The Dagara farmer at home and away: migration, environment and development in Ghana
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Citation for published version (APA):
The Malthus-Boserup curve and migration in Northern Ghana

Abstract
The impact of rural out-migration on agricultural development in migrants’ source areas has been studied extensively, but with very mixed results. A common problem in these studies is reverse causality. This paper highlights the role of population density as a mediator in the relation between rural out-migration and agricultural development. It links the academic field of migration and development to the Malthus-Boserup debate about population growth and agricultural change. The central thesis is that one has to know where a region is situated in the transition to more intensive land use to understand the impact of out-migration on agricultural development. Once the intervening role of population density has been acknowledged, more cogent statements can be made with regard to directions of causality. Demographic and agricultural production data of twenty-four districts in Northern Ghana are used to illustrate this. A U-shaped ‘Malthus-Boserup curve’ between population density and agricultural productivity is discernible in Northern Ghana. A negative correlation between crop yields and out-migration is found in the twenty districts situated in the first half of the curve, where Malthusian tendencies dominate. After controlling for the effect of population density it is shown that low crop yields are a cause and not a consequence of migration. Furthermore, there is a positive effect of out-migration on farm sizes and output per capita. Out-migration in Northern Ghana leads to agricultural extensification. In districts at the bottom of

1 A shorter version of this chapter has been submitted for publication and is currently under review.
the Malthus-Boserup curve, large-scale out-migration removes the incentives for a necessary intensification of agricultural practices.

Introduction

Marginal rural areas in developing countries are important migrant source areas. Stagnant agricultural economies and a lack of non-farm income sources are common push factors in these migration flows. The perceived opportunities in urban areas, more favourably located rural areas and places abroad exert a pull on potential migrants. A common objective of these migrants is to amass some wealth or at least improve their livelihood security. Although levels of success vary, most migrants do achieve some improvement in their living standards (UNDP 2009). The impact of rural out-migration on development in migrant source areas is more contentious. In the 1950s and 1960s neo-classical economists and modernization theorists were optimistic about the effect of out-migration in areas of origin and destination. Migration was thought to transfer surplus labour from sub-productive rural areas to centres of economic growth where it would be used more effectively. Migration would lead to more labour shortage and – so they thought – higher wages in source areas. Return migrants would become ‘agents of change’ in their home societies. In the 1970s and 1980s structural-historical and dependencia scholars drew much more negative conclusions. In their view, migration contributed to underdevelopment in migrants’ marginalized home areas by removing vital human resources to the benefit of the capitalist ‘core’ destination areas. Migration, they argued, caused increased inter-regional disparity and dependency, which in turn would lead to more migration. In the 1990s and 2000s, pluralist views dominated, with the perspective shifting to households, risk spreading and the development potential of remittances. This generally resulted in more positive conclusions (de Haas 2010).

A specific branch of research in the migration-development nexus deals with the impact of rural out-migration on agricultural development. Most scholarship in this area focused on the balance between the negative effect of labour loss and the positive effect of the investment of migrant savings and remittances in agriculture (e.g. Cleveland 1991; Rozelle et al. 1999). This balance was often found to be negative (Lipton 1980; Rubenstein 1992), albeit with notable exceptions. For example, a famous case study from the Indian Punjab showed that remittances contributed greatly to agricultural development (Oberai and Singh 1980). More recently, De Haas (2006) found that international migration and remittances played a pervasive role in transforming agriculture in his case study area in Morocco.

Some studies also stress that out-migration from densely populated rural areas reduces the pressure on land, which is commonly judged as being positive (Piore
The assumption behind this ‘safety valve’ argument is essentially Malthusian or Neo-Malthusian. It presupposes that migrant source areas benefit from a reduction in population pressure, leaving more fertile land to farm for those who stay behind. However, in the aftermath of Ester Boserup’s (1965) groundbreaking work on population growth and agricultural change, and especially after the publication of the book “More People Less Erosion” by Tiffen et al. (1994), it is increasingly acknowledged that population growth can provide important incentives for a transition to more sustainable land use and higher yields. In this vein, Mortimore and Adams (2001: 51) speak of a “challenge to the Neo-Malthusian paradigm of population growth, and its effects on agricultural productivity and resource sustainability.”

Studies of transitions to more sustainable land use in the context of population growth usually identify ‘population thresholds’ at which major changes occur. Such thresholds vary per location because population density is not the same as population pressure, and because change may be induced under different conditions (Dietz et al. 2009). Before the threshold is reached, yields tend to decrease with increasing population pressure. This is due to fallow periods becoming shorter and the inadequacy of measures taken to counter the concomitant soil fertility decline. In areas where such conditions exist, land use dynamics are dominated by Malthusian processes. The short-term effect of out-migration in this situation is that it slows down population growth and makes crop yields decline less rapidly. In Malthusian theory, out-migration is one of the population checks that increase the means of subsistence of those who stay behind. When population pressure reaches a critically high point and expansion to new lands is no longer possible, Malthus expected famine, misery and vice. By contrast, Boserup found that a shift in farm technology and/or labour input resulting in higher crop yields is more likely in such conditions. Not surprisingly, a key phrase in Boserupian theory is that ‘necessity is the mother of invention’. If population growth up to a certain threshold indeed causes declining crop yields and if population growth beyond a certain threshold leads to a transition to more intensive land use and higher yields, there would be a U-shaped curve between population density and yields. This U-shape could be called the ‘Malthus-
Boserup curve’ (see figure 6.1). This curve could describe the process of population growth and agricultural change over time for a particular geographic area (longitudinal), but it could also describe different positions of a set of areas at a particular point in time (cross-sectional).

Figure 6.1 The Malthus-Boserup curve between population density and crop yields

Although innovations and agricultural change often occur in a shock-wise manner, changes can also be more gradual. It should be noted that the shift to more intensive land use, or the ‘transition tendency’ as Burger and Zaal (2009) call it, depends on many more factors than population growth alone. Some of the critics of Tiffen et al. (1994) even doubt whether population density is indeed the most important factor in the land use transition (see Dietz et al. 2009 for a discussion of reviews). Prominent other factors are market conditions and the policy environment (Zaal and Oostendorp 2002). Market conditions include access to urban markets and prices of agricultural inputs and outputs, which partly depend on supply and demand on the world market. The policy environment involves government or non-governmental interventions that stimulate or discourage a transition to more intensive land use. Such interventions can be local (e.g. agricultural extension) or at a higher level of geographic scale (e.g. national price policies and laws governing access to land).

