COPING WITH CLIMATE CHANGE IN DRYLAND GHANA: THE CASE OF BOLGATANGA

Netherlands Research Programme on Climate Change
IMPACT OF CLIMATE CHANGE IN DRYLANDS (ICCD)

BOLGATANGA REGIONAL STUDY, GHANA

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Inhoudsopgave

A Introduction to Ghana  2
B Regional study  10
  1 Introduction to the study area  10
  2 Changes in the physical environment of the study area  21
  3 Demographic change  40
  4 Economic change in the agricultural sector  47
  5 Economic change in the non-agricultural sector  62
  6 Changes in the livelihood strategies and in pathways of portfolios of options  66
  7 Climate change?  80
  8 Bibliography and references  84
  9 Acknowledgements  86
INTRODUCTION TO GHANA

The study area forms the eastern part of the uppermost area in Ghana (with a few tiny portions of Togo and Burkina Faso part of the 1 by 1 degree ‘cell’).

Figure 1 The location of the research area
Together with some areas near Accra, the study area forms the driest part of the country, in good years sub-humid in character with savannah vegetation; in bad years semi-arid. Most parts of Ghana have a humid climate and the original vegetation in the southwestern and central parts of the country is tropical rain forest. Not much of it remains, though. Large areas have been converted during this century to cocoa growing regions. Most of Ghana’s food consumption is based on root and tuber crops. Only in the northern, drier areas grains dominate.

The total area of Ghana is 23.9 m. ha. Using FAO data the ‘forest and woodland area’ has been set at 9.6 m. ha between 1960 and 1990, but declining afterwards. The agricultural area of Ghana as a whole has been estimated at 11.8 m. ha in the 1960-’75 period; afterwards almost constantly rising to 12.9 m.ha in 1994, so increasing from 49% to 54% of the total land area of the country. Permanent pasture has almost always been estimated at 8.4 m. ha, forming the bulk of what is regarded as ‘agricultural area’. The area under arable and permanent crops has always been much lower. This increased from 3.3 m. ha in 1960 to 4.5 m ha in 1994, of which arable land increased from 1.7 m ha in 1960 to 2.8 m ha in 1994, while the area under permanent crops (e.g. cocoa) remained more or less stable, at 1.6 m. ha. Irrigation is negligible: increasing from almost nil in 1960 to 7,000 ha in 1970 and decreasing again to 6,000 ha in 1996.

The population of Ghana as a whole increased from 7 million inhabitants in 1960 to 17 million in 1994 (and 20 million currently) (World Bank data; various World Development Reports). Per capita it means that the average number of ‘agricultural hectares per capita’ decreased from 1.7 to 0.8 and out of this the average number of ‘arable hectares’ from 0.24 in 1960 to 0.16 in 1994.

Crops which are relevant in the northern parts of Ghana include maize, sorghum, millets, rice, groundnuts and cotton. Most of the crop (harvest area) data recorded by the FAO for these crops for Ghana as a whole can be attributed to the northern areas.

Maize has almost always been the most important grain crop of Ghana, in terms of hectarage (although more important in the centre-north areas and not in the upper-north areas). The maize area increased from between 200,000 and 300,000 ha in the 1960s to a level between 600,000 and 700,000 ha in the late 1990s. The year 1984 was an absolute peak year, with 720,000 ha. The years 1965 and 1978 were the lowest with less than 200,000 ha.

Sorghum and millets are the most important crops for the upper north areas. The sorghum area increased with ups and downs from 150,000 ha in the 1960s to more than 300,000 ha in the late 1990s. The area of millet production increased from 100,000 ha in the early 1960s to 180,000 ha in the late 1990s, but with higher figures in between (more than 240,000 ha in 1970, 1979 and 1989).

The rice (paddy) area increased from 25,000 ha in the early 1960s to more than 105,000 ha in the late 1990s; a steep increase. However, rice hectarage showed extreme fluctuations: up to 130,000 ha in 1977, down to 40,000 ha again in 1983.
The area of groundnuts production was 60,000 ha in the early 1960s, decreased to half of this in the mid 1960s and increased to fluctuating levels around 90,000 ha in the 1970s, 120,000 ha in the 1980s and more than 160,000 ha in the late 1990s. The seed cotton production area has always been much less. From almost zero in 1960 to 25,000 ha in 1970, down again to almost zero in 1978, but increasing considerably until the 1990s (up to 50,000 ha).

Looking at the ‘northern crops’ as a whole we can notice a steep increase in total hectarage: from less than 600,000 ha in 1960 to more than 1.4 m. ha in the late 1990s. In the total Ghanaian hectarage of arable crops the ‘northern crops’ increased its share from one-third to half of the land use importance. Probably there are two causes: arable land use in the north increased, following an impressive increase in the rural population; but also: ‘northern crops’ steadily ‘moved south’.

Using estimated hectarage and estimated production data, the FAO data also suggest changes (and fluctuations) in yield levels. These will be given in table 1.

### Table 1 Ghana, ‘northern crops’, 1960-1998, yield levels (in kg/ha)

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>maize</td>
<td>1155</td>
<td>430 (’83)</td>
<td>1648 (’98)</td>
<td>258 (22)</td>
<td>1200</td>
<td>1100</td>
<td>1000</td>
<td>1400</td>
</tr>
<tr>
<td>sorghum</td>
<td>753</td>
<td>482 (’83)</td>
<td>1124 (’96)</td>
<td>161 (21)</td>
<td>600</td>
<td>700</td>
<td>700</td>
<td>900</td>
</tr>
<tr>
<td>millets</td>
<td>665</td>
<td>477 (’65)</td>
<td>1020 (’96)</td>
<td>131 (20)</td>
<td>600</td>
<td>600</td>
<td>700</td>
<td>800</td>
</tr>
<tr>
<td>rice</td>
<td>1234</td>
<td>590 (’82)</td>
<td>2075 (’98)</td>
<td>438 (35)</td>
<td>1100</td>
<td>900</td>
<td>1200</td>
<td>1800</td>
</tr>
<tr>
<td>groundnuts</td>
<td>1033</td>
<td>670 (’91)</td>
<td>1697 (’80)</td>
<td>248 (24)</td>
<td>900</td>
<td>1200</td>
<td>1200</td>
<td>800</td>
</tr>
<tr>
<td>seed cotton</td>
<td>696</td>
<td>305 (’70)</td>
<td>1014 (’85)</td>
<td>208 (30)</td>
<td>500</td>
<td>600</td>
<td>800</td>
<td>no data</td>
</tr>
</tbody>
</table>

*Source: FAO data; compiled by Maaike Snel and Jacoline Plomp, supervised by Marcel Put, in March 1999.*

The FAO data suggest a number of interesting conclusions about yield developments:

- For all grains the 1990s seem to be ‘breakthrough years’ with suddenly much increased yield levels. This improvement is not recorded for groundnuts (decrease) and for cotton (no data yet);
- For maize and rice the 1970s show poorer crops than the 1960s, for millets stagnating levels, for sorghum some improvement and for the cash crops groundnuts and cotton much improved yield levels;
- The 1980s show a further deterioration for maize, stagnation for sorghum and groundnuts, and improved levels for millets and cotton;
- In terms of average yields of the grain crops for the period as a whole, rice leads (but less impressive than elsewhere), followed by maize, sorghum and millets. It is interesting to note that maize had better average yields than rice in the 1960s and 1970s;
- Looking at the standard deviation of annual crop yield data, and comparing those with average yield figures it is evident that millets are the least risky crop (in terms of yield fluctuations), but closely followed by sorghum and, surprisingly, by maize. Also groundnuts have quite comparable levels of fluctuations. Both rice and cotton are ‘gamble crops’, with rather extreme fluctuations.
Increased hectarage and increased yield levels for all major grains have resulted in a considerable increase in grain production. In the early 1960s total grain production reached 410 m. kg, or 60 kg/cap for Ghana as a whole. In the late 1990s the total production had more than quadrupled, to 1790 m. kg, or 105 kg/cap for Ghana as a whole, despite the almost 250% increase in the number of people. This very positive result can mainly be attributed to the 1990s, when both yield levels dramatically improved and hectarages increased.

The production of starchy crops -cassava, yam, cocoyam and platain-, mainly in the south and centre of the country, also increased, and reached about 12,000 m. kg, both because of an increase in the area under cultivation and because of yield increases, to a level of 10,000 kg/ha (but with much less food value per kg than grains).

The yield data allow a preliminary analysis of relatively bad years in productivity terms: all years with a lower yield than the previous year are called ‘bad years’. A really bad year shows when all six crops have lower yields than the previous year. A year in which all crops show improved yields compared to the previous year can be regarded as a ‘good year’ or at least (much) better than the previous year. Table 2 shows the results. Three years have been extreme, with 1975 as the year with the worst experience, when all six crops had lower yields compared to 1974, but 1980 and 1982 were problematic as well. In 1980 only groundnuts and in 1982 only cotton had better results than in 1979 resp. 1981; all other crops fared worse. The analysis also shows that the 1990s were much better than previous decades in terms of short-term yield deterioration.

**Table 2 Yield data of six ‘northern crops’* compared with previous years (1962-1998)**

<table>
<thead>
<tr>
<th>Decades</th>
<th>1960s</th>
<th>1970s</th>
<th>1980s</th>
<th>1990s***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crops with lower yields than previous year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>all 6 crops</td>
<td>-</td>
<td>1975</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5 crops</td>
<td>-</td>
<td>-</td>
<td>1980, 1982</td>
<td>-</td>
</tr>
<tr>
<td>4 crops</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Maize, sorghum, millets, rice, groundnuts, cotton

**For the period 1993-1998 cotton yield data are missing, so there are only five crops**

Source: own calculations, using FAO data compiled by Maaike Snel and Jacoline Plomp, supervised by Marcel Put, in March 1999.

The northern part of Ghana can also be regarded as the most important livestock area
Livestock production trends can also be found by using the FAO data base. Total (commercial) meat production steadily improved in the 1960s, from a level of 60,000 metric tonnes to about 80,000 metric tonnes. After 1976 there was a major increase, to a level of 140,000 metric tonnes in 1984 and afterwards this level was maintained. However, the recorded beef and veal production in Ghana shows a slightly downward trend from the 1960s until now, although it can also be said that the period 1974-78 showed a tremendous downfall, and after that the production improved again to the current level which is still slightly below the high 1970-74 level of 22,000 metric tonnes. Both goat meat and mutton and lamb production steadily improved, from 3,000 metric tonnes each in the early 1960s to 6,000 metric tonnes each currently. Other meat includes chicken, guinea fowl and pig meat.

Commercial milk production increased from a level of 10,000 metric tonnes in the early 1960s to 24,000 metric tonnes currently. There was a steady increase with the exception of a severe crisis between 1974 and 1980. The Ghanaian production of meat and milk combined remained rather stable per capita, at a level of 10 kg/cap/annum.

Table 3 gives the production data in a summarised form. Looking at the production variability (standard deviation divided by the mean for the period as a whole) it becomes clear that beef and veal production was the most stable livestock food, closely followed by goat meat, mutton/lamb and milk. Total meat production showed the largest fluctuations (because of chicken, fowls and pigs?).

Table 3  Livestock production in Ghana, 1961-1998 (in metric tonnes)

<table>
<thead>
<tr>
<th>Product</th>
<th>Average Production</th>
<th>Minimum (yr)</th>
<th>Maximum (yr)</th>
<th>Standard Deviation (and SD/av)</th>
<th>Production level 1960s</th>
<th>1970s</th>
<th>1980s</th>
<th>1990s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat Total</td>
<td>107,055</td>
<td>61,284 ('62)</td>
<td>143,923 ('98)</td>
<td>31,610 (30%)</td>
<td>70,000</td>
<td>100,000</td>
<td>120,000</td>
<td>140,000</td>
</tr>
<tr>
<td>Beef &amp; Veal</td>
<td>19,213</td>
<td>12,995 ('78)</td>
<td>23,000 ('69)</td>
<td>2,661 (14%)</td>
<td>22,000</td>
<td>17,000</td>
<td>18,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Goat Meat</td>
<td>4,295</td>
<td>3,040 ('65)</td>
<td>5,938 ('98)</td>
<td>821 (19%)</td>
<td>3,000</td>
<td>4,000</td>
<td>4,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Mutton &amp; Lamb</td>
<td>4,910</td>
<td>3,102 ('62)</td>
<td>6,545 ('98)</td>
<td>1,102 (22%)</td>
<td>3,000</td>
<td>5,000</td>
<td>5,000</td>
<td>6,000</td>
</tr>
<tr>
<td>Milk</td>
<td>18,621</td>
<td>9,750 ('61)</td>
<td>23,920 ('95)</td>
<td>4,052 (22%)</td>
<td>14,000</td>
<td>16,000</td>
<td>19,000</td>
<td>23,000</td>
</tr>
</tbody>
</table>

Source: FAO data; compiled by Maaike Snel and Jacoline Plomp, supervised by Marcel Put, in March 1999.

Food security does not only mean the capacity to feed the population with food that is produced in the country itself. Food security can also be attained by importing food. Food imports can come through food aid or through trade. In Ghana the food aid component of food imports has mostly been small. Food aid data for the period after 1970 show that the average cereal imports were about 80,000 metric tonnes, with peaks in 1977-80, 1983-85, 1987, 1991 (an absolute peak of 200,000 metric tonnes), and 1992-93. Cereal aid mainly consisted of wheat, wheat flour and rice, although coarse grains were included as well. After 1993 cereal aid gradually came to an end.
The US dollar value of total agricultural imports in Ghana has risen steeply: from a level of 50 m$ in the early 1960s to 350 m$ currently. The increase mainly started in 1986. Registered livestock imports decreased considerably, though: from a level of 120,000 annual cattle imports in 1961 to almost zero after 1975 ($ value: from about 8 m$ to less than 1 m$). The import of goats decreased from 130,000 per year to almost zero after 1977 (value dropped from 1.5 m$ to less than 0.2 m$) and the import of sheep from 100,000 to less than 10,000 after 1978 (value dropped from 1.2 m$ to 0.6 m$). Most animals used to come from Burkina Faso, but after the 1974 drought the livestock trade petered out (at least the registered trade). Nowadays most agricultural imports consist of food grains, but FAO data are lacking.

Between 1960 and 1998 the consumption of food in Ghana as a whole (per capita) shows a change in composition, with a much higher importance of grains in the average diet, and hence a greater importance for the ‘northern crops’ (and for grain imports):
- maize consumption increased from a level of 20-25 kg/cap in the early 1960s to 35-40 in the 1990s, with peaks first around 1970 and after 1984;
- rice consumption is on the increase, from 10 kg/cap until 1990 to between 20 and 30 kg/cap in the 1990s;
- millet consumption was rather stable, with 8 kg/cap (peaks in the 1970s); sorghum consumption increased (from 9 kg/cap in the early 1960s to 13 kg/cap nowadays, but after rather low levels of 6-7 kg/cap in the 1980s;
- groundnut consumption first increased from a level of 2 kg/cap to between 4 and 6 between 1970 and 1990, and down again to a level of between 2 and 3 kg/cap in the 1990s
- meat consumption was rather stable, at 10 kg/cap (but less beef, veal, goat, and mutton), while milk consumption deteriorated (between 6 and 12 kg/cap before 1978 and between 2 and 6 kg/cap afterwards).
- unfortunately FAO does not give data on root and tuber crops, and on fish; important for the diet of inhabitants of southern Ghana mainly.

Agricultural policy changes in Ghana

Agricultural planning already started during the colonial period, but its emphasis was on cash crop production. The first major agricultural policy reform occurred in 1957, just after Ghana’s Independence, when the then Convention Peoples Party under the leadership of President Nkrumah discontinued the second phase of a 10-year development plan which the colonial government of Gold Coast had been pursing. In its place a new 7-Year Development Plan (1963-70) was formulated and implemented. In this plan food production was emphasised.

The second agricultural policy change took place after the overthrow of the CPP government in 1966 (which was backed by influential people from the north; a considerable part of the military came from the north of Ghana). The Seven-Year Development Plan was abandoned in favour of a Three-Year Development Plan (1968-70). The focus of this policy was to correct the disequilibrium in the economic system through import liberalisation, devaluation of the national currency, the cedi, and deflationary monetary and fiscal policies. Efforts were made to harness the potential of the private sector for economic development. The Plan included setting up
seed improvement and multiplication programmes for food grains (mainly cereals) and the establishment of an Agricultural Development Bank to provide credit to farmers. Subsequent governments in the 1970s followed similar plans and also promoted the production of cereals and other food crops. This culminated in the “Operation Feed Yourself” in the early 1970s by the National Redemption Council government, under President Acheampong, also with attention for the problematic food situation in the north.

A third agricultural policy reform was initiated with the inception of the Economic Recovery Programme (ERP) in 1983 and the Structural Adjustment Programme of the Provisional National Defence Council under President Rawlings. Under the ERP the Ghana Agricultural Policy Action Plans and Strategies (1984-86) emphasised self-sufficiency in cereal production, maintenance of adequate stocks of grains, especially maize and rice, to ensure food availability during the lean season, price stability and provision of maximum food security against crop failure and other natural hazards. The strategy was focused on a boost of maize, rice and cassava production in high potential areas. The second phase of the ERP, from 1986 to 1988, focused on increased productivity and internal price stability in the agricultural sector as a whole. Specific goals included:

- attaining self sufficiency in cereals, starchy staples, animal protein foods and agro-industrial crops
- maintaining buffer stocks for reasons of price stability and food security
- improving storage, processing and distribution systems in order to reduce post-harvest losses
- increasing export of non-traditional crops
- improving the performance of the livestock and fisheries subsectors
- strengthening the policy formulation capacity of the Ministry of Agriculture
- improving agricultural research, credit and marketing facilities
- ensuring high enough returns to efficient farmers to promote the adoption of improved technology.

The third phase of the ERP emphasised the deregulation of commodity and service markets to reduce domestic price distortions, as well as liberalisation of import and export markets. The agricultural policy focused on the provision of an enabling environment. The food and agricultural development strategy was set out in the Medium Term Agricultural Development Programme; an Agenda for Sustained Agricultural Growth, 1991-2000. The liberalisation programme brought in its wake the abolishing of guaranteed minimum prices for maize and rice and the removal of all subsidies including subsidies for agricultural inputs (Asuming-Brempong, 1994). Since the 1980s there is increased attention for land degradation, especially in the northern parts of Ghana. In the Ministry of Food and Agriculture soil and water conservation issues are dealt with by the Land and Water Management Section.

During the 1990s issues related to Global Warming also entered the Ghanaian policy debate. The government of Ghana has put in place a number of organisations to assist in either preventing the causes of Climate Change (industrial pollution; indiscriminate felling of trees) or helping the people to adapt to these changes. Several afforestation programmes and Forest Reserve preservation programmes were put in place to regain some biomass, that could be a base for increases in precipitation. The Environmental Protection Agency (EPA) is the government’s agency responsible for all
environmental issues. The mission statement of EPA is to co-manage, protect and enhance the country’s environment as well as seek common solutions to global environmental problems. This is to be achieved through an integrated environmental planning and management system established on a broad based public participation, efficient implementation of appropriate programmes, and technical services, giving good council on environmental management as well as effective and consistent enforcement of environmental laws and regulations (EPA, 1998). The Ozone Office of EPA is responsible for programmes that are geared towards the reduction of CFC gasses. Many refrigerator mechanics have been trained. As a result there is a drastic reduction in the use of CFC gasses. The Department even won an international award in 1997 (EPA, 1997). The EPA also started holding seminars, after Ghana became a party to the Convention on Climate Change to discuss and create dialogue on impacts of climate change and response strategies.

Some notes on Ghana’s economy

The Ghanaian economy has been hailed as a miracle under the economic recovery programme and IMF-supported structural adjustment programme. During the 1990s real economic growth has been achieved, distinguishing Ghana from most other sub-Saharan countries. A GDP growth rate of 3.8%, 4.5% and 5.2% was achieved in 1994, 1995 and 1996 respectively. Services contribute most to the GDP (48%) followed by agriculture (41%) (ISSER, 1996). The economically active currently make up 51% of the total population. The so-called informal sector represents about 80% of all employment, with agriculture being the most important sub-sector. The proportion of the economically active population in agriculture has been declining steadily over the years: from 52% in 1987 to 48% in 1994. However, in absolute numbers the economically active population in agriculture has increased at a rate of 1.8% per annum: from 2.6 million in 1987 to 2.9 million in 1994 (FAO, 1995). Agricultural growth figures have been very fluctuating from year to year. In 1984 the sector attained its highest growth rate in recent times (9.7%), while a problematic year like 1990 only had a growth rate of 2%.

The import liberalisation policy initiated under the ERP/SAP was aimed at efficient allocation of resources so as to encourage only the production of commodities over which the country has comparative advantage. The policy has increased international competition for local production of some agricultural commodities such as rice, poultry, meat, fish and edible oil (Nyanteng, 1997). The cost of production of agricultural produce has increased considerably, due to the rising input costs, resulting partly from the abolition of subsidies and the realignment of the exchange rate of the cedi. This has forced some agro-business concerns to fold up.
CHAPTER 1  INTRODUCTION TO THE STUDY AREA

1.1  Summary
The Bolgatanga cell in North East Ghana is demarcated by latitudes 10 degrees and 11 degrees North and longitudes 0 degrees and 1 degree West. In the framework of the ICCD research it was chosen as an example of an area with:
- sub-humid characteristics (at least in the 1930-60 period)
- relatively high land degradation (according to Glasod assessment)
- relatively low population density (in 1960)
- without a major urban centre

The cell partly lies in the Upper East Region of Ghana, of which the headquarters is the city of Bolgatanga. The other half of the cell (the lower part) is part of the Northern region of Ghana. Headquarters is Tamale, but this town is located outside the study area, towards the south. The Bolgatanga cell is also part of two cultural-geographical regions; the upper part of the cell is part of the North Mamprusi area. The lower part of the cell is part of South Mamprusi-Dagomba.


According to the GLASOD assessment of soil degradation the northern part of the area suffers from severe land degradation, mainly caused by water erosion, in some areas loss of topsoil and in other areas terrain deformation and mass movement. Agricultural activities and overgrazing are given as major causes. In the southern part land degradation is moderate, mainly in the form of water erosion and loss of topsoil and caused by overgrazing, deforestation and removal of natural vegetation (see GLASOD, 1990).

Around 1960 the cell had an average population density of less than 50 inhabitants per square kilometre (although by that time, parts of the northern area already had densities far beyond that). On average, though, the density still was regarded as ‘low’ compared to other drylands in the tropics. In 1999, the Bolgatanga cell has between 0.7 and 0.8 million inhabitants, which means an average population density of between 60 and 70 inhabitants per square kilometre; high in relative terms. The Upper East Region has a very high population density with an average of 200 persons per square kilometre.
Figure 2  Detailed map of the study area
The whole of the Bolgatanga study area is generally rural in character. Main cities in the cell are: Bolgatanga, Bongo, Zebila, Walewale and Gambaga. Bolgatanga nowadays has 70,000 inhabitants; Zebilla 25,000, Bongo 30,000, Walewale 20,000 and Gambaga 15,000. Including some minor centres the total ‘urban’ population is less than 20% of the population. However, the rate of urbanisation (and deagrarianisation) is probably rather high. Nearby the border town of Bawku has 50,000 inhabitants and is an important market centre for the region. The nature of the rural settlements in the area is such that one cannot easily distinguish one village from the other. Houses are dispersed over the whole area with only a few patches of unoccupied lands which are often forest reserves.

The area is far from the economic centre of Ghana. It can be reached by air though: west of the study area there is a minor airfield; nowadays with weekly flights to Paga from Accra and Tamale. Driving takes a full day or more, although the road is fully tarmaced. The principal all-season motor road in the region runs from Paga or Navrongo eastwards to Bolgatanga-Zuarungu and further to Bawku and Pusiga and into Togo and Burkina Faso. The connection to the south consists of a road from Bolgatanga to Tamale (and further to the Coast). The road connection to the north brings a traveller to Ouagadougou in a few hours drive.

