustainable maize production in Nigeria: The challenge in the coming millennium. edited by J.A. Valencia, A.M. Falaki, S. Miko and S.G. Ado. Proceedings of the national maize production workshop, July 22–24. Ahmadu Bello University, Zaria. SG 2000/IAR/FMARD/ADPs.

FAOSTAT. 2006. Food and Agriculture Organization, Rome, Italy.

Fofana, M., T. Abdoulaye, Ntji Coulibaly, D. Sanogo, and R. LaRovere. 2009. Characterization of Maize Producing Communities in the Sikasso region of Republic of Mali, DTMA Project Country Report–Community Survey. pp.17.

Hodson, D.P., E. Martinez-Romero J.W. White, J.D. Corbett, and M. Bänziger. 2002.Africa Maize Research Atlas (v. 3.0). CD-ROM publication. (CIMMYT, Mexico D.F.)

Jaffee, S. and J. Srivastava. 1994. The roles of the private and public sectors in enhancing the performance of seed systems. World Bank Research Observer 9: 97–117.

Jagtap, S.S. 1995. Changes in annual, seasonal and monthly rainfall in Nigeria during the period 1961–1990 and consequences to agriculture. Discovery and Innovation 7(4): 311–426.

Kamara, A.Y., I. Kureh, A. Menkir, P. Kartung, B. Tarfa, and P. Amaza.2006. Participatory on-farm evaluation of the performance of drought-tolerant maize varieties in the Guinea savanna of Nigeria, Journal of Food Agriculture and Environment 4(1): 192–196.

Lericollais A. 1999. La dégradation de l'aménagement agraire. *In* Lericollais A. (ed.). *Paysans Sereer dynamiques agraires et mobilités au Sénégal.* IRD, Paris, France, 118–138.

Louwaars, M.P. and G.A.M. Marrewijk. 1999. Seed supply systems in developing countries, CTA, Wageningen, The Netherlands.

Obinyan, E. 1994. Seed Marketing in Nigeria. Evolving Nigerian Seed Development Plan. Pages 248–253 edited by N.O. Adedipe, I.A. Usman, and N.S. Maini. Federal Department of Agriculture, Abuja, Nigeria.

Olarinde, L.O., V.M. Manyong , and J.O. Akintola. 2007. Attitudes towards risk among maize farmers in the dry savanna zone of Nigeria: some prospective policies for improving food production. African Journal of Agricultural Research 2 (8): 399–408.

Omaliko, C.P.E. 1998. Nigeria seed industry and its potential role in food security within the West and Central Africa subregion, Proceedings of International Conference on seed security for food security, 30 December–1 November, 1998, Florence, Italy, FAO, Rome (online). Available:- http://www.fao.org/ag/agp/agps/georgof/Gerogo14htm (retrieved: 12 April 2003).

Onyibe, J.E., J.O. Adeosun, R.A. Emolehin, I. Kureh, and F.A. Showemimo. 2006. Promotion of adoption of drought tolerant maize varieties using community based seed schemes for poverty reduction in the drier savannah zones of Nigeria, A PowerPoint presentation.

Phillip, D. 2001. Evaluation of social gains from maize research in the northern Guinea savanna of Nigeria. *In* Impact, challenges and prospects of maize research and development in West and Central Africa, edited by B**.** Badu-Apraku, M.A.B. Fakorede, M. Ouedraogo, and R.J. Carsky Proceedings of a regional maize workshop, IITA-Cotonou, Bénin Republic, 4–7 May 1999. WECAMAN/IITA, Ibadan, Nigeria.

Smith, J., G. Weber, V.M. Manyong, and M.A.B. Fakorede.1997. Fostering sustainable increases in maize productivity in Nigeria. Chapter 8 *in* Africa's emerging maize revolution, edited by D. Byerlee and C.K. Eicher. Lynne Rienner Publishers, London, UK.

Thirtle, Colin, Lin Lin, and Jennifer Piesse. 2003. The impact of research-led agricultural productivity growth on poverty reduction in Africa, Asia and Latin America. World Development 31 (12):1959–1976.

Upton, M. 1976. Agricultural production economics and resource-use. Oxford University Press, London.

Wiredu, A.N., K.O. Gyasi, T. Abdoulaye, D. Sanogo. and R. LaRovere. 2009. Characterization of Maize Producing Communities in the Northern Region of Ghana. DTMA Project Country Report–Community Survey. 17 pp.