Boserupian intensification processes may be thwarted when migration becomes a widely used strategy to reduce the pressure on land and to supplement local farm incomes with remittances. If a region’s agriculture is in crisis, and there is relatively easy access to migration opportunities, the area in question will be in danger of remaining at the bottom of the U-shaped curve between population density and crop yields (see figure 6.1). Rural out-migration has the potential to remove the
incentives for a transition to more sustainable and rewarding land use. This indirect effect of rural out-migration on agricultural development has – to the best of my knowledge – not yet been identified or described in the literature. A likely reason is that its existence is hard to measure or prove. The effect is somehow hypothetical: it requires the researcher to ‘imagine’ what the area would have looked like if no out-migration had taken place and if population density had been much higher than it is in reality. Another complicating factor is that land use intensity is not determined by population density alone. This makes it more difficult to ‘see’ the causalities clearly. As mentioned above, the policy environment and market conditions can play an important role in determining the course of the Malthus-Boserup curve shown in figure 6.1. In addition, other factors like climatic conditions, soil type and terrain may influence the ‘transition tendency’.

The theory that out-migration can remove the incentives for a transition to more intensive land use can only be validated (or falsified) in study areas with long records of population, migration and agricultural statistics. In addition, longitudinal data on market access, climatic conditions, soil dynamics and the policy environment would strengthen the analysis. In the absence of sound time series data, an – admittedly imperfect – way of looking into the hypothetical future is to compare a study region with areas in similar agro-ecological zones that already have higher population densities. In other words, a cross-sectional analysis could be used to see how different population densities and migration rates relate to agricultural productivity.

This paper studies the complex relation between rural out-migration and agricultural development in Northern Ghana. It links the academic debate on migration and development to the debate on population growth and agricultural change (known as the Malthus-Boserup debate). Figure 6.2 shows a simple causal model that links these two debates. The model identifies a direct effect of rural out-migration on agricultural productivity and an indirect effect that is mediated by population density. In this causal model, out-migration is defined as the number of out-migrants as a proportion of the total population. Population density is defined as an area’s total population divided by its surface (inhabitants per square kilometre). When data availability allows, this crude measure could be refined to rural population density or agricultural population density. The cross-sectional analysis presented below uses agricultural population density. Agricultural productivity can involve returns to land (crop yields per hectare) or returns to labour (agricultural output per capita). In this paper, a slightly more complex version of the model, which will be tested for

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4 In more exceptional circumstances, local case-study material can also go a long way to proving the relation between out-migration and land use sustainability. In a study of the Mandara Mountains in Cameroon, for example, an intensive and sustainable farming system under high population density collapsed when large-scale out-migration to the adjacent plains became possible and population densities reduced (de Groot and Zuiderwijk, 2009).
Northern Ghana, examines these two types of productivity separately. What follows is a brief explanation of the causal relations in this theoretical model.

**Figure 6.2** A simple model of migration, population density and agricultural productivity

(a) Out-migration has a negative effect on population density: when people migrate out of an area, population density becomes lower than it would have been had they not migrated. However, natural population change (births – deaths) also influences population density. In areas with massive out-migration population density can still increase albeit at a slower pace.

(b) Changes in population density can have positive or negative effects on agricultural productivity depending on whether Malthusian or Boserupian processes dominate in the area or, in others words, depending on the area’s position in the U-shaped curve between population density and land use intensity. There are separate effects on yields per hectare and cultivated acreage per capita, which together determine agricultural output per capita. Negative effects of increased population density on crop yields are reduced fallows and the need to expand farms to more marginal lands. Positive influences of increased population density on crop yields can be increased labour/capital input, improved technology and greater market integration. In most circumstances, increasing population densities will have a negative effect on the *acreage* cultivated per capita (*farm size*). When population density increases there will, on average, be less land to cultivate for each farmer. However, in areas where Malthusian processes dominate – when population growth causes declining crop yields – subsistence farmers can be forced to increase their farm sizes for mere survival. This is more likely to be the case when there is still enough room for expanding farms and when non-farm income and migration opportunities are limited.

(c) In situations of agricultural decline people are under greater pressure to seek their fortune elsewhere. Conversely, in most circumstances agricultural productivity growth will have a tempering effect on out-migration because it improves living conditions at home. Gray (2009) calls this the ‘environmental-amenity thesis’ that—
in his Ecuadorian case study – was most relevant for internal migration flows. A cross-district analysis of Northern Ghana confirmed that districts with scarcer natural resources and lower crop yields experience more out-migration. Interviews with 203 rural-rural migrants also revealed that scarcity of fertile land was the primary reason to migrate (Van der Geest 2011). In more exceptional cases increased agricultural productivity could lead to more out-migration if it enables farmers to overcome capital constraints that previously made it impossible for them to migrate. Gray (2009) calls this the environmental-capital thesis. This hypothesis is most relevant in the case of international migration and in other situations in which the cost of migration is high (e.g. migration from a remote rural area to a national capital with relatively high cost of living).

(d) The direct effect of rural out-migration on agricultural productivity can be positive or negative. A first positive influence can be that migrants return with new ideas, knowledge and skills that can boost agricultural production. Secondly, migrants’ remittances and savings can be invested in agricultural inputs that have a positive effect on crop yields or farm sizes (e.g. fertilizer, improved seed varieties or bullock ploughs). Thirdly, the removal of labour can contribute to a trend towards more mechanization and higher-yielding cultivation practices. A direct negative effect of out-migration on agriculture is related to the selectivity of migration. People at a productive age tend to migrate more, and this may have a negative effect on agricultural production at home. Moreover, if more enterprising and innovative people are more likely to migrate, as is usually assumed, this may curb agricultural development. Secondly, a substitution effect may occur when income from remittances reduces the need to invest in more rewarding land use practices. Thirdly, migrants may return with new ideas and knowledge about – and preferences for – non-farm activities that may reduce their involvement in agriculture. In the long term, this effect can be positive if it creates an internal market for farm produce, which can provide a price incentive for agricultural intensification.