1.2 Administrative description of the Bolgatanga cell

The Bolgatanga study area comprises parts of ten administrative/political districts, namely Navrongo/Nankani, Bongo, Bolgatanga or Frafra, Bawku West, Bawku East (which includes Pusiga), Mamprusi East, Mampusi West, Gushiegu/Karaga and Savelugu/Nanton Districts. The first six are part of Upper East Region, while the last four are part of Northern Region (see figure 3). They are governed by local councils with different administrative names, resp. Kassena-Nankani and Chiana-Paga, Bongo-Nabdam, Bolgatanga-Tongo, Kusanaba-Zebilla, Bawku/Tempane-Guru, Pusiga-Pulumakum, Nalerigu, Walewale and Gushiegu/Karaga)-Chereponi(Saboba). Between the Upper East Region and Northern Region there is a natural divide, consisting of the Gambaga Escarpment, which rises from around Pwalugu (near the White Volta river) and goes eastwards to Nakpanduri and beyond). It forms a picturesque scarp around Nakpanduri.
Figure 3 Administrative map of the study area
Details about the four quarter sections of the regional cell are as follows:

### Table 4 Administrative details of the study area

<table>
<thead>
<tr>
<th>D</th>
<th>A</th>
<th>B</th>
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<tbody>
<tr>
<td>C</td>
<td>B</td>
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**A:**

<table>
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</thead>
<tbody>
<tr>
<td>Upper East Region</td>
<td>933</td>
<td>Pusiga-Pulumakum local council (Pusiga District)</td>
<td>half</td>
</tr>
<tr>
<td>Upper East Region</td>
<td>932</td>
<td>Bawku urban council (part of Bawku East District)</td>
<td>small part</td>
</tr>
<tr>
<td>Upper East Region</td>
<td>931</td>
<td>Tempane-Guru local council (Bawku East District)</td>
<td>all</td>
</tr>
<tr>
<td>Upper East Region</td>
<td>930</td>
<td>Kusanaba-Zebilla local council (Bawku West District)</td>
<td>most</td>
</tr>
<tr>
<td>Northern Region</td>
<td>741</td>
<td>Nalerigu local council (East Mamprusi District)</td>
<td>minor part</td>
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**B:**

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<tr>
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<td>Nalerigu local council (East Mamprusi District)</td>
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</tr>
<tr>
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<td>723</td>
<td>Gushiegu-Chereponi local council (Gushiegu/Karaga District)</td>
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**C:**

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<tr>
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<td>741</td>
<td>Nalerigu local council (East Mamprusi District)</td>
<td>small part</td>
</tr>
<tr>
<td>Northern Region</td>
<td>723</td>
<td>Gushiegu-Chereponi local council</td>
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</tr>
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<td>Northern Region</td>
<td></td>
<td>Savelugu/Nanton District</td>
<td>minor part</td>
</tr>
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<td>740</td>
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<td>minor Walewale</td>
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**D:**

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<tbody>
<tr>
<td>Upper East Region</td>
<td>911</td>
<td>Chiana-Paga local council (Nankani</td>
<td>minor</td>
</tr>
</tbody>
</table>
Bolgatanga Town is located in the administrative area of the Bolgatanga-Tongo local council, also known as Frafra district. In 1988 it had a population of about 60,000 inhabitants and it is and was the administrative headquarters of the Upper East Region. Bolgatanga began as a trading centre situated at a major road junction. It is also a major educational and health centre for much of the Upper East region.

Bolgatanga is a rapidly growing urban centre (Dickson and Benneh, 1988). Walewale has a population of about 20,000 inhabitants. It is located on the Tamale-Bolgatanga road, where a branch road leads off to Gambaga. It is an important trade route junction. Part of its population comes from Togo and Burkina Faso. Gambaga has a population of approximately 15,000 inhabitants. The town is located in the Northern Region, Mamprusi-East district. It used to be the traditional centre in precolonial times and during part of the colonial era as well.

### 1.3 Positioning of the study region in the wider area

The study area is located in the far north-eastern part of Ghana, and borders Togo in the east and Burkina Faso in the north.

#### Table 5 The study area in the region

<table>
<thead>
<tr>
<th>No.</th>
<th>District</th>
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<th>Local Council</th>
<th>Population</th>
</tr>
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<tbody>
<tr>
<td>1</td>
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</tr>
<tr>
<td>2</td>
<td>Bongo-Nabdam</td>
<td>Upper East</td>
<td>Bongo-Nabdam local council (Bongo District)</td>
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<tr>
<td>3</td>
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<td>Upper East</td>
<td>Bolgatanga-Tongo local council (Bolgatanga District)</td>
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</tr>
<tr>
<td>4</td>
<td>Kusanaba-Zebilla</td>
<td>Upper East</td>
<td>Kusanaba-Zebilla local council (Bawku West District)</td>
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</tr>
<tr>
<td>5</td>
<td>Walewale</td>
<td>Northern</td>
<td>Walewale local council (West Mamprusi District)</td>
<td>very minor</td>
</tr>
<tr>
<td>6</td>
<td>Nalerigu</td>
<td>Northern</td>
<td>Nalerigu local council (East Mamprusi District)</td>
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Map 4  The study area in its administrative surroundings

Still to be added
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<thead>
<tr>
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<th>Districts (1984)</th>
<th>Settlements</th>
</tr>
</thead>
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<td>Sandema local council</td>
<td>all</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper East Region</td>
<td>910</td>
<td>Navrongo local council</td>
<td>most</td>
</tr>
<tr>
<td></td>
<td>911</td>
<td>Chiana-Paga local council</td>
<td>most</td>
</tr>
<tr>
<td>Ghana: Upper West</td>
<td>820</td>
<td>Tumu local council</td>
<td>half</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper West Region</td>
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<td>Nadawli-Fundi local council</td>
<td>minor</td>
</tr>
<tr>
<td></td>
<td>800</td>
<td>Wa urban council</td>
<td>very minor</td>
</tr>
<tr>
<td>Ghana: Northern</td>
<td>701</td>
<td>Damongo local council</td>
<td>very minor</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern region</td>
<td>740</td>
<td>Walewale local council</td>
<td>almost all</td>
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<th>Districts (1984)</th>
<th>Settlements</th>
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</thead>
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<td>Northern Region</td>
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<td>Savelugu local council</td>
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<td></td>
<td>732</td>
<td>Tolon local council</td>
<td>almost all</td>
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<tr>
<td>Northern Region</td>
<td>800</td>
<td>Wa urban council</td>
<td>very minor</td>
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<tr>
<td></td>
<td>801</td>
<td>Nadawli-Funsi local council</td>
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<th>Settlements</th>
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<tr>
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<td>730</td>
<td>Savelugu local council</td>
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<td>Region</td>
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<tr>
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<td>731</td>
<td>Tamale Urban council</td>
<td>all</td>
</tr>
<tr>
<td></td>
<td>732</td>
<td>Tolon local council</td>
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</tr>
<tr>
<td></td>
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<td>Nyankpala Agricultural station</td>
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<td>720</td>
<td>Bimbilla local council</td>
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</tr>
<tr>
<td></td>
<td>722</td>
<td>Yendi local council</td>
<td>most</td>
</tr>
<tr>
<td></td>
<td>721</td>
<td>Saboba-Zabzugu local council</td>
<td>very minor</td>
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<td>Gushiegu-Chereponi local council</td>
<td>half</td>
</tr>
<tr>
<td></td>
<td>740</td>
<td>Walewale local council</td>
<td>very minor</td>
</tr>
</tbody>
</table>
4: Ghana: Northern Region 723 Gushiegu-Chereponi local council very minor
Northern Region 721 Saboba-Zabzugu local council half Zabzugu
Northern Region 722 Yendi local council minor
Northern Region 720 Bimbilla local council very minor Bimbilla + Wulasi
Togo Region des Savanes minor
Togo Region des Savanes half Bassar + Guerin-Kouka
Togo Region Kara

5: Ghana: Upper East Region 931 Tempane-Guru local council very minor
Ghana: Northern Region 741 Nalerigu local council minor
Northern Region 723 Gushiegu-Chereponi local council
Togo Region des Savanes half Dapaong + Dapaong +
Togo Region des Savanes
Benin Atakora minor Sansanne-Mango
Burkina Faso Province le Gourma

For Togo see De Haan, 1993
For Benin see De Haan, 1997

6: Ghana: Upper East Region 931 Tempane-Guru local council very minor
Upper East Region 933 Pusiga-Pulimakum local council very minor Sinkasse
Togo Region des Savanes very minor Bawku
Burkina Faso Province le Gourma half Pama +Sanga

7: the ICCD Tenkodogo cell
Ghana: Upper East Region 933 Pusiga-Pulimakum local council half Tenkodogo
Upper East Region 932 Bawku urban council half +Garango
Upper East Region 930 Kusanaba-Zebilla local council very minor
Upper East Region 921 Bongo-napdam local council very minor
Burkina Faso Province le Boulgou minor
Burkina Faso Province le Zoundweogo half
1.4 Most important elements of the pre-1960 history

Most people who currently live in the Bolgatanga area are descendants of people who originally came from the northeast. In pre-colonial times the Bolgatanga area was a refuge area for people who fled the slave raids in the central area of current-day Ghana and turmoil in the outskirts of the Mossi Kingdom towards the north. As such it belongs to a belt of densely populated areas, all at the same latitude in west Africa. Most of the groups living in the study area trace their lineage back to one ancestry: Na Gbewaa, who was king of the Mamprusi Traditional Area, which included most of study area and which had its headquarters in Nalerigu. During the 19th Century the area was influenced by, but never became part of the Asante (Ashanti) Empire. It was much more under the influence of the so-called Mossi States (Dagomba in the south and Mamprusi in the north), with an increasing influence even at the end of the 19th Century (Atta-Quayson, 1995, p. 36).

The eastern part of the study area (east of the White Volta River) was colonised in the early 1900s by Germany as part of German Togoland, while the western part was colonised at around the same period by Great Britain as part of the zone of influence of the Gold Coast which had become a British Colony in 1874: in 1901 the Northern Territories were declared a British Protectorate. In 1919 the former German colony became a Protectorate under the League of Nations, partly under French, and partly under British mandate. The relevant area in the study area became British, first with its provincial headquarters in Gambaga, from 1911 onwards in Tamale (Bening, 1973, 1974, 1975, 1990, p. 8).

During the Colonial era the districts in the current Upper East Region were together referred to as North Mamprusi, while the two districts in the current Northern Region were referred to as South Mamprusi. A large part of the inhabitants of the study area regarded the Nalerigu chief as their king, who ‘enskinned’ many of the paramount chiefs in the Bongo, Bolgatanga, Mamprusi-East and Mamprusi-West areas. This is still largely the case nowadays.
When Ghana became an independent republic in 1957 former German Togoland that had been administered by the British and the Gold Coast were united as one independent country and the two parts of the study area were joined as Northern Region. Soon after Independence this region was divided into Upper and Northern Regions. Later, in 1985, Upper East region was divided in Upper East and Upper West Regions.
CHAPTER 2  CHANGES IN THE PHYSICAL ENVIRONMENT OF THE STUDY AREA

2.1 Description of the natural terrain
The study area predominantly consists of gently undulating slopes at an altitude of between 110 and 200 metres above sea level, with slopes ranging from 1% to 5%, although there are inselberg outcrops and some uplands with slopes of more than 10%. The Gambaga Escarpment in the centre of the study area, from west to east, rise to an altitude of 450 meters.

Map 5 The natural area

The northern part of the study area is part of the Volta River basin, where the White Volta, the Red Volta (from Burkina Faso) and the Morago (from Togo) come together. Geologically the area consists of igneous rocks, in the western part combined with metamorphic rocks. The southern part of the cell is part of the Nasia River basin, a tributary of the Volta. It is described in the book ‘Soils of the Nasia River basin’ (Adu, 1995). Geologically the southern part consists of sedimentary rocks: Upper Voltaian sandstones, lower Voltaian shales and basal sandstones. The Gambaga hills in the central part of the study area are composed of massive sandstones. Most of the Nasia Basin is very gently undulating. It has broad, poorly drained valleys and extensive floodplains adjacent to the Volta and Nasia rivers where altitudes vary between 110 and 140 meters above mean sea level.

In the Langbens area in the southern part of the study area there are long slopes, often more than one kilometre, and broad summits. Langbens itself is situated in the foothills at the western edge of the rather rolling Gambaga Scarp. Most slopes are between 2 and 5%. Streams are slightly incised and have formed narrow valleys.

2.2 Description of the hydrology and water availability
Two rivers dominate the area: the White Volta and the Nasia, which empties in the Volta. In the Nasia Basin the drainage system has mainly north and south directions.
The main surface water resources within the region are concentrated in the White Volta and the Nasia river systems. The volume of water in these rivers has a direct relation with the seasonal rainfall (with a time lag of about a month), with its peak in August-September. The White Volta flows permanently, although during the period of January to April it is reduced to a little stream. The Nasia river tends to respond more quickly to rainfall fluctuations than the White Volta. This is due to the more restricted catchment area. In severe dry seasons there is no flow, but only pools of water in the river bed (Adu, 1995). The smaller tributaries of the rivers are seasonal and flow between May and mid-November. Apart from these rivers, some permanent and seasonal water resources exist in the form of old ox-bow lakes and cut-offs in the alluvial plains adjacent to the river courses, which serve as valuable sources of potential catch reservoirs. With regard to the Nasia and White Volta, little of the region’s population is found within the alluvial areas and therefore not much water is used by human beings, except at certain accessible points (Nasia and Pawlugu bridges). Tributaries from the Gambaga Scarp are the most important sources of water for humans and livestock (mainly for those living south of the Gambaga watershed) (Adu, 1995). The water table is quite deep in most of the study area and therefore expensive to utilise. During the rainy season soils which are formed from lower Voltaian shales often become waterlogged due to their high clay and silt content. Rice cultivation is practised in some of those areas. From the mid 1960s onwards the valleys of the major and minor tributaries of the Nasia river, as well as the small-scale irrigation areas (e.g. Vea) have become the main areas of rice production in Northern Ghana.

During the 1960s many small water dams have been constructed; according to representatives from the Ministry of Food and Agriculture there were more than 200 or even 250 in Upper East Region alone (An IFAD-funded project counted 256 of them). An average dam can irrigate 10 hectares of land, mainly for tomatoes, onions or other vegetables, or even rice. According to a natural resource management expert in the area the Region needs at least 450 additional dams. Most of the existing small dams silted up during the 1970s and ‘80s. Recently a start has been made to rehabilitate these dams and encourage farmers to use them for dry-season cultivation. In 1999 44 of these dams had been rehabilitated and their use as areas of intensive cultivation of rice and horticultural produce has indeed increased considerably. People have come to see their importance and much more effort is put in maintaining and preserving the dams.

People report that the number of ‘swimming pools’ has become much less (especially pools along rivers have disappeared) and that also many running streams become stagnant water pools more early in the season than before. As a result the water quality from those sources becomes worse and there are more mosquitos breeding. Some water sources which used to be good now became salty. In addition chemical pollution (pesticides; mining chemicals) has increased. However, due to much improved modern drinking water supplies, the average quality of drinking water has improved a lot, certainly for the urban population. Hand dug wells and boreholes provided by CIDA, COWAP and some other NGOs helped a lot. It is interesting to note that in urban areas water is rapidly commercialising, with water vendors selling water to those without proper own provisions. Thanks to improved drinking water in the urban areas guinea worm infestations are no longer a severe problem, as it was before.
2.3 Description of the soils

Half of the area consists of ‘Savanna Ochrosols’, which are well drained porous loams, which are extensively and in some areas intensively farmed. These soils can be found in the Gambaga Escarpment area, near Bolgatanga and near Bongo. The other half of the area (in the northeast and in the south) consists of much poorer ‘Groundwater Laterites’, which are poorly drained loams (Atta-Quayson, 1995, p. 12).

Upland soils have mainly developed from granite rocks with a shallow and complex basement, which is generally low in inherent soil fertility and weak with a low organic matter content. In those parts there is severe sheet and gully erosion, especially during the rainy season.

In the Langbensí area the uniform geology of Voltaian sandstone has given rise to a series of soils, which are strongly related to the physiography. (Soils series found are: Kintampo, Techiman, Wenchi, Mimi, Murugu and Yaroyiri series).

The southern part of the study area is covered entirely by Voltaian sandstones. In the middle of the study area the Gambaga sandstone escarpment is located. Here, deep, red, well drained soils which developed over sandstone and over some terrace areas, are currently intensively used for the cultivation of a wide range of crops. These areas are not overcrowded and still have development potential beyond their present use (according to Adu, 1995).

Extensive lands on the Volta and Nasia flood plains and in sloughs are relatively unused because they are subject to annual waterlogging or flooding and to the incidence of the sleeping sickness (Trypanosomiiasis) and river blindness (Onchocerciasis). According to the World Health Organisation river blindness has been eradicated in the areas between the two Voltas in 1991, after measures from 1982 onwards. However, because the fly is still there, many people don’t trust it. If they have started to cultivate in this area, they still live a few kilometres away from their fields. In the Volta and Nasia flood plains the soil is a heavy, silty clay and not easily cultivated. In the shales the soils are poor, very shallow, very concretionary and not well drained. Farmers generally avoid these areas. The crops that are farmed are yams and cereals, and further the land is used for rough grazing. In the scarplands (the steep parts of the Gambaga Hills) we find the leptosols. These areas are steep and have rocky slopes, and are generally inaccessible for cultivation. These areas are mainly used as forest reserves (Adu, 1995).

Based on interpretations of Prof. Ofori-Sarpong, we can arrive at a rough and static assessment of agricultural potential of the study area, using current agricultural technology, sustainable forms of soil use, and realistic assessments of potential land to be cultivated and yield levels for the most suitable crops. In total this assessment arrives at an estimated potential average grain production of 500,000 tonnes of food, enough to feed two to two-and-a-half million people (if we use a grain needs figure of 200 to 250 kg/person/year). This is more than enough for the current people living in the area, but not sufficient for the more than three million people predicted to live in the area in the year 2050. Much depends on the development of cultivation practices in the first soil type to be described, though. And much depends on the yield developments influenced by climate change and land and water management.
Figure 6  Sketch map of the soils
The following landscape/soil types can be discerned:

- **Alluvial soils**, near the Volta Rivers and the rivers coming from the Gambaga Escarpment. The soils are generally excellent up to two kilometres from the river. However, during the rainy season there are severe flood risks. After the eradication of the tsetsefly farmers have started to cultivate gardens in the dry season (November-February), but there is still quite some reluctance to start building homesteads near the river. In total the best area can be estimated to be 2,000 km². In addition 3,000 ha are currently irrigated, and have two harvests of tomatoes and rice mainly. Both types of areas can be cultivated every year, without fallow requirements, although the irrigated areas need additions of nutrients; rice cultivation (1,500 kg/ha) could have the potential to produce 300,000 tons of grains per annum, and double the amount if, by using drainage and flood defence works, two harvests could be produced per annum;

- **Wenchi soil series**, in the northwest, have patches with reasonably good soils, with intensive cultivation, but surrounded by lots of boulders and interspersed with isolated tabular hills (‘buttes’) which rise two to 60 meters above the surrounding topography, especially near Bongo. Upper slopes and summits usually have shallow soils, and are characterised by heavy presence of sheet iron pans, less than 30 centimetres from the surface. Those sections can better be left under grass for grazing. This area is approximately 1,000 km² and could produce 30,000 tonnes of grains per annum(at 70% cropping; 50% fallow and with 800 kg/ha of sorghum, millet or maize).

- **Bawku Series and related soils** in the rest of Upper East (3,000 km²) have moved to a dangerous situation of overcultivation (or undermanuring), with ever growing areas of continuous cultivation at low yield levels and bushfarms with decreasing fallow. With good soil management the area could possibly produce 60,000 tonnes of grains (60% cultivation; 50% fallow; millet and sorghum yields of 700 kg/ha).

- **Techiman soil series** in the Gambaga escarpment area (on the summits and upper slopes) are fit for forest and ranching. The area is about 1,000 km² and cultivation possibilities are meagre; part of the area (3000 ha?) is a forest reserve. These soils are moderately deep, well drained, reddish brown and with a sandy loam to sandy clay loam texture, with many large iron-manganese concretions, ferruginized sandstone gravels and pieces of ironstone (Asamah et al., 1997). The soils are less suitable for agriculture because of poor workability (only suitable for hand or in some areas bullock cultivation), poor nutrient supply (very low amounts of phosphorus and potassium) and poor moisture retention capacity as a result of the abundance of coarse fragments. If farmers take the trouble to cultivate crops here they need to be shallow rooted crops (e.g. groundnut, tobacco, guinea corn, millet, pepper, okra, beans), but they better don’t (Adu, 1995).

- **The Mimi soil series** in the foothills of the Gambaga escarpment (2,500 km²) need 75% fallow on the western side and 67% fallow on the eastern side; most of the area can be cultivated. In total the area could produce 50,000 tonnes of grains (80% cultivation area, 25 resp. 33% annual use, 900 kg/ha sorghum or maize). These soils are by far the most cultivated in the Langbens area, south of the Gambaga scarp: they are moderately deep to deep, well drained, dark red to red and they have a sandy loam to clay loam texture; they are almost free of iron-manganese concretions and gravel (Asiamah et al., 1997). These soils are easy to till and are suitable for crops like maize, sorghum, millets, groundnut, bambara beans,
cowpeas, cotton and soya beans. They need careful soil management to prevent soil erosion.

- The Muruga/Yarayiri soil series in the southern part of the study area need longer fallows (80-85%), but the area could be and is being used for rainfed rice production. With 3,500 km² the area could produce, with current technology, 50,000 tonnes of grains (80% potential cultivation area; 15% annual use; rainfed rice at 1,000 kg/ha). The Murugu soils are mainly distinguished from the Mimi series by its yellowish brown colour in stead of red, due to the relatively poor drainage of the Murugu series. These soils are found in sland depressions and lower slopes. The soils have a higher moisture content than the Mimi series which makes them less drought prone during short dry spells in the rainy season (Asiamah et al, 1997). They are not as suitable as the Mimi series in terms of chemical composition and inherent fertility (hence longer fallow requirements). The Yaroyiri series are alluvial soils found in narrow valleys. They are poorly drained, with a light to grey colour. The profile consists of 30 centimetres of more or less crumbly, loose, fine sand, brownish grey in colour (with humus stains in the top 8 cm), over 30-150 cm of brown, or yellow brown fine sand which is porous and crumbly (Adu, 1995). Inherent fertility is low, but their topographical position and sub-soil water retention capacity makes them useful for dry-season gardening. Rice cultivation is very much on the increase. With some exceptions (Kunkwa area) the area is free from river blindness. People have started to settle in the area, because it is generally too far for them to go back and forth to their original homes in Walewale and surroundings. In an area south-west of Yagaba people who have settled are very isolated, because during the rainy season the roads are not passable and there are no bridges. The place is called ‘over seas’.

2.4 Description of the natural vegetation and fauna

Natural vegetation is mostly of the tree savanna type (‘Guinea Savanna Woodland’) (Taylor, 1952). The upper Voltaian sandstone soils show a greater density and variety of tree growth, due to deeper and more favourable soils.

The vegetation in the north-eastern corner of the region consists of short grasses and some scattered fire-resistant acacia and baobab trees (‘Sudan Savanna’, according to Atta-Quayson, 1995, p. 12). This kind of vegetation has resulted mainly from prolonged grazing, burning and cultivation. The original vegetation was much richer with more trees. Some of the trees are typical for the drier forest in the northern Asante region (Dickson and Benneh,1988). The vegetation is a fire sub-climax, developed through a long period of denudation and modification by human activity, especially by farming and burning (Taylor, 1952). In the area between the two Voltas there is a seasonal elephant route, with a lot of destruction of crops among the (few) farmers who have dared to settle there. These riverine areas are still largely regarded as posing major health risks (e.g. eye diseases) in addition to the crop loss risks due to elephants and other wild animals.

Vegetation in the Langbenshi area is predominantly tall grass ‘Guinea’ savanna with widely spaced, fire resistant short trees and shrubs. Bare patches of land exist as well. However, the original vegetation has been replaced in many areas by a woodland savanna with fire resistant trees and cultivated farm sites. Important economic trees are the sheanut (Butyrospermum parkii) and the Dawadawa (Parkia clappertonniana)
Asiamah et al., 1997). The areas that come closest to the natural vegetation are those near the scarps and rock outcrops where farming activities have never been possible. According to many people the Dawadawa is disappearing: the old trees still produce, but young trees are few. This is seen as a major indicator of changes in nature, possibly climate change.

2.5 History of the weather

In considering climate change, the major factors to look at are rainfall, temperature, wind speed, cloud cover, evapotranspiration and vegetation cover. Whereas all factors are more or less interdependent, in the study area the major factor as far as agriculture is concerned, is rainfall (Atengdem & Dery, 1998).

Prof. Ofori Sarpong did a survey for all data that exist about rainfall in northeast Ghana as a whole, for the period 1900-1993. The average rainfall for this area (which is considerably bigger than our study area and which includes rainfall stations to the more humid south as well) for the century as a whole was slightly higher than 1200 mm. The five-year moving average shows interesting and quite substantial fluctuations. The century started with a bad rainfall situation between 1900 and 1915, with droughts in 1904 and 1912. The late 1910s were good, with an all-time annual peak of close to 2000 mm in the year 1917, followed by drought again in 1918-1920. The period 1920-1935 was more or less average, followed by a dry period between 1935 and 1945. The period 1945 till 1975 was very good as a whole, with the exception of 1957-1960 (1960 being extremely bad). After 1975 the rainfall situation deteriorates a lot, reaching averages of 200 mm below the level for the century as a whole. However, after 1985 the situation improves somewhat. Figure 7 gives the details (Ofori Sarpong, personal communication 1999).

The study area proper is located in the sub-humid zone of northern Ghana, with alternating wet and dry seasons. The climate is influenced by the convergence of two air masses, the boundary of which is called the Inter-Tropical Convergence Zone. The one air mass is continental and dry and is associated with the Azores High, which extends over the Shara and gives rise to the Northeasterly Trade Winds of ‘harmattan’. In the dry season almost every part of Ghana comes under the influence of these winds. The other is the moist tropical air mass, which originates from the South-Atlantic anticyclone and is associated with the moist southeasterly winds, which bring copious rainfall to Ghana during the rainy season. The boundary fluctuates north-south (Walker, 1957). Annual rainfall averages about 900-1100 mm in the northern part and 1000-1200 mm in the southern part. For the northern part, the Upper East Region as a whole, the Ministry of Food and Agriculture recently stated that the ‘normal annual rainfall, was about 950 mm and that any value below this can be regarded as a risk situation for local agriculture’ (MOFA, 1997). Rainfall is concentrated in the period from April to October, during which 95% of the precipitation occurs. The South-West Monsoon rains reach their peak levels in August with about 1/4 of the annual rainfall. Rainfall intensity can be high during this period, with rain storms causing severe erosion of unprotected soils. The mean number of rain days varies from 90 in the south of the study area to 73 in the north. In the period December - February the dry northeastern trade winds (Harmattan) can cause dust storms. The Meteo office in Bolgatanga uses the following seasonality description for three rainfall stations in the area (see table 6). Looking at the totals one
cannot escape the suggestion that these
Figure 7 Northeast Ghana: Annual Rainfall 1900-1993
data are still based on old datasets (e.g. 1930-1965) when the rainfall situation in the whole area was (much) better compared to the 1965-1997 period.

Table 6 Rainfall seasonality in Upper East Region: mean monthly rainfall in mm (25-40 years average)

<table>
<thead>
<tr>
<th>Month/Station</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Tot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bawku</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>46</td>
<td>91</td>
<td>123</td>
<td>169</td>
<td>237</td>
<td>213</td>
<td>65</td>
<td>8</td>
<td>1</td>
<td>974</td>
</tr>
<tr>
<td>Zuarungu</td>
<td>2</td>
<td>4</td>
<td>16</td>
<td>47</td>
<td>108</td>
<td>144</td>
<td>172</td>
<td>247</td>
<td>219</td>
<td>65</td>
<td>11</td>
<td>1</td>
<td>1038</td>
</tr>
<tr>
<td>Navrongo</td>
<td>1</td>
<td>7</td>
<td>19</td>
<td>46</td>
<td>113</td>
<td>137</td>
<td>206</td>
<td>264</td>
<td>235</td>
<td>62</td>
<td>5</td>
<td>2</td>
<td>1100</td>
</tr>
</tbody>
</table>

Source: Meteo Office Bolgatanga. Nowadays, Zuarungu is no longer regarded as an important rainfall station.

Temperatures are high throughout the year, averaging about 28°C (with a range between 26-32°C). During the dry season from November to April day and night temperatures are high, up to 46°C during the day in the shade (with the exception of night temperatures in December and January, which are relatively low, e.g. 15°C). High temperatures, dry conditions and (harmattan) wind encourage bushfires. Relative humidity is strongly fluctuating, less than 35% during the dry season, and more than 70% during the rainy season. Diurnal fluctuation is large as well, with the highest humidity recorded in the morning, when it is often greater than 90% from July to September, while the lowest is recorded in the late afternoon. The length of the growing period for rainfed crops is more than 80 days in the southern part and less than 60 days in the northeastern part (Atta-Quayson, 1995, p. 10). In the Langbensi area the relative humidity goes down to 20 percent during the dry season and there is one short rainy season of four months on average. Atta-Quayson (1995, p. 11) gives a seasonal rainfall and temperature diagram for Navrongo, near the northwestern part of the study area (see figure 8).

Figure 8 Navrongo: seasonal rainfall and temperature

Long-term climate data up to the current period exist for three relevant stations: Gambaga in the central part of the area, Bawku, just outside the northeastern corner of the cell, and Navrongo, just outside the northwestern corner of the cell. Data from
FAO’s Agrhyemet source are slightly different from data given by ISRIC, because reference years differ. For Gambaga the first source can be used to calculate an average annual rainfall (based on 1960-1997) of 966 mm. ISRIC gives 950 mm. In the rainy season (defined as five months, March-September) averages are 855 mm resp. 813 mm. August is clearly the wettest month, followed by September and July. For Navrongo the FAO and ISRIC data give more or less the same results: 966 mm on average and 840 mm in the rainy season (however: for Navrongo eight years are missing in the FAO data set). The Meteo Office in Bolgatanga uses data which give a much higher average (see table above). For Bawku we only have FAO data, showing an annual average of 871 mm, of which 733 mm in the rainy season. Also for Bawku the local Meteo Office data give a considerably higher average. Gambaga and Navrongo receive more rain compared to Bawku. There are also other rainfall stations in the area (e.g. Zuarungu, Bolgatanga, Nakong, Paga, Sandema, Wiaga, Binduri, Garu, Kugri, Vea), but for those centres there are only a few years available and the Ghana Meteorological Services Dept. does not regard these data as very reliable. There has been a period in which they engaged schools to carry out rainfall measurements, but during school holidays results became very unreliable (according to a meteorologist working in the area it was not always clear if they measured water or urine…). For Navrongo and Bawku (and for a rainfall station at the Vea Dam site, in the northwestern part of the research area) we received data for the years 1994-1997 from the Ghana Meteorological Services Department at Bolgatanga.

Annual rainfall totals can be quite different from year to year. In Gambaga the lowest rainfall measured during the 1960-1993 period was 731 mm (in 1962 and in 1977) and the highest rainfall was 1222 mm (in 1991). In Navrongo the extremes were 776 mm (1984) and 1272 mm (1973) and in Bawku 644 mm (1983) and 1118 mm (1989). If we combine the data for these three stations (although part of the years deficient for Navrongo) we get an assessment of the rainfall differences between the years for the region as a whole. For 1994-97 we combine the data for Navrongo, Bawku and Vea.

Low rainfall years (or worse: periods) have been 1961-62, 1964-65, 1972, 1977, 1981, 1983-87, 1990, 1992-93 and 1995 or more in detail:

**Table 7 Good and bad rainfall years in Upper East Region, 1960-1997**

<table>
<thead>
<tr>
<th>Rainfall Range</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 700 mm</td>
<td>1977</td>
</tr>
</tbody>
</table>

Is there a rainfall trend in the area? The combined rainfall data for the research area as a whole shows an upward trend in the 1960s (a five-years average figure that moves from about 940 mm to more than 1000 mm in 1969) and a more or less continuous trend downwards from 1000 mm in 1969 until slightly above 800 mm in 1985. In the second half of the 1980s the trend improves again and does so rather rapidly (to an average of 975 mm in 1990), after which year the trend moves slightly downwards again, towards a level of 930 mm in the mid 1990s. The lowest point was reached in the 1981-87 period, after which the ‘Sahelian crisis’ seems to be over in many other...
parts of western Africa as well. Data for the period 1985-1997 do certainly not suggest a further deterioration of the rainfall situation.

Annual rainfall data are not the most relevant to use for an analysis of agricultural (crop cultivation) risks. Data for the growth season are much more important and especially if they take into account if there are dangerous dry spells during the rainy season. For the ICCD project a ‘drought risk assessment’ (DRA) was developed with a six-point scale, from no (0) to extreme (5) drought risks for the cultivation of sorghum and millets. During the period 1960-93 there have been 13 years with no drought risks (index 0) in Gambaga, 12 years with very light drought risks (index 1), 7 years with light drought risks (index 2), and (surprisingly) 2 years with extreme drought risks (DRA 5). These two extreme years were 1962 and 1970. However, in 1962 the drought risk for Navrongo and Bawku was only very light (DRA 1), while they were light (DRA 2) in those two centres in 1970. The average drought risk assessment for Gambaga was 1.1, which is on average very light. In Navrongo the number of years with no drought risk (index 0) was much lower: only five, while there were 11 years with very light drought risks and 9 with light drought risks. There was one year (1967) with a moderate drought risk (DRA 3). On average the drought risk was only slightly above the one for Gambaga: 1.2 (but based on only 26 years of data). In Bawku the average drought risks were considerably higher: 1.8. Here there was only one year without drought risks, 16 years had a very light drought risk, 16 a light drought risk while one year (1980) had a moderate drought risk. Within the study region in most years the drought risk figures do not show a consistent pattern. If we consider an index of 2 or higher as a signal of drought problems (in relative terms) there are only six years in which all three rainfall stations show the same relatively problematic situation: for 1963, 1970, probably 1977, 1981, 1984, and 1990. Out of those years only 1977, 1984 and 1990 also had a relatively low annual rainfall total.

Note:
The Drought Risk Assessment DRA gives the estimated chances of a crop failure of sorghum and millets, due to inadequate rainfall for those crops. It is based on monthly rainfall data, and evapotranspiration and temperature estimates in the rainy season.

DRA = 0 indicates that there were at least four consecutive months with ample rainfall
DRA = 1 that there were at least four consecutive months with adequate rainfall
DRA = 2 that there were three but not four consecutive months with adequate rainfall
DRA = 3 that there were three consecutive months with barely enough rainfall
DRA = 4 that there were no three consecutive months with barely enough rainfall, but that the deficit was compensated by surplus rainfall during the previous month (soil moisture storage)
DRA = 5 that there was inadequate rainfall and not enough surplus rainfall to compensate for the deficit; moisture stress will be extreme for even the most stress-adapted grain crops.

In the research area sorghum and groundnuts generally need three to four months of adequate rainfall, while the early-maturing millets need two to three months and other millets three to four. Maize is a more risky crop and needs at least four months. Rice is mainly cultivated in small-scale irrigated areas and in low-lying marshy soils (as rainfed rice). The adequacy of soil moisture storage (important in cases of DRA 3 and 4 for millets and 2, 3 and 4 for sorghum) depends on soil types. Sandy soils are generally more risky during dry spells, while clayey soils are more favourable. Also the location of fields matters: both the exposure to the sun (northern versus southern hill sides) as well as uphill (water losing) versus downhill (water gaining, or even ‘water harvesting’) can have an important impact on plant survival and productivity during droughts.

The DRA does not indicate other climate-related risks, like winds (the harmattan during the early cropping season can destroy young plants), floods (a low DRA however may suggest a higher likelihood of excess rainfall), and hail (very rarely). It also does not indicate pests, although again a
low DRA may suggest a higher likelihood of competing weed growth, and damaging insects, fungi, and birds.

The fact that the DRA uses monthly data makes it a rather rough instrument; 10-day data would be better but it is very difficult to get access to those data for a sufficient number of years.

2.6 Detailed analysis of the rainfall situation 1987-1997 and of the variation in agricultural productivity

For the years 1987-1997 data exist about the agricultural production per average hectare in Upper East Region, for five crops: millet, sorghum, groundnuts, maize and rice. For 11 rainfall stations in this region we also have rainfall data, both annual and monthly, which enable us to calculate the drought risk assessment per station per year and for the area as a whole (although not far all stations data are complete). For reference purposes we also give rainfall data and drought risk assemsments of two nearby rainfall stations in Northern Region (Walewa and Gambaga), both also located in the study area, and of the regional headquarters, Tamale, more to the south.

Table 8  Annual Rainfall Data and Drought Risk Assessments for Rainfall Stations in the Western Part of Upper East Region, 1987-97

<table>
<thead>
<tr>
<th>Station</th>
<th>Nakong</th>
<th>Sandema</th>
<th>Wiaga</th>
<th>Paga</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>P</td>
<td>DRA</td>
<td>P</td>
<td>DRA</td>
</tr>
<tr>
<td>1987</td>
<td>nd</td>
<td>nd</td>
<td>1217</td>
<td>0</td>
</tr>
<tr>
<td>1988</td>
<td>nd</td>
<td>nd</td>
<td>907</td>
<td>1</td>
</tr>
<tr>
<td>1989</td>
<td>nd</td>
<td>nd</td>
<td>1155</td>
<td>0</td>
</tr>
<tr>
<td>1990</td>
<td>nd</td>
<td>2</td>
<td>745</td>
<td>2</td>
</tr>
<tr>
<td>1991</td>
<td>925</td>
<td>3</td>
<td>1142</td>
<td>2</td>
</tr>
<tr>
<td>1992</td>
<td>486</td>
<td>2</td>
<td>851</td>
<td>1</td>
</tr>
<tr>
<td>1993</td>
<td>584</td>
<td>2</td>
<td>851</td>
<td>1</td>
</tr>
<tr>
<td>1994</td>
<td>748</td>
<td>2</td>
<td>1130</td>
<td>1</td>
</tr>
<tr>
<td>1995</td>
<td>770</td>
<td>2</td>
<td>nd</td>
<td>1</td>
</tr>
<tr>
<td>1996</td>
<td>521</td>
<td>5</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td>1997</td>
<td>712</td>
<td>3</td>
<td>nd</td>
<td>3</td>
</tr>
<tr>
<td>Average</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
<td>1.3</td>
</tr>
</tbody>
</table>

nd = no complete data

Table 9  Annual Rainfall Data and Drought Risk Assessments for Rainfall Stations in the Central Part of Upper East Region, 1987-1997

<table>
<thead>
<tr>
<th>Station</th>
<th>Navrongo</th>
<th>Vea Dam</th>
<th>Zuarungu</th>
<th>Binduri</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>P</td>
<td>DRA</td>
<td>P</td>
<td>DRA</td>
</tr>
<tr>
<td>1987</td>
<td>1133/nd</td>
<td>1/nd</td>
<td>900</td>
<td>0</td>
</tr>
<tr>
<td>1988</td>
<td>915/nd</td>
<td>1/nd</td>
<td>937</td>
<td>1</td>
</tr>
<tr>
<td>1989</td>
<td>1080/nd</td>
<td>0/nd</td>
<td>1217</td>
<td>1</td>
</tr>
<tr>
<td>1990</td>
<td>866/849</td>
<td>2/2</td>
<td>835</td>
<td>2</td>
</tr>
<tr>
<td>1991</td>
<td>980/1058</td>
<td>3/2</td>
<td>984</td>
<td>2</td>
</tr>
<tr>
<td>1992</td>
<td>1032/909</td>
<td>0/1</td>
<td>1186</td>
<td>0</td>
</tr>
<tr>
<td>1993</td>
<td>789/844</td>
<td>1/1</td>
<td>842</td>
<td>2</td>
</tr>
<tr>
<td>1994</td>
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<tr>
<td>1995</td>
<td>nd/687</td>
<td>nd/3</td>
<td>826</td>
<td>1</td>
</tr>
<tr>
<td>1996</td>
<td>nd/1104</td>
<td>nd/1</td>
<td>1064</td>
<td>3</td>
</tr>
<tr>
<td>1997</td>
<td>nd/940</td>
<td>nd/3</td>
<td>833</td>
<td>1</td>
</tr>
<tr>
<td>Average</td>
<td>nd/nd</td>
<td>nd/nd</td>
<td>964</td>
<td>1.2</td>
</tr>
</tbody>
</table>

No data = no complete data
For Navrongo we have two data sets, which are slightly different.

### Table 10  Annual Rainfall Data and Drought Risk Assessments for Rainfall Stations in the Eastern Part of Upper East Region, 1987-1997

<table>
<thead>
<tr>
<th>Year</th>
<th>Bawku</th>
<th>Garu</th>
<th>Kugri</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>DRA</td>
<td>P</td>
<td>DRA</td>
</tr>
<tr>
<td>1987</td>
<td>771</td>
<td>nd</td>
<td>1</td>
<td>nd</td>
</tr>
<tr>
<td>1988</td>
<td>883</td>
<td>1</td>
<td>956</td>
<td>1</td>
</tr>
<tr>
<td>1989</td>
<td>1118</td>
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<td>1139</td>
<td>0</td>
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<td>1990</td>
<td>742</td>
<td>2</td>
<td>768</td>
<td>2</td>
</tr>
<tr>
<td>1991</td>
<td>1084</td>
<td>2</td>
<td>1182</td>
<td>0</td>
</tr>
<tr>
<td>1992</td>
<td>813</td>
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<td>nd</td>
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<tr>
<td>1993</td>
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<td>1994</td>
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<td>817</td>
<td>1</td>
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<tr>
<td>1996</td>
<td>1028</td>
<td>3</td>
<td>1079</td>
<td>1</td>
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<tr>
<td>1997</td>
<td>952</td>
<td>1</td>
<td>996</td>
<td>1</td>
</tr>
<tr>
<td>Average</td>
<td>933</td>
<td>1.5</td>
<td>nd</td>
<td>nd</td>
</tr>
</tbody>
</table>

**nd** = no complete data

### Table 11  Annual Rainfall Data and Drought Risk Assessments for Rainfall Stations in the North-eastern Part of Northern Region and Tamale, 1987-1997

<table>
<thead>
<tr>
<th>Year</th>
<th>Gambaga</th>
<th>Walewale</th>
<th>Tamale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>DRA</td>
<td>P</td>
</tr>
<tr>
<td>1987</td>
<td>964</td>
<td>0</td>
<td>623</td>
</tr>
<tr>
<td>1988</td>
<td>1016</td>
<td>1</td>
<td>510</td>
</tr>
<tr>
<td>1989</td>
<td>1161</td>
<td>0</td>
<td>1065</td>
</tr>
<tr>
<td>1990</td>
<td>796</td>
<td>2</td>
<td>760</td>
</tr>
<tr>
<td>1991</td>
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<td>1</td>
<td>900</td>
</tr>
<tr>
<td>1993</td>
<td>913</td>
<td>0</td>
<td>948</td>
</tr>
<tr>
<td>1994</td>
<td>979</td>
<td>0</td>
<td>1053</td>
</tr>
<tr>
<td>1995</td>
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<td>1996</td>
<td>1064</td>
<td>3</td>
<td>993</td>
</tr>
<tr>
<td>1997</td>
<td>833</td>
<td>1</td>
<td>807</td>
</tr>
<tr>
<td>Average</td>
<td>973</td>
<td>0.9</td>
<td>872</td>
</tr>
</tbody>
</table>

Note: Rainfall data were provided by the Meteorological Services Departments in Bolgatanga and Tamale; drought risk assessment calculations were done by Dr Marcel Put, based on a model developed by Dr Sjoerd de Vos. Data for Tamale were added (it is not part of the study area) because of the fact that the rainfall situation in this most important government, university and business centre in Northern Ghana probably influences perceptions of drought a lot.

The period covered starts after the bad rainfall period of the late 1970s and early 1980s. The years 1987-1994 are generally quite good, with 1990-91 a bit less so in Upper East (but 1991 not in Northern; there 1987 and partly 1988 were quite bad, as well as 1992-93). In Upper East the period 1995-1997 is worse though, with Drought Risk Assessment figures 2.6 for 1996 and 2.5 for 1997, against an average for the period of 1.4. On an annual basis the rainfall situation was not the worst for these two recent years during this period, though. The average rainfall annual total was lowest in 1990 (808 mm, with a DRA of 1.7). It was highest in 1989 (1158 mm) with the lowest average DRA (0.3).
Looking at the regional details, the large resemblance is striking in some years (e.g. 1987-1989 with DRA figures either 0 or 1), while in other years the location mattered a lot: in 1996 and 1997 the DRA was 1 in the best areas, but the DRA suggests an absolute crop failure (DRA = 5) in some other parts, like Nakong in 1996 and Paga in 1997. The overall situation in 1996 was one of good rainfall in June (in some places even starting in May), a rather dangerous dry spell in most of the area in July, and abundant rainfall in August, continuing in most areas into September. In Nakong - in the extreme northwestern part of Upper East Region - the season started late, July was exceptionally good, but August exceptionally bad and most farmers will have experienced severe difficulties. In places nearby, like Navrongo and Wiaga, the situation was not bad at all, though. In Kugri, in the extreme eastern part of UER, the month of July posed a problem, but thanks to surplus rainfall in June, the soil was probably moist enough for the crops to survive. In Walewale, in northern region, the same situation could be found. Here, surplus rainfall in June probably was not enough, so farmers were faced with a high risk of crop failure, especially those farmers with their fields in uphill and sandy locations. In 1997 the overall rainfall situation was not very promising. In a place like Paga it was even very bad in all months.

Table 12  Bolgatanga study area, rainfall in the rainy season, 1996, in mm.

<table>
<thead>
<tr>
<th>Rainfall Station</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>Drought Risk Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper East Region</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bawku</td>
<td>139</td>
<td>149</td>
<td>71</td>
<td>257</td>
<td>261</td>
<td>3</td>
</tr>
<tr>
<td>Binduri</td>
<td>175</td>
<td>117</td>
<td>71</td>
<td>117</td>
<td>71</td>
<td>3</td>
</tr>
<tr>
<td>Garu</td>
<td>126</td>
<td>170</td>
<td>98</td>
<td>316</td>
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</tr>
<tr>
<td>Kugri</td>
<td>82</td>
<td>175</td>
<td>70</td>
<td>258</td>
<td>73</td>
<td>4</td>
</tr>
<tr>
<td>Zuarungu</td>
<td>64</td>
<td>nd</td>
<td>nd</td>
<td>578</td>
<td>298</td>
<td>nd</td>
</tr>
<tr>
<td>Vea Dam</td>
<td>141</td>
<td>196</td>
<td>73</td>
<td>278</td>
<td>245</td>
<td>3</td>
</tr>
<tr>
<td>Navrongo</td>
<td>195</td>
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<td>108</td>
<td>301</td>
<td>207</td>
<td>1</td>
</tr>
<tr>
<td>Paga</td>
<td>51</td>
<td>87</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td>Wiaga</td>
<td>140</td>
<td>212</td>
<td>129</td>
<td>344</td>
<td>314</td>
<td>1</td>
</tr>
<tr>
<td>Sandema</td>
<td>71</td>
<td>124</td>
<td>nd</td>
<td>323</td>
<td>232</td>
<td>nd</td>
</tr>
<tr>
<td>Nakong</td>
<td>29</td>
<td>98</td>
<td>149</td>
<td>36</td>
<td>130</td>
<td>5</td>
</tr>
<tr>
<td>Northern Region</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gambaga</td>
<td>141</td>
<td>196</td>
<td>73</td>
<td>278</td>
<td>245</td>
<td>3</td>
</tr>
<tr>
<td>Walewale</td>
<td>135</td>
<td>98</td>
<td>67</td>
<td>325</td>
<td>210</td>
<td>5 (?)</td>
</tr>
<tr>
<td>Average</td>
<td>115</td>
<td>152</td>
<td>91</td>
<td>284</td>
<td>210</td>
<td>2.9</td>
</tr>
</tbody>
</table>
Figure 9  Rainfall stations and DRA in 1996 and 1997
Table 13  Bolgatanga study area, rainfall in the rainy season, 1997, in mm

<table>
<thead>
<tr>
<th>Rainfall Station</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>Drought Risk Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper East Region</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bawku</td>
<td>105</td>
<td>236</td>
<td>115</td>
<td>216</td>
<td>201</td>
<td>1</td>
</tr>
<tr>
<td>Binduri</td>
<td>82</td>
<td>187</td>
<td>99</td>
<td>169</td>
<td>210</td>
<td>1</td>
</tr>
<tr>
<td>Garu</td>
<td>125</td>
<td>238</td>
<td>92</td>
<td>233</td>
<td>186</td>
<td>1</td>
</tr>
<tr>
<td>Kugri</td>
<td>124</td>
<td>228</td>
<td>85</td>
<td>204</td>
<td>145</td>
<td>3</td>
</tr>
<tr>
<td>Zuarungu</td>
<td>101</td>
<td>231</td>
<td>76</td>
<td>153</td>
<td>225</td>
<td>3</td>
</tr>
<tr>
<td>Vea Dam</td>
<td>99</td>
<td>194</td>
<td>103</td>
<td>128</td>
<td>209</td>
<td>1</td>
</tr>
<tr>
<td>Navrongo</td>
<td>156</td>
<td>204</td>
<td>91</td>
<td>195</td>
<td>179</td>
<td>3</td>
</tr>
<tr>
<td>Paga</td>
<td>62</td>
<td>31</td>
<td>30</td>
<td>70</td>
<td>62</td>
<td>5</td>
</tr>
<tr>
<td>Wiaga</td>
<td>68</td>
<td>123</td>
<td>76</td>
<td>125</td>
<td>151</td>
<td>3</td>
</tr>
<tr>
<td>Sandema</td>
<td>89</td>
<td>159</td>
<td>73</td>
<td>148</td>
<td>131</td>
<td>3</td>
</tr>
<tr>
<td>Nakong</td>
<td>52</td>
<td>140</td>
<td>134</td>
<td>80</td>
<td>173</td>
<td>3</td>
</tr>
<tr>
<td>Northern Region</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gambaga</td>
<td>99</td>
<td>194</td>
<td>103</td>
<td>128</td>
<td>209</td>
<td>1</td>
</tr>
<tr>
<td>Walewale</td>
<td>139</td>
<td>91</td>
<td>173</td>
<td>116</td>
<td>116</td>
<td>?</td>
</tr>
<tr>
<td>Average</td>
<td>101</td>
<td>174</td>
<td>96</td>
<td>151</td>
<td>169</td>
<td>2.3</td>
</tr>
</tbody>
</table>

The next tables show the variability of crop harvests for five crops in the same period for Upper east Region as a whole and link the yield indexes of these crops to the DRA data. If the DRA would be a good ‘predictor’ of yield levels, there would be a negative correlation between yield index data and drought risk assessment data. The correlation that is found, though, is completely spurious, for all crops individually and for the five crops combined. On the basis of DRA data the year 1996 could be expected to be the worst performing year. Instead, it was almost the best year as far as yield levels (kg/ha) were concerned, with the exception of groundnuts. The year 1997 was almost as bad in DRA terms, and there indeed the yield situation proved to be bad (with rice as an exception). The best years in yield terms for individual crops were all years with a relatively high DRA: 1995 for millet and rice (DRA=1.7), 1996 for sorghum (DRA=2.6), 1991 for maize (DRA=1.7). Only groundnuts had its best performance in a year with a low DRA (1987: DRA=0.7).