In practice, the direct and indirect effects of migration on agriculture are likely to interact. In an early phase, when migration reduces the pressure on land, it may also reduce the need for a transition to more intensive land use. However, if migrants return in a situation of increased pressure they might become the pioneers of agricultural change. This depends on the skills they learned in the migration process, the level of savings they were able to make and the viability of investment in agriculture vis-à-vis other income generating activities. This again depends on the context of market conditions and the policy environment.

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5 A Kenyan case study shows that investments in terracing to counter soil erosion were most often made by farmers who had recently bought a plot of land (Oostendorp and Zaal 2009). In a similar way, migrants could use the ‘momentum’ of their return to do things in a radically different way.
A long-standing problem in migration and development studies is how to isolate different directions of causality (de Haan et al. 2000; de Haas 2009). The same is true of the relation between migration and agricultural development. When a correlation exists, for example when households, villages or regions that experience more out-migration have lower levels of agricultural productivity, we do not know whether low productivity is an effect or a cause of out-migration or both. Similarly, in the absence of correlation between out-migration and agricultural development, there can be causal effects that work in opposite directions and therefore nullify each other. For example, when out-migration has a positive effect on agricultural productivity, this effect can be rendered invisible when agricultural development reduces out-migration rates. When the effect is negative in both directions, a dynamic of cumulative causation (a vicious circle) evolves to the detriment of the home area of migrants. Different directions of causality exercise their influence simultaneously. However, so far academics have not been able to separate such effects in a satisfactory way. Human geographers, anthropologists and development scholars tend to ignore this problem and simply focus on the effect they are interested in. At most, they acknowledge that correlations found do not imply causality in a certain direction. Economists and econometricians usually try to tackle the causality problem with statistical methods that are often incomprehensible to other academics. They mostly fail to translate their findings in a satisfactory way.

This paper does not pretend to solve the causality problem in migration and development studies. However, it does try to deal with the causality dilemma in a particular geographic setup. An important step in the procedure is to recognize the importance of population density as an intervening variable and to understand that some of the mixed findings in migration and (rural) development studies are the same as those found in studies focusing on the impact of population growth on agricultural productivity. The central thesis of this paper is that one has to know where a region is situated in the transition to more intensive land use (the Malthus-Boserup curve, see figure 6.1) to be able to assess the impact of out-migration on agricultural development.

**Methods and outline**

To study the relation between population density, migration and agricultural development in Northern Ghana, demographic and agricultural production data for the twenty-four districts in Northern Ghana was retrieved from population censuses and the Ministry of Food and Agriculture. Additional information on rainfall, soils and vegetation in Northern Ghana was retrieved from rainfall gauges, soil maps and remote sensing. The cross-district analysis presented below focuses primarily on the relation between agricultural population density, out-migration and three measures of agricultural productivity: acreage per capita, yield per hectare and output per...
capita. Agricultural population density was calculated as the crude population density (inhabitants per km$^2$) at the time of last population census in 2000 multiplied by the proportion of the economically active population engaged in agriculture.$^6$ The agricultural production data are calculated over a five-year period before and after the census year (1998-2002) to reduce the influence of idiosyncrasies caused by good and bad rainfall years. Acreage and output per capita involve the total production of eight crops: maize, millet, sorghum, groundnuts, cowpea, rice, yam and cassava. Crop yields are weighed for acreage and are expressed in caloric terms instead of weight because yam and cassava yields are much bulkier, but with lower energy values per unit weight.$^7$ Out-migration rates are expressed as the people who migrated out of the district divided by the total district population. The Ghana Population and Housing Census provides data on out-migration at regional level, but not at district level. Therefore, district out-migration rates were estimated as a function$^8$ of population aged over sixty-five, sex ratio of the population aged 15-64 and population growth between 1970 and 2000. These variables explain 92.1 percent of the variation in out-migration rates at regional level.

This paper is organized as follows. Section two provides a descriptive and spatial analysis of population dynamics and agricultural productivity in Northern Ghana. Special attention is paid to rainfall, soil characteristics and population distribution in Northern Ghana. A cross-district analysis of migration, population density and agricultural productivity in Northern Ghana is presented in section three.$^9$ Due to the nature of the data, the cross-district analysis examines outcomes rather than the mechanisms through which migration can have positive and negative effects on agriculture.$^{10}$ Section four is the conclusion.

**Northern Ghana**

Ghana is situated on the West Coast of Africa. The study area in the North of Ghana has a savannah ecology and is located on the Southern fringes of the semi-arid Sahel. Northern Ghana is divided into three administrative regions: the Northern Region, the Upper West Region and the Upper East Region. At national level, Ghana has been faring quite well in terms of economic growth and poverty

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$^6$ The average proportion of the economically active population engaged in agriculture in Northern Ghana is 70.8 percent. The range for all districts except the predominantly urban Tamale Municipal Area is 50.6 percent to 87.7 percent. The proportion for Tamale is 29.1 percent.

$^7$ Conversion factors: Sorghum: 3,430 kcal/kg; millet: 3,400 kcal/kg; maize: 3,560 kcal/kg; rice: 3,360 kcal/kg; groundnuts: 4,140 kcal/kg; cowpea: 3,420 kcal/kg; yam: 1,010 kcal/kg; cassava: 1,090 kcal/kg (source: FAO 2010).

$^8$ Out-migration rate (%) = 80.48 - 0.073 * population growth 1970-2000 (%) - 0.643 * sex ratio (15-64) + 1.528 * proportion elderly (65+)(%). The estimation procedure is elaborated in the Appendix.

$^9$ See Van der Geest et al. (2010) for a more detailed description of migration data in the Ghana population census.

$^{10}$ These mechanisms are studied in more detail in the next chapter.
reduction. However, the North of Ghana is lagging behind and the gap with the South is widening. Nationally, the proportion of people living below the poverty line dropped from 51.7 to 28.5 percent between 1991 and 2006 (Ghana Statistical Service, 2007). In the rural savannah, poverty rates decreased at a much slower pace, from 73.0 to 60.1 percent. Within Northern Ghana, the Upper West Region had the highest incidence of poverty (87.9 percent), followed by the Upper East (70.4 percent) and the Northern Region (52.3 percent).