Table 14  Harvest estimates (index figures) in Upper East Region, 1987-1997

<table>
<thead>
<tr>
<th>Year / Crop</th>
<th>Millet</th>
<th>Sorghum</th>
<th>Groundnuts</th>
<th>Maize</th>
<th>Rice</th>
<th>Five crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>76</td>
<td>77</td>
<td>140</td>
<td>88</td>
<td>63</td>
<td>89</td>
</tr>
<tr>
<td>1988</td>
<td>82</td>
<td>116</td>
<td>83</td>
<td>92</td>
<td>74</td>
<td>89</td>
</tr>
<tr>
<td>1989</td>
<td>101</td>
<td>110</td>
<td>87</td>
<td>64</td>
<td>120</td>
<td>96</td>
</tr>
<tr>
<td>1990</td>
<td>70</td>
<td>92</td>
<td>74</td>
<td>88</td>
<td>40</td>
<td>73</td>
</tr>
<tr>
<td>1991</td>
<td>72</td>
<td>82</td>
<td>99</td>
<td>153</td>
<td>95</td>
<td>100</td>
</tr>
<tr>
<td>1992</td>
<td>70</td>
<td>84</td>
<td>98</td>
<td>118</td>
<td>102</td>
<td>94</td>
</tr>
<tr>
<td>1993</td>
<td>142</td>
<td>99</td>
<td>113</td>
<td>112</td>
<td>98</td>
<td>113</td>
</tr>
<tr>
<td>1994</td>
<td>101</td>
<td>86</td>
<td>104</td>
<td>100</td>
<td>120</td>
<td>102</td>
</tr>
<tr>
<td>1995</td>
<td>158</td>
<td>113</td>
<td>111</td>
<td>115</td>
<td>144</td>
<td>128</td>
</tr>
<tr>
<td>1996</td>
<td>145</td>
<td>145</td>
<td>96</td>
<td>106</td>
<td>132</td>
<td>125</td>
</tr>
<tr>
<td>1997</td>
<td>81</td>
<td>96</td>
<td>98</td>
<td>59</td>
<td>108</td>
<td>88</td>
</tr>
<tr>
<td>Average in kg/ha (index = 100)</td>
<td>740</td>
<td>830</td>
<td>820</td>
<td>850</td>
<td>1670</td>
<td>982 (unweighted)</td>
</tr>
</tbody>
</table>
Source: Ministry of Food and Agriculture UER, annual reports, for the kg/ha estimates, based on expert assessment by MOFA field-level staff at district level, converted to an estimate at regional level by the Head of the MOFA at UER level. The staff making these judgements continuously changes.

For millets and sorghum, providing the bulk of food grains in Upper East, there have been three years during this period when yield levels for both crops dropped compared to the previous year: 1990, 1994 and 1997. If we compare this with the data for (northern) Ghana as a whole, as presented in part A of this study, the same years were mentioned. The data about the ‘bad years’ in the last decade seem to be consistent. For Upper East particularly the situation in 1997 must have been rather dramatic: compared to the yield level in 1996 the millet yield was 44% less and the sorghum yield 34% less.

Table 15 Harvest indexes compared with Drought Risk Assessments in Upper East Region for five crops, based on data for 1987-1997

<table>
<thead>
<tr>
<th>Crop</th>
<th>DRA 0.3</th>
<th>0.7</th>
<th>0.7</th>
<th>0.9</th>
<th>0.9</th>
<th>1.2</th>
<th>1.7</th>
<th>1.7</th>
<th>1.7</th>
<th>2.5</th>
<th>2.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millet</td>
<td>101</td>
<td>76</td>
<td>101</td>
<td>82</td>
<td>70</td>
<td>142</td>
<td>158</td>
<td>70</td>
<td>72</td>
<td>81</td>
<td>145</td>
</tr>
<tr>
<td>Sorghum</td>
<td>110</td>
<td>77</td>
<td>86</td>
<td>116</td>
<td>84</td>
<td>99</td>
<td>113</td>
<td>92</td>
<td>82</td>
<td>96</td>
<td>145</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>87</td>
<td>104</td>
<td>140</td>
<td>83</td>
<td>98</td>
<td>113</td>
<td>111</td>
<td>74</td>
<td>99</td>
<td>98</td>
<td>96</td>
</tr>
<tr>
<td>Maize</td>
<td>64</td>
<td>88</td>
<td>100</td>
<td>92</td>
<td>118</td>
<td>112</td>
<td>115</td>
<td>88</td>
<td>153</td>
<td>59</td>
<td>106</td>
</tr>
<tr>
<td>Rice</td>
<td>120</td>
<td>63</td>
<td>120</td>
<td>74</td>
<td>102</td>
<td>98</td>
<td>144</td>
<td>40</td>
<td>95</td>
<td>108</td>
<td>132</td>
</tr>
<tr>
<td>All five</td>
<td>96</td>
<td>89</td>
<td>102</td>
<td>89</td>
<td>94</td>
<td>113</td>
<td>128</td>
<td>73</td>
<td>100</td>
<td>88</td>
<td>125</td>
</tr>
</tbody>
</table>

We may conclude that we are confronted with a situation that is difficult to explain: the expectations about the role the DRA could play as a tool in crop performance assessments appear to be illusions. Worse even, if DRA data are so problematic in predicting harvest levels of crops, and especially for crops for which the DRA has been developed -in this case millet and sorghum, it can also not function as a tool in harvest scenarios following climate change.

So it is wise to brainstorm about the various reasons why the correlations between yield levels and DRA data are so spurious. A workshop in Ghana in March 1999 (Bolgatanga) discussed at length about the various reasons. A training session of CERES PhD students in the Netherlands did the same on March 30, 1999 (Hilversum). We acknowledge their contributions to this section.

- The reliability of the rainfall data can be regarded as rather questionable. Bad recording and mistakes while copying data from one level to the next can cause problems of interpretation. Changes in personnel can cause gaps in reliability and care. Higher-level ‘corrections’ of lower-level data can sometimes be very confusing;
- The rainfall data are point data. We have tried to use as many stations as possible to arrive at a ‘regional figure’. However, the large intra-regional variations and the fact that rainfall often comes in localised rainstorms, makes any ‘upscaleing’ of point data to area data questionable. The location of the rainfall stations might also not give a representative overview of the most important agricultural production areas. Some productive areas might not be easily accessible for agricultural staff during the harvest months, due to the road conditions and lack of transport;
The yield data can be regarded as very questionable. Crop acreages, kg/ha assessments and total production figures are based on ‘expert’ assessments (by local low-level personnel of the MOFA) at district headquarters, later upscaled to the level of the Region as a whole. Agriculture is mainly subsistence oriented. It is unclear whether ‘eating from the field’ in the pre-harvest period is included, if volume assessments are based on ‘wet’ or ‘dry’ harvests, and if yield assessments are based on representative samples or just a guess from the office. In a situation where not all planted land is also harvested, and where mixed cropping is the norm, mistakes can easily be made and confusion reigns. Later, higher-level civil servants arrive at a ‘regional’ figure. “(Some) Garbage In, (More) Garbage Out”. Some civil servants tend to increase the yield data, either because their reference farmers tend to be the rich and more successful ones, or because they want to ‘prove’ that their extension and other efforts have been successful. During perceived drought situations the opposite can also happen: harvests are underreported, and the food crisis exaggerated, to impress on national decision makers the urgent need for relief food.

The yield data for particular crops might not refer to responses to the rainfall situation, but to genetic improvements (or deteriorations) in particular varieties or crops; or to changes in fertilization, use of pesticides, irrigation, water harvesting and drainage, and farm management techniques (as a result of changes in extension or otherwise); it might also reflect gradual changes in soil fertility, which over an 11-year period can be considerable.

The DRA formula might be faulty, or the cut-off points between classes wrong. The DRA method itself is based on monthly rainfall data. For soil moisture assessments (relevant for the jump from DRA 3 to DRA 4 and from DRA 4 to DRA 5) more detailed analysis would in fact be required: based on weekly or 10-day averages and specifying for different soil and landscape types. In the DRA method the rainfall data are taken from real measurements, but the temperature data and evapotranspiration data are estimated and ‘static’. It is probable though that during droughts actual temperatures are higher (and more fluctuating) and hence actual evapotranspiration is higher as well, resulting in even more drought stress for plants.

The DRA method does not take into account that plant moisture needs vary over the growing cycle of plants, with the highest moisture needs somewhere in the middle: the impact of a dry spell in July can thus even be more dramatic than the DRA model predicts.

The yield variability because of nature’s whims is of course not only a result of droughts. Excess rainfall at the wrong time can also be quite devastating. Harvests rotting in the field, excessive weeds, pests (e.g. fungi in maize) and plant diseases can cause havoc. For quite a number of millet and even sorghum varieties that are locally used a lower rainfall and higher DRA (e.g. between 2 and 3) could even be a more optimal situation than a DRA between 0 and 2;

The most important factor to explain the differences between DRA scores and yield levels is probably the preventive, coping and adaptive strategies of the farmers:

Many farmers combine a rather large variety of crops and crop varieties and various rounds of seeding, to spread risks ad harvest moments; many farmers start with fast-maturing millets, followed by other millets and sorghum, and some maize and beans, often in the same fields, and with overlapping farm management cycles. During a drought they give up on more risky crops as far as drought stress is
concerned and concentrate their efforts on crops and varieties which are more likely to succeed;

- Many farmers combine various locations, with different soils, exposure to the sun, slope, and water conditions. In many parts of the area farmers combine ‘compound farms’ and ‘bush farms’ (see later) with different, but varying time and care investments, depending on the quality of the season; especially on compound farms, near the homestead, additional care (adding water, better weeding, manure application) can result in good harvests, even if the rainfall situation is quite bad;

- There probably is an inverted U-shaped curve of care (and labour investments): when the rainfall situation is good, farmers tend to be ‘lazy’ (that is: they prefer leisure above hard work); when the rainfall situation begins to be tricky farmers increase their care (e.g. apply more manure; reseeding if needed) and labour input (more weeding); when the rainfall situation deteriorates further farmers tend to give up and spend time on non-agricultural alternatives. A perception of drought can also alter labour patterns (e.g. more child labour). Each farmer will have different behavioural patterns in this respect, so the combined effort is a result of highly varying farm management practices. The overall result is that yields during good years will not necessarily be better compared to yields during drought years, except for very dry years, when most farmers give up. In the research area these extreme conditions hardly occurred though;

- After a good year, with relatively abundant harvest and a good food stock, farmers probably tend to ‘relax’ their effort; after a bad year farmers tend to increase their acreage, they tend to favour less risky crops/varieties and spend more time in their expanded fields. However, they often have to spread their efforts over larger areas, and fields further apart; during and after a bad year their ‘effort capacity’ can also be undermined by a higher disease occurrence and higher labour investments in activities outside home agriculture (e.g. ‘hunger trips’);

- After a very bad year there might be a seed problem. Many farmers have to buy, barter or ‘beg’ seeds, sometimes with unknown characteristics, which creates a more insecure situation, but also a higher ‘experimentation attitude’. After a very bad year food donations and other institutional interventions can change attitudes of farmers towards farming and farm effort.

“In a dry year there will be a good harvest. Formerly the young did not understand, but now they do” (old farmer in Bongo).
CHAPTER 3 DEMOGRAPHIC CHANGE

3.1 People in the past
The Bolgatanga study area has a relatively high overall population density. One of the reasons is that population was attracted to this region in historical times because of trade opportunities which arose from the fact that the major trade routes from the international market of Salaga northwards passed through the region. Also the area was not affected by the slave raids of Samori and Babatu in the 1880s (Der, 1998), and the region was not disturbed by wars in the past as much as the population in the ‘middle belt’ of current-day Ghana. Also this area was strong militarily and relatively stable (Dickson and Benneh, 1988).

The rural settlements in this part of Ghana were and still are generally dispersed and by no means evenly distributed, while those of the rest of Ghana are generally nucleated. The house type is a round hut with a flat or conicle roof. The huts are generally arranged in a circle within an enclosing wall to form a compound household. A family lives within the compound, together with a poultry yard, a grain store and a piece of land where cattle is kept for the night.

Until World War II there was little development of towns in north Ghana and a lot of old towns decayed. This explains the rather small number of towns found in this area. The new towns are all found on the principal roads (which run north-south). Away from these roads there are hardly any towns (Dickson and Benneh, 1988).

Originally the population lived in the river valleys. As the fertility of the soils became exhausted, the population moved to the watersheds, which are now overpopulated. The deserted valleys became breeding ground for disease–carrying flies, and are until now avoided by most of the population, despite the anti-fly programmes which started in the 1960s and which were rather successful.

At the beginning of the century the population of the study area can be estimated at between 120,000 and 130,000 inhabitants. The Northern Territories as a whole had 362,000 inhabitants in 1911 and 631,000 in 1921 (but then it included parts of former German Togoland). Population growth between the early 1920s and 1948 must have been considerable: to 1,077,000 inhabitants for the Northern Territories as a whole and an estimated 310,000 inhabitants in the study area. This indicates a population growth of almost 2% per annum during colonial times (see Bening, 1990, p. 82; own estimates added).

3.2 Population changes, 1960-1999
The current population of the Bolgatanga study area is between 800,000 and 900,000 inhabitants; an average population density of 70-80 inh./km².

The southern part of the cell has a population density of 10-50 persons per square kilometre, and the population is fairly evenly distributed there. The population density increases towards the top of the Gambaga escarpment, which runs from west to east in the central part of the study area. The part of the study area which is located to the north of the Gambaga escarpment can be divided in three parts. The western part of
the area (which includes Bolgatanga Town) has a population density of 100-200 persons per square kilometre. The central northern area has a population density of 50-100 persons per square kilometre. And the upper eastern area is more densely populated with a population density of 100-200 persons per square kilometre. (See figure 10; Dickson and Benneh, 1988, p. 47).

**Figure 10  Population density in Ghana, 1984**

The population census data for 1984 for the relevant districts are the following.

<table>
<thead>
<tr>
<th>District</th>
<th>Population in 1984</th>
<th>F/M x 100 in 1984</th>
<th>% children (0-15) in 1984</th>
<th>Population estimate for 1998 (and in study area)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UPPER EAST REGION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kasina-Nankeni</td>
<td>149,680</td>
<td>105</td>
<td>42</td>
<td>226,000 (10,000)</td>
</tr>
<tr>
<td>Bolgatanga</td>
<td>173,367</td>
<td>111</td>
<td>43</td>
<td>246,000 (240,000)</td>
</tr>
<tr>
<td>Bongo</td>
<td>68,554</td>
<td>116</td>
<td>41</td>
<td>94,000 (94,000)</td>
</tr>
<tr>
<td>Bawku East</td>
<td>251,221</td>
<td>110</td>
<td>49</td>
<td>360,000 (180,000)</td>
</tr>
<tr>
<td>Bawku West</td>
<td>63,565</td>
<td>112</td>
<td>46</td>
<td>90,000 (75,000)</td>
</tr>
<tr>
<td><strong>NORTHERN REGION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walewale</td>
<td>59,130</td>
<td>105</td>
<td></td>
<td>102,000 (30,000)</td>
</tr>
<tr>
<td>Nalerigu</td>
<td>141,742</td>
<td>103</td>
<td></td>
<td>245,000 (180,000)</td>
</tr>
<tr>
<td>Gushiegu-Chereponi</td>
<td>101,939</td>
<td>103</td>
<td></td>
<td>176,000 (60,000)</td>
</tr>
<tr>
<td>Savelugu</td>
<td>82,918</td>
<td>106</td>
<td></td>
<td>143,000 (10,000)</td>
</tr>
</tbody>
</table>

Source: Statistical Service of Ghana: 1984 Population Census; Statistical Services Bolgatanga for the 1998 estimate; own calculations based on 4% growth per annum for Northern Region in 1998; own rough estimate for population in the study area in 1998.
The Upper East Region of Ghana, which includes the northern part of the study area, but is slightly larger (8,842 km² of which approx. 5,000 km² in the study area), had a population of 773,000 inhabitants in 1984, from 415,000 in 1960 and 540,000 in 1970 (with a growth rate between 1970 and 1984 of 2.6% per annum, with Kasina Nankendi the area with the highest average growth rate (3.0%) and Buialsa and Bongo the lowest (1.8% resp. 2.3%). The average population density was 47 persons per km² in 1960 and 87 persons per km² in 1984. For every 100 men there were 110 women in 1984. Children formed 45% of the total population. The UE Regional Office estimated a relatively high annual growth rate of 3.1% per annum for the 1990s (Regional Office, 1997) and a current population of 1,102,000 inhabitants, with an overall population density of 125 inhabitants per km². The highest current density is found in Bongo, with an estimated 204 persons per km². The urban population is estimated at 15% of the total population of the region.

The Northern Region of Ghana, which includes the southern part of the study area, but is much larger (74,384 km² of which only approx. 7,000 km² is located in the study area), had a population of 462,000 inhabitants in 1960 and 1,165,000 at the latest Census, in 1984. This indicates an annual growth rate for the period as a whole of close to 4%, although higher between 1960 and 1970 (4.6% annual growth rate) compared to the period between 1970 and 1984 (3.4% annual growth rate). The population density in the period between 1960 and 1984 grew from 6 to 17 per km², but the region still has the lowest population density in Ghana. In 1984 there were 102 females for every 100 males, indicating a light labour outmigration. However, from Upper East and Upper West Regions migrants enter the region, probably more men than women. In 1984 the urbanization stood at 25%. (Quarterly Digest of Statistics, 1991). In 1983 the NORRIP Technical Unit estimated the life expectancy in the region at 43 years; higher for females than for males. Life expectancy was projected to increase to 51 years in the year 2000. Based on the population census of 1970 NORRIP estimated the population of the region in the year 2000 to be 2,107,000 inhabitants, using a growth rate between 1984 and 2000 of 4% per annum. The percentage of children (0 to 15 years of age) was projected to increase from 51% to 53% of the total population.

The 1984 Census took place in March, towards the end of the dry season. This probably underestimates the number of people, as many men were probably away, only to come back during the rainy season. Officially people counted elsewhere had to give their ‘home area’ and were added there but the reliability of this system of counting can be doubted.

There is a certain amount of out-migration of young men to Asante and southern Ghana. Due to the Damongo scheme Frafra farmers were encouraged to migrate to Damongo in Gonja in Northern Region soon after Independene. But the farmers did not want to live in a strange area and returned home during the late 1970s. It seems that attachment to the home area is very strong in the region. The majority of out-migrants who are employed in the south regard their absence as a temporary one (Dickson and Benneh, 1988).

3.3 Population scenarios until 2050
Expectations are that annual population growth for Ghana as a whole will be around 2.8% during the period 1990-2050 (World Bank, 1995). For the northern part of the country the annual growth figures will probably be a bit lower. If there would be 2.6% growth per annum, the population in the Bolgatanga study area would grow from 700,000 in 1990 to 3.3 million in 2050, and the average population density would become 280 people per square kilometre. In terms of food needs this would mean 700 million kg of grain equivalents, or - if all land would be cultivated and if all food would be produced locally - a necessary average food crop yield of 600 kg/hectare.

3.4 Changes in physical and economic infrastructure and in demand, 1960-1999
Like the rest of northern Ghana, the study area has often been referred to as the most ‘underdeveloped’ area in the country; deliberately neglected by first the Colonial and
later the various Independent governments of Ghana. Only recently the Tamale-Bolgatanga trunk road became a first-class road, which forms 80% (about 90 kilometres) of the total tarred roads in the study area. The total area has 130 km of tarred road nowadays. There is a good network of feeder roads but many of them are only motorable in the dry season. Transportation between the numerous villages is largely by bicycle and those are owned by many of the households in the area.

Coming from Tamale, the main road first reaches Walewale, where it branches to Gambaga, Nalerigu and Nakpanduri, where it connects with the Yendi-Gushiegu-Bawku road. In Walewale a northward branch goes to Bolgatanga, via minor centres (Wulugu, Pwalugu, where it crosses the Volta River). In Bolgatanga there is a road going to Navrongo and from there further to the west, to the small airfield at Paga and to Burkina Faso. Another road goes to the northeast: via Zuarungu, Zebilla to Bawku and from there northward to Burkina Faso and eastward to Togo. In Zuarungu there is a road going to Bongo. See Map…

Pipeborne water is available only in the district capitals. There is however a considerable number of boreholes and hand-dug wells dotted all over the area. Electricity is presently mainly limited to district capitals (but not yet Bongo), although some of the villages along the main Tamale-Bolgatanga road have also been connected to the national grid. The problem with rural electrification is the extreme dispersal of houses in most of the areas.

### 3.5 Changes in health and education, 1960-1999

Western-type education became important in the area only after Independence in 1957. Until then there was not a single secondary school in the whole area. At Independence there were only three so-called middle schools in the study area and five in the neighbourhood.

#### Table 17 Middle Schools at Independence

<table>
<thead>
<tr>
<th>School, place</th>
<th>Managed by</th>
<th>Year of establishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. Mary’s, Navrongo</td>
<td>Catholic Mission</td>
<td>1936</td>
</tr>
<tr>
<td>Nalerigu/Gambaga (+)</td>
<td>Local Authority</td>
<td>1949 (1952)</td>
</tr>
<tr>
<td>Bawku (-)</td>
<td>L.A.</td>
<td>1952</td>
</tr>
<tr>
<td>Navrongo (-)</td>
<td>L.A.</td>
<td>1954</td>
</tr>
<tr>
<td>Sandema (-)</td>
<td>L.A.</td>
<td>1954</td>
</tr>
<tr>
<td>St. John’s Bolgatanga</td>
<td>Catholic Mission</td>
<td>1956</td>
</tr>
<tr>
<td>Walewale (+)</td>
<td>L.A.</td>
<td>1956</td>
</tr>
<tr>
<td>Blobia (Navrongo) (-)</td>
<td>L.A.</td>
<td>1957</td>
</tr>
</tbody>
</table>

*Source: Bening, 1990, p. 146; +: in the study area; -: in the neighbourhood*

The school in Gambaga had grown from a difficult beginning as a tiny government-managed primary school in 1912, amidst opposition from existing koran schools and most parents (Bening, 1990, p. 6; p. 14: the enrolment figures for Gambaga P.S. were 14-15 in 1912-1915; 33-42 in 1916-1924 and 65-79 in 1924-1926, when it was still the only government-managed primary school in the study area). In 1935 the ‘native authority’ started new primary schools, first in Bawku and later in Sandema (1936) and Zuarungu (1938) (Bening, 1990, p. 87). It lasted until 1952 before a ‘middle school’ was started as an extension of the Gambaga Primary School (Bening, 1990, p. 139), followed by government (local authority) initiatives to start middle schools in Bawku, Navrongo, Sandema, Walewale and Blobia. According to Bening (1990, p. 218-220) the Nkrumah Self-Government between 1951 and 1957 refused to develop education more fully because the north was regarded as a solid opposition area.
(during the elections in 1954 and 1956 most people voted for the Northern Peoples Party and few for Nkrumah’s Convention People’s Party).

In Navrongo, Catholic White Fathers (originating from French-Canada) had started a mission station and primary school in 1907, which functioned until 1914 despite opposition from the colonial authorities at district level. It restarted in 1921 and again in 1924 (Bening, 1990, p. 21-29). Requests by the White Fathers to start additional primary schools in Bongo and Tongo, in 1924, were turned down, but the establishment of a school in Bolgatanga - in 1927 - was encouraged, as well as one in Wiaga (Bening, 1990, p. 32, 38; the school in Wiaga only existed between 1930 and 1933). In 1931 the missionaries started a seminary class in Navrongo and in 1937 a teacher training institution. With an interruption due to the war it expanded gradually and by 1957 it had produced more than 50 certified teachers from the north (between 1946 and 1957 it had an annual enrolment of between 5 and 22 pupils) (Bening, 1990, p. 111-119). In 1954 another teacher training college was started (managed by the government, next to the one in Tamale) in Pusiga, which would serve pupils from the eastern parts of the study area. Just before Independence the missionaries had also started a secondary school in Bolgatanga.

The educational infrastructure improved after 1957, but still leaves much to be desired. Both with regard to possibilities to get income through labour migration and to get involved in non-agricultural businesses in the area itself, the low educational status, low level of business training and experience and poor infrastructural facilities hamper the development of alternatives for resource-based (mainly agricultural) forms of livelihood in the study area.

Between 1957 and 1975 the number of primary schools in Northern Ghana as a whole increased threefold (from 215 to 696), the enrolment of pupils more than fourfold (from 20,000 to 86,000). Middle Schools (or Lower Secondary) increased almost sixfold (from 38 to 224) and their enrolment ninefold (from 2,300 to 21,000). However, with 20% of Ghana’s population, the share of primary school pupils only increased from 4% in 1958 to 7% in 1975, and the share of middle school pupils from 2% to 5% only (calculated using Bening, 1990, p. 217-218). It lasted until 1960 before a secondary school was started in the upper east region (in Navrongo, by the government), followed by one in Bawku in 1963, and in Zuarungu in 1970 (Bening, 1990, p. 220). In 1965 the government added a Women’s Teacher Training College in Bolgatanga which became a Girls Secondary School in 1973, in 1966 the Nalerigu Teacher Training College (which became a secondary school in 1973 as well) and before 1971 also a Farm Institute at Navrongo. The Catholic Mission added a Technical Institute at Pusiga around 1970, taken over by the government later. However, quite a number of students in these schools did not come from the north: according to Bening (1990, p. 226) in the late 1960s only around 50% did. Secondary School Sixth Form departments (enabling pupils to go to university) were only started in 1972 in Navrongo and in 1975 in Bawku. The total university student population from Upper East in 1964 was less than 10 (calculated from Bening, 1990, p. 233). Gradually the situation improved though, and in 1998 Navrongo even became the site for a subsidiary campus of the Tamale University for Development Studies.

Recently the enrolment situation of secondary schools has probably deteriorated because of the increase of school fees. In early 1999 parents for every child had to pay c80,000 per year for the junior secondary school and c120,000 for the senior secondary school. Primary education is still free.

The information about the growth of health facilities is lacking. Recent information shows that the overall health conditions of the population (and children in particular)
leave much to be desired. In the northern areas the situation during the ‘lean period’ is especially bad. As elsewhere in dry-season environments in the tropics the months prior to the next harvest are the critical period in terms of food intake. Stocks are low and prices go up. A study done by NORRIP Technical Unit, in 1983 (after a few difficult years) showed that one-third of the adult population experienced severe food energy deprivation during the period before the main harvest. Only half of these individuals would regain acceptable body status over the period following the harvest. These are mostly men, due partly to the fact that women in the region generally have access to food in the household only after the men have eaten. Over 80% of the children are affected by food shortages resulting in growth failure. It can be expected, though, that the situation in 1991-96 was better, but that 1990 and 1997 have been rather critical (see ch. 2).

3.6 Ethnicity
Most of the area is populated by Nankani, Grune and Kusasi ethnic groups, which belong to the Moshie language cluster. In the southwest there are Mamprusi and some Dagomba groups and in the southeast Konkomba groups, all of which belong to the Dagbani language cluster (Atta-Quayson, 1995, p. 20). All groups originally came from the northeast, from current-day Burkina Faso; some via current-day Togo. In the west of the study area there are mainly Nankana or Nankansi. In Bolgatanga and Bongo Districts the Frafra dominate, with subgroup Borsis mainly in Bongo and subgroups Grunshis (or Grune), Nabdams (or Namnams) and Talensis mainly in Bolgatanga. In Bawku West District the Kusasis are the main group, but there area also Talensis; in Bawku East the Kusasis, Busangas and Mamprusis share the resources. In Mamprusi East and West the main group is the Mamprusi, in Mamprusi East together with the Bimobas (or Bimawba). In the southwest of the study area there are Grusi. In the study area quite a number of Moshi and related people (e.g. Kasena) have settled from Burkina Faso. In the southeast and east there are Konkomba groups (e.g. Nawuri, Basari, Chekos or Kyokosi) who are linked to Konkomba groups in northern Togo. During the 1910s, the 1940s and again in the 1980s and in 1994-95 there was a lot of violence (during the last period even a state of emergency) between the Konkomba on the one hand and the Dagomba, Mamprusi and Nanumba - south of the study area - on the other hand (the ‘Konkomba Wars’, see Martinson, 1995; Moerkamp, 1997, p. 39).

The Nankana people speak Navonga, the Frafra and related groups Grune, the Kusasi Kusaal and the Mamprusi Mamprule. The languages or dialects, except Busanga and Bimowa/Konkomba, are all mutually intelligible.

3.7 Social Relationships and Networks
The various ethnic groups have not carved out exclusive niches for themselves. Their territories do not completely correspond to district boundaries. They have a dispersed settlement pattern that tends to overlap (Runge-Metzger & Diehl, 1993). The groups are patrilineal and women generally come from other villages and upon marriage move to the homesteads of their husbands. Most marriages are within ethnic (sub-)groups.

Based on a long and partly violent history, some traditional leadership positions in Upper East (and especially in the Bawku area) are still in the hands of Mamprusi
chiefs, originating from the Gambaga-Nalerigu area. Ethnic relationships are generally cordial, with the exception of the relationships of the Mamprusi with the Bimoba/Konkomba. The southeastern part of the study area was touched by the so-called Konkomba Wars of the 1980s.

3.8 Political and Legal Organisation

Administratively the study area forms part of Upper East Region and of Northern Region, each with a Regional Minister in the central government of the Republic of Ghana and each with a government-appointed Regional Coordinating Director as head of the regional civil service. Each Region is divided in districts, with a district assembly (partly elected, partly nominated, partly with ex-officio members), an appointed district chief executive (who comes from the area) and a District Coordinating Director as head of the civil service at district level. Most government ministries have a representation in each of the district headquarters. Below the level of districts there are zonal offices and below that unit committees, representing a number of village and hamlet communities. The elected members of the district assembly consist of people elected by a geographical constituency at unit level. Since Ghana became a multiparty republic again (in 1988, during the ‘4th republic’) the population in the study area massively voted for the leading party of President Rawlings; many of the elected members of the district assemblies belong to the same party. Besides the system of elected councillors at the level of the district assembly, there is a system of chiefs: headmen or subdivisional chiefs at the lowest level; divisional chiefs; and paramount chiefs, who form a Regional House of Chiefs with an elected President. In the study area there are twelve paramount chiefs (all men, with currently one exception: Bongo’s female chief). In the north the traditional system also has a component of ‘earth priests’ (tindanas), the custodians of traditional land ownership and land management monitoring.
CHAPTER 4  ECONOMIC CHANGE IN THE AGRICULTURAL SECTOR

4.1 Farming activities; types of farmers; land tenure situation

Importance of farming

Farming, especially crop farming, is the main productive activity in the research area. According to the 1984 Census, about 80% of the population of Upper East Region derives its primary livelihood from farming. But for most of the other 20% farming is still important as a secondary activity. Farming is rather complex and adapted to the difficult agro-ecological conditions prevalent in the area. Almost all farmers, though, use simple farm technology and farming depends on locally available inputs and resources. The locally produced hoe, cutlass and sickle are still in use. Traditional varieties, which have adapted to the variable climatic conditions continue to dominate. Storage systems rely on traditional structures and inputs. Food processing technologies are largely domestic.

The Farming System

Common features of the farming systems are:
- a strong tendency and orientation towards subsistence and low cash income;
- mixed farming (with livestock), with an emphasis on shifting cultivation and mixed cropping;
- small fragmented land holdings, mostly not exceeding five hectares for the nuclear family
- a three year bush fallow
- dependence on simple hand equipment
- low levels of use of external farm inputs
- average yields and net returns of resources employed in farming are relatively low.

The objective of the farmer is one of survival, of minimization of risk. The unreliable environment results in some risk of crop failure. The assurance of subsistence for the family, rather than maximisation of production, let alone profit, is the major objective. To most households farming is a way of life, rather than a business and risk aversion is more prominent than profitability (Atengdem, 1997).

The labour situation

A farm usually consists of a group of persons living together as one unit and sharing farming and other housekeeping arrangements. Labour is undertaken primarily by the farm family. However, the noboa concept is practised as well: people come together to provide labour activities in turns. The typical farm family consists of about seven persons, which in general is sufficient for the labour to be provided on most of the farms. Whilst men are mainly responsible for tilling the land, women are involved in almost all farming practices. In all households women provide labour for their husband’s fields and cultivate their own lands in both the ‘compound’ and the ‘bush’ farms (see 5.2). In women-headed and old people’s households labour is a major constraint for heavier farm tasks. Elders normally don’t till the land, because their younger relatives are usually supposed to assist them. With a growing number of young people migrating to other places and customs of respect eroding growing
numbers of elderly people can now be seen working in their fields. This can clearly be regarded as a sign of problems. Work is different in the different seasons. In the wet season almost all members of the household are very busy with planting, weeding, and harvesting. In the dry season farm work depends on the availability of water, since most of the region depends on rain-fed agriculture.

Large farmers and small farmers
There are very few large-scale farmers; that is: with more than 5 ha of cultivated land and/or more than ten head of cattle. Small-scale farmers dominate agriculture in the region. Most of their farms are between 0.8 and 1.6 ha. Large farms can’t be managed by making use of household labour alone. Here farmers have started to hire labour for their farm operations. They also use machines and implements like combine harvesters, tractors, ploughs, ridgers, planters and harrows. And they use improved seeds, fertilisers and pesticides. Some small farmers who can afford to do so have also started to hire tractor services for ploughing. Others (but still a small group) make use of bullocks and donkeys for animal traction. Those who had started to make use of fertilisers and pesticides during the 1980s now have all gone back to other forms of fertilisation, due to prices which are regarded as too high.

Indigenous opinions about differences in wealth
People in the area were generally of the opinion that there were clear differences in ‘average wealth’ between subregions. Within Upper East Region the most western area, Builsa - outside the study region proper - was regarded as the best place, with good soil fertility, lots of trees remaining, the possibility to cultivate yams, and the existence of a few good irrigation schemes. Also Navrongo was regarded as relatively good. Here some commercial farmers cum government employees can be found, who generally hire labour and who employ a caretaker to manage their relatively large farms. The eastern part of the study area, Bawku, was regarded as considerably worse off, but everybody agreed that Bongo was the poorest part by far. Definitions of ‘wealth’ also differ considerably between these areas. In Navrongo the wealthy households have tractors, at least eight hectares in use, a link with an irrigated plot in one of the schemes, at least 100 head of cattle, two or three wives; electricity, a tv and video in the house, a motorbike and occasionally a car. Generally they nowadays send at least part of their children to a secondary school and if they have older children they stimulate them to spend some years elsewhere (even aborad; there is a lot of talk about the ‘middle east’), and to send remittances home. In Bawku the wealthy households should have at least two wives, 10 to 30 head of cattle and 20 to 30 sheep and/or goats, a bullock plough (there are hardly any tractors), a donkey cart, a bicycle (there are hardly any motorcycles) and the house should have a zinc roof. Access to land for crop cultivation is not very highly valued, but this is changing with the recent boom in onion production: a wealthy household should at least have a profitable onion ‘business’ and should be involved in some trade business. Compared to the other places, in Bongo wealth is more valued in the ‘traditional’ way. Wealthy households here should have three or four wives, 25 head of cattle, and access to at least one hectare of farm land. They should use a bullock for ploughing, or even better: hire a tractor service. In the past having a radio could be seen as a sign of relative wealth but in all places this is no differentiating variable anymore because virtually everybody has a ‘wireless’ nowadays. In all three places, but specifically in Bongo, if people
come to you for food during a general crisis situation is seen as a sign of wealth, of a high status in the community. It shows that you can handle a crisis situation successfully. Poverty in all places can not be measured in terms of landlessness yet. All households in the region still have a right to their own house and a small garden around the house. But there are people whose land is so small that they can’t feed their household members in ‘normal years’; let alone ‘bad years’, and these households are badly in need of additional sources of food and income to add to their food reserves. There are households who are regarded as ‘poor immigrants’, who do get land, but only in the less fertile areas, and no ‘bush farms’; only a place around the house. Poverty in all areas is locally regarded as severe if people have a grain harvest which does not “last them during the year”, that is: if before their next harvest they are forced to get food through gifts or through the market.

Land tenure situation
Land is vested in the community by custom and constitutional law. It is still largely administered in accordance with customary law and practices. The basis of traditional land law is that land is held in trust for the inhabitants by the Tindana, who is the spiritual/traditional leader and who is entitled to grant usufruct rights to individual families. The Tindana of a given area is a patrilineal descendant of the original family which settled at the place. In the rural society of Northern Ghana the Tindana occupies a position of deep religious and political significance and all land matters are traditionally subject to his authority. The inheritance system is through the male heir. At the discretion of the family head land can be divided among family members. The land given to the individual is deemed to be held in trust and can thus not be sold. Land transfers are, however, possible provided the authority of the Tindana has been sought and all customary procedures are followed. Under such circumstances an individual may agree to give up the rights to a parcel of land and agree that somebody else may use it. In recognition of the fact that the user has given up on an asset, the recipient may then offer the original occupier a material consideration. A farm ‘leasehold’ is then established.

The effect of the Tindana system is that every family in the jurisdiction of a Tindana has a right to some land. Customary law does not recognise female right of usufruct, though. This law notwithstanding, codified law protects a woman’s right to inheritance. In practice women-headed households are always allocated land. Where land is leased out for agriculture the control over trees and other perennial features on the land remains as a right of the original owner. Recent developments, partly spurred by growing population pressure on land has resulted in some violation of these traditional regulations on land. Land is now sold for cash, kind or both, depending on the contractual arrangements. This mainly happens around Bolgatanga town and in the area between Langbensi and Gambaga. The role of chiefs in land ownership decision making has increased and in many areas the building of a house on a particular spot is no longer under the authority of the Tindana.

4.2 (Changes in) crop cultivation
In terms of crop combinations, four groups of farming systems can be differentiated in the northern region of Ghana, but these are all present in the study area as well (Millar, 1996):
1. the millet-based system with sorghum and cowpeas as additional crops in the north-east
2. The maize, sorghum, cowpea, groundnut system with yam and cassava as root crops, in the central parts.
3. The sorghum system with maize or cowpea and yam as root crop, in the west.
4. The yam system with maize, sorghum and groundnut, in the southeast.
Cropping patterns tend to change in the course of cultivation of a piece of land over several years.

There are two types of farm fields in the study area, the ‘compound farms’ which lie immediately around the house and which are cultivated year in year out, and the ‘bush farms’ which may border on the compound farm or which are located up to 6 km. away from the main village. Most farmers combine a bush farm with a compound farm. The top of the Gambaga escarpment seems to be the area where the ‘dual farming practices’ are still practiced in their purest form. For Ghana this form of agriculture is rather exceptional (Dickson and Benneh, 1988).

**Compound farms**

Compound farming is a mixed form of agriculture in which the soil is maintained at a high fertility level as a result of the dumping of household waste and livestock droppings. The land immediately around the compound is used for minor crops such as hibiscus, okra, tobacco, gourd, melon, tomato, pepper and sweet potato. Outside this range early and late millet is planted, often together with sorghum, guinea corn or maize (often early or yellow maize) in a mixture with cow peas and bambara beans. In other fields groundnuts, cow peas, maize or rice are planted as single crops. The average size of a compound farm is 0.8 ha in the southern parts and 0.4 ha in the most densely populated portions in the north (as in Bongo). Next to family fields, there are specific men’s and women’s fields. Often the men cultivate cereals on these fields, and the women vegetables. The general pattern is that men have square or rectangular main fields and women cultivate in the surrounding strips. If men’s fields become exhausted often their use is given to the women, who plant legumes among other things. After some time the soil’s fertility is restored and the fields go back to the men.

The farmers also keep large numbers of chickens and guinea fowls around the house. The waste of the household always fertilizes areas around the compound. Composting is utilized very rarely within the region. The use of chemical fertilizer is low: it is usually applied on cash crops, and its use has dropped considerably since the cut in subsidies after the introduction of Structural Adjustment Policies. Farmers are improving their methods of ‘low external input sustainable agriculture’. At the time of planting many households nowadays keep their animals indoors; collect and redistribute the dung, and release the animals to the compound fields after the harvest. Many goats and sheep are tethered on open grass patches.

In March 1993 a group of researchers connected with the Center for World Food Studies of the Free University of Amsterdam carried out a detailed analysis in a village ten kilometres east of Bolgatanga Town: Dulugu (see Al-Hassan et al., 1998) and they compared this ‘compound farm’ village with a ‘bush farm’ village in the northwestern part of Ghana. Dulugu had 210 compounds (‘dwellings’) and 60
households were interviewed. Part of those had already been included in an ongoing research project of the Savannah Agricultural Research Institute at Nyankpala, near the University of Tamale. In their study Dulugu represented a situation of high population density (close to 200 inh/km², comparable with Bongo, see later). Fields in Dulugu are farmed permanently on a year-to-year basis (the ‘Ruthenberg factor’ is 99%; 98% of the fields had been continuously cultivated for more than seven years; cow-dung use is 100%, and fertiliser use 9%; there were only 6 trees per ha of farm land; idem p. 139). Of all farm households in Dulugu only 7% also had access to bush farms elsewhere; so ‘distant farming’ is not a significant factor anymore. The researchers found a diverse cropping system in which most fields (56% of the total cropped area) consisted of a combination of various types of cereals (early millet and sorghum mainly) and 31% of a combination of various legumes. Ten percent of all fields had a cereal-legume combination while a very small part of the fields (only 3%) had a monocrop (idem, p. 135). An average farm household cultivated 1.4 ha (which meant 0.2 ha/cap. and 0.42 ha per man-equivalent labour; idem, p. 145). All crops which are being produced are purely meant for home consumption. Households do not sell crops at all. An average household stored 1.25 tonnes of grain. An average household bought 314 kg of cereals and legumes during the period between May 1993 and April 1994, with a peak in February-March and again in June. Stock levels of sorghum, maize, millet and groundnuts are high in September, immediately after the harvest, and in February, before the ‘hunger season’. With an average of 5 consumer units per farm household the total food availability is quite high.

An average farm household in Dulugu had a total Tropical Livestock Unit base of 1.9, consisting of 1.6 head of cattle, 3.6 goats, 2.3 sheep, 2.5 guinea fowls, 6.0 chicken and other fowls, 0.4 pigs, 0.1 rabbits and 0.1 donkeys (idem, p. 137). An average farm household sold c16,000 ($20) of livestock during the 1993-94 agricultural year, with the highest sales in November-December providing cash for (partly) grain purchases for storage against the hunger season in May-June; and again a peak, although lower, in March-April which is meant for financing farm input purchase and to a limited extent, food. On the other hand farm households bought livestock for almost c12,000. Over 80% of all farm labour is family labour, 10% is hired labour, 8% communal labour (mainly weeding) and 2% reciprocal labour and labour by visitors. The per hectare labour investment in the compound system was calculated to be close to 800 hours per season. During the farming season farm households spent 12.1 ‘average adult hours per day’ on economic activities: 6.7 hours on farm activities; and 4.8 hours on non-farm and ‘other’ activities. During the off-farm season the average number of hours per day was 10.0 (1.6 on farm activities and 8.4 on non-farm and other activities). About 11% of all households own bullocks and implements for ploughing individually and another 5% as part of a larger collectivity. Tractors are owned by only 3% of all farm households, but it means that in theory all households would have access to tractors and bullocks if they would be able to pay for the services. Not many households are.

In Dulugu 47% of all household members, both men and women, have crafts (basketry and blacksmithing mainly) as their secondary occupation, besides farming. Non-farm income was quite high (more than c300,000; idem p. 145)

**Bush farms**
Shifting cultivation, combined with crop and land rotation is practised on bush farms. Long fallow up to five years and more can still be found in less densely populated areas. A typical cropping sequence of most bush farms for shifting cultivation is as follows:

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yam or maize</td>
<td>Maize and Cowpea</td>
<td>Sorghum and Cowpea</td>
<td>Millet and/or Groundnut</td>
<td>Groundnuts or Cotton</td>
<td>Fallow</td>
</tr>
</tbody>
</table>

(Source: Millar, 1996)

Bush farms are not manured. The farming system used is land rotation. The bush farms vary in size, but are about 1.2 ha. The bulk of the cereals are produced on these bush farms. In the bush-fallow system fallow periods tend to become shorter, 2-4 years, as a result of population increase and pressure on the land use. Bush fallow, shifting cultivation, the intercropping and rotations practiced by farmers are all attempts at redressing the low soil fertility levels. Crop rotation is practised along with inter-cropping. The tendency is to move to millet and legumes as soil fertility and thus yield decreases. A typical example of the normal pattern of rotation is as below:

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yam or maize</td>
<td>Maize minor/ Sorghum with cowpea</td>
<td>Sorghum/ Millet with cowpea/ Groundnut</td>
<td>Groundnut with millet or sorghum as minor crop</td>
<td>Fallow</td>
<td></td>
</tr>
</tbody>
</table>

(Source: Millar, 1996)

In recent years the shifting cultivation system has begun to give way to more permanent cultivation. In many areas the fallow period has been reduced to 2-3 years because of increasing population and inadequate land. This has put a considerable pressure on yields on the plots actually used. The emerging system is that of land rotation combined with intensive cultivation, often fertilized with farmyard manure.

On both types of farms planting usually begins soon after the first heavy rains (June/July); weeding starts between two weeks and month after sowing; and the crops are ready to be harvested early in the dry season. In the Upper East Region there appears to be little interest shown in dry season gardening, although soils and water conditions seem favourable near some of the larger settlements. In some of the areas towards the south, in the Nasia valley, farmers from the Gambaga areas settle in temporary houses to cultivate rice and vegetables in the dry season in places which are marshy during the wet season (a form of ‘transhumant agriculture’).

We will look at two areas in particular: Bongo in the northern part and Langbenshi in the south.

**Bongo District** is one of the most densely populated areas, with population densities of more than 200 inhabitants per square kilometre. Almost every available piece of land is cultivated here; that is: if there are no rocks and boulders, which abound in this area. People even cultivate land under trees and other shady places, although they know that yields will be low. Every plot that is cultivated means some extra food. The few exceptions to the rule are ancient holy places, with vegetation which might be over one hundred years old. The ones in Tongo Hills are well known in the area. Bongo District has a ‘bush reserve’, but people do not respect the government-imposed rules. There are a few cases of illegal farming in this bush reserve, where farmers have cut down trees to make a farm field. Some farmers were caught and got fines to pay. Farmers who could not afford were sent to prison. Bongo District is one of the places where the dual farming system of compound farms and bush farms has
given way to intensified farming all over. There is no fallow period any more. Only the older
generations know of times when fallow periods were still used on the old bush farms. Nowadays also
all trees in the area are ‘economic trees’. The farmers in Bongo improve their land with manure of
animals and with their own excrements, using the land around their compound as a toilet. Some people
use composted leaves and farm waste, but usually these are used as fuel, as firewood has become
increasingly scarce. Only few farmers can afford chemical fertilisers. Farmers are aware of erosion
cau sed by water. Wherever possible they leave the grass to avoid the wash out of nutrients, and as a
natural border between fields. Farmers have little or no possibilities to do something about water
management, with the exception of farmers who have access to irrigation, those with plots at the
nearby Vea Scheme.

In the Langbens area the compound farms near the settlements are intensively cultivated with maize,
millet and sorghum (as well as bambara beans, cowpeas and occasionally soybeans), while bush
farms, which generally occur within a 2 km radius of the settlement, are more frequently used for
cotton and yam cultivation. Fallow is short, not more than a couple of years. Millet, maize and
sorghum are grown on ridged fields (usually ploughed using bullocks) with low capital investment and
low recurrent expenditures. Limited amounts of animal waste and compost are applied. The crops are
grown concurrently and, with the exception of early millet, are harvested around the same period,
about 120 days after planting. Family hands are the main source of farm labour. Grain yields are
generally low. Labour requirements are high during planting and harvesting times. At the end of a
cropping cycle before fields are left fallow some farmers cultivate cotton as a monocrop.

In the research area, crop yields vary greatly between farms, depending on:
- The farming system practised (fallow; intercropping; weeding intensity; soil and
  water management techniques)
- The land preparation methods used (ploughing versus manual land preparation)
- The level of use of inputs such as high-yielding varieties and fertilizers
- The location of the farm (with compound farm fields yielding up to three times more
  than bush farms)

Yields also vary in time due to changes in the rainfall pattern. In chapter 2 we have
compared the rainfall variability with yield variability, as assessed by MOFA UER
during the years 1986-97. In 1990 MOFA published a ‘Medium Term Agricultural
Development Programme’ for Upper East Region in which they also presented data
on average yields (based on the 1980s?), comparing the ‘traditional’ with ‘improved’
smallholders. Improved smallholders were said to use moderate levels of fertilizers
(up to 75 kg/ha) and improved varieties where available. We will present these data
here with the intention to show the ranges in the various assessments. It is very
remarkable that the MOFA 1990 data for the two most important crops, millet and
sorghum, are so much lower than the MOFA assessments of the annual production in
the area during the period between 1986 and 1997. MOFA data for the Upper East
Region (1986-1997) are lower than the FAO data for Ghana as a whole for these six
crops (as given in part A of this study), as can be expected.

Although the overall yields have improved for most crops during the 1990s, land
scarcity and population growth have resulted in a problematic food situation in the
Upper East Region. According to Otipiri (1997) the Region can be labelled as the
‘Food Deficit Region of Ghana’. The food balance for millets and maize has been
negative in all years between 1993 and 1997; the sorghum balance was negative in
1997 and the rice balance in 1994. The drought year 1997 had a cereal deficit to the
tune of 14,000 metric tonnes (or 20 kg/cap). In the so-called ‘Low Risk Rice Project’
in the Region 40 ha (out of 140 ha) had a complete harvest failure. Water dams
experienced a drastic reduction in the amount of water, with the result that dry season gardening failed as well.

**Table 18 Estimates of (small holder) yields in Upper East Region and in Ghana as a whole (kgs/ha)**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Millet</td>
<td>225</td>
<td>265</td>
<td>740</td>
<td>520 ('90 ; '92)</td>
<td>1170 ('95)</td>
<td>800</td>
</tr>
<tr>
<td>Sorghum</td>
<td>315</td>
<td>600</td>
<td>830</td>
<td>640 ('87)</td>
<td>1200 ('96)</td>
<td>900</td>
</tr>
<tr>
<td>Maize</td>
<td>600</td>
<td>1000</td>
<td>850</td>
<td>500 ('97)</td>
<td>1300 ('91)</td>
<td>1400</td>
</tr>
<tr>
<td>Rice</td>
<td>1000</td>
<td>2200</td>
<td>1670</td>
<td>670 ('90)</td>
<td>2400 ('95)</td>
<td>1800</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>425</td>
<td>675</td>
<td>820</td>
<td>610 ('90)</td>
<td>1150 ('87)</td>
<td>800</td>
</tr>
<tr>
<td>Cowpea</td>
<td>125</td>
<td>500</td>
<td>no data</td>
<td>no data</td>
<td>no data</td>
<td>no data</td>
</tr>
<tr>
<td>Beans</td>
<td>125</td>
<td>240</td>
<td>no data</td>
<td>no data</td>
<td>no data</td>
<td>no data</td>
</tr>
</tbody>
</table>

Sources: MOFA 1990 and MOFA Upper East Region Annual Reports 1987-1998; FAO Production Yearbooks

Government projects have brought new (varieties of) crops to the area. The reason for most farmers to use these is not because the crops are more adapted to the climate. Some crops are even more sensitive to drought. But most farmers use them to spread their risks. When an old variety fails, a new variety may give a yield and the other way around.