Map 6.1 shows four thematic maps of Northern Ghana depicting population density, crop yield, out-migration rates and population growth at district level at the time of the last population census (2000). The scatter plot in map 6.1 indicates that the U-shaped Malthus-Boserup curve between population density and crop yields, discussed in the introduction to this paper, is discernible in Northern Ghana. Crop yields decrease with increasing agricultural population density up to about seventy-five inhabitants per square kilometre. For crude population density the ‘threshold’

Map 6.1 Population density and growth, crop yields and out-migration in Northern Ghana

Sources: Ghana Statistical Services (2005b); Central Bureau of Statistics (1984); Ministry of Food and Agriculture.
lies at just over one hundred. When population densities surpass this threshold, crop yields no longer decline. Only four districts in Northern Ghana have agricultural population densities of more than seventy-five inhabitants per square kilometre. In these districts, crop yields are higher than one could expect if there were a linear – Malthusian – relation between population density and agricultural productivity.¹¹

To understand contemporary migration patterns in Northern Ghana, it is important to know a bit more about the region’s settlement history, population distribution, rainfall pattern and soils. Northern Ghana is situated in the Guinea Savannah and has one rainy season, lasting approximately from May to October. The long-term average annual amount of rainfall for Northern Ghana is approximately 1000 millimetres, and increases from North to Southeast (see map 6.2). As was shown in map 6.1, the larger part of Northern Ghana is sparsely populated with some pockets of higher population density in the Northeast, Northwest and around Tamale. The population distribution in Northern Ghana has been labelled ‘anomalous’ (Holden 1965, Wardell et al. 2003) because climatic conditions for agriculture deteriorate towards the North (see map 6.2) despite this area being the most densely populated. Most sources link this particular population distribution pattern to the history of slave trade. In this view, the sparsely populated areas were depopulated because of slave raids and the densely populated areas were safe havens for acephalous groups that tried to escape these raids. Other densely populated areas were home to more centrally organized groups that engaged in slave raiding and trading. The sparsely populated area in the South of the present Northern Region is thought to have been a buffer zone between the savannah empires in the North and the forest empires in the South, which have been at war for long episodes of the region’s history (Varley and White 1958; Hart 1982; Der 1998). Although the history of the slave trade and the wars between the Ashanti and Northern kingdoms have undoubtedly left their mark, a very important additional explanation is that the densely populated areas were simply the areas with the most suitable soils (see map 6.2). The population distribution in Northern Ghana is less anomalous if one takes account of the fact that, in the centuries preceding colonial rule and before the introduction of cassava, the main food crops of the area were millet, guinea corn and groundnuts. Rainfall conditions in the present Upper Regions were very suitable for the cultivation of these crops and soil quality was the critical factor.

¹¹ An objective way to test whether the relation between two scale variables is non-linear is to compare the F-value of a linear regression with – in the case of a U-shape – the F-value of a quadratic regression. If the F-value is higher for the quadratic regression, this means that the relation is not linear. The linear regression produces an F-value of 2.593 (p = 0.122). The quadratic regression yields an F-value of 3.468 (p = 0.050). This indicates that the U-shaped Malthus-Boserup curve indeed produces a better fit than a negative (Malthusian) line. If West Mamprusi District (outlier with low population density and low yields) is excluded from the regression, the relation becomes much stronger and significant (R square = 0.408, p = 0.005).
Map 6.2  Rainfall, soils and rain use efficiency in Northern Ghana

There is no sound data on current soil fertility and land degradation in Northern Ghana. In the 1960s and 1970s some extensive soil surveys were carried out by Ghana’s Soil Research Institute in collaboration with the UN Food and Agricultural Organization (FAO). The results were published in maps by Ghana’s Survey Department. A digitized and simplified version, dating from 1971, is shown in map 6.2 and is contrasted with a soil quality proxy map based on more recent data.

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12 FAO’s National Soil Degradation Maps of Ghana, based on the GLASOD Survey that was carried out in the 1980s, provides insufficient geographic detail.

13 The original map distinguished – within the three categories mentioned in the simplified map – the principle limitations of the soils (shallowness, texture, erosion and wetness). The unclassified areas are rivers and adjacent alluvial soils. These soils have agricultural potential, but are traditionally under-utilized because of infestation with vector diseases. With the eradication of some of these diseases, this is gradually changing (McMillan et al. 1998).
vegetation and rainfall data (1982-2002).\textsuperscript{14} The soil proxy map uses the so-called ‘rain-use efficiency index’ as proposed by Prince \textit{et al.} (1998). The Normalized Difference Vegetation Index (NDVI) measures the greenness of the environment which is, to a large extent, determined by rainfall conditions. Areas that receive more rainfall tend to be greener than areas that receive less rainfall.\textsuperscript{15} The variation in NDVI that is not explained by rainfall can, to a large extent, be attributed to differences in soil quality. With equal amounts of rainfall, areas with good soils are likely to have more green cover than areas with less fertile soils. Other factors that influence vegetation cover are mostly related to human activities.\textsuperscript{16} Map 6.2 shows the residuals from a linear regression predicting average vegetation cover (NDVI) with average annual rainfall amounts for the 1982-2002 period. Areas with positive residues (dark shaded) have higher rain use efficiencies, or in other words, NDVI values are higher than could be expected on the basis of rainfall amounts. Such areas have more fertile soils and/or less human disturbance. Less human disturbance can be a result of low population density, environmentally more sustainable land use systems or the presence of nature reserves.\textsuperscript{17}

The most densely populated areas in the Northeast, the Northwest and around Tamale are located in areas that used to have relatively good soils.\textsuperscript{18} Nowadays, however, the quality of these soils seems to have declined considerably.\textsuperscript{19} In the sparsely populated Southern districts of Northern Ghana present rain use efficiency largely correlates with the old map of soil suitability. The areas with good soils in the Southwest have more positive NDVI/rain residuals (rain use efficiency) than the areas with poorer soils in the Southeast. In the Northern Districts, and around Tamale, the situation is reverse. Areas which had good soils originally are densely settled and continuous farming over many decades seems to have caused a substantial decline in soil fertility. More recently, however, the most densely populated areas (in the Northeast) have experienced a very positive trend in rain use efficiency. This area has become greener despite a slightly negative rainfall trend

\textsuperscript{14} The source for the vegetation data is the Normalized Difference Vegetation Index (NDVI) of the Global Inventory Modelling and Mapping Studies (GIMMS) group (Tucker \textit{et al.}, 2005). The rainfall data was derived from the CRU TS 2.1 dataset of the Climate Research Unit of the University of East Anglia (http://www.cru.uea.ac.uk).