Three different mechanization methods are being used within this system: tractor cultivation, bullock cultivation and hand cultivation. Most people prefer the use of the hoe for farming, because they are convinced that it gives higher yields. There is a close interaction between livestock and the cropping system. The inter-relationship is gaining prominence as people cannot afford fertilizer; resulting in an emphasis on organic farming and the improvement of the environment. Farmers try to cultivate different types of fields with different soils. If possible they try to combine one or more fields near rivers or damsites, to get yields during dry years, with fields on higher spots, to get yields when it is a very wet year. They also adapt their labour investments when they fear it might become a very dry year or a very wet year. In a dry year they put more emphasis on the low-lying areas, and they stop weeding the fields in higher spots. Some farmers deliberately sow on a large number of days, to get plants in different stages of growth, to distribute risks.

According to assessments by MOFA irrigation would be possible on 33,400 ha in Upper East Region as a whole. Most of this potential can be found just outside the study area, near Navrongo. There are a few irrigation schemes (Tono and Fumbisi near Navrongo, and Vea in Bolgatanga District). Outside these ‘schemes’ irrigation is practised in few areas. In those areas two harvests are generally possible. Irrigation is possible near dams, but farmers have to pay for water, and they regard this as a major constraint in drought years. A number of Land Planning Areas have been established where ways of solving the agricultural problems are being studied. One of the outcomes of this study implied that irrigation leads to large increases in crop harvests and ensures the success of the cultivation of crops such as banana, tobacco and large...
tomatoes. Other crops cultivated in the irrigated area are rice, maize, sorghum, groundnuts and fibre plants. The Tono irrigation project nearby (in the Navrongo District; 2,490 hectares) serves as model farm area and as a source for the supply of fingerlings. Also the Vea Irrigation Scheme in Bolgatanga District (850 hectares) plays such a role. With the introduction of irrigation in the area, some improved crop varieties with higher yields have been introduced into the region through MOFA and Non-Governmental Organisations working in the area (see 4.7). Apart from the larger irrigation schemes there are many dugouts and dams, used by groups of farmers, although farmers complain that quite a number of water bodies have dried up (also the water in the Vea and Tono schemes is reduced due to siltation and evaporation). There are no farmers practising on-farm borehole irrigation.

The main soil and water conservation methods in the region are mounding, ridging, stone lines, basins and stone terracing. Other methods include cover cropping, laying of stalks on contour bunds to reduce erosion, and strip cropping. Organic fertilisers, mainly animal manure, crop residue, household refuse, and in practice also humanure, are used on compound farms. Inorganic fertilizers are used mainly by large-scale farmers and to a limited and decreasing extent by small-scale farmers. The main inorganic fertilizers used are NPK and Sulphate of Ammonia.

Inter-cropping is a common practice in the region. The following sub-categories of inter-cropping can be distinguished (Adolph et al., 1993):

- mixed inter-cropping with no distinct row arrangement
- row inter-cropping: different crops are planted in rows
- strip intercropping: crops are planted in strips wide enough to permit independent cultivation, but narrow enough for crops to interact
- patch intercropping: the component crops are planted in patches
- relay inter-cropping: the growth periods of the crops overlap for part of their growing cycle (e.g. early millet, late millet, sorghum)

Cash crops of the area are shea nuts (for making shea butter) and bambara beans, cotton mainly in the northeastern part, tobacco in the area south of Bolgatanga, some groundnuts mainly in the southern part and rice in the irrigation areas (Atta-Quayson, 1995, p. 15). In the last two decades agricultural marketing has become more important for most farmers in the area. Most cash crops are sold locally. Few crops reach markets in the south of Ghana and hardly any agricultural produce is being exported to the world market (with the exception of shea butter). Soya bean production is on the increase and this could become an important export crop. Cotton first became important in the 1970s (especially around Bolgatanga), but due to marketing problems it virtually disappeared. Now it is coming back again as an important cash crop.

In the Bolgatanga study area there are a couple of farms, established by the bast Fibres Development Board, which stimulates the cultivation of fibre plants. The farms are located in a.o Walewale, Nakpanduri-Gambaga, Tolon, and Zebilla. The cultivation of fibre plants (kenaf, jute, roselle and congo jute) requires rainfall of 1700 mm during the growing season, high tempatures of between 18°C and 26°C, plentiful sunshine and well drained, crumbly soils (Dickson and Benneh, 1988). So the Bolgatanga area is actually much too dry for these crops. The towns and villages use the fibre for
cottage industries such as weaving of door mats, car mats, ropes, carpets, handbags, hats and baskets.

4.3 Animal husbandry

According to Dickson and Benneh (1988) 90% of the population in the northern parts of Ghana is engaged in a combination of cattle rearing and crop farming. However, in the study area animal husbandry is practised on a limited scale only. In Upper East Region the livestock population in 1988 was estimated at 189,000 cattle, 174,000 sheep, 167,000 goats, 37,000 pigs and over 600,000 chicken and guinea fowl (MOFA 1990). Per capita this would mean an estimated 0.2 head of cattle, 0.2 sheep, 0.2 goats, 0.04 pigs and 0.7 fowls; in total 0.2 Tropical Livestock Units. In parts of Upper East Region farmers also keep dogs for food purposes, although most of it is ritualised consumption. Dogs are also bought and sold. A few farmers have large herds of cattle, goats and sheep, though, and some of them engage the services of professional herdsmen, Fulanis. Many small farmers have no cattle, a few goats or sheep and occasionally a few pigs, while almost everybody (90% of all women) has chicken and guinea fowls. Having cattle is a sign of wealth (with an estimated 10% of all adult men owning cattle). Having no goats or sheep is a sign of rather desperate poverty (with 80% of all men having sheep and 20% of all women having between two and five goats). During the farming period cattle are kept confined, but they are allowed to graze freely during the dry season. Guinea fowls, chicken and goats are regularly sold to traders for transport to Kumasi and Accra. Small ruminants are very much regarded as a form of security (‘insurance on the hoof’), but also fowls play such an insurance role, especially managed by women. There is quite a considerable export of livestock and poultry to the South. Income from the sale of livestock forms a substantial proportion of cash proceeds from agriculture.

In the north of Ghana most farmers invest their wealth in cattle: the extent of a person’s wealth is determined by the number of cattle he owns (Dickson and Benneh, 1988). About 90% of the cattle population of Upper East Region in 1988 was made up of the West African Shorthorn breed, with the remaining being Zeba, Sanga and N’dama breeds (MOFA 1990). Problems faced by cattle rearers are lack of drinking water in the dry season, shortage of feed in the dry season when no forage grows, pests and diseases and overstocking due to the emphasis placed on numbers and not on quality. Recently cattle thefts, raids and ‘looting’ (stealing astray animals) became a menace and robberies with violence were reported to be on the increase. MOFA experts suggest an increasing number of animals during the 1990s and regard it as both effect and cause of increasing land degradation. Both the sheep and goats are predominantly West African Dwarf breeds, with few Long-legged Sahelian breeds. A recent problem that is often mentioned is the fact that many goats die because of eating plastics. Plastic waste materials are indeed everywhere to be seen.

During the dry season shepherds from Burkina Faso migrate with their cattle to some areas in the Upper East region and further to the south in search of feed and water. This is accepted practice, hitherto without many problems. There is some transhumance of Upper East cattle as well, especially during dry years. Fulani herdsmen are used to set fire on the grass with the intention that fresh grass will sprout with the onset of the rains. Cases of careless bushfires abound, with loss of property as a result. Bushfires at the end of the dry season expose the thin top soil to the strong
winds, causing erosion and destruction of soil microorganisms. In 1994 it was reported that bushfires destroyed 36 ha of rice fields in Upper East Region.

During droughts fodder generally becomes a problem as well as distances to water sources. Herders try to collect acacia fruits as additional fodder (“goat biscuits”) and recently these are even being bought and sold, generally by poor women and their children. During times of drought stress animals have to walk further to water. Once they have arrived at a water hole herders often do not want to leave, which may lead to severe overgrazing in the vicinity of these fallback water sources.

4.4 Changes in horticulture
Tomatoes are cultivated on a rather large scale nowadays on irrigated farms at Vea. Here 920 hectares of land are irrigated. The tomatoes are transported fresh to Accra and other urban centres. Also in rainfed but well-watered fields commercially oriented farmers nowadays plant tomatoes, pepper and onions as commercial crops. Recently (since the 1980s) onions became a booming business in the northeastern part of the study area, around Bawku. Most of it is transported to Accra as well.

At Vea in March 1999 Accra women bought tomatoes for c45,000 per crate (with approx. 10,000 tomatoes), slightly below the market price in Bongo (c500 for ten tomatoes). They sell in Accra for c120,000. The best price is paid in the period between September and December (up to c80,000 per crate); but there have also been months with only c10,000 per crate. Farmers at Vea try to cultivate 0.2 ha of tomatoes each, which can give 10 crates (or on average c500,000) per annum. They have to pay a water levy of c45,000 for the same 0.2 ha to the Vea Irrigation Authority, or less than 10% of their annual gross income. Accra women have a virtual monopoly because they hire trucks for transporting the tomatoes from Vea to Accra. According to local spokeswomen “you can’t form a cooperative because no truck owner would dare to make their truck available to you”. Tomato production is currently the most lucrative activity at Vea. Rice production gives lower rewards and this is also acknowledged by the Irrigation Authority who only ask c35,000 water levy per 0.2 ha if farmers cultivate rice. At small dams many small farmers have also started to cultivate tomatoes and other vegetables. Acreage per women is often very small (e.g. two rows only). These small dam areas are communally owned and managed. There is no water levy. In 1999 with UNDP funds farmers were experimenting with integrated pest management for tomatoes, cabbage and rice.

4.5 Changes in the forestry sector
Charcoal production is a common practice, mainly for home consumption, although some villages seem to specialise in commercial charcoal production. In the Langbensi area this is particularly done by the inhabitants from the Tangbini village. On the way from Bolgatanga to Tamale there are several places near the road where people make and sell charcoal. In the northern part of the study area charcoal production more or less came to an end. There is only one place left near Bolgatanga. There are simply not many trees left to make charcoal.

The Department of Forestry of the Ministry of Lands and Forests has 28 forest reserves in Upper East Region totalling 1536 km², of which 11 covering 749 km² fall within the study area proper (Forestry, 1994). Each year the boundaries of these reserves are cleaned to clearly demarcate the reserves to prevent encroachment and bush fires. Regular patrols and inspections are made to prevent encroachment. Many Tindanas (see later) do not recognise the government’s right to these forest reserves and claim authority, although in practice this does not result in a lot of problems. The Ghana Fire Service has formed several bushfire squads to assist in the prevention and spreading of fires and to educate the public. Recently the attention of the Forestry
Department has shifted to a greater emphasis on community forestry. Seeds of some selected tree species are nursed and transplanted by the department or sold out to individuals and community groups who are interested in tree planting. In 1996 rural communities were assisted to establish their own nurseries: 36 hectares were planted with trees in Bawku district, 42 ha in Navrongo district and 41 ha in Bolgatanga district (Forestry, 1996).

Several Non-Governmental Organisations are encouraging tree planting as well (afforestation, agroforestry), nowadays often in an explicit attempt to mitigate the effects of climate change, to prevent soil degradation and to induce precipitation. The Adventist Development and Relief Agency ADRA in the Upper East Region is involved in afforestation through seedling production. These seedlings are planted by farmers in their fields and cared for while cultivating their land. Each year over 100,000 seedlings are produced and transplanted (ADRA, 1997). Educational and environmental awareness trainings are held from time to time for ADRA clients to promote afforestation. The Catholic Diocese of Bolgatanga through the Bongo Afforestation Project aims among other things to establish community nurseries, improve the environment through tree planting and reclaim destroyed land. This project, which started in 1987, has 42 functioning groups, seven volunteers and eight schools involved in its implementation. Currently the groups are involved in the use of stone and grass bunds to prevent erosion and conserve water in the soil in addition to tree planting. Educational meetings on environmental management systems are also held frequently. The National Council for Women and Development co-ordinates all women programmes in the region, some of which are geared towards afforestation and soil conservation. Other NGOs involved in environmental programmes include TRAX (a British NGO) and PACIPE. According to local key persons northern Ghana still has a long way to go compared to Burkina Faso. North of the Burkina-Ghana boundary the land quality was said to be much better maintained since the early 1980s.

4.6 Some notes about the importance of fisheries, hunting and gathering

There is some fishing in the White Volta. In the past there were many more small water bodies in the region, with quite a lot of fish. Many former water bodies are dry now, resulting in restricted fishery possibilities. The depletion of forest resources in the region has led to a drastic reduction in hunting activities. With the exception of a few animals, like mice, lizards etc., all animals have sought refuge in the few forest reserves where hunting is formally prohibited. Gathering of firewood, sheanut, dawadawa, baobab and some other wild fruits is still prevalent in the region.

4.7 Prices and Caloric Terms of Trade

It was not possible to construct time series of prices of crops and livestock. For the situation in (early) 1998 it was possible, though, to compare all relevant prices and to calculate the (caloric) terms of trade after the harvest and during a ‘normal’ dry season. For some products it was also possible to estimate the price levels during one of the worst periods during the last decade: the bad rainy season around July 1997, when prices of grain crops had gone up considerably and prices for livestock were bad. Table … gives the results of the prices and of the caloric terms of trade calculations. If we compare the prices paid per 1000 Calories for millets and sorghum on the one hand and all other products on the other, we can arrive at ‘caloric terms of trade’. The comparison shows the large fluctuations between the seasons and the
crisis situation in July 1997. It also shows a hierarchy in agricultural trade goods to obtain grains. After a normal harvest, when prices of livestock are generally good and prices of grains are low it is always much better to sell an animal or groundnuts and to purchase grains with the proceeds than to eat those products. Fowls (both poultry and guinea fowls) even give a very good return in caloric terms: selling 1000 Calories of fowl gives more than 22,000 Calories of millets or sorghum in return. Also cattle and goats give excellent returns in food terms. The caloric returns of groundnuts are much less, but still favourable. During a normal dry season the livestock prices generally deteriorate (although dog prices are rather stable; consumption is more for ritual purposes) and prices of grains go up. During a normal dry season it is still quite favourable in food terms (Calories) to sell animals or groundnuts in stead of eating it). During the problematic period of July 1997, when many people wanted to sell livestock and prices became very low, while the prices for crops were going up, as many people expected a bad harvest, the caloric terms of trade for most products (except dogs, cattle and fowls) dropped below parity. This means that in food acquisition terms it became better to eat goats, sheep, pigs and groundnuts for their caloric value, instead of selling them and buying grains with the proceeds. Comparing this with other calculated situations in Africa during bad periods it is a rather extreme situation.

Table 19 Prices of major crops and livestock in Bolgatanga (in cedis) and caloric terms of trade

<table>
<thead>
<tr>
<th>Crop/Animal</th>
<th>After-harvest price</th>
<th>Price during normal dry season</th>
<th>Price in July 1997 (bad season)</th>
<th>Estimated kg food weight</th>
<th>Cal/kg Estimated kg food weight</th>
<th>Price per 1000 Cal bad period of July 1997</th>
<th>Price per 1000 Cal normal dry season</th>
<th>Price per 1000 Cal normal after harvest period</th>
</tr>
</thead>
<tbody>
<tr>
<td>millet or sorghum</td>
<td>800-1000 per 2.5 kg bowl</td>
<td>1600-2500 per 2.5 kg bowl; 60,000-70,000 per 92 kg sack</td>
<td>2000-2500 per 2.5 kg bowl</td>
<td>-</td>
<td>3500</td>
<td>230-285</td>
<td>180-285</td>
<td>90-110</td>
</tr>
<tr>
<td>groundnuts (40 kgs unshelled = 15 kgs shelled)</td>
<td>25000-30000</td>
<td>50000</td>
<td>50000</td>
<td>-</td>
<td>6000</td>
<td>560</td>
<td>560</td>
<td>270</td>
</tr>
<tr>
<td>cattle</td>
<td>300000-400000</td>
<td>160000-200000</td>
<td>?</td>
<td>70-300 kg</td>
<td>2000</td>
<td>?</td>
<td>500-1000</td>
<td>1000-1400</td>
</tr>
<tr>
<td>goats</td>
<td>350000-400000</td>
<td>20000-30000</td>
<td>5000-10000</td>
<td>18-25 kg 1600</td>
<td>175</td>
<td>780</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>sheep</td>
<td>350000-400000</td>
<td>20000-30000</td>
<td>5000-10000</td>
<td>18-25 kg 3000</td>
<td>90</td>
<td>420</td>
<td>530</td>
<td></td>
</tr>
<tr>
<td>fowls</td>
<td>40000-60000</td>
<td>2500-30000</td>
<td>800-1000</td>
<td>1 kg 2500</td>
<td>320-400</td>
<td>1000-1200</td>
<td>1600-2400</td>
<td></td>
</tr>
<tr>
<td>pigs</td>
<td>45000-60000</td>
<td>35000-45000</td>
<td>20000-25000</td>
<td>40 kg 2500</td>
<td>200-250</td>
<td>350-450</td>
<td>450-600</td>
<td></td>
</tr>
<tr>
<td>dogs</td>
<td>35000-50000</td>
<td>same</td>
<td>same</td>
<td>15-20 kg 2000</td>
<td>1150-1250</td>
<td>same</td>
<td>same</td>
<td></td>
</tr>
</tbody>
</table>
Table 20 Caloric terms of trade in Bolgatanga during a normal after harvest period, during a normal dry season and during the food crisis in July 1997

<table>
<thead>
<tr>
<th>Period</th>
<th>CTOT Hierarchy</th>
</tr>
</thead>
<tbody>
<tr>
<td>After normal harvest</td>
<td>Fowl (22-27), Cattle (15), Dog (13), Goat (11), Pig (6-7), Sheep (5-9),</td>
</tr>
<tr>
<td></td>
<td>Groundnuts (3)</td>
</tr>
<tr>
<td>During normal dry season</td>
<td>Dog (5), Fowl (4.2-5), Cattle (4.2), Goat (3.2), Groundnuts (2.3), Sheep</td>
</tr>
<tr>
<td></td>
<td>(1.8), Pig (1.7)</td>
</tr>
<tr>
<td>During the food crisis in July</td>
<td>Dog (1.4), Cattle (1.8), Fowl (1.2), Groundnuts (0.9), Pig (0.7), Goat (0.6),</td>
</tr>
<tr>
<td>1997</td>
<td>Sheep (0.3)</td>
</tr>
</tbody>
</table>

For the functioning of the caloric exchange rates the role of middlemen/traders becomes very important. Often they are (ethnic) outsiders. The sale of animals seems to show an interesting gender-differentiated seasonality pattern: animals which belong to the women are generally sold in the period before Christmas (to enable the wives to contribute to the festivities during this period, and because of the large demand for goats). The animals of the men are generally sold later in the dry season, between January and April.

4.8 Changes in agricultural services

Agricultural services are relatively scarce and have reached the area rather late. The MOFA extension services and veterinary care are thin on the ground. Credit is a relatively scarce resource for the small-scale farmer. Livestock watering sources are mainly dams and dugouts, managed by groups of farmers themselves. Those who take part in ‘projects’ have access to credit through such projects. Examples of such projects are the IFAD-funded Smallholder Credit Input Supply and Marketing Project (SCISMP), Sasakawa Global 2000 project and others coming from international NGOs. The irrigation schemes (Vea, Tono) are being managed on behalf of the government by the Irrigation Company Upper East.

Between 1977 and 1985 the Upper Region Agricultural Development Project (URADEP), with financial support from foreign donors, vigorously carried out development projects that sought to increase the production of both crops and livestock. This was mainly done through the provision of inputs, improved technical services and supporting infrastructure in an area of 27,300 km², with 125,000 farm families. Even though the project officially ended in 1984 the Government of Ghana, through the Ministry of Food and Agriculture (MOFA) continued to finance the project under a URADEP subvention item in the MOFA budget, that is, through a composite allocation rather than through separate departmental funding. The project’s impact was disappointing. This was attributed, among other things, to the following reasons: 1) an optimistic project design which failed to provide for the difficult geographic location of the region; 2) management problems arising from unclear specification of the relationship between the project management and the existing government institutions (including the district-based extension agencies of MOFA) and 3) lack of beneficiary participation and incentives.
With funds from IFAD the Ministry of Food and Agriculture in Upper East Region started the ‘Upper East Region Land Conservation and Smallholder Rehabilitation Project (UER LACOSREP). One of the objectives is to establish mechanisms for environmental protection and improvement.

4.9 Land use change, 1960-1999
Land use change in the study area can be summarised as:
- an increased use of riverine areas;
- an increased use of formerly marshy areas (partly because of drying up, partly because of increasing rice cultivation);
- a rehabilitation and expansion of small dams which are increasingly used for dry-season cultivation;
- an increased use of the areas near the watersheds;
- an increased use of lands which used to be avoided for crop cultivation because of their function as shrines and sacred groves; people are less ‘scared’ of these ‘bushes’;
- a reduced fallow period; more continuous cropping; in the most densely populated areas (e.g. Bongo) fallow has disappeared altogether; in other areas the ‘compound farm’/’bush farm’ dichotomy changes in favour of the compound farms;
- a diminishing size of plots; and more intensive cropping per hectare;
- a change of grazing lands to crop lands;
- an increasing importance of cotton, tomato and onion production.
CHAPTER 5  ECONOMIC CHANGE IN THE NON-
AGRICULTURAL SECTOR

5.1 Handicrafts and manufacturing
The Bolgatanga study area is and has always been basically a crops-animals
production economy. Industrial development has always been very limited in the study
area. In Bolgatanga and Pwalugu there are some food processing industries and in
Bawku and Bolgatanga there are industries which are engaged in the production of
leather goods (Atta-Quayson, 1995, p. 17). There used to be a meat factory in the area,
in Bolgatanga Town, but it has gone bankrupt years ago. Also the Tomato Factory in
Pwalugu has not functioned for quite some time due to inadequate initial feasibility
studies, lack of raw materials and poor management. Most of the area’s tomatoes
(mainly from the irrigation schemes like Vea) are now being purchased directly by
Accra-based merchants and transported to the South. Currently the Ghana Cotton
Company is completing a ginnery in Bolgatanga, banking on increased cotton
production in the region (and maybe expecting a southward move of the cotton belt, as
a result of climate change?).

In the past the majority of the inhabitants of Walewale were engaged in many craft
industries, especially the weaving and dying of cloth. In Zuarungu, an ancient crafts
area in the Bolgatanga area, but also elsewhere in the region, many farmers are
involved in the production of hats, mats, bags and baskets made of vetiver grass
(which is also important for soil and water conservation purposes). Bolgatanga Town
is gradually taking over the marketing role. In the last decades the selling of these
products has become more and more popular as an activity to get additional income.
Recently some workshops were held to teach people how to make new models of
baskets. Most of the baskets and hats are exported to Accra, and from there to foreign
countries, including the Netherlands. But also a considerable quantity of these craft
products are transported to market places in Burkina Faso, through the Bongo District
Border. Most farmers who are engaged in the production of hats and baskets regard it
as an extra source of income, not as a possibility for making a living out of it. In
drought years, though, this craft income tends to become relatively important (e.g. in
1997). Recently the commercialisation of grass (as feed for animals) is on the
increase. In November-January many men go to the bush to cut grass for sale. In
Bolgatanga a grass market exists in those months.

Production of the locally favored ‘smock’ clothes can be found in the urban centres as
a small-scale activity. For instance the Bawku market abounds with those smocks. In
rural centres one can also find traditional blacksmiths and a lot of pottery activities,
although commercial pottery was thought to be decreasing.

Many non-farm activities, or cottage industries, are agro-based, very small scale, and
often seasonal. Some of these ventures are so small that they could exist for only a
couple of months or that they exist for years but with virtually no growth. Some of the
more continuous agro-based activities include small-scale rice mills, dotted all over
the area. They are very much dependent on the quality of the season, though. In 1997,
when the area experienced a rather serious drought and rice yields were low, the mills
were virtually idle.
Other agro-based village activities include groundnut oil extraction. Groundnut oil extraction and the making of ‘kulikuli’ (fried groundnut cake) has been an age-old tradition in the study area. Production methods however need to be improved to make the oil extraction more efficient and economical. A development project was recently launched to make peanut butter from groundnuts, for local sale. The local soup is often made of peanut paste, but to make it from groundnuts is a time consuming activity for women. The peanut paste project had the intention to reduce the cooking time for the women. However, only women with relatively high incomes seem to be able to afford this product.

Pito brewing is another age-old practice that has been commercialised very significantly in the study area. Sorghum is being used as the raw material for this local beer. “The degree of importance of a town or a village market can be measured by the quality and quantity of pito sold in the market”, according to a middle-aged trader from Sheaga in the Bolgatanga District. Also, pito marsh, a by-product of the pito industry, is very good pig feed. The pig industry, which is growing in the area, is largely dependent on pito marsh. Some women have specialised in the sale of pito marsh in exchange for small pigs.

At the workshop in Bolgatanga in March 1999 there was quite some discussion about the economics of pito brewing. Pito brewing is a major activity after the sorghum harvest. If women use ten bowls of sorghum (=25 kg; value: c60,000) they can produce three basins of malt, which is enough for three jerrycans of pito, or between 160 and 175 litres of pito beer. This sells at c550 per litre (c2500 per gallon, the normal measure), which means that the total sale could be between c88,000 and c96,000. In addition the women can sell the pito marsh, but they also have charcoal expenses and of course they spend their labour time. According to this calculation it is a profitable enterprise, but only if all goes well. For many women it might be their only real source of income, but judged economically it is a rather marginal activity.

Shea butter extraction is based on nut gathering of trees which are not cultivated, although they are protected and regarded as very important economic trees. Shea butter is becoming an important export commodity and its production is likely to receive more attention by the government and the private sector in the near future.

Another tree that is held in high esteem is the dawadawa tree, of which the fruits are used as the raw material for a kind of marmite or maggi, which is locally used in the sauce. There is fear, however, that the dawadawa is about to disappear. Unlike the sheanut tree it seems to be failing to recover from the dry period of the 1970s and 80s. Old trees still produce, but few young trees survive.

5.2 The Mining Sector
Gold panning (‘lakpikit’ or ‘galamsey’) has become quite an important activity for many people around Bolgatanga Town. Commercial prospectors have also entered the scene. The Bolgatanga District is now regarded as a major gold producing area. It is a fact that it was gold mining that helped to prevent a famine situation in 1997 when there was a rather severe drought. Also, several houses in the Nabdam and Talensi Areas of the Bolgatanga District are now roofed with zinc and aluminium sheets instead of thatch as a result of money from gold. Surface gold mining has thus brought some degree of prosperity to the people who are engaged in it. However, gold mining
has also caused serious degradation of the soil and the general environment. The major mining area used to be ‘forested’ and there were several water bodies in the area. The vegetation has changed dramatically within the last four years and the water bodies are disappearing. The situation is bound to have adverse effects on the local climate. Gold mining also has some adverse effects on the social fabric of the local society. As mining is a major activity of young men, some of them have become very rich overnight. They tend to challenge the existing status hierarchy and they generally turn their back to agricultural labour. Old people tend to criticize these young men for their lack of responsibility and lack of respect.

5.3 Trade
In the past the most important trading centre of the study area was Walewale, where many specialised traders resided, many of whom were mainly trading in kola nuts which came from Asante through Salaga. Part of this trade has been diverted to the fast growing towns of Tamale and Bolgatanga. This has reduced the importance and the rate of growth of Walewale considerably.

The area is full of village markets (every three or six days), where men are mainly involved in the buying and selling of livestock, while women are very active in marketing crops. There is no law or custom preventing men from marketing crops, nor women from engaging in livestock marketing. The present practices have evolved over time. A man who wants to sell his cultivated millet or groundnuts gives the produce to his wife to take it to the market. And a woman who wants to sell her goat or sheep either gives it to her husband or a son to take it to the market. In big towns such as Bolgatanga and Bawku, however, many men now market grains, but in relatively large quantities.

The big market towns are Navrongo, Bolgatanga, Bawku and Zebilla, where markets are taking place at the same day; in all smaller markets in their neighbourhood the market day is the day afterwards.

Especially after the drought of the early 1980s the government has invested in the improvement of the trade structure, by improving the roads, providing electricity to some of the market centres, and stimulating the market activities in Bolgatanga. This has been quite successful: market activities in Bolgatanga have increased considerably, especially during the 1990s. After the recent improvement of the main road from north to south Ghana crops like tomatoes, onions and others are more easily being transported towards the south. More food, but also clothes, soap and other consumer goods are now being transported to the region from the south. Some of it finds a further destination towards Burkina Faso. The market street of Bawku, the border town, just outside the study area, is a bustling place. Smaller markets exist as well, like the one in Bongo. Local people generally talk about a ‘commercial boom’ during the (late) 1990s.

5.4 Changes in the Service Sector
After Independence the number of government employees (including teachers) in the area increased, until the 1980s. The government’s presence is relatively unimportant, and government salaries are certainly not the engine of economic growth in the area. Neither the government nor private entrepreneurs stimulated the development of a
tourist industry in the area. Facilities are very limited, and restricted to Bolgatanga. Some tourists use the Tamale-Bolgatanga-Bawku-Ouagadougou road, but they only travel through the area, having a brief stop only in Bawku. The scenic areas of the Gambaga Escarpment area are not exploited at all. There are also no game reserves in the area. However, some 3000 ha of the area has been declared a forest reserve.

5.5 Remittances and external economic support
An increasing number of people, mostly young men, are going to the southern parts of Ghana to look for a job. Most families nowadays have a network of family and friends in the South, where they can send relatives to to enable them to get settled in their new, often temporary environment. Many of these migrants only get unskilled jobs (e.g. watchmen, or assisting traders). Most migrants send money or material goods (clothes, tools) home on an irregular basis. It is customary to send money on special occasions, like funerals. Quite a lot of the migrant remittance money is used for paying labour, health care and school fees. Very few people from the study area have a network of relatives beyond Ghana (with the exception of some cross-border relatives in Burkina Faso). Persons who are moving abroad are usually members of wealthy educated families. E.g. in the whole of Bongo District there are few if any ‘foreign’ relatives.

When people face severe problems and they do not have anything left to sell, they try to do farming jobs for other farmers elsewhere, first in the neighbourhood and if that is unsuccessful, they move towards the south. When the farming season is over almost all of them return home. In families with low incomes children are sent away during bad years. They are temporarily adopted by rich families or they have to find a job elsewhere. Some poor families try to arrange a marriage for their daughters during bad periods.

Occasionally there was food aid in the area. In 1997/98 once a month food (rice) was given by the Catholic Church to children in Bongo, although quantities were very limited. In Dua the Red Cross gave food to the children, the sick and the elderly once a month. Also the government occasionally does.

Development projects nowadays do provide some jobs and hence income for local inhabitants. The most important of these are WFP, ADRA, CRS and Action Aid, besides government projects.
CHAPTER 6 CHANGES IN LIVELIHOOD STRATEGIES, AND IN PATHWAYS OF PORTFOLIOS OF OPTIONS

6.1 Risk management and risk coping

6.1.1. Introduction

Like in many other dryland areas, farmers in the Bolgatanga study area operate in an economic and physical environment prone to risks and uncertainties. Chambers (1985) describes them as Complex, Diverse, Risk-prone environments (CDRs). To survive in such circumstances, farmers have to evolve risk-taking or risk-avoiding strategies. As cultivators of the land, farmers are uncertain about when the rains will start, when inputs will be available and whether there will be demand or market for their produce. Farmers thus face production and marketing risks which put their livelihood systems under perpetual stress.

We may use three concepts to deal with the way farmers in risky dryland circumstances act to counter the risks they face:

- insurance strategies (by diversifying their livelihood activities and their farming practices as part of those; by maintaining social networks which can act as fall-back possibilities in times of distress; by maintaining linkages with the state and private sector agencies which can also possibly assist);
- coping strategies, when times are bad: the actual behaviour during a drought, or an economic or security crisis;
- adaptation and recovery strategies, after a crisis period

To deal with or cope with the risks in their livelihood systems, farmers adopt what is referred to here as coping strategies. These coping strategies take the form of various tactical and strategic decisions aimed at mitigating the stress when it presents itself. According to Janet Corbett (1988), coping strategies typically fall into three distinct stages, with each one having a distinct response and critical consequences for the current and future survival of household members. The outlines of the three stages are as follows:

- First is the initial use of established insurance mechanisms (such as any changes in cropping patterns and ‘placing’ (or location of agricultural activities), the sale of small stock, reduction of current consumption levels, use of inter-household transfers and loans, migration in search of employment, sale of provisions etc);
- The second stage is based on the gradual disposal of key productive assets once the insurance mechanisms prove ineffective (such as sale of cattle, productive she-goats and sheep, agricultural tools, or mortgage of land, credit from merchants and money lenders etc);
- The third stage is the terminal stage of destitution and distressed migration.

This section examines the various risks farmers face and the livelihood strategies farmers adopt to cope with these risks.

Farmers face numerous risks. Two of these which are central are production and marketing risks. Other risks which will not be fully discussed here include technological, institutional, policy, and general uncertainties or risks. These are however related to the marketing and production risks and shall be mentioned where
they relate to the two.

6.1.2 Production risks.
Farmers face numerous production risks in their farming. The most important production risk facing farmers pertains to yield. Crop failure and loss of animals present farmers with yield uncertainties. The lack of inputs, their insufficient or unfairly delivery play significant roles in this respect. Crop failure often arises from unpredictable rainfall. Rains could be insufficient, in excess or untimely thus resulting in crop failure. The untimely delivery of irrigation water or its insufficiency in the dry season also presents risks to farmers thus reducing crop yields. Other inputs which they often lack or which are in short supply are draught animals, land, labour, seeds, manure, fertilisers, implements, capital, and credit. Farmers, especially small scale farmers who constitute the bulk of the agricultural population, often have small land holdings to cultivate. This is often not adequate to provide enough food to meet the family needs. The system of land tenure in most places, places constraints on the acquisition of land for farming (especially by women). Where such land tenure systems require small farmers to pay huge sums of money or a large part of the harvested produce in a share cropping system, farmers often face risks in feeding the household, putting their livelihood systems under stress. Also, many farmers are poor and do not own draught animals. Because they are poor they can also not hire tractor services, if these are available. The end result is that they are unable to cultivate fields large enough to meet their needs. Also, most farmers plant late in the season because they have no cattle or donkeys, and cannot pay for tractor services. This often results in crop failure as the season has passed before they can harvest. Labour is a critical constraint facing most farmers. Labour shortages often result from rural - urban migration, illness and death of household members. This constraint limits the area a family can put under cultivation. Untimely execution of agricultural practices on a farm such as weed control and harvesting, reduces crop yield; particularly when under stress. Other production risks include the lack of or insufficient seeds, manure and fertiliser. Implements like ploughs, for example are lacking. These problems result because farmers are poor. Lack of capital or its insufficiency, and the absence of credit, does not permit farmers to expand their farms, acquire improved technology, or hire labour. These handicaps put their livelihood system under perpetual stress. The last type of production risk involves pest and diseases which attack crops and animals, thus reducing yields. All these risks work together to ensure reduction in yield of crops and loss of animals. Some of the risk-taking and/or risk-avoiding strategies of farmers are identified in the case studies conducted in Bongo, Langbensi, and Gambaga.

6.1.3 Marketing risks.
Farmers also face marketing risks after they harvest their produce. The lack of storage facilities and the perishability of agricultural commodities compel most farmers to sell produce which they intend to sell at give away prices immediately after harvesting. During harvest time, prices go down drastically. Since the time crops are grown is different from the time of sales, farmers encounter the problem of price differentials. Also, there is often no ready market for their produce. At the macro level, Government imports and exports affect prices of farm produce and this presents risks to farmers. Besides, farmers face risks due to the change in taste of customers. The consumption of foreign rice for example, disrupts the market for local rice and brings down prices drastically. This has led many farmers to abandoning rice production in Ghana.
Production and marketing risks work in hand to put farmers’ livelihood systems under stress. The ensuing chapter examines some of the ways farmers cope with their risks.

6.2 Farmers’ coping strategies during periods of stress
Farmers' coping strategies during periods of stress are reflected in livelihood strategies related to consumption, production, animal husbandry, income, mobility and social networks. Each of these is described in turn.

6.2.1 Livelihood strategies related to consumption
Households who are faced with cereal and other food shortages generally tend to reduce the number of meals; in really bad years to only one meal a day. Many farmers report that they or their (grand-)parents were for the first time confronted with this sign of severe stress “somewhere during the 1960s”. But in other areas (e.g. Bongo) farmers said that stories about periods of severe stress “go back to prehistoric times”. Really poor families tend to restrict food consumption by fasting (days with no meals) and only feeding their children. During bad periods not only the quantity but also the quality of the meals deteriorates: less protein (no fish anymore; less dawadawa, groundnuts and beans), more cassava (konkonte), and instead of a ‘strong’ millet only millet flour water (zom koom), which is normally used as a sour drink besides other food. The importance of wild fruits in the diet increases, as well as guava tree seeds, baobab and kapok seeds, termites, grasshoppers, caterpillars, frogs, mice and rats, lizards and whatever game is still available. Consumption of these food items can be seen as sure indicators of stress. An extreme sign of poverty and stress is the eating of moles. Festivities (when normally rice and maize are being eaten and lots of pito beer are being drunk) are not taking place in these lean periods. Sacrifices (with goats and sheep being slaughtered and eaten) are restricted as well, while poor people try to avoid having visitors, because of their shame of not being able to feed them.

6.2.2 Livelihood strategies related to crop production.
One major livelihood strategy farmers adopt to cope with production risks is crop diversification. These take the form of different crops in a mixture (mixed cropping), mixing crops with animals (mixing farming) or different seeds put in one hole (mixed seeding; often three different seeds). It could also be by planting different varieties of one particular crop so that the farmer has early maturing varieties, next to varieties which can be harvested later. Farmers also diversify their crop by growing crops at different locations. Yet another strategy is to grow specialised crops that are well adapted to the local environment. Crop rotations and shifting cultivation are a part of this strategy. Farmers also use specific technologies like bundling to store water in the field to mitigate dry wells. The use of dried plant parts and weed extracts as pesticides also serve to control pests so as to reduce crop losses. Domestic animals are also treated with plant extracts to control pests and diseases. As a form of insurance, farmers often store grains in silos or drums using local preservatives. Some use approved chemicals like Actellic dust. Seeds for the next season cropping are stored separately, away from grains to be consumed. This is to ensure a supply of seed for cropping. In the past many farmers had special, favoured, plots to produce crops for seed production and no-one would eat from it. Nowadays people during stress periods tend to eat all their seeds as well. They then become dependent on bought or given seeds, increasing the uncertainty of farming. Farmers are very adaptive to the use of new storage technologies. People gradually
change their harvest storage techniques from the traditional granaries to jute sacks and polythene bags, which was said to increase post-harvest losses.

### 6.2.3 Livelihood strategies related to animal husbandry.
Here, diversification takes the form of the farmer rearing different animals. In a herd you find cattle, goats, sheep, donkeys, together; with birds like fowls, guinea fowls, turkey and ducks. This ensures the controlled spread of diseases and therefore deaths. Farmers also tend to specialise in particular breeds of animals where these animals have proved to be more adapted to the harsh environment and still give a relatively high yield. The actual production systems in the Bolgatanga area combine crops with livestock and other livelihood systems. Within the livestock system, various other subsystems - as reflected in the different husbandry practices - are evolved by farmers to cope with stress. In the area of animal health, the indigenous veterinary science shows that animals are treated using various local herbal preservatives (as medicines). This is to ensure the sustainability of their investments, their ‘banks on the hoof’, and hence their major element of wealth. Farmers sell animals for grains when there is food shortage. Animals (and especially cattle) are regarded as assets and are an indicator of their social status. They are critical in most social obligations and yet are the most vulnerable in times of stress. Farmers know this and so make special efforts to protect them as in their housing, feeding, and medication. However, they are the first to be made to fend for themselves in times of severe stress.

### 6.2.4 Livelihood strategies related to income.
The most important income-related livelihood strategy for coping with possible stress is the diversification of sources of income. In addition to the normal crop production and animal husbandry sources, farmers tend to take many off-farm and non-farm jobs to give them different sources of income. Thus a farmer may fish, hunt (also hunting with bush fires), or gather fruits, to supplement their regular agricultural activities. To mitigate stress, farmers also rely on remittances of food aid (from family, friends, neighbours, or from external sources such as Government agencies or NGOs), and credit. Food aid is obtained from members of the clan, tribe or extended family. Remittance contributions come from family members who have taken up paid jobs in the cities or villages elsewhere. As a matter of traditional community principles, no member of the community is allowed to die of hunger when another can still afford to eat. Being each other’s keeper is a very strong moral obligation among rural communities in the research area. This bond compels them to share even their poverty during times of severe stress. Merchants, philanthropists, and money lenders give credit to farmers to finance their farming as well as to face harsh conditions. This credit comes both as kind and as cash. Sometimes, it is the equivalent of the request that is traded (maybe the giver does not exactly have what is requested). Reliance on these income-related livelihood strategies to cope with stress is on the increase as farmers are getting more and more distressed, and poorer. In places like Bolgatanga Town poor people have recently started to sell drinking water, and especially during periods of water shortage due to drought this becomes a lucrative activity.

### 6.2.5 Livelihood strategies related to mobility.
The mobility of labour is one livelihood strategy that farmers adopt during periods of stress. The able-bodied village-folk are often the ones who temporarily out migrate. Farmers (often mainly the young men) thus move to nearby villages where they can
perform as wage labourer either in the agricultural or non-agricultural sector. Often they do it on and off and often for short periods only. Most of these migrants may return to their villages when the rainy season begins so that they can farm at home. There is also a category of people who out migrate when they have finished cultivating their land, when there is a stress situation, to work elsewhere during the dry season. These are the seasonal out migrants. They are often the ones who take part in rural-urban migration; a typical form of out migration which sees farmers moving into big towns to take up any available jobs. When they decide not to go back again, the third category of permanent out migrants result and they often end up in communities in the big towns. There is a fourth category of mobility. In the case of herdsmen, the family moves with their herd of animals in search of fertile land for grazing or water points.

Remittances are clearly on the increase and they become quite important as part of households’ portfolios. According to respondents there were very little remittances twenty years ago and people who had migrated got more assistance from the home area than they gave in return. After about 1980 things changed and urban areas began to ‘subsidise’ the rural areas through remittances, and especially as ‘Christmas gifts’ brought home. Specifically mentioned as very much favoured nowadays are remittances sent by Ghanaian soldiers coming from the research area who are part of UN peace keeping forces elsewhere in the world. There are also quite some households who get pensions (after working in the mines, the cocoa plantations and as service men).

6.2.6 Livelihood strategies related to social networks.
Farmers use various support mechanisms. Some of these take the form of sharing at various levels from neighbours to friends, relatives, money lenders, members of a certain lineage, clan or and other groups. Marriages are another method of establishing social networks that become handy during periods of stress. During periods of stress deferment of bride prices often takes place; it can be seen as a flexible credit. In-laws are morally bound to help each other when in need. In periods of stress non-family members of households are sent away first (if possible to family members elsewhere) while soon after that young men are expected to take care of themselves (and help the family), and they are being sent to more well-to-do family members elsewhere, if possible. Betrothals (of daughters mainly) are part of this arrangement, and sometimes suspended marriages are arranged in order to cope with stress. In periods of food stress people first tend to turn to their maternal uncles for support. It is accepted practice to defer funeral ceremonies (which are symbolic and can take place long after the actual burial) until better times, and often it is accepted to combine several of these funerals into one.

The link between families and relations in the urban centres and the village has become very important. In addition to the regular submissions that are expected, the physical movement of some family members to join those in the urban areas does occur - sometimes such movements become permanent. It is a moral obligation for those already living in town to assist their next of kin when they are joining them in the city. Certain functionaries (also those having Government or NGO jobs) become enrolled in social coping networks. Either by their previous relations or by the fact that they once received a favour from the community, they are compelled to assist during any crisis. Reciprocity is a key aspect of the culture and this must be seen to be demonstrated. Some distressed persons might be drawn into certain social networks as a survival mechanism or some form of indebtedness. Lastly, the traditional institutions or their leaders have networking relationships with the people they are supposed to serve. They
are also often relatively well endowed compared to the average person in the village. By virtue of their structural position, they have the responsibility to assist during periods of stress, and this they do in order to secure and maintain the existing social networks. As long as there are people in the community with enough food, sharing is still a desired social practice and a sure sign of status. As one respondent says: “if people die of hunger, you can be sure there is hunger in the whole community”.

An exception exists for middlemen/traders. They are generally outside reciprocity arrangements and therefore can function as such. When things are really bad they are the ones who can still provide the community with food (often on credit, but at ‘commercial rules’) and hence avoid a complete breakdown of the food security situation.

6.3 Institutional/collective responses in case of drought
The important institutions that deal with drought are:
i) The Tindana (traditional land ‘owner’/Earth Priest). They are traditionally responsible for natural resources. They are also custodians of these resources so they are called first in case of trouble. This is linked to the consultation of soothsayers and bringing sacrifices;
ii) The Chief and his Elders. They consult the soothsayer and he tells them what sacrifice to be made and the particular god or spirit to give the sacrifice to. The Chief then takes this message to the community through their sectional leaders and purchases the items, to make the needed sacrifice;
iii) The rain maker (sadana/sabonega) is also hired to ‘make’ (or ‘call’) rain; he uses herbs and sacrifices to pray to their gods for rain;
iv) The Moslems among the community pray to Allah for rains;
v) The Christians among the community also pray to God for more rain;
vi) Individuals also do offer prayers and sacrifices to various deities.

The social control system includes respect for the elderly and proper bride wealth arrangements. These loyalties weaken in bad years. Some individuals fail to observe them altogether. It was reported that quarrels among couples are frequent in bad years. Parents also lose total control of their children as most of them travel outside home. Because there is an increase in social mobility, in the eyes of many respondents many vices are brought back into the family that give problems to cultural law and order.

Credit arrangements with the formal banking system are only available for the happy few. Banks exist in Bolgatanga, Bawku and Navrongo, but the large majority of farm households never make use of them for getting loans (some do get their remittances and pensions through the formal banking system, though). Formal credit is also regarded as expensive. Informally there are lots of credit arrangements; in both cash and kind and with flexible conditions. Security is often provided by the family or clan, and the ‘family name’ works as collateral. Shop owners and traders are key players as well and during times of stress they perform important buffer functions. Some NGOs nowadays provide credit, but many people in the area suggested that “they always deal with the same people”.

Food aid by government and NGO institutions is a relatively recent phenomenon. It did not exist in and before the 1960s. In 1983 a major food aid operation brought in maize for the first time. Many key people in the area were against food aid: it does not reach
the needy; it becomes an instrument in political and ethnic brokerage; it creates an atmosphere of mistrust; it creates dependency (“people become lazy”) and it kills indigenous coping strategies. Some people criticised the paternalistic ways the existing aid agencies in the area organised their activities (the IFAD-funded activities, the World Food Programme, the food for work activities of ADRA, and the activities of the Catholic Relief Services). Another criticism is the type of food that is being distributed. Quite a lot of it is (poor-quality) rice, while rice is generally regarded as the preferred food for festive occasions. People become ‘addicted’ to rice and fail to produce their own traditional foods. In 1997 people had to buy the food aid and as people without any cash left were forced to sell their last goat at a give-away price this was quite a windfall for livestock traders in the area.

People with formal leadership positions in the area are generally in a better position to use their political office or their position as a civil servant to cope with a bad period. As one key person said “corruption is simply the change of loyalty from the government, a donor or an NGO into loyalty to yourself”. On the other hand leaders are brokers, and they are often challenged by their clientele to solve their difficulties, particularly during bad times. So the phrase “loyalty to yourself” in practice often means loyalty to a huge group of people who all claim to be entitled to some form of help.

6.4 Individual responses in case of drought: results of a field study
A preliminary study was done, with field level investigations in Bongo and Gambaga areas.

Methodological remarks
The interview targeted farmers on a genealogical basis with core and general questions in the form of a checklist. In the case of the Gambaga area, the farmers reached were mainly from Langbensi township and its immediate environs, and Gambaga and 12 families (10 from Langbensi and 2 from Gambaga) were interviewed, the composition of which gave a total number of 87 individuals, and a focus group discussion was also conducted of 17 members, putting the grand total at 104 respondents. For Bongo, 12 families were also interviewed with a total of 190 individual members (of this group 80 were interviewed) and focused discussions with another 20 people. In both areas the families were deliberately selected to include poor, middle and rich groups. In Langbensi/Gambaga three families were locally regarded as rich, five as middle-income level and four as poor. In Bongo three were relatively rich families, three middle income and six poor. The potential respondents in the interviewed families fell under the following categories of people.

<table>
<thead>
<tr>
<th>Category</th>
<th>Langbensi/Gambaga</th>
<th>Bongo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand fathers</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Grand mothers</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Sons (fathers)</td>
<td>27</td>
<td>34</td>
</tr>
<tr>
<td>Daughters (mothers)</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>Grand-sons</td>
<td>8</td>
<td>44</td>
</tr>
<tr>
<td>Grand-daughters</td>
<td>2</td>
<td>48</td>
</tr>
<tr>
<td>Son's wives</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>Non-family respondents</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Focus group</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>104</td>
<td>210</td>
</tr>
</tbody>
</table>

The data was gathered by students from Accra assisted by some literate people living in the area. This combined interpretations for the non-natives and direct interviewing by those who speak the language. It also combine data collection by strangers and by familiar persons. All the data gatherers were given the
same level of preparation and guidance from the supervisors from the University of Tamale. This preparation was coupled with visiting them in the field, discussions about outcomes and back-stopping. Since all those who were gathering the data had to live in the communities, interviewing was combined with participant observation. Day time interviews were also combined with late evening discussions. Formal and informal discussion techniques were used. Time lines, Trend Analysis, Life Histories, and Mind Mapping were the social survey tools that were supported by direct questionnaire interviewing and the use of check lists. The list of areas or themes to be investigated was separated into “core” and “periphery” questions. The core questions under the various themes shown on the checklist were coded as (a,b,c, ..... ) to offer ease of interpretation.

6.4.1 Farmers’ views on drought experiences
On the average, most respondents said 1997 and 1988 were the most severe droughts of recent memory. It was realised that the farmers had forgotten the exact dates of past droughts. Using a combination of Time Line and Life History and by linking them to events, it was realised that also 1990, 1970, 1962/63 and 1946 were bad years or drought years. Other years mentioned frequently were 1984, 1978 and 1976.
The main problems during these drought years have been;
(i) food scarcity as a result of crop failure
(ii) water shortages
(iii) animal deaths
They were also forced to accept new food crops e.g. maize in 1946 and again in 1997, and out migration on both a permanent and a temporary basis was one of the obvious results.
Many farmers in the area use age-old cultural responses to droughts: they first rely on the tindana, who, as earth priest, is expected to bring sacrifices to nature. If people begin to fear that this does not bring the expected results they go to the elders and the chief who consults a soothsayer. People might also form prayer groups to beg for rain.