\textsuperscript{15} In a cross-sectional analysis of 153 quarter degree cells the correlation (R) between average annual rainfall (1982-2002) and average annual NDVI (1982-2002) is 0.653 (p<0.001).

\textsuperscript{16} Adding population density as an explaining variable to the linear regression of vegetation cover and rainfall increases the correlation (R) from 0.653 to 0.753 (p<0.001).

\textsuperscript{17} The boundaries of nature reserves, taken from Nabila (2001), are indicated with white polygons in map 6.2c.

\textsuperscript{18} The correlation (R) between rural population density and soil suitability at district level is 0.643 (p<0.01). To determine soil suitability at district level, a GIS analysis was conducted to calculate the proportions of the district surfaces covered with each soil suitability class. Weights of 1, 2 and 3 were assigned to the three categories in ascending order of soil suitability.

\textsuperscript{19} The correlation (R) between population density and rain use efficiency at district level is -0.410 (p<0.05).
(Van der Geest et al. 2010). This could be an indication of a U-shape relation between population density and the environmental sustainability of land use.

Historic sources describe the sparsely populated districts in the Northern Region as very unattractive places. In his ‘Geography of Ghana’, Boateng (1966: 60) writes that these areas have “… the poorest soils in Ghana. (..) They tend to get water-logged during the rains and to dry out during the long dry season.” Earlier, Cardinall (1931)\textsuperscript{20} wrote that these areas were “to all intents and purposes uninhabitable” because of the poor soils and lack of access to groundwater. In recent decades, the sparsely populated districts in the Northern Region seem to have become more attractive. They experience substantial population growth (see map 6.1), partly because of in-migration from the Upper Regions. Crop yields are higher there nowadays than in the old settlement areas further North. A possible explanation for this trend could be that parts of this area are quite suitable for cassava production, which soared in the 1990s (FAO-STAT 2010).

A recent study of the relation between out-migration and natural resources scarcity in Northern Ghana showed that districts which are poorly endowed in terms of rainfall, vegetation cover and crop yields experience more out-migration (Van der Geest 2011). A similar analysis can be conducted for the relation between migration and soil suitability after calculating the proportion of district surfaces within each soil category. This analysis yields a positive correlation coefficient of 0.554 (p = 0.006). Areas that (used to) have more suitable soils for agriculture experience more out-migration than areas that used to have less suitable soils. This finding is paradoxical or at least counter-intuitive. The explanation is that areas which used to have good soils are now densely populated, resulting in increased pressure on land with inadequate measures to maintain soil fertility. This has resulted in more out-migration. An analysis of the relation between out-migration and the more current soil quality proxy, based on rain use efficiency (map 6.2), yielded no significant correlation (R = -0.157, p = 0.475).

The more densely populated areas that existed at the turn of the 20\textsuperscript{th} century when Northern Ghana was colonized by the British later became the prime source areas of migrants who were recruited – by force – to work in the mines and infrastructural projects in Southern Ghana. Pressure on farmlands and reduced fallows may already have played a role, but it is more likely that the colonial officers simply preferred to concentrate recruitment in these areas because the concentration of people made it easier and cheaper to recruit. In the course of the 20\textsuperscript{th} century population density increased and the North-South migration system matured. Forced labour recruitment stopped in the mid 1920s, but by that time a culture of migration had evolved and people now migrated voluntarily (Lentz 2006), especially from the more densely populated areas. Mobility remained a young adult male affair for some decades, but

\textsuperscript{20} In Hilton (1960: 25).
gradually it also became more common for women and entire households to migrate. Population density in Northeast and Northwest Ghana increased much more slowly than in the rest of the country because of large-scale out-migration.

Cross-district analysis of migration and agricultural productivity

*Causal model*
In the introduction to this paper, a simple causal model of out-migration, population density and agricultural productivity was presented. In this section, a slightly more complex version of this causal model (figure 6.3) is used to analyze the complex relation between migration and agricultural productivity in Northern Ghana, and to explore the intervening role of population density. The main addition in this second model is that the variable ‘agricultural productivity’ is made more explicit. A distinction is made between returns to land (yield per hectare) and returns to labour (production per capita). Agricultural production per capita is a function of cultivated acreage per capita and crop yield per hectare. This elaboration of the causal model enables an analysis of the differential effect of out-migration on agricultural intensification (higher yield per hectare) and extensification (higher acreage per capita). Strictly speaking, the causal model describes processes over time. However, in the absence of longitudinal data with a long-enough time span, it is tested in a cross-sectional analysis of 24 districts in Northern Ghana. Population densities vary widely within the North of Ghana, from less than ten to over a hundred inhabitants per square kilometre. These districts are in different stages of land use intensity, as was also illustrated by the U-shape in map 6.1.

The solid lines in figure 6.3 are causal or logical relations that do not necessarily need to coincide with statistical correlations. Arrow (a) for example, indicates that out-migration – logically – has a negative effect on population density. The correlation between out-migration and population density does not need to be negative, however. This is because the opposite effect can be positive and stronger, i.e. when population pressure is an important cause of out-migration. In such a situation densely populated areas tend to experience more out-migration than sparsely populated areas (spatial relation) and increasing population pressure will cause more out-migration (temporal relation). It is important to realize, however, that out-migration does not increase because of increasing population density per se, but because increasing population density may have a negative effect on agricultural livelihoods. When increasing population pressure has a negative (Malthusian) effect on agricultural productivity and when agricultural decline pushes people to migrate, the correlation between population density and out-migration rates will be positive.
Figure 6.3 A causal model of migration, population density and agricultural productivity

Notes: Explanation of the relations in the causal model (see introduction for more detail): letters (a-d) refer to causal or 'logical' relations and digits (1-3) refer to academic debates. (a) If people migrate out of an area, population density becomes lower than it would have been had they not migrated. (b) When population density increases, on average there will be less land to cultivate for each farmer. (c) Farm size and yield levels together determine the output per capita. (d) If productivity decreases, people are 'pushed' more to migrate. (1) The Malthusians/Boserup debate about the impact of increased population density on agricultural productivity. (2/3) The debate about the direct effect of out-migration on agricultural development.

The dotted lines in figure 6.3 represent relations between variables which are disputed in the academic literature, and which are time and space specific. The crucial relation in this causal model is arrow (1) representing the Malthus-Boserup debate. In conventional studies of the relation between migration and agricultural development, the focus is on arrow (2) and (3) representing the direct effects of migration on farm sizes and yields. By contrast, this paper also acknowledges the indirect effect of out-migration that runs through population density. When arrow (1) is negative, i.e. when Malthusian processes dominate, the indirect effect of out-migration on crop yields is positive, at least in the short to medium term, because it relieves the pressure on farmland. In the long run, the effect can be negative when out-migration removes the incentives for a transition to more sustainable land use. This effect is most relevant for areas that are at the bottom of the Malthus-Boserup curve. When arrow (1) is positive, i.e. when Boserupian processes dominate, the indirect effect of out-migration on crop yields is negative because it curbs the transition to more intensive land use and higher returns to land.
The causal framework shown in figure 6.3 is a closed model. In reality, however, all variables in the model can be influenced by a large variety of external factors like, for example, market conditions, the policy environment, climate change and developments in the non-farm economy, both in the source and destination areas of migrants. In addition, the direct and indirect effects of out-migration on agricultural development interact. For example, in a region where Boserupian processes dominate, remittances are more likely to be invested in agricultural production than in a region where Malthusian processes dominate. Moreover, if the land use transition is capital-intensive, the negative ‘loss of labour effect’ of out-migration will be less detrimental than when the transition is labour-intensive.

Results
In Northern Ghana a negative spatial correlation exists between out-migration and crop yields. Districts with more out-migration tend to have lower crop yields than districts with less out-migration (see also Van der Geest 2011). The question is: what is the direction of causality? Does out-migration have a negative effect on crop yields or is low agricultural productivity a major cause for people to migrate? Or does the causality work in both directions? And what is the relation between out-migration and per capita farm size, the variable that together with yield per hectare determines per capita food production?

Table 6.1 shows the statistical relations between out-migration, population density, cultivated acreage per capita, crop yields and output per capita in Northern Ghana. Instead of using the crude population measure, population density is expressed as districts’ agricultural population per square kilometre. The table shows the correlations between (agricultural) population density and out-migration on the one hand, and the agricultural production variables on the other. The correlations between population density, crop yield and output per capita are moderately negative, and insignificant because the most densely populated districts show an upward turn in crop yields. The bivariate correlations between out-migration and the agricultural productivity indicators are a bit stronger, but also insignificant at the \( p < 0.05 \) level. Crop yields tend to be lower in districts with more out-migration, but the acreage under cultivation tends to be higher, resulting in a weakly positive correlation between out-migration and output per capita. It seems surprising that the correlation between out-migration and agricultural output per capita is positive (but not significant). One would expect low food security to be an important stimulus of migration (Gray’s environmental amenity thesis, discussed in the introduction). As we will see below, this effect does indeed exist, but is countered by an opposite

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21 \( R = -0.396, p = 0.062 \) when expressed in caloric terms (see table 1). The correlation is stronger and significant \( (R = -0.517, p = 0.012) \) when yield is expressed in monetary terms. If outlier West Mamprusi (see figure 4) is excluded from the analysis, the relation between agricultural population density and crop yield is also stronger and significant \( (R = 0.500, p = 0.029) \).
tendency, namely the positive effect of out-migration on farm sizes and per capita production.

Table 6.1 (first row) also shows that the relation between out-migration and population density in Northern Ghana is positive, but not significant (R = 0.397, p = 0.062). The correlation would have been much stronger (R = 0.741, p = 0.000) had there not been an ‘Upper West effect’. In this region out-migration rates are much higher than one might expect on the basis of some indicators of resource scarcity. Van der Geest (2011) provides some cultural-historical explanations for this phenomenon.

\textit{Table 6.1} Out-migration, population density and agricultural productivity (N=23)

<table>
<thead>
<tr>
<th>Correlations (R)</th>
<th>Agricultural population density</th>
<th>Out-migration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural population density</td>
<td>...</td>
<td>+0.397 (0.061)</td>
</tr>
<tr>
<td>Acreage/capita</td>
<td>-0.163 (0.457)</td>
<td>+0.411 (0.051)</td>
</tr>
<tr>
<td>Yield/ha</td>
<td>-0.336 (0.117)</td>
<td>-0.396 (0.062)</td>
</tr>
<tr>
<td>Output/capita</td>
<td>-0.304 (0.158)</td>
<td>+0.233 (0.284)</td>
</tr>
</tbody>
</table>

Notes: (1) For each correlation p-values are stated between parentheses. (2) The ‘per capita’ agricultural production measures (acreage and output) are calculated as ‘per agricultural capita’ (e.g. acreage per capita = total cultivated acreage / agricultural population). One district (Tamale Metropolitan Area) has been excluded from the analysis because it is predominantly urban and only a minority of the population are engaged in farming.

As was shown in map 6.1, the relation between agricultural population density and crop yields in Northern Ghana is negative (Malthusian) up to about seventy-five inhabitants per square kilometre. For crude population density the ‘threshold’ lies at just over one hundred. Districts with higher population densities show an upward turn in crop yields, marking the start of a U-shape move towards more intensive land use (Boserupian processes). The relation between population density and crop yields is not linear and this makes the correlation analysis presented in table 6.1 less compelling. Arrow (1) in the causal model is predominantly negative (Malthusian) for Northern Ghana, but the Boserupian dynamics in the most densely populated districts obscure some of the relations. When districts with more than seventy-five agricultural inhabitants per square kilometre are excluded from the analysis (see table 6.2), i.e. when the analysis is limited to districts that are in the first half of the Malthus-Boserup curve, the relations become clearer. For ease of interpretation, the relations are shown graphically in scatter plots (figure 6.4). The first seven plots show the bivariate relations and the last three plots show the partial relation after controlling for population density.
Table 6.2  Out-migration, population density and agricultural productivity, subset of districts in the first half of the Malthus-Boserup curve (N=20)