6.4.2. Water responses
River water, bore-holes, dams, wells and collected rain water (during rainy seasons) were cited as the normal sources of water for humans and animals in the area. It must be emphasised that, proximity determines the sources people use. Droughts generally mean that water sources nearby dry up and people have to walk ever further to collect water. They also accept water that is regarded as polluted or dirty. Mostly, the water is used for cooking, drinking, bathing, construction, washing, watering of farm animals, dry season gardening, and on a few occasions, for commercial purposes (brewing of pito ("dazio"). Droughts mean that people restrict their use of water to a minimum, because of the time it takes to collect water. Sacred water bodies were also mentioned which used to serve as sources of fish. These water bodies have dried up now (after the drought of 1997). Before they dried up, they were constantly abused because of need for water during stress periods.

Mostly, the dam water is only used for watering farm animals and construction, because it is highly polluted. The pollution came from the very beginning of the dam since it was purposely constructed to water farm animals. As a result, care was not taken to keep it clean. At Gambaga, it also came to light that the bore-hole there is not used for washing because the water is perceived as hard and because of that it wastes soap. However, for drinking and cooking, most people preferred the bore-hole. During the drought of 1997 it proved reliable.

Occasional problems with water sources include drying up of wells and streams/streams/
and breakdown of bore-holes. These problems were severe during droughts e.g. in 1997 and at the peak of any dry season (harmattan) i.e. between March and May. Solutions to the above-named problems were mainly given as i) contribution on a sectional basis to repair the bore-holes, and ii) digging of temporary wells within the stream/river course. Some farmers blamed the tsetse eradication programme for the drying up of streams, because farmers started clearing the bushes in the micro water catchment areas for cultivation purposes.

Generally, the respondents were of the view that there were no problems with the sources of water in the past because the rainfall situation was regarded as better than ‘today’ (which was of course influenced by the fact that the interviews were held after a drought. The streams/rivers and wells were not drying up in dry seasons like today, people said consistently. With regard to the future water situation, there were mixed responses. The old people would mostly not want to comment. For the future, the rest agreed that the rainfall situation would be worse, but water for domestic purposes will not become a problem, they think, because of the construction of more bore-holes, household wells, and the extension of pipe-borne water will save the situation. People feared the future water situation for their animals, though.

6.4.3 Energy related issues
Firewood and charcoal are the major sources of energy for the two communities. Other sources are electricity and LP gas for the small centres of Gambaga and Bongo, cereal stalks and cobs, kerosene stoves, and solar energy. In the most densely populated areas (e.g. Bongo) people have started to use animal dung as a source of energy (at the expense of fertilising the soil). The energy is used for cooking, drying, heating, lighting and warming. Occasionally people mention ‘spiritual energy’ and this is associated with healing; the application of heat or fire for cures of certain diseases. Solar energy (sunlight) is generally used for drying farm produce and washed clothing. The rest are used for cooking, and firewood and charcoal are the most frequent source for cooking.

Most of the respondents said that they now use less energy (firewood) by putting the fire off as soon as they finish cooking. Some also use fewer sticks at a time for cooking. About 1/3 of the respondents however, reported no conscious effort to use less energy, since they still see firewood as easily available.

Bad rainfall years make firewood, their main sources of energy, abundant. A few people said they have their firewood stolen, since sales (and also theft) are intensified during bad years to buy food.

Almost all the respondents said there was no problem with energy (firewood) in the past. Today, they are experiencing a growing firewood shortage as reflected in the increase in travel distances. They also say there is an increased competition in the use of crop by-products for livestock feeding, fertility regeneration and cooking. Increasingly, more of the by-products are put into energy use. They claim that initially only Guinea corn (sorghum) stocks were used for fuel but now millet stocks have been added. Charcoal has also come into use but it is expensive because they have to compete with the nearby urban centres. They cited deforestation and expansion of farm holdings as a result of population growth to be a major threat for the future. Hence the majority of the respondents claim the future will be worse than now. A few said it will be better with
the introduction of substitutes like electricity and LP gas.

Strategies to combat the future scarcity were perceived to include tree planting, natural regeneration of trees, selective extraction, more efficient use of what they have already, stopping the bush fires and to have more sacred lands such as groves and shrines that are been lost as a result of construction and human activity.

6.4.4. Food habits
TZ (a Nigerian expression, from ‘tuo zafi’, it is a hot porridge of millet and sorghum), 'gorba' (bean cake), rice, beans, bambara beans, groundnuts, porridge, yam, kenkey, banku, nwasintiri (maize balls), "bito" (leaves mixed with maize or millet flour) and vegetables (for the soup) are the main dishes people normally eat. However, every respondent mentioned TZ first, and they also regard it as the commonly eaten food in the area. Food eaten in times of abundance are TZ, "gorba" (bean cake), rice and yams. People were asked to rank their food during normal years and during droughts. With the ranking, it was realised that shifts are made in bad years. These take the form of limiting the quantity of food and changing the combinations of ‘normal’ food, especially at the initial stages. The introduction and acceptance of what is regarded as ‘inferior food’ comes later, when the crisis deepens. People often mentioned "Konkonte" (cassava flour) as the most important example of crisis food. For Langbensi and Gambaga the quality shift is from maize, then millet, then white sorghum, then red sorghum and cassava last. For the Bongo area it is millet, then white sorghum /maize, red sorghum and then cassava is again last.

Dawadawa, sheanuts, berries, ebony (fruits and leaves), oak fruits, and baobab fruits are the fruits that are commonly eaten. Dawadawa, shea and baobab fruits are preferred fruits, then berries, ebony and oak fruits much later in the hierarchy of preferences. Eating the last is a sign of crisis.

Additional food or cash to buy food is acquired in the following ways (this is arranged in the order of which is done first):

i) Sale of poultry; fowls and guinea fowls.
ii) Sale of firewood or charcoal, or groundnut vines or stocks.
iii) Money from petty trading especially by the women and also sale of cash crops (cotton and groundnuts).
iv) Sale of food crops: cereals also.
v) Sale of small ruminants: sheep and goats.
vi) Remittances from family members outside the area.
vii) Some members also travel to work and send food items home (mostly they go to the south)
viii) Sale of large farm animals: cattle.
ix) Sending family members out to live with others elsewhere
x) Acquiring food aid/loan.
xii) Sending non-family members away.
xii) Go for wild sources: irregular fruits and leaves.

According to the information gathered, strategies from (viii) downwards are regarded as signs of stress and strain and if these begin to appear in poor families also the others begin to worry. Also the agricultural staff often refer to these observations as stress signs.
The respondents said that most of the wild foods and additional food acquired from elsewhere come in during the peak of the lean reason. This is often between March and June and especially in April and May when planting has just been done and there is no food left from the former harvest. In times of little rain, off season, and in drought years, people eat small quantities of TZ, more wild fruits, and konkonte, as well as plenty vegetables from wild plants or trees.

6.4.5 Social security responses to droughts
According to the responses, the wealthy families had an increase in family size during bad years (extended family members joined). With average and poor families, some had no change and others had a reduction by compelling some members to move out to other distant relations or to sell their labour elsewhere. It is also because, in most of the bad years, some members, especially the males, travelled to work in the south to bring food/money home. This shows a conscious expulsion of extended family members due to drought conditions.

Celebrations are all observed, even in bad years. It is rather the ‘extravagancy’ that goes down. Example: a fowl may be sacrificed instead of a goat/sheep. However, with performances such as funeral and marriage rites, there are occasional postponements until good times are back again. There are mentioned instances of early bethrothedness, receipt of food favours instead of the actual brideprices. There is also exchange of productive labour as temporary indication of the desire to marry. But these are said to be few.

The indigenous social security arrangements in the society are:

i) A deferred payment system in kind linked to reciprocity arrangements. This already exist but gets protracted during periods of stress;

ii) A loan system of both grain and occasional cash. This takes two forms; one without interest from the relatives (extended family) and the other one which carries an interest of 100%. All are payable in subsequent good years;

iii) Labour is also exchanged for food;

iv) Marriage arrangements are entered into as social security arrangements, e.g. the wealthy get the poor bethrothed; the rich are generally marrying the rich, assisting an upper layer of (traditional) society with a higher overall security in times of stress;

v) A closer relationship with traditional institution. This mainly manifests itself in an increased linkage with traditional spiritual institutions.

Most of the respondents were of the view that the above-mentioned measures have prevented starvation and also bring harmony into the society. In some bad years, though, many make use of assistance by churches and governmental food aid.

6.4.6 Agricultural responses to drought
Most of the poor families do not measure what they get from their farms in a year. They are affected heavily during bad years since in most cases seeds become a problem. The absence of seed is one sure sign of stress. On the whole, people report that a good year’s harvest is about four times higher than a bad year’s harvest. Crops that were said to be relatively good in bad years are groundnuts, cotton and millet.
The farmers’ agricultural responses in bad years are by:
i) Relying more on legumes than on cereals for immediate food needs, and exchange ‘cash crops’ for food or sell them for cash;
ii) Shifting their planting season (late planting);
iii) Refilling, transplanting, and replanting altogether;
iv) Use drought tolerant crops and early maturing varieties (especially their traditional varieties);
v) Eating more of crops prematurely on the field before the harvest is due;
vi) Go out of production and sell their labour for cash or food.

Concerning the animals the farmers’ responses to drought are:
i) They are sent to places where water and feed may be available e.g. the White and Red Volta and various resilient streams and rivers;
ii) Store beans and groundnut vines for them after harvesting;
iii) Allow the animals to roam wide in search of feed and water;
v) A conscious choice for small ruminants;
v) Reduction of the herd size through sale.

On the average, most of the animals are sold out, to re-stock in good years. Effort is also made to preserve waste water used in the house for the animals and animals normally hover around these areas.

The respondents were conscious of the fact that irrigation will save the crops and livestock in drought years but they do not have the water bodies to embark on irrigation. They suggested the use of early maturing crops, late maturing crops and a combination of the two. Other measures that were mentioned are multi-cropping, relay-cropping, and inter-cropping. Other peripheral responses also included the abandonment of farming to engage in other economic activities because of unreliable rainfall and resultant poor yields - i.e. leaving agriculture altogether.

6.4.7 Non-farm local responses

The respondents were all farmers or had been farmers before. The farming activities are mainly crop cultivation (millet, sorghum, maize, cowpea, bambara beans, groundnut, vegetables and cotton) The animals kept are cattle, sheep, goats, pigs, fowls and a few donkeys. The non-farm activities include petty trading, artisan activities and cottage industry.

The men engage mainly in land preparation, weeding, hunting and building. The females also do the planting, harvesting, petty trading and they are involved in weeding, rearing animals, household chores and cooking. Nowadays most of the children go to school and learn their gender roles. Some of the school-age children do not go to school because their parents say they cannot afford to send them or they have to herd animals.

During the rainy season, farming is the dominant activity i.e. weeding, planting, and later harvesting. Petty trading and cottage industry (weaving) is also done but on a small scale.

Petty trading is intensified in the dry season especially by the women. Repairs of old
buildings and the building of new houses are carried out during this period and hunting is done by the men. Craft work is also undertaken as well as dry season vegetable gardening. The women cut firewood to store for the next raining season.

The volume of activity goes down during a drought including farming and petty training. Most people take a rest at home.

6.4.8 Demographic responses

Most of the respondents were married. The general indication is that a large family size was still very much favoured. The highest family size recorded was that of a grandfather at Gambaga with 34 children, while Bongo families had the highest median of 10 children. This section also revealed that infant mortality had been high. For example a grandfather lost 11 of his children.

The respondents also said that low births were registered in bad years. Asked further, they said that, bad years did not directly influence infant mortality or delivery rates, but did so indirectly because of food shortages.

The small compound/nuclear family had a membership ranging from four to twenty (4-20). The respondents in most instances estimated the complete extended family as ranging from fifty to eighty (50-80).

The predominant activities of the extended family were reported to be farming with trading and civil services following in the order or importance. The young members are mostly students and apprentices.

The average number of wives per member of the extended family is estimated to be two. However, most of the young members (the grandsons) had either no wife or only one wife. The old men have more wives than the young men. It was also revealed that the tendency to marry more wives is directly related to one’s age (the older a person is, the higher the number of wives). This is not a function of educational status or wealth. Most of the grandfathers (old men) have four wives.

A few of the extended family members reported to have travelled to far-away places. The main destination had been southern Ghana and neighbouring states (Togo and Burkina Faso). They were reported to be mostly farmers and traders. There are however a few civil servants. Normally, they visit and go back. On arrival, most of the men stay in their family house and the females also stay with their husbands. A small number of them stay in their own houses upon arrival. It was realised that, they were mostly farmers before they left home. The motivation to travel had generally been the search for greener pastures.

6.4.9 Some concluding remarks

The interaction with the farmers reveals that really severe droughts or famines had not hit the community, at least not in recent times. Even the recent events of 1997 were not seen as severe enough to regard them as a crisis situation. Their main problem had been that of poor distribution and irregular nature of rainfall, coupled with population pressure on limited farm lands. It is a fact that farming is 100% rain fed - either directly
or indirectly. In drought years, the seasonal gardens fail, because the water sources dry up and watering of plants/crops becomes impossible. The general environmental context of the community makes firewood, which is their main source of energy, difficult to come by. According to the farmers, the travel distance for firewood has more than doubled in recent years. The main problem, they say, is caused by the increase in population, overcultivation, and cutting down of trees for charcoal and rafters.

Respondents claimed that hitherto traditional institutions (Chiefs and the Tindanas), the strengths of their ancestral spirits (the soothsayers and medicine men), and the body of indigenous knowledge they had, enabled them to survive stress situations. Old people fear that this is now all dying with the changing generation. “If nothing is done to re-discover this heritage”, Grand Father Akkare Adongo says, “the next severe stress will find us all in our graves; for we cannot cope with it”.

The responses received from the farmers at Gambaga showed a slight difference in the water and agricultural responses compared to those of Langbensi in the same District. The water situation at Gambaga is worse in bad years than that of Langbensi and its environs. The travel distances in Gambaga to sources of water in bad years are much further. The general observation was one of differences in micro-environmental and edaphic factors. It is therefore suggested that further probes into the impact of climate change in dry lands should take into consideration the micro-climatic environmental and edaphic factors.
CHAPTER 7 CLIMATE CHANGE?

7.1 Are there indications of climatic change in the study area?
It is evident that a comparison between the rainfall situation in the middle of this century with the period 1970-1990 reveals a major climate deterioration, but that after 1992 the situation improved again, until the 1997 drought which was generally seen as problematic, but not causing a major crisis. The farmers who were interviewed generally see a lot of evidence of long term climatic change. They observe a change in the natural vegetation and in the relative importance of some trees (e.g. the gradual disappearance of the economically important Dawadawa tree). They also observe a lower water reliability and a shift in the planting season. In the past many farmers already started in April, or even late March, but many have changed to May or even June. The early maturing millet varieties are on the increase, late millet is disappearing, and in the mix of white and red sorghum the more drought-tolerant red varieties become more important. People say that the traditional signs of the start of the rainy season are no longer reliable: the behaviour of birds, and ants, the changing of the winds, the coming of new leaves, the water tables in wells, the harvest of dawadawa trees. People are confused nowadays. Also they regard the rainy season as more uncertain and shorter than before. People who used to rely on riverbed cultivation after the rainy season are nowadays regularly confronted with dry riverbeds that are ‘dead’. Farmers also observe a growing importance of sheep and goats and a diminishing emphasis on cattle, who are seen to be confronted with an increasing ‘feed stress’ unlike sheep and especially goats.

On the other hand cotton is observed to be on the increase, especially in the southern part of the study area, near Langbens.

7.2 What were the driving forces of land use change?
The growing importance of cotton cultivation could be seen as part of a ‘southern shift’ of the cotton belt; and one of the consequences of climate change. What used to be ‘normal’ in southern Burkina Faso now becomes ‘normal’ in northern Ghana. However, it is too easy to see this as a straightforward ‘proof’ of climate change. The increasing activities of cotton factories in the area, the recent attention it gets from government agencies and in ‘public opinion’, and the better access to cotton inputs are all factors which can also be seen as important.

Many farmers have been trying to cultivate more land during the last decade; where possible (so not in Bongo and in the most densely populated parts of the Gambaga area) holdings have been expanding. This can be regarded as a response of farmers to higher risks, but it can also be seen as a move towards more commercial agriculture and a response to generally more favourable agricultural market conditions for Ghana after the economic crisis of the 1970s and ‘80s had ended.

7.3 What are the changes in coping strategies with regard to drought?
It can be observed that people are changing the composition of livelihood portfolios by relying more on non-agricultural sources of income, by adding more market-oriented agricultural activities (cotton, onions, tomatoes) and by changing their food production strategies to more drought-adapted varieties on the one hand and to less water-stressed fields on the other hand (where they produce vegetables and rice).
Animal husbandry is changing as well, with relatively more emphasis on goats, pigs and fowls.

**7.4 What will probably happen in case of (further) climate deterioration?**

If the temperature will increase with on average one or two degrees and rainfall will deteriorate with 20% the area will clearly become semi-arid (P/ETP < 0.45), with rainfall between 700 and 800 mm. A probably shorter and less reliable rainy season will result in an average drought risk situation between 2 and 3, with a higher chance of drought risk situations of 4 and 5.

Depending on market price developments for animals, groundnuts, onions, tomatoes and cotton in the southern parts of Ghana it can be a possible strategy for farmers to rely less on autarchic food production at household level, and to try and diversify agricultural and non-agricultural risks. The southern move of the cotton belt could mean a major challenge, with secure marketing arrangements and price levels as an important prerequisite for gaining farmer’s trust. With cotton and groundnuts as dryland crops in non-valley fields and rice, tomatoes and other vegetables in valley/riverine areas the area could be expected to move away from a strong reliance on the millet-sorghum-legumes complex. With more emphasis on higher-yielding, but drought-tolerant millet and sorghum varieties the most densely populated areas could be assisted in a necessary intensification process (higher average yields per hectare). The farming experiences and practices of immigrant farmers from Burkina Faso can be trusted to show interesting possibilities.

**7.5 How to mitigate the climate change risks?**

It is evident that increased chances of low harvests from time to time will mean that more farm households will be confronted with inadequate cereals from their own fields to get them to the next harvest. Old traditions might be revived to try and store harvests from excess years and this means that areas where people still can expand their fields (within Upper East the areas in between the Voltas, and areas towards the west and south; and in Northern Region considerable areas in the Nasia and Volta valleys) should be supported in producing and storing more cereals. For the densely populated areas (like Bongo, Bawku, Gambaga) market-led forms of intensification might be a solution, supported by increased forms of irrigation (water dams) and water harvesting techniques. In these areas it is obvious that agricultural depopulation should be encouraged, either by slowing down population growth, and/or by outmigration, more remittances and more non-farm income. It would probably be a wise decision to encourage more children to go to secondary schools, especially in the most densely populated areas, as a preparation for either outmigration or non-farm activities in the area itself. The recent approach to sell food aid in stead of giving it out for free or as ‘food for work’ should be encouraged, with exception of arrangements for old and sick people. Traders perform key roles in a more commercially-oriented food acquisition system and the infrastructure for trade should be safeguarded. Food aid arrangements can easily undermine existing systems of commercial exchange of food.

**7.6 What research activities are most urgent to be better prepared for climate change?**
During the 1999 workshop in Bolgatanga the following suggestions were done for further studies related to climate change observation and mitigation:

- Is it indeed true that indicator species in the natural vegetation show that ‘normal’ species are disappearing and that more ‘northern’ (Burkina) species are becoming more important? What commercial/useful species of the zone 200-300 kilometres more to the north could be developed more rapidly in the Bolgatanga region?
- Is it true that hydrological features are having a lower quality than before (less water in the Volta and other rivers; seasonal rivers drying up more rapidly; groundwater tables going down; dams drying up)?
- How important is the influx of immigration from Burkina Faso and if engaged in farming, how do their farm practices differ from those of the indigenous population? Are farm practices of immigrants from the north more appropriate for drought conditions? Do immigrants from the north generally get lower quality land?
- If indeed micro-differences in terrain are so important for farmer’s strategies it would be good to start in-depth research over a number of years in which a few farmers with diversified plots are being followed with regard to their actual land use practices, their harvests and the rainfall conditions.
- If farmers tend to drift to riverine and (ex-)marshy areas what does this mean in terms of crop risks (e.g. floods; crop diseases) and human health risks (water-borne diseases)?
- More research is needed to explain the differences in yields between farmers and to explain the seeming incompatibility of rainfall (drought risk) data and harvest data over years.
- Is it indeed true that ‘wealthy’ farmers are those who never experience food shortages using their own fields or is there a category of farmers on the increase who specialise in more lucrative commercial crops at the expense of autarchic food security at the farm level? How risky is this strategy in terms of food stability and income variability?
- It is important to find out if land tenure changes result in land use changes and changes in land management practices; do ‘private owners’ take more risks? Do they experience a higher yield variability between bad rainfall years and good rainfall years?
- Is it indeed true that the non-agricultural element in livelihood portfolios is increasing and that this is becoming an important element of food stability and food security at the household level?
- If it is true that migrant (remittancy) income becomes more important, how important is labour migration for what types of households? Is the image correct of multi-location, intra-lineage assistance in dire times or could lineage network analysis indicate a more restrictive mutual support system?
- Is it true that state and NGO food aid kills initiative and severely threatens existing mutual assistance patterns?
- Is there a changing cost-benefit situation with regard to wood/charcoal versus other energy sources? What are the experiences of forest rehabilitation (e.g. in shrine and grove areas; on hillsides; on watersheds)?

The survey research revealed a number of issues which should be covered in a more in-depth follow-up study, if that is going to take place:

- the role of sacred water bodies in environmental preservation; their role in
biodiversity;
. the institutional structures and organisation to regulate water use during stress situations;
. the order of use of ‘strategies’ during stress and the order of loss as a result of stress;
. Regenerative efforts after one stress period to pre-empt losses afterwards;
. monitoring change e.g. the use of resource mapping over a period to empirically ascertain change.

In general it is recommended to start monitoring studies (e.g. by using the same SARI-villages) to find easy early warning indicators of stress by combining efforts of the Ministry of Energy, Ministry of Food and Agriculture, Ministry of Lands and Forests, the Meteorological Service and strategic persons in the region.
CHAPTER 8  BIBLIOGRAPHY AND REFERENCES


GLASOD, 1990 to be added


FAO, various years, Production yearbooks, Rome


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Information for chapter 2 was provided by Edward Ofori-Sarpong.

Information for chapter 6 was gathered by David Millar, Peter Osei-Adjei, Kwadwo Owusu and Petra Rijkes.

In March 1999 a workshop was organised to finalise this paper and to organise a discussion about the conclusions, which are summarised in chapter 7. The workshop was hosted by CECIK in Bolgatanga and the venue was the Catholic Social Centre.

Written workshop contributions were:
Ton Dietz and Saskia Jordens: preliminary report about the Bolgatanga cell
Saa Dittoh: the Bolgatanga Regional Cell: Location
Saa Dittoh: the Bolgatanga Regional Cell: the Non-Farm Economy
David Millar: Climate Change and Farmers’ Coping Strategies
Francis Obeng: Climate Fluctuations in the last 40 years for selected stations in Northern Region of Ghana
Edward Ofori Sarpong: State of the Economy; Physical Environment
Marcel Put: Analysis of Rainfall Data collected by weather stations located in Ghana, cell 181 and 182
Petra Rijkes: Options for Bongo District
Richard Yeboah: Impact of Climate Changes on Water Availability, Agriculture and Food Security in Drylands, with Focus on Northeast Ghana (Upper East Region): Introduction, Fluctuations/Trends in Agricultural Production, Food Security, Population, the Rural Economy
These have all been integrated.

Participants at the workshop were:
Beatrix Bawah (MOFA, Bongo), Samuel Donkoh (UDS Tamale), F.M.Zakari (Environmental Protection Agency Bolgatanga), A.B.Dery (MOFA Bolgatanga), Peter Atoeyure and Richard Aniah (Gowrie-Kimkwa Community Bolgatanga), Aduku Moses A. (Bongo Agroforestry project), Kwadwo Owusu and Peter Osei-Adjei (University of Ghana, Legon), S.Y.Apiiga (MOFA Bolgatanga), David Millar, Saa Dittoh, Francis Obeng, Richard Yeboah (all: UDS Tamale), and Annemieke van Haastrecht and Ton Dietz (University of Amsterdam). We would like to thank them for very fruitful discussions.
The programme of the workshop was as follows:

March 22, 1999:
David Millar  Welcome address
Ton Dietz  Portfolio of options
David Millar  Response and debate
Richard Yeboah  Demography
Francis Obeng  The rural economy
David Millar  Coping strategies: results from the surveys

March 23, 1999
Saa Dittoh  The non-farm economy; Indicators of climate change
Ton Dietz  Rainfall and crop yields
Working Group 1  Changes in food demand and other coping strategies (written report by F.M. Zakari)
Working Group 2  Market changes (report by Ton Dietz)
Working Group 3  Land use changes and How to mitigate climate change (written report by Annemieke van Haastrecht)

Reporting and discussion
David Millar  Points for further research

March 24, 1999
Fieldwork visits in the Bongo and Vea areas

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