<table>
<thead>
<tr>
<th>Correlations (R)</th>
<th>Agricultural population density</th>
<th>Out-migration</th>
<th>Out-migration after controlling for the effect of agricultural population density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agric pop dens</td>
<td>+0.483 (0.031)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acreage/capita</td>
<td>-0.107 (0.654)</td>
<td>+0.465 (0.039)*</td>
<td>+0.593 (0.007)**</td>
</tr>
<tr>
<td>Yield/ha</td>
<td>-0.541* (0.014)</td>
<td>-0.412 (0.071)</td>
<td>-0.205 (0.401)</td>
</tr>
<tr>
<td>Output/capita</td>
<td>-0.326 (0.160)</td>
<td>+0.282 (0.229)</td>
<td>+0.531 (0.019)*</td>
</tr>
</tbody>
</table>

Notes: see table 6.1. The excluded districts are Tamale, Bolgatanga, Bawku East and Bongo.

As could be expected, excluding the most densely populated districts in Northern Ghana results in a substantially stronger and significant correlation between population density and crop yields (R = -0.541, p = 0.014). The correlation between population density and out-migration also becomes stronger and significant (R = 0.483, p = 0.031). In this sub-set of districts, sparsely populated districts tend to have higher yields and lower out-migration rates than the more densely populated ones. Another correlation that becomes stronger and significant after excluding the most densely populated districts is that between out-migration and farm sizes (R = 0.465, p = 0.039).

Based on the causal model in figure 6.3 and the bivariate correlations between migration, population density and agricultural productivity (column 2 and 3 of table 6.2), the following hypotheses can be formulated for districts in Northern Ghana that are situated in the first half of the Malthus-Boserup curve:

1. The negative relation between out-migration and crop yields is due to the intervening effect of population density.
2. Out-migration has a positive effect on output per capita, but this effect is obscured because of the negative effect of population density.

A way to test these hypotheses is to calculate the partial correlations between out-migration and agricultural productivity (yields and output per capita), controlling for the effect of population density. The results are shown in the last column of table 6.2 and the last three graphs in figure 6.4. To start with the first hypothesis, it

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22 The partial correlations were calculated as follows. First, four linear regressions were conducted in which agricultural population density was the independent variable, and migration, acreage, yield and output were the dependent variables. The non-standardized residues from these regressions were saved. After that, the residues from the linear regression predicting out-migration were related to the residues of the linear regressions predicting the three agricultural productivity indicators.
appears that only part of the negative relation between out-migration and crop yields can be attributed to the negative effect of population density. After controlling for population density, the correlation between out-migration and crop yields is still negative, but weaker (R = -0.205, p = 0.401). This does not confirm the hypothesis formulated above but rather indicates that out-migration does have a slightly negative effect on crop yields. However, there is another important intervening variable, namely rainfall. Districts that received more rainfall in the study years (1998-2002) also had higher yields (R = 0.645, p = 0.005). As described in the section on the ‘anomalous’ population distribution in Northern Ghana, the densely populated areas are located in the least humid areas. The relation between (agricultural) population density and rainfall is negative and quite strong (R = -0.683, p = 0.000) and so is the correlation between rainfall (1998-2002) and out-migration (R = -0.688, p = 0.000). A partial correlation between migration and crop yields, controlling for the effect of population density and rainfall (R = 0.139, p = 0.583) indeed shows that the negative relation between migration and crop yields can entirely be explained by population density and rainfall. Crop yields are not lower in districts with more out-migration because of out-migration, but because such districts have lower rainfall and higher population density. Low crop yields are a cause, not a consequence of out-migration.

To test the second hypothesis, a partial correlation analysis of migration and output per capita is conducted, controlling for the negative effect of population density. The analysis shows that the relation between out-migration and output per capita is positive and fairly strong (R = 0.531, p = 0.019) when the influence of population density is controlled for. This is an indication that districts in which Malthusian processes dominate benefit from out-migration in terms of food security. An analysis of people’s perceptions of the consequences of out-migration in Lawra District in the Upper West Region yielded exactly this finding (Van der Geest 2010a). As we saw above, out-migration does not seem to have an effect on crop yields. The positive effect of out-migration on production per capita is entirely due to its effect on the acreage cultivated per capita (R= 0.593, p = 0.007). Given a certain population density, out-migration leaves more land to farm for those who stay and, possibly, there are some autonomous effects of migration that have a stimulating effect on farm size.

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23 It could be argued that the procedure followed (with partial correlations) first gives all the explanatory power to rainfall and agricultural population density before looking at the effect of migration. Therefore a linear regression of crop yields with agricultural population density, rainfall and out-migration as dependent variables was also conducted. The contribution of out-migration was virtually zero (t = -0.001, p = 0.999).
Figure 6.4  Migration, population density and agricultural productivity in N-Ghana

Notes: APD = agricultural population density; MIG = Out-migration rate; grey circle = Lawra District. The scatter plots show the twenty districts with fewer than 75 agricultural inhabitants per km$^2$. 
When the cross-sectional analysis is reduced to a subset of districts with fewer than seventy-five inhabitants per square kilometre, i.e. districts in which Malthusian processes dominate, more cogent statements can be made with regard to the directions of causality. Figure 6.5 summarizes the findings of the cross-sectional analysis. Despite a negative relation between out-migration and crop yields, out-migration does not have a negative effect on crop yields. Rather, the causality runs in the opposite direction: low crop yields are an important cause of out-migration. As noted earlier, the correlation between out-migration and agricultural output per capita is – somehow surprisingly – weakly positive. This finding is surprising because one might expect the pressure to migrate to be higher in districts with lower food security. The present analysis suggests that this effect does indeed exist, but is countered by an opposite and stronger effect, namely the positive effect of out-migration on output per capita. However, it also seems that low crop yields are a stronger determinant of out-migration than low output per capita. This could mean that, as far as most Northern Ghanaians are concerned, out-migration is not a ‘last resort’ to attain food security when all other options have failed. For most migrants from Northern Ghana, the move to Southern Ghana seems to be pro-active rather than forced. When crop yields decline and more labour has to be invested to achieve the same harvest from a larger portion of land, the migration option becomes more attractive.

Figure 6.5  Summary of findings for districts in the first half of the Malthus-Boserup curve
Evaluation of the causal model

The cross-district analysis, based on the causal model in figure 6.3, has shown that agricultural population density is an important intervening variable in the relationship between migration and agricultural productivity. The academic debate about the effects of out-migration on agricultural development in migrants’ source areas can benefit from cross-fertilization with the Malthus-Boserup debate. By combining the two debates, it becomes possible to disentangle some of the causality problems that are common in studies of migration and agricultural development. In the case of Northern Ghana, Malthusian processes seem to dominate, but Boserupian tendencies are present as well. This required a separate analysis for the twenty districts with fewer than seventy-five agricultural inhabitants per square kilometre, i.e. districts that are positioned in the first half of the Malthus-Boserup curve. The more densely populated of these districts tend to have lower crop yields and more out-migration. After controlling for population density and rainfall, no effect of out-migration on crop yields was found, and this indicates that low crop yields are a cause and not a consequence of migration. The effect of out-migration on agricultural output per capita is positive because of the positive effect on farm sizes. Out-migration in these districts is associated with agricultural extensification rather than intensification. If more districts in Northern Ghana were on the Boserupian side of the Malthus-Boserup curve, it would have been interesting to conduct a similar analysis with a sub-set of densely populated districts.

The logic of the causal model discussed in this paper – and any causal model – is temporal while the analysis has been spatial. No data is available for a longitudinal analysis with a long enough time span to cover the different stages of land use intensity (from shifting cultivation, via bush fallow to permanent cultivation). An alternative would be to conduct a historic analysis of population pressure, migration and agricultural change in an area that has made a clear transition to more intensive land use in the nearby past. Unfortunately, this is not the case for the area discussed in the next chapter (Nandom in the Lawra District). Nandom may be on the eve of such a transition, and there may be villages within the area in which such a transition has already started, but so far it seems that large-scale out-migration and concomitant low population growth have removed the incentives for such a transition.

Conclusion and implication for policy

Studies on out-migration and agricultural development in migrants’ source areas have focused too narrowly on the direct effects of migration. Most research in this area has been conducted in a ‘geographic vacuum’, neglecting the importance of population density as a major determinant of farming systems. This blind spot can
explain some of the mixed findings in the migration and agricultural development literature. Cross-fertilization with the Malthus-Boserup debate could offer an escape from this impasse.

A cross-district analysis of population density and agricultural productivity in Northern Ghana shows that there is a non-linear, U-shaped, relation between agricultural population density and crop yields. This curve could be labelled the Malthus-Boserup curve. In districts with fewer than 75 agricultural inhabitants per square kilometre, Malthusian processes dominate and increasing population density is associated with declining yields. Beyond this population threshold, however, Boserupian processes dominate and crop yields increase. Farmers in these areas have been able to make a successful shift to more intensive land use resulting in higher yields. The Malthus-Boserup curve has important implications for the study of migration and agricultural production.

The curve could be divided into three parts: low population density, medium population density and high population density. In areas that find themselves in the first part of the curve, with low population densities, out-migration rates tend to be low. An effect of out-migration in this stage is that it slows down population growth, making fallow periods and yields reduce less rapidly. A transition to more intensive land use is not yet necessary in this stage and it is unlikely that migrant savings and remittances will be invested in more intensive farm practices. In the second part of the curve, with medium population densities and lower crop yields resulting from reduced fallows and inadequate soil fertility management, out-migration rates are higher and population growth lower. In this stage, the need for a transition to more intensive land use is apparent, but the out-migration option may be more attractive, especially if there are suitable destination areas. An effect of out-migration in this stage is that it may remove the incentives for a land use transition, thereby keeping the area at the bottom of the Malthus-Boserup curve. In this stage, agricultural systems are in crisis and people become more dependent on remittances for survival. The third part of the curve, with high population densities, marks the transition to more intensive land use resulting in higher yields. If migration was driven purely by low crop yields – which it is not – out-migration rates could be expected to reduce during this stage. In reality, they are likely to remain high for some time. In this stage, investments of migrant savings and remittances in agriculture are more viable. An important question is: under what conditions were farming systems in the most densely populated areas able to intensify? Migration, remittances and return may play a role, but other factors, such as improved access to markets and a high density of government and NGO projects have probably been more decisive.

The findings from this chapter have important implications for government agencies and non-governmental organisations working in Northern Ghana. The course of the Malthus-Boserup curve depends to a large extent on market conditions,
infrastructure and support to farmers. For districts with medium population densities, which are at the bottom of the Malthus-Boserup curve, policy should focus on lowering the population threshold for a transition to more intensive and environmentally sustainable land use (see figure 6.6). In such areas, the need to intensify cultivation practices is apparent, but intensification requires substantial amounts of human and/or financial capital, and it may take some years before the fruits of increased labour and money input are reaped. In the short term, the out-migration option may seem easier and more rewarding, but out-migration diverts the attention away from livelihood sustainability problems in the long run. Moreover, the potential contribution of migration and remittances to agricultural development does not materialize as long as the conditions for investment of remittances in farming are poor. If agricultural investments become more viable, these areas can move from a position in which they partly depend on remittances for survival to a position in which remittances will be used to bring about more sustainable improvement in livelihoods.

**Figure 6.6  Policy implications**

In recent years, large quantities of oil and gas were found just off the coast of Ghana and exploitation of these resources will start soon. The government would do well to avoid a similar path as nearby Nigeria where the oil boom of the 1970s resulted in agricultural decline, urban bias and uneven development (Watts 1988; Nyatepo-Coo 1994; Berry 2008). A Comparative study of four minerals-dependent countries shows that a focus on small-scale agriculture, as has been common in Indonesia, produces the most sustainable effects on development (Berry 2008). An
important lesson from Berry’s study is that large-scale investment in capital-intensive development in countries with a labour surplus produces undesirable effects. This is the moment for the Ghanaian government and its international partners to create the conditions for viable agricultural livelihoods and poverty reduction in Northern Ghana. The objective should not be to reduce migration, but to enable migrants and their relatives at home to realize the full development potential of migration and remittances in their strategy to attain more sustainable livelihoods. The findings from this study suggest that policies should be tailored to suit the specific needs of areas at different stages of transition to more intensive land